

[54] COMMUNICATION SYSTEM

[75] Inventor: Henri G. Busignies, Montclair, N.J.

[73] Assignee: International Telephone and Telegraph Corporation, Nutley, N.J.

[22] Filed: May 2, 1960

[21] Appl. No.: 26,232

[52] U.S. Cl. .... 340/4 R, 325/28, 325/116, 343/709, 343/719

[51] Int. Cl. .... H04b 13/02, H01q 1/04

[58] Field of Search .... 340/2, 4, 4 A; 343/707, 343/709, 710, 719, 720; 174/101.5; 250/3, 4, 5; 325/28, 111, 116, 112, 4, 5, 8, 9, 10, 14; 246/30

[56] References Cited

UNITED STATES PATENTS

|           |         |                   |         |
|-----------|---------|-------------------|---------|
| 979,144   | 12/1910 | Fessenden.....    | 250/3   |
| 1,173,957 | 2/1916  | Hahnemann.....    | 340/4   |
| 1,331,640 | 2/1920  | Hahnemann.....    | 340/4   |
| 1,349,103 | 8/1920  | Rodgers.....      | 343/719 |
| 1,530,129 | 3/1925  | Loftin et al..... | 340/4   |
| 1,557,049 | 10/1925 | Hammond, Jr.....  | 340/4   |
| 1,944,891 | 1/1934  | Hill.....         | 340/4   |
| 2,048,811 | 7/1936  | Peirce.....       | 343/709 |
| 2,067,337 | 1/1937  | Polatzek.....     | 343/709 |
| 2,478,133 | 8/1949  | Shanklin.....     | 343/720 |
| 2,838,741 | 6/1958  | Mason.....        | 340/2   |

FOREIGN PATENTS OR APPLICATIONS

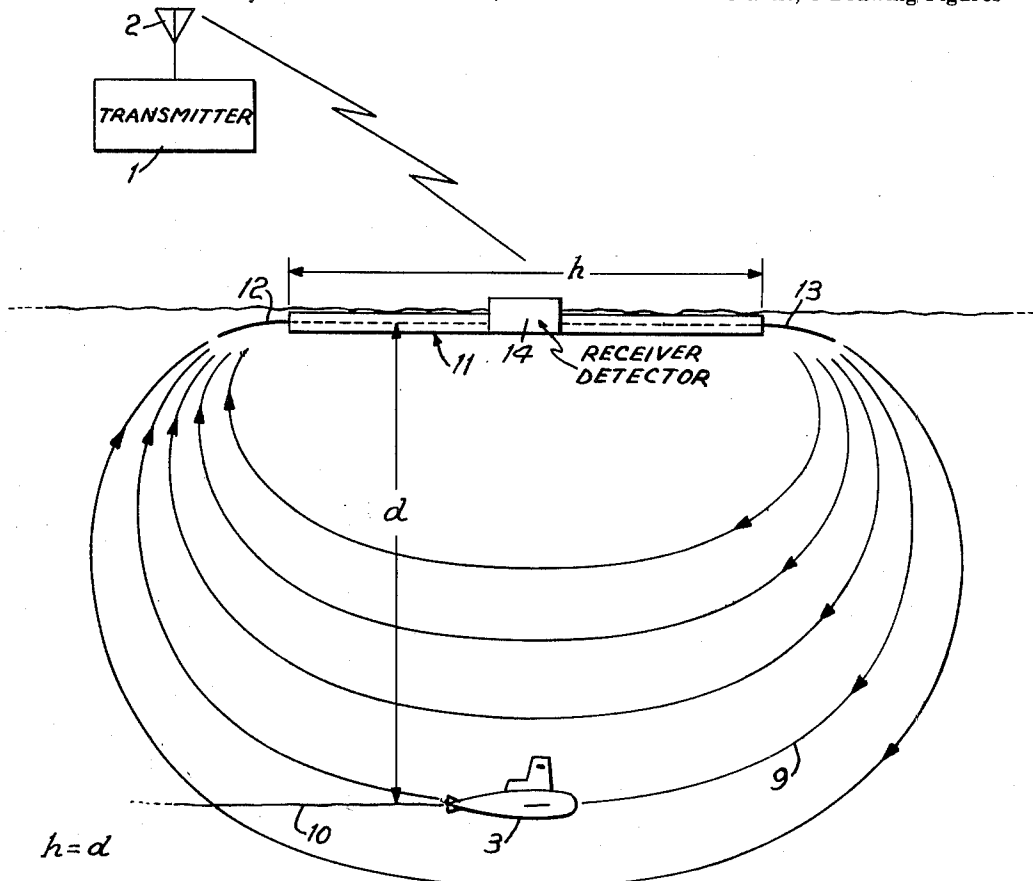
|           |        |              |       |
|-----------|--------|--------------|-------|
| 1,024,854 | 2/1958 | Germany..... | 340/5 |
|-----------|--------|--------------|-------|

