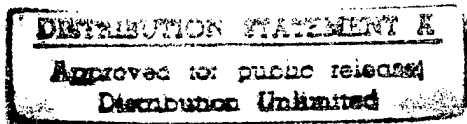


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NOTICE

The above identified patent application is available for licensing. Requests for information should be addressed to:



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DEPARTMENT OF THE NAVY  
CODE OCCC3  
ARLINGTON VA 22217-5660

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DTIC QUALITY INSPECTED 1

1 Navy Case No. 73994

2  
3 FLEXIBLE FERRITE LOADED LOOP ANTENNA ASSEMBLY

4  
5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and used  
7 by or for the Government of the United States of America for  
8 governmental purposes without the payment of any royalties  
9 thereon or therefore.

10  
11 BACKGROUND OF THE INVENTION

12 (1) Field Of The Invention

13 This invention relates to a flexible ferrite loaded loop  
14 antenna assembly and more particularly, to a flexible antenna  
15 assembly that will permit VLF/LF reception in the athwart  
16 direction (side to side) relative to its deployment along a  
17 cable.

18 (2) Description of the Prior Art

19 Three types of antennas have been used by submarines for  
20 reception of radio signals in the very low frequency and low  
21 frequency (VLF/LF) transmission bands. The first is a mast  
22 mounted antenna which is omni-directional and extends above the  
23 ocean surface. Such an antenna is used when the submarine is not  
24 concerned with being detected. The second, a voltage probe  
25 antenna exists in the periscope and extends above the ocean

1 surface. The third, a buoyant cable antenna, is used when the  
2 submarine is submerged and must avoid detection.

3 The buoyant cable antenna floats on the ocean surface and is  
4 deployed along with a buoyant cable. The buoyant cable antenna  
5 must be flexible because it is launched through a transfer  
6 mechanism which bends the cable through a six inch radius.  
7 Because flexibility is required, buoyant cable antennas have  
8 employed a horizontal wire antenna element which can receive only  
9 in the fore and aft (front and back) direction relative to its  
10 deployment. This limits the reception capability of the buoyant  
11 cable antenna.

12 Accordingly, there is a need for a buoyant cable antenna  
13 system with omni-directional capability that can be launched  
14 under all sea conditions at depth without danger of being  
15 detected. To achieve omni-directionality, such a buoyant cable  
16 antenna system requires the addition of a loop antenna that can  
17 receive VLF/LF in athwart direction relative to ship's heading.  
18 A buoyant cable mounted loop antenna must be capable of being  
19 bent through at least a six inch radius during deployment, and  
20 pass signals received on the wire antenna. Therefore, what is  
21 required is a buoyant cable antenna system including a flexible  
22 loop antenna which will provide the desired omni-directional  
23 signal reception and is compatible with existing deployment  
24 mechanisms.

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The core region including the plurality of ferrite beads includes a loop wire element wrapped helically around it, forming the loop antenna. The loop wire element starts and ends at the same end of the core region.

1 second amplifier, then travels by twisted pair parallel with the  
2 coaxial cable, through a transmission cable back to the vessel.

3 In the preferred embodiment, the entire cable is buoyant to  
4 float on the surface of the ocean, and is sufficiently flexible  
5 to bend around a 6 inch radius during deployment. A submarine  
6 can therefore remain undetected underwater, yet receive radio  
7 transmissions on an omni-directional antenna.

