(No Model.) 5 Sheets—Sheet 1.

E. HUBER & F. J. KNEUPER.

NAUTICAL SIGNAL OR SEA TELEPHONE.

No. 467,102. Patented Jan. 12, 1892.

Fig. 1.

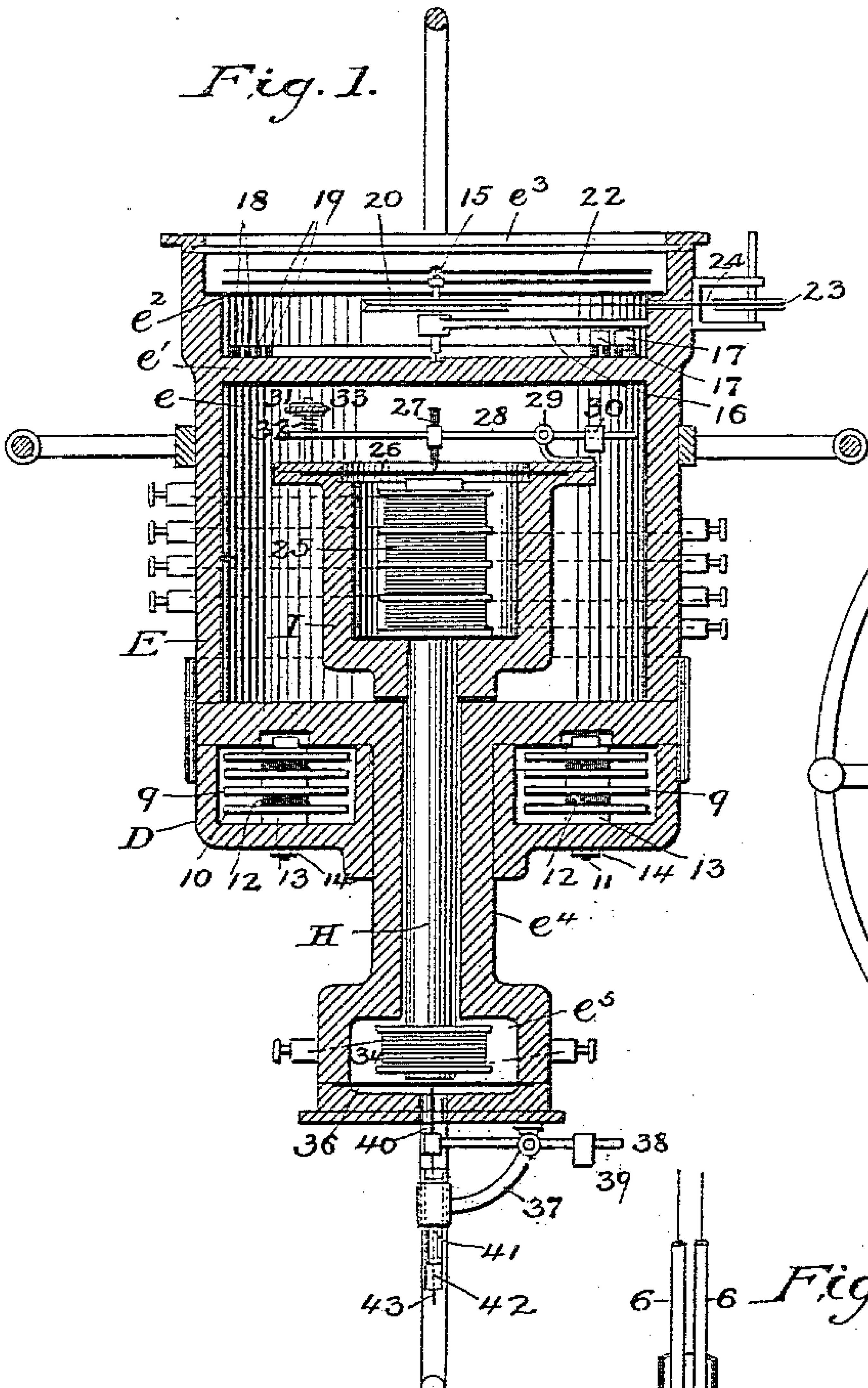


Fig. 2.

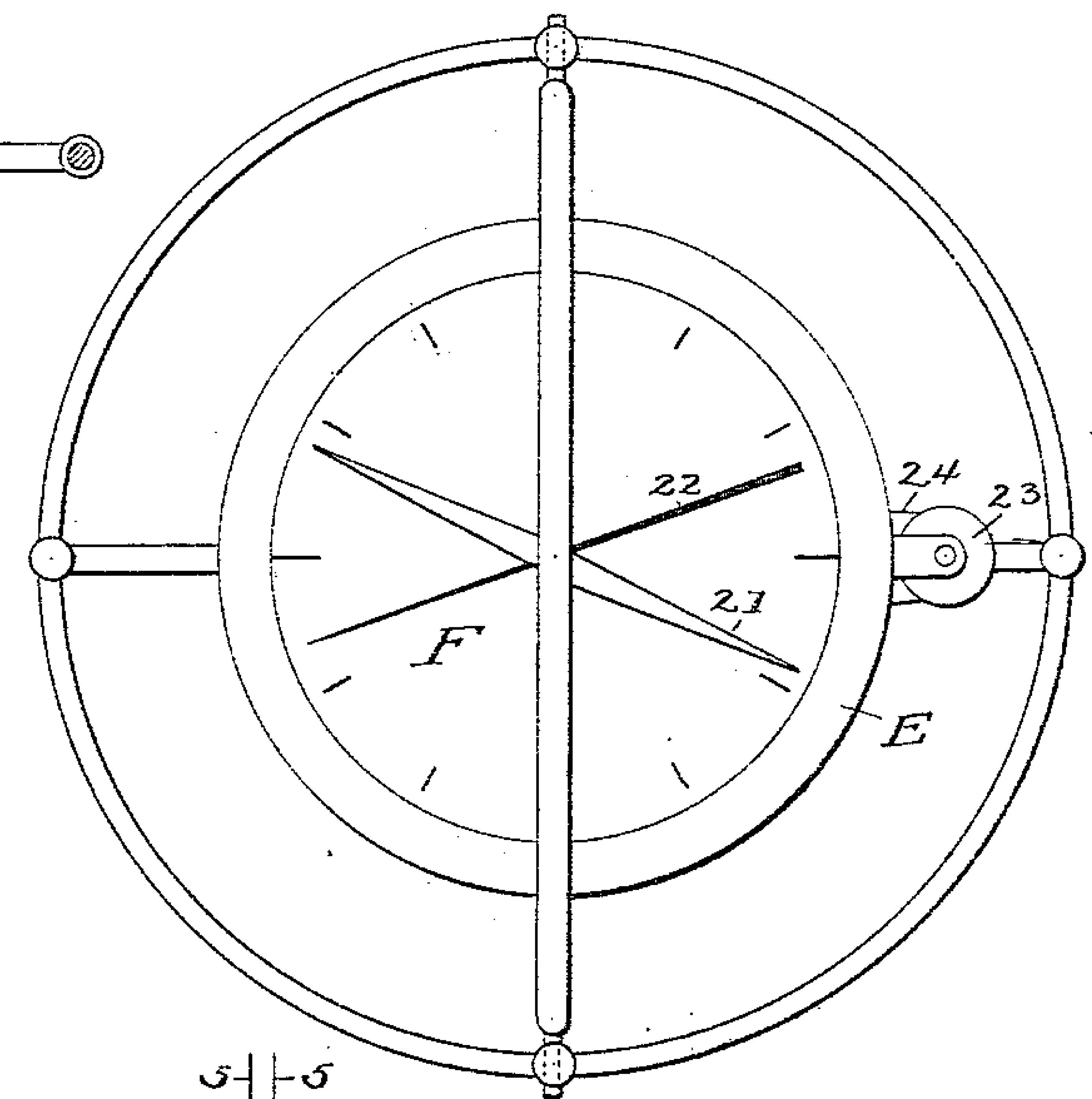


Fig. 3.

