United States Patent [19]

Tryon

[11] **3,987,741**

[45] **Oct. 26, 1976**

[54] **REMOTE UNMANNED WORK SYSTEM (RUWS) MATING LATCH**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

[22] Filed: **Jan. 12, 1976**

[21] Appl. No.: **648,220**

[52] **U.S. Cl.** .... **114/16 R;** 61/69 R; 114/51; 114/235 A; 285/DIG. 21; 294/83 AA

[51] **Int. Cl.**[2] **B63G 8/00;** B63G 8/42

[58] **Field of Search** .... 114/16 R, 16.4, 51, 114/235 A; 61/69 R, 69 A; 294/83 AA; 403/316, 317, 322, 321; 285/18, 316, DIG. 21

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Assistant Examiner—Gregory W. O'Connor
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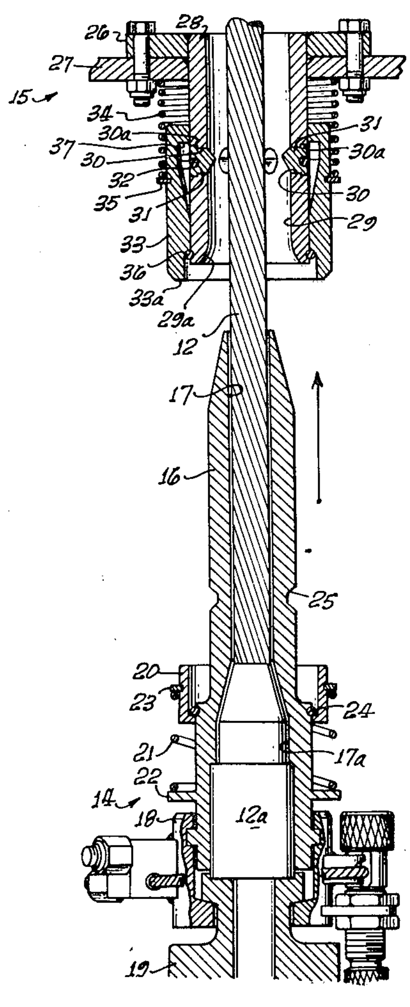
[57] **ABSTRACT**

A remote interconnection of a first undersea vehicle tethered to a second undersea vehicle is assured by mating assemblies carried on both vehicles. The tethering cable extends through a prod assembly carried on the tethered vehicle and functions mainly to deploy and retrieve the tethered vehicle. During the connection of the two vehicles the cable serves to draw the prod assembly into a latching assembly carried on the second undersea vehicle. Several pawls are cammed into an annular groove on the prod assembly and a pair of opposing helical springs mechanically interact to lock the pawls in place. The coaction of the springs' working on a collar on the prod assembly and a sleeve on the latching assembly makes accidental disengagement nearly impossible until hydraulic actuators assist the force produced by the sleeve spring to overcome the force exerted by the collar spring to release the pawls.

