Sept. 7, 1937. F. G. TROISI 2,092,435

SALVAGE APPARATUS

Filed Feb. 26, 1934 5 Sheets-Sheet 1

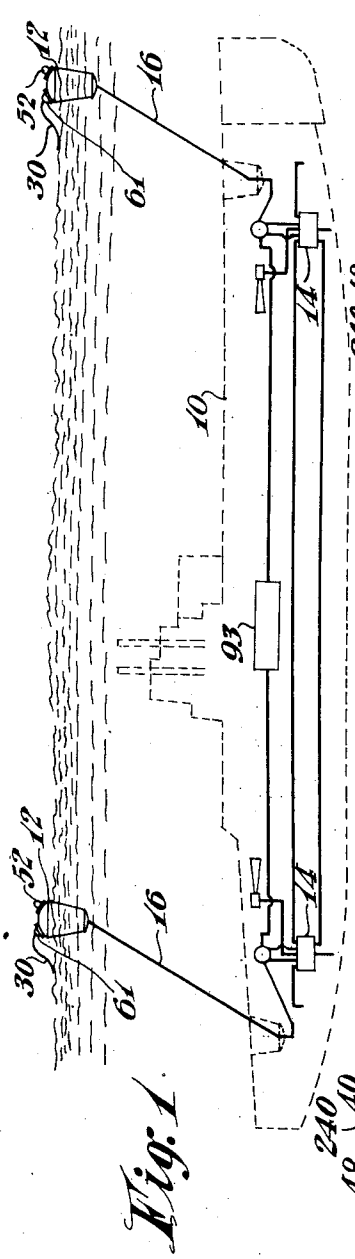

Fig. 1.

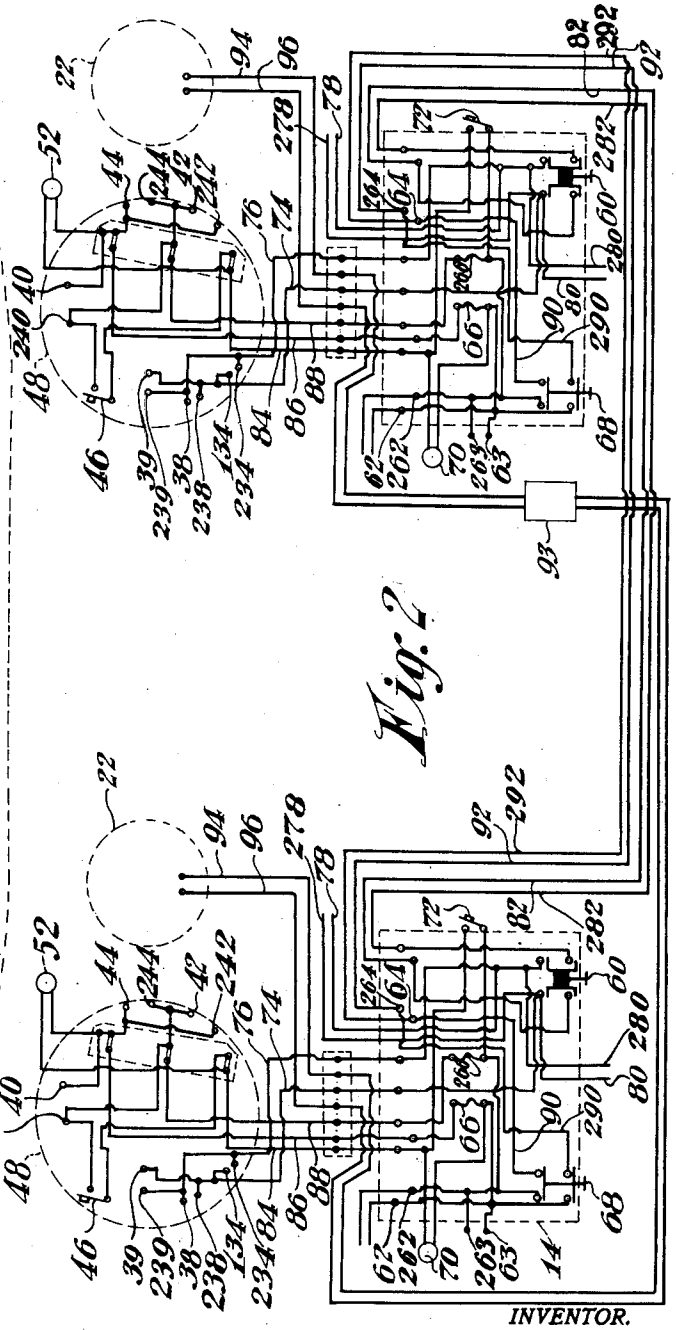

Fig. 2.