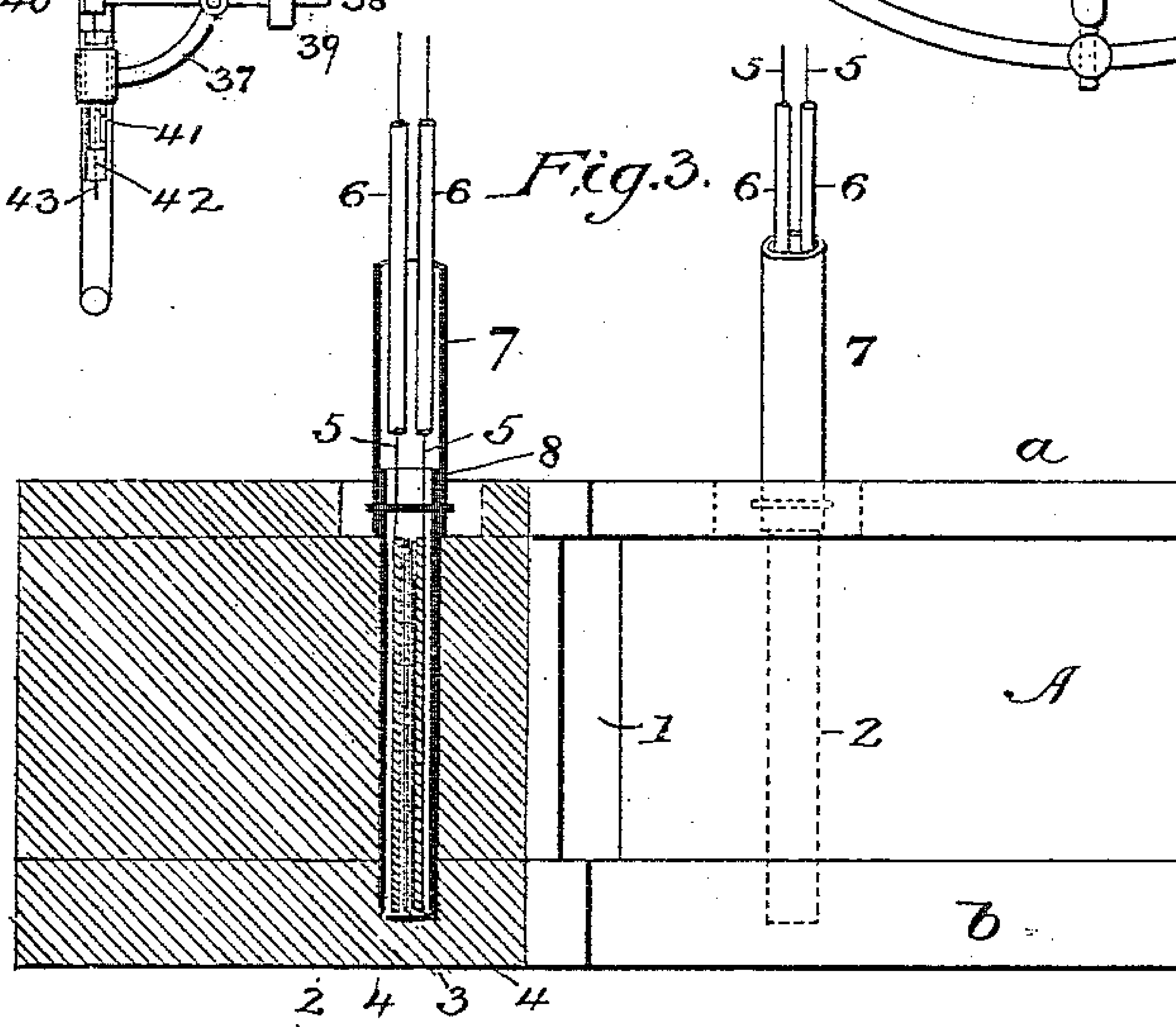
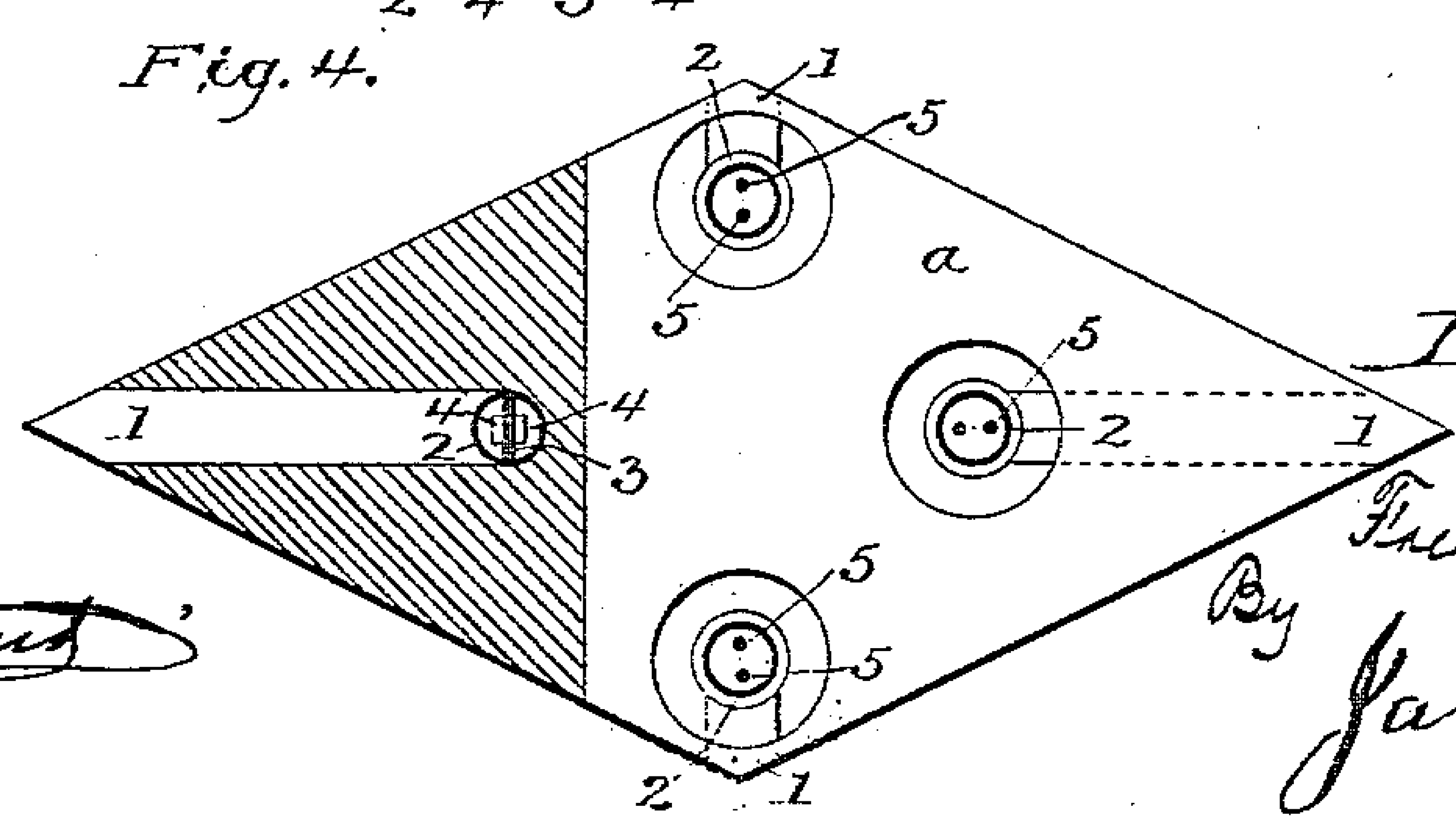


Fig. 4.



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(No Model.) 5 Sheets—Sheet 2.

E. HUBER & F. J. KNEUPER.

NAUTICAL SIGNAL OR SEA TELEPHONE.

No. 467,102. Patented Jan. 12, 1892.

FIG. 5.

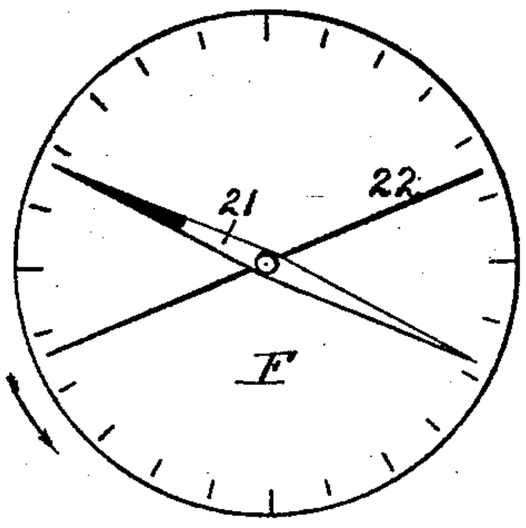


FIG. 6.

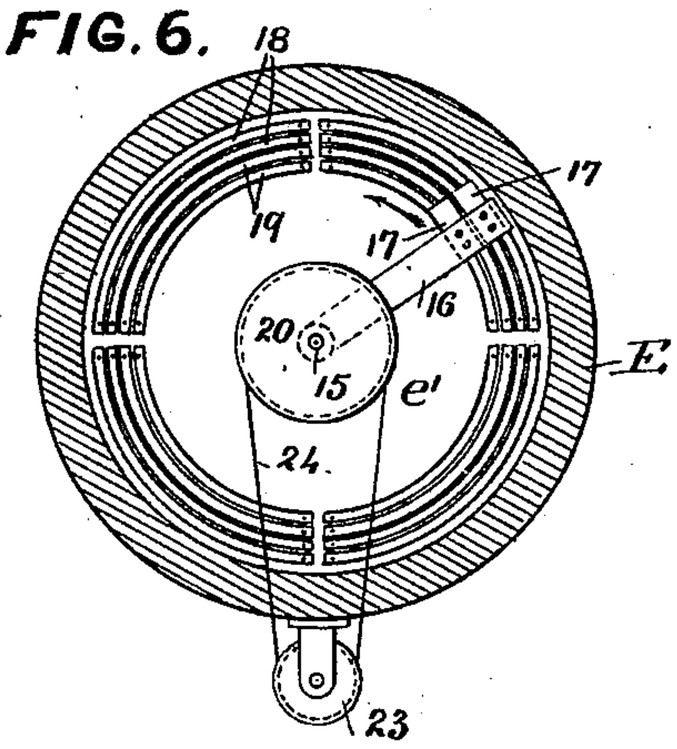


FIG. 7.

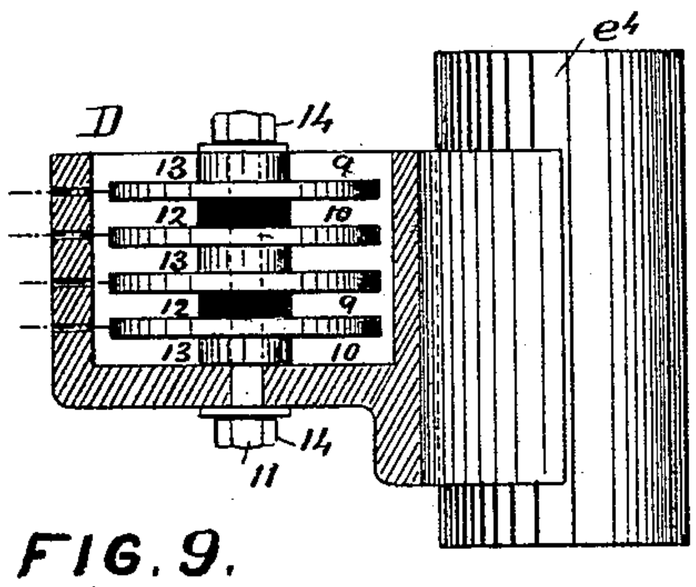


FIG. 8.

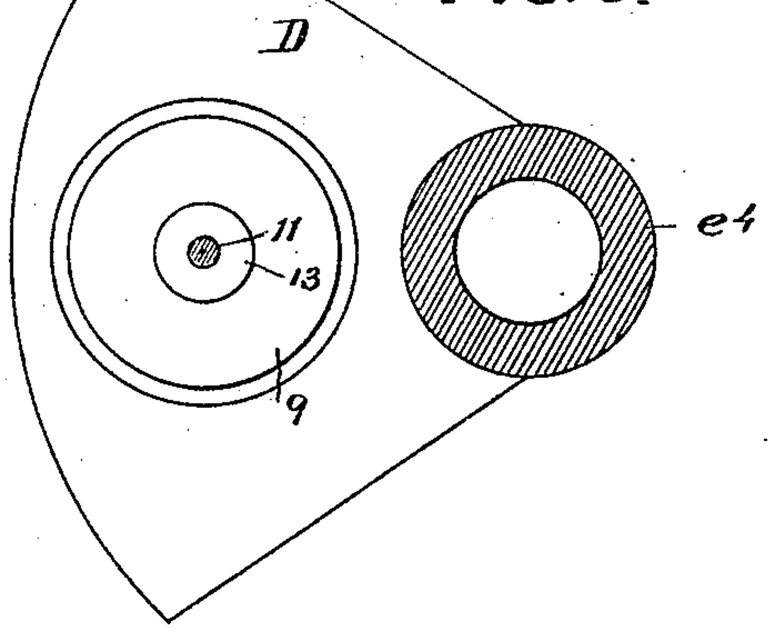


FIG. 9.