7 Claims, 4 Drawing Figures



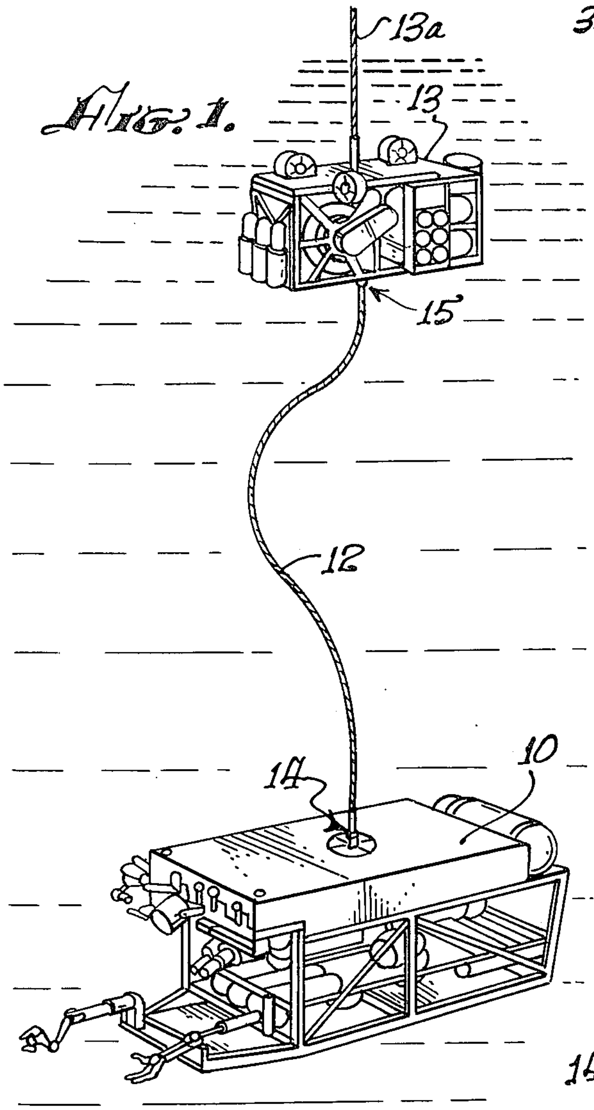
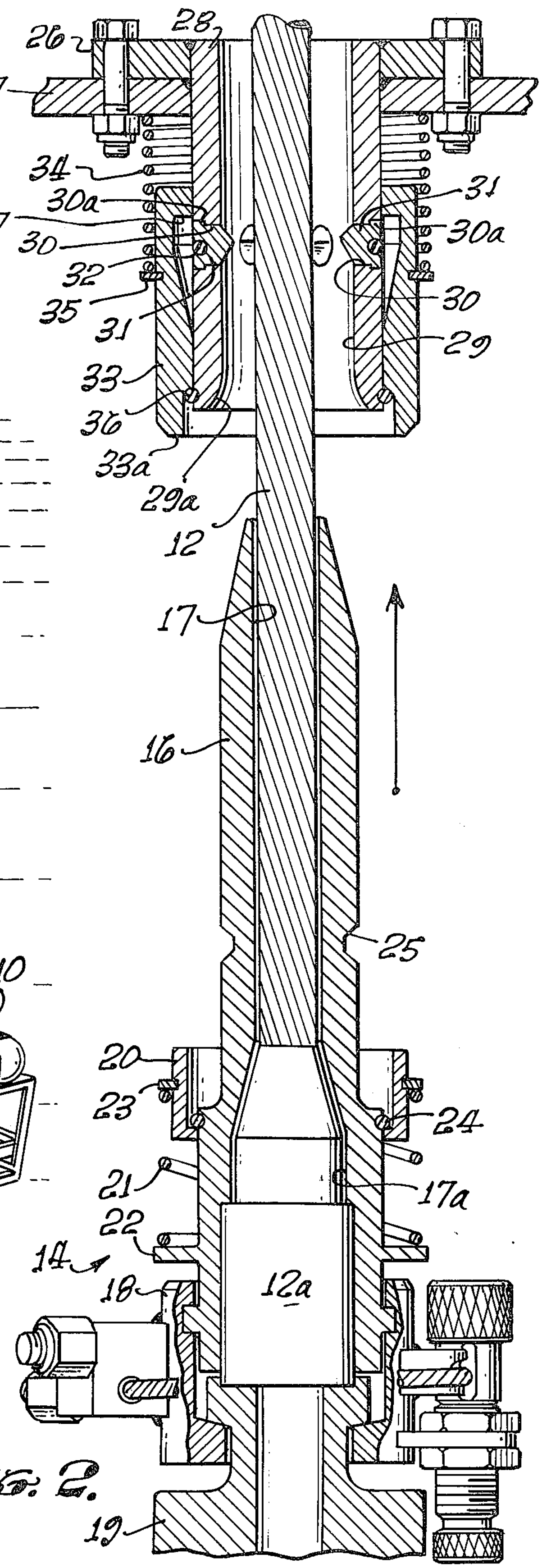

13a
13
15
12
14
10

FIG. 1.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12a
19

FIG. 2.

