A pier positioned on the ocean floor having a circular track disposed around a working area, such as oil well heads, wherein the track is contoured to allow a descending submarine to engage the track at its upper edge and then, by losing buoyancy, pivot downward about the track to a horizontal position to engage the track under its lower edge. The submarine has drive wheels which engage the track to cause the submarine to move along the track to service the different well heads.
SUBMERGED PIER FOR MOVING A SUBMARINE UNDER WATER

FIELD OF INVENTION

This invention relates to an underwater pier for a submarine and, more particularly, to a pier with a horizontal track which the submarine can engage and the submarine is free to move therealong. This invention is a continuation-in-part of our U.S. Pat. Application, Ser. No. 771,903, filed Oct. 30, 1968 and now abandoned.

BACKGROUND OF THE INVENTION

Submarine type vehicles equipped with manipulator arms can perform various work functions underwater. In performing these functions, some basic problems are encountered. For example, the vehicle must align itself with the object to be worked on before the manipulators can engage the object. In practice, this is a difficult feat because the vehicle is continually subjected to the forces of currents and buoyancy. Even when one of the manipulators is finally engaged, a torque applied by the manipulator to the object will cause a counter action on the vehicle which tends to rotate the vehicle. One attempted solution has been to provide the vehicle with anchors that are attached to cables to draw the vehicle into close alignment with the object and to hold the vehicle steady. Another attempted solution is to provide the vehicle with one extra manipulator arm which can be used to grasp and hold the object while the remaining manipulators do the necessary work.

Neither of the above methods is completely satisfactory in that accurate positioning using the anchor method is not possible because of the stretch in the tension lines. When a large number of objects are to be serviced, it is necessary to up the anchors and reposition them for each object. Underwater vehicles have a limited amount of reserve power and such an operation would severely curtail the length of time that useful work could be performed at a site. The extra manipulator method, besides requiring extra expensive mechanisms, still requires that the submarine maneuver into an initial position at each object before the manipulator can be attached. The amount of counter torques, that can be effectively countered with a single manipulator, is limited especially when the manipulator is used to hold the vehicle in place under the forces generated by water currents.

It would, therefore, be highly advantageous to have a holding system which requires no power and which is capable of handling large torques. It would also be desirable to have a system which could move the vehicle into accurate positions with respect to a plurality of objects using minimum power and maneuvering and which could effectively maintain these positions without further expenditure of energy.

SUMMARY OF INVENTION

In a preferred embodiment of the invention, a group of underwater well heads are surrounded by a track or rail which is positioned in close proximity to each well head. A static rack gear is affixed to the track. An underwater vehicle has affixed to its hull a means for grasping the track. A driving pinion gear is affixed to the means for engagement with the rack gear. When the driving gear is rotated the vehicle moves along the rail to the several well heads. A snubbing means is interposed between the vehicle's hull and the grasping means to take up any shock forces which may be generated during the engagement and while the vehicle is positioned on the rail.

OBJECTS OF THE INVENTION

Accordingly, an object of the present invention is to provide an improved positioning system for an underwater vehicle.

A further object of the present invention is to provide an engageable positioning system for engaging a vehicle on the structure.

Another object of the present invention is to provide a drive track vehicle for underwater use.

The aforementioned and other objects of the present invention will become more apparent when taken in conjunction with the following description and drawings, throughout which like characters indicate like parts, and which drawings form a part of this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the preferred embodiment of the invention;
FIG. 2 is a top view of the vehicle attachment system taken substantially on line 2—2 of FIG. 4;
FIG. 3 is a front view of the vehicle attachment system;
FIG. 4 is a side view of the vehicle attachment system;
FIG. 5 is a sectional view of a snubber which may be used in the system;
FIG. 6 is a sectional view of the snubber of FIG. 5 taken along the line 6—6 of FIG. 5;
FIG. 7 is an elevation of the vehicle, the outline of which is shown by broken lines and is shown descending to a place of anchor;
FIG. 8 is an elevation of the vehicle and showing the vehicle of FIG. 7 about to engage the rail;
FIG. 9 is an elevation of the vehicle of FIG. 7 showing the vehicle engaged with the rail; and
FIG. 10 is a plan of the vehicle and the rail of FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, an underwater vehicle 10 is shown attached to a pier having a rail or track 20 by an attaching and snubbing structure 30. A plurality of well heads 40 are shown positioned around the inner periphery of the track 20. In operation, the vehicle 10 is driven around the track 20 into alignment with a selected well head by a driving means affixed to the attaching and snubbing assembly 30 and which is described in more detail in the following discussions. The vehicle 10 has propellers 11 suitably mounted to provide thrust in any direction.

