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(54) ARM DRIVING DEVICE FOR FLUID LOADING APPARATUS

(71) We, NIIGATA ENGINEERING CO., LTD., a Japanese company of No. 4-1, Kasumigaseki, 1-chome, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a fluid loading apparatus for use in, in particular, loading and unloading fluid from a tanker to an installation on land, and, more particularly, to a driving mechanism for driving the inboard arm and the outboard arm of the apparatus.

It is desired for the fluid loading apparatus to make the swing ranges of an inboard arm thereof with respect to a stand pipe, to the top of which one end of the inboard arm is rotatably connected and of an outboard arm thereof with respect to the inboard arm, to the outer end of which one end of the outboard arm is rotatably connected, as wide as 180°, respectively.

As a typical driving device for the fluid loading apparatus, which satisfy the above mentioned requirement, there are two systems, in one of which the inboard arm is rotated with respect to the stand pipe by pulling a looped wire rope or chain by means of a hydraulic motor provided in the loop and in the other of which the inboard arm is rotated with respect to the stand pipe by a hydraulic cylinder which drives the inboard arm directly. In these typical conventional systems, however, the maintenance of the wire rope or chains in the first system is very difficult because the fluid loading apparatus must be installed in a salty atmosphere on shore and there is a need of frequently providing a rust-resisting lubricant thereto. Furthermore, due to the elastic elongation of the wire rope, time lags may be introduced in starting and stopping rotations of the arms, resulting in

some difficulty in operation. Although the second system has no disadvantages inherent to the first system, the swing angle can not in practice be widened up to 180°.

Describing the conventional apparatus of these types in more detail, an example of the firstly mentioned conventional fluid loading apparatus is shown in Fig. 1.

In Fig. 1, a stand pipe 10 having a lower end connected to a pipeline providing a fluid passage to a suitable reservoir on land or settled on a firm base structure such as a seaberth or pier is provided. An upper end of the stand pipe 10 is connected to an inner end of an inboard arm 14 by a hollow three-dimensionally rotatable joint 12. To an outer end of the inboard arm 14, an inner end of an outboard arm 18 is connected by a hollow rotary joint 16 which arm is rotatable in a vertical plane. A hollow, three-dimensionally rotatable joint 20 is connected to an outer end of the outboard arm 18. The inboard arm 14 has an extension member 22 which extends from the inner end thereof and acts, together with a counterweight 24, as a balance arm. The hollow rotatable joints 12, 16 and 20 allow the fluid loading apparatus to provide for a three-dimensional movement of a manifold flange (not shown) provided on a tanker, which is connected to an outer end of the rotatable joint 20, relative to the land. A pair of wheels 26 and 28 are employed, between which a looped wire 30 is stretched. The wheel 26 is fixed to the joint 12 and the wheel 28 is rotatably connected to the inboard arm 14. The wire rope 30 is driven by a hydraulic cylinder 32 to thereby swing the inboard arm 14 with respect to the stand pipe 10. As regards the swing between the inboard arm 14 and the outboard arm 18, a pair of wheels 26' and 28', a wire rope 30' and a hydraulic cylinder 32' are used together with another pair of wheels 34 and 36, a wire rope 38 and a counter weight 40. The wheel 26' is

rotatably mounted on the extension 22 of the inboard arm 14 and fixedly connected to the wheel 34 and the weight 40. The wheel 36 is fixed to the inner end of the outboard arm 18 and rotatable with respect to the outer end of the inboard arm 14. The apparatus of this type can provide an inner angle between the inboard arm and the stand pipe up to 180°. However, it is required to supply the rust-resisting lubricant to the wire rope frequently and to check for breaking of filaments of the wire for maintenance thereof. Further, there is a problem that the wire is possibly elongated by the load exerted thereon as mentioned previously, causing the mechanical balance to be broken.

