

March 10, 1925.

1,529,065

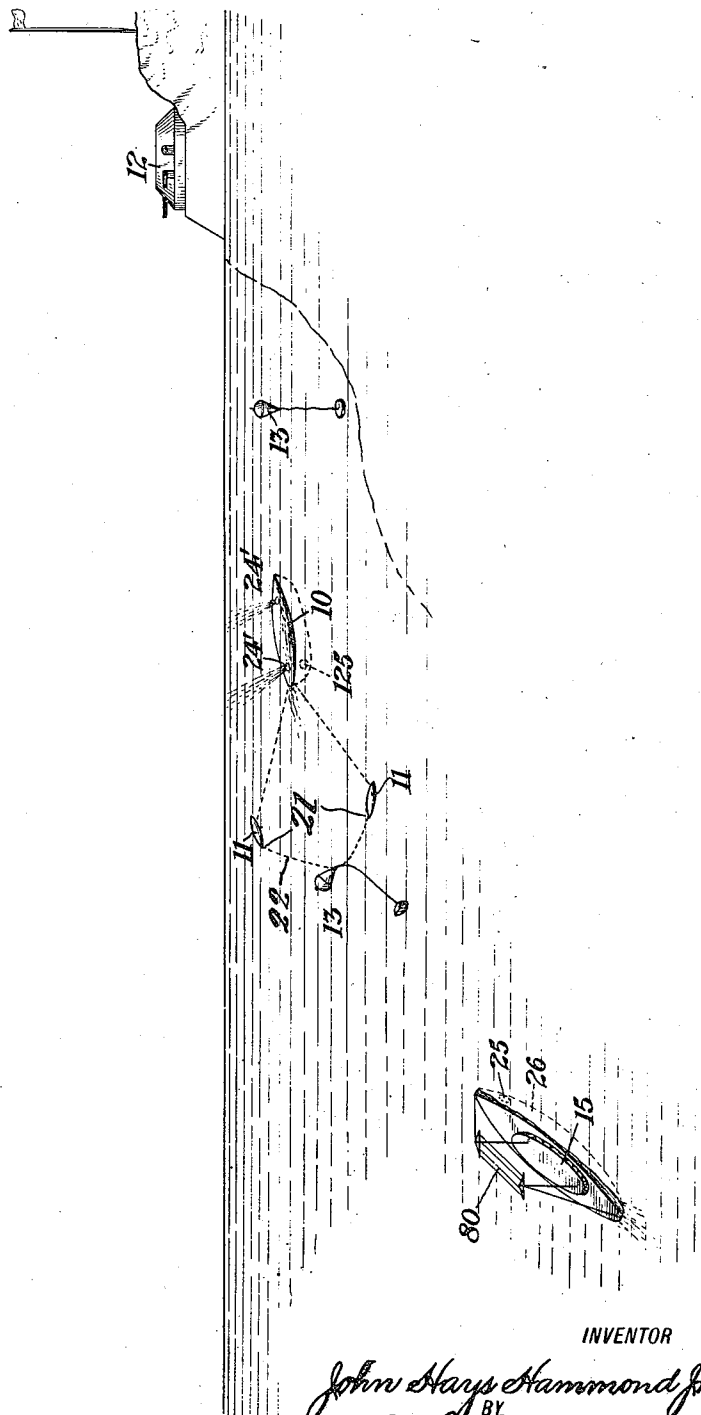
J. H. HAMMOND JR

SYSTEM OF RADIOCONTROL

Original Filed Dec. 11, 1916

5 Sheets-Sheet 1

Fig. 1



WITNESS

Chas. J. Clagett

INVENTOR

John Hays Hammond Jr.
BY
A. J. Gardner
HIS ATTORNEY

March 10, 1925.