#### 8 9 BRIEF DESCRIPTION OF THE DRAWINGS

10 A more complete understanding of the invention and many of  
11 the attendant advantages thereto will be readily appreciated as  
12 the same becomes better understood by reference to the following  
13 detailed description when considered in conjunction with the  
14 accompanying drawings wherein:

15 FIG. 1 is a schematic view of the deployable antenna cable  
16 assembly according to the present invention;

17 FIG. 2 is a sectional view of the athwart loop antenna  
18 portion of the deployable antenna assembly according to the  
19 present invention;

20 FIG. 3 is a sectional view of the core segments that form  
21 part of the present athwart loop antenna;

22 FIG. 4 is a sectional view of the athwart loop antenna  
23 encased in polyethylene; and

24 FIG. 5 is a schematic of the major elements that make up the  
25 deployable antenna cable assembly.

1                                    DESCRIPTION OF THE PREFERRED EMBODIMENT

2            An omni-directional, buoyant, deployable cable antenna,  
3 assembly 10, FIG. 1, according to the present invention is  
4 deployable from a vessel such as submarine 12. Buoyant cable 10  
5 is intended for use in the Navy buoyant cable antenna assembly  
6 used on submarines to receive VLF/LF (very low frequency/low  
7 frequency) signals. Buoyant cable 10 is deployed while the  
8 submarine is submerged, through the buoyant cable transfer  
9 mechanism 14 and it floats on the surface of the ocean 16, to  
10 allow reception of radio signals while avoiding detection of  
11 submarine 12 by sea or air vessels.

12           The present invention combines a standard prior art  
13 horizontal wire antenna element 18 which can receive radio  
14 transmissions in the fore and aft (front and back) direction as  
15 designated generally by arrow 19. Horizontal wire antenna  
16 element 18 is connected to amplifier 20 which boosts the signal  
17 from wire antenna element 18. The athwart loop antenna 22  
18 provides reception in the athwart ship (side to side) direction  
19 as designated generally by arrow 21. The signal from loop  
20 antenna 22 is boosted by another amplifier 23. Both loop antenna  
21 22 and horizontal wire antenna 18 are connected to a buoyant  
22 cable transmission line 26 which connects to submarine or other  
23 vessel 12. This allows the antenna assembly 10 to receive  
24 transmissions omni-directionally.

1           When the cable antenna assembly 10 is deployed, it is bent  
2 through a radius of 6 inches by transfer mechanism 14. Coaxial  
3 cable 27 FIG. 2, passes through the center of the loop antenna  
4 and carries the signal from the horizontal wire antenna amplifier  
5 to the ship or submarine. Surrounding coaxial cable 27 are  
6 ferrite beads 24 which form the center core of the loop antenna  
7 22 and allow the athwart loop antenna to bend through a 6 inch  
8 radius. The ferrite beads are held captive proximate at least a  
9 first end 29 by fixed end retainer 28 which is secured to coaxial  
10 cable 27 by set screw 30. At the second end 31 of the loop  
11 antenna is fixed spring retainer 36 also secured to coaxial  
12 cable 27 by a set screw 38. Compression spring 34 is located  
13 between fixed spring retainer 36 and flexible spring retainer 32  
14 which is proximate the ferrite beads 24. Compression spring 34  
15 maintains the ferrite beads 24 under minimum pressure to keep the  
16 beads in contact with each other and maintain the antenna core  
17 conductance. As athwart loop antenna 22 flexes, the beads 24  
18 will maintain contact with each other while spring 34 is further  
19 compressed. This allows flexibility and crush resistance during  
20 deployment and use of the athwart loop antenna.

21           Each ferrite bead such as ferrite bead 24a of FIG. 3 is  
22 machined to be generally cylindrical or annular in shape and  
23 including exterior region 46, concave end 40 and convex end 42.  
24 Typical dimensions of each ferrite head such as 24 are .39" in  
25 diameter, and .5" long with .195" concave and convex regions.

1 Hole 44 through the center of the ferrite bead 24 allows coaxial  
2 cable 27 to pass through ferrite beads. The concave tapering of  
3 end 40, and convex tapering of end 42 allow adjacent ferrite bead  
4 such as ferrite beads 24b and 24c to maintain substantial contact  
5 with each other when the cable assembly is flexed. This ensures  
6 the ferrite beads will maintain good electrical contact as the  
7 cable flexes.