Referring now to FIGS. 2, 3, and 4 wherein the attaching and snubbing assembly 30 is shown in detail, two pairs of accessory attachment fixtures 21 and 22 (FIG. 4) are attached to the hull of vehicle 10. The fixture pair 21 (FIG. 3) is attached to the forward lower
portion, or underside, of the vehicle with the fixture pair 22 affixed to the upper front portion of the vehicle. A pair of snubber cylinders 12 are affixed, one each to the lower attachment fixtures 21 (as shown in FIG. 2). An X-shaped cross brace 45 is connected between both snubber cylinders 12 to provide structural reinforcement and a base support for a position and snubber actuator unit 14. A vertical support arm 24 (FIG. 3) extends between each snubber 12 and an attachment 23 which in turn is affixed to fixture 22 to provide additional structural support. Pistons 13 (FIG. 2) move within the snubbing cylinders 12 under the influence of forces applied on the axes of the pistons.

Referring to FIGS. 5 and 6, which is a sectional view of one of the snubber cylinders 12 taken along the center line thereof, the outer cylinder 12 has multiple ports 46 through which sea water flows and is used as the damping fluid. The piston 13 is terminated in a piston cup 47 retained in place with pins 48. Mounted to the end of the cup by means of rod end 43 is a self-aligning bearing 44. A return spring 49 acts against the piston to extend it to its unloaded position. A spring guide and anti-rotation tube 50 passes concentrically through the center of cylinder 12 and is affixed at one end to piston 13 by means of retainer pins 51. An anti-rotation slot close-out tube 52 is affixed to the other end of tube 50. A closed-ended slot 54 extends along a section of tube 50. The slot 54 should be long enough to allow the piston to traverse its compression stroke. Bolts 53 (FIG. 6) extend through the base of cylinder 12 into the respective slots 54 to prevent the piston 13 from being disconnected from the cylinder and from rotating within the cylinder. In operation, as the piston 13 moves into cylinder 12, the number of openings 46 that are closed off increases, thereby slowing the fluid escape from the cylinder which, in turn, increases the resistance felt by piston 13.

Referring back to FIGS. 2, 3, and 4, an L-shape main frame 11a is attached to the pistons 13 by bolts 27 (FIG. 2) which pass through the lugs 32 affixed to frame 11a, and through the self-aligning bearings 44. Centering springs 43 are positioned on each side of the bearing 44 to permit the main frame to slide sideways to prevent binding, but maintain the bearings 44 in a substantial centered position. The position and snubbing actuator 14 (FIG. 4) is connected at one end to the X-brace 45 by means of a clevis-type connection 31 (FIG. 2) and to the main frame 11a by means of a second clevis-type connection 28 (FIG. 4) on a piston 29. A built-in pressure release valve (not shown for purposes of clarity) allows the actuator 14 to act as a snubber when the vehicle, first engages the track by providing the escape of hydraulic fluid under the influence of compression forces acting on piston 29. Once the vehicle 10 is in position, further positioning may be accomplished by extending or retracting the piston 29 through hydraulic power source 60 (FIG. 4) connected by hydraulic lines 61 and 62 and valves 63 and 64, respectively, to the actuator piston chamber, not shown. In operation, the direction of fluid flow through lines 61 and 62 is controlled by the power source 60, and the amount of fluid flow is controlled by valves 63 and 64.

