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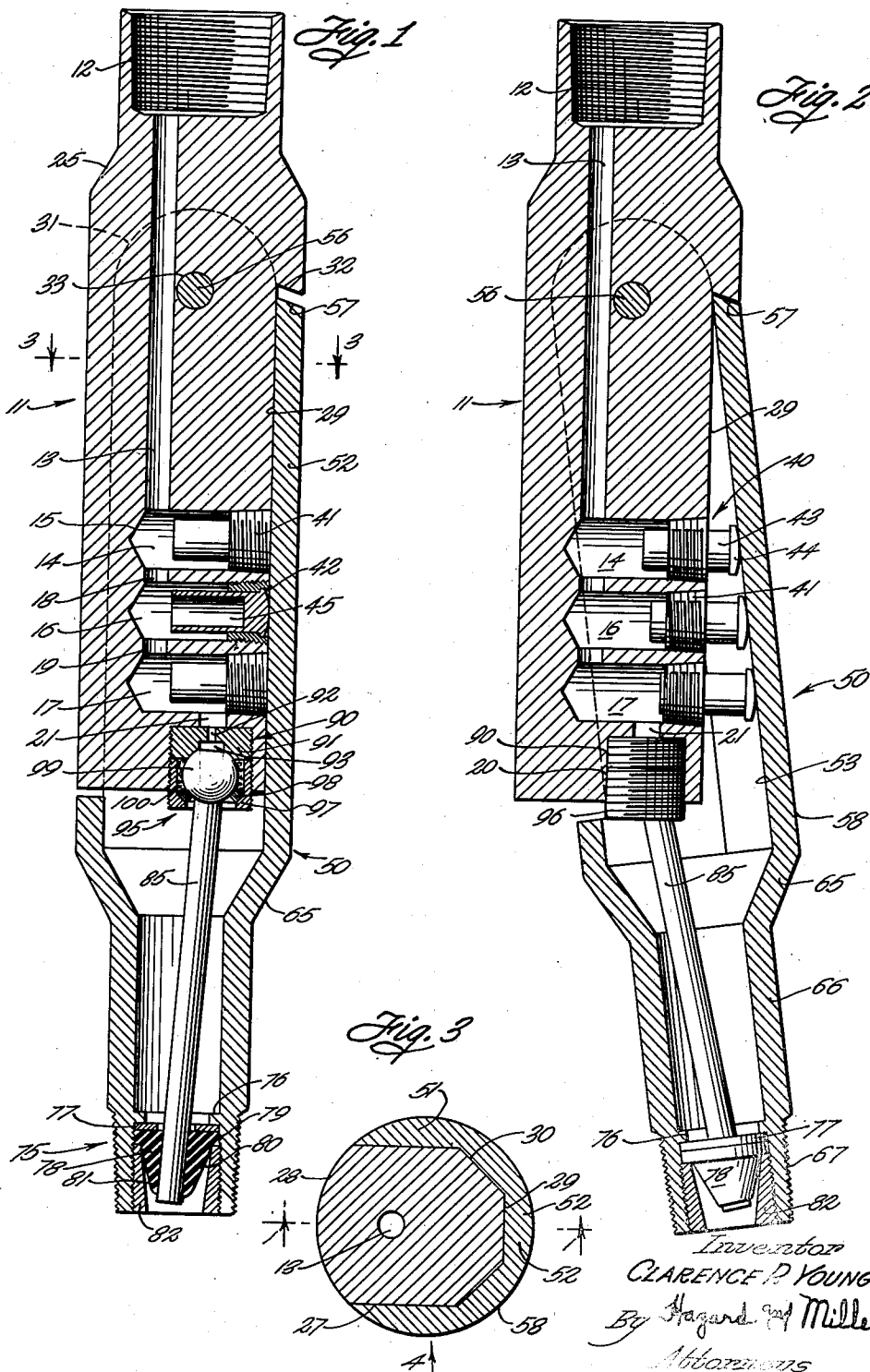
C. P. YOUNG