An example of the secondly mentioned conventional apparatus is shown in Figs. 2 and 3, in which a hydraulic cylinder 44 is rotatably secured to an extension of the inboard arm 14 and a top of a piston rod 46 is connected to an arm 42 fixed to the joint 12. An arm lever 50 is fixedly secured to the inner end of the outboard arm 18. An outer balance arm 48 having a counterweight 54 at one end thereof is rotatably secured to the rear end portion of the extension portion 22' of the inboard arm 14 and a free end of the arm lever 50 is connected to the free end of the outer balance arm 48 by a connecting rod 52 so that, when the outboard arm 18 moves with respect to the inboard arm 14, the outer balance arm 48 is moved through the arm lever 50 and the connecting rod 52 to maintain the balance therebetween.

This fluid loading apparatus has an advantage that the maintenance is relatively easy because of the use of the connecting rod instead of the wire rope. However, since the load exerted on the piston rod 46 and/or the connecting rod 52 may be unreasonably increased because the length of the moment arm becomes very short when the angle between the associated members becomes large, a sufficient inner angle (more than approximate 160 degrees) between the inboard arm and the stand pipe and/or the two arms can not be obtained and so the range of operation is relatively narrow. Further, since when the outboard arm 18 is retracted inwardly, a compressive force is exerted on the connecting rod 52, the cross-sectional area of the connecting rod and hence the buckling force thereof must be sufficiently large.

Although this structure provides an advantage in maintenance, the rotation angle of the inboard arm 14, about the center O is practically 120° at most as shown in Fig. 3. In order to achieve a wider rotation range, it is necessary to use a powerful hydraulic pressure cylinder

having a longer stroke. This is not practical.

An object of the present invention is to provide a driving mechanism for a fluid loading apparatus which is not affected by elastic elongation and does not use any wire rope and whereby there can be obtained substantially 180° rotation range between the inboard arm and the outboard arm.

According to the present invention there is provided fluid loading apparatus comprising a hollow inboard arm having one end connected rotatably in three-dimensions to a hollow stand pipe installed on land or other support surface and having an extension member to form an inner balance arm, a hollow outboard arm connected at one end thereof to the other end of said inboard arm rotatable in a vertical plane with respect thereto and having at the other end a three-dimensionally rotatable joint and an outer balance means and an operation means for determining an angle between said inboard arm and said stand pipe, in which said operation means comprises a first hydraulic cylinder rotatably supported by said inboard arm and having a piston rod, and a first V-link comprising a pair of first and second link arms connected rotatably with each other at one end thereof, an end of said piston rod remote from said hydraulic cylinder being rotatably connected to a suitable portion of either of said link arms, the other end of said first link arm being connected rotatably to a suitable portion of said inboard arm and the other end of said second link arm being connected rotatably to said stand pipe.

For the driving of the inboard arm with respect to the stand pipe, the driving mechanism is mounted on an extension member of an inboard arm which is supported rotatably in three dimensions by a stand pipe, with the free end of the first link arm being connected rotatably to the extension member and the free end of the second link arm being connected rotatably to an arm lever fixedly connected to the stand pipe. For the driving of the outboard arm with respect to the inboard arm, the free end of the first link arm is rotatably connected to a counter balance arm and the free end of the second link arm is connected rotatably to a member rotatable with respect to the extension member of the inboard arm. The latter member is mechanically ganged with another member fixedly secured to the outboard arm, so that, upon the actuation of the cylinder, the movable member rotates with respect to the inboard arm and the rotation is transmitted to the other member causing the outboard arm to be rotated about the upper end of the inboard arm.

The invention will now be described by

way of example with reference to the accompanying drawings, in which:

Figs. 1 and 2 illustrate schematically side views of two conventional fluid loading apparatus respectively and a Fig. 3 shows a drive mechanism of Fig. 2 in more detail which apparatus were described already;

Fig. 4 is a side view of an embodiment of the present invention;

Fig. 5 is a plan view of an end portion of the embodiment in Fig. 4;

Fig. 6a—d illustrate the operation of the drive mechanism in Fig. 4;

Fig. 7a—c are explanatory illustrations showing locuses of various points of the embodiment in Fig. 6;

Fig. 8 is a plan view of another embodiment of the present invention;

Fig. 9 is a side view of the embodiment in Fig. 8;

Fig. 10 is an enlarged plan view of the end portion in Fig. 9;

Fig. 11 is a side view of a portion of the embodiment of Fig. 10; and

Fig. 12 illustrates in geometrical terms the operation of the embodiment of Fig. 9.

