E. GRAY, DEC'D.

D. M. GRAY, EXECUTRIX.

TRANSMISSION OF SOUND.

APPLICATION FILED FEB. 21, 1906.

985,524. Patented Feb. 28, 1911.

4 SHEETS—SHEET 1.

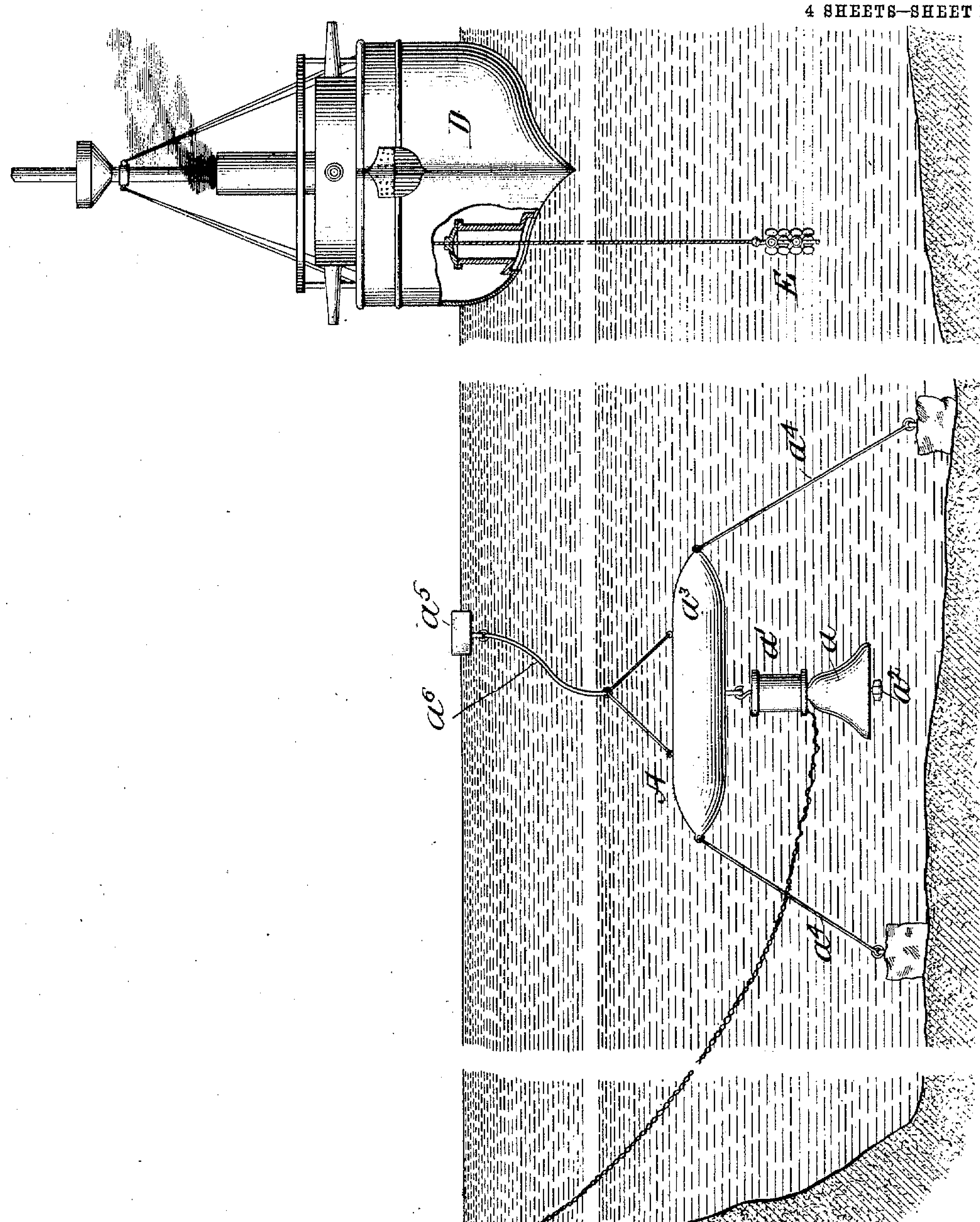

Fig. 1.

WITNESSES
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M. V. Foley.

INVENTOR
Delia M. Gray Executrix
of the will of Elisha Gray
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4 SHEETS—SHEET 2.

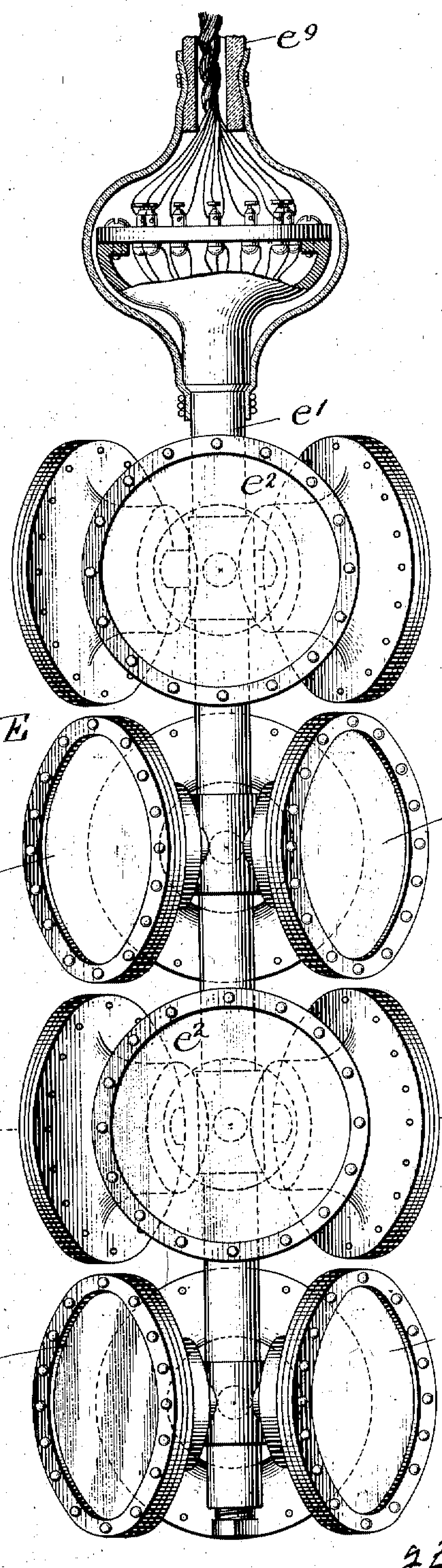

Fig. 2.

WITNESSES
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4 SHEETS—SHEET 3.