2,242,279

HYDRAULIC KNUCKLE

Filed Feb. 9, 1940

2 Sheets-Sheet 1



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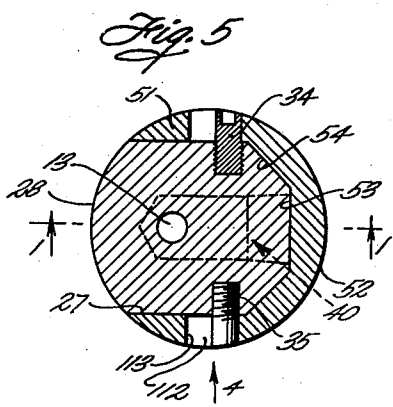
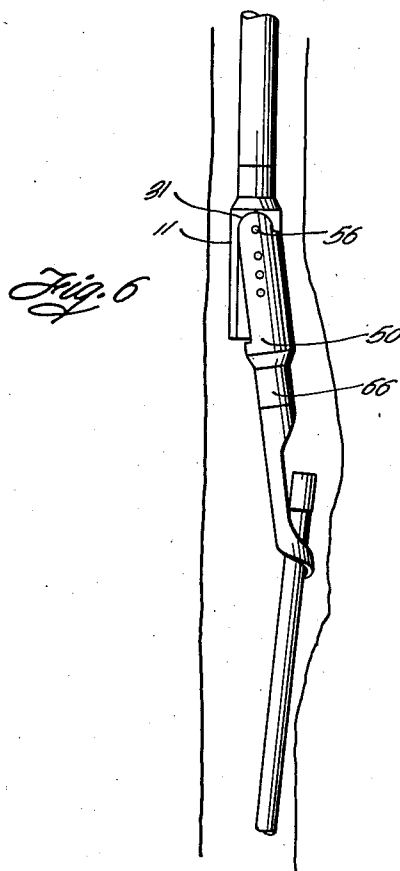
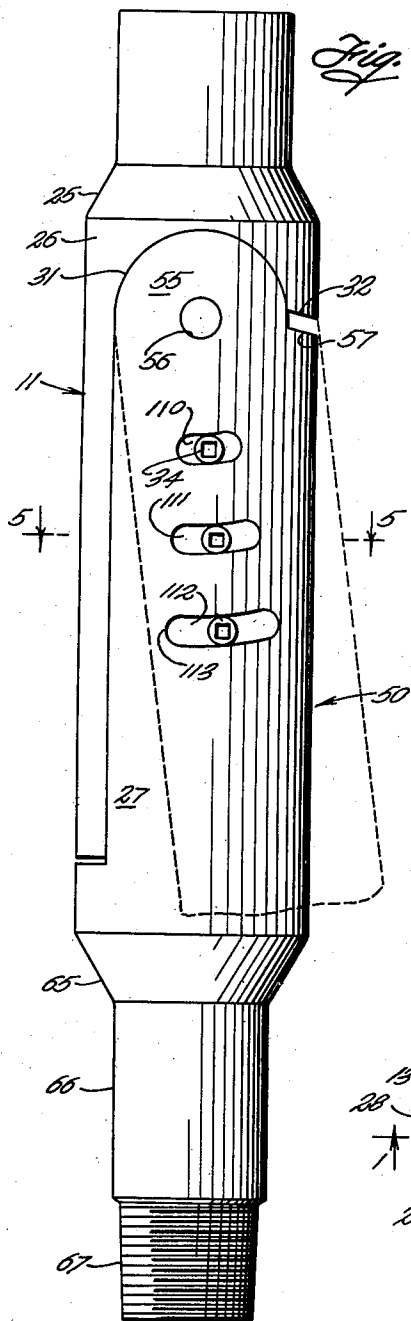
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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HYDRAULIC KNUCKLE

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Application February 9, 1940, Serial No. 318,046

17 Claims. (Cl. 285—93)

My invention, designated a hydraulic knuckle, is for use mainly in fishing jobs for tools or equipment lost in deep well drilling or for similar purposes. This may be considered as an improvement or further developments of structures presented in the patent for a Hydraulic wall hook, P. G. Gates et al., No. 1,594,668, issued August 3, 1926 and Wash-over hydraulic wall hook, No. 1,800,490, issued on April 14, 1931 to myself.

