This invention relates to a system for mating a submersible vehicle, such as the deep submersion rescue vehicle (DSRV) with a submersible carrier and locking the DSRV in place on the carrier. The mechanism, called a mating system, has two portions: a forward portion and a stern portion. The forward portion includes a means, such as a sonar buoy, for guiding the vehicle to it and a locking mechanism for locking the vehicle to the carrier. The stern portion of the carrier is designed to accommodate the stern of the DSRV and also includes a locking mechanism. The combination of the forward and stern portions of the carrier serve to deploy the DSRV, ensnare the DSRV upon its return to the carrier vessel, mate with the DSRV and then bring it down into a locked position on the carrier vessel ready for transport.

10 Claims, 8 Drawing Figures
SUBSURFACE SUBMERSIBLE MATING SYSTEM

The invention described herein may be manufactured and used by or for the Government of the United States of America for Governmental purposes without the payment of any royalties thereon or therefor.

DESCRIPTION OF THE PRIOR ART

The prior art dealing with deep submersion rescue vessels shows capsules tied to a submarine for use as a lifeboat in case of an emergency. Also, the prior art shows escape bells, lowered to a mating position with the submarine escape hatch. The escape bells include guiding systems to guide the bell down to the escape hatch in the submarine and cam systems cooperating with the bell to lock it in place and effect a water tight connection.

However, the prior art does not show an apparatus for transporting and deploying and then recapturing a deep submersion rescue vehicle nor does the prior art show methods for deploying, transporting and recapturing deep submersion vehicles. The prior art, pertaining to deep submersion vehicles is limited to vessels which are either used one time as a lifesaving vessel or which are deployed from a submersible vessel but attached to a guidance line so that the submersed rescue vehicle is never at any time free of the carrier vessel.

SUMMARY OF THE INVENTION

This invention relates to a mechanism for transporting, mating, deploying and recovering a submersible vehicle by a submersed carrier vessel while in a submerged mode of operation. The mechanism is designed to accommodate a vehicle such as the deep submersion rescue vessel (DSRV) and the mechanism generally has two portions, combining to form the mating system.

While deployed in the DSRV is free of the carrier and operates under its own power. This system is designed to hold the DSRV locked to the carrier vessel during transport, to release the vessel for operation under its own power and then to ensnare, mate with and lock the vehicle to the carrier for transport. The mating system has two portions: a forward portion for accommodating the bow of the DSRV and a stern portion for accommodating the stern portion of the DSRV. Generally, the forward portion is designed to (1) provide a beacon, such as a sonar beacon, to the incoming DSRV; (2) mate with the DSRV and to lock onto the bow section of the DSRV; (3) bring the DSRV down towards the deck and stern portion of the submersed carrier; and (4) when the DSRV mates with the stern portion, to cooperate with the stern portion to bring the DSRV down to its locked position on the deck of the submersed carrier ready for transport.

As the DSRV operates unhindered and free from the submersed carrier, any system for accommodating the DSRV on the carrier system must have the capability of guiding the DSRV towards the carrier vessel, enshirring it, and then bringing it down to its locked position in which it can be transported, while held fast to the deck of the carrier vessel. Within this context, the advantages of this invention are: (1) it presents a target to the homecoming DSRV; (2) it enables capture of the DSRV relatively high above the deck of the submersed carrier thereby decreasing the chances for collision between the DSRV and the carrier vessel; (3) it is adaptable to various types of submersed vehicles; (4) it provides positive control of the submersible DSRV prior to bringing the DSRV into a locked transporting mode on the deck of the submersed vehicle; (5) it provides shock mitigating and cushioning features to prevent damage to the DSRV; (6) it assures positive locking of the DSRV onto the mating sections; and (7) it permits capture of a disabled DSRV.

OBJECTS OF THE INVENTION

It is accordingly, a first object of this invention to provide a transporting, mating, deploying and recovering system to enable the DSRV to operate from a submersed carrier.

It is a second object of this invention to enable the DSRV to be captured high above the deck of the submarine, decreasing the possibility of collision between the DSRV and the submersed carrier.