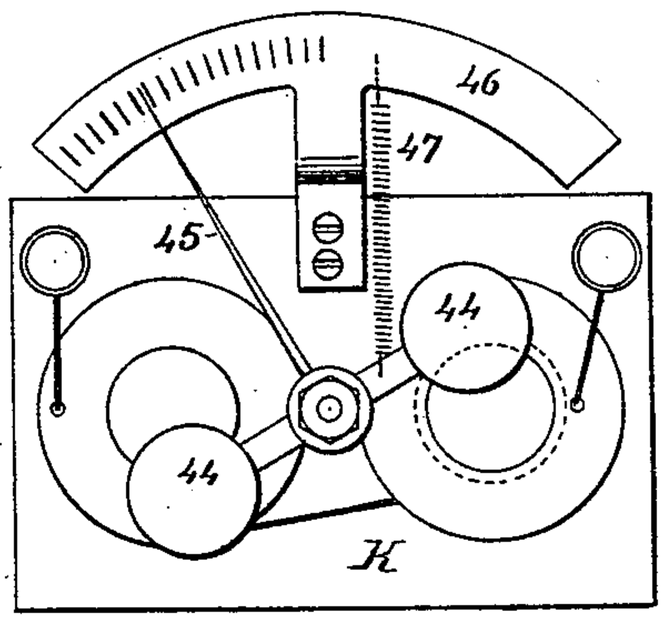
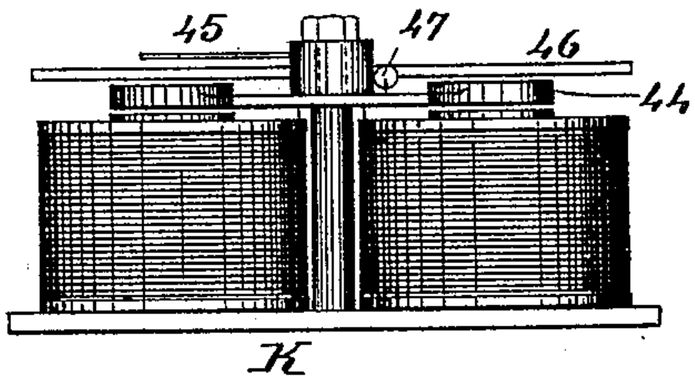


FIG. 10.



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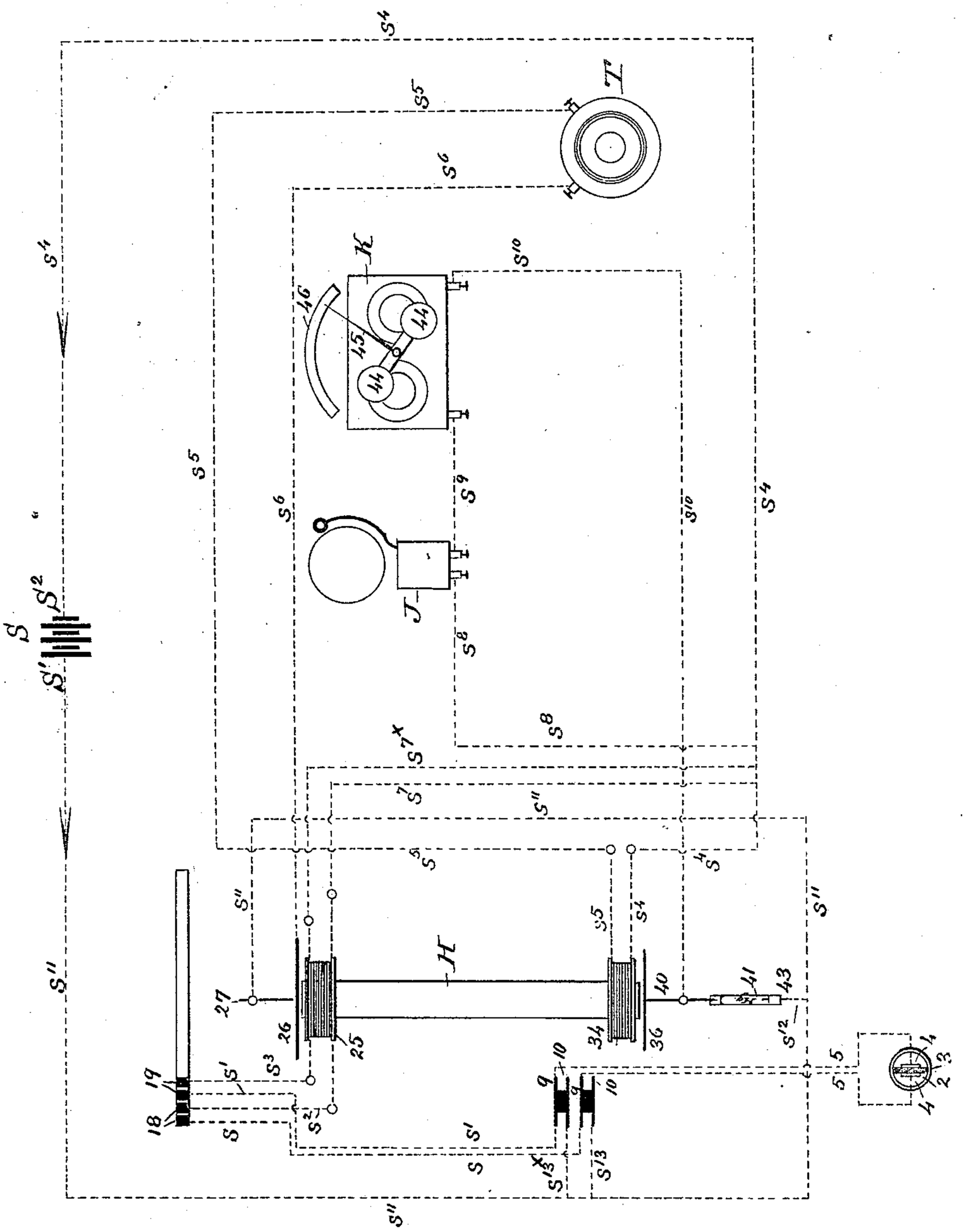
(No Model.) 5 Sheets—Sheet 3.

E. HUBER & F. J. KNEUPER.

NAUTICAL SIGNAL OR SEA TELEPHONE.

No. 467,102. Patented Jan. 12, 1892.

FIG. 11.



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E. HUBER & F. J. KNEUPER.

NAUTICAL SIGNAL OR SEA TELEPHONE.

No. 467,102. Patented Jan. 12, 1892.

FIG. 15.

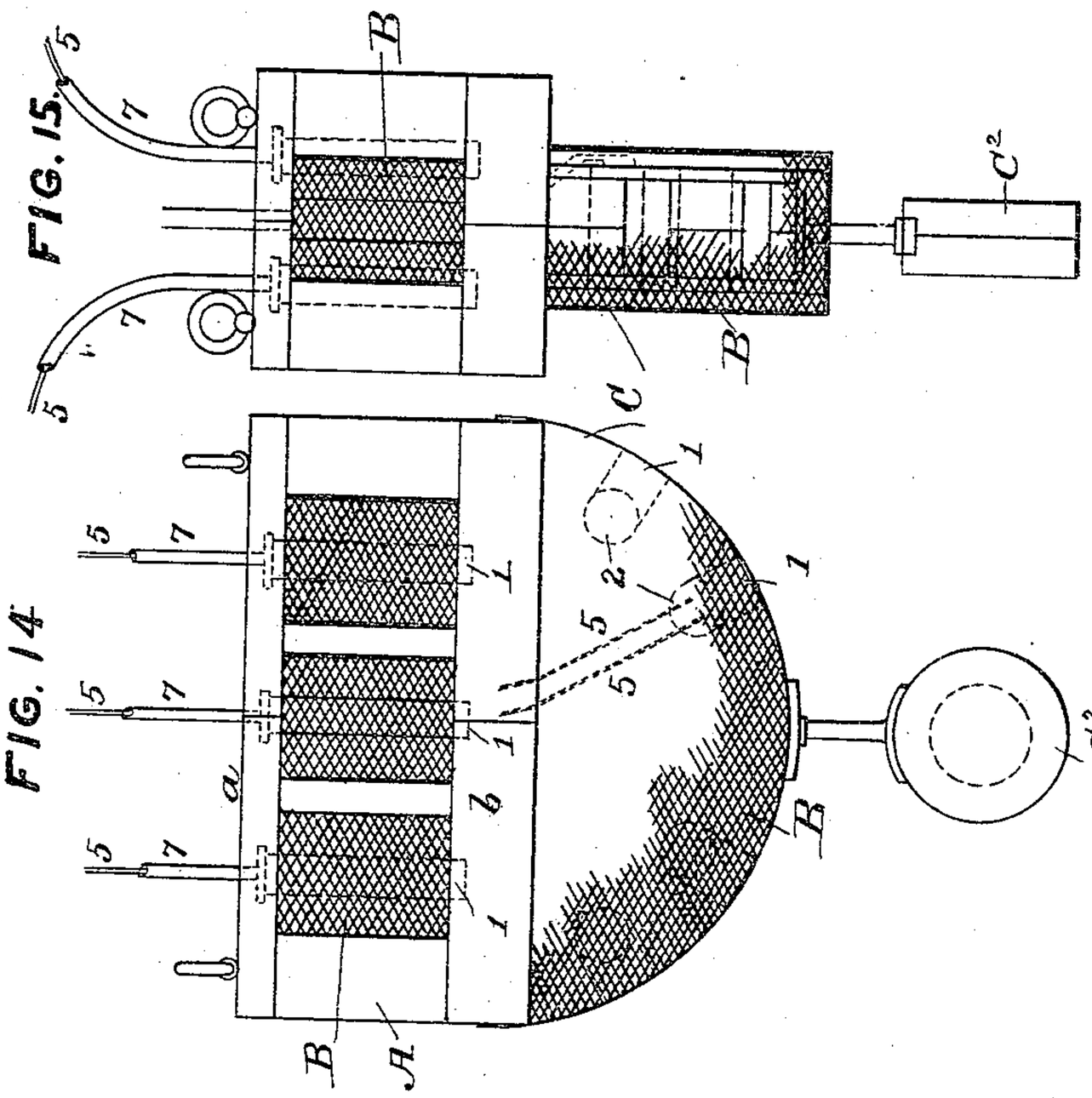


FIG. 14.

FIG. 16.

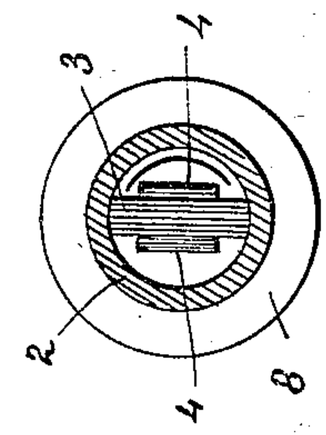


FIG. 12.