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SALVAGE APPARATUS

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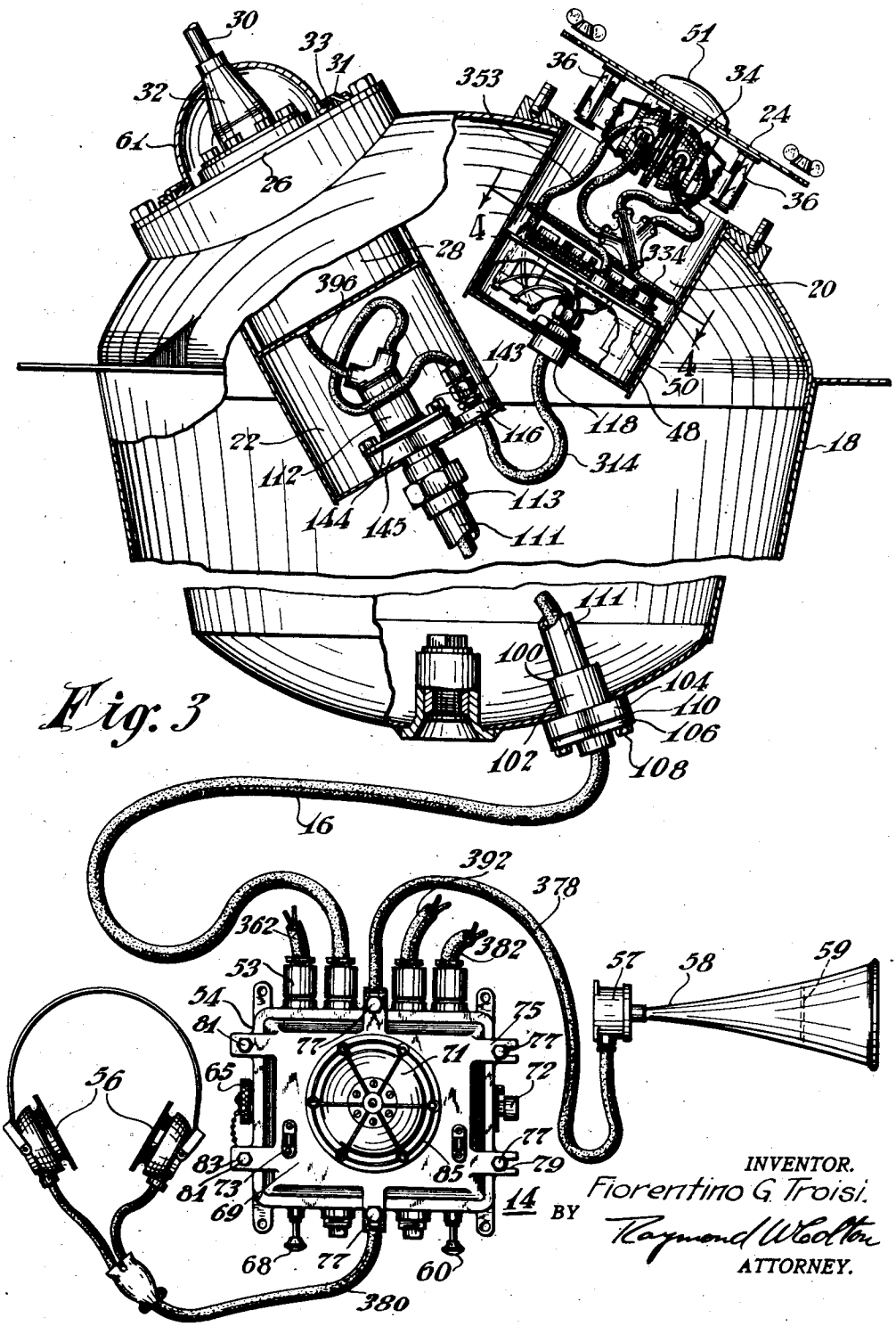