We return now to Figs. 4 to 7 inclusive which show an embodiment of the present invention. This embodiment utilizes a hydraulic cylinder to control the inner angle between the inboard arm and the stand pipe and between the inboard arm and the outboard arm, respectively.

In Fig. 4 showing a side view of the embodiment, the overall construction thereof is based on the construction of the conventional apparatus such as shown in Fig. 1 of our British Patent Specification No. 1,442,700; the principal elements, i.e., the inboard arm 14, the outboard arm 18, the stand pipe 10, the counterweights 24, 40 and the hollow joints of this embodiment are substantially the same as those shown in Fig. 1 of British Patent Specification No. 1,442,700.

A main feature of this embodiment is that the swing of the inboard arm 14 relative to the stand pipe 10 and the swing of the outboard arm 18 relative to the inboard arm 14 are performed by similar driving mechanisms each comprising a combination of a hydraulic cylinder and V-connected link arms. The cylinder 64 of the driving mechanism A is rotatably secured on an integral member 62 of the inboard arm 14 by a shaft pin 66 and a top of a link 70 whose root end is secured rotatably by a shaft pin 76 to an integral member or torque arm 60 mounted on a hollow rotatable joint 12 and a top of the link 72 whose root end is secured rotatably by a shaft pin 78 to the inboard arm 14 are connected rotatably to a cylinder rod 68 by a shaft pin 74. Fig. 5 is a top view of the driving mechanism A in Fig. 4.

The actual vertical swing of the inboard arm 14 relative to the stand pipe 10 caused by the axial displacement of the cylinder rod 68 of the cylinder 64 of the drive mechanism A is shown in Figs. 6a—6d.

When the piston rod 68 of the cylinder 64 of the mechanism A is gradually extended from the completely retracted state shown in Fig. 6(a), the inboard arm 14 is rotated clockwise relative to the stand pipe 10 and experiences the states shown by Figs. 6b and 6c, in that order. When the rod 68 is completely extended as shown by Fig. 6d, the inboard arm 14 is rotated by 180°. This arrangement may be utilized for rotation less than 180° to reduce the cylinder stroke. This is, of course, the same for the activation of the driving mechanism B.

This link mechanism will be geometrically explained with reference to Fig. 7.

Assuming that the lengths of the links 70 and 72 are L_1 and L_2 respectively, the distance between the rotation center O of the inboard arm relative to the stand pipe 10 and the shaft pin 76 is l , the distance between the center O and the shaft pin 78 is e and the cylinder 64 drives the shaft pin 74, the following phenomena occur.

(1) When $L_1=e$ and $L_2=l$, a rotation angle α of the shaft pin 74 relative to the shaft pin 76 becomes equal to a rotation angle β of the shaft pin 78 relative to the rotation center O, as shown in Fig. 7a;

(2) When $L_1>e$ ($L_2=l$), the relation of the rotation angle becomes $\beta>\alpha$ as shown in Fig. 7b and the rotation is amplified; and

(3) When $L_2>l$ ($L_1=e$), the angle relation becomes $\beta>\alpha$ as shown in Fig. 7c, and the rotation is amplified.

Therefore, in practising the present invention it is desirable to select the distances as $L_1>e$ and/or $L_2>l$.