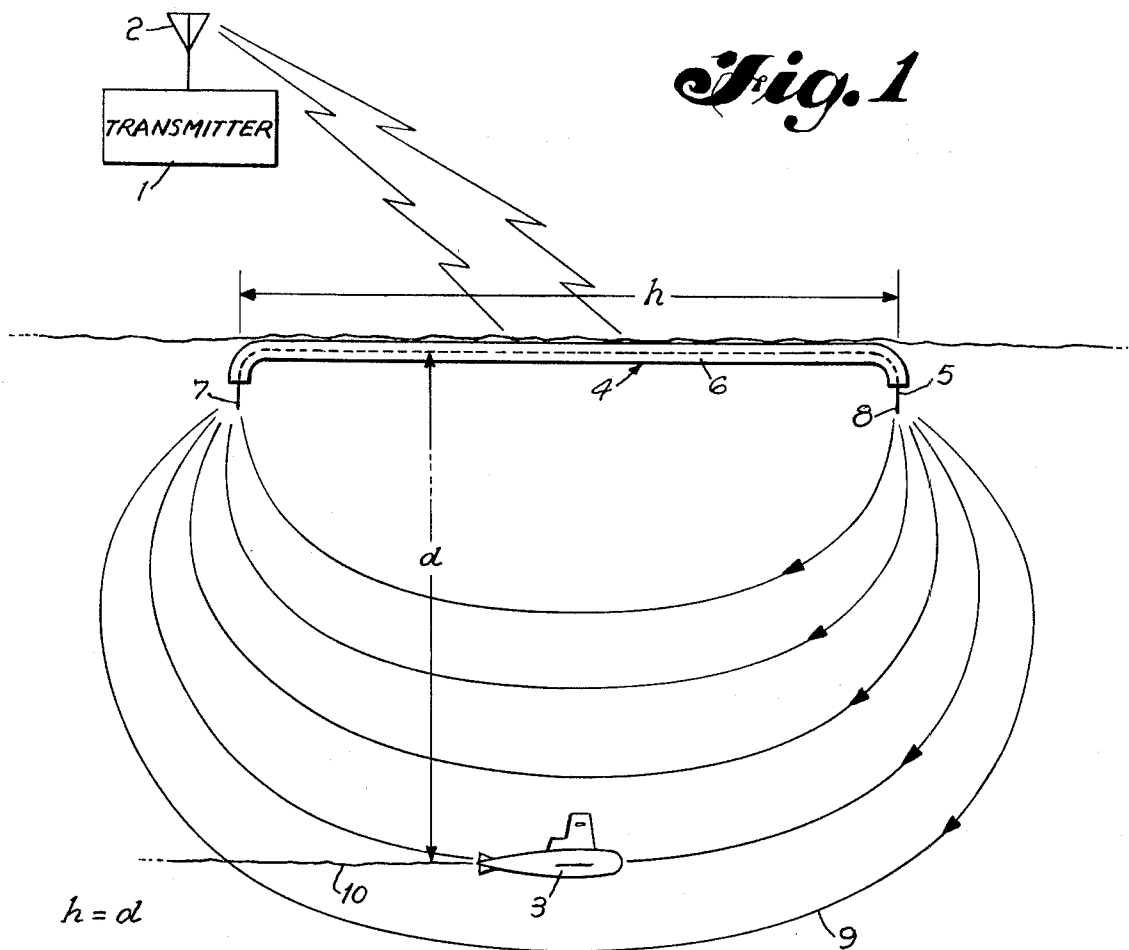
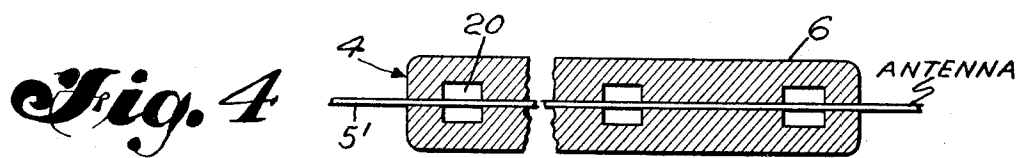
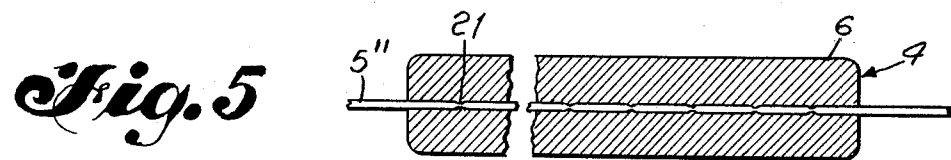
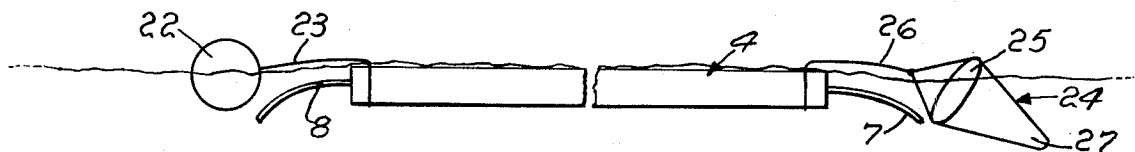
Primary Examiner—Richard A. Farley  
Attorney, Agent, or Firm—John T. O'Halloran;  
Menotti J. Lombardi, Jr.; Albert C. Hill

