

April 9, 1929.

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1,708,071

RADIO SIGNAL APPARATUS

Filed Oct. 31, 1919

3 Sheets-Sheet 1

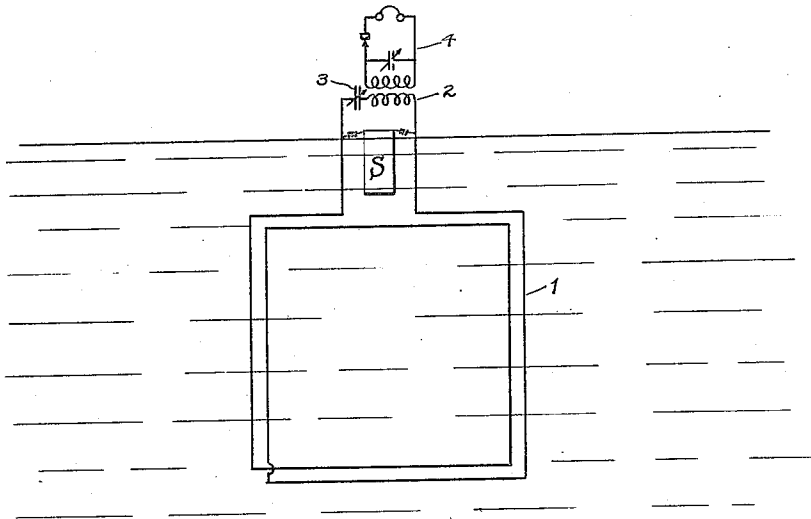


Fig. 1.

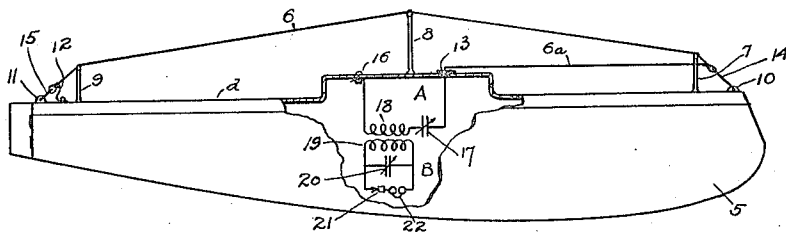


Fig. 2.

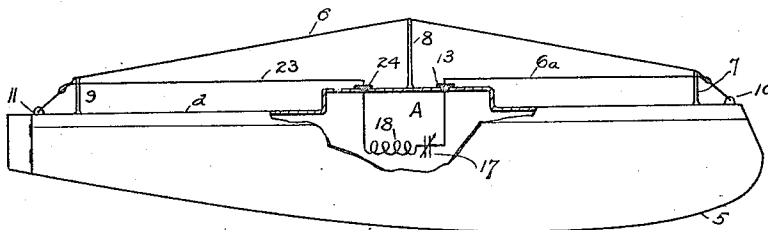


Fig. 3.

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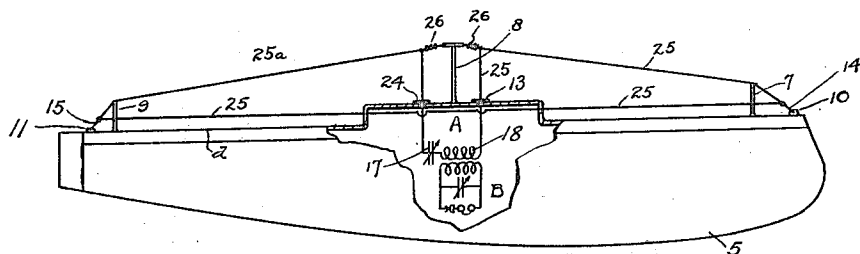


Fig. 4.

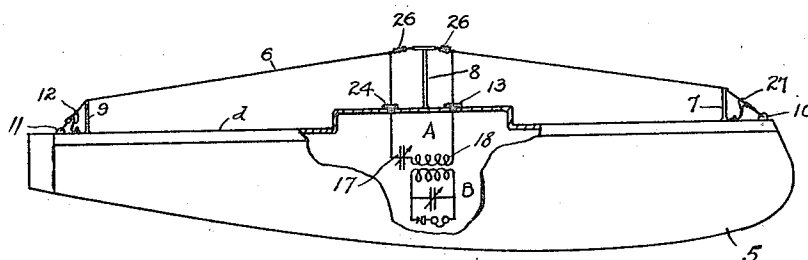


Fig. 5.

