The interiors of the area 12 and the segments 13 and 14 are cylindrical and the couplings between the sliding members of the structure are made watertight by a series of cylindrical bellows seals 22, 23 and 24. The outermost seal 22 prevents water from entering the interior of the structure between the storage area 12 and the segment 13, the intermediate seal 23 prevents water from entering the interior between the segments 13 and 14, and the innermost seal 24 prevents water from entering between the segment 14 and the carriage 15.  

FIGURES 2-5 are detailed illustrations of this structure. FIGURE 2 showing the details of the left end section that includes the pulley 17, FIGURE 3 showing the details of the section that includes the coupling between the storage area 12 and the segment 13, FIGURE 4 showing the details of the section that includes the coupling between the two segments 13 and 14, and FIGURE 5 showing the details of the section that includes the antenna probes 16 and the carriage 15.  

The apparatus illustrated in FIGURE 2 is mounted within the interior of the hull 11 behind the storage area 12 and includes a container 25 that is fixed to the storage area 12 by suitable means such as bolts or welding. Mounted within this container 25 is a motor and transmission box 26 which is coupled to drive the cable storage pulley 17 and the retracting cable 19. This is preferably an electric motor which is coupled to a suitable source of electric power by a coupling 27 and a power line 27'a which are mounted on the container. The retracting cable 19 is looped around an idler pulley 28, which is mounted on a bracket 29, and rests on a guide 30 which keep the cable 19 on a straight line down the center of the segments 13 and 14.  

The container 25 is made air tight by seals 31 between this container and the hull 11 and by seals 32 between the container 24 and an access cover 33, which is fastened to a flange 34 on the container 24 by a plurality of bolts. The source of fluid under pressure is fastened to a coupling 35 and a conduit 36, the coupling 35 being mounted in one wall of the container 25. When the antenna probes 16 are to be extended to their outermost points, the fluid source is turned on and it fills the container 24, the storage area 12, and the casing segments 13 and 14, and force these elements and the carriage 15 outwardly. Later when the antenna is to be retracted the pressure is withdrawn and electric power is applied to the electric motor drive. The retracting cable 19 then winds up around the cable storage pulley 17 and causes the carriage 15 and antenna probes 16 to be drawn into the interior of the casing segment 14 and the two segments 13 and 14 to be drawn into the antenna storage area 12.  

The cable 21 which connects to the antenna probes 16 is preferably a coaxial cable which follows a spiral path around the retracting cable 19. The rearward of this cable is held in place by a clip 37 that is fastened to the guide 30 stand, and it is electrically coupled to a tuner 38 by means of an electrical coupling 39.  

A structural ring 39 is fastened to the casing for the storage area by a plurality of bolts. Another bolt 41 extends through the stand for the guide 30, a spacer 42, the structural ring 39, and a bellows mounting ring 43, thereby mechanically coupling the guide 30 stand and the ring 43 to the structural ring 39 and the vessel hull. The bracket 29 for the idler pulley 28 is also mounted on this structural ring.  

A cylindrical bellows seal 22 is fastened to the bellows mounting ring 43 by suitable means such as bolts, and two annular seals 45 and 46 are seated in grooves formed in the structural ring 39. These seals prevent water from passing from the space on the outside of the bellows seal
into the container with the result that the interior of the vessel and the container are made watertight.

FIGURE 3 is a detailed illustration of the coupling between the casing for the antenna storage area 12 and the casing segment 13. The antenna storage area 12 includes the bore 50 that receives the cylindrical casing segment 13. The segment 13 rides on two sleeve bearings 51 and 52, both being fastened to the segment 13. These two bearings may be formed in a continuous ring around the segment 13 or they may be a plurality of arcuate strips that are spaced at substantially equal angular distances around the segment 13. The bearings can be fastened in any suitable means, and the bearing 52 is prevented from moving by a snap ring 55.

A cylindrical bellows support 56 is threaded into the interior surface of the casing segment 13 and is fastened directly to the outer end of the bellows seal 22. The innermost end of the bellows support 56 is fastened to a second bellows mounting ring 57 which supports the intermediate bellows seal 23. The bellows mounting ring 57 is held in place on the bellows support 56 by a portion 59 which fits into a groove formed in the support 56, and a seal 60 makes the connection between the ring 57 and the support 56 watertight.

Water may enter the bore 50 in the space between the inside of the storage area 12 and the outside of the outermost bellows seal 22, the interior of the antenna structure is still dry because of the bellows seal 22 which is fastened in a watertight manner between the outside of the casing segment 13 and the inside of the antenna storage area 12.

