

United States Patent [19]**Stein**[11] **3,911,441**[45] **Oct. 7, 1975****[54] MULTIPURPOSE ANTENNA SYSTEM FOR A SUBMARINE****[75] Inventor:** Ira S. Stein, Fairlawn, N.J.**[73] Assignee:** International Telephone and Telegraph Corporation, Nutley, N.J.**[22] Filed:** Oct. 9, 1973**[21] Appl. No.:** 405,719**[52] U.S. Cl.** 343/709; 343/725; 343/872; 343/876**[51] Int. Cl.²** H01Q 1/34**[58] Field of Search** 343/709, 725, 883, 895, 343/872, 876**[56] References Cited****UNITED STATES PATENTS**

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[57]**ABSTRACT**

There is disclosed herein a multipurpose antenna system for a submarine having a hollow mast capable of movement into and out of a submarine hull. A first antenna system is mounted at the top of the mast with this first antenna system being capable of transmitting and receiving in a time shared relation a radar signal and a satellite communication signal. A second antenna system is disposed in the mast below the first antenna system. This second antenna system is capable of receiving an electronic countermeasure signal. The second antenna system includes a plurality of different antennas disposed in spaced relation with respect to each other about the circumference of a transverse cross-section of the mast. The plurality of different antennas are flush mounted with respect to the outer surface of the mast. Each of the plurality of different antennas of the second antenna system employs two printed circuit spiral antennas stacked in the same plane one above the other with one of the spiral antennas being responsive to right-hand circular polarization and the other spiral antenna being responsive to left-hand circular polarization. A switching arrangement is coupled to each of the spiral antennas to appropriately cause the plurality of spiral antennas to scan 360° in both left-hand and right-hand circular polarization.