Although, in Fig. 6, the links 70 and 72 have the same length and the distance between the rotation center O of the inboard arm 14 relative to the stand pipe 10 and the shaft pin 76 is made equal to the distance e between the center O and the pin 78, it may also be possible to select them to have other relations. Further, although in Fig. 4 in the drive mechanism A, the cylinder 64 is mounted on the rotation side i.e., the inboard arm 14 by the shaft pin 66, and in the driving mechanism B, the cylinder 80 is mounted on the stationary side i.e., extension member 22 by the shaft pin 84, it is possible to mount the cylinder 64 on the stationary side i.e., the stand pipe 10 in the driving mechanism A and to mount the cylinder 80 on the rotation side i.e., cam plate 34' in the mechanism B. The

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shaft pins 66, 78, 74 and 76 are generally supported by oil-less bearings respectively to smoothe the movements thereof and facilitate the maintenance thereof.

5 A square cam plate 36' is fixedly secured to the inner end of the outboard arm 18 and another square cam plate 34' is provided in the end portion of the extension member of the inboard arm 14 rotatably about a
10 mounting pin 98, implanted in an inner balance arm, i.e. extension member 22 of the inboard arm. The cam plate 36' is adapted to follow the vertical swing of the outboard arm 18 relative to the inboard arm
15 14.

It should be noted that, in this case, the counterweight 24 is mounted on the inner balance arm 22 so that the attitude thereof in a vertical plane can be regulated and the
20 counterweight 40 is mounted on an outer balance arm 96 and fixed to the cam plate 34'. A connecting link is linked up between the cam plates. The connecting link comprises a plurality of link elements 201,
25 each having a length corresponding to a side length of the cam plate, and a pair of connecting rods 202.

It is possible to constitute the connecting link with two link element portions 201 and connecting rods 202 for connecting the link
30 element portions as shown in Fig. 4. In the same Figure, a turn buckle 200 is provided for regulating the length of the connecting link. The function of the connecting links is to synchronously move the outboard arm
35 18 and the outer balance arm 96 to thereby retain a substantial balance therebetween.

The driving mechanism B for driving the outboard arm 18 with respect to the inboard arm 14 is composed of a hydraulic cylinder 80 similar to the cylinder 64 and a pair of link arms 88 and 90 similar to the link arms 70 and 72. The cylinder 80 is rotatably supported by a member 82 fixedly
40 mounted on the extension member 22. The free end of the link arm 88 is rotatably connected to the member 82 by a shaft pin 94, and the cam plate 34' is connected to the outer balance arm 96 and, together with the latter, rotatably mounted on the extension member 22 by the shaft pin 98.
45 The free end of the link arm 90 is rotatably connected to an end portion of the balance arm remote from the counter weight 40. The other ends of the link arms are jointed together by a pin 92 to which the top of the piston rod 86 is connected. By actuating the cylinder 80, the balance arm is rotated
50 together with the cam plate 34'. The rotation of the cam plate 34' is transmitted through the connecting loop to another cam plate 36' fixedly secured to the inner end of the outboard arm 18.

65 The structure of the cam plates and the connecting link has advantages of simple

construction and high mechanical strength, resulting in an easy maintenance. However, with the scope of the invention many modifications may be easily made on the above structure. For example, it may also be possible to construct it with a structure comprising the conventional sheeve and wire construction or a structure by which the synchronous motion of the outboard arm and the outer balance arm is caused by a connecting rod.

It should be noted in Fig. 4 that although the square cam plates are preferred, other configuration of the cam plates may be utilized. It is also possible to set the cam plate 34' on a horizontal arm of the hollow rotatable joint 12.

Although, in the embodiment shown, the driving mechanism B is disposed in the side of the root end of the inboard arm 14, that is, in the side of the inner balance arm i.e. the extension member 22, the position of the driving mechanism B is not limited by this and it is possible to position it in the side of the top end of the inboard arm 14, and the root end of the outboard arm 18. However, where the mechanism B is provided in the shown position, a total weight of the associated members can act as a part of the counterweight 24 and therefore the reduction of weight 24 is achieved.