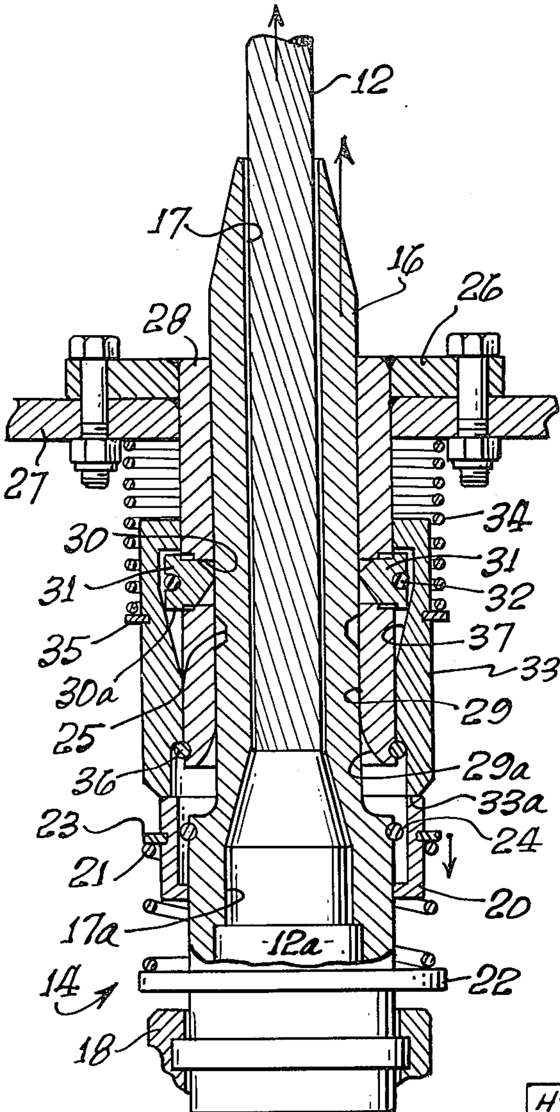
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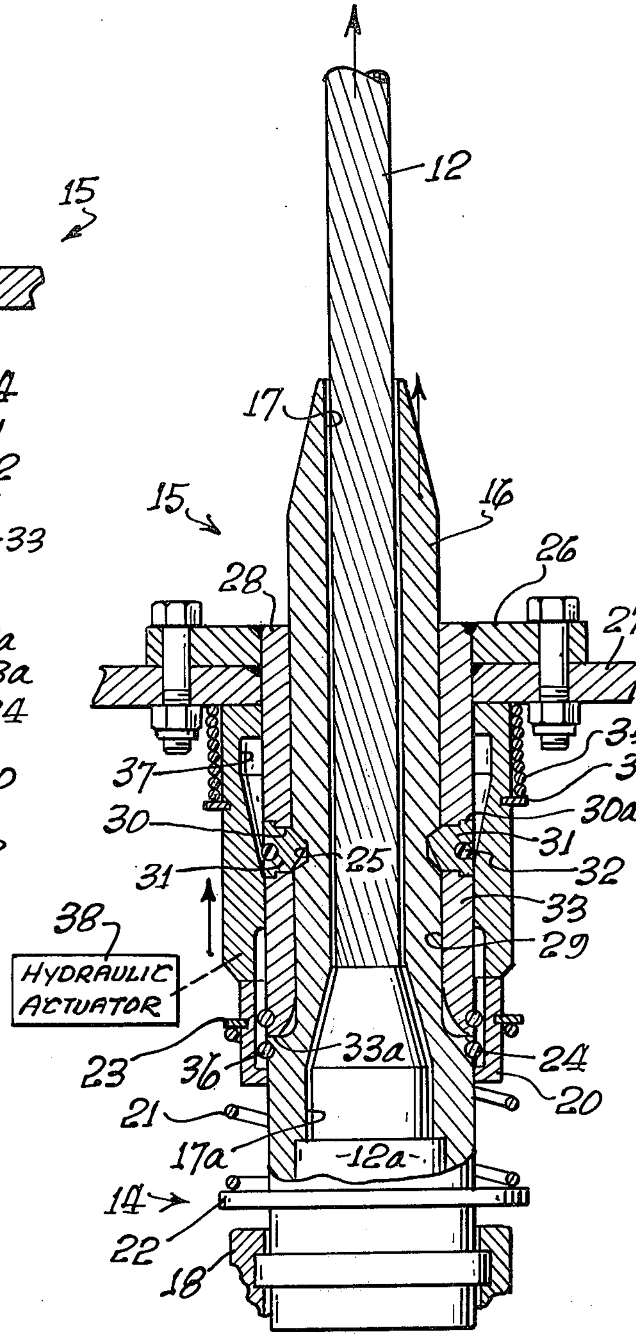
Fig. 3.