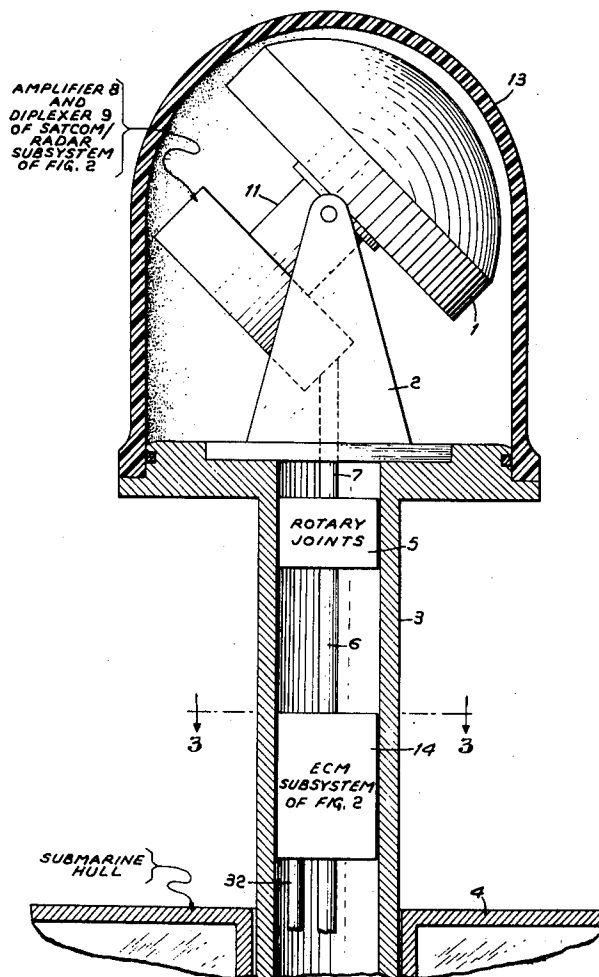
15 Claims, 6 Drawing Figures

Fig. 1

AMPLIFIER 8
AND
DIPLEXER 9