Figs. 8 to 12 inclusive shows another embodiment for driving the outboard arm with respect to the inboard arm. Rotatable arms 102 and 104 which are interconnected by a connecting rod 100 are rotatably supported by pins 120 and 106 implanted on the inboard arm 14 at the vicinities of the top end thereof and the end of the extension member thereof, respectively. Rotatably connected between the inboard arm 14 and the connecting rod 100, which is maintained in parallel with the inboard arm 14 by pins 112 and 116 at intermediate locations on the arms 14 and 100 is an auxiliary rotatable arm 114 which is adapted to prevent the sag of the connecting rod 100 due to its own weight and to increase the buckling strength thereof against compressive force. If the length of the connecting rod 100 is relatively short, such auxiliary arm may be omitted. A link arm 124 is rotatably supported at one end thereof by the pin 118 and the other end of the link 124 is rotatably connected to a free end of a lever arm 122 by a pin 126. The lever arm 122 is fixedly secured to the outboard arm 18. The free end of the link 110 is rotatably connected to the rear end of the connecting rod 100 is rotatably connected to one end of the outer balance arm 130 by a shaft pin 128, the balance arm being rotatably secured to the extension member 22 of the

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inboard arm 14 by a shaft pin 107. At the other end of the balance arm 130, a counterweight 132 is provided. The balance mechanism of this type can much improve the angle range between the inboard arm and the outboard arm with respect to the conventional mechanism such as shown in Fig. 2. A drive cylinder 140 is rotatably supported by a support member 142 fixedly secured to the rear of the extension member 22 of the inboard arm 14 and an end of a piston rod 144 thereof is rotatably connected to an intermediate portion of the rotatable arm 104 as shown in Figs. 10 and 11. The function of the rotatably supported cylinder assembly 140, 144 is to rotate the outboard arm 18 with respect to the inboard arm 14.

In operation, when the outer end of rotatable joint 20 is connected to manifold flange (not shown) provided on a tanker, the outboard arm 18 is moved according to the movement of the ship and rotated with respect to the inboard arm 14, the arm lever 122 is also rotated together with the outboard arm 18 causing the link 124 to move. By the movement of the link 124, the connecting rod 100 is moved with respect to the inboard arm 14, so that it causes the outer balance arm 130 to rotate about the pin 107 through the link 110 to maintain the balance. When the outer balance arm 130 is rotated, the outboard arm is balanced. However, as will be clear from Fig. 12, the rotation angle α of the rotatable arm 102 or 104 becomes smaller than the rotation angle β of the lever arm 122 and hence of the outboard arm 18. Therefore, it is possible to enlarge the maximum inner angle between the inboard arm and the outboard arm so that the operation range thereof is widened. In practice, since it is possible to make $\beta=180$ for the inner angle $\alpha=90$ by designing the ratio in length of the link 102 or 104 to the arm 122 or 136 as $L/c=2/1$, the compressive force exerted on the connecting rod 100, when the outboard arm 18 is retracted, does not become large because the length of moment arm does not become too short and therefore, there is no need of making the cross-sectional area thereof large to provide a sufficient mechanical strength and this is advantageous in economy. By the use of oil-less metal for each of the portion around the respective shaft pins the maintenance is facilitated.

The connecting rod 100 and the rotatable arms 102 and 124, etc., may be mounted in lower side of the inboard arm 14 as shown by chain lines in Fig. 9 or it may be possible to mount them in both the upper side and the lower side. Further, although it is preferred to rotatably connect the junctions of links 124 and 102 and of 104 and 110 to

the connecting rod 100 by means of the pins 118 and 105, it may be possible to connect the rod 100 to other portions than the junctions of the rotatable link arms, such as, for example, to suitable portions of extensions of the rotatable arm 124 and 110 or 102 and 104, provided that the inboard arm and the connecting rod are maintained in parallel.

Further, the top end of the cylinder rod 144 may be connected to any position between the pins 105 and 106 of the front link 104, to the pin 105 of the link 104 or to the auxiliary rotatable arm 114.