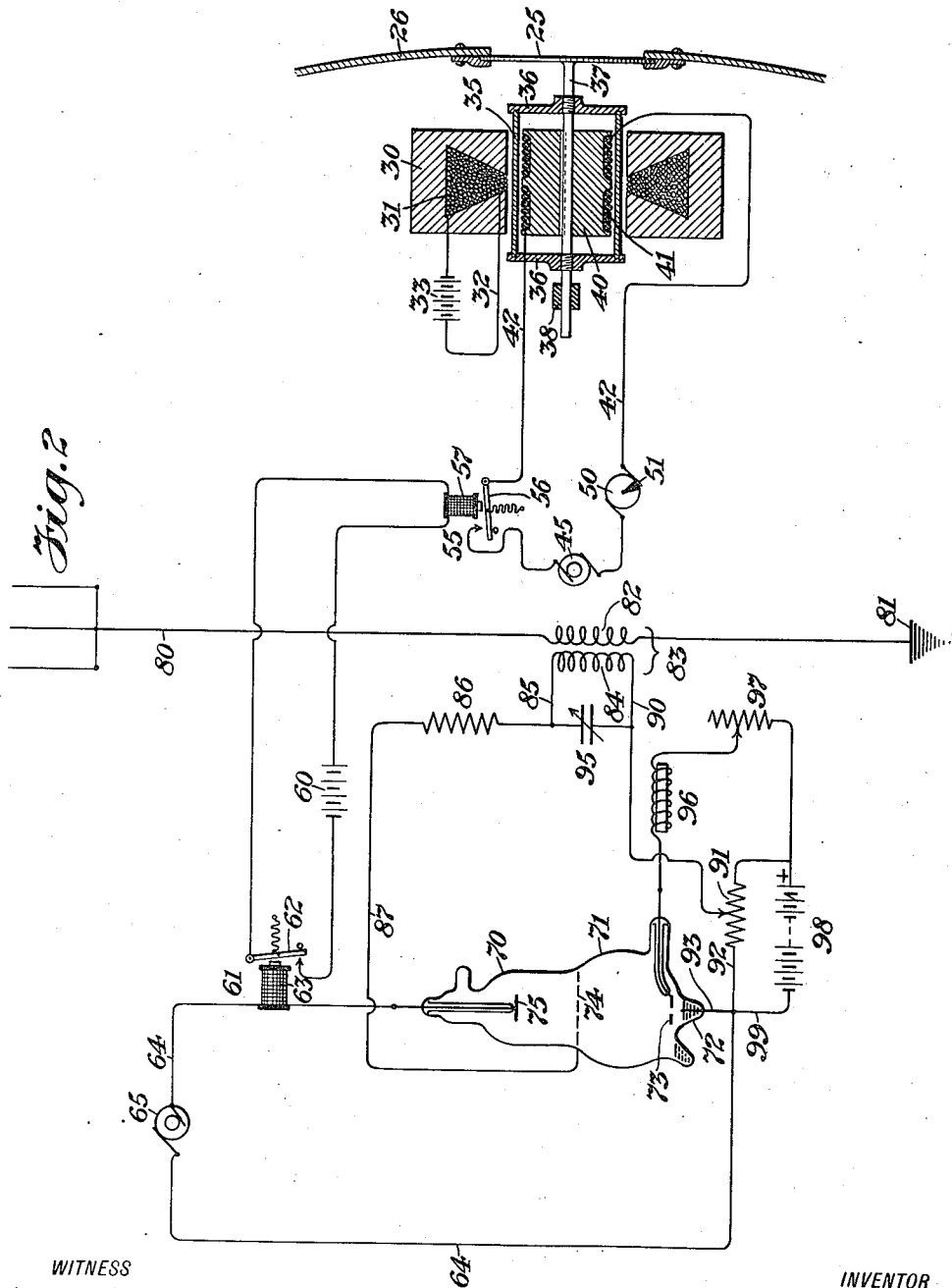
1,529,065

J. H. HAMMOND JR

SYSTEM OF RADIOCONTROL

Original Filed Dec. 11, 1916

5 Sheets-Sheet 2



WITNESS
Chas. Clagett

INVENTOR
John Harry Hammond Jr.
BY
A. J. Gardner
HIS ATTORNEY

March 10, 1925.

J. H. HAMMOND, JR

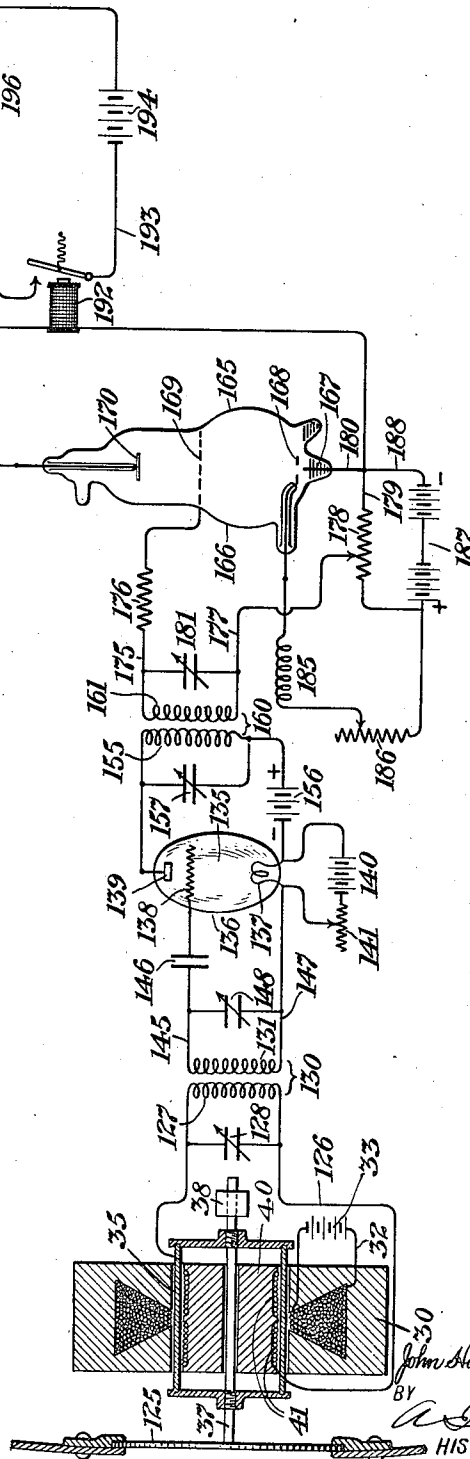
1,529,065

SYSTEM OF RADIOCONTROL

Original Filed Dec. 11, 1916

5 Sheets-Sheet 3

Fig. 3



WITNESS
Chas. J. Claggett

INVENTOR
John Hays Hammond, Jr.
BY
A. J. Gardner
HIS ATTORNEY

March 10, 1925.

1,529,065

J. H. HAMMOND, JR

SYSTEM OF RADIOCONTROL

Original Filed Dec. 11, 1916

5 Sheets-Sheet 4

Fig. 4

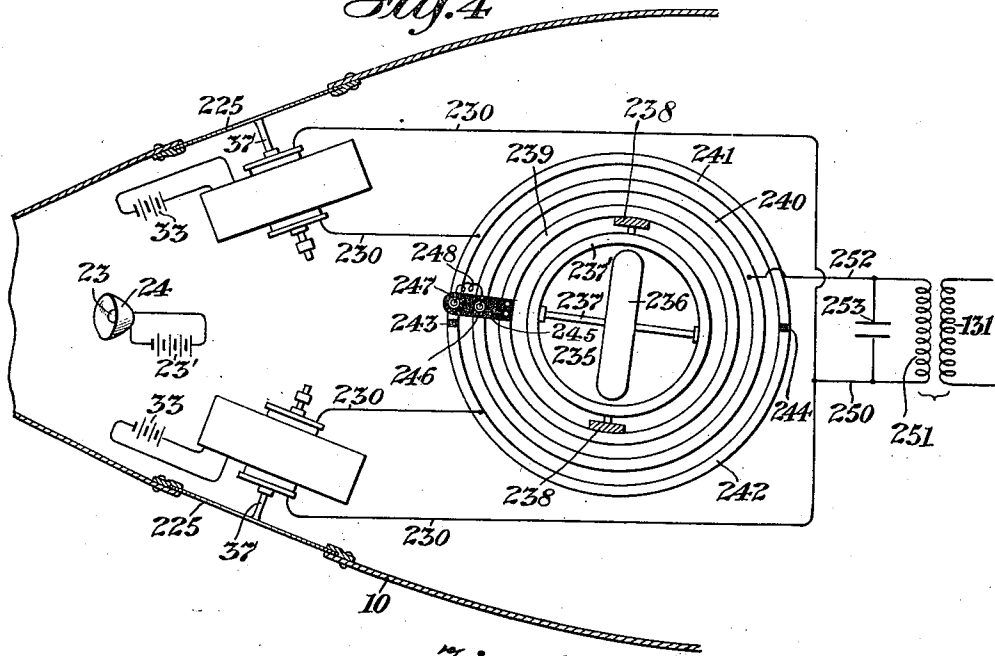
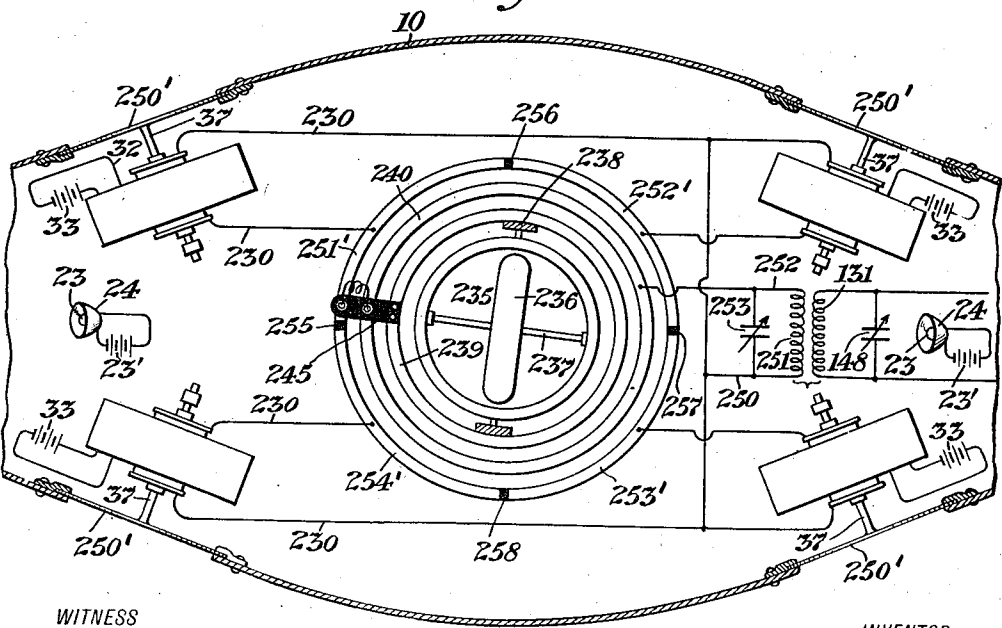