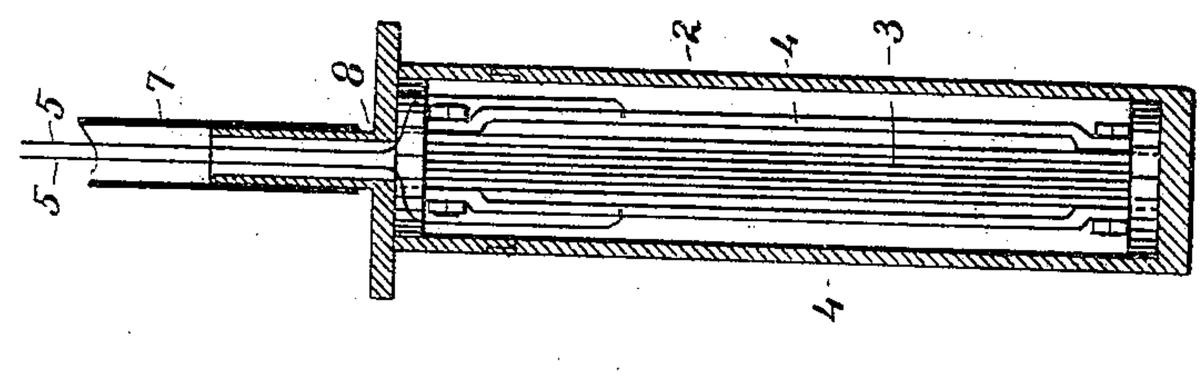
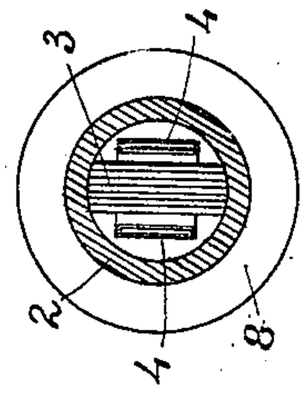


FIG. 13.



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E. HUBER & F. J. KNEUPER.

NAUTICAL SIGNAL OR SEA TELEPHONE.

No. 467,102. Patented Jan. 12, 1892.

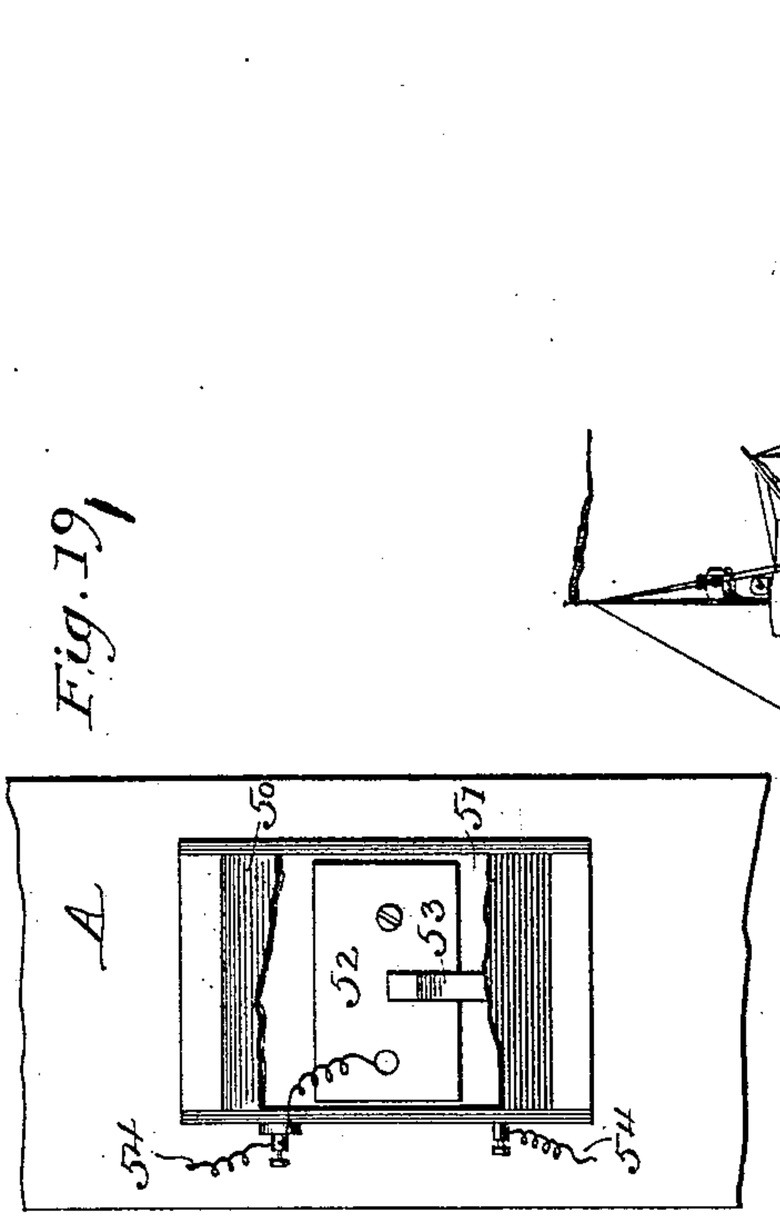

Fig. 19.

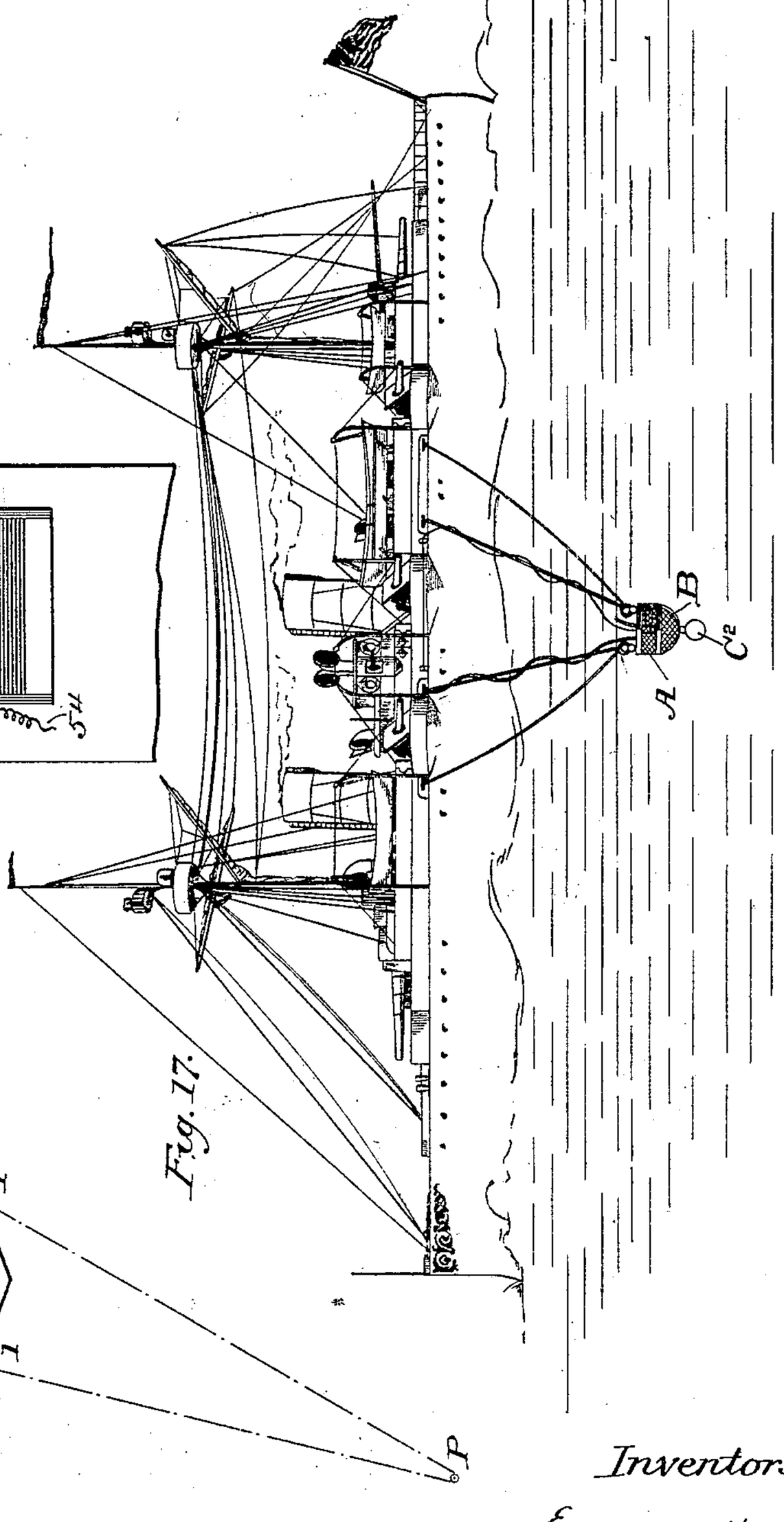

Fig. 17.

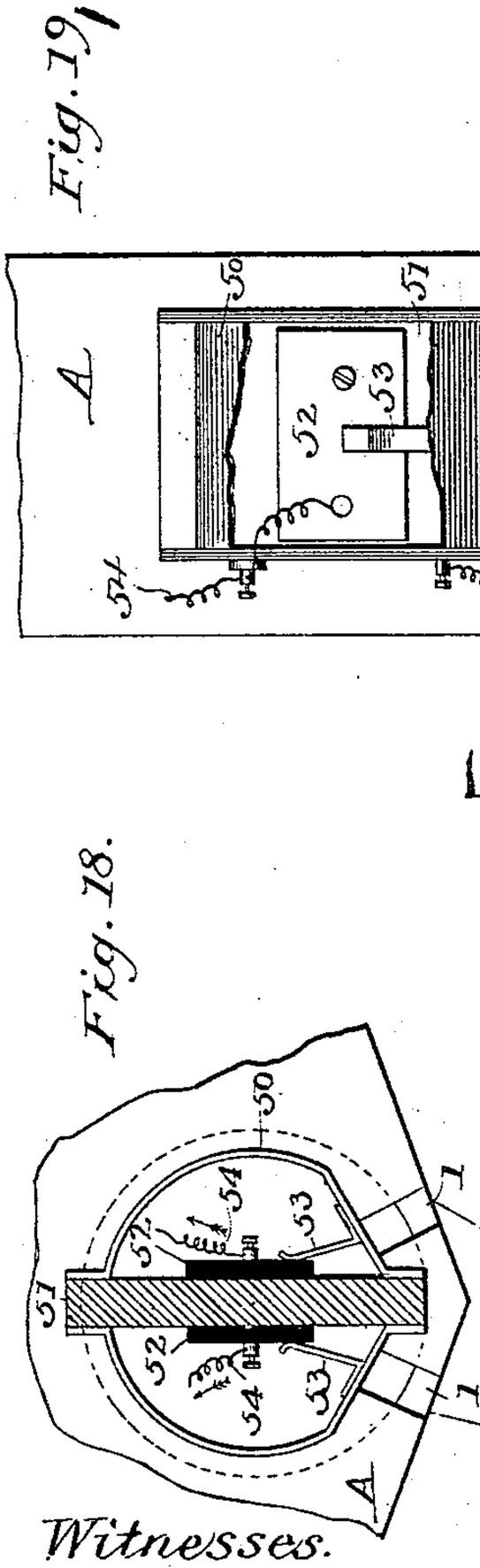

Fig. 18.

Witnesses.

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UNITED STATES PATENT OFFICE.

ERNST HUBER AND FREDERICK J. KNEUPER, OF NEW YORK, N. Y., ASSIGNORS OF ONE-THIRD TO JAMES R. DAVIES, OF SAME PLACE.