12
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30a
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32
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38
HYDRAULIC
ACTUATOR
29
23
36
33a
24
21
20
17a
12a
14
22
18

Fig. 4.

REMOTE UNMANNED WORK SYSTEM (RUWS) MATING LATCH

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

Mechanisms for coupling vehicles, structural elements or machinery for that matter are many and varied in design. Usually the mechanical coaction called for represents an end product which is commensurate with the evolution of a system. As an example, the technological advancements in undersea technology have fostered a whole new breed of sophisticated undersea craft. Some of the latest developments in this field are the family of unmanned undersea vehicles usually controlled from the surface. Unmanned vehicles have a number of features making them particularly acceptable when hazardous conditions are expected. A recent development has extended the capabilities of existing tethered vehicles. The system is generally referred to as the remote unmanned work system (RUWS). RUWS is capable of performing underwater search, inspection, work, and object recovery tasks at great ocean depths and is provided with acoustic and visual sensing and location devices. This system deploys an interconnected secondary vehicle and a tethered primary vehicle by a relatively heavy cable which also transmits electric power lines and command and control lines etc. The primary vehicle disconnects from the secondary vehicle at or near the work site at a predetermined depth. It is tethered to the secondary vehicle via a lighter weight cable which also feeds power and control signals. The tethered vehicle carries the tools necessary to perform a task and support equipment such as lights, cameras, etc., while the secondary vehicle acts as a platform for power conversion equipment, signal processing circuitry, etc. The advantages of such an arrangement are obvious. Once the task is completed the primary vehicle becomes connected to the secondary vehicle and the entire package is retrieved by a surface support vessel via the heavy cable. Heretofore, problems have arisen because of the coupling between the two vehicles. If the two vehicles are not capable of joining and separating reliably, there is a possibility of damage and consequent mission ineffectiveness. A continuing need exists in the state-of-the-art for a mechanism which ensures reliable joining and separation of a pair of tethered vehicles remotely from a support ship.

SUMMARY OF THE INVENTION

The present invention is directed to providing an apparatus for remotely connecting a primary underwater vehicle tethered by a cable to a secondary underwater vehicle. A prod assembly is mounted on the primary underwater vehicle and includes an elongate prod provided with a coaxial bore sized and shaped to receive and retain the cable therein. An annular groove is machined on the outer surface of the prod and a collar is slidably mounted on the prod and is biased toward the prod's annular groove. A latching assembly is mounted on the secondary underwater vehicle and has a tubular fitting provided with an axial bore sized to slidably receive the prod assembly. The plurality of pawls extends through the tubular fitting and a sleeve slidably carried on the tubular fitting has an interior annular recess for receiving the pawls. The sleeve is biased to a position radially aligning the pawls with the annular recess in the sleeve, upon insertion of the prod assembly in the latching assembly, the biased collar is displaced until the pawls are cammed into the annular groove on the prod at which time the sleeve is axially displaced by the collar to lock the pawls in the annular groove of the prod thereby securing the two assemblies together.

An object of the invention is to provide an improved connection between two tethered underwater vehicles.

Another object is to provide an underwater connection made up of a prod assembly carried on a tethered vehicle and a latching assembly mounted on a secondary vehicle.

Another object is to provide a connection relying upon a coaxially mounted tether cable joining two undersea vehicles together.

Yet another object of the invention is to provide a connection having the capability to be remotely coupled and uncoupled.

Still another object is to provide a connection between undersea vehicles having a locking capability.

A further object is to provide a mechanism for possessing an inherently high degree of reliability by reason of its straightforward, uncomplicated design.

These and other objects of the invention will become more readily apparent from the ensuing description when taken with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric depiction of a portion of the RUWS system.

FIG. **2** is a cross-sectional view of the invention with the two assemblies approaching one another.

FIG. **3** is a cross-sectional view of the invention showing the partial engagement of the two assemblies.

FIG. **4** is a cross-sectional view of the invention fully engaged and locked.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIG. **1**, a representative embodiment of the RUWS system is depicted as it seeks to accomplish some undersea task. A tethered work vehicle **10** is coupled to the end of a cable **12** which reaches from a secondary vehicle **13.** The secondary vehicle is suspended by a heavy duty main cable **13*a*** which supplies the power and control functions for the system.