It is a third object of this invention to ensure the DSRV and provide positive control over the DSRV prior to locking the DSRV in place on the deck of the submersed carrier.

It is a fourth object of this invention to provide shock mitigating and cushioning features preventing damage to the DSRV and accurate control lowering the DSRV to its locked position once the DSRV has been ensnared.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a perspective view of the preferred embodiment of the mating system.

FIG. 1(a) shows a plane view of the forward portion of the preferred embodiment shown in FIG. 1.

FIG. 1(b) shows a plane view of the stern portion of the preferred embodiment shown in FIG. 1.

FIG. 2 shows a perspective view of a first alternative embodiment according to the principles of this invention.

FIG. 2(a) shows a side view, the forward portion of the embodiment of FIG. 2, when in an erected position, ready for mating with the DSRV.

FIG. 3 shows a perspective view of a second alternative embodiment according to the principles of this invention.

FIG. 3(a) shows a plane view, the forward portion of the embodiment of FIG. 3, when in an erected position ready for mating with the DSRV.

FIG. 4 shows in perspective a third alternative embodiment according to the principles of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the preferred embodiment for the mating system is shown. The forward mating assembly designated generally by 10 is mounted firmly to deck 13 of the submersed carrier by support structure 11. Mounted within support structure 11 is telescoping boom 15 held within structure 11 guide channel structure 17. A chain drive (not shown), mounted on support structure 11 and powered from within the carrier, raises boom 15 vertically within guide channel 17, from the deck 13 of the submersed carrier. Guide channel 17 and boom 15 are mounted on plate 21, which rotates in a plane parallel to the carrier deck 13. Rotating plate 21, powered by the carrier, can be rotated to a suitable angle point to a homecoming DSRV; upon an appropriate command from the carrier vessel. Support arms 23 and 25 are attached to telescoping boom 15 and provide a mounting for the forward mating assem-
Lock 27. Lock 27 is mounted on support arms 23 and 25 by means of four springs, one at each corner of lock 27, two springs 29 and 31 being shown in the front view 1a, of the forward mating assembly 10.

The four springs supporting the mating assembly lock 27 allow slight movement of the mating assembly about vertical axis 28 and horizontal axis 30, axes 28 and 30 being shown in FIG. 1a.

Mating assembly lock 27 includes two dogs 37 and 39, each dog having a camming surface 37a and 39a, respectively. The dogs 37 and 39 are held in the position shown in FIG. 1b, by springs located within mating housing lock 27. As the DSRV comes down upon the lock in the direction of arrow 45, the force of the DSRV nose probe on the surfaces 37a and 39a of the dogs result in a camming action which pushes the dogs 37 and 39 into the mating assembly lock housing parts 27a and 27b until the DSRV nose probe mating recesses are aligned with dogs 37 and 39, whereupon the springs within the housing push the dogs 37 and 39 out into the DSRV nose probe mating recesses to hold the DSRV locked in place. The dogs 37 and 39 may also be withdrawn or inserted by positively operated power means such as by a solenoid or hydraulic motor, powered by the carrier.

A storage receptacle 35 contains a sonar beacon 47, attached to a wire 49. The sonar beacon may be released and retracted under a command from the carrier vessel, the sonar beacon 47 having positive buoyancy so that when released it rises in the vertical direction from the submerged carrier through passage hole 32 in lock 27. Bumpers 33 are cantilevered from lock 27 and provide a shock absorbing capability in the event of a near miss by the DSRV.

Referring now to FIG. 1, the stern support assembly is shown in perspective and in FIG. 1b the stern saddle 50, of FIG. 1, is shown in a plane view. The stern saddle is shown to include a U-shaped receiver 51, having recesses 53 and 55 extending into support block 57. Support block 57 is supported by hinge pins 59 and 60, and support arms 61, 63, 65 and 67 (hidden). Support arms 63 and 65 comprise a first pair and support arms 61 and 67 comprise a second pair, pair 61 and 67 being hinged to pin 60 mounted within support block 57 and pair 63 and 65 being hinged to pin 59. The opposite ends of the support arms are pivotally mounted in a carriage 71, at points 73, 75, 77 and 79 (hidden). A rail system comprising rails 89 and 91 supports carriage 71. The carriage 71 includes wheels mounted at the end of each support arm adjacent the rails 89 and 91 and by means of these wheels the carriage 71 may be moved along the rails under the appropriate command from the submerged carrier. In addition, sensors are located along the rails to signal the position of the carriage 71 along the rails 89 and 91. Hydraulic cylinders 81 and 83 are attached to cross pieces 85 and 87 of carriage 71. Under the appropriate command from the carrier, the hydraulic cylinders either force the cross pieces away from each other or force the cross pieces toward each other, scissoring the support block 57 and U-shaped receiver 51 down or up, respectively.