OF SATCOM/
RADAR
SUBSYSTEM
OF FIG. 2

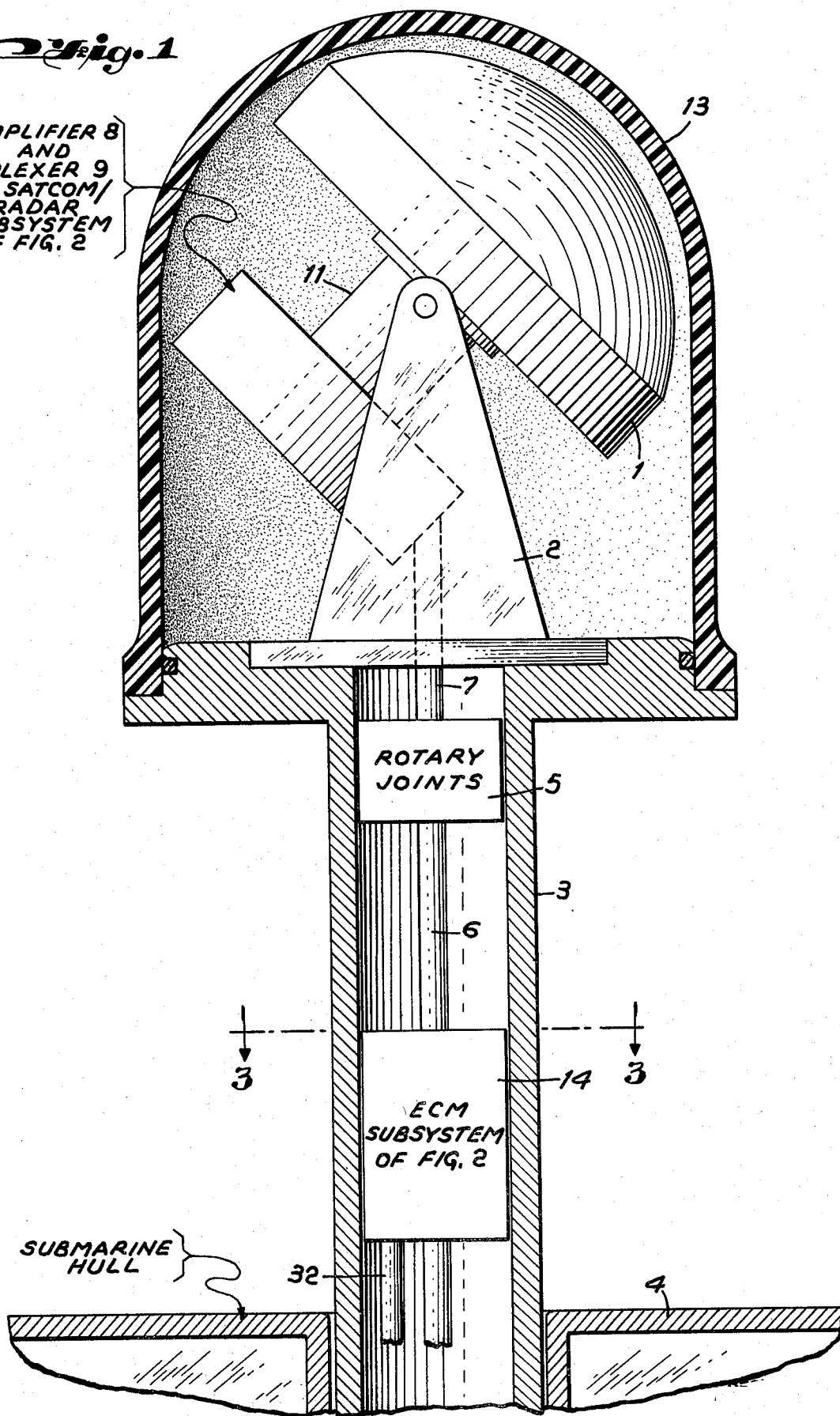


Fig. 2

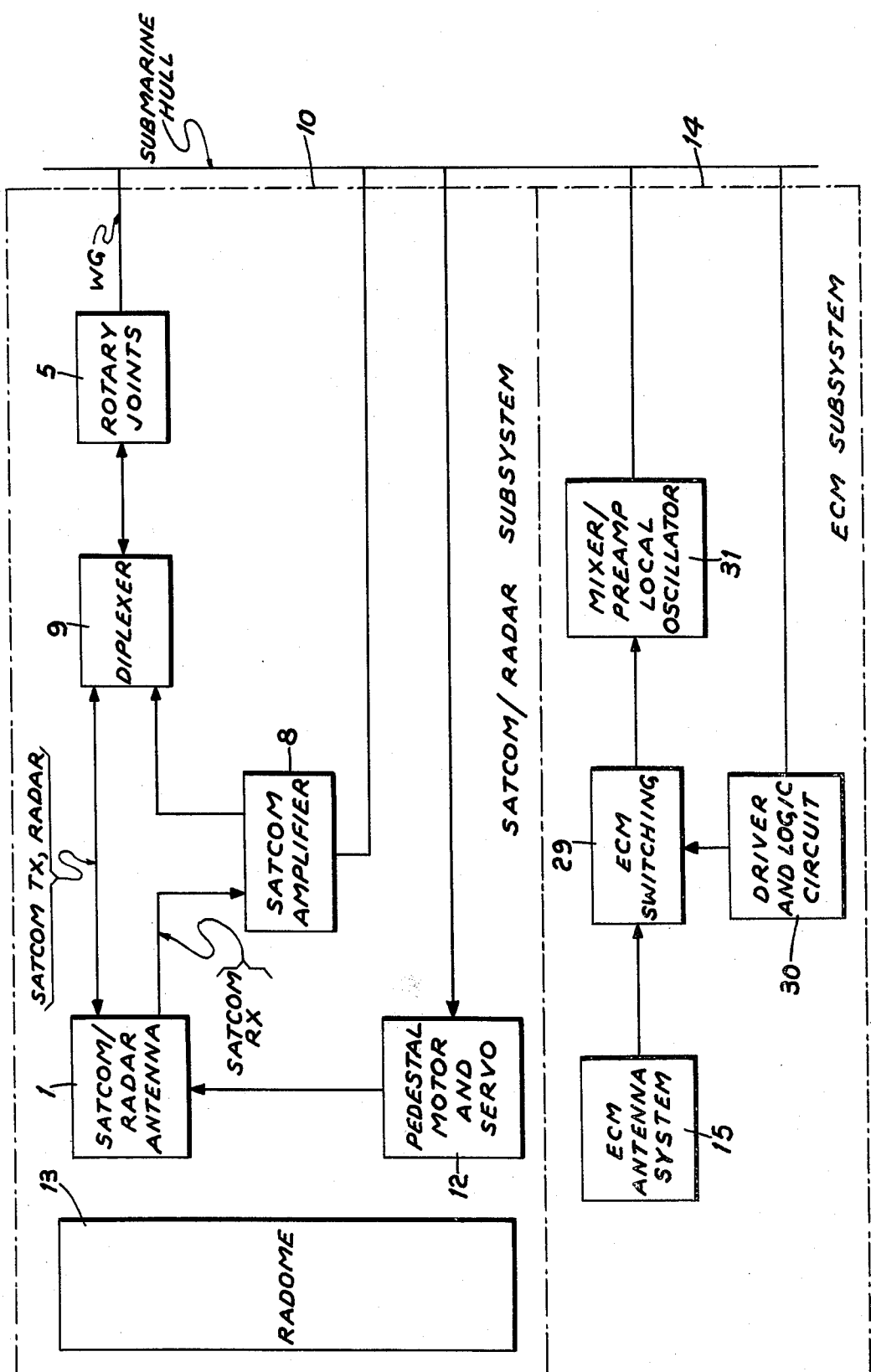