Fig. 3

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SALVAGE APPARATUS

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Fig. 4

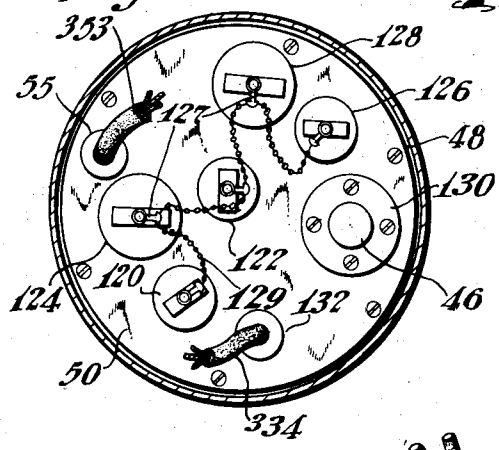


Fig. 5

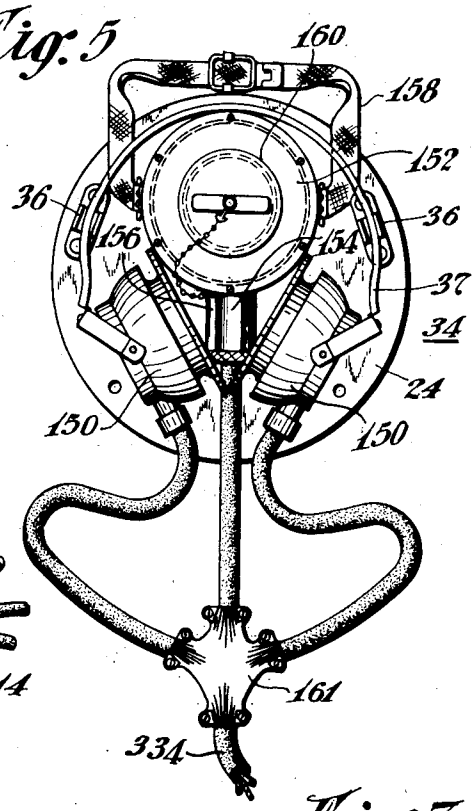


Fig. 6

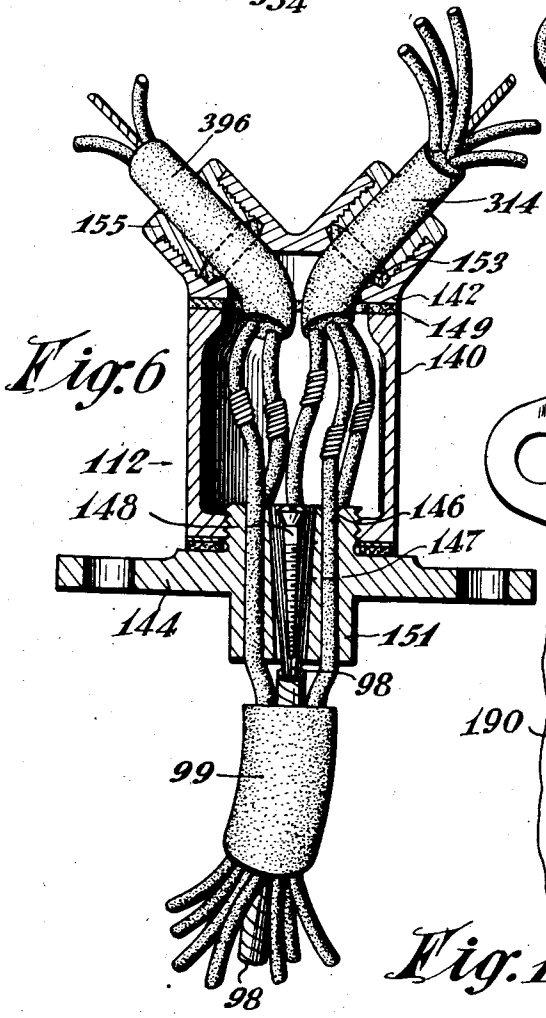


Fig. 7

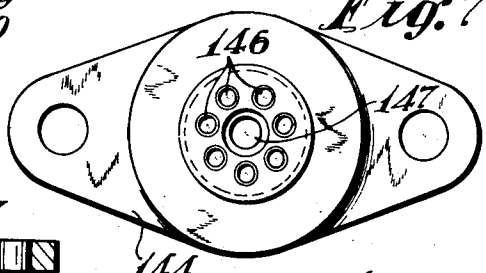


Fig. 12

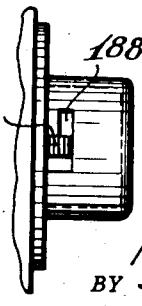
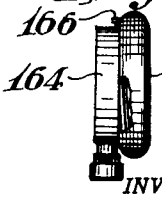


Fig. 11



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SALVAGE APPARATUS

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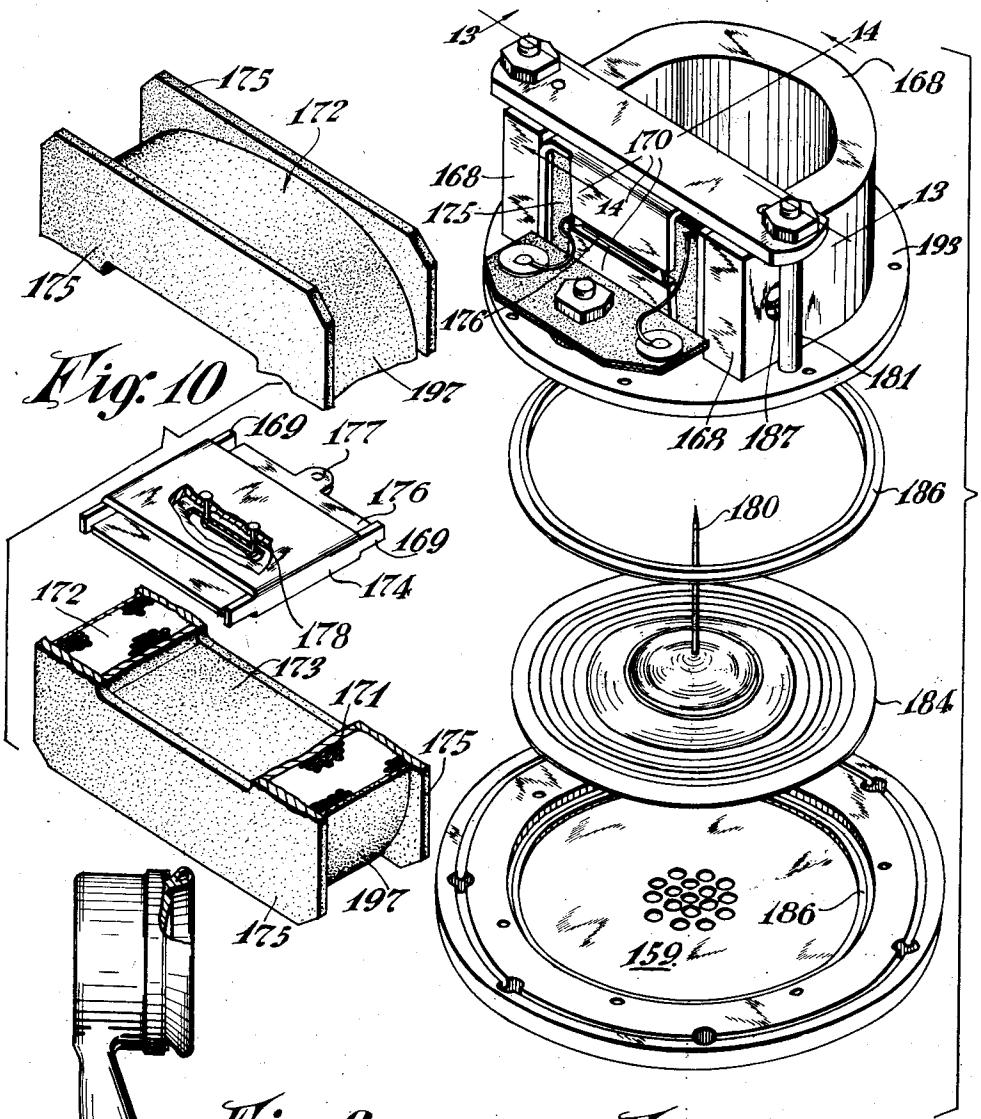