8 Ferrite beads 24 are surrounded by a polyethylene tube 54 as  
9 shown in FIG. 4. Polyethylene tube 54 is etched to allow a  
10 copper wire 56 (litz wire) forming the loop antenna to be wrapped  
11 around polyethylene tube 54. The etching scribes an evenly  
12 spaced helix from start to finish and return, and allows litz  
13 wire 56 to form a helix that begins and ends at point 59 in  
14 athwart loop antenna 22, forming the loop antenna. The doubling  
15 back of the loop antenna winding helps to cancel out any signal  
16 noise from the coaxial cable passing through the center of the  
17 ferrite beads 50 not mentioned.

18 The signal from litz wire loop 56 is carried by twisted pair  
19 wires 60, while the signal from the horizontal wire loop  
20 amplifier is carried by coaxial cable 27. Twisted pair wire 60  
21 carry the signal from the athwart loop antenna amplifier. Loop  
22 antenna assembly is coated with foamed polyethylene with glass  
23 balloons 58 to provide water protection and buoyancy for the  
24 cable assembly.

1           Horizontal wire antenna element 18, FIG. 5 is comprised of  
2           100 feet of wire which provides an effective height of 15  
3           millimeters at 20 kilohertz. Horizontal wire antenna element 18  
4           is grounded at cable termination point 61, and feeds the signal  
5           into a standard type of wire antenna amplifier 20. Wire antenna  
6           amplifier 20 provides 32 decibel gain within the range of 10 to  
7           200 kilohertz. Wire antenna amplifier 20 provides an amplified  
8           signal on coaxial cable 27.

9           Loop antenna 22 provides a signal on twisted pair lines 60  
10          to a loop antenna amplifier 24. Loop antenna amplifier 24  
11          provides 50 decibel gain at 20 kilohertz (kHz). The signals  
12          carried on coaxial cable 27 and twisted pair 62 pass through  
13          buoyant cable transmission line 26.

14          The novel, omni-directional cable antenna as disclosed  
15          achieves omni-directionality by combining a standard wire antenna  
16          element with a unique loop antenna element which can bend and  
17          flex during deployment and use. This allows submarines to remain  
18          submerged and undetected when they need to receive VLF/LF radio  
19          messages. The cable antenna can be deployed and retracted  
20          underwater, yet provides the omni-directionality of a mast-  
21          mounted antenna which can only be used on the surface.

22          Many modifications of the presently disclosed invention will  
23          become apparent to those of skill in the art  
24

1 Navy Case No. 73994

2  
3 FLEXIBLE FERRITE LOADED LOOP ANTENNA ASSEMBLY

4  
5 ABSTRACT OF THE DISCLOSURE

6 A buoyant loop antenna, deployable along a cable, includes a  
7 core region comprising a plurality of annular ferrite beads.  
8 These annular shaped beads include a center hole and generally  
9 concave first end and a generally convex second end. The ferrite  
10 beads are aligned with the concave end of one bead against the  
11 convex end of another bead. This allows the cable to flex while  
12 the beads maintain contact with each other, providing flexibility  
13 and resistance to crushing. The core region has a loop wire  
14 wrapped helically around it, forming the loop antenna. The loop  
15 wire element starts and ends at the same end of the core region,  
16 forming a loop. This loop allows transmission and reception in  
17 and athwart (side to side) direction. This novel wire loop  
18 antenna can be combined with a straight wire antenna (which  
19 provides reception in a fore and aft direction) to provide an  
20 omni-directional cable antenna assembly.  
21