Fig. 3

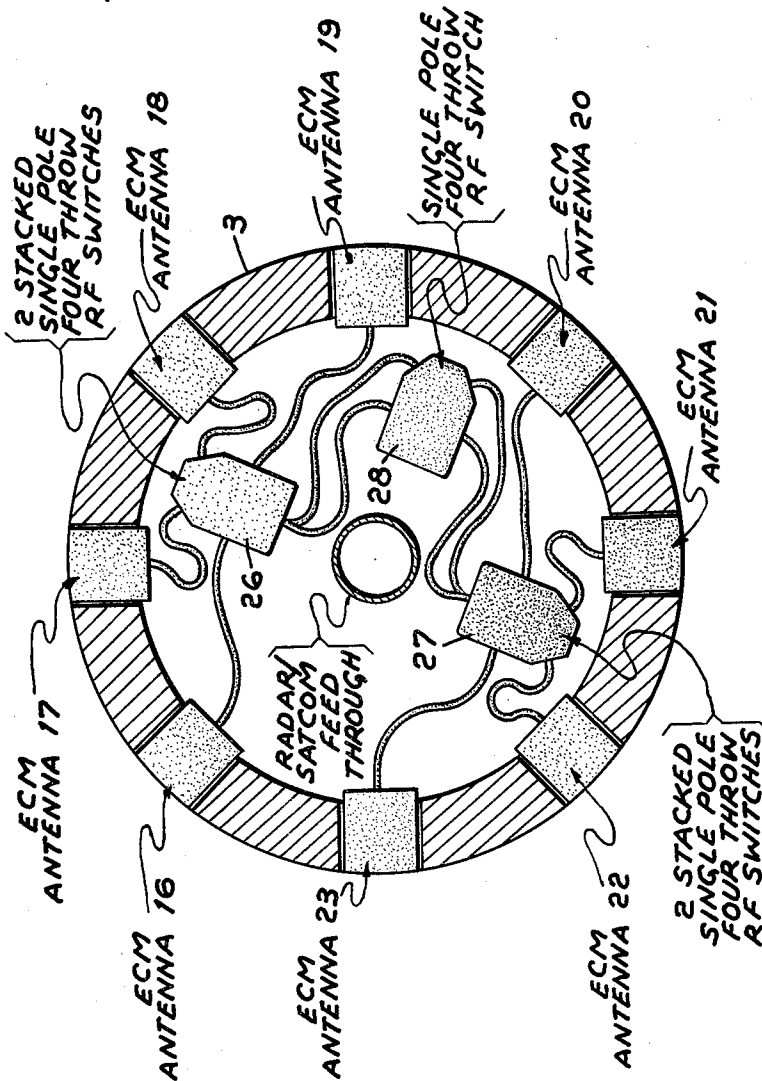
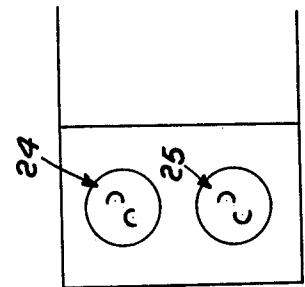