Fig. 10

Fig. 9

Fig. 8

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Fig. 13

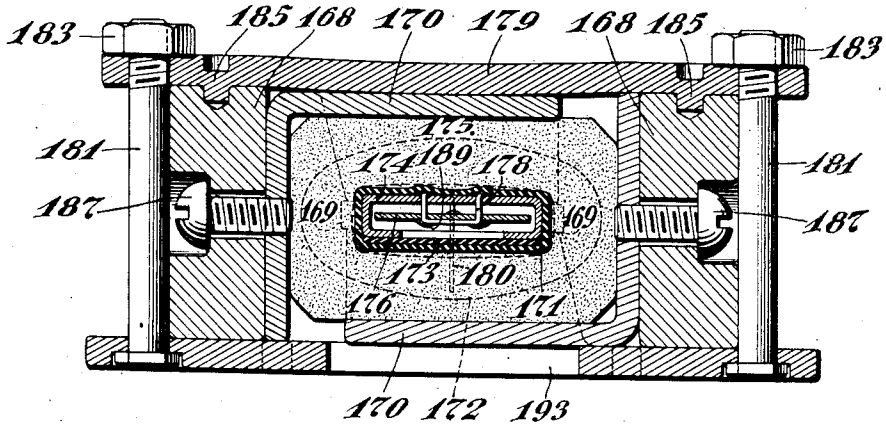


Fig. 15

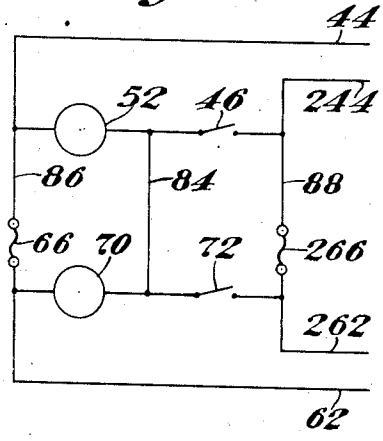


Fig. 14

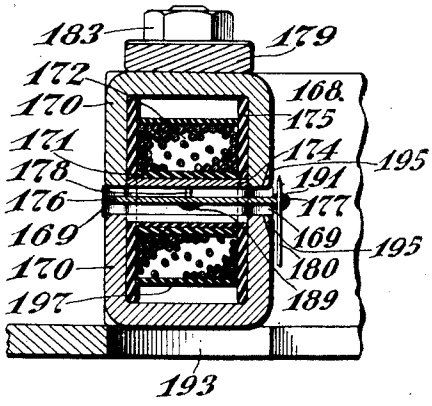
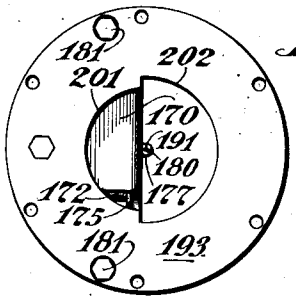


Fig. 16



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UNITED STATES PATENT OFFICE

2,092,435

SALVAGE APPARATUS

Fiorentino G. Troisi, Pittsburgh, Pa.

Application February 26, 1934, Serial No. 713,023

2 Claims. (Cl. 114—16.5)

The present invention relates to apparatus intended for the location of submarine vessels which have become disabled to the extent that they can not be brought to the surface by their own facilities; to apparatus for establishing mutual communication between a rescue party and the crew of the disabled craft; and to apparatus for electrical power transmission from the surface to the submarine vessel or from the latter to the surface.

Whereas many prior proposals have been made for accomplishing results similar to those achieved by the present invention, none of them has been sufficiently adaptable to the needs of the emergencies for which they are intended, to be generally acceptable to the agencies employing such apparatus.

It is necessary that equipment for the purpose be simple, rugged, foolproof and resistant to the distintegrating influences of the elements to which they are subjected. At the same time the apparatus must be instantly responsive when called into use and sufficiently versatile to adapt itself to the facilities of the rescue ship and to remain operative even though a portion of the apparatus should become useless through accident.

The prior devices referred to have contemplated releasable buoys carried by a submarine, the buoys containing various visible and/or audible signalling and communicating means. Some earlier inventors have proposed a plurality of such buoys, one for each compartment of the submarine. Others have suggested various circuits and instruments for carrying out their plans, but none has provided an apparatus complete in itself, capable of serving the functions of the present invention.

The present invention purposes to overcome the inherent faults and limitations of prior devices, by the provision of a buoy which is releasable by the occupants of a submarine, said buoy carrying visible and audible signalling devices, power lines and electrical outlets, which are all maintained in water-tight condition, and which are operable in conjunction with cooperating units aboard the submarine, equally from the submarine vessel itself by its crew, or from the surface by the rescue party. Telephone units are arranged in the buoy and in the submarine compartment or compartments, which derive their actuating current from the voice itself, obviating the need for batteries or other external current sources. The peculiar construction of these telephone units renders them interchangeable as transmitter or receiver and especially adapts them to deep sea use among others. They are designed to produce substantially uniform intensity throughout the audio frequency range. The cable connections and the circuits employed, eliminate an excessive number of conductors and make feasible the use of a single reinforced multi-conductor cable for both physical and electrical connection between the submarine and its buoy. When a plurality of signal stations are provided aboard the submarine in its various compartments, provisions are made for operating their respective signal and power circuits either independently or in multiple so that power and intelligence may be transmitted between any number of the sub-surface stations, between any number of the surface stations, from any number of surface stations to any number of sub-surface stations, and between any number of such stations and any number of divers who may be reconnoitering or working below the surface, exteriorly of the disabled vessel. Besides submarine salvage, other applications of the invention are contemplated, which will suggest themselves upon a study of the present disclosure.

The signalling apparatus of the preferred embodiment comprises radiant energy communicating means; a telephone system which preferably requires no external source of current; and a key operated telegraph system, serving additionally under certain conditions as a flasher for summoning assistance.

The power transmission assembly comprises a system whereby electrical energy may be supplied or utilized from a plurality of points, and means for preventing injury to the system should sources of current be applied simultaneously and improperly.

The buoy itself is preferably divided into waterproof compartments, with stuffing boxes for the cables at various required points to accommodate their special construction.

The manner of mounting the various instruments and receptacles, and the construction of the telephone unit itself, also constitute a portion of the invention.

The complete invention will become apparent upon reference to the detailed description and the accompanying drawings.

Fig. 1 represents diagrammatically, a submarine vessel from which a pair of buoys have been released.

Fig. 2 is a circuit diagram of the electrical connections existing between two buoys and two submarine stations.

Fig. 3 shows portions of the buoy and vessel assemblies, partially in section.

Fig. 4 is a plan along line 4—4 of Fig. 3, showing the inner cover plate of one compartment.

Fig. 5 is a bottom plan view of the outer cover plate and its assembly.

Fig. 6 is a sectional elevation of a stuffing box, showing the various cables associated therewith.

Fig. 7 is a plan of one of the stuffing box elements.

Fig. 8 shows one form of assembly of the telephone units.

Fig. 9 is an exploded view of the preferred type of telephone unit.

Fig. 10 shows details of parts of the telephone unit, partially broken away.

Fig. 11 shows certain details of a telephone unit.

Fig. 12 shows a signalling key.

Fig. 13 is a section along line 13—13 of Fig. 9.

Fig. 14 is a portion of the section along line 14—14 of Fig. 9.