In the construction and the usage of a hinged or pivoted hydraulic type of joint, a number of problems arise such as securing the maximum benefit of the hydraulic pressure developed by the slushing liquid pumped downwardly through the well, hence by my present invention I utilize displacing pistons operating in a cylinder in the hydraulic block, the cylinders being transverse to the axis of said block and each being a straight cylinder and hence utilizing a straight piston moving therefore in a straight line direction. Such piston or pistons therefore have a direct outward thrust of their heads against a wall of the arm pivoted to the hydraulic block. A further feature of improvement is the manner of supplying the liquid to the base of the cylinders by providing a duct or passage through the hydraulic block leading to one side of the uppermost cylinder and thence in succession to other cylinders where a plurality of these are utilized. The construction likewise applies for a circulation area around the pistons when retracted, hence providing an adequate space for a sufficient volume of liquid to provide for the displacement and outward movement of the pistons. A further detail feature of my invention is in having the hydraulic cylinder or cylinders located below the hinge pintle of the joint instead of above as in the patents above noted and thus avoid a double lever action in the movement of the pivoted or hinged arm. Further, to develop an adequate thrust with the maximum torque or leverage, such cylinders and their pistons are presented in a vertical row as to the hydraulic block. The advantage of having the arm as a single lever resides in providing a much longer leverage with the thrust pistons below the pintle and further in such construction there is no upper part of the arm to be pressed sidewise.

Another detail feature of improvement is in the provision of a plurality of stop pins or lugs which have a pin and slot connection between the hydraulic block and the sides of the hinged arm operative to limit the outward movement of such arm and further to provide additional strength over that of the main pintle or hinge

pin for pulling up or jarring on a fish caught by a suitable tool attached to the arm.

In the prior procedure of use and operating fishing tools attempts have been made to obtain a wash-over of the fish by discharging slushing fluid to loosen the material in the well which becomes caught and embedded in the tool or well equipment and prevents its ready removal. With my invention I have developed a combination with the joint of the hydraulic construction for hinged joint as well as the downward discharge of slushing liquid under high pressure between the hydraulic block connected to a string of drill pipe or the like and the arm which may have attached thereto various fishing tools.

In this connection a feature of my invention includes a strong yet flexible tilting piping connection between the lower end of the hydraulic block and a sealing member mounted in a cylindrical portion of the arm and through which flexible member the flushing liquid may be forced downwardly under the desired high pressure. In view of the fact that this flexible tilting tubular connection must provide for an angular movement, my invention contemplates a flexibly mounted contact with a hydraulic connection to the passage and cylinders in the hydraulic block so that when the arm is displaced outwardly and the pumping of the liquid is maintained, there will be a sufficiently large volume of slushing fluid discharged downwardly to start the upward circulation of the dead fluid in the lower part of the well, this also provides for discharge and circulation of oil where such is needed for lubricating purposes.

A detail feature of my invention in regard to the flexible tilting conduit connection includes preferably providing a strong tube with a ball and socket connection to the lower end of the hydraulic block and providing a flexible rubber seal in a pipe forming part of the hinged arm. This rubber seal is somewhat in the form of a cone shaped or tapered annular gasket with the apex pointed downwardly and the tube extending through the center. Therefore as the hydraulic fluid is forced through the universal joint, the tubing and to a location below the seal, the bottom pressure building up closes and presses this annular gasket in close contact with the pipe thereby preventing an upward flow through the rubber seal. This cone shaped construction also permits an angular motion of the tube in relation to the hydraulic knuckle and to the hinged arm, this latter being due to the ball and

socket axis of movement being spaced considerably below the main pintle of the hinge.

Another detail improvement is the construction and use of a hydraulic bean which is a metal block having an orifice therethrough positioned above the ball and socket joint and below the lowermost cylinder. The resistance of the bean to hydraulic flow thus causes the building up of a sufficient hydraulic pressure in the cylinders to operate the pistons.