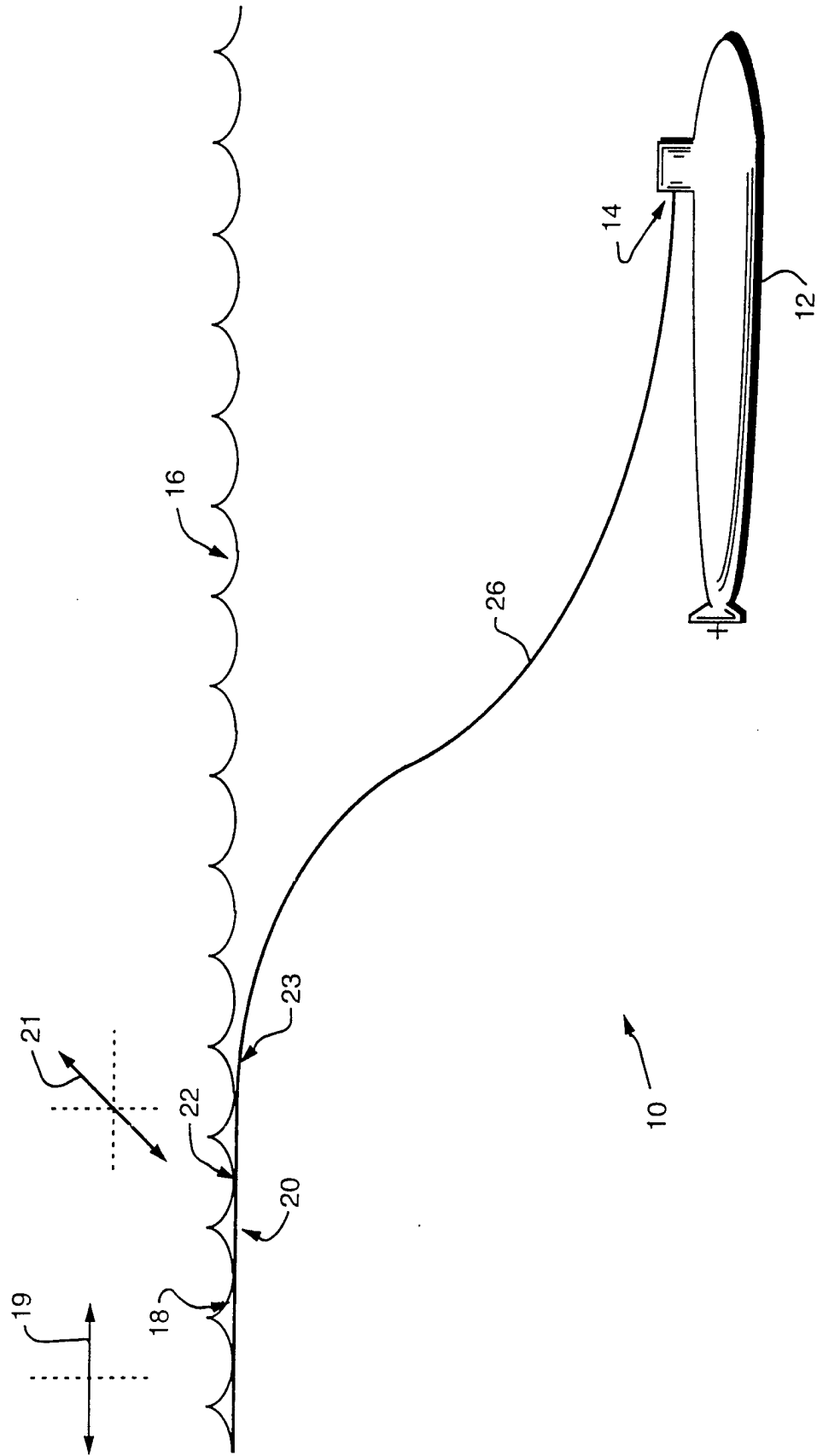


FIG. 1

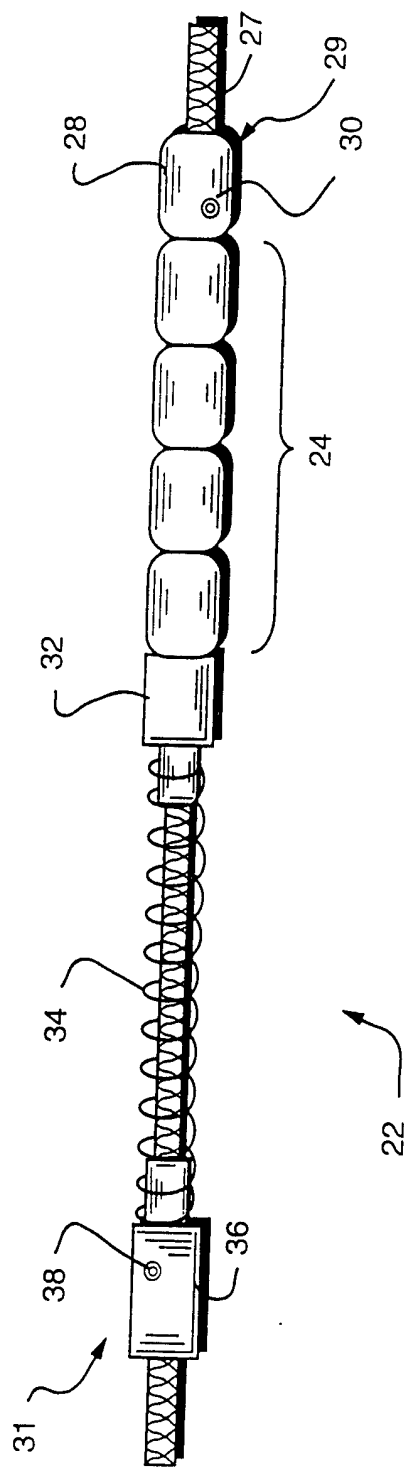