EXEMPLARY CLAIM

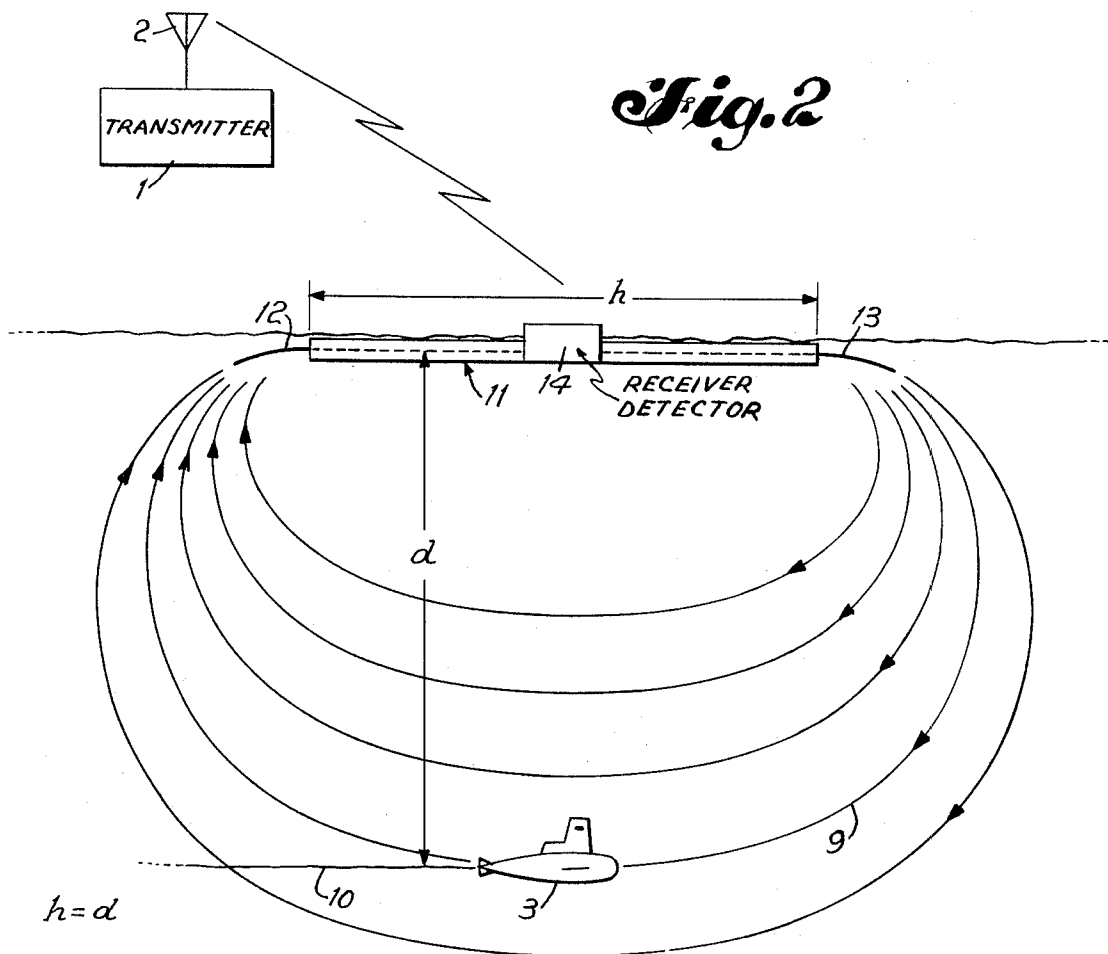
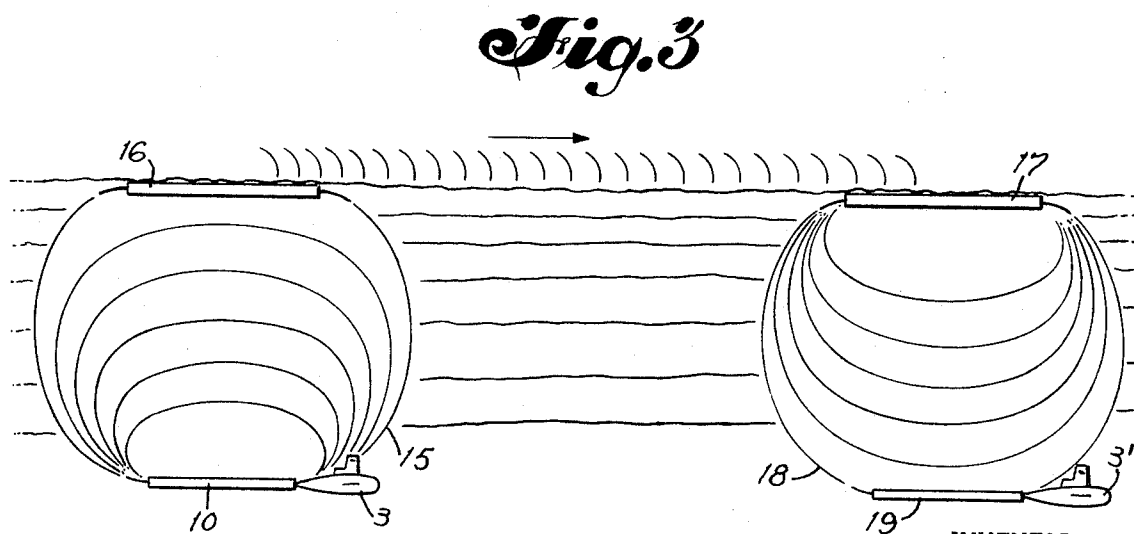
7. A system for communicating electromagnetic signals through the atmosphere between at least two underwater objects capable of transmitting and receiving electromagnetic signals comprising a transmitter and receiver for said signals carried by each of said objects, first conductive means carried by each said object and disposed within the water for radiating said transmitted signals into the water and producing conductive currents and corresponding fields in the water surrounding said object and capable of receiving incoming signals carried by other conductive currents in the vicinity, second conductive means carried by each said object and releasable by each said object to be disposed at the surface of the water separate from said object and in the vicinity of each of said objects with the ends thereof in contact with the water and capable of receiving the transmitted signals of said conductive currents and to radiate said transmitted signals into the atmosphere for reception by the second conductive means disposed on the surface of the water separate from and in the vicinity of the other object, said second conductive means being capable of detecting said signals radiated through the atmosphere and radiating said signals through said ends into the water and producing conduction currents and corresponding fields in the water surrounding the adjacent object.