Fig. 15 is a somewhat simplified diagram of a portion of the circuit of Fig. 2.

Fig. 16 is a bottom plan view of a portion of the telephone unit.

A submarine 10, shown in broken lines in Fig. 1, having become disabled and incapable of rising to the surface, has had released therefrom a pair of buoys 12 which have been depicted as floating upon the surface of the water. By virtue of the cables 16 having their ends attached to the submarine and their respective buoy, physical and electrical connections between the buoys and the disabled craft are maintained. Whereas the submarine has been shown as equipped with two such buoys, one fore and one aft, any suitable number may be used, such as one for each of the submarine compartments. The submarine control unit 14 is in permanent electrical connection with the apparatus carried by the buoy, through the conductors of cable 16, to be more fully described.

Each of the buoys 12 comprises a casing 18 which may be of metal or other suitable material, sufficiently strong to withstand the shocks which it must undergo, and sufficiently buoyant to carry the buoy contents and cable to the surface, when released from the submarine. Two main compartments are provided in each buoy, the power and wired communication compartment 20, and the radio compartment 22. Each compartment is made watertight with respect to the casing 18 by welding or the like, and with respect to the exterior of the buoy by the cover plates 24 and 26 respectively which are bolted to the casing, the joints being completed by the interposition of suitable gaskets.

An antenna assembly 28 is provided in the upper portion of compartment 22, projecting from which, into the atmosphere, is a lead 30 constituting the antenna proper. As shown, a stuffing box 32, bolted to the cover plate 26, provides a watertight outlet for the lead 30. A reflector 61, which may be of polished metal, glass, etc., substantially a hollow hemisphere in form, is provided with a flange 33 which is engaged through an interposed gasket by an annulus or series of clips 31 by which it is bolted to the cover plate 26. The reflector is preferably pierced with an opening through which the stuffing box 32 may pass in concentric relation therewith.

The power and wired communication compartment 20 contains a sub-compartment 48 which serves as a terminal and outlet box for the power and communication leads, and is fitted with a watertight cover 50 carrying a number of bosses. Mounted on the cover 50, and accessible through its bosses, there are a series of electrical outlets or jacks, including a rescue telephone jack 38—238, a diving telephone jack 39—239, a commercial type receptacle 40—240, a special receptacle 42—242, and a special receptacle 44—244. These jacks and receptacles are provided with closures 120, 122, 124, 126 and 128 respectively, detachably mounted in watertight relation upon their respective bosses on the cover plate. These closures, shown in Fig. 4, are attached together to prevent their loss, by a chain 129 engaging the lugs 127 which are swivelly mounted upon the respective closures. A fitting 130 carried by the cover 50, supports the exposed button of the buoy signal key 46. A pair of watertight bushings 55 and 132 are assembled in the cover 50 for the passage therethrough of the signal lamp cable 353 and the telephone cable 334 respectively.

The cable 353 is carried to the buoy signal lamp 52, which is housed in the cover plate 24 in a watertight manner, and provided with a transparent or translucent exterior window 51 attached to the cover plate. The cable 334, is divided at the junction box 161, into three parallel cables leading to the buoy telephone set 34, comprising receiver units 150 and transmitter unit 152. The receiver units are assembled as a headset by a headband 37 which is releasably held by the clips 36 carried by the under side of the cover plate 24. The transmitter 152 is also detachably carried by the cover plate 24, by a pair of telescoping tubular elements 154 and 156, the former being fixed to the transmitter and housing its conductors, the latter being formed with a longitudinal slot through which the conductors may pass when the unit is removed from its position for use. A watertight cap 160, similar to those for the receptacles and jacks, is provided for protection of the transmitter, and an adjustable suspension strap 158 is provided for supporting the unit when in use.

The submarine control unit 14, shown in Fig. 3, one of which is preferably supplied for each buoy carried by the submarine, receives the lower end of the cable 16 and its conductors. This unit comprises a watertight casing 54 provided with a removable door 69, attached by a plurality of bolts 77 and 81 passed through apertured lugs 75 and 83 respectively, integral with the door. The bolts 81 are preferably hinged to the casing, while bolts 77 are passed through slots 79 formed in the lugs 75, so that removal of bolts 77 from the slots will permit the door to be opened, giving access to the interior of the casing. Emerging through suitable watertight stuffing boxes 53 on the casing, there are a number of conductor carrying cables leading to the various equipment aboard the vessel. A telephone cable 380 leads to the telephone headset 56, which is mounted when not in use, in the clips 73 carried by the door. Another telephone cable 378 leads to the transmitter unit 57, provided with an exponential horn 58 in which there is fixed a screen 59 for the exclusion of foreign material which would tend to adversely affect its operation. The screen may be connected by tack soldering or other suitable means.

A power supply cable 362 is provided with conductors to be connected with the submarine power source. A parallel telephone cable 382 is carried to the similar control units 14 aboard the submarine. A parallel power cable 392 is led to the power circuits of the other units.

On one wall of the casing, a power outlet is arranged for which a chain retained, watertight, removable closure 65 is provided. The casing also carries a signalling key 72, which is depicted as a push button (Fig. 12), having a bayonet slot 188 for engagement with a bayonet lug 190 carried by the casing, for maintaining the key circuit closed when desired. Mounted in watertight relation with the door, there is a window 71 of transparent or translucent material, behind which, within a socket attached to the door, there is mounted the submarine signalling lamp 70. For protection of the window, a guard 85 is provided, attached to the casing in a suitable manner.

A pair of single throw, double pole switches 60 and 68 are provided within the casing, and are preferably of the push-pull type, having their actuating rods extending through the casing in watertight relation therewith. The switch 60 serves to interconnect or to disconnect the telephone circuits of adjacent units, while the switch 68 serves a similar purpose for the power circuits.

The cable 16 extending between the vessel and buoy, comprises a central core 98 which is preferably of stranded stainless steel wire having high tensile strength and sufficient flexibility. Naturally, other materials possessing the same or superior qualities may be used for the core. Disposed about the core there are a series of insulated current carrying conductors for completing the electrical circuits of the submarine and buoy, seven such conductors being selected as the minimum requirement for the present case. A sheathing 99 is formed about the cable and may be of rubber, rubber and fabric, or of such other material as will resist deterioration and possess the flexibility requisite to successful operation.