FIG. 2

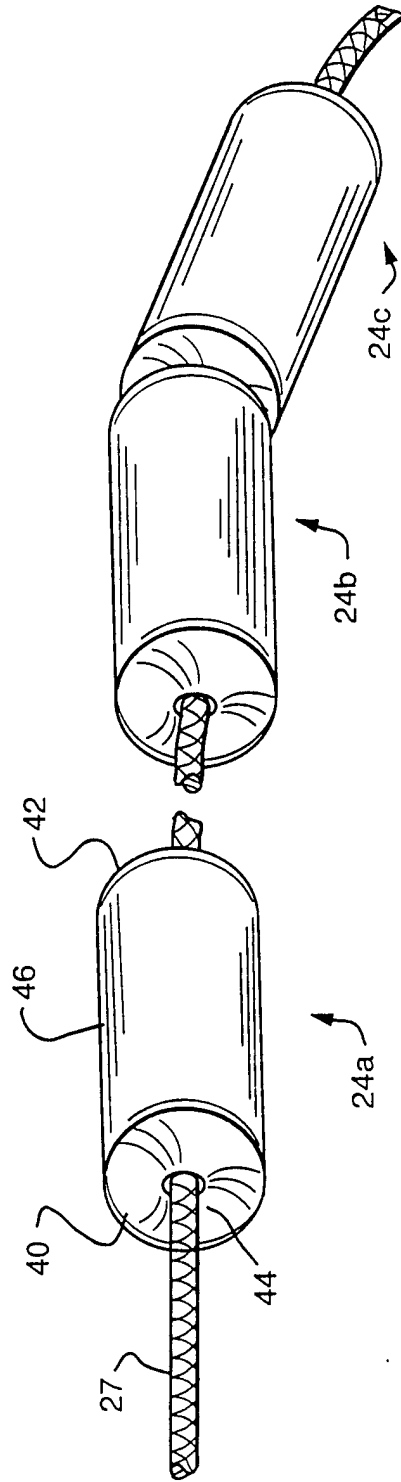


FIG. 3