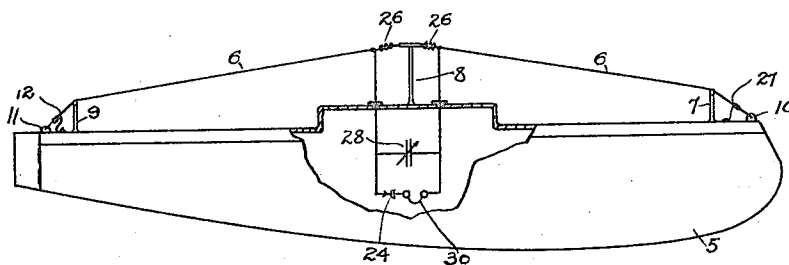


Fig. 6.

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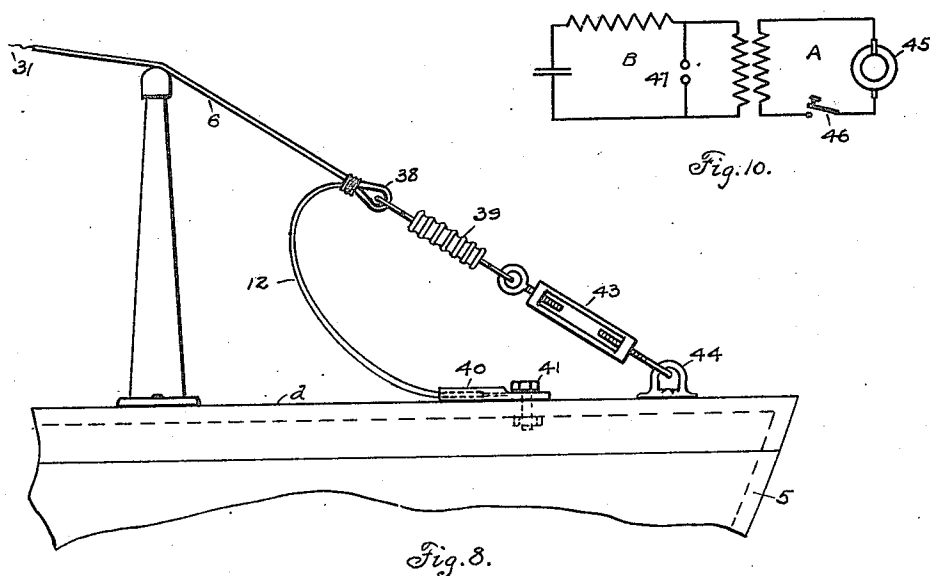
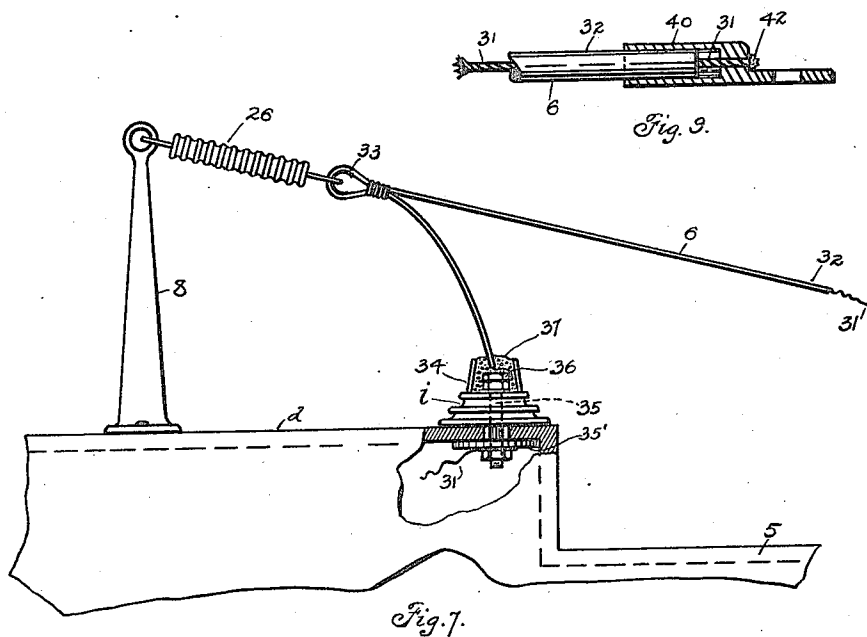
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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RADIO SIGNAL APPARATUS.