Fig. 5



WITNESS

Chas. J. Claggett

INVENTOR

John Hays Hammond Jr.
BY
A. J. Gardner
HIS ATTORNEY

March 10, 1925.

1,529,065

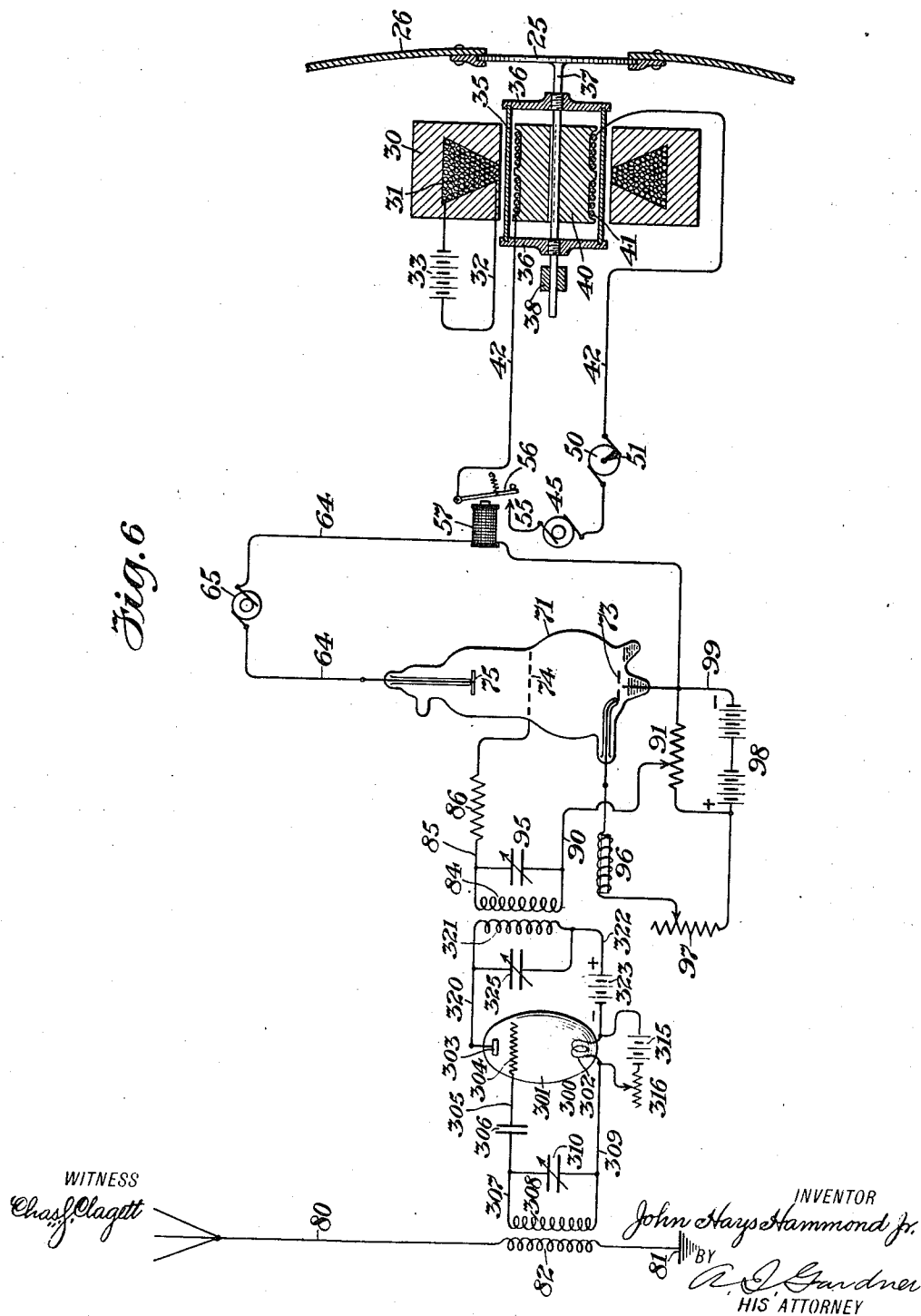
J. H. HAMMOND, JR

SYSTEM OF RADIOCONTROL

Original Filed Dec. 11, 1916

5 Sheets-Sheet 5

Fig. 6



Patented Mar. 10, 1925.

1,529,065

UNITED STATES PATENT OFFICE.

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS.

SYSTEM OF RADIOCONTROL.

Application filed December 11, 1916, Serial No. 136,249. Renewed October 17, 1923.

To all whom it may concern:

Be it known that I, JOHN HAYS HAMMOND, Jr., a citizen of the United States, and a resident of Gloucester, county of Essex, State of Massachusetts, have invented a new and useful System of Radiocontrol, of which the following is a specification.

Some of the objects of this invention are to provide a transmission system controlled by radiant energy for producing sound waves; to provide improved transmission means for producing a series of groups of sound waves having a predetermined wave frequency and a predetermined group frequency; to provide an improved receiving system for controlling a movable body or functioning device in response to sound waves; to provide an improved sound receiving system; to provide an improved system for the control of a submarine vessel or other movable body; to provide an improved system of submarine mine sweeping; and to provide other improvements as will appear hereinafter.