NAUTICAL SIGNAL OR SEA-TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 467,102, dated January 12, 1892.

Application filed April 25, 1891. Serial No. 390,481. (No model.)

To all whom it may concern:

Be it known that we, ERNST HUBER and FREDERICK J. KNEUPER, citizens of the United States, residing in New York, county and State of New York, have invented certain new and useful Improvements in Nautical Signals or Sea-Telephones; and we do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to apparatus employed for the detection of sounds proceeding from any object in contact with water, whether the said sounds originate from such objects or by the use of our apparatus are originated at the place of observation and reception and are there received when reflected from such object.

Our apparatus is intended to receive sound-waves pulsating in a body of water and to so transform and intensify, transmit, and indicate the impression or its effect so produced that the position, distance, and orbit of the object from which such sound-waves proceed may be determined.

Our invention therefore consists in apparatus adapted to be placed upon vessels afloat at sea or at fortresses, to be located at entrances to harbors and other places, and by means of which may be ascertained the location, distance, and movements of objects in the water, and also in apparatus by means of which persons at a distance from each other may employ systems of signaling and communication by the transmission of sounds through the water.

This apparatus involves the following well-known principles: First, sound-waves of any number may interfere with and cross each other without losing their distinguishing and individual character; second, liquids, principally water, are better conductors of sound than air and the metals are better conductors of sound than either water or air; third, sound is either intercepted, absorbed, reflected, or refracted by screens properly placed intermediate the vibratory center and the receiver; fourth, metal bars, strips, and wires will transmit or conduct sound to distant places without difficulty and with great rapidity.

In constructing this apparatus the above principles are utilized in the following manner: Sound-waves produced in a body of water and passing therethrough will contact with metal strips immersed in such body of water and suitably arranged in what we term an "intercepter." The metal strips will thereby be caused to vibrate. The vibrations, not being of the desired intensity, are transmitted by wires to microphones or microphonic resounders, which greatly magnify and intensify such sound-vibrations. The microphones are inserted into telephonic circuits and are connected with telephones of a character which will multiply and magnify the vibrations. Having been received, magnified, multiplied, and transmitted, the intensity of the sound-vibrations is caused to be indicated by a suitable device termed an "indicator." Certain other devices are also employed to give notice of disturbances in the apparatus and to indicate the direction and distance of the author of such disturbances.

The details of construction are shown in the accompanying drawings, in which—

Figure 1 is a vertical sectional view of the casing for supporting certain of the parts of the apparatus and showing the primary and secondary telephones, part of the director, a series of groups of resounders, and certain other co-operating parts. Fig. 2 is a top plan of the same, showing the means for suspending. Fig. 3 is a side elevation of the intercepter-block, showing one portion in section to disclose the construction of intercepter-tubes. Fig. 4 is a top plan of the intercepter-block, showing a part in section to indicate location and structure of intercepter-tubes. Fig. 5 is a plan of the dial. Fig. 6 is a cross-section of the casing, showing the director in plan. Fig. 7 is a detail view showing in side elevation the elongated tubular portion of the casing and a single group of resounding-plates, also the supporting-casing in section; Fig. 8, a top plan of Fig. 7; Fig. 9, a top plan of the indicator; Fig. 10, a side elevation of the indicator; Fig. 11, a plan of the circuits, showing the different parts of the apparatus arranged therein for operation. Fig. 12 is a vertical section of one of the intercepter-tubes. Fig. 13 is a horizontal section of one

of the intercepter-tubes. Fig. 14 is a side elevation of the intercepter-block, showing the protecting wire screens and also the auxiliary intercepter-block secured to the bottom of the primary block and its protecting wire screen, and also showing the signaling-bell. Fig. 15 is an end elevation of the parts shown in Fig. 14. Fig. 16 is a horizontal section of one of the intercepter-tubes, showing the sound-absorbing section. Fig. 17 shows a vessel with the intercepter-block and its attachments lashed to the side thereof in operative position. Fig. 18 is a top plan of a portion of the intercepter-block, showing a modification in which the intercepting-tubes and microphonic resounders are combined, the diaphragm being shown in section; and Fig. 19 is a side elevation of Fig. 18, a section being broken away to show certain interior parts.

The sound or sound-wave intercepter consists of a block A of proper dimensions and of a form and shape suitable to accommodate the sound-wave-receiving tubes. The block is preferably diamond shape in outline and has formed in the sides thereof at each angle a deep vertical recess 1 rounded out at its inner end and being open toward the side of the block, thus allowing the passage of the water to the extreme inner or closed end of the recess. The block is composed of non-metallic material, such as wood, paper, hard rubber, &c., and is preferably composed of lamellas of such different non-conducting materials secured together in any suitable way, this construction making the block, as nearly as possible, a non-conductor of sound. At the extreme inner end of each recess 1 is secured a metallic tube 2, closed at the bottom and divided longitudinally by a non-conducting or absorbing diaphragm 3, and each of the two chambers in each tube 2 thus made is filled with water or a watery solution of any suitable salt, such as chlorides or sulphates, thus producing a conductor of sound homogeneous in nature to the surrounding conducting medium (sea-water) in which the sound-intercepter is placed when in operation. On each side of each diaphragm 3 is located a metallic strip 4, and to each strip 4 is attached a wire 5, of silver, copper, or other suitable conducting material, covered with a tube of rubber 6. Each metallic tube 2 has the end of a rubber tube 7 stretched over its neck 8, which rubber tube 7 incloses the pair of rubber-tube-inclosed wires 5, extending from the respective conducting-strips 4. The conducting-wires 5 are covered in the manner above described to prevent contact with each other. The metallic tubes 2 are protected top and bottom by plates *a* and *b*, of any material which will resist water and violence, and are made to conform in size and shape to the upper and lower surfaces of the block A, to which they are securely fastened. The metallic receiving-tubes are placed in the recesses of the block, so that a flat side of each diaphragm will be presented to the open end of each recess. In the rear chamber of each receiving-tube 2 is located and secured in any suitable manner a section of a tube *a'*, composed of non-conducting or absorbing material, such as wood, gutta-percha, electrical insulating material, &c. This section of tube is for the purpose of intercepting and absorbing all sounds coming from the opposite side of the block, and thus preventing such sounds from striking the conducting-strip on the rear side of the diaphragm. (See Fig. 16.) It is manifest that sound-vibrations passing through the water and entering the recesses in the intercepter-block will strike the exposed curved surface of the intercepter-tube 2 and will pass therethrough and passing through it will be communicated to the metal conducting-strips through the watery conducting medium in said tube. From the conducting-strips the sound-vibrations will be conducted through the wires 5 to the microphones.

A block of the shape shown in the drawings and above described is conceived to be the best adapted to cut water; but it may be of any other shape suitable for the purpose. The block will be submerged in the water to a depth sufficient to avoid the majority of or all sounds emanating from the surface, and may be protected against animal and vegetable deposits by removable wire screens, as shown at B in Figs. 14 and 15. When used upon a vessel afloat, it may be placed beneath the keel amidships, and when so placed will be securely but adjustably and removably fastened thereto. It may be attached to any suitable suspending apparatus and passed over the bows and allowed to run astern and be lashed to the deck on each side at the desired place of adjustment, as in Fig. 17. For observation from shore it may be placed in the water at a suitable depth and at any distance from shore and connected with the accessory receiving, transforming, &c., devices located on shore at a proper observatory.

In order to intercept sound emanating or reflected from the bottom of the sea, a secondary block C may be attached to the bottom of the sound-wave intercepter or block and supplied with the same arrangement of tubes and wires above described. (See Figs. 14 and 15.) This secondary block may be a semicircular and vertically-disposed segment, as shown in said figures.

An ordinary electric bell submerged in the water and to be rung by the observer is a part of the apparatus, as shown at C^2 in Figs. 14 and 15. Each pair of wires 5 is conducted from its intercepter to a microphone or microphonic resounder comprising a case D. This case is composed of any suitable material which is a non-conductor of sound. Each resounder consists of two pairs of resounding-plates 9 10 and 9 10, perforated for the passage of the insulated bearing-pin 11, having its ends screw-threaded. The plates of each pair are in microphonic contact with carbon

12, and the two pairs of plates are separated from each other and also from the casing by the washers 13, which are composed of any insulating substance, the carbons and washers being also perforated for the passage of the insulated pin 11 and the pairs of plates, the carbons and the washers being firmly held together and to the casing by the clamping-nuts 14 on the screw-threaded ends of the insulated pin 11.

There is a microphonic resounder for each tube of the intercepter, and each tube is connected with its respective resounder by the pair of conducting-wires 5, one plate in one of the two pairs of resounding-plates being connected to one of the pair of wires and one plate of the other pair being connected to the other of the pair of wires.

Bells, hollow plates, or other mechanical devices for transmitting sound may be employed for the resounders, flat metal plates being shown in the drawings.

The devices thus far described constitute in effect a mechanical telephone and are of a form which is thought to be best adapted to receive, transmit, and magnify sound-vibrations or the effect produced thereby. After the sound-vibrations have been transmitted to the microphone they at such device cause the well-known changes in the carbon contacts, which on their part cause undulations in the current passing through the carbons and through the other parts of the apparatus by suitable electrical connections or circuits, as hereinafter fully explained.

The casing E, to which the several parts of the apparatus are secured and by which they are inclosed and supported, is circular in shape and composed of any suitable material. The casing is provided with a large chamber *e* for the reception of the multiplex telephone, such chamber being closed near the top of the casing by a partition *e'*, which supports the parts of the director. Above the partition and seated on the shoulder e^2 is the dial F, and above the dial is the transparent covering e^3. From the bottom of the chamber *e* extends the elongated tubular portion e^4, ending in another but smaller chamber e^5, in which is located the steno-resounder. The microphonic resounders are arranged in the casing D, which is placed just beneath the large chamber *e* and surrounding the elongated tubular portion e^4 of the casing.

While we have described and shown the microphonic resounders as combined with the main apparatus—that is, arranged adjacent that portion of the apparatus which will be located on shipboard—it is manifest that the same result would be attained by combining such microphonic resounders or equivalent microphones or resounding-plates with the intercepter-block, arranging the same in the intercepting-tubes. By this construction it is apparent that a compact and simplified arrangement of intercepting-tubes and microphones will be secured, the whole to be submerged, as above described. (See Figs. 18 and 19.) In these figures, A indicates the intercepter-block; 1, recesses therein; 50, metallic receiving-tube; 51, the diaphragm to which are secured microphonic carbon-plates, 52 53 being contact-springs between the plates 52 and tube 50, and 54 the connecting-wires or electrodes. In operation the microphonic carbons 52 are counterbalanced by the differential coils of the telephone. P indicates the center of sound-vibrations. This modified construction manifestly results in bringing the microphones or equivalents into such close relationship to the intercepter-tubes and makes the sound-wave connections between the intercepter-tubes and microphones so short as to render the reception of the sound-waves, their transmission to the microphones, and their transformation and intensification practically simultaneous, thus avoiding either the loss of power or time.