Application filed October 31, 1919. Serial No. 334,720.

(GRANTED UNDER THE ACT OF MARCH 3, 1883, AS AMENDED APRIL 30, 1928; 370 O. G. 757.)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to them of any royalty thereon.

5 Our invention relates to radio or wireless communication or signaling and its object is to provide a new and useful form or arrangement of antenna that may be used in combination with radio sending or receiving sets or
10 installations for the transmission or reception of radio signals.

A further and distinguishing object of our invention is the provision or arrangement of the antenna for use when submerged either
15 wholly or partially in sea, saline or fresh water; and also antenna for use on submarine or submersible vessels or boats, or on boats operating only on the surface, and that require no housing or re-erection when the submersible vessel equipped therewith respectively submerges or rises for surface operation.

20 These and other objects descriptive of the nature and uses of the invention are set forth more fully and in detail in the following description and drawing.

25 In the drawing, which is of diagrammatic character—

Figure 1 illustrates a form of antenna with associated apparatus or installation for use
30 when the antenna is submerged either in saline or fresh water.

Figures 2 to 6 inclusive illustrate submersible boats or ships embodying our invention with various differences in arrangement, circuits and other details that will later be explained.

Figures 7, 8 and 9 show various details of mounting or connection later fully explained, and.

40 Figure 10 is a diagram illustrating a circuit arrangement suitable for sending or transmitting in connection with such forms or structures as illustrated in Figures 1 to 6 inclusive.

Our invention consists broadly in providing
45 an antenna of covered or insulated wire or cable of bronze, copper or other suitable conductive material, that is operative for sending and receiving signals when wholly or partly submerged in a river, harbor, sea or other
50 body of water, whether saline or fresh, or in any fluid medium (other than air) whether non-conductive or partly or wholly conductive.

In Figure 1 the numeral 1 represents the covered or insulated antenna, supported by a
55 buoyant element S, the covering being of any suitable insulating material, such as gutta percha, rubber, or the like, that is water-proof. The antenna shown is arranged in the form of a loop composed of two turns or coils of 60 wire. The leads from the loop antenna are connected with an inductance 2 and a capacity 3 which may be in the form of a variable condenser. As shown, this antenna is connected in any suitable way with a local receiving or
65 transmitting set. Figure 1 shows the antenna inductively coupled with a receiving set comprising a transformer or coupling coil, detector, telephone receivers and a condenser. As will be apparent, tuning of the antenna
70 circuit may be accomplished by adjustments of the capacity 3 or the inductance 2 and tuning of the detector circuit with the antenna circuit may be made by means of its variable capacity or its inductance, as is usual. With
75 an antenna of the form and construction described and illustrated good signals have been received from long distances. While we have shown the loop antenna 1 of rectangular form and of two turns or coils, it is understood
80 that the invention is not limited to this particular form and arrangement, but that other forms of loop and different numbers of coils or turns therein may be employed to secure the results desired. It is found that a loop antenna such as described has marked directional
85 properties. A transmitting set may be also connected or coupled with such an antenna as is illustrated in Figure 10, wherein A represents the generating circuit including a
90 generator 45, a telegraph key 46, this circuit being coupled through transformer coils to an oscillation circuit B containing inductance capacity and a spark gap. It will be understood that the oscillation circuit is connected
95 or coupled to the antenna in any suitable way well understood in the art. The advantages of antennas of the character described are obvious. Among these are that the antenna is not visible and the existence of a station is
100 thus readily concealed and also that it is readily portable and shifted from place to place as may be desired. Its directional properties may also be useful, for example, by eliminating undesired signals from a given direction.
105 Our invention further consists in provid-

ing radio or wireless equipment for boats and ships, particularly those of the submarine or submersible class. This is illustrated in Figures 2 to 6 inclusive, with details of mounting and connection shown in Figures 7, 8 and 9.