16 Claims, 6 Drawing Figures





INVENTOR.  
HENRI G. BUSIGNIES  
BY *Judas Fogut*  
ATTORNEY



INVENTOR.

HENRI G. BUSIGNIES  
BY *Juday Logut*  
ATTORNEY

## COMMUNICATION SYSTEM

This invention relates to radio communication systems and more particularly to radio communication with underwater or undersea objects.

At present, communication with a submarine is had by letting up a buoy to or near the surface of the water, the buoy being provided with an antenna to pick up the radio signals and a lead-in wire connecting the antenna with the receiver and transmitter in the submarine. Such a system is not satisfactory since the buoy must be close to the surface within two or three feet thereof, to pick up radio signals, since attenuation of the signals is very high in sea water and increases by the square of the distance. Also, when the submarine moves, the buoy is pulled lower than when the submarine is motionless. The problem is complicated further by the fact that nuclear submarines operate at depths much greater than was formerly though possible with conventional powdered submarines. It is apparent that communication with submarines in the manner described above is unsatisfactory and undependable. It is also necessary that the means of communication with submarines be secret and undetectable as far as possible. Again, in this regard buoys are susceptible to detection and the presence of a submarine below can be assumed.

It is an object of this invention to provide a system for communicating with submarines that is simple, economical, and difficult to detect; the communications made possible being between the atmosphere and points submerged below the water level and also between two submarines submerged a considerable distance apart.

Another object is to provide a means for receiving signals transmitted through the atmosphere and retransmitting the signals to the submarine below the surface of the water, by means of a combination of conduction currents and the corresponding electromagnetic fields in water.

Another object is to provide means within the antenna to destroy the antenna after it has been exposed to the water for a predetermined time.

A feature of this invention is a system for communicating electromagnetic signals between the atmosphere and an underwater object capable of detecting electromagnetic signals comprising conductive means disposed at the surface of the water adapted to detect the signals. The conductive means are disposed in the vicinity of the object with the ends of the conductive means exposed in contact with the water, the received signals into the water from the ends and producing electric and magnetic fields in the water surrounding the object.

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

FIG. 1 is a diagram of one embodiment of this invention;

FIG. 2 is a diagram of a second embodiment;

FIG. 3 is a diagram of a communication system between two submerged submarines in accordance with this invention;

FIG. 4 is a longitudinal cross-section view of one form of an antenna to be used in this invention;

FIG. 5 is a longitudinal cross-section view of a second

antenna useful in the operation of this invention; and FIG. 6 is a diagram showing how the antenna may be properly disposed on the surface of the water.

Whereas in air the velocity of propagation of electromagnetic waves is constant, in sea water it increases with frequency and results in frequency distortion of the wave; in air the wavelength varies inversely as the first power of frequency, in sea water it varies inversely as the half power. The attenuation of the electromagnetic propagation in sea water is a function of frequency as shown by the following relation:  $\alpha = 0.0118f^{0.5}$  db/ft. It has been shown that the maximum depth for useful 10kc to 20kc signals would be no more than roughly 50 to 100 feet. It appears then that it would be necessary to transmit signals of frequencies less than 10kc to assure optimum communication conditions with submarines submerged at great depth. Electromagnetic propagation of waves in free space is in the form of displacement current; in conductive material such as metals and also the earth and sea water the propagation is in the form of conductive currents with associated fields; and a third form is convection currents, such as the stream of electrons in a cathode ray tube. In this invention it is desired to utilize conduction currents and their associated fields which are produced in sea water as a result of conductive radiation from an antenna disposed on the surface of the water with its conductive ends in contact with the water and receiving displacement currents propagated in the atmosphere.

Referring now to FIG. 1, there is shown a transmitter 1 having a transmitting antenna 2 located at relatively great distance from a submerged submarine 3 and transmitting signals through the atmosphere. An antenna 4 is disposed in elongated form out on the surface of the ocean above the submarine 3. The antenna 4 can be carried by the submarine in a coiled fashion to save space and then released at any desired point to float upwards toward the surface and there be stretched out and so remain in elongated condition on the surface of the water for a desired length of time before being self destroyed as will be explained later on. The antenna 4 comprises a conductive wire 5 of great length, say 300 feet or more as may be desired, and insulated with a dielectric material 6 over substantially the entire length of the antenna leaving the ends 7 and 8 exposed and in contact with the sea water. This then comprises in effect an end exposed antenna.