Referring now to FIG. 1b, the apparatus for locking the DSRV and holding it in place in the U-shaped support stern saddle 51 is shown to include two dogs 93 and 95, held within support block 57. Dogs 93 and 95 are held in the withdrawn position by two springs (not shown). The DSRV possesses two mating flanges 3 and 5, which fit into recesses 53 and 55 within the U-shaped saddle. When the support block 57 is drawn down to deck 13 of the submerged carrier by the force of hydraulic cylinders 81 and 83, ends 94 and 96 of dogs 93 and 95 come in contact with deck mounted paws 97 and 99, respectively. The dogs, under the force of the paws are pushed in an upward and outward direction through openings 7 and 9 in flanges 3 and 5, respectively, and hold the vehicle locked in the stern saddle when the support block is scissored down to its anchor position on the deck of the submerged carrier. When the hydraulic cylinders 81 and 83 are activated to raise the stern saddle, the dogs 93 and 95, under the force of the springs (not shown) withdraw the dogs from the flanges 3 and 5 and release the DSRV from the stern saddle mounting 51.

Referring now to FIG. 2, a first alternative embodiment according to the principle of this invention is shown. The stern support assembly on this embodiment is the same as that used in the preferred embodiment shown in FIG. 1 and with like numerals designating the same and similarly operating parts. The forward mating head is designated generally by numeral 100 and is shown to include a support structure 103 mounted on carrier deck 13 and on which arm stanchion 103 is mounted for rotation on shaft 105. Shaft 105 can be rotated 360° about an axis perpendicular to deck 13 of the submerged carrier and is powered and controlled from within the submerged carrier. Arm boom 109 is pivotally mounted on stanchion 103 by hinge pin 107. Attached to arm boom 109 at hinge pin 111 is arm 113. Arm 113 can pivot about arm 109 by means of hinge pin 111. Attached to arm 113 at surface 114 is support 115. Mounted on support 115 is mating box 117, bumper ring 119 and the funnel shaped mating head 121. Mating ring 119 is attached to arm 113 by supports 118 shown in FIG. 2a. Mating head 121 is a funnel shaped device which is spring mounted to mating box 117 at its narrow end. The spring mounted head 121 undergoes small angular deflections under the force of the DSRV, about the point of attachment of the head 121 to the mating box 117.

The mating box 117 includes sensors for sensing the entrance of a DSRV nose probe within head 121 and includes a lock (not shown) similar to lock 27 of FIG. 1 for holding the nose probe of the DSRV attached to the forward mating head 100. The funnel shaped head 121 guides the nose probe into the locking box 121 where the locking box dogs engage with the nose probe to hold it firmly in place. Forward mating head 100 includes means, powered from the carrier vessel to rotate boom 109 about pin 107 and arm 113 about pin 111. Any conventional means such as hydraulic or electric machinery may be used for this purpose.

Referring now to FIG. 3, a second alternative embodiment according to the principles of this invention is shown to include a stern saddle assembly 130 having a U-shaped member 131 shaped to the contour of the DSRV and firmly attached to deck 13 of the submerged carrier by stanchion 133. Recesses 135 and 137 (not shown) are provided in the U-shaped saddle 131 to receive the DSRV locking flanges 3 and 5. The stern saddle 131 includes dogs, similar to the dogs 93 and 95 shown in FIG. 1b. The dogs are housed within the stern saddle 131 and are activated upon an appropriate command from the submerged carrier to engage the DSRV flanges as shown in FIG. 1b. Suitable machinery such
as hydraulic motors may be provided for this purpose.