The cable 16 is led into the buoy casing and into the submarine shell through especially designed watertight stuffing boxes 100, one of which is represented in Fig. 3. Each stuffing box comprises a sleeve 102 having an integral attaching flange 104 which is fixed to the buoy casing (in the example shown) by means of welding or other usual means. A gland 106 through which the cable is passed into the stuffing box is separated from the flange 104 by a gasket 110, whereupon the assembly is drawn together in fluid tight relation by bolts 108. A conduit 111 for the cable, is attached to the sleeve 102 and extends to a fitting 113 to which it is also attached. The cable passes through the conduit and fitting into a second stuffing box 112 which is provided within the compartment 22. This stuffing box is attached by means of bolts 143 to an annulus 145 mounted in the compartment 22. The bolts are passed through openings in the flange 144 and into corresponding registering threaded openings in the annulus.

A sleeve 151 is disposed centrally of the flange 144 and extends from its opposite faces. The upper portion of the sleeve is provided with external threads for cooperation with those formed in the lower reduced end of the stuffing box barrel 140 to which it is connected with the interposition of suitable packing. The sleeve 151 is provided with a central downwardly tapered opening 147 for reception of the cable core 98, and a series of circumferentially spaced passages 146 for reception of the individual cable conductors whose resilient coverings effectively seal the openings against leakage. These passages may be arranged so as to have their axes parallel, or they may converge at the base of the sleeve to prevent sharp bending of the conductors. Since the cable core is terminated at this stuffing box, after its end has been inserted in the opening 147, the strands are separated and forced apart by an expanding element, such as the screw 148, which is driven into firm engagement therewith. By soldering, brazing, or other appropriate means, the splayed end of the core, the screw and the sleeve are made substantially unitary in order to assure a permanent joint of high strength. In this manner, all stresses in the cable are borne by the core itself, the conductors being thus protected against strain and breakage so that they will properly serve their electrical functions.

Attached to the upper end of the barrel, there is pothead 142, provided with two angularly disposed internally threaded passages. Between the pothead and barrel, which are bolted together, a gasket 149 is disposed. The cable 396 carrying the antenna conductors emanates from one passage and the cable 314 carrying the remaining conductors from the other. These two cables are packed in the passages by suitable rings 153 which are compressed by the threaded nuts 155, to preclude leakage. The cable 314 passes from the radio compartment through a suitable watertight fitting 116 and into compartment 20 through a second watertight fitting 118.

In Fig. 2, the subcompartment 48 and the radio compartment 22 are represented by broken lines. Likewise, the control unit 14 is illustrated by broken lines. The conductors carried by the cable 16 are designated as 74, 76, 84, 86, 88, 94 and 96, and are shown in their relative arrangements with respect to the buoy and vessel apparatus. The conductors 74 and 76 are provided for telephone communication, conductors 84, 86 and 88 serve for the transmission of power and signal current, and conductors 94 and 96 are for radio signalling.

Terminals 38 and 238 for a rescue telephone, 39 and 239 for a diving telephone, and 134 and 234 for the buoy telephone 34, are tapped from the conductors 74 and 76 for connection of the various named telephones to cooperating instruments in the submarine. In the submerged vessel, there are also several parallel taps from these conductors, namely, to the headset leads 80 and 280, to the horn unit leads 78 and 278, and to the upper terminals of the double pole switch 60. When the switch 60 is open, the telephone circuit of each buoy is confined to its corresponding submarine control unit. When the switch is closed however, and the similar switches of adjacent control units are also closed, the telephone circuits of several buoys and their control units will be in parallel, whereby any number of interconnected stations may be established. The conductors for establishing these parallel connections are denoted 82 and 282, and are connected to the lower terminals of the switches 60.

A radiant energy receiver and transmitter 93, diagrammatically shown, is connected by the conductors 94 and 96 to the radio compartment 22 of each of the buoys depicted, for cooperation with the antenna devices. It is also contemplated that more than one station such as 93 be provided in the vessel, with means for associating them with one another and with the various antenna devices.

The signal and power circuit comprising the conductors 84, 86 and 88, appears in a somewhat simplified form in Fig. 15. The surface or buoy terminals 44 and 244 are connected by conduc-

tors 86 and 88, to the submarine power terminals 62 and 262, all respectively. Suitable fuses 66 and 266 are interposed in the conductors 86 and 88 respectively for a purpose to be described. Shunted across the conductors 86 and 88 is a series circuit containing the buoy signal lamp 52 and the buoy signal key 46. At a point in the series circuit between the lamp and the key, the upper end of conductor 84 is connected, the lower end of which is connected between the submarine signal lamp 70 and the submarine signal key 72 which constitute a second series circuit shunted across the conductors 86 and 88. Although other arrangements are contemplated, the positions assumed by the fuses 66 and 266 are between the series circuits aforementioned. Moreover, the current carrying capacity of fuse 66 is preferably somewhat greater than that of fuse 266.

Assuming that the source of current is applied at the surface across the terminals 44 and 244. When the key 46 is closed, current will flow through terminal 44 and its lead, one portion flowing to supply lamp 52 and a second portion flowing through conductor 86 and fuse 66 to lamp 70, and returning by conductor 84. The two current paths reunite to flow through key 46 and back to source by 244. If instead the submarine key 72 be closed, current from 44 again flows to the parallel lamp circuit, then by key 72 and conductor 88, to source at 244.

Now assuming that a current source aboard the submarine is utilized. When the key 72 is closed, current flows from terminal 262, key 72, the parallel lamp circuit, and back to source at terminal 62. When the key 46 is closed instead under this condition, the current path is from terminal 262, fuse 266, conductor 88, key 46, parallel lamp circuit and to source at 62.

In the arrangement shown, should only the fuse 266 become spent, if current is supplied from the surface, signals may still be transmitted to the submarine. Likewise, if the supply is from below, signals may be transmitted from the submarine to the buoy.