My invention is illustrated in connection with the accompanying drawings, in which:

Fig. 1 is a vertical section as if taken on the line 1—1 of Fig. 3 or 5 in the direction of the arrows illustrating, however, the pistons and the cylinder bushings in elevation and vertical section. This shows the knuckle in the retracted position with the arm in alignment for inserting in a well hole.

Fig. 2 is a section similar to Fig. 1 with the arm in the extended position, the pistons being thrust outwardly and illustrating the pressure tube connection canted in a reverse direction to that of Fig. 1.

Fig. 3 is a transverse section on the line 3—3 of Fig. 1 in the direction of the arrows.

Fig. 4 is a side elevation taken in the direction of the arrow 4 of Fig. 3 or 5.

Fig. 5 is a transverse section on the line 5—5 of Fig. 4 in the direction of the arrows.

Fig. 6 is a side elevation similar to Fig. 4 on a reduced scale illustrating the knuckle joint used with a wall hook in a well fishing job.

The hydraulic knuckle is composed of one of the main elements, the hydraulic block designated 11, this being a substantially heavy metal structure shown as provided with an internally screw threaded box 12 at the top for connection to a string of drill pipe or the equivalent by which the tool is lowered into the well and the slushing fluid forced downwardly by the pumps at the top of the well. A duct 13 leads downwardly to conduct the slushing liquid and such duct enters an upper cylinder 14 on its upper side. Such cylinder is transverse to the axis of the hydraulic block and preferably has a slightly recessed inner end indicated at 15 to provide a relatively large capacity for the liquid. Below the upper cylinder there is illustrated a middle cylinder 16 and a lower cylinder 17, these being connected by passageways 18 and 19 respectively. All of the cylinders preferably have the same diameter and depth and are preferably in vertical alignment. At the bottom of the block there is a large recess 20 for a universal joint and a fluid passage 21 leading from the bottom cylinder to such recess.

The exterior of the hydraulic block is characterized by a bevel 25 at the top below the box structure, a circular section 26 therebelow, the opposite flat sides 27 to accommodate the portions of the arm hereunder described. This leaves the partial circle 28 of the front section. At the back the hydraulic block has a flat side 29 and bevel corners 30 from the sides 27 to the back 29. The shape of course may be departed from where desired. The back 29 thus forms part of a cord of the transverse circle defining the upper portion of the hydraulic block. At the upper ends of the sides 27 there is the part circular socket 31 terminating at the shoulder 32 above the back 29. The hydraulic block has a hinge or pintle perforation 33 extending diametrically there-through from the sides 27 and immediately below the part circular sockets 31. There are also stop

pins 34 of which three are shown on each side threaded into recesses 35 leading from the sides 27. These are preferably all located on a radius line from the pintle opening 33. These pins are illustrated as having a recessed wrench head.

Each of the cylinders has a bushing and piston assembly 40 having threaded bushings 41 threaded into a slight taper formed on the outer portions of the cylinders and extending inwardly from the back 29. Each bushing has a slight shouldered recess 42. The pistons 43 are all of a similar type having a piston head 44 slightly domed on its outside surface and of sufficient diameter to fit in the shouldered recess 42 and seat against the bottom of such recess. Each piston has a chambered inner end 45 forming a space to receive the hydraulic fluid. This also reduces the weight of the pistons. The pistons when retracted are adapted to have the outside of the heads either flush with or slightly inside of the surface of the back 29. It is to be noted that a duct 13 for the flushing fluid is on the front side of the pintle perforation 33, thus entering at the inner heads of the cylinders.

It will be noted also that even when the pistons are in their innermost position that there is sufficient space for the flow of liquid through the connecting passageways or ports 18 and 19 and also as the pistons are of less diameter than the cylinders, there is quite an ample annular space around the pistons. These are guided solely in their extending and retracting movement by the bushings.