In Figure 2 the antenna considered as a whole comprises the metallic hull of the boat 5 and the covered or insulated wire 6 connected to said hull near the stem and stern thereof, the wire 6 being carried upon struts or masts 7, 8 and 9. As will be seen, the wire or cable 6 is downwardly inclined from its central support 8, towards the stem and stern of the boat. This form possesses the advantage that it not only forms part of the wireless equipment of the boat, but that the inclined portions between the central support 8 and the connections to the hull at stem and stern also form obstruction-clearing members which deflect obstructions likely to be encountered by the boat in its submerged course or path,—such obstructions being nets, wires, mines, &c. The wire portion 6 of the antenna forms a permanent structure on the boat and does not have to be unshipped or housed and re-erected when the boat submerges or rises to the surface, as has heretofore been the practice with other forms of wireless installations on such craft. The wire 6 may be a phosphor-bronze wire or cable or it may be of other suitable conductive material and may be of suitable strength or size to act as a deflector for obstructions. The covered wire or cable 6 is secured to the hull at the bow and stern of the vessel as indicated at 10 and 11 respectively. The ends of the cable are electrically connected either to the associated apparatus or to the hull of the vessel or both as may be required in the particular case to be used.

Several possible methods of connection are shown in Figures 2 to 6. In Figure 2, one end of the combined antenna and obstruction-clearing element 6, is electrically connected to the metallic deck of the vessel by means of a short conductor 12, the antenna passing from this terminal 12 over supports 9, 8 and 7, thence back at 6^a to a suitable part of the deck to a lead-in 13, and through the deck to the remainder of the antenna circuit, which may consist of condenser, inductor transformer etc., shown diagrammatically at A. The antenna of this figure is insulated from the deck in any suitable manner except where connection is made by means of the conductor, 12, noted above, the sections 14 and 15 of the obstruction-clearing element carrying a suitable insulating means. The antenna circuit is grounded at 16 to the vessel and is shown including a condenser 17 and coil 18. In this form of the invention, the loop forming the antenna includes the conductor 12, obstruction-clearing device 6, the conductor 6^a, terminal 16 and the deck *d*, between terminal 16 and the conductor 12. Associated with the antenna circuit is shown a secondary or closed

circuit B having a secondary coil 19, a variable condenser 20, a detector 21 and a telephone 22, all of which may be of any desired form or arrangement.

The disclosure in Figure 3 is somewhat similar to that shown in Figure 2, except that the section of the deck *d*, of the vessel is not a part of the loop-oscillating circuit, but in lieu of the conductor 12 and the deck *d* a conductor 23 extends from the stern of the vessel 5, through a lead-in 24, to the other apparatus A to complete the antenna circuit.

Figure 4 shows an arrangement of the loop antenna provided with a continuous bottom conductor 25. The antenna in this figure shows the continuous conductor 25 extending upwardly from the bow support 7 to insulator 26, at the midship support 8, thence downwardly through lead-in 13 to the terminals of the inductance coil and condenser A. The opposite end of the conductor 25 extends from stern support 9 to form the section 25^a which leads to an insulator 26 carried by midship support 8 and thence downwardly through lead-in 24 to the terminals of the inductance coil and condenser A. In this arrangement of the loop antenna, the antenna wire or cable is attached to the bow and stern of the vessel by means of insulators as at 14 and 15, and the intermediate portion of the antenna is spaced apart and insulated from the midship support, and the ends of the antenna lead into the vessel to the electromagnetic signaling instruments.

The circuit in this form of loop antenna is the reverse of that shown in Fig. 3 in that the leads to the condenser 17 and transformer coil are from the upper part of the loop.

The embodiment of the invention shown in Fig. 5 is similar to that shown in Fig. 4, with the difference that the upper limb or portion of the cable or wire 6 is electrically connected to the hull 5 of the boat at bow and stern through connections 27 and 12, respectively, thus constituting the hull of the boat part of the loop circuit.

By this arrangement the metallic hull of the vessel is provided with a combined insulated radio conductor and obstruction clearing element which extends longitudinally of the vessel and is connected electrically at its ends with the hull whereby a loop oscillating circuit is provided to cooperate with the electromagnetic signaling instrument carried by the vessel.

Figure 6 shows a similar arrangement of loop circuit to that shown in Fig. 5, the hull of the boat forming part of the loop circuit. But in Fig. 6 the receiver circuit including detector 24, telephone 30 and variable condenser 28 is directly connected to the loop circuit instead of being inductively coupled thereto as in Fig. 5.