Fig. 4

Fig. 5

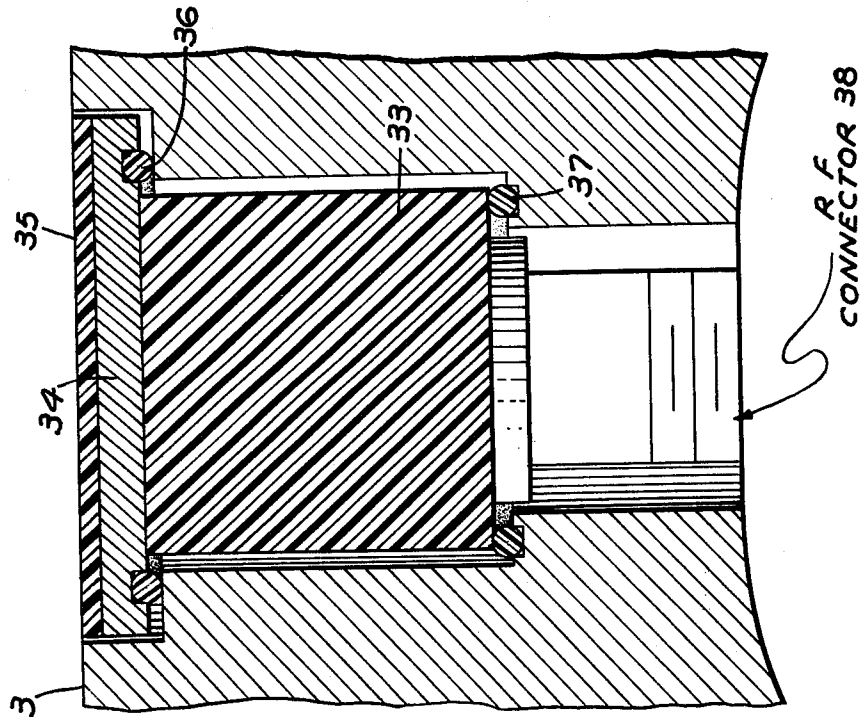
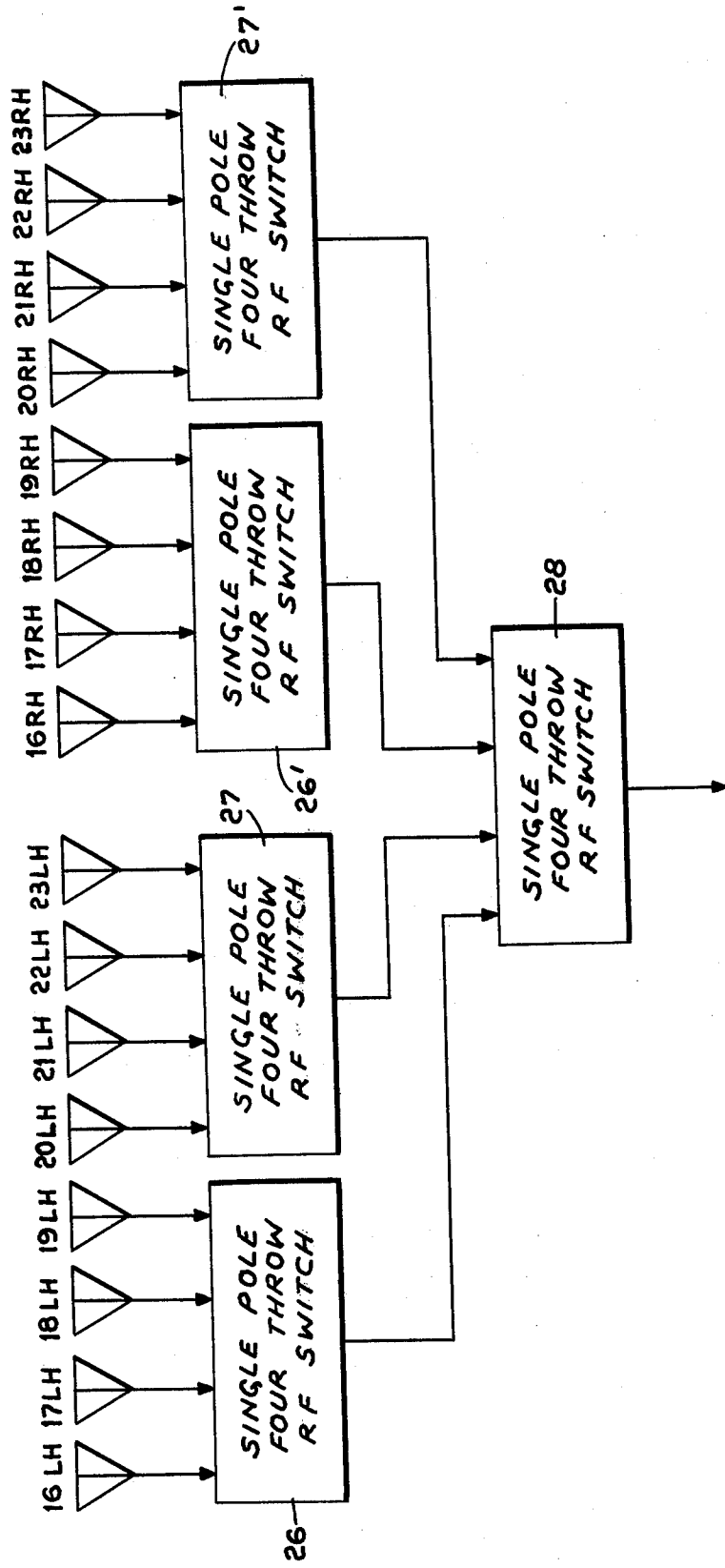


Fig. 6



MULTIPURPOSE ANTENNA SYSTEM FOR A SUBMARINE

BACKGROUND OF THE INVENTION

This invention relates to antenna systems and more particularly to an antenna system for a submarine.