A seal bleed 61 is formed in the casing segment 13 so that air and water can pass into and out of the bore 50 of the storage area as the segment 13 is being extended and retracted. A circular scraper 62 is fastened to the mouth of the bore 50 and bears against the segment 13 and removes debris.

FIGURE 4 gives a detailed presentation of the details of the coupling between the two casing segments 13 and 14. These two segments are hollow cylinders and two circular bearings 65 and 66, which are fastened to the segment 14, provide a bearing surface between them. Once again, a key 67 fastened to the inner casing segment 14 rides in a keyway 68 formed in the segment 13 and guides the relative movement of these two segments. The outer segment 13 also has a scraper 69 fastened to it by a bolt 70, which bears against the inner segment 14 and removes debris when the antenna is being retracted. A cylindrical bellows support 71 is threaded into the interior of the casing segment 14 and is fastened to the outer end of the intermediate bellows seal 23. The end of the bearing support 71 is fastened by a bolt 72 to another bellows mounting ring 73 which in turn is fastened to the innermost bellows seal 24. A ring seal 75 and a guide member 76 are fastened between the bellows support 71 and the bellows mounting ring 73, the guide member 76 ensuring that the retracting cable 19 and the coaxial cable 21 will remain in approximately the center of the casing segments and not get snagged on any of the moving parts.

Once again it can be seen that in the event water enters the interior of the casing segments 13 it will be prevented from entering the interior of the segment 14 due to the watertight coupling presented by the bellows seal 58. A seal bleed 77 is again formed in the casing segment 14 which permits air and water to flow when the antenna is being extended and retracted.

With reference to FIGURE 5, four equally spaced antenna probes 81 are mounted on the carriage 15 in the casing segment 14. The probes 81 include metallic cylinders 80 which are wrapped in a sheath 81 of an insulating material such as plastic. Each antenna probe is slidably held in a sleeve 82 made of insulating material which is rotatably mounted in a bracket 83. The circular bracket is in two parts and a central screen 84 is held in place between them to keep out debris. A plurality of bolts 85 fasten the bracket 84 to the carriage 15.

The carriage 15 includes a metallic mounting bracket 86 that is pivotally linked to the four metallic antennas 80 by four metallic pins 87. These pins 87 are preferably silver coated to reduce resistance. The outside of the mounting bracket 86 is also coated with an insulating material 88, such as plastic, and the couplings between probes 16 and the mounting bracket 86 are covered in each case by a reinforced cylindrical boot 89, also made of an insulating material. Two tension bands 90 and 91 are provided for each boot 89 to hold them in place. The electrical connection to the metallic antennas 80 from the coaxial cable 21 is made through a conventional coaxial connector 92, the mounting bracket 86 and the pins 87. A waterproof insulating material 93 encloses this connector 92.

The metallic mounting bracket 86 is threaded into an annular member 94, made of an insulating material, which in turn is mounted on a sleeve 100 by a plurality of set screws 100a. The sleeve 100 slides along the interior of the casing segment 14 and has a key 101 which rides in a keyway 102 and guides the movement of the carriage.

The retracting cable 19 is coupled to the carriage 15 by a plurality of links 95 that are threaded at one end into a plurality of yokes 96 and at their other ends to a coupling 97. The yokes 96 are fastened to the carriage by pins 98 that extend through the yokes 96 and an annular bellows mounting ring 99. The ring 99 is fastened to the bellows 24 and is threaded into the sleeve 100 that also receives the member 94. Two circular seals 103 and 104 are positioned between the sleeve 100, the ring 99 and the member 94 make the coupling with the sleeve watertight.

In the event water enters the interior of the casing segment 14, it cannot reach the interior of the antenna structure and the electrical connections because of the watertight coupling presented by the bellows seal 74 and the seals 103 and 104. Once again, a seal bleed 105 formed in the sleeve 100 permits air and water to flow into and out of the interior of the casing segment 14 from the outside of the bellows seal 74 as the carriage 15 is being extended and retracted.

The telescoping members may be so constructed that when they are pulled by the cable 19 to their most retracted positions, the telescoping members bear against each other and make the structure better able to withstand the high pressure encountered during dives. For example, the innermost ends of the bellows supports 76 and 71 may bear against the mounting rings 43 and 57.