In the accompanying drawings, Fig. 1 is a perspective view of one embodiment of this invention as applied in a system for the control of a submarine mine sweeper from an aeroplane; Fig. 2 is a diagrammatic view of a system constructed in accordance with this invention for producing sound waves as a result of the action of electro-radiant energy; Fig. 3 is a diagrammatic view of a receiving system constructed in accordance with this invention for controlling the movements of a boat or other functioning device in response to sound waves; Fig. 4 is a modified receiving system constructed in accordance with this invention for controlling a boat or other functioning device in response to sound waves; Fig. 5 is a further modified receiving system constructed in accordance with this invention for controlling a boat or other functioning device in response to sound waves; and Fig. 6 is a diagrammatic view of a modified form of a system for producing sound waves as a result of the action of electro-radiant energy.

In the drawings this invention is shown as applied to the control of a submarine mine sweeper 10 which is towing the usual floats 11 and which is operating within the range of a fort 12 upon a "field" containing submarine mines 13. The submarine mine sweeper 10 is controlled through the agency of sound waves which are transmitted from

a control boat 15 beyond the range of the fort 12. The control boat 15 may be a torpedo boat or any other suitable vessel, and is controlled by electro-radiant energy transmitted from a hydroaeroplane or other air craft which also controls by electro-radiant energy the sound transmission system upon the control boat 15. The floats 11 may be submerged or partially submerged and are provided with rudders 21 so fixed as to cause the floats to be steered outwardly and to remain spaced apart and diverging forwardly. The floats 11 may be connected by a piano wire 22 hanging in the form of a loop arranged to engage under the mines and to drag or "sweep" the mines out of their field.

To facilitate the observation of the movements of the mine sweeper 10, when submerged, from the air craft 20, the mine sweeper 10 may be provided both forward and aft with an internal electric lamp 23 energized by a battery 23' or other suitable means and provided with a reflector 24 arranged to reflect the rays of light from the lamp upwardly and through a corresponding glass covered opening 24' provided therefor in the upper surface or deck of the mine sweeper, the glass closures of the two openings 24' being preferably differently colored.

For controlling the submarine mine sweeper 10 there is located upon the control boat 15 a system controlled by electro-radiant energy for the generation of sound waves. This system comprises, as shown in Fig. 2, sound transmission means including a flexible circular diaphragm 25 of metal or any other suitable material, which is mounted in any suitable manner in an opening provided therefor in the hull 26 of the boat 15 so that the outer surface of the diaphragm will be in contact throughout approximately its entire area with the surrounding water. The diaphragm is preferably but not necessarily arranged so that it will stand normally in an approximately vertical plane.

For vibrating the diaphragm 25 at any predetermined frequency, for instance, at 500 cycles or vibrations per second, there is arranged within the boat an electrical oscillator of well known construction and comprising a massive ring magnet 30 which is arranged to be energized by a coil 31 which is in series with a circuit 32 which contains

a battery 33 or any other suitable source of direct current for energizing the coil 31. Arranged loosely within the ring magnet 30 and coaxial therewith is a cylindrical copper vibrator 35 which is clamped between two rigid disks 36 which are threaded upon and thus fixedly secured to a rod 37, one end of which is secured to the central portion of the diaphragm 25, and the other end of which is slidably supported in a fixed bearing 38, the rod 37 being coaxial with the vibrator 35 and perpendicular to the diaphragm 25.

Loosely arranged within the vibrator 35 and coaxial therewith is a stationary cylindrical armature 40 through which the rod 37 passes freely and which carries a fixed winding 41, one half of which is wound clockwise, and the other half of which is wound counter-clockwise around the armature 40.

The winding 41 is in a circuit 42 which is arranged to be energized by an alternating current generator 45 having a frequency equal to the desired frequency of vibration of the diaphragm 25, for instance, a frequency of 500 oscillations per second. The circuit 42 extends through and is controlled by a commutator 50 which is provided with any suitable number of segments, and which is arranged to be rotated at any suitable constant speed so as to cause any desired number of regular interruptions per minute in the circuit 42 from the alternating current generator 45 through the coil 41. The commutator 50 may be provided, for instance, with a single segment 51 and may be rotated, for instance, at 100 revolutions per minute so as to cause 100 interruptions per minute in the circuit 42. The circuit 42 is controlled by a normally open electromagnet switch 55 including an armature 56 which is pivoted to swing about a fixed axis, and a stationary electro-magnet 57 arranged to control the armature 56.

In the operation of the oscillator for generating sound waves, when the electro-magnetic switch 55 is closed alternating current flows from the alternator 45 through the winding or coil 41 and induces a corresponding alternating current in the copper vibrator 35. As the copper vibrator 35 lies in a powerful field of force created by the ring magnet 30, the action of the alternating currents passing through the winding 41 causes the vibrator 35 to be reciprocated with a frequency equal to the frequency of the alternator 45, thus vibrating the diaphragm 25 in the same frequency. The commutator 50 acts to break up the electrical oscillations in the circuit 42 into groups having a group frequency depending upon the rate of rotation of the commutator and the number of segments with which the commutator is provided. When the commutator is provided with a single segment and

is rotated at 100 revolutions per minute, the electrical oscillations in the circuit 42 would be divided into groups having a group frequency of 100 groups per minute, and consequently the vibrations of the diaphragm would be divided into corresponding groups having the same group frequency.

For controlling the vibrations of the diaphragm 25 in response to electro-radiant energy, the electro-magnet 57 of the switch 55 is arranged in a circuit including a battery 60 and a normally open electro-magnetic switch 61 which includes an armature 62 arranged to swing about a fixed axis, and an electro-magnet 63. The electro-magnet 63 is arranged in a circuit 64 which is arranged to be energized by an alternating current generator 65 or other source of energy, and which is controlled by a mercury vapor detector 70. The detector 70 may be of any well known or suitable construction and in the form shown includes a glass bulb 71 which contains a mercury cathode 72, a flat annular anode 73, a grid 74 and a top terminal 75.

For causing the detector 70 to act in response to electro-radiant energy an antenna 80 or open aerial circuit projects upwardly from the control boat 15 and is grounded as at 81 upon the boat. This circuit has in series therewith a coil 82 which forms the primary of a transformer 83 having a secondary coil 84, one end of which is connected through a conductor 85, resistance 86 and conductor 87 to the grid 74 of the detector 70. The other end of the coil 84 is connected through a conductor 90, a potentiometer 91, conductor 92 and a conductor 93 with the mercury cathode 72. A condenser 95 is connected upon one side of the conductor 85 and upon its other side to the conductor 90 and is in a closed oscillatory circuit which includes the secondary coil 84 which is tuned to the natural frequency of the aerial circuit 80, 82.