At present a submarine uses separate masts for a radar antenna, a satellite communications antenna and an electronic countermeasures antenna. This approach requires three hull penetrations which reduces the reliability of the submarine. In addition, the three separate antenna masts increase the radar detection cross-section of the submarine and, hence, the probability of submarine detection increases.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a multipurpose antenna system for a submarine which combines the radar, the satellite communications and the electronic countermeasures antennas into one common mast.

Another object of the present invention is to provide the radar and satellite communications antennas operating from a common radome at the top of a telescoping mast in the form of a hollow tube and to provide the electronic countermeasure antenna in a flush mounted relation with the outer surface of the telescoping mast.

A feature of the present invention is the provision of a multipurpose antenna system for a submarine comprising: a hollow mast capable of movement into and out of a submarine hull; a first antenna system mounted at the top of the mast, the first antenna system being capable of transmitting and receiving at least a first type of electromagnetic radiation; and a second antenna system having a plurality of different antennas spaced with respect to each other and flush mounted with respect to the outer surface of the mast around the circumference of a transverse cross-section of the mast below the first antenna system, the second antenna system being capable of at least receiving a second type of electromagnetic radiation.

BRIEF DESCRIPTION OF THE DRAWING

Above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawing, in which:

FIG. 1 illustrates a diagrammatic longitudinal cross-sectional view, partially in block diagram form, of a multipurpose antenna system for a submarine in accordance with the principles of the present invention;

FIG. 2 is a schematic block diagram of the two subsystems employed in the multipurpose antenna system of FIG. 1;

FIG. 3 is a diagrammatic transverse cross-sectional view, partially in block diagram form, taken along line 3—3 of FIG. 1;

FIG. 4 is a diagrammatic front plan view of one of the electronic countermeasure antennas of FIG. 3;

FIG. 5 is a longitudinal cross-sectional view, partially in elevation, of one of the electronic countermeasures antenna of FIG. 3; and

FIG. 6 is a block diagram illustrating the switching arrangement associated with the plurality of antenna elements in the electronic countermeasure antenna system of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is illustrated therein a diagrammatic longitudinal cross-sectional view, partially in block diagram form, of an SHF (super high frequency) multipurpose antenna system in accordance with the principles of the present invention capable of operating in three modes — (1) SHF satellite communications, abbreviated in the drawings and hereinafter as Satcom, (2) X-band harbor navigation radar, abbreviated in the drawings and hereinafter as Radar, and (3) SHF passive electronic countermeasures, abbreviated in the drawings and hereinafter as ECM — from a common mast.

With the arrangement disclosed in FIG. 1, the Satcom and Radar signals will be processed in a time shared manner by an antenna 1 mounted on a pedestal 2 which includes herein appropriate mechanism for moving the antenna 360° in azimuth and also for tilting the antenna 1 in elevation. Antenna 1 can be employed for both Satcom and Radar signals because these two signals are close in operating frequency. Antenna 1 may be a dish-shaped antenna employing a dual circularly polarized feed arrangement or it may take the form of a matstrip antenna such as disclosed in U.S. Pat. No. 3,681,769 issued to E. J. Perrotti, J. C. Ranghelli and R. A. Felsenheld and assigned to the same assignee as the present application, whose disclosure is incorporated herein by reference. The purpose of using a dual circularly polarized antenna is to enable, for instance, transmission of right-hand circularly polarized radiation and reception of left-hand circularly polarized radiation.