Again referring to Fig. 2, additional to the terminals 44 and 244 of the special receptacle already referred to, terminals 42 and 242 of another special receptacle, and terminals 40 and 240 of the commercial type receptacle, are also taken as parallel taps from the conductors 86 and 88. Besides the terminals 62 and 262 in the submarine, the terminals 63 and 263, and 64 and 264 are in parallel with the conductors 86 and 88. In order to interconnect the power circuits of adjacent control units, the conductors 86 and 88 are connected to one pair of poles of a double pole switch 68, to the other poles of which a pair of leads 90 and 290 are connected. These leads are connected to the conductors 92 and 292 extending to a similar control unit, so that upon closing the switch 68, the power circuits of adjacent units will be connected in multiple.

Should sources of current be applied simultaneously at the surface and in the submarine, so that they tend to set up short circuit conditions, that is, with improper polarity, the fuse 266 will blow, relieving the condition, whereupon, the signalling circuit will remain partially operative as set out above. On the other hand, if proper polarity is observed in connecting the sources, both may be maintained in circuit without injuring the operation of the apparatus.

The telephone units themselves are preferably of a type, not requiring an external current source for their energization, depending for their operation upon the currents induced in their windings in response to the voice of the user, yet producing an intensity of received signal, greater than usually experienced. As shown in Figs. 9, 10, 13, 14, and 16, each of these units comprises a diaphragm 184, sandwiched between two spacing rings 186, one of which is received against the perforated diaphragm cover 159, defining an air chamber between the diaphragm and its cover, the other ring bearing against the base plate 193. The base plate and cover are provided with suitable registering openings for the reception of assemblying screws, and appropriate means is provided for the attachment of a suitable casing, not shown, for enclosing the working parts in watertight condition.

Secured to the base plate 193 by bolts 181, is the assembly for effecting the induced currents in response to the voice frequencies as impressed upon the diaphragm. This assembly comprises a permanent horseshoe magnet 168, pole pieces 170, an armature 176, an armature housing 174, a winding 172 properly insulated from the metallic structure, and means for holding the various elements in assembled relation and properly spaced. A pin 180 couples the diaphragm to the armature to which elements its respective ends are positively connected, though adjustably, by solder or the like.

The bolts 181 have their heads countersunk in the base plate, their shanks extending through the same with a forced fit in order to maintain them in rigid spaced relation. The spacing of these bolts is such, that the ends of the horseshoe magnet 168 are nicely received therebetween and frictionally held thereby. Openings formed near the opposite ends of the magnet, receive the screws 187 having their heads countersunk. These screws threadedly engage the pole-pieces 170 to fasten the same to the poles of the magnet. Each of the pole-pieces is preferably formed from a flat sheet of magnetic material, which is cut to a substantially T-shape, the horizontal bar of the T tending to converge at its extremities by virtue of a slight taper on its bottom edge. In assembled relation, these pole-pieces each have a vertical portion contiguous to and coextensive with the horseshoe poles. One end of each of these vertical portions (in Fig. 13 the upper end of the left hand pole-piece and the lower end of the right hand pole-piece) joins a horizontally extending portion which is substantially coplanar with one of the planes of the horeshoe magnet. The tips of the pole-pieces are formed by folding inwardly towards the axial plane of the permanent magnet, a pair of wings which constituted the horizontal bar of the original T. These wings or tips of the respective pole-pieces extend towards one another, but are maintained in a predetermined spaced relation by a series of lugs 169 extending from the armature housing.

A light weight armature 176 of magnetic material, and substantially rectangular in plan, has a short perforated integral lug 177 extending centrally from one side thereof. Parallel to the side bearing the lug 177, on a line passing through the center of gravity of the armature, a pair of openings are formed, symmetrical with respect to said center of gravity, through which the ends of supporting pin 178 are passed. The pin is preferably a length of resilient wire having its ends bent at 90° to their base forming a pair of parallel arms. The base of the pin is perma-

nently attached to the armature, as by soldering or the like, indicated at 189.

The ends of the pin 178 are received in openings formed in the top surface of a one piece armature housing 174 which is of rigid, light nonmagnetic material, preferably metal. The armature is centered in its housing, whereupon the pin ends are riveted and affixed to the housing by soldering or the like. The housing comprises the top surface, a pair of side walls perpendicular thereto, opposed base sections spaced from one another, parallel to the top surface, and carefully calibrated lugs 169 projecting from both ends of both side walls, making four in all. The top and bottom edges of all of these lugs 169 lie in two parallel planes, for the purpose of spacing the pole tips. The base of the housing, being discontinuous, prevents to a large extent, the effects of eddy currents.

Bridging the gap between the base sections of the armature housing, there is provided an insulation block 173, which in conjunction with its insulating wrapping 171, spaces the spool flanges 175 of insulating material, which are provided with slots for the reception of the armature housing. Thus, except for its lugs 169, the armature housing serves as a core for the magnet winding 172 which is formed upon the wrapping 171 and between the flanges 175. These elements are held in assembled relation by bending the four lugs 169 outwardly along their line of junction with the housing proper. After the predetermined number of turns of suitable gage wire have been applied, an insulating covering 197 is wrapped about the coil so formed.

A clamping bar 179 of non-magnetic material is provided with openings for the reception of the threaded ends of the bolts 181, for clamping the assembly to the base plate upon application of the nuts 183. The bar is provided with a pair of locating pins 185, preferably pressed from the material of the bar itself, which pins are received in a pair of cooperating openings in the upper surface of the magnet. Also, the bar is preferably bowed downwardly at its central portion so as to resiliently bear against the horizontal portion of the upper pole piece 170. The lower pole piece is also given a definite bearing surface against the base plate by designing the latter in the manner shown in Fig. 16. The central aperture of the base plate is formed of two concentric semi-circles of different radii. Thus the smaller semi-circle 201 leaves sufficient material to support the pole piece without unduly damping the diaphragm, while the larger semi-circle 202 provides a sufficiently large passage for air within the instrument so as not to interfere with its sensitivity and operation.