The radiations transmitted from the transmitter 1 through the atmosphere are received by the antenna 4 and retransmitted by conduction to the water through the ends 7 and 8 and to the water producing conduction currents, shown as ellipses 9, to submarine 3 which has a suitable antenna 10 for receiving the conduction currents. It can be assumed that the radiations transmitted by the antenna 2 constitute a vertically polarized wave in the air which becomes a horizontally polarized wave in sea water with its electric vector in the same vertical plane as the direction of propagation in air as shown by the ellipses radiating from one end 7 of the antenna 4 through the sea water and back to the other end 8 of the antenna 4. The dielectric 6 of the antenna is of such material that it will disintegrate after a short period (a few hours, for example, or even a shorter period). The wire would also be so treated that it also would disintegrate within a predetermined time. Alternatively, as will be described later, provision can

be made within the dielectric to incorporate means for destroying the wire after the required period has elapsed. In FIG. 1 it is assumed that very low frequency signals will be transmitted from the transmitter 1, say in the frequency range 10kc and lower. The antenna 4 has a length  $h$  which is approximately equal to the depth  $d$  at which the communication system will operate.

With reference to FIG. 2, another embodiment of this invention is shown adapted to receive high frequency radiations from the transmitter 1 and to retransmit lower frequency radiations through the sea water to the submarine below. An end exposed antenna 11, which may be a single dipole antenna, is shown disposed on the surface of the water and constructed in a similar manner to the antenna 4 of FIG. 1 with the exposed ends 12 and 13 in contact with the water to provide for conduction thereto of the signals from the atmosphere received by the antenna. A receiver and detector 14 is carried by the antenna 11 to detect the modulation on the carrier of the high frequency radiations and to retransmit the modulation through the water to the submarine below by means of the conduction currents. The detector output is connected to the same wires 12 and 13 coupled to the water but this time the demodulated energy is at a much lower frequency; for instance, a few hundred cycles per second or lower (as the output of a frequency shift keying for instance or amplitude modulated signal). The modulation or subcarrier could be in the frequency range of 400 to 800 cycles per second. This demodulated signal propagates in the water to much greater depths than the carrier signal. The demodulated signal could also be D.C. These low frequency signals would undergo a minimum sea water attenuation and the signals could be detected by the sensitive receiver in the submarine. The receiver detector unit 14 could include a transistor detector and amplifier arrangement powered by miniature cells such as mercury cells or similar type cells used for hearing aids which would be suitable for a short life performance and also would be of extremely small and compact size.

An embodiment of this invention useful for communication between submerged submarines is shown in FIG. 3. Submarine 3 for the purpose of the discussion will be considered the transmitting submarine and submarine 3' the receiving submarine. The antenna 10 carried by submarine 3 is useful both for transmitting and receiving signals by means of conductive currents in the water. Submarine 3 of course must have transmitting equipment of sufficiently high power to radiate the signals from the antenna 10 into the water producing conduction currents shown as ellipses 15. The submarine 3 also releases an end exposed antenna 16 which is similar to antenna 4, constructed, as will be described further on, to rise to the surface of the water and float thereon in a stretched out position for a desired length of time in the vicinity of and preferably above the submarine 3. The conduction currents 15 will then circulate in the antenna 16 and thus produce radiation of the signals from the antenna 16 into the atmosphere. The signals after propagating through the atmosphere will be picked up by the end exposed antenna 17, similar to antennas 3 and 16, floating on the surface of the water in the vicinity of a second submerged submarine 3'. The received signals in the antenna 1, will then produce conduction currents 18 in the water which propagating

downward will contact the antenna carried by the submarine 3' and thus be received and detected by the receiver equipment 3' in the submarine. The reverse process of transmitting signals by submarine 3' and receiving signals by submarine 3 can then be carried out in a similar manner.