The tethered vehicle can be provided with a variety of devices such as a pair of manipulator arms, flood lights, television cameras, hydraulic actuators, etc. for performing underwater tasks. The secondary vehicle houses most of the support equipment for the primary vehicle such as power conversion units, hydraulic pressure sources, etc.

The cable interconnecting the two vehicles is not as substantially constructed as the main cable, yet it possesses sufficient strength to withstand the abuses of working at extreme depths in the ocean. It may have a multiconductor core for transmitting power and control signals to the tethered vehicle. Optionally, the tethered cable is neutrally buoyant by the inclusion of a number of flotation elements along its length.

The RUWS system is primarily designed for working at great depths. Experience has demonstrated that deployment to the great depths is expedited when the primary work vehicle and secondary support vehicle are connected together during descent and ascent. Once at the desired working depth, the vehicles separate and the primary tethered vehicle is released to accomplish its task.

Highly reliable interconnection between the two vehicles during launch and recovery is assured by the inclusion of a prod assembly **14** carried on the tethered vehicle and a latching assembly **15** mounted on the secondary vehicle.

Looking to FIG. **2**, showing the two assemblies approaching each other, it is apparent that tethering cable **12** coaxially extends through both the prod assembly and the latching assembly. The cable is reeled in and reeled out of vehicle **13** and is anchored in a prod assembly by a swaged slug **12*a*** on its distal end. Power and control conductors extend into the tethered vehicle to perform various functions although they are not shown in the drawings while the load bearing components of the tethered cable terminate in the swaged slug.

The prod assembly includes an elongate prod having a tapered nose portion and is provided with a central bore **17**. The bore has a diameter sized to receive the tethering cable and an inner portion **17*a*** is enlarged to accommodate the swaged slug. A split collar **18** on the opposite end of the prod secures the prod assembly to a structural member **19** located on the upper surface of the tethered vehicle.

An actuator collar **20** is slidably carried on the outside of an enlarged portion of the prod and is axially forced toward the tip of the prod by a helical biasing spring **21** exerting equal and opposite forces against a rim **22** and a retaining clip **23**. The actuator collar is prevented from sliding off the prod by a retaining clip **24** that bears against an inner rim of the actuator collar.

The outer surface of the prod is shaped with an annular groove **25** circumferentially reaching about the prod. The annular groove is disposed for mechanical coaction with latching assembly **15** as the elongate prod slides within a flanged member **26**.

The flanged member is anchored to a structural element **27** on vehicle **13** and is welded to a tubularly shaped member **28**. The inside of the tubularly shaped member is formed with an axial bore **29** sized to slidably receive elongate prod **16**. To facilitate entry of the prod in the latching assembly, an outer lip **29*a*** is machined to have a slightly tapered surface to accommodate insertion of the prod.

A number of openings **30** is provided in tubularly shaped member **28** and each have shoulder portions **30*a***. Each of the openings is sized to contain a pawl **31** held therein by a ring shaped resilient retainer **32**. In a preferred embodiment of this invention six palls were included being equidistantly circumferentially spaced in a correspondingly number of openings in the tubularly shaped member. Although only two openings and their respective pawls are depicted in the drawings, it is understood that this arrangement is only meant to be representative to show the inventive concept.

A sleeve **33** is carried on the outer surface of the tubularly shaped member and is capable of reciprocal motion thereon. At the furthermost extension of the sleeve a surface **33*a*** is formed that is dimensioned to be longitudinally aligned with actuator collar **20** of the prod assembly.

A helical biasing spring **34** tends to urge the sleeve beyond the end of the tubularly shaped member as it exerts a pushing force between a retainer ring **35** and an outer surface of structural member **27**. The sleeve is retained on the tubularly shaped member by a keeper ring **36** mounted in a groove provided in the mouth of the tubularly shaped member.

When the sleeve is so extended an annularly tapered recess **37** is aligned with openings **30**. This deposition allows the recess to receive the pawls in a manner to be elaborated on below.

The spring constant of spring **34** and the force exerted is less than the spring constant and force of the biasing spring **21**. The specific feature ensures reliable locking of the prod assembly and the latching assembly.

Looking to FIG. **2** prod assembly **14** is being drawn into latching assembly **15** by cable **12**. Resilient retainer **32** pushes the pawls into axial bore **39** of the tubularly shaped member. As the nose of prod **16** passes the pawls, it cams them into the circumferentially aligned annular tapered recess **37**.