In Fig. 7 we have shown details of construction for the midship supports of the loop

portion 6 on the mast 8. The loop wire is indicated at 31 with its insulating covering 32. This wire is bent around eyelet 33 and passes thence to insulated bolt 35 by which it is secured to the hull. Bolt 35 at its upper portion passes through an insulator 26 on which is carried a cup 34 surrounding the connection of the loop wire 31 by tap 36 to the bolt 35. This cup is filled with a suitable waterproofing material 37 such as marine glue. The lead interior of the hull is connected to the lower end of said bolt 35 as shown at 31, the inner end of said bolt being insulated from the hull by insulating washer or plate 35'. The connection to the mast support 8 is by means of insulator 26, connected as shown at eyelet 33 and to the mast.

The particular electrical connection illustrated at 12 or 27 is shown in Figure 8, wherein the combined antenna and obstruction clearing element 6 is bent around an eyelet 38 to form a mechanical connection with the strain insulator 39, and after passing through eyelet 38 the element then forms the conductor 12 or 27 where it terminates within a watertight socket 40, which is preferably metal and is secured at 41 directly to the deck of the vessel to make a direct electrical connection therewith. This socket 40 as disclosed in Figure 9 receives the element 6 in its entirety, but the insulated covering 32 may be cut off to permit the bare conductor cable 31 to extend through an aperture in the end of the socket 40 to permit the cable 31 to be soldered or otherwise connected at 42 to the socket member 40.

In the structure illustrated in Figure 8 there is employed a turnbuckle 43 which connects the strain insulator 39 with a deck eye 44, to maintain the combined antenna and obstruction clearing element taut above the hull.

The diagrammatic view of Figure 10 is of a conventional sending apparatus or circuit which can be employed in connection with the structures illustrated in Figures 1 to 7 of the drawing. This shows a generator circuit A having a source of power 45 and a key 46, associated with an oscillation circuit B, having a spark gap 47. It is understood that this oscillation circuit is arranged in any usual or suitable way to transfer its energy to the loop antennae shown in Figs. 1 to 6 inclusive. It is obvious that any other form of circuiting arrangement of electromagnetic signaling elements may be employed than those illustrated and described herein.

We claim—

1. The combination with a vessel, of a radio conductor extending longitudinally thereof but insulated therefrom and from the water except at its ends which make electrical connection with the vessel, an electrical connection between said ends of the radio conductor through said vessel, and electromag-

netic signaling instruments associated with the said radio conductor at a point between its ends.

2. The combination with a submarine vessel having a metallic hull, of an insulated radio conductor extending longitudinally thereof and connected electrically at its ends with said hull, whereby a loop oscillating circuit is provided, and electromagnetic signaling instruments associated with said looped oscillating circuit.

3. The combination with a submarine vessel having a metallic hull, of an insulated radio conductor extending longitudinally thereof and connected electrically at its ends with said hull, whereby a loop oscillating circuit is provided, a tuning condenser in said oscillating circuit, and electromagnetic signaling instruments associated with said looped oscillating circuit.

4. The combination with a submarine vessel having a metallic hull, of an insulated radio conductor extending longitudinally thereof and connected electrically at its ends with said hull, whereby a loop oscillating circuit is provided, electromagnetic signal instruments associated with said radio conductor between its ends, and a tuning condenser in circuit with said conductor.

5. A wireless signaling device having electromagnetic wave instrumentalities, and a submersible waterproof antenna in the form of a loop mounted upon a submarine vessel and operatively connected with said instrumentalities, said loop being provided with a condenser.

6. In a wireless signaling device, a submersible loop antenna insulated substantially throughout its length and mounted upon a submarine vessel, said loop antenna having a condenser in series therewith, and electromagnetic signaling instrumentalities associated with the loop.

7. A radio signaling device, comprising a submersible support, an antenna extending thereabove and insulated intermediate its ends from the support and forming a loop therewith, and electromagnetic wave apparatus operatively connected with the antenna.

8. A radio signaling device, comprising a submersible vessel having supporting means, an antenna carried by the vessel and insulated intermediate its ends from said vessel, and radio signaling apparatus operatively connected to the antenna intermediate its ends, the antenna and its supporting vessel serving as a loop for the sending and receiving of radio signals.

9. A radio signaling device, comprising a support formed as the hull of a vessel, a loop antenna carried thereby, said antenna being connected at its ends to the hull and its intermediate portion insulated therefrom, and radio signaling apparatus operatively connected with said antenna for the receiving

and sending of electromagnetic waves, said hull forming a part of an oscillation circuit.

10. A radio signaling device, which comprises a metallic support and adapted to be submerged in a fluid, an antenna, including a condenser in series therewith, connected at its ends to the support and having its intermediate portion spaced and insulated from said support, the arrangement of the support and antenna forming a loop, and electromagnetic wave apparatus operatively connected with the antenna.