A cross-section of the unique antenna of this invention is shown in FIG. 4. This is one embodiment of the self-destruct feature of this antenna. The antenna wire 5' is covered for almost its entire length by the dielectric material 6 which can be of any suitable material such as paper which when exposed to water will gradually absorb the water and thus facilitate the disintegration of the paper within a relatively short time. The precise period of time that is suitable of course is determined by the required length of time for communications and the characteristics of the dielectric paper or otherwise can be determined to assure that such disintegration will be completed at the end of that period. To further facilitate the destruction of the wire 5' into small pieces and thus minimize the possibility of detection by any surface detection means, there is provided at spaced intervals within the dielectric 6 and adjacent to the wire 5' small pellets 20 which can be of such a material that on contact with water sufficient heat or other forms of energy can be generated which will tend to break the wire at those points thus breaking up the wire into a great number of small pieces which can then sink into the water. Of course, it is possible to have an antenna wherein the dielectric will disintegrate within the desired time and the wire 5' will then float downward when released from the buoyancy of the dielectric material. The pellets 20 can be of sodium or similar material which when reacting with water generates great quantities of heat that would be sufficient to melt the wire at the point of contact. It could also be a slat that dissociates in water producing an acid reaction which would thus attack the wire 5 at these various points and break it up into a plurality of small pieces.

FIG. 5 illustrates another version of a self-destructive feature incorporated within the wire. In this embodiment the wire is crimped or indented, without completely severing the same, with crimps 21 at spaced intervals as shown. The depths of the crimping can be determined by how much time is required for the communication feature. After the disintegration of the dielectric 6 in the water, the flexing of the wire will be accelerated and will induce rapid breakage of the wire at the various points of crimping.

It is desirable that as many of these antennas be carried within the submarine for communications as possible; therefore, it is necessary that these antennas be stowed away in a most convenient and space saving manner. Also, when the antennas are released from the submarines and float upward, it is necessary that the wire be stretched out so that a substantially horizontal disposed antenna floating on the surface of the water is procured. This is accomplished in the manner shown in FIG. 6. In this figure a buoyant float 22 is attached to one exposed end of the antenna 4 by a cord 23. The other end of the antenna is attached by a cord 26 to a sea anchor 24 which is simply an open canvas cone with the large end 25 attached to cord 26. The sea currents flowing through the large end 25 and out through the smaller end 27 exert a stretching force on the antenna wire. The float 22 together with the action of the sea water on the sea anchor 25 maintains the antenna

4 in a stretched out manner on the surface of the water to provide the substantially horizontally disposed antenna.

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 system for communicating electromagnetic signals between the atmosphere and an underwater object, comprising insulated conductive means carried by said object and releasable by said object to be disposed at the surface of the water adapted to detect said signals, said conductive means being disposed separate from and in the vicinity of said object and having uninsulated ends thereof in contact with said water, said received signals being radiated into said water from said ends and producing conduction currents and corresponding electromagnetic fields in the water surrounding said object.

2. A system for communicating electromagnetic signals between the atmosphere and an underwater object, comprising an insulated conductor carried by said object and releasable by said object to be disposed at the surface of the water separate from and in an overlying relationship to said underwater object, said insulated conductor being a length at least equal substantially to the depth of said object, said conductor being uninsulated at the ends thereof to place said conductor in conductive relation with said water at widely spaced points, said conductor being capable of detecting electromagnetic signal energy in said atmosphere and producing corresponding conduction currents and corresponding electromagnetic fields in said water to the depth of said object and for detecting electromagnetic conducting currents and corresponding electromagnetic fields radiated from said object and for producing corresponding electromagnetic radiations into the atmosphere.

3. A system according to claim 2 further including means to maintain said conductor in extended condition at the surface of said water.

4. A system according to claim 3, wherein said last named means includes an anchor at one end of said conductor and a float in the other end of said conductor.

5. A system according to claim 2, wherein said insulated conductor includes a transducer to change the frequency of the signal energy detected by said conductor.

6. A system according to claim 2, wherein the insulation of said insulated conductor includes water reacting material adapted to reduce the buoyancy of said insulated conductor after a predetermined period of immersion.