The arm assembly designated by the numeral 50 has opposite side members 51 and a back portion 52. These are internally shaped with flat surfaces, sides having a working fit over the sides 27 of the hydraulic block and also having an internal surface 53 which is flat and conforms to the back 29. There are also internal corner surfaces 54 corresponding to the surfaces 30 of the hydraulic block. The upper ends of the sides have ears 55 through which extends the main pintle 56 of the hinge, this extending through the perforation 33 of the block. There is also a sloping shoulder 57 at the upper end of the back which in the retracted position of the arm is spaced from the shoulder 32. The back and sides of the arm have a partly circular surface 58 which when the arm is in the retracted position form with the surface 28 of the hydraulic block a true circle in cross section. The sockets 31 as above noted are concentric with the pintle 56 as is also the upper end of the ears 55 of the arm. There is a close fit between the ears and the socket. Therefore, on a down thrust part of this is transmitted directly between the ears 55 to the socket 31. This would take place when the arm is in the retracted position as shown in full lines in Figs. 1 and 4. By providing the desired fit some of the thrust is removed from the pintle 56 and from the pins 34. In any upward pull as in a jarring action this is taken care of by the pintles and the pins in their respective slots.

The lower portion of the arm may be of different designs depending on the purpose for which it is intended. In the illustration however there is a tapered portion 65 connecting from the sides 51 and the back 52 to an integral tubular section 66, which is illustrated as externally threaded at 67 at its lower portion for attachment of various tools. A hydraulic seal assembly 75 utilizes an internal shoulder 76 in the tube 66. Against this shoulder there is seated a flat

metal ring 77. This ring forms a base or support for the rubber expansible packing ring or gasket 78, this being illustrated as provided with an annular base portion 79 and a conical section 80 having a cylindrical opening 81 therethrough. The rubber gasket is held in place by an internally tapered gland 82 which is externally threaded and threads into internal threads within the lower end of the tubular section 66, the inner end of the gland fitting against a shoulder portion 78 of the gasket. Through perforation 81 is fitted the fluid pressure tilting pipe 85. There is a sufficient sized opening in the ring 77 to accommodate any possible movement laterally of such pipe when the knuckle is shifted from the retracted to the extended position.

The initial hydraulic pressure is built up in the upper part of the hydraulic block by utilizing a hydraulic bean designated by the assembly 90. This is a metal block 91 screw threaded into the recess 20 and having a small orifice 92 communicating with the passage 21 and developing a resistance to the flow of the slushing liquid. This bean is illustrated as having a recess 93 on its discharge side and also as forming the upper bearing for a universal joint assembly 95. This joint has a sleeve 96 threaded into the recess 20. Internally the sleeve has a tapered shoulder 97 with a thrust bearing 98 engaged therewith. The upper end of the tilting tube 85 has a tubular ball 99 connected thereto seated against the bearing surfaces on the lower part of the bean and the bearing rings 98. To prevent leakage there is packing 100 surrounding the ball and between the two bearing surfaces. The pipe 85 while it is illustrated as rigid is part of a flexible pipe connection as such terminology is used in the art. The ball and socket joint 99 operating in the bearing and the hydraulic seal assembly 75 form with the pipe 85 flexible connections. Moreover the gasket 78 being made of rubber is flexible and thus allows the pipe 85 in its tilting motion to have the flexible hydraulic connection form the lower part of the hydraulic block to the tubular portion of the arm below the hydraulic seal 75.

The side walls 51 of the arm 50 are provided with arcuate slots illustrated as three in number and designated 110, 111, and 112, each being of increasing length and formed concentric with the pintle 56. The stop pins 34 fit in these slots, the forward end 113 of these slots defining the limit of motion of the arm from its retracted to its extended position.