The pedestal 2 is mounted on top of a hollow mast 3 in the form of a tube which telescopes into and out of a submarine hull 4. To accommodate the azimuth rotation of antenna 1 and to facilitate the coupling of the Radar and Satcom signals to and from antenna 1, rotary joints 5 are provided coupled to waveguides 6 and 7 extending to the amplifier 8 and diplexer 9 of the Satcom/Radar subsystem 10 of FIG. 2. The equipment container containing amplifier 8 and diplexer 9 is coupled to the antenna by means of a bracket 11 which contains therein necessary waveguides for coupling the Satcom transmission (TX) and Radar signals to antenna 1 and to couple the Satcom received (RX) signal from antenna 1 to the amplifier 8. Diplexer 9 is provided to enable combining the Satcom and Radar signals so that a common waveguide 6 and 7 can be used for the run through rotary joints 5, the hull penetration and down into the radio room. As previously mentioned, the pedestal motor and servo 12 of FIG. 2 is mounted in pedestal 2 of FIG. 1 to provide the desired azimuthal and elevational motion of antenna 1. Antenna 1 and the outboard electronic components associated therewith are protected by radome 13 which is capable of withstanding the enormous pressure environment of a submarine and introducing minimum attenuation and reflection in the RF (radio frequency) signal path. To meet these specifications, a single wall radome made of high strength material such as epoxy bonded fiber glass may be employed. The ECM subsystem 14 of FIG. 2 is incorporated within mast 3 surrounding the Radar/Satcom feedthrough which includes waveguide 6 and necessary control conductors for the pedestal motor and servo 12.

The ECM subsystem 14 includes the ECM antenna system 15 (FIG. 2) which includes eight ECM antennas 16-23 as illustrated in FIG. 3. ECM antennas 16-23 include two spiral antenna elements 24 and 25 in the same plane and in a stacked relation as shown in FIG. 4. One of elements 24 and 25 will be responsive to left-hand circular polarization and the other of elements 24 and 25 will be responsive to right-hand circular polarization. Antennas 16-23 are spaced in eight positions (0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°) around the circumference of a transverse cross-section of mast 3. For scanning purposes, two stacked single pole, four throw RF switches 26 and 27 and a single pole, four throw RF switch 28 are appropriately coupled to antennas 16-23 to cause these antennas to scan 360° about mast 3 in both right-hand and left-hand circular polarization. This ECM antenna switching arrangement is illustrated by block 29 of subsystem 14 in FIG. 2 and is controlled by a driver and logic circuit 30 to cause the desired scanning and receiving of ECM signals. The output of the switching arrangement 29 may be coupled to a mixer and preamplifier local oscillator 31 prior to being coupled to the radio room inside the submarine by waveguide 32 as illustrated in FIG. 1.

FIG. 5 illustrates a longitudinal cross-section of one of the antennas 16-23. As illustrated, each of the antennas 16-23 includes an alumina substrate 33 upon which is printed the spiral antenna elements 24 and 25 (FIG. 4) in portion 34. These printed spiral antenna elements 24 and 25 are protected from the pressure environment of the submarine by a protective cover 35 which must have minimum attenuation and reflections in the RF signal path and may be composed of epoxy bonded fiber glass. O-rings 36 and 37 provide a seal against penetration of sea water into the interior of mast 3. An RF connector 38 is fastened to substrate 33 and appropriate RF connections (not illustrated) are made to the spiral antenna elements 24 and 25 printed at portion 34 on the outer surface of substrate 33.

FIG. 6 illustrates in block diagram form the electrical connection between switches 26-28 and the left- and right-hand circularly polarized elements of each of the ECM antennas 16-23. The reference characters associated with each one of the antenna symbols of FIG. 6 have the suffix LH and RH. The suffix LH refers to the left-hand circular polarized element and the suffix RH refers to the right-hand circular polarized element of each of the antennas 16-23. As previously mentioned, switch 26 is a stack of two single pole, four throw RF switches and are illustrated by switches 26 and 26' of FIG. 6 where switch 26 controls the connection to antennas 16LH - 19LH and switch 26' controls the connection to antennas 16RH - 19RH. Similarly, switch 27, as illustrated in FIG. 3, is a stack of two single pole, four throw RF switches and are illustrated in FIG. 6 by switches 27 and 27' where switch 27 controls the connection to antennas 20LH - 23LH and switch 27' controls the connection to antennas 20RH - 23RH. Switch 28 of FIG. 3 is shown by switch 28 of FIG. 6 which controls the connection from switches 26, 27, 26' and 27' to the input to the submarine radio room. Under control of the driver and logic circuit 30 of subsystem 14 (FIG. 2), the switches 26, 26', 27, 27' and 28 will be controlled in a manner to cause antennas 16-23 to scan 360° about the mast 3 for both right-hand and left-hand circular polarization radiation.