7. A system for communicating electromagnetic signals through the atmosphere between at least two underwater objects capable of transmitting and receiving electromagnetic signals comprising a transmitter and receiver for said signals carried by each of said objects, first conductive means carried by each said object and disposed within the water for radiating said transmitted signals into the water and producing conductive currents and corresponding fields in the water surrounding said object and capable of receiving incoming signals

carried by other conductive currents in the vicinity, second conductive means carried by each said object and releasable by each said object to be disposed at the surface of the water separate from said object and in the vicinity of each of said objects with the ends thereof in contact with the water and capable of receiving the transmitted signals of said conductive currents and to radiate said transmitted signals into the atmosphere for reception by the second conductive means disposed on the surface of the water separate from and in the vicinity of the other object, said second conductive means being capable of detecting said signals radiated through the atmosphere and radiating said signals through said ends into the water and producing conduction currents and corresponding fields in the water surrounding the adjacent object.

8. A system for communicating electromagnetic signals between the atmosphere and an underwater object capable of detecting electromagnetic signals, comprising insulated conductive means carried by said object and releasable by said object to be disposed lengthwise at the surface of the water separate from and in the vicinity of said object, said conductive means being insulated from said water except for the ends thereof which are in contact with said water, said detected signals radiating into said water from said ends and producing conduction currents and corresponding electromagnetic fields in the water surrounding said object.

9. A system for communicating high frequency electromagnetic signals between the atmosphere and an underwater object capable of detecting low frequency signals comprising insulated conductive means carried by said object and releasable by said object to be disposed at the surface of the water adapted to detect said high frequency signals, said conductive means being disposed separate from and in the vicinity of said object and having ends thereof in contact with said water, means carried by said conductive means to convert said high frequency signals to said low frequency signals, said converted low frequency signals radiating into said water from said ends and producing conduction currents and corresponding electromagnetic fields in the water surrounding said object.

10. A system for communicating electromagnetic signals between the atmosphere and an underwater object capable of detecting electromagnetic signals comprising insulated conductive means carried by said object and capable of being released by said object when underwater, means carried by said conductive means to cause said conductive means after said release to assume a position lengthwise on the surface of the water separate from and in the vicinity of said object, with uninsulated ends of said conductive means in contact with said water, said conductive means being adapted to detect said signals and radiate said detected signals into said water from said ends.

11. A system for communicating electromagnetic signals between the atmosphere and an underwater object capable of detecting electromagnetic signals, comprising conductive means carried by said object and releasable by said object to be disposed at the surface of the water adapted to detect said signals, said conductive means being disposed separate from and in the vicinity of said object and having the ends thereof in contact with said water, said detected signals radiating into said water from said ends and producing conduction currents and corresponding electromagnetic fields in the water sur-

rounding said object, and means included around said conductive means for destroying said conductive means within a predetermined time.

12. A system for communicating electromagnetic signals between the atmosphere and an underwater object capable of detecting electromagnetic signals comprising conductive means carried by said object and capable of being released by said object when underwater, buoyant material disposed around said conductive means and means disposed at each end to maintain said conductive means in a stretched out position disposed lengthwise on the surface of the water separate from and in the vicinity of said object, with the ends thereof in contact with said water, said conductive means being adapted to detect said signals and said detected signals radiating into said water from said ends.

13. An antenna to be disposed on the surface of a body of water and capable of detecting electromagnetic signals in the atmosphere, said antenna comprising a conductive wire, insulation material surrounding said wire, the ends of said wire being exposed and in contact with said water, said detected signals radiating into said water from said ends, said insulation material comprising buoyant material for maintaining said antenna disposed at the surface of the water for a predetermined length of time, means coupled to said antenna

to maintain said antenna in an extended position at the surface of the water and means included within said insulation material to destroy said antenna after the expiration of said predetermined time.

14. An antenna according to claim 13 wherein said destruction means comprise a plurality of masses of water reacting material disposed at discrete intervals along the length of said wire within said insulating material, and said insulating material comprises material penetrable by said water at a predetermined rate until said water reaches said water reacting material through said insulation material to react with said water reacting material.

15. An antenna according to claim 13 wherein said destruction means comprise a plurality of indentation in said wire spaced along the length of said water and said insulating material comprises material penetrable by said water at a predetermined rate for disintegration of said antenna into discrete pieces after said predetermined time.

16. An antenna according to claim 13 wherein said means for maintaining said antenna in an extended position on the surface of the water comprise a float coupled to one end of said antenna and a sea anchor coupled to the other end of said antenna.

\* \* \* \* \*

30

35

40

45

50

55

60

65