The manner of operation and functioning of my invention is substantially as follows: The hydraulic joint may be connected at the lower end of a string of drill pipe as indicated in Fig. 6 and have a suitable tool attached to the lower end of the arm, this being indicated as a wall hook to engage the upper end of a fish inclined in a well, however, the knuckle joint when lowered is in the retracted position shown in Fig. 4, then at the desired depth at which the tool is to operate the slushing liquid is pumped downwardly through the drill string from the surface of the well. The first reaction of the liquid which fills the passage 13, the cylinders 14, 16, and 17 under the pumping pressure is to build up a high hydraulic pressure within the cylinders. At this stage of the operation the bean 90 having only a small orifice 92 restricts the flow of liquid and hence causes the development of a high pressure within the bores. The pistons 43 are thus forced outwardly from the retracted posi-

tion of Fig. 1 to the extended position of Fig. 2. The heads of the pistons as above noted bear against the inner surface 53 of the back wall 52 of the arm and tilt the arm on its pintle 56 outwardly to the extended position. This extended position is limited by the studs 34 secured to opposite sides of the knuckle block 11 engaging the forward ends 113 of the respective slots 110, 111 and 112 formed in the sides of the arm. By having a plurality of pins the stresses due to the outward thrust action is distributed.

Of course after the arm has been extended laterally and during the maintenance of the pumping of the slushing liquid, this is discharged downwardly through the orifice 92 of the bean 90, thence through the pipe 85 by the universal ball and socket joint 95 and the hydraulic seal connection 75. This flow however does not interfere with the operation of a wall hook or other tool in catching a fish inclined to one side of the axis of a well hole and in centering such fish into axial alignment with the well. When the fish has been properly caught by the wall hook, the pumps may either be temporarily stopped or the hydraulic pressure decreased so that the fish can be worked into axial alignment and the arm 50 retracted to its aligned position. Some of these types of wall hooks are provided with slips or other devices to grip the fish when properly centered and when such is the case or the fish is aligned and held in any suitable manner, then the pump pressure on the slushing fluid may be increased, thence due to the fact that the fish being held in position restrains the arm 50 from being thrust laterally, all of the flow of the slushing liquid is forced downwardly through the bean 90, the pipe 85 and discharged below the seal formed by the gasket 78. It will be noted that this gasket being formed of rubber may flex through quite an angle from one side to the other as indicated by the change from Figs. 1 to 2. The pressure being built up below this gasket on account of the gasket being coned develops a squeezing pressure on the rubber against the pipe 85 thus preventing upward leakage of the slushing liquid. The swinging movement of the arm 50 of course develops a slight up and down movement of the lower end of the pipe 85 relative to the gasket as the distance between the center of the ball and socket joint 95 to the rubber seal is shortest when these are in vertical alignment and longest when the arm is extended as in Fig. 2. The rubber however yields to this motion or else allows a slight slip of the pipe in the rubber.

In loosening and gripping a fish caught in a well and also on the upward pull exerted to remove such fish, the stop pins 34 have an additional function of taking part of the lifting stress which would otherwise come solely on the pintle pin 56 as these pins have a close fit as to the upper edge of the slots within which they operate and therefore materially add to the strength of the tool in removing a fish from the well. As the slushing liquid may be flushed downwardly around the fish or if the fish is caught in the proper type of tool through the fish, such liquid is operative to aid loosening the caught fish from the well hole.

In constructing the knuckle joint care should be taken that there are no openings leading into the arm and particularly the circular portion 66 thereof by which dislodged large stones or the like may enter and thus possibly break the pipe 85 or damage the ball and socket joint or the seal 75. Therefore the tapered portion 65

of the arm 50 forms a full circle as does also the portion immediately thereabove which includes the lower part of the back 52 and the sides 51 completing the circle. The knuckle block on the front side is also continued downwardly to align with the bottom, this being the portion designated as having the surface 28. Thus when the arm is in the retracted position of Figs. 1 and 4, there is only a small clearance space of insufficient size to allow entry of any foreign material which might cause any serious damage. It will be understood of course that the liquid such as oil, slushing liquid or water in the well hole enters this clearance space as the tool is lowered and hence develops a hydraulic pressure equivalent to the hydraulic head in the well at any depth at which the tool is operated. While in the specification it has been mentioned that the usual hydraulic fluid for hinging the joint and for flushing purposes is the ordinary slushing liquid known as slushing mud, it is apparent that where circumstances warrant, oil may be pumped downwardly and discharged below the seal for the purpose of forming a lubricant.