Further motion by the prod into the tubularly shaped member brings axially aligned surface **33*a*** into contact with actuator collar **20**. Since the pawls are pressed against the outer surface of elongate prod **16**, they cannot be cammed from annular tapered recess **37** by displacing the sleeve. As tethering cable **12** exerts more force to draw the prod assembly further into the latching assembly, the stronger biasing force of biasing spring **21** is overcome yet biasing spring **34** remains relatively uncompressed. This is because the pawls **32** are wedged between an outer surface of prod **16** and the inner surface of annular tapered recess **37**.

However, when annular groove **25** becomes aligned with openings **30** and their respectively contained pawls **31**, biasing spring **21** is no longer retained by the otherwise wedged pawls and the spring pushes sleeve **33** toward structural member **27**. This motion compresses spring **34** and cams the pawls into locking engagement in annular groove **35** on the prod. The latching prod now has securely locked the prod assembly in place and the two vehicles are secured together.

Unlocking the two assemblies becomes a simple operation. An interconnected hydraulic mechanism, schematically shown by reference character **38** feeds pressurized fluid to an appropriately coupled piston to overcome the biasing force of biasing spring **21**. The hydraulically induced force displaces sleeve **33** toward structural member **27**.

The retaining tension is relaxed on tethering cable **12** and the weight or downward thrust from tethered vehicle **10** pulls on prod **16**. Pawls **31** are cammed out of annular groove **25** in the prod and are repositioned in the radially aligned tapered recess **37**. Cable **12** is unreeled from the secondary vehicle and the primary vehicle is remotely deployed. After completion of a task, the vehicles are rejoined as described above.

What has been described in a positive method and apparatus for interconnecting two remotely operating submersibles. This deployment and recovery pose less of a possibility of accidently damaging the vehicles since they are securely interconnected. A tethering vehicle is positively releaseable to perform its undersea task.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than specifically described.

What is claimed is:

1. Apparatus for remotely connecting a primary underwater vehicle tethered by a cable to a secondary underwater vehicle comprising:

a prod assembly mounted on the primary underwater vehicle including

an elongate prod provided with a coaxial bore sized and shaped to receive and retain the cable therein and further provided with an annular groove on its outer surface,

a collar slideably mounted on the prod in a position spaced from the annular groove and

means carried on the prod for biasing the collar toward the annular groove and

a latching assembly mounted on the secondary underwater vehicle including,

a tubular fitting having an axial bore sized to slideably receive the prod assembly therein and being provided with a plurality of openings,

at least one pawl extending through the openings and partially into the axial bore

a sleeve slideably mounted about the tubular fitting having an interior annular recess for receiving the pawl,

means for biasing the sleeve to a position radially aligning the pawl with the annular recess, upon insertion of the prod assembly in the latching assembly, the collar biasing means first compresses until the pawl is cammed into the annular groove on the prod at which time the force of the collar biasing means overcomes the sleeve biasing means axially displacing the sleeve to lock the pawl in the annular groove of the prod.

2. An apparatus according to claim 1 further including:

means for retaining the collar at an extended position on the prod and

means for retaining the sleeve at an extended position on the tubular fitting to ensure the aligned coaxial engagement of the collar and tubular fitting as the prod enters the tubular fitting.

3. An apparatus according to claim 2 in which the collar biasing means and the sleeve biasing means are a helical collar spring and a helical sleeve spring, the collar spring has a greater spring constant than the sleeve spring to ensure the positive engagement of the pawl in the annular groove of the prod.

4. An apparatus according to claim 3 in which there are provided a plurality of pawls circumferentially equidistantly spaced in the tubular fitting.

5. An apparatus according to claim 4 in which the collar and prod are provided with a ring and rim respectively to hold the collar spring therebetween and the sleeve and tubular fitting are provided with a ring and surface respectively to hold the sleeve spring therebetween to ensure the extended positioning of the collar and sleeve.

6. An apparatus according to claim 5 in which the prod has a tapered nose section and the tubular fitting has a tapered lip to facilitate engagement.

7. An apparatus according to claim 6 further including:

means coupled to the sleeve for axially displacing it to overcome the biasing force of the collar spring thereby permitting the annular groove on the prod to cam the pawls into the annular recess and release the prod assembly from the latching assembly.

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