When the carriage 15 is pulled tightly in, the bellows seal 24, in its collapsed position, has sufficient strength to withstand these pressures. It is apparent that the small openings between the members reduces the water pressure on these bellows seals, and air pressure may be maintained within the structure to support the bellows seals.

The antenna storage area 12 may be constructed in the hull 11 so that its mouth is flush with the hull, or it may be projected as shown. While four whip antenna probes 16 are shown mounted on the carriage, it is obvious that a greater or lesser number can be used, or entirely different types may be used. Also, additional telescoping segments can be used.

It is apparent that a novel and useful antenna structure for a submersible vessel has been provided. The antenna structure is easily extended for operation when the vessel is surfaced by injecting a gas under pressure into the interior of its telescoping casing segments which forces these segments to their extended positions. This action also causes the retracting cable 19 to unwind from the cable storage pulley 17. When the structure is so extended it rises to a considerable height, and, even at this height, it is still sturdy enough to withstand the forces of high winds and rough water. When the
vessel is preparing to submerge the motor attached to the pulley storage cable pulley 17 is energized which causes the cable 19 to wind up around the pulley 17 and pull the carriage 15 and the two telescoping casings 13 and 14 into the antenna storage area 12. The bellows seals coupling these telescoping members together makes the apparatus watertight. The external surfaces of the casing segments are perfectly smooth and snug free, and the antenna circuit is insulated and located inside of the dry antenna structure.

It will be apparent that other modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A retractable antenna structure adapted to be installed on submersible vehicles comprising at least outer and inner telescoping segments, an antenna carriage mounted within said inner segment, means for mounting said outer segment on the vehicle, a first bellows seal coupling said outer segment to the vehicle, a second bellows seal coupling said outer and inner telescoping segments, and a third bellows seal coupling said carriage to said inner segment, a retracting cable connected to said carriage and adapted to be connected to a drive motor for retracting said antenna structure, means for coupling a source of gas under pressure to the interior of said outer and inner segments, and electrical cable means connected to said antenna probe which is adapted to be connected to an electrical circuit means.

2. A retractable antenna structure adapted to be installed in a submarine comprising an antenna storage area constructed in the submarine, a first segment slidably mounted within said storage area, a second segment slidably mounted within said storage area, a first bellows seal coupling said antenna storage area to said first segment, a second bellows seal coupling said first segment to said second segment, a third bellows seal connecting said second segment to said carriage, at least one antenna probe mounted on said carriage and retractable within said carriage in fluid tight relation therein, a retracting cable coupled to said carriage and adapted to be connected to a drive motor, means for coupling the interior of said first and second segments and said antenna storage area to a source of pressurized gas, and electrical cable means connected to said antenna probe which is adapted to be connected to a tuner.

3. A retractable antenna adapted to be installed in a submarine comprising an antenna storage area, means for coupling the interior of said antenna storage area to a drive motor, means for retracting at least one antenna probe within said segment, first bellows seal means coupling said antenna storage area to said segment, second bellows seal means coupling said segment to said antenna probe mounting means, a retracting cable connected to said probe mounting means which is adapted to be coupled to a drive motor, means for coupling a source of pressurized gas to the interior of said antenna storage area and said segment, and means electrically connecting said antenna probe to an electric circuit means.

4. A retractable multiple whip antenna for a submarine comprising an antenna storage area adapted to be installed in the submarine, said antenna storage area having a substantially cylindrical bore which is adapted to slidably receive a cylindrical first casing segment, airtight container mounted on said antenna storage area over one end of said bore, first bellows seal connected between the inside of said antenna storage area and the outside of said first casing segment, said first casing segment having a substantially cylindrical bore which is adapted to slidably receive a cylindrical second casing segment, second bellows seal coupling the inside of said first segment to the outside of said second segment, said second segment having a substantially cylindrical bore which is adapted to slidably receive an antenna probe carriage, third bellows seal connecting the inside of said second segment and said antenna carriage, at least one antenna probe mounted on said carriage and retracted therein, a retracting cable connected to said antenna carriage and running down the center of said first and second segments and said antenna storage area to a drive motor, said drive motor being mounted within said airtight container, an electrical cable connected to said antenna probe and coiled within the center of said first and second segments and said antenna storage area and adapted to be connected to a tuner, and means mounted on said airtight container for coupling the interior of said container to a source of pressurized gas, the construction being such that said segments and said carriage are extended when the pressurized gas is applied and said segments and carriage are retracted when said drive motor is energized.

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