The director is composed of concentric ring-segments 18 and 19 in groups of four each, circularly arranged and secured to the partition *e'*. A vertical rotary shaft or pin 15, having a bearing in the partition *e'* and extending through and supported by the dial F, carries an arm 16 below the dial, provided with a pair of spring friction pads or brushes 17, each of which bears upon two successive segments of the groups of four ring-segments 18 and 19 of the director. The pin or shaft 15 also carries a belt-pulley 20, located below the dial *e'*, and a compass-needle 21 and indicating-hand 22, both located and revolving above the dial *e'*. This construction enables the indicating-hand and compass-needle to be observed at the same time. The shaft or pin 15 is made to revolve by any suitable means, such as clock-work, small dynamo, &c. (Not shown.) As shown in the drawings, such actuating means will cause a belt-pulley 23 to be rotated, a strap or belt 24 extending from said pulley 23 through the casing E and around the pulley 20 on the shaft or pin 15, which carries the brush-carrying arm 16. There are as many groups of directors as there are intercepter-tubes and resounders. The indicating-hand will be caused to have between one hundred and one hundred and fifty revolutions per minute.

While we have shown the compass-needle 21 as carried by the revolving shaft 15, it will be manifest that we may locate the same above the glass cover, the main object being to have the relation of the compass-needle and indicating-hand such as to enable them both to be observed at the same instant. Now by mounting the compass-needle on the revolving shaft, as shown in the drawings, manifestly the revolution of such shaft will tend to cause the revolution of such needle. The friction between the point of the shaft 12 and the cup of the compass-needle, however, will be of such an immaterial degree as to cause but a slight movement or variation of such needle in opposition to the force of the "mag-

netic pole," which will tend to hold it stationary. The variation or movement caused by this opposition of mechanical power to natural force will not exceed five degrees.

The multiplex and differential telephone or receiver consists of a magnetized steel core H, extending through the longitudinal tubular portion of the casing E and into the chamber *e*, and surrounding this core and located within the chamber is a small casing I. Within the small casing I and upon the core H are placed as many bobbins 25 as there are resounders and intercepters. Each bobbin is provided with two coils wound in opposite directions. The differential coiling of these bobbins is for the purpose of eliminating all sounds produced by the vessel proper. The object of having several bobbins upon the magnetized steel core is to provide a complemental bobbin for each group of director-segments, each group of microphonic resounders, and each tube of the indicator. The differential winding of such bobbins is for the purpose of providing two direct circuits or connections, respectively, from the two conducting-strips located in each intercepter-tube through the respective complemental microphones and groups of ring-segments to the respective complemental bobbins. Thus the apparatus is made to receive simultaneously two differential sound-waves counterbalancing each other, either partly or entirely, as will be described and brought out theoretically hereinafter.

Above the core H is a diaphragm 26, suitable for telephonic transmission. A microphonic carbon-pin 27, supported vertically on an arm 28, rests normally on the diaphragm 26. The arm which supports the carbon-pin 27 is pivoted to the casing I, as shown at 29, and a counter-balance 30 is secured to the pivoted end thereof beyond the pivotal point. The other end of the arm is provided with a screw-threaded pin 31 and spring 32, a thumb-nut 33 regulating the pressure of the carbon-pin 27 on the diaphragm 26. The carbon-pin 27 is adjustable on the arm 28.

A steno-resounder or secondary telephone is located at the bottom of the casing E in the small chamber e^5, and consists of the bobbin 34, wound with a simple coil of insulated copper wire and secured to the lower end of the core H. Below the bobbin 34 is the diaphragm 36, supported by the casing E. To the casing is also secured a bracket-arm 37, to which is pivoted an arm 38, provided at its rear end with a counter-balance 39 and at its forward end with a socket, in which is adjustably secured a steel pin 40, which rests normally against the diaphragm 36. The bracket-arm also supports a capillary tube 41, filled with mercury. The bottom of this tube is closed by a stopper 42, which is transfixed by a steel needle 43. When the telephone is inactive, the pin 40 is withdrawn from the mercury and rests against the diaphragm 36.

The sound-waves or sound-vibrations transmitted from the wave-intercepter to the differential coils of the multiplex telephone by means of the wires running from the wave-intercepter to and from the microphonic resounder being very feeble, their effect must be magnified. Therefore by arranging the primary and secondary telephones upon the same magnetized steel core, as shown in the drawings, they are made to strengthen each other reciprocally and by their dependent and co-operative action to magnify and multiply the vibrations caused primarily by sound-vibrations, for a minute change of the contact between the microphonic carbon-pin 27 and the diaphragm 26 will cause an energetic play of the diaphragm of the secondary telephone. This on its part will increase the vibration of the diaphragm 26, and so on until action and reaction between both the diaphragms have reached a maximum corresponding in intensity to the original exciting power of the wave-intercepter.

The alarm J is an ordinary electric bell.

The intensity-indicator consists of an electro-magnet K of ordinary construction and an armature 44, supplied with a hand 45, moving with respect to a scale 46. The armature is controlled by a spring 47, the tensions of which may be regulated in any suitable manner. If a current resulting primarily from the sound-vibrations passes through the electrodes, the armature will, according to the intensity of the interrupted current and the time of influence, be attracted by the cores of the magnet, and the hand therefore will have a certain deflection, which will be shown by the scale over which such hand moves. The intensity-indicator as well as the alarm are set to work by the vibrations of the diaphragm of the secondary telephone. The vibrations of the diaphragm of the secondary telephone force pin 40 into the mercury of the tube 41, thus establishing the circuit between the alarm and indicator and the other devices of the apparatus.

Each microphonic resounder is connected with its respective director by two wires *s s'*, connecting, respectively, with the upper ones of the two pairs of resounding-plates 9 10 and extending thence to and connecting, respectively, with two alternating segments 18 19 of the corresponding group of director-segments. To the other alternating two of such groups of director-segments are respectively connected two wires $s^2 s^3$, which extend thence to and are connected, respectively, with the oppositely-coiled wires of a single and corresponding bobbin 25 of the multiplex telephone. It follows, therefore, that each of the brushes 17 is always in contact with a segment having connection with the multiplex telephone and also with a segment having connection with a microphonic resounder.

Any suitable battery S or electrical generator is employed, the circuits from which extend as follows: The opposite poles are represented at S' S^2, Fig. 11, and from the posi-

tive pole S′ extends a circuit s'' to the carbon-pin 27, and by the contact of said pin 27 with diaphragm 26 to the telephone-receiver by circuit s^6, from thence by circuit s^5 to the bobbin 34, and from thence by circuit s^4 to the negative pole S^2 of the battery S. From the circuit s'', extending from the positive pole of the battery, extends another circuit s^{13} to the lower plate of the lower pair of microphonic resounders, through the carbon to the upper plate of such lower pair, and from thence by connection s to the outer one of the pair of director-segments 18. At this point the circuit is continued by the revolution of arm 16 and contact of one of the spring pads or brushes 17 with the pair 18 of ring-segments, through the second ring-segment of pair 18, and by connection s^2 to the bobbin 25, and from thence by circuit s^7 s^4 to the negative pole of battery. Another circuit $s^{13\times}$, complemental to the one last above described, extends from circuit s'' to the lower plate of the upper pair of microphonic resounders, through the carbon to the upper plate of such upper pair, and from thence by connection s' to the first ring-segment of pair 19 of the director. At this point the circuit is continued by the revolution of arm 16 and contact of the second one of the pair of spring pads or brushes 17 with the pair 19 of ring-segments, through the second ring-segment of pair 19, and by connection s^3 to the bobbin 25, and from thence by circuit $s^{7\times}$ s^4 to the negative pole of battery. From the circuit s'' extends another circuit s^{12}, connecting with pin 43 projecting into the tube 41. At this point the circuit is continued by the dipping of pin 40 into the mercury of tube 41, (caused by vibrations of diaphragm 36,) from pin 40 through circuit s^{10} to the indicator K, through the electro-magnet of such indicator to the alarm J by connection s^9, and from thence by circuits s^8 s^4 to the negative pole of battery. It will thus be seen that the different parts of the apparatus are electrically connected in multiple arc and that there are three definite branches, as follows: first, positive pole of battery, carbon-pin 27, telephone-receiver T, secondary telephone, negative pole of battery; second, positive pole of battery, two pairs of resounder-plates, director-segments, multiplex telephone with differential coils, negative pole of battery; third, positive pole of battery, capillary mercurial tube, intensity-indicator, alarm, negative pole of battery. It is manifest that the intensity of the current pervading each of these three branches may be suitably regulated by inserted resistances. The connection between the tubes of the intercepter and the michrophones is by wires 5, which are two for each receiving-tube and its complemental microphone. Such wires are connected, respectively, with the two conducting-strips located in the receiving-tubes, and from thence extend to and are connected, respectively, with the upper one of the two pairs of microphonic resounding-plates. It will be manifest that though single-wire connections are shown in the drawings, Fig. 11, as extending throughout and connecting the different parts of the apparatus, as many wires as are deemed necessary and expedient for the different purposes may be employed. The casing E is suitably arranged for a "Cardanian suspension," as shown in Figs. 1 and 2.

The operation is as follows: When the intercepter has been arranged and placed in the desired position, sound-waves proceeding from any moving object in the water or reflected from some object in the water and entering the recesses 1 of the block A are received by the metallic conducting-tubes, conveyed across the watery conducting contents of said tubes to the conducting-strips of the diaphragm 3, and transmitted by the wires to the microphones, where they cause vibrations of the plates 9 thereof. At this point of their passage the sound-vibrations are increased in volume or made stronger and transformed into electrical vibrations. From the microphones the sound-vibrations are transmitted to the director. The brushes 17, having been set in motion, pass over the ring-segments, and upon each revolution successively open and close the different circuits between the primary or multiplex telephone and the microphones. The primary telephone being influenced, the diaphragm thereof vibrates, thus causing a change of contact between the carbon-pin 27 and the diaphragm. This contact of pin 27 with its diaphragm causes an energetic play or vibration of the diaphragm 36 of the secondary telephone or steno-resounder. By the vibrations of the diaphragm 36 of the secondary telephone the pin 40 is immersed in the mercury in the tube 41 to a greater or less degree, thus establishing the several circuits and actuating the alarm J, which directs attention to telephonic disturbances, while the hand of the intensity-indicator K is caused to be deflected over the scale 46 and thus show the nature and extent of such disturbance.

The theory of these parts is as follows: Any medium placed in the way of translatory undulations absorbs them partly or entirely, according to the individual character of the vibratory movement and to the physical qualities of the medium. Light and sound vibrations are subjected to the same laws. A diaphragm composed of n layers or films being struck on its face by a quantity of sound V lets pass a quantity $V_{\times} n$ and therefore absorbs a quantity $V(1-x^n)$, x being a fractional coefficient which changes with the character of the absorbing medium and the character of the sound-vibrations absorbed. Therefore we will have for two different characters or categories of sound-vibrations the following expressions:

$$\begin{aligned} A_1 &= V_1(1-x_1^n) \\ A_2 &= V_2(1-x_2^n) \end{aligned} \quad 1a)$$

Sound-waves striking upon a system composed of two metallic plates separated by a

diaphragm of so-called "insulating material" will be divided up in the different parts of said system in the following way: Let the initial quantity be V. Then, first, a partial reflection takes place on the face of the front plate equal to Vr; second, a partial absorption takes place in front plate equal to Vo; third, a partial absorption takes place in diaphragm equal to $V(1-x^n)$; fourth, a partial absorption takes place in rear plate equal to V1; fifth, the rest passing through the system equal to V2. Evidently $V=Vr+Vo+V(1-x^n)+V1+V2$.(1.)