The forward mating assembly shown in FIG. 3 is
denoted generally by numeral 140. The forward mating
assembly consists of locking mount 141 shaped to re-
cieve the DSRV nose probe and having openings 143
and 145 to engage locking dogs contained in the nose
probe of the DSRV and operated upon command from
the DSRV. Pivottally mounted to stanchion 147 by
hinge 148 is a mating boom 149. Channeled within
mating boom 149 is extensible section 151. Attached
to the top of extensible section 151 is mating ring 153
for engaging and holding the DSRV nose probe.
Extensible arms 155 and 157 are pivoted to extensible
section 151 at 159 and 161, respectively. Extensible
arms 155 and 157 are held by and slide in and out of
support arms 163 and 165, the support arms being piv-
ottally mounted to deck 13 at 167 and 169. Hydraulic
actuator 171 pivotally attached to boom 149 at hinge
point 173, raises and lowers boom 149 by rotating it
about boom hinge pin 148. Hydraulic motors or
other suitable device may be used to raise boom 149.
When boom 149 is in its vertically erect position,
extensible arms 153 and 157 are driven out of support
members 165 and 163 to raise section 151 and mating
ring 153 above the deck 13 of the submerged carrier.
Any suitable means such as hydraulic motors may be
used to extend or withdraw arms 155 and 157 from
support members 163 and 165.

Referring now to FIG. 4, the third alternative em-
bodyment according to the principles of this invention
is shown as having a stern saddle 50, substantially as
shown in the preferred embodiment of FIG. 1 and with
like numerals designating the same and similarly oper-
ating parts. The forward mating assembly generally
designated by numeral 200 is substantially similar to
the stern mating assembly, with the same numbers de-
noting the same and similarly operating parts. The dif-
ference between the forward mating assembly 200
and the stern assembly, is that the forward assembly does
not include mounting block 57 nor U-shaped receiver
51, but in its place has a U-shaped mounting block 201,
shaped to accommodate the forward section of the
DSRV. Extending through the block 201 is a U-shaped
stiff wire 203, which may be drawn into or extended
from storage members aligned with the support arms
65 and 67 (not shown). The stiff wire 203 may be with-
drawn into or extended from the support block by any
suitable power means and may be extended or with-
drawn upon appropriate command from the submerged
carrier. The extended wire in its mating position is
shown in phantom and denoted by numeral 205, 207
denotes the hook of the DSRV 209 engaging the ex-
tended stiff wire 205 and mating with the forward mat-
ing assembly 200.

OPERATION

The mating assembly shown in FIGS. 1, 1a, and 1b is
operated to deploy the vessel by releasing dogs 37 and
39 from the nose probe of the DSRV under an appro-
priate command from the submerged carrier. Hydrau-
llic cylinders 81 and 83 are then powered to drive cross
pieces 85 and 87 of carriage 71 towards each other,
thereby raising support block 57 away from deck 13 of
the submerged carrier, and dogs 93 and 95 away from
paws 97 and 99. The dogs 93 and 95, reacting to the
force of the springs (not shown) are withdrawn from
mating openings 7 and 9 within flanges 3 and 5 of the
DSRV and the DSRV can be powered free of the
mounting.

To recapture the vehicle, the stern mounting assem-
bly is scissored to its maximum vertical distance from
the deck 13 of the submerged carrier by powering hy-
draulic cylinders 81 and 83 to draw cross pieces 85
and 87 of carriage 71 towards each other. Forward mating
assembly boom 15 is extended to its maximum dis-
tance from deck 13 and rises within housing support
structure 11 and channel 17. Stowage box 35, under an
appropriate command from the submerged carrier, re-
leases sonar beacon 47, tied to the forward mating as-
sembly by wire 49. Beacon 47 emits a sonar signal
which guides the DSRV into visual contact where the
vehicle is maneuvered to capture the wire 49 in a
DSRV capture mechanism. The DSRV is then down
hauled by wire 49, with a powered assist from the
drive of the DSRV. The DSRV nose probe is drawn
into and is locked within the locking head 27. The lock-
head 27 may be rotated about axis 28 by rotating
table 21, to be in alignment with the DSRV. Upon
locking the nose probe into place in the forward mat-
ing assembly, the boom 15 is retracted into support
structure 11 and the DSRV is brought down into
contact with the stern saddle 50. The stern assembly
is then scissored down under the force of hydraulic
cylinders 81 and 83, to its anchor position where paws
97 and 99 engage dogs 93 and 95, locking the DSRV
into the stern saddle.