The anode 73 is connected through a choke coil 96 and variable resistance 97 with the positive pole of a battery 98, the negative pole of which is connected by a conductor 99 and the conductor 93 with the cathode 72.

When a signal of electro-radiant energy is received by the antenna 80 electrical oscillations are produced in the closed oscillatory circuit 84, 95, and these oscillations act upon the detector 70 to change the potential of the grid 74 and to consequently increase the apparent conductivity of the detector, thus permitting a unidirectional current to flow from the alternator 65 through the control circuit 64 and detector 70. This unidirectional current acts upon the electro-magnet 63 and closes the circuit through the battery 60, and the electro-magnet 57 is thus energized and acts to close the circuit through the alternator 45, commutator 50

and winding 41, which causes the diaphragm 25 to be vibrated at a given frequency and in groups of vibrations having a predetermined group frequency as hereinbefore described. These vibrations of the diaphragm 25 cause corresponding compressional waves corresponding to sound waves to be set up in the water which presses against the outer surface of the diaphragm.

For receiving the compressional waves transmitted through the water from the control boat 15, the mine sweeper 10 is provided with any suitable receiving system, one form of which is diagrammatically shown in Fig. 3, and comprises a receiving diaphragm 125 which is secured in any suitable manner in an aperture provided therefor in the side of the mine sweeper. This diaphragm is rigidly connected to one end of the shaft 37 of an electrical oscillator which is constructed as hereinbefore described, but the armature 40 of which instead of having its winding 41 energized and controlled as hereinbefore described, has its winding 41 in a circuit 126 which has in series therewith a coil 127, and which has a variable condenser 128 shunted around the coil, the coil 127 and the condenser 128 being in an oscillatory circuit which is tuned to the frequency of the alternator 45 of the transmission station. The coil 127 forms the primary of a transformer 130 having a secondary coil 131 and arranged to control a gaseous detector 135 which may be of any well known or suitable construction, and in the form shown includes a vacuized glass bulb 136 which contains a filament 137, a grid 138 and a top terminal or plate 139. The filament 137 is heated by a battery 140 acting through a variable resistance 141. One end of the coil 131 is connected by a conductor 145 with one side of a stoppage condenser 146, the other side of which is connected to the grid 138. The other end of the coil 131 is connected by a conductor 147 to the circuit of the filament 137. A variable condenser 148 is connected between the conductors 145 and 147 and is arranged in an oscillatory circuit including the coil 131 and which is tuned to the frequency of the oscillatory circuit 127, 128.

The detector 135 controls a circuit which includes a coil 155 and a battery 156 or other source of electrical energy. A variable condenser 157 is shunted around the coil 155 and is in an oscillatory circuit including the coil 155, and which is tuned to the group frequency of the transmission station, or in other words, to the frequency determined by the commutator 50.

The coil 155 forms the primary of a transformer 160 which has a secondary coil 161 and which is arranged to control a mercury vapor detector 165 constructed as hereinbefore described, and including an evacu-

ated glass bulb 166 which contains a mercury cathode 167, a flat annular anode 168, a grid 169 and a top terminal 170. One end of the coil 161 is connected through a conductor 175 and a resistance 176 to the grid 169, and the other end of the coil 161 is connected through a conductor 177, potentiometer 178, conductor 179 and conductor 180 to the mercury cathode 167. A variable condenser 181 is shunted around the coil 161 and is in an oscillatory circuit including the coil 161, and which is tuned to the frequency of the circuit 155, 157, or in other words, to the frequency determined by the commutator 50 of the transmission station. The anode 168 is connected through a choke coil 185 and variable resistance 186 with the positive pole of a battery 187, the negative pole of which is connected through a conductor 188 and the conductor 180 with the mercury cathode 167.

The detector 165 controls a circuit 190, which has in series therewith an alternating current generator 191 or other source of electrical energy, and an electro-magnet 192 which forms part of a relay which controls a normally open circuit 193 which includes a battery 194 or other source of electrical energy, and a solenoid 195. The solenoid 195 is arranged to reciprocate a rack 196 which engages a gear 197 which is mounted to rotate freely upon a shaft 198, which is arranged to rotate about a fixed axis coincident with its longitudinal axis, and which has rigidly secured thereto a ratchet 199 which is arranged to be rotated step by step through the action of a pawl 200 which is pivotally secured to the gear 197. The shaft 198 is thus arranged to be rotated through one step each time that the rack 196 is reciprocated, and the shaft 198 is connected to a valve or commutator or any other suitable controlling device (not shown) which may be arranged in any well known or suitable manner to control the steering mechanism of the mine sweeper, and also to control various functioning devices upon the mine sweeper, as may be desired.

In the operation of the receiving system shown in Fig. 3, the compressional waves transmitted through the water and received by the diaphragm 125 causes the diaphragm to vibrate with a frequency corresponding to the frequency of the waves received and in groups corresponding to the group frequency of the waves. These vibrations of the diaphragm cause the corresponding vibrations of the cylindrical copper vibrator 35, and as this vibrator is arranged in the field of force of the ring magnet 30, the vibrator causes in a well known manner electrical oscillations to be set up in the winding 41, and through the circuit 126. These electrical oscillations have a wave frequency and a group frequency equal respectively to the wave frequency and group frequency of the

compressional waves received by the diaphragm 125. These electrical oscillations act through the transformer 130 in a well known manner to cause variations in the potential of the grid 138 of the detector 135, and cause unidirectional impulses of current in the circuit 155, 156 controlled by the detector 135. These unidirectional impulses set up electrical oscillations in the oscillatory circuit which includes the coil 155 and the condenser 157, having a frequency equal to the group frequency of the transmission station, and these oscillations act upon the secondary coil 161 of the transformer 160 to vary the potential of the grid 169 of the mercury vapor detector 165 which causes corresponding variations in the apparent conductivity of the detector 165, thus permitting a unidirectional current to flow from the source 191 through the detector 165. This unidirectional current in the control circuit 190, 191 acts upon the electro-magnet 192 to close a normally open circuit through the battery 194 and solenoid 195, thus reciprocating the rack 196 and causing the shaft 198 to be rotated through one step. In this manner the direction of movement of the mine sweeper 10 may be controlled.

In the modified form of this invention shown in Fig. 4, the submarine mine sweeper or controlled boat 10 is provided with a modified receiving system comprising two oppositely disposed receiving diaphragms 225 which are suitably mounted in corresponding apertures provided therefor in the opposite sides respectively of the hull of the boat and so that the diaphragms will be substantially vertical and in contact throughout their entire areas with the water surrounding the boat. Each of these diaphragms 225 is connected as hereinbefore described to the shaft 37 of a corresponding oscillator constructed as hereinbefore described and shown in Fig. 3, and the armature of which is in a circuit 230.