Two idler track engaging wheels 15 (FIG. 4) are attached by shafts 26 to a bearing housing 25 which, in turn, is supported on an upper horizontal leg 11b of the main frame 11a. Each wheel has a flange or a lip portion 19 for engaging the top of a vertical plate 70 on rail 20. A toothed drive wheel or pinion gear 16 is rotatably affixed to the lower end of the vertical leg 11c of the main frame 11a by means of a drive shaft 42. A hydraulic reversible motor 23 drives the drive shaft 42 through a gear box 41. The teeth on gear 16 engage the teeth on a stationary rack gear 17 which is affixed along the lower edge of plate 70 on the support track 20. The motor 23 is driven by means of the hydraulic power source 60 with the direction of rotation controlled by valves 65 and 66. A flange 18 is affixed to the end of gear 16 to extend under the plate 70 to keep the vehicle engaged with the track support structure 20.

The operation of the snubbing system is sequentially shown in FIGS. 7 to 10. In FIG. 7, the submersible vehicle 10, with its attaching and snubbing structure 30 attached, approaches the track rail 20 with a nose-down attitude in a neutrally buoyant condition, the propellers 11 providing forward thrust. Upon contacting the rail 20 (FIG. 8), the built-in snubbing structure 30 will absorb the impact load. Once contact has been made, the direction of thrust as produced by the propellers 11 is changed by means well known in the art and the buoyancy is made negative by causing sea water to enter ballast tank 10a within the hull 10 so that the attitude of the vehicle is changed. Therefore, the vehicle now applies a forward-downward thrust with its propellers 11 of the main propulsion system, pushing the vehicle 10 against and yet permitting it to slide down the rail 28, thus engaging the flanged wheels 15 over the plate 70 (FIG. 4) on track rail 20. Continued downward thrust after wheels 15 engage the rail will rotate the vehicle about the rail (FIG. 9) to allow the pinion gear 16 to engage the static rack gear 17 (as shown in FIG. 4). The flange 18 on the bottom of the pinion gear 16 insures proper engagement and prevents accidental disengagement of the vehicle. Application of power to the drive pinion gear 16 moves the vehicle laterally on the static rack gear (FIG. 10). The vehicle will, through the use of the ballast tank 10a maintain negative buoyancy when attached to the support rail system thus ensuring locking therewith. To release the vehicle, the trim is changed to positive buoyancy through the use of the ballast tank 10a, which will cause the vehicle to rotate about the rail automatically disengaging it from the rail system.

While there has been shown what is considered to be the preferred embodiment of the present invention, it will be manifest that many changes and modifications may be made therein without departing from the essential spirit of the invention. It is intended, therefore, in the annexed claims, to cover all such changes and modifications as may fall within the true scope of the invention.

What is claimed is:
1. In combination:
   a. a pier rigidly disposed;
   b. a track fixed to said pier and disposed substantially horizontal, said track having substantial vertical thickness; and
   c. a self-propelled vehicle having:
      first means for changing buoyancy relative to the fluid in which said vehicle is submerged,
second means for changing the attitude of said vehicle,
a support structure disposed at the front end end of said vehicle and having one leg disposed substantially vertically and another leg disposed substantially horizontally from the upper end of said one leg,
first hook means on the outward end of said other leg adapted to hook over the upper edge of said track,
second hook means on the lower end of said one leg adapted to hook under the lower edge of said track, and
power means on said support structure disposed to engage said track to move said vehicle along the track.
2. The combination of claim 1 wherein:
said first hook means includes two spaced wheels disposed to rotate about substantially vertical axes and to engage the track on the far side from said vehicle,
said second hook means includes a wheel disposed to rotate also about a vertical axis and engages said track on the side near of said vehicle so that said vehicle is disposed substantially horizontally, and said power means is disposed to rotate at least one of said wheels.
3. The combination of claim 2 wherein:
said track has a rack gear disposed on its near side,
said wheel on said second hook means is a pinion gear for engaging said rack gear, and
said power means rotates said pinion gear.
4. In the combination of claim 3 wherein:
said support structures further includes snubber means for absorbing any shock loads developed when engaging said track,
said rack gear is disposed near the lower edge of said track, and
said pinion gear has a flange that extends under the track.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,698,197 Dated October 17, 1972

Inventor(s) Robert G. Cook and Charles E. Bodey

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

TITLE AND ABSTRACT PAGE:

After Item "[72] Inventors" and before "[22] Filed" please insert the following:

[73] Assignee: North American Rockwell Corporation

Signed and sealed this 3rd day of April 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCHALK
Attesting Officer Commissioner of Patents