One of the advantages of the present multipurpose antenna system employing the same mast as described hereinabove is that one subsystem, such as subsystem 10, can be employed for both Radar and Satcom signals on a time shared basis with the ECM subsystem 14 being capable of simultaneous operation with each of the Satcom and Radar signals. Two other advantages are achieved by the elimination of two masts of the three masts as employed by present submarines as mentioned hereinabove under the heading "Background of the Invention," namely, increased submarine reliability and reduction of the radar detection cross-section of the submarine because only one mast will be surfaced to carry on the plural functions present in the single mast of the present invention.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A multipurpose antenna system for a submarine comprising:

- a hollow mast capable of movement into and out of a submarine hull;
- a first antenna system mounted at the top of said mast, said first antenna system being capable of transmitting and receiving at least a first type of electromagnetic radiation; and
- a second antenna system having a plurality of different antennas spaced with respect to each other and flush mounted with respect to the outer surface of said mast around the circumference of a transverse cross-section of said mast below said first antenna system, said second antenna system being capable of at least receiving a second type of electromagnetic radiation;
- each of said plurality of different antennas including an antenna arrangement capable of receiving left-hand and right-hand circularly polarized second type of electromagnetic radiation;
- said antenna arrangement including
 - a substrate extending radially into the wall of said mast to a given point spaced from the outer surface of said mast,
 - spiral type antenna elements printed on the surface of said substrate adjacent said given point, and
 - a protective cover transparent to said second type of electromagnetic radiation disposed over said printed antenna elements, the outer surface of said protective cover being flush with the outer surface of said mast.

2. A multipurpose antenna system according to claim 1, wherein

- said first antenna system includes
 - a dish-shaped antenna, and
 - a radome to protect said dish-shaped antenna.

3. A multipurpose antenna system according to claim 2, wherein

- said first type of electromagnetic radiation is a radar type electromagnetic radiation.

4. A multipurpose antenna system according to claim 2, wherein

- said first type of electromagnetic radiation is a satellite communication type of electromagnetic radiation.

5. A multipurpose antenna system according to claim 2, wherein said dish-shaped antenna is employed on a time sharing basis for said first type of electromagnetic radiation and a third type of electromagnetic radiation.
6. A multipurpose antenna system according to claim 5, wherein said first type of electromagnetic radiation is a radar type electromagnetic radiation, and said third type of electromagnetic radiation is a satellite communication type of electromagnetic radiation.
7. A multipurpose antenna system according to claim 1, wherein said first antenna system includes means to transmit and receive radar signals as said first type of electromagnetic radiation.
8. A multipurpose antenna system according to claim 1, wherein said first antenna system includes means to transmit and receive satellite communication signals as said first type of electromagnetic radiation.
9. A multipurpose antenna system according to claim 1, wherein said first antenna system includes means to transmit and receive satellite communication signals as said first type of electromagnetic radiation for a first selected period of time and to transmit and receive radar signals as a third type of electromagnetic radiation for a second selected period of time different than said first selected period of time.
10. A multipurpose antenna system according to claim 1, wherein said second type of electromagnetic radiation is an electronic countermeasure type of electromagnetic

- radiation.
11. A multipurpose antenna system according to claim 10, wherein said first antenna system includes a dish-shaped antenna, and a radome to protect said dish-shaped antenna.
12. A multipurpose antenna system according to claim 11, wherein said first type of electromagnetic radiation is a radar type electromagnetic radiation, said electronic countermeasure type of electromagnetic radiation and said radar type electromagnetic radiation being processed simultaneously by said first and second antenna systems.
13. A multipurpose antenna system according to claim 11, wherein said first type of electromagnetic radiation is a satellite communication type of electromagnetic radiation, said electronic countermeasure type of electromagnetic radiation and said satellite communication type of electromagnetic radiation being processed simultaneously by said first and second antenna systems.
14. A multipurpose antenna system according to claim 11, wherein said dish-shaped antenna is employed on a time sharing basis for said first type of electromagnetic radiation and a third type of electromagnetic radiation.
15. A multipurpose antenna system according to claim 14, wherein said first type of electromagnetic radiation is a radar type electromagnetic radiation, and said third type of electromagnetic radiation is a satellite communication type of electromagnetic radiation.

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