The embodiment utilizes one drive cylinder driving the inboard arm together with a link mechanism arranged in a V, a connecting rod and the inboard arm. This structure provides many advantages over the conventional driving mechanism using a drive cylinder and a direct drive of the outboard arm as shown in Fig. 1 or 2. That is, the maintenance of the apparatus is facilitated and the rotation range of the outboard arm with respect to the inboard arm can be made large enough, providing a smooth operation thereof.

The fluid loading apparatus according to the present invention is utilized by connecting the stand pipe to a fluid transporting pipe provided in the seaberth and connecting the hollow rotatable joint 20 to the manifold on the tanker as in the conventional manner, the operation thereof is very easy because the driving mechanism for rotating the inboard arm and the outboard arm is constructed with the cylinders and a pair of links so that the rotation angle becomes as much as 180° . Further, since the links do not require frequent provisions of rust-resisting lubricant in comparison with the conventional wire rope or chain, the maintenance is facilitated and it can provide a simple structure having sufficient mechanical strength.

WHAT WE CLAIM IS:—

1. A fluid loading apparatus, comprising a hollow inboard arm having one end connected rotatably in three-dimensions to a hollow stand pipe installed on land or other support surface and having an extension member to form an inner balance arm, a hollow outboard arm connected at one end thereof to the other end of said inboard arm rotatable in a vertical plane with respect thereto and having at the other end a three-dimensionally rotatable joint and an outer balance means and an operation means for determining an angle between said inboard arm and said stand pipe, in which said operation means comprises a first hydraulic cylinder rotatably supported by said inboard arm

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inboard arm 14 by a shaft pin 107. At the other end of the balance arm 130, a counterweight 132 is provided. The balance mechanism of this type can much improve the angle range between the inboard arm and the outboard arm with respect to the conventional mechanism such as shown in Fig. 2. A drive cylinder 140 is rotatably supported by a support member 142 fixedly secured to the rear of the extension member 22 of the inboard arm 14 and an end of a piston rod 144 thereof is rotatably connected to an intermediate portion of the rotatable arm 104 as shown in Figs. 10 and 11. The function of the rotatably supported cylinder assembly 140, 144 is to rotate the outboard arm 18 with respect to the inboard arm 14.

In operation, when the outer end of rotatable joint 20 is connected to manifold flange (not shown) provided on a tanker, the outboard arm 18 is moved according to the movement of the ship and rotated with respect to the inboard arm 14, the arm lever 122 is also rotated together with the outboard arm 18 causing the link 124 to move. By the movement of the link 124, the connecting rod 100 is moved with respect to the inboard arm 14, so that it causes the outer balance arm 130 to rotate about the pin 107 through the link 110 to maintain the balance. When the outer balance arm 130 is rotated, the outboard arm is balanced. However, as will be clear from Fig. 12, the rotation angle α of the rotatable arm 102 or 104 becomes smaller than the rotation angle β of the lever arm 122 and hence of the outboard arm 18. Therefore, it is possible to enlarge the maximum inner angle between the inboard arm and the outboard arm so that the operation range thereof is widened. In practice, since it is possible to make $\beta=180$ for the inner angle $\alpha=90$ by designing the ratio in length of the link 102 or 104 to the arm 122 or 136 as $L/e=2/1$, the compressive force exerted on the connecting rod 100, when the outboard arm 18 is retracted, does not become large because the length of moment arm does not become too short and therefore, there is no need of making the cross-sectional area thereof large to provide a sufficient mechanical strength and this is advantageous in economy. By the use of oil-less metal for each of the portion around the respective shaft pins the maintenance is facilitated.

The connecting rod 100 and the rotatable arms 102 and 124, etc., may be mounted in lower side of the inboard arm 14 as shown by chain lines in Fig. 9 or it may be possible to mount them in both the upper side and the lower side. Further, although it is preferred to rotatably connect the junctions of links 124 and 102 and of 104 and 110 to

the connecting rod 100 by means of the pins 118 and 105, it may be possible to connect the rod 100 to other portions than the junctions of the rotatable link arms, such as, for example, to suitable portions of extensions of the rotatable arm 124 and 110 or 102 and 104, provided that the inboard arm and the connecting rod are maintained in parallel.