As shown in Fig. 14, the armature is preferably terminated in the planes of the pole-piece surfaces so as to be cut by substantially the total flux emanating therefrom. To prevent breakage through fatigue, the armature lug 177 is made as short as possible, and to allow for the solder 191 or the like applied thereto for holding the pin 180, the rear surfaces of the pole-pieces are provided with grooves 195.

After the diaphragm 184 is clamped into position, the pin 180 is inserted through the lug opening, and with the armature assigned to its final neutral position with respect to the opposed pole tips, the pin is fixed to the lug. Should the diaphragm subsequently become bent, or should there be need of adjustment for another reason, the pin may be readjusted on the armature lug and a new joint formed.

The ends of the winding 172 are brought out to a suitable terminal block, from which they are connected to their respective conductors carried by the cables already described.

The diaphragm 184 is preferably a thin disk of resilient flexible material, such as duralumin, highly responsive to voice frequencies, which in the form shown, has been impressed with a series of concentric corrugations, the spacing and depth of which increase as their diameters decrease.

The air chamber between the diaphragm and the diaphragm cover is designed with respect to the moving system, that is the diaphragm, its pin and the armature, so that when a plurality of the units are connected in a circuit, the circuit will be substantially uniformly responsive to frequencies throughout the audible range. That is, the resonance of a unit used as a receiver will be different than when used as a transmitter, due to a change of its effective air chamber, and the number of different resonant frequencies of the system will be increased tending to render uniform the output of the system over the whole voice range.

As appears in Fig. 13, the length of the pole tips is necessarily slightly greater than the length of the armature housing for the lugs 169 to perform their spacing function.

These telephone units operate as transmitter or receiver, interchangeably and due to their construction, operate efficiently under the high pressure conditions to which they are frequently subjected. When used as a transmitter, the vibrations of the diaphragm set up by the voice, are imparted to the balanced armature through the pin 180. The movements of the armature in the field of the permanent magnet, vary the reluctance of the magnetic circuits with a frequency proportional to that of the sound waves producing these movements. Accordingly, proportional currents will be induced in the winding which will be carried to similar units serving for the instant as receivers. When current flows in the receiver winding, magnetic flux will be produced to oppose or reinforce that of the permanent magnet, depending upon the direction of the current. Thus the armature will become unbalanced and be caused to vibrate about its fulcrum, which vibrations will be transmitted to the receiver diaphragm and be emitted as sound waves.

Fig. 8 depicts a pair of such telephone units assembled as a hand set, having a single casing for the units, the cable being led into the casing through a watertight stuffing box.

An assembled unit is shown in Fig. 11 in which the cap 162 is threaded upon the casing 164 and held in non-rotatable relation therewith by a set screw 166.

The operation of the apparatus as a whole is as follows:

When the submarine has become disabled below the surface, the buoy or buoys are released by members of the crew by any suitable means known in the art. Their buoyancy causes them to rise to the surface, with their trailing cables 16 of adequate length connecting them physically and electrically to the vessel. Upon reaching the surface, the antenna leads are projected in a suitable manner whereby radiant energy signals may be transmitted and received aboard the submarine.

The reflecting member 61 serves as a sort of heliographic signalling means, responding to light rays from either natural or artificial sources. By operation of the key 72, signals may be transmitted by the signal lamp 52, which may be replaced by or combined with other electrically operated visible or audible signalling devices.

Upon the arrival of a rescue vessel in response to these signals, in compliance with instructions carried by the buoy, as by a direction plate affixed thereto or indicia engraved or embossed thereupon, the nuts securing the cover plate 24 will be removed whereupon access is had to the various devices housed in the compartment 20, all of which will carry suitable identification specifying their use. With the buoy signal key 46, the surface crew can signal the submarine crew telegraphically, and with the buoy telephone units, spoken communication may be established. Should it be desired to establish additional telephone connections, a line to the rescue ship may be connected to the rescue telephone terminals 38—238, and a diving telephone to the terminals 39—239 provided therefor. Where there are a plurality of these buoy-submarine telephone arrangements, the buoys and submarine stations may be operated separately or in interconnected relation by operation of the switches 60. Thus two or more surface parties may be put into telephonic contact as well as two or more divers, two or more submarine stations, or any combination or combinations of these, all of the units serving equally as transmitter and receiver and being in parallel connection with one another.

Electrical power may likewise be supplied by either the surface craft or the submarine to the other, should either source of supply fail. This is provided for by the various power receptacles carried by the buoy and the submarine. These power circuits may equally operate independently or in multiple, depending upon the position of the switches 68.

Although the construction of the telephone units especially adapts them to use in connection with the present salvage apparatus, they have been highly successful in other uses and their application is not to be restricted beyond the scope of the appended claims.

Moreover, certain other phases of the invention are readily applicable to uses other than submarine salvage, as for example to mine signalling, balloon signalling, general diving and caisson work, etc. Under these conditions, it might suffice to employ only a portion of the apparatus disclosed, as for example in the mining field, the signal stations could be permanently or portably located, with the cable extending from the shaft to the surface. In observation work, a balloon might be of the captive type, connected to the ground by the multi-conductor cable disclosed, and may carry apparatus corresponding more or less to that described as within the buoy. A free balloon might carry the complete apparatus including the second control unit which could be lowered to the ground by releasing the cable.

These and other modifications and adaptations will be suggested to a worker in the communications art.

I claim:

1. Submarine salvage apparatus comprising a submarine and a buoy connected by electrical conductors having parallel supply terminals in said submarine and in said buoy, a series circuit containing a lamp and key connected across a pair of said conductors in said buoy, a series circuit containing a lamp and key connected across said pair of conductors in said submarine, and a lead connecting said series circuits intermediate their lamps and keys and fuses of unequal current carrying capacities inserted in said pair of conductors.

2. Submarine salvage apparatus comprising a submarine and a buoy connected by electrical conductors having parallel supply terminals in said submarine and in said buoy, a series circuit containing a lamp and key connected across a pair of said conductors in said buoy, a series circuit containing a lamp and key connected across said pair of conductors in said submarine, and a lead connecting said series circuits intermediate their lamps and keys and fuses of unequal current carrying capacities inserted in said pair of conductors within the submarine.

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