11. In a radio signaling device, an antenna, a submergible vessel to support the antenna, and electromagnetic wave apparatus operatively connected with the antenna, said antenna being insulated intermediate its ends and forming with its support a loop oscillating circuit.

12. Radio signaling apparatus comprising in combination a submersible vessel, a loop antenna of which the vessel structure forms part of the loop circuit, a reception or oscillation circuit carried by said vessel and means associated with both circuits for transferring the oscillations from one circuit to the other, said means being connected to that part of the loop circuit that is exterior to the hull.

13. A submersible vessel provided with an obstruction clearing cable forming a loop-oscillating circuit with the vessel and an electromagnetic wave apparatus operatively connected with said loop circuit.

14. A vessel having a metallic hull and provided with a combined radio insulated conductor and obstruction-clearing metallic element extending longitudinally of the vessel and electrically connected with said hull to form a loop-oscillating circuit, and electromagnetic signaling instruments associated with said looped oscillating circuit.

15. In a submarine vessel, a combined obstruction-clearing and insulated antenna element extending above the deck of a vessel and having one end secured to a cupped terminal support which is insulated from the vessel, said end of the element being sealed within the cup support, the other end of the antenna element being secured in a water-tight socket terminal, the insulation of the antenna extending within the socket and the metallic core of the combined obstruction-clearing device and antenna being inserted through the terminal socket and metalically secured thereto to thereby provide a loop-oscillating circuit including the vessel and antenna.

16. In a radio-signaling apparatus, an antenna carried by a freely movable submergible vessel to form a loop circuit therewith whereby the antenna may be utilized as a directional signaling element, and electromagnetic signaling instrumentalities associated with the loop.

17. The combination with a submarine

vessel having a metallic hull provided with a support, of an insulated radio conductor connected electrically at its ends to the metallic hull and having its intermediate lead-in portions mounted on and insulated from said support, the lead-in portions being spaced apart substantially parallel from the support to the electro-magnetic wave apparatus positioned within the hull of the boat to thereby increase the strength of the signals, and electro-magnetic wave apparatus operatively connected to the insulated radio conductor.

18. The combination with a submarine vessel having a metallic hull, of an insulated radio conductor serving as a loop antenna, which conductor is connected electrically at its ends to the metallic hull and having its intermediate lead-in portions mounted in spaced relation on and insulated from a substantially centrally positioned support, the lead-in portions terminating substantially centrally of the loop to provide a plurality of sections of the radio conductor which are of substantially the same area, inductance and distributed capacity, to thereby reduce the change in capacity when submerging the vessel, and electro-magnetic wave apparatus operatively connected with the antenna at the lead-in portions within the boat.

19. In a radio signaling apparatus, a submarine vessel having a metallic hull, a pair of collector wires each having one end electrically connected to the hull, said collector wires extending longitudinally of the hull to provide two wave collector areas, and tuning means between the associated ends of the collector wires.

20. In a radio signaling apparatus, a submarine vessel having a metallic hull, a pair of insulated collector wires each having one end electrically connected to the hull, said collector wires extending longitudinally of the hull to provide two wave collectors of substantially the same area, and tuning means within the hull of the boat coupled to the associated ends of the collector wires.

21. In a radio signaling apparatus, a submarine vessel having a metallic hull, a pair of insulated collector wires each having one end electrically connected to the hull near the ends thereof, said collector wires extending longitudinally of the hull to provide two wave collector areas in substantially the same plane and tuning means within the hull coupled to the associated ends of the collector wires.

22. In a radio signaling apparatus, a submarine vessel having a metallic hull, a pair of insulated collector wires serving as radio conductors, each having one end electrically connected to the hull of the vessel, said conductors extending longitudinally of the hull to provide two wave collectors of substantially the same area and positioned in substantially the same vertical plane, and tuning means

coupled to and positioned between the associated ends of the collector wires.

23. In a radio signaling apparatus, a submarine vessel having a metallic hull, a pair
5 of insulated collector wires serving as radio conductors, each having one end electrically connected to the metallic hull, a portion of each of said collector wires extending paral-

lel and in spaced relation to each other to form two wave collectors of substantially the same area and positioned in substantially the same vertical plane, and tuning means interposed between such last named parallel ends of the collector wires. 10

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