Referring now to FIG. 2 and FIG. 2a, the method of
operation of the first alternative embodiment is de-
scribed. The vehicle is released from its stern mating
assembly as described in regard to the preferred em-
bodyment of FIG. 1. Forward mating assembly 100,
under the appropriate command from the submerged
carrier rotates arm boom 109 about hinge pin 107 and
rotates arm 113 about hinge pin 111 to raise the DSRV
attached to mating head 121 to its extended position as
shown in FIG. 2a. The dogs within locking box 121 are
then released upon command by the submerged carrier
and the vehicle is floated back and free of the mating
head 121.

To recapture the vehicle, the mating head 119 is ex-
tended as shown in FIG. 2a. In addition to the abili-
ty to maneuver the mating head in a vertical plane above
the carrier deck the mating head may also be rotated
about an axis vertical to the carrier deck and through
shaft 105. A sonar buoy within mating head 117 emits
a signal which guides the DSRV into visual contact with
the mating head 121. When visual contact is realized,
the DSRV operator guides the nose probe into mating
ring 121 and into contact with lock box 117. Sensors
located in lock box 117 alert the operator of the mating
head, in the submerged carrier, to the fact that the nose
probe is in place and upon appropriate command, auto-
matically as in the operation of lock 21 of FIG. 1, the
dogs within lock box 121 are extended into matching
recesses in the DSRV nose probe to hold it locked in
place. The mating assembly is then lowered towards the
position shown in FIG. 2, with an assist by the DSRV
drive where the DSRV mates with the stern saddle
assembly. The forward mating assembly and the stern
assembly are then drawn down to the anchor position
where the vehicle is locked in place.

Referring now to FIG. 3 and FIG. 3a, the method of
operation of the second alternative embodiment ac-
ording to the principles of this invention is shown. To
release the vehicle, the dogs insertedly fitted into openings 143 and 145 within forward mating head 141 are retracted upon command from the DSRV vehicle. The stern saddle dogs inserted in the DSRV flanges 3 and 5 are similarly withdrawn upon command from the DSRV vehicle and the DSRV is floated free of the carrier vessel.

To recapture the DSRV, reference is now made to Fig. 3a. Boom 149 under the force of hydraulic cylinder 171 is extended to a vertical position with respect to the carrier deck 13. Extendable section 151 is then vertically extended from boom 149 by hydraulic cylinders or any other suitable devices which drive extendable arms 155 and 157 from within support arms 163 and 165. The DSRV is guided to mating head 153 by a sonar buoy and upon making visual contact the DSRV nose probe is inserted into mating head 153 and locked. Mating head 153 and extendable section 151 are then drawn down into boom 149 under the force of hydraulic actuator 171 and extendable arms 155 and 157 driven back into support arms 163 and 165, until the DSRV nose probe makes contact with mounting block 141. DSRV nose probe dogs are then inserted into recesses 143 and 145, the DSRV disengaged from head 151 and boom 149 is then rotated about hinge 148 by hydraulic cylinder 171 to its rest position, shown in Fig. 3, and the DSRV is anchored to the stern saddle 131.