For simplifying the expression let Vr equal o and V2 equal o.(2.) Then the quantity of sound absorbed by the metallic plates is obviously for one category of sound-waves: $Vp'=Vo'+V2$,(3,) and for another we get: $V'p=V'o+V'2$.(4.)

It is evident, also, that we may create conditions under which either Vp or $V'p$ may turn out equal to o; but either of them being zero excludes the other expression from being zero, the fraction in equation 1[a] and the quantity of sound being different in both cases: Suppose Vp equal o.(5.) Then Vo equal V2,(6,) and consequently $\Delta V'p=V'o-V'2$.(7.)

The quantities Vo, V2, $V'o$, $V'2$ are those parts of the sound-waves which will be transmitted from the "wave-intercepter" to a "microphonic resounder."

In order to eliminate a certain category of sound-waves and to transmit another, equations 6 and 7 show that a differential bobbin is used, each coil of which is supplied by its respective metallic wave-intercepter-plate. The number of wave-intercepters corresponds with the number of differentially-wound bobbins, which constitute the primary telephone. The same results will be obtained if equation 3 be represented under this form: (8) $\Delta mVp=m(Vo-V2)$, m representing the number of wave-intercepters. m increasing, it is obvious that the limit of equation 8 will be: (9) ΔmVp equal constant, an expression which represents the general form of equation 6.

If, instead of an impractically high m and a slow speed of the director, the speed of the director is raised, *e. g.*, to one hundred and twenty revolutions per minute and the number m kept within very restricted limits, equation 9 will hold strong. Supposing the number of wave-intercepters to be, *e. g.*, sixteen, the number of circuits inserted within one second's time will be thirty-two. Thereby the constancy of the "indicator-level" is easily kept up.

Equation 6 may be fulfilled by inserting proper resistances into one of the differential coils of the bobbins of the primary telephone.

It will be manifest that the theory above given remains the same if the resounder-plates or microphones are placed in the block with the intercepter-tubes, as shown in Figs. 18 and 19, because it is immaterial where the parts of the apparatus are placed so long as they, theoretically and practically, perform the same functions.

Resuming, from the results obtained we find that an apparatus which shall indicate a certain character, or, as we may call it, a certain "color," of sound and eliminate or reduce to constancy any other sound color which is not wanted will be composed principally of the following parts: first, sound-wave intercepters; second, differential bobbins, (primary telephone;) third, a multiplier of those differential actions exerted upon the differential bobbins—viz., a "steno-sounder," (secondary telephone;) fourth, a director for connecting the intercepters successively with the circuits; fifth, accessory parts by which the observer may detect those multiplied differences both by the eye and ear.

Any number of receiving-tubes may be employed, dependent upon the horizontal scope and range it is desired to command, the drawings, Fig. 4, showing four of these tubes corresponding to the main points of the compass. Each tube governs a certain point of the horizon, and sound-waves emanating from an eastern center of vibration will not enter the northern recess, or, if they do, will not strike the flat face of the diaphragm vertically, but, entering the recess diagonally, will be either absorbed or have their mechanical power and effect weakened by repeated contacts with and reflection from the walls of the recess, and therefore partially if not entirely lost.

Sounds made by superficial agitation of the water and sounds proceeding from the structure to which the apparatus is attached will enter both compartments and will influence both strips of the diaphragm alike. The latter class of sounds manifestly will be constant in their nature, and will therefore constantly influence the apparatus in an easily-recognizable manner, while, on the other hand, sounds which are within the intended scope of reception will influence the apparatus to an extent plus the amount which such constant sounds do, and will consequently be easily detected.

Sounds emanating from the structure to which the apparatus is attached and sounds caused by superficial agitation of the water will influence both the conducting-strips within the intercepter-tubes to the same degree, and therefore will actuate equally both pairs of resounder-plates, and the microphonic action thereby produced may be rendered equal by the insertion of suitable resistances, if it is not already equal, and consequently no telephonic action will be apparent. Both coils working equally, the diaphragm 26 is at rest, as both influences are acting upon it oppositely. Thus will be eliminated all sounds not within the intended scope of reception.

The sound-waves originating from another center of vibration distant from the vessel will be received by that intercepter-tube only

facing the same directly. The rear strip of the diaphragm cannot be influenced to the same extent as the front one, as explained, on account of its location. If one coil only is at work, the diaphragm 26 is in operation.

The mechanical power developed by the coils of the secondary telephone or steno-resounder depends upon the intensity of the vibrations of the diaphragm of the primary or multiplex telephone. The telephones being upon the same core and in the same circuits afford mutual reinforcement and magnify and intensify in each other the telephonic demonstration. In their revolution each of the brushes 17 bears upon a pair of the ring-segments of the director, one of each pair being connected with the multiplex telephone and the other with a microphonic resounder, thus successively establishing the different circuits between the microphonic resounders and the multiplex telephone.

The needle 43 and the pin 40 are in the circuit indicated by the wires s^{11} s^{10}, which is closed by the contact of the pin 40 with the mercury in the tube 41. The time during which the pin 40 remains in the mercury controls the extent of movement of the armature, and consequently the extent of deflection of the hand carried by the armature. The time during which the pin 40 remains in the mercury depends upon the intensity of vibration of the diaphragm 36, causing vibrations of the said pin.

The energy of the sound-waves produced and the duration and intensity of their telephonic equivalents, as shown by the hand 45, will be a measure of the character, distance, approach, or recession of the object from which the sound-waves proceed.

The time during which the steel pin is immersed in the mercury depends upon the vigor of the diaphragm of the secondary telephone, which forces the said pin more or less deeply into the mercury. Let the number of oscillations or vibrations of said diaphragm be u and the time of immersion due to the unit of force exerted upon the needle during one oscillation equal t_0. Then the integral time for all the oscillations in the unit of time will be T_I equals *uoto*. For any other amount of forcing-in power we therefore have T_I equals $u_1 t_1$. The action of the current passing the electro-magnets of the intensity-indicator upon the armature being dependent upon the time during which the cores of the magnet are influenced, it is obvious that the deflection of the needle will be a function of that time and proportional to it, or angular deflection equals $f(u_1 t_1)$ equals $c. u_1 t_1$ where c is constant. This equation formally corresponds with equation 6, whereby it is provided that the wave-intercepter and intensity-indicator—*i.e.*, originally the "steno-sounder"—are homogeneous in their action and correlating. As to the "alarm," it may be regulated so that it is set to motion when T_I equals $u^2 t^2$—*i. e.*, when the intensity of approaching danger reaches a certain pitch.

The telephone-receiver T, held to the ear of the observer, affords prompt information of the activity of the telephones and of its character and extent.

The alarm-bell calls attention to the activity of the apparatus.

The electric bell submerged may be used to obtain from any object in contact with water a reflection of the sound produced by the bell, from which exact calculations of the distance of the object may be made.

Two persons using the apparatus may by means of the submerged bell, to be rung according to conventional systems—such as the "Morse" alphabet or flag-signaling—communicate to any desired extent.

The term or phrase "sound-wave connections" is employed in contradistinction to electrical connections.

Having thus fully described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The combination, in an apparatus for receiving, transmitting, and indicating sound, of the sound-wave intercepter, the resounder, the receiver, the director, the indicator, sound-wave connections between the several parts above named, an electric battery, and an electric circuit extending from the battery to and through the resounder, receiver, director, and to the indicator.

2. The combination, in an apparatus for receiving, transmitting, and indicating sound, of the sound-wave intercepter, the resounder, the director, the multiplex telephone, the steno-resounder, the indicator, sound-wave connections between the several parts above named, an electric battery, and an electric circuit in which the several parts above named are located.

3. The combination, in an apparatus for receiving, transmitting and indicating sound, of the sound-wave intercepter, the auxiliary intercepter secured thereto, the resounder, the receiver, the director, the indicator, sound-wave connections between the several parts above named, an electric battery, and an electric circuit in which the several parts above named are located.

4. The combination, in an apparatus for receiving, transmitting, and indicating sound, of the sound-wave intercepter, a protector therefor, the resounder, the receiver, the director, the indicator, sound-wave connections between the several parts above named, an electric battery, and an electric circuit within which the several parts above named are located.

5. The combination, in an apparatus for receiving, transmitting, and indicating sound, of the sound-wave intercepter, the resounder, the receiver, the director, the indicator, the alarm, and telephone-receiver, sound-wave connections between the several parts above named, an electric battery, and an electric

circuit, the resounder, receiver, director, indicator, alarm, and telephone-receiver being located within such electric circuit.

6. The combination, in an apparatus for receiving, transmitting, and indicating sound, of the sound-wave intercepter, an electric bell, the resounder, the receiver, the director, the indicator, sound-wave connections between the several parts above named, an electric battery, and an electric circuit extending from the battery to and through the resounder, receiver, director, and the indicator.

7. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

8. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm, a sound-wave absorber located within one of the chambers of each tube, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

9. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm, a sound-wave absorber arranged within one of the divisions of the tubes, consisting of a section of a tube of non-conducting material, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

10. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a conducting medium and containing a dividing-diaphragm, conducting-strips located on each side of said diaphragm, a resounder, receiver, director, and indicator, and sound-wave-connections extending from the intercepting-tubes to and through the resounder, receiver, director, and to the indicator.

11. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a medium homogeneous to the conducting medium in which the block is to be submerged and containing a dividing-diaphragm, conducting-strips on each side of said diaphragm, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

12. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses circularly arranged, a sound-wave-intercepting tube located within each recess at its extreme inner end, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm arranged transversely to the horizontal depth of the recesses, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

13. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a diamond-shaped block having at each angle thereof a recess the extreme inner end of which is rounded out, a sound-wave-intercepting tube located within each recess at the extreme inner end, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm, a resounder, receiver, director, and indicator, and sound-wave connections extending from the intercepter-tubes to and through the resounder, receiver, director, and to the indicator.

14. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm, a resounder, rubber-covered wires connecting the intercepting-tubes with the resounder, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

15. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, a sound-wave-intercepting tube located within each recess, such tubes being filled with a conducting medium and containing a dividing conducting diaphragm, a resounder, connecting-wires extending from each intercepter-tube to the resounder, such wires being covered and separated from each other by rubber tubes and the rubber-tube-covered wires of the respective intercepter-tubes being inclosed by a protecting rubber tube, which latter is con-

nected with the said intercepter-tube, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

16. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter consisting of a block provided with a series of recesses, each recess having located therein a sound-wave-intercepting tube, such tubes being filled with a conducting medium and containing a conducting dividing diaphragm, non-conducting protecting-plates secured top and bottom to said block, a resounder, receiver, director, and indicator, and sound-wave connections extending from the interceper-tubes to and through the resounder, receiver, and director. and to the indicator.

17. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, and connections between the two, the resounder consisting of a series of groups of resounding-plates, each group comprising four plates centrally perforated, microphonic carbons separating certain of the plates of each group, a screw-threaded insulated pin passing through the plates and carbons, and clamping-nuts on the ends of said pin for securely holding said plates and carbons together, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

18. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, and connections between the two, the resounder consisting of a series of groups of resounding-plates, each plate of each group being perforated, perforated microphonic carbons separating certain of the plates of each group, an insulated screw-threaded pin passing through the plates and carbons, and clamping-nuts on the ends of said pin for securely holding said plates and carbons together, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

19. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, and connections between the two, the resounder consisting of a series of groups of resounding-plates, each group comprising four centrally-perforated plates arranged in pairs divided from each other by a washer, centrally-perforated microphonic carbons separating the plates of each pair, a screw-threaded insulated pin passing through said plates, carbons, and washer, and clamping-nuts on the ends of said pin for securely holding the parts together, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

20. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter comprising a series of intercepting-tubes, a resounder consisting of a series of groups of resounding-plates, each group comprising four plates arranged in pairs divided from each other by a washer, microphonic carbons separating the plates of each pair, means for holding the plates, carbons, and washers together, connections between the intercepter and resounder, consisting of two wires extending from each tube of the intercepter to and connected, respectively, with one plate of a complemental pair of a corresponding group of resounder-plates, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

21. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter comprising a series of intercepting-tubes, a resounder consisting of a series of groups of resounding-plates, each group comprising four plates arranged in pairs divided from each other by a washer, microphonic carbons separating the plates of each pair, means for holding the plates, carbons, and washers together, connections between the intercepter and resounder, consisting of two wires covered and separated from each other by rubber tubes and arranged within a common protecting-tube, such wires extending from each tube of the intercepter to and connected, respectively, with one plate of a complemental pair of a corresponding group of resounder-plates, a receiver, director, and indicator, and sound-wave connections extending from the resounder to and through the receiver and director and to the indicator.

22. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a casing having a large chamber and below the same a small elongated portion, a sound-wave intercepter, a resounder consisting of a series of groups of resounding-plates, a casing in which the groups are circularly arranged, said casing of plates being secured to and encircling the elongated portion of the first-named casing and being located immediately below the large chamber of the latter, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

23. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a multiplex telephone or receiver consisting of a centrally-perforated casing having a chamber into which extends a sound-conducting core, a series of bobbins seated in said chamber and upon said core, a diaphragm seated in said casing above the bobbins, an arm pivoted to said casing above the diaphragm and car-

rying an adjustable carbon-pin and a counter-balance at one end and adjusting device at the other, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

24. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a multiplex telephone or receiver consisting of a centrally-perforated casing having a chamber into which extends a sound-conducting core, a series of bobbins located within said casing and upon said core, a diaphragm seated in said casing above the bobbins, an arm pivoted to said casing above the diaphragm and carrying a carbon-pin and a counter-balance at one end and adjusting device at the other, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

25. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a multiplex telephone or receiver consisting of a centrally-perforated casing having a chamber into which extends a sound-conducting core, a series of bobbins located within said chamber and upon said core one above the other, a diaphragm seated in said casing above the bobbins, an arm pivoted to said casing above the diaphragm and carrying an adjustable carbon-pin and a counter-balance at one end and a spring under tension at the other end, and a screw for regulating the expansion of the spring, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

26. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a multiplex telephone or receiver consisting of a centrally-perforated casing having a chamber into which extends a sound-conducting core, a series of bobbins located within said chamber and upon said core one above the other, each bobbin consisting of two coils of wire wound oppositely, a diaphragm seated in said casing above the bobbins, a pivoted arm above the diaphragm carrying a carbon-pin, a counter-balance, spring, and adjusting-screw, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

27. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a main casing having a large chamber and below the same a small tubular elongated portion, a sound-wave intercepter, a resounder, a multiplex telephone or receiver comprising a small casing having a chamber, a diaphragm seated in the upper end of said small casing, and a pivoted arm carrying a carbon-pin, located above said diaphragm, all located within the chamber of said main casing, a sound-conducting core extending through the elongated portion of the main casing and into the chamber of the small casing, a series of bobbins carried on said core below said diaphragm, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, and director, and to the indicator.

28. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a multiplex telephone or receiver comprising a sound-conducting core, a series of bobbins, a diaphragm, and carbon-pin, a secondary telephone or steno-sounder consisting of a bobbin secured to the lower end of the said sound-conducting core and composed of a coil of copper wire, a diaphragm, a pivoted arm carrying a counter-balance at one end and an adjustable steel pin at its other end, a tube filled with mercury suitably supported directly under said pin, said tube having a stopper in its lower end transfixed by a needle, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

29. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a primary telephone or receiver comprising a sound-conducting core, a series of bobbins, a diaphragm, and carbon-pin, a secondary telephone or steno-sounder consisting of a bobbin secured upon the lower end of said core, a diaphragm, a pivoted arm carrying a counter-balance and a steel pin, a tube filled with mercury suitably supported directly under said pin, said tube having a stopper in its lower end transfixed by a needle, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, primary and secondary telephones, director, and to the indicater.

30. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a casing comprising a large chamber and a small chamber and an elongated tubular portion connecting the two chambers, a sound-wave intercepter, a resounder, a primary telephone or receiver comprising a sound-conducting core, a series of bobbins, a diaphragm, and carbon-pin, a secondary telephone or steno-sounder consisting of a bobbin secured upon the lower end of said core, a diaphragm seated in the small chamber of the casing, a bracket-arm secured to said casing and supporting a tube filled with mercury, having a stopper in its lower end transfixed by a needle, an arm pivoted to said bracket-arm and carrying at one end a counter-balance and at the other an adjustable steel pin located directly over the said tube and under the last-named diaphragm, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the re-

sounder, primary and secondary telephones, director, and to the indicator.

31. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a casing comprising a large chamber and a small chamber and an elongated tubular portion connecting the two chambers, a sound-wave intercepter, a resounder, a primary telephone or receiver comprising a sound-conducting core, a series of bobbins, a diaphragm, and carbon-pin, a secondary telephone or steno-sounder consisting of a bobbin secured upon the lower end of said core, composed of a coil of insulated copper wire, a diaphragm seated in the small chamber of the casing, a bracket-arm secured to said casing and supporting a tube filled with mercury, having a stopper in its lower end transfixed by a needle, an arm pivoted to said bracket-arm and carrying at one end a counter-balance and a socket at the other, in which is adjustably secured a steel pin, said pin being located directly over the tube and between the same and the last-named diaphragm, a director, and an indicator, and sound-wave connections extending from the intercepter to and through the resounder, primary and secondary telephones, director, and to the indicator.

32. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, primary and secondary telephones, a director consisting of a series of groups of ring-segments circularly arranged, a vertical shaft carrying an arm provided with brushes, said shaft also carrying a band-pulley, an indicating-hand, and a compass-needle, means for rotating said shaft, a dial arranged relatively to said hand and needle, and sound-wave connections extending from the intercepter to and through the resounder, telephones, director, and to the indicator.

33. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, primary and secondary telephones, a director, a casing for supporting the resounder, telephones, and indicator, the director consisting of a series of groups of ring-segments circularly arranged, a vertical shaft carrying an arm provided with brushes, said shaft also carrying a band-pulley, an indicating-hand, and a compass-needle, a dial seated in said casing between said arm and the hand, an indicator, and sound-wave connections extending from the intercepter to and through the resounder, telephones, director, and to the indicator.

34. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, resounder, primary and secondary telephones, a director, a casing for supporting the resounder, telephones, and director, said director consisting of a series of groups of ring-segments circularly arranged, each group consisting of four segments, a vertical shaft carrying an arm provided with two brushes, each bearing upon two successive segments, said shaft also carrying a band-pulley above said arm and an indicating-hand and compass-needle above said pulley, a dial seated in said casing between said pulley and hand, an indicator, and sound-wave connections extending from the intercepter to and through the resounder, telephones, director, and to the indicator.

35. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, primary and secondary telephones, a director, a casing having a large and a small chamber in which the primary and secondary telephones are respectively located, and also having an elongated portion connecting the two chambers and to which the resounder is secured, and also having a partition by which the parts of the director are supported, said director consisting of a series of groups of ring-segments circularly arranged, a shaft carrying an arm, to the free end of which latter is secured a pair of brushes which bear upon the segments, a band-pulley, indicating-hand, and compass-needle also carried by said shaft, a dial seated in the casing below the hand and compass-needle, an indicator, and sound-wave connections extending from the intercepter to and through the resounder, telephones, director, and to the indicator.

36. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder consisting of a series of groups of resounding-plates, each group arranged in pairs, a primary telephone comprising a series of oppositely-wound bobbins, a secondary telephone, a director comprising a series of groups of ring-segments, an indicator, sound-wave connections extending from the intercepter to the resounder, and a sound-wave connection extending from each group of resounding-plates to the corresponding group of ring-segments of the director and each connection consisting of two wires connected, respectively, with one of a pair of resounding-plates and with one of a corresponding group of ring-segments, connections between the director and primary telephone, consisting of two wires connected, respectively, with another of the ring-segments in the same group and with an end of one of the oppositely-wound coils of a corresponding bobbin of the primary telephone, and connections between the primary and secondary telephones and between the latter and the indicator.

37. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a receiver, a director, and an indicator, the latter consisting of an electro-magnet having the pivoted armature carrying an indicating-hand, a scale suitably supported adjacent the hand, and sound-wave connections extending

from the intercepter to and through the resounder, receiver, director, and to the indicator.

38. The combination, in an apparatus for receiving, transmitting, and indicating sound, of a sound-wave intercepter, a resounder, a receiver, a director, and an indicator, the latter consisting of an electro-magnet having a spring-controlled armature carrying an indicating-hand, an adjusting device for controlling the tension of said spring, a scale suitably supported adjacent the hand, and sound-wave connections extending from the intercepter to and through the resounder, receiver, director, and to the indicator.

39. A casing for holding an apparatus for receiving, transmitting, and indicating sound, the same consisting of a body portion having a large chamber for the primary telephone, a smaller chamber for the secondary telephone, and an elongated tubular portion connecting the two chambers, a chamber for the microphonic resounder between the said large and small chambers, and a chamber for the director and dial.

40. A casing for an apparatus for receiving, transmitting, and indicating sound, comprising a large chamber *e*, and a small chamber e^5, separated from each other by a tubular portion e^4, the bottom of the large chamber and the top of the small chamber being perforated and the bottom of the small chamber being open.

41. A casing for an apparatus for receiving, transmitting, and indicating sound, comprising a body portion having chambers for the primary and secondary telephones, a chamber for the microphonic resounder, a chamber for the director, dial, and hands, and means for suspending the said casing.

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