For causing the two receiving diaphragms 225 and their corresponding oscillators to become alternately active to control the mine sweeper, depending upon the direction of movement of the mine sweeper 10 with respect to the source of sound on the control boat 15, the mine sweeper 10 is provided with a gyroscope or other direction maintaining means 235. The gyroscope 235 has the usual or any suitable rotary member 236 arranged to rotate about a spindle 237 and to remain always in a substantially fixed vertical plane. The rotary member 236 of this gyroscope is ordinarily given such an initial adjustment that it will remain in a normally substantially vertical plane which extends through the rotary member 236 and ordinarily approximately in the direction of the control boat 15. The shaft 237 of the

gyroscope is terminally supported for rotation in a ring 237' which is mounted in a normally vertical ring 238 which is supported in a well known manner to rotate freely about a normally substantially vertical axis which is fixed with respect to the boat 10, and which extends centrally through the longitudinal axis of the shaft 237. Surrounding and fixedly secured to this ring 238 is a normally horizontal ring 239, surrounding which and coaxial therewith is a continuous conducting ring 240, surrounding and coaxial with which are two oppositely arranged substantially semi-circular conducting segments 241 and 242. The opposite ends of the segments 241 and 242 are separated by narrow strips 243 and 244 of insulating material which are arranged in a line extending longitudinally and centrally of the mine sweeper 10. The continuous ring 240 and the segments 241 and 242 are fixedly secured to the hull of the mine sweeper 10 and are arranged in a plane with the inner ring 239. The inner ring 239 carries secured thereto a substantially horizontal arm 245 of insulating material which projects outwardly therefrom and which extends over and is spaced slightly above the conducting ring 240 and the conducting segments 241 and 242. This arm 245 carries two conducting brushes 246 and 247 which are arranged to slidably engage the conducting ring 240 and the conducting segments 241 and 242 respectively. These two brushes 246 and 247 are electrically connected by a conductor 248. The inner ends of the two armature circuits 230 are connected respectively to the two segmental conductors 241 and 242 and the outer ends of the armature circuits 230 are both connected to one end of a conductor 250, the other end of which is connected to one end of a coil 251 and the other end of the coil is connected by a conductor 252 to the conducting ring 240. A condenser 253 is connected between the conductors 250 and 252 and is in an oscillatory circuit with a coil 251 which is tuned to the frequency of the submarine sound waves transmitted by the transmission diaphragm 25 of the sending station upon the control boat 15. The coil 251 is coupled with the hereinbefore described coil 131 (see Fig. 3) of the hereinbefore described system for controlling the movement of the mine sweeper 10. The coil 131 of Fig. 4 is connected as hereinbefore described through detectors 135 and 165 to control the solenoid 195 by which the movement of the mine sweeper is controlled.

In the operation of the receiving system shown in Fig. 4 it is evident that when the mine sweeper 10 is in such a position that the brush 247 carried by the arm 245 is in contact with the segment 241 as shown in Fig. 4, then the upper diaphragm 225 and

its corresponding oscillator will be operatively connected to control the movement of the mine sweeper, and the lower diaphragm 225 and its corresponding oscillator will be disconnected. When the parts are in the position shown in Fig. 4, the oscillator current produced in the winding of the armature of the upper oscillator by the vibration of the diaphragm 225 in response to sound waves transmitted from the control boat 15 will pass from one end of the armature winding through the lower portion of the upper circuit 230 through the segmental conductor 241, brush 247, conductor 248, brush 246, conducting ring 240, conductor 252, coil 251, conductor 250 and back through the upper portion of the circuit 230 to the other end of the armature winding. The electrical oscillations thus produced in the coil 251 will produce corresponding oscillations in the coil 131 which will eventually cause the solenoid 195 to be energized, and to cause the shaft 198 to be rotated through one step as hereinbefore described to control the direction of movement of the mine sweeper. If the mine sweeper 10 should swing clockwise about a vertical axis from the position shown in Fig. 4, through a sufficient angle, the segmental contact 241 would move with the boat out of contact with the brush 247 and the other segmental contact 242 would be brought into contact with the brush 247 and thus the lower diaphragm 225 would be operatively connected to the segment 242, brush 247, conductor 248, etc. to control the mine sweeper 10 while the upper diaphragm 225 would be disconnected, it being understood that the arm 245 would be caused to point in a substantially fixed direction by the gyroscope 235. It is therefore evident that as the mine sweeper 10 is rotated or turned either in one direction or in the opposite direction, the diaphragms 225 would be thrown alternately into operation, and the diaphragm which is in the better position to receive the submarine sound waves would be the one which would be connected to control the movement of the mine sweeper.

In the modified form of this invention shown in Fig. 5, the mine sweeper or controlled boat 10 is provided with four receiving diaphragms 250' which are connected respectively to four shafts 37 of four corresponding oscillators which are constructed as hereinbefore described. In this modified form the construction and operation are the same as that shown in Fig. 4 and just described except that in this modified form shown in Fig. 5, four diaphragms and corresponding oscillators are used instead of two, and four segmental conductors 251', 252', 253', and 254' are substituted for the two segmental conductors 241 and 242 of Fig. 4. The four segmental conduc-

tors 251', 252', 253' and 254' are separated by narrow strips of insulation 255, 256, 257 and 258. The inner ends of the armature circuits 230 are connected respectively to the four segments 251', 252', 253' and 254', and the outer ends of the armature circuits 230 are all connected to one end of the hereinbefore described conductor 250 which has in series therewith the coil 251 which is coupled as hereinbefore described to the coil 131, which in turn is operatively connected through the two detectors 135 and 165 with the solenoid 195 which controls the movement of the mine sweeper.

The operation of the system shown in Fig. 5 is similar to that shown in Fig. 4 except that four diaphragms are controlled instead of two, and as the mine sweeper 10 rotates about a vertical axis the diaphragm 250' which is in the most effective position to receive the submarine sound waves from the control boat 15 will be the diaphragm which is connected through the action of the gyroscope 235 to control the receiving system which ultimately controls the solenoid 195 and the movement of the mine sweeper 10.

Instead of the radio receiving system shown in Fig. 2, a doubly tuned or duplex receiving system, such as is shown for instance in Fig. 6, may be used to control the electromagnet 63 and consequently the submarine sound transmitter.