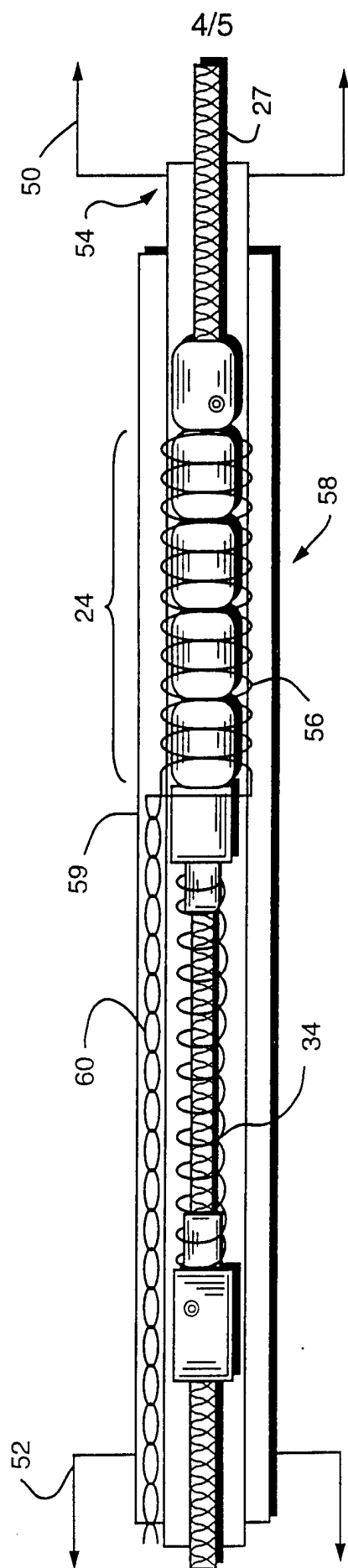


FIG. 4

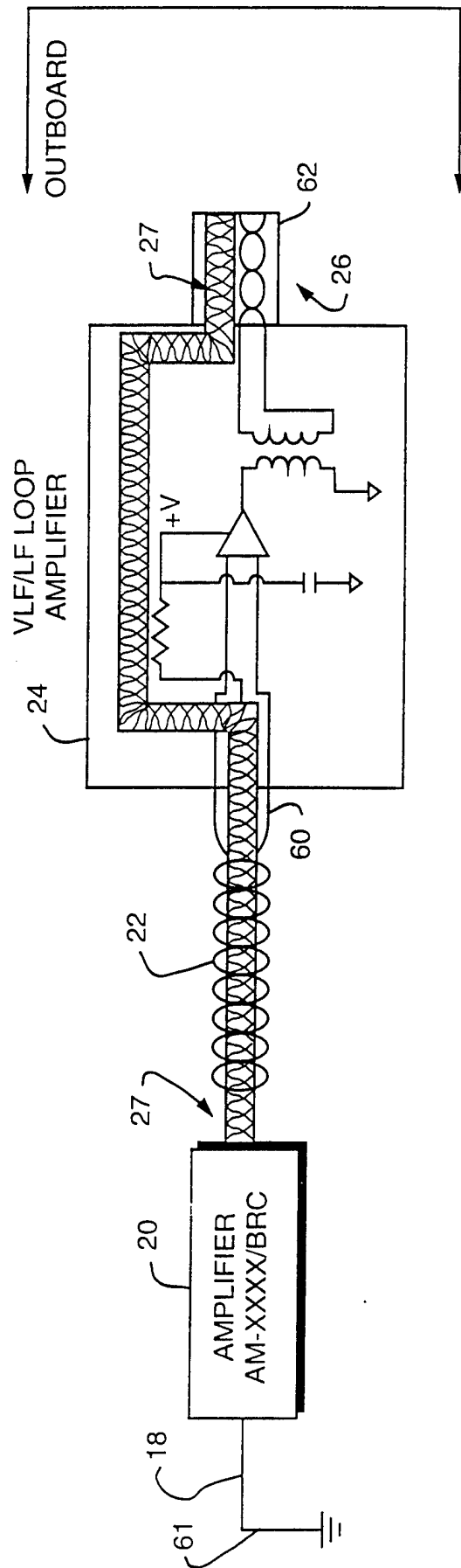


FIG. 5