Referring now to Fig. 4, the method of operation of the third alternative embodiment is shown. Stiff wire 203 is extended away from the forward mounting portion and the deck 13 of the carrier vessel to its extended position shown in phantom and designated by numeral 205. The DSRV is maneuvered into visual contact with the carrier vessel where it snares stiff wire 205 with DSRV hook 207. Stiff wire 205 is then retracted into the forward mounting portion, forcing the DSRV into contact with stern saddle 50. The stiff wire is then withdrawn into the forward mating portion forcing the DSRV onto impact blocks 211 and 213 and at the same time the stern saddle is retracted to its anchor position. The stern saddle dogs then engage the DSRV flanges 3 and 5, locking the DSRV stern and the DSRV forward portion is held fast to the forward mating portion 200 by stiff wire 203.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A subsurface submersible system for mating with and deploying a vehicle from a submerged carrier vessel, comprising:
   a forward portion having means for connecting to a submerged vehicle and a support structure mounted to the upper deck of the carrier;
   means for extending said connecting means in a vertical plane away from the upper deck of the carrier and for forcing the submerged vehicle, when engaged with said connecting means, down towards the upper deck of the carrier;
   a stern portion comprising a means for receiving and holding the stern of said submerged vehicle;
   means for locking said submerged vehicle to said stern receiving means; and
   means for moving said stern receiving means along the deck of the carrier and for moving said receiv-

2. The mating system of claim 1, wherein:
   said connecting means comprises a telescoping boom mounted in said support structure for movement along its longitudinal axis and for rotation about said longitudinal axis;
   said boom having a means for mating with and locking the submersible vehicle to said forward portion;
   means pivotally connecting said locking means to said boom; and
   means for rotating said boom about said longitudinal axis.

3. The mating system of claim 2, wherein:
   said pivotal connecting means includes at least one spring connecting said locking means to said boom;
   said locking means including opposed dogs for insertion into said submerged vehicle, to anchor said vehicle;
   said locking means including a float and a wire attached to said float at one end and to said boom at its other end; and
   means for retracting said wire and said float into said boom for down hauling said submerged vehicle into mating contact with said locking means.

4. The mating system of claim 1, wherein:
   said connecting means comprises a boom arm mounted to said support structure for pivoting movement about an axis perpendicular to said vertical plane; and
   means to rotate said boom about said perpendicular axis.

5. The mating system of claim 4, wherein:
   an arm is pivotally mounted on said boom arm;
   said arm having means, for mating with and locking the vehicle to said arm, connected to said arm at an end opposite to said pivotal connection;
   means to pivot said arm about said boom;
   said means to rotate and said means to pivot moving said locking means in said vertical plane;
   said locking means including a funnel open at its wide end;
   a locking box;
   said funnel being pivotally attached to said locking box at its narrow end; and
   a bumper ring connected to said arm and concentric with said funnel.

6. The mating system of claim 4, wherein:
   said boom includes an extensible section mounted for movement along the longitudinal axis of said boom to extend or retract said section from said boom;
   means to extend and retract said extensible section;
   a mating ring attached to said section for engaging and holding said submerged vehicle; and
   means for anchoring said submerged vessel.

7. The mating system of claim 1, wherein:
   said forward portion support structure includes a carriage mounted for movement in the plane of said carrier vessel deck;
   at least one pair of support arms pivotally mounted to said carriage at separate points and aligned in the path of movement of said carriage;
   said support arms being pivotally connected to each other at its ends opposite from its connection to said carriage;
   a mounting block supported on said support arms at its ends pivotally connected to each other;
means to drive said support arm ends pivotally connected to said carriage towards each other or away from each other to raise or lower said mounting block; and means extendable from said mounting block for engaging said submerged vehicle.

8. The mating system of claim 7, wherein: said means for engaging is a U-shaped wire; and including means for extending said wire.

9. The mating system of claim 1, wherein: said means for moving said receiving means includes at least one pair of support arms pivotally connected to said means for moving at separate points on said means for moving; said support arms being pivotally connected to each other at their ends opposite their connection to said means for moving;

said receiving means being mounted on said support arms at said point of connection to each other; and means to drive said separate support arm ends toward each other or away from each other to move said receiving means in said vertical plane.

10. The mating system of claim 9, wherein: said receiving means includes a plurality of recesses for receiving the submerged vessel mating flanges; a plurality of pawls mounted on said carrier vessel deck; said receiving means having a plurality of dogs for engaging with said pawls; and said dogs being driven into said mating flanges when said receiving means is driven toward said carrier deck and said pawls engage said dogs.

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