Various changes may be made in the details of the construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. A hydraulic knuckle including in combination a knuckle block, an arm hinged thereto, the knuckle block having a passage for flow of liquid, the arm having a seal remote from the axis of the hinge and a tilting flexible piping connection from the said block spaced from the hinge of the arm to and through the said seal to transmit hydraulic pressure from above the block to below the said seal.

2. A hydraulic knuckle including in combination a knuckle block, an arm hinged thereto, the knuckle block having a passage for flow of liquid, the arm having a seal remote from the axis of the hinge and a tilting flexible piping connection from the said block spaced from the hinge of the arm to and through the said seal to transmit hydraulic pressure from above the block to below the said seal, a hydraulic means in the block and operative between the block and the arm to force the arm laterally.

3. A hydraulic knuckle including in combination a knuckle block, an arm hinged thereto, the knuckle block having a passage for flow of liquid, the arm having a seal remote from the axis of the hinge and a tilting flexible piping connection from the said block spaced from the hinge of the arm to and through the said seal to transmit hydraulic pressure from above the block to below the said seal, the said block having one or more hydraulic cylinders transverse to its axis and each having a piston slidable therein, the piston or pistons having means to engage the said arm and a connection from each cylinder or cylinders to the liquid passage in the said block.

4. A hydraulic knuckle including in combination a knuckle block having a longitudinal liquid passage with one or more straight cylinders connected thereto, each cylinder having a piston operative therein, an arm hinged to the block, the pistons being positioned to react against the arm to thrust such arm laterally on development of a hydraulic pressure through the said passage to the cylinder or cylinders, the arm having a hydraulic seal remote from the end of the block, a tilting flexible pipe connection from the lower part of the block to and through the said seal, 75

and a liquid flow means connecting said pipe to the said passage of the block.

5. A hydraulic knuckle having a knuckle block, an arm hinged thereto by a pintle, the block and the arm extending below the pintle, a hydraulic means including a liquid passage in the block for displacing the arm laterally, said displacing means being below the pintle, the arm having a tubular portion with a hydraulic seal and a tilting flexible pipe connection from the lower part of the block to and through said seal and a liquid flow connection in the block from the said liquid passage to the said pipe.

6. A hydraulic knuckle having a knuckle block with a liquid passage therethrough, an arm hinged to the block by a pintle adjacent the upper end of the arm, the block and the arm extending below the said pintle, one or more cylinders in the block connected to the liquid passage and each having a piston therein reacting against the arm to thrust the arm laterally, said cylinders being straight and the said pistons being straight to develop a straight line motion, the portion of the arm below the block having a tubular section with a hydraulic seal fitted therein to restrain the leakage of liquid under pressure upwardly through said seal and a pipe having a jointed connection with the lower portion of the block, there being a liquid connection in the block from the passage to said jointed connection and the pipe having a closed fit with the said seal to transmit liquid under pressure from the block to and below the said seal.

7. In a device as described, the combination of a knuckle block and an arm hinged thereto, the knuckle block having a passage for liquid, the arm having a tubular section with a hydraulic seal including a flexible gasket, a pipe having a jointed connection with the block, there being a liquid connection from the passage to said jointed connection, the said pipe having a tight fit with the said gasket whereby liquid under pressure is transmitted through the pipe to and below the said seal, the said gasket being adapted to form a tight closure on the pipe due to hydraulic pressure below the gasket.

8. A hydraulic knuckle including in combination a knuckle block having two flat sides, an arm also having two sides with flat inner surfaces complementary to the flat sides of the block, a hinge pintle through the sides of the arm and the knuckle block, a passage for liquid through the knuckle block, a hydraulic means interacting between the block and the arm to extend the arm laterally, the arm having a tubular downward extension, there being a slight clearance between a portion of said tubular extension and the lower portion of the knuckle block insufficient in size for entry of obstructing material, a seal in the lower part of the tubular extension and a flexible hydraulic connection between the block to and through the said seal.