Further, the top end of the cylinder rod 144 may be connected to any position between the pins 105 and 106 of the front link 104, to the pin 105 of the link 104 or to the auxiliary rotatable arm 114.

The embodiment utilizes one drive cylinder driving the inboard arm together with a link mechanism arranged in a V, a connecting rod and the inboard arm. This structure provides many advantages over the conventional driving mechanism using a drive cylinder and a direct drive of the outboard arm as shown in Fig. 1 or 2. That is, the maintenance of the apparatus is facilitated and the rotation range of the outboard arm with respect to the inboard arm can be made large enough, providing a smooth operation thereof.

The fluid loading apparatus according to the present invention is utilized by connecting the stand pipe to a fluid transporting pipe provided in the seaberth and connecting the hollow rotatable joint 20 to the manifold on the tanker as in the conventional manner, the operation thereof is very easy because the driving mechanism for rotating the inboard arm and the outboard arm is constructed with the cylinders and a pair of links so that the rotation angle becomes as much as 180° . Further, since the links do not require frequent provisions of rust-resisting lubricant in comparison with the conventional wire rope or chain, the maintenance is facilitated and it can provide a simple structure having sufficient mechanical strength.

WHAT WE CLAIM IS:—

1. A fluid loading apparatus, comprising a hollow inboard arm having one end connected rotatably in three-dimensions to a hollow stand pipe installed on land or other support surface and having an extension member to form an inner balance arm, a hollow outboard arm connected at one end thereof to the other end of said inboard arm rotatable in a vertical plane with respect thereto and having at the other end a three-dimensionally rotatable joint and an outer balance means and an operation means for determining an angle between said inboard arm and said stand pipe, in which said operation means comprises a first hydraulic cylinder rotatably supported by said inboard arm



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5 and having a piston rod, and a first V-link comprising a pair of first and second link arms connected rotatably with each other at one end thereof, an end of said piston rod remote from said hydraulic cylinder being rotatably connected to a suitable portion of either of said link arms, the other end of said first link arm being connected rotatably to a suitable portion of said inboard arm and the other end of said second link arm being connected rotatably to said stand pipe.

10 2. A fluid loading apparatus according to Claim 1, further comprising a second hydraulic cylinder suitably supported and having a piston rod, and a second V-link comprising first and second link arms connected rotatably with each other at one end thereof, an end of said piston rod remote from said second cylinder being rotatably connected to a suitable portion of said link arms of said second V-link, the other end of said first link arm of said second V-link being connected rotatably to a suitable portion of said extension member, the other end of said second link arm of said second V-link being rotatably connected to a suitable portion of said outer balance means, a first means fixedly connected to said one end of said outboard arm and a second means mechanically interconnecting said balance means and first means.

15 3. A fluid loading apparatus according to Claim 2, in which said outer balance means comprises a lever pivotably supported by said portion of said extension member and

having one end connected to the other end of said second link arm and the other end connected to a counterweight.

4. A fluid loading apparatus according to Claim 2 or 3, in which said first means is a lever arm and said second means is a connecting rod interconnecting said balance means and said first means.

5. A fluid loading apparatus according to Claim 2 or 3, in which said first means is a polygonally cornered cam member and said balance means includes a polygonally cornered cam member identical to said first cam member and said second means is a loop chained round said two cam members and constituted by chained rod members connected by a pair of parallel rods, each of said chained rod members having a length corresponding to one side length of the polygon so that said chained rod members mesh with the cam members.

6. A fluid loading apparatus substantially as hereinbefore described with reference to and as illustrated in Figs. 4 to 7 or Figs. 4 to 7 with Figs. 8 to 12 of the accompanying drawings.

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