In the radio receiving system shown in Fig. 6, the construction is substantially the same as that shown in Fig. 2, except that instead of having the coil 84 of the detector 71 inductively connected to the antenna 80 and tuned to respond to the frequency of the antenna, a primary gaseous detector 300, or other suitable detector of radiant energy, is interposed between the detector 70 and the antenna 80. This primary detector 300 is of well known construction, and includes an evacuated bulb 301 containing a filament 302, a terminal 303 and a grid 304. The grid 304 is connected by a conductor 305 to one side of a condenser 306, the other side of which is connected by a conductor 307 with one end of a coil 308, the other end of which is connected by a conductor 309 with one end of the filament 302. A variable condenser 310 is connected between the conductors 307 and 309. The coil 308 is inductively connected to the coil 82 of the antenna 80, and is in a closed oscillatory circuit including the variable condenser 310 which is tuned to respond to the frequency of the antenna 80. The filament 302 is heated by a battery 315 acting through a variable resistance 316. The terminal 303 is connected by a conductor 320 with one end of a coil 321, the other end of which is connected by a conductor 322 to one side of a battery 323, the other side of which is con-

connected to the filament 302. A variable condenser 325 is connected between the conductors 320 and 322, and is in a closed oscillatory circuit with the coil 321, which is tuned to respond to a predetermined group frequency which is less than the frequency of the antenna 80. The coil 321 is inductively connected to the coil 84 which controls the hereinbefore described detector 70. The closed oscillatory circuit which includes the coil 84 and the variable condenser 95, is in this case tuned to respond to the frequency of the closed oscillatory circuit 321, 325 by which it is controlled.

In the operation of the system shown in Fig. 6, any suitable transmission system is used upon the aeroplane 20 to transmit electroradiant waves having a predetermined wave frequency and a predetermined group frequency less than the wave frequency. The closed oscillatory circuits 308—310 and 84—95 of the receiving system are accordingly tuned to respond to the wave frequency and the group frequency of the transmission station. When an impulse of radiant energy having the required wave frequency and group frequency is received by the system shown in Fig. 6, the closed oscillatory circuits 308—310 will be energized, and will cause the operation of the gaseous detector 300 to permit a unidirectional pulsating current to flow through the circuit 320—321 from the battery 323, and oscillations having a frequency corresponding to the group frequency of the received waves will be set up in the closed circuit 321—325, which will cause corresponding oscillations to be set up in the circuit 84—95 of the secondary detector 71, which will cause the operation of the secondary detector 71 to control the emission of sound waves by the submarine sound transmitter including the diaphragm 25, as hereinbefore described.

In this modified form of receiving system shown in Fig. 6, it is evident that it is necessary to have the received waves of the predetermined wave frequency and predetermined group frequency in order to effect the operation of the submarine sound transmitter, thus rendering it difficult for an unfriendly operator to interfere in the operation of the system without knowing the necessary combination of frequencies required to operate the system.

Although only a few of the many forms in which this invention may be embodied have been shown and described herein, it is to be understood that the invention is not limited to any particular system but might be embodied in various systems without departing from the spirit of the invention or the scope of the appended claims.

Having thus described my invention, I claim:

1. A method for controlling a movable

body, which consists in producing electro-radiant oscillations, transforming said oscillations into sound waves, and steering the body in response to the sound waves thus produced.

2. A method for controlling a movable body, which consists in producing electro-radiant oscillations, transforming said oscillations into submarine compression waves, and controlling the body in response to the compression waves thus produced.

3. A method for controlling a movable body, which consists in transmitting radiant oscillations through the atmosphere, causing said radiant oscillations to produce compression waves in a body of water, and controlling a body in response to the compression waves thus produced.

4. A system for controlling a movable body, comprising receiving means tuned to respond to sound waves of a given frequency, means for producing sound waves of said frequency, and means responsive to electro-radiant energy for controlling said sound producing means.

5. The combination with a marine vessel, of means carried thereby and responsive to sound waves transmitted through the water surrounding said vessel for controlling the movement of said vessel, a second marine vessel, means carried by said second vessel for producing sound waves in the water surrounding said second vessel, and means carried by said second vessel and arranged to respond to radiant energy for controlling said sound producing means.

6. The combination with a marine vessel, of means carried thereby and responsive to sound waves transmitted through the water surrounding said vessel for controlling the movement of said vessel, a second marine vessel, means carried by said second vessel for producing sound waves in the water surrounding said second vessel, and means carried by said second vessel and arranged to respond to electro-radiant energy for controlling said sound producing means.

7. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried thereby, and means carried by said body and operable by the deviation of said body from a predetermined course to automatically render one or another of said receiving devices operative depending upon the position of rotation of said body about a given axis said means including an element automatically maintained substantially fixed against rotation about said given axis.

8. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to radiant energy carried thereby, and means carried by said body and operable by the deviation of said body from a predetermined course to

automatically render one or another of said receiving devices operative depending upon the position of said body relative to a given axis, said means including an element automatically maintained substantially fixed against rotation about said given axis.

9. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to sound waves carried thereby, and means carried by said body and operable by the deviation of said body from a predetermined course to automatically render one or another of said receiving devices operative depending upon the position of said body relative to a given axis, said means including an element automatically maintained substantially fixed against rotation about said given axis.

10. In a system of distant control, the combination with a movable body, of means for controlling the movement of said body comprising a plurality of receiving devices carried by said body and separately operative to control the movement of said body about a given axis, and means carried by said body and automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body said means including an element automatically maintained substantially fixed against rotation about said given axis.

11. In a system of distant control, the combination with a movable body, of a plurality of separately operative sound receiving devices carried by said body, means controlled by said devices for producing electrical oscillations, means arranged to respond to said electrical oscillations to control the movement of said body, and means automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body.

12. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried thereby, and direction maintaining means carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body relative to a given axis, said means including an element automatically maintained substantially fixed against rotation about said given axis.

13. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried thereby, and direction maintaining means carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of rotation of said body about a given axis, said means including an element automati-

cally maintained substantially fixed against rotation about said given axis.

14. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to radiant energy carried thereby, and direction maintaining means carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body relative to a given axis, said means including an element automatically maintained substantially fixed against rotation about said given axis.

15. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to sound waves carried thereby, and direction maintaining means carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body relative to a given axis, said means including an element automatically maintained substantially fixed against rotation about said given axis.

16. In a system of distant control, the combination with a movable body, of means for controlling the movement of said body comprising a plurality of receiving devices carried by said body and separately operative to control the movement of said body about a given axis, and direction maintaining means carried by said body and automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body, said means including an element automatically maintained substantially fixed against rotation about said given axis.

17. In a system of distant control, the combination with a movable body, of a plurality of separately operative sound receiving devices carried by said body, means controlled by said devices for producing electrical oscillations, means arranged to respond to said electrical oscillations to control the movement of said body, and direction maintaining means automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body.

18. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried thereby, and a gyroscope carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body.

19. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried thereby,

and a gyroscope carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of rotation of said body about a given axis.

20. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to radiant energy carried thereby, and a gyroscope carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body.

21. In a system of distant control, the combination with a movable body, of a plurality of receiving devices responsive to sound waves carried thereby, and a gyroscope carried by said body and automatically operative to render one or another of said receiving devices operative depending upon the position of said body.

22. In a system of distant control, the combination with a movable body, of means for controlling the movement of said body comprising a plurality of receiving devices carried by said body and separately operative to control the movement of said body, and a gyroscope carried by said body and automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body.

23. In a system of distant control, the combination with a movable body, of a plurality of separately operative sound receiving devices carried by said body, means controlled by said devices for producing electrical oscillations, means arranged to respond to said electrical oscillations to control the movement of said body, and a gyroscope automatically operative to render one or another of said receiving devices operative to control the movement of said body depending upon the position of said body.

24. A system for mine sweeping, comprising a mine sweeping vessel, means responsive to sound waves for controlling the movements of said vessel, a control vessel, means on said control vessel and responsive to radiant energy for causing the production of submarine sound waves, an air craft, and means carried by said air craft for transmitting radiant energy.

25. A system for mine sweeping, comprising a submarine mine sweeping vessel, means responsive to sound waves for controlling the movements of said vessel, a control vessel, means on said control vessel and responsive to radiant energy for causing the production of submarine sound waves, an air craft, and means carried by said air craft for transmitting radiant energy.

26. A system for mine sweeping, compris-

ing a submarine mine sweeping vessel, means towed by said vessel for removing submarine mines from a mine field, means responsive to submarine sound waves for controlling the movements of said vessel, a control vessel, means responsive to radiant energy for controlling the movements of said control vessel, and means carried by said control vessel and responsive to radiant energy for producing submarine sound waves for controlling said submarine mine sweeping vessel.

27. A method for mine sweeping, which consists in controlling the movements of a mine sweeping vessel by submarine sound waves transmitted from a control vessel and controlled in response to radiant energy transmitted from an air craft.

28. In a system of distant control, the combination of a station for the transmission of electro-radiant energy, a plurality of independently movable bodies, receiving means on one of said bodies responsive to radiant energy transmitted from said station, means operated by said receiving means for translating said energy into sound waves, and steering means upon another of said bodies adapted to be controlled by said sound waves.

29. In a system of distant control, a primary movable vessel, means responsive to radiant energy for steering said vessel, a control vessel, receiving means on said control vessel responsive to radiant energy, means on said control vessel for automatically relaying received waves of radiant energy to said primary vessel, and a station at a distance for transmitting radiant energy to said control vessel.

30. In a system of distant control, a primary movable vessel, means on said vessel responsive to radiant energy of a predetermined character for steering said vessel, a station at a distance for transmitting radiant energy, a control vessel, receiving means on said control vessel responsive to radiant energy transmitted from said station, and means controlled by said control vessel receiving means for translating the received radiant energy into radiant energy of the predetermined character to operate said primary vessel steering means.

31. In a system of distant control, the combination of a main station for the transmission of electro-radiant energy, a movable body, an intermediate station between said main station and said movable body, receiving means at said intermediate station responsive to radiant energy transmitted from said main station, means operated by said receiving means for translating said energy into sound waves, and steering means on said body arranged to be controlled by said sound waves.

32. In a system of distant control, the combination with a movable body, of a plurality of receiving devices carried by said body, and means including an element fixed against rotation in space about a given axis to automatically render one or another of said receiving devices operative depending upon the position of rotation of said body about said axis.

33. In a system of distant control, the combination of a plurality of receiving devices carried by said body, and means including an electrical contact fixed against rotation in space about a given axis and a plurality of contacts arranged to move with said body to automatically render one or the other of said receiving devices operative depending upon the position of rotation of said body about said axis.

34. The method of transmitting signals from a position within one natural medium to a position within a second natural medium, which consists in emitting energy modified in accordance with desired signals of a character readily transmitted through the first named medium from the first position to an intermediate position adjacent the surface of the second named medium, receiving the energy at said intermediate position, retransmitting the energy, modified in accordance with the signals, of a character readily transmitted through the second medium and receiving the signals at the position within the second medium upon a receiving device.

35. The method of controlling a body capable of moving through one natural medium, from a second body positioned in a second natural medium, which consists in producing oscillations capable of transmission through the second named medium with relatively greater facility than through the first, transforming the oscillations into differently characterized oscillations capable of transmission through the first named medium with relatively greater facility than through the second, and steering the first named body in response to the oscillations thus produced.

36. The method of controlling a body capable of moving through one natural medium, from a second body positioned in a second natural medium, which consists in producing oscillations capable of transmission through the second named medium with relatively greater facility than through the first, emitting said oscillations from the second named body, transforming the oscillations at a position spaced apart from both of said bodies into differently characterized oscillations capable of transmission through the first named medium with relatively greater facility than through the second, and steering the first named body in response to the oscillations thus produced.

37. In a system of signaling, means for sending signals capable of transmission through one natural medium with greater facility than through a second natural medium, a relay station responsive to signals transmitted through the first named medium and arranged to emit corresponding but differently characterized signals capable of transmission through the second named medium with greater facility than through the first, and a receiving device responsive to the last named signals.

38. In a system of signaling, means for sending signals capable of transmission through the atmosphere with greater facility than through water, a relay station responsive to signals transmitted through the atmosphere and arranged to emit corresponding but differently characterized signals capable of transmission through water with greater facility than through the atmosphere and a receiving device responsive to the last named signals.

39. A method of controlling a movable body, which consists in producing oscillations capable of transmission through one natural medium with relatively greater facility than through a second natural medium, transforming said oscillations into differently characterized oscillations capable of transmission through the second medium with relatively greater facility than through the first, and steering the body in response to the last named oscillations.

40. The method of controlling a movable body which consists in producing energy having a wave form capable of acting through one natural medium with greater facility than through another, converting said energy into energy having a different wave form capable of acting through the second named medium with greater facility than through the first, and steering the body in response to the last named energy.

41. In a system of signaling, the combination of a movable body and a control vessel arranged to float on the surface of the water, means positioned upon the control vessel for transmitting to the first named movable body signals capable of transmission through water with relatively greater facility than through the atmosphere, of a source of radiant energy movable through atmosphere and means positioned upon the control vessel and responsive to radiant energy transmitted from said source for controlling the energy transmitted from the control vessel to said movable body.

Signed at Gloucester, in the county of Essex, and State of Massachusetts this seventh day of December A. D. 1916.

JOHN HAYS HAMMOND, JR.

Witnesses:

LESLIE BUSWELL,
ABBIE F. RUST.