9. A hydraulic knuckle including in combination a knuckle block having a longitudinal liquid passage with one or more straight cylinders connected thereto, each cylinder having a piston operative therein, an arm hinged to the block above the cylinders, the pistons being positioned to react against the arm below the hinge to thrust such arm laterally on development of a hydraulic pressure through the said passage to the cylinder or cylinders.

10. A hydraulic knuckle including in combination a knuckle block having a longitudinal liquid passage with one or more straight cylinders con-

nected thereto, each cylinder having a piston operative therein, an arm hinged to the block above the cylinders, the pistons being positioned to react against the arm below the hinge to thrust such arm laterally on development of a hydraulic pressure through the said passage to the cylinder or cylinders, one or more stop pins having a working fit connection between the arm and the block to limit the outward movement of the arm.

11. A hydraulic knuckle having a knuckle block, an arm hinged thereto by a pintle, the block and the arm extending below the pintle, a hydraulic means including a liquid passage in the block for displacing the arm laterally, said displacing means being below the pintle to react between the portions of the block and arm below the pintle.

12. A hydraulic knuckle having a knuckle block with a liquid passage therethrough, an arm hinged to the block by a pintle adjacent the upper end of the arm, the block and the arm extending below the said pintle, one or more cylinders in the block connected to the liquid passage below the pintle, and each having a piston therein reacting against the arm below the pintle to thrust the arm laterally, said cylinders being straight and the said pistons being straight to develop a straight line motion.

13. In a device as described, the combination of an arm having a tubular section, a liquid seal assembly mounted therein and including a flexible resilient gasket having a conical shaped portion facing downwardly and said gasket having a central aperture from top to bottom, means to confine the peripheral portion of the gasket to prevent leakage, a pipe extending through the tubular portion of the arm and through the central aperture of the gasket, means forming a hydraulic connection to the opposite end of the pipe adapted to develop an angular movement of the pipe in reference to the hydraulic seal, the conical portion of the gasket being adapted to move laterally with the pipe and the liquid discharged by the pipe below the seal being adapted to develop hydraulic pressure on the gasket to form a seal against the pipe at the said aperture.

14. A knuckle joint comprising in combination a knuckle block, an arm hinged thereto by a pintle adjacent the upper end of the arm, the said

arm in the opposite sides having one or more pairs of slots below the pintle, the knuckle block having one or more pairs of pins attached thereto below the pintle and fitting in said slots, a surface of the slots interacting with the said pins whereby when a fish or the like is engaged by the arm and an upward lift produced, the pulling stresses react on all of the pins and the pintle.

15. A hydraulic knuckle comprising in combination a knuckle block having a longitudinal liquid passage, a cylinder intersecting such passage, a bushing at the open end of the cylinder, a piston slidable and guided in the bushing, a head on the piston seating on the bushing, the inner portion of the piston extending through the bushing where the head is seated on the bushing, there being a space between the inner end of the piston and the cylinder, an arm having a hinged connection to the knuckle block by a hinge pintle located above the cylinder whereby on producing a pressure of liquid in the cylinder the said piston forces the arm outwardly in a pivoted manner.

16. A hydraulic knuckle having a knuckle block, an arm pivoted thereto, a passage in the block and hydraulic actuated means to displace the arm laterally combined with a portion of the block extending below the pintle, the arm below the pintle having a tubular portion with a hydraulic seal and a liquid tight connection from the said passage in the lower portion of the block to and through the said seal for transference of liquid under pressure through the block to and beyond the seal.

17. A hydraulic knuckle having a knuckle block, an arm hinged thereto by a pintle at the upper portion of the arm, the block and the arm extending below the pintle, a hydraulic means including a liquid passage in the block with means reacting between the portion of the block and the arm below the pintle to displace the arm laterally, the arm having a tubular portion below the pintle with a hydraulic seal, a liquid tight connection between the said liquid passage in the block to and below the said seal for transfer of liquid under pressure from the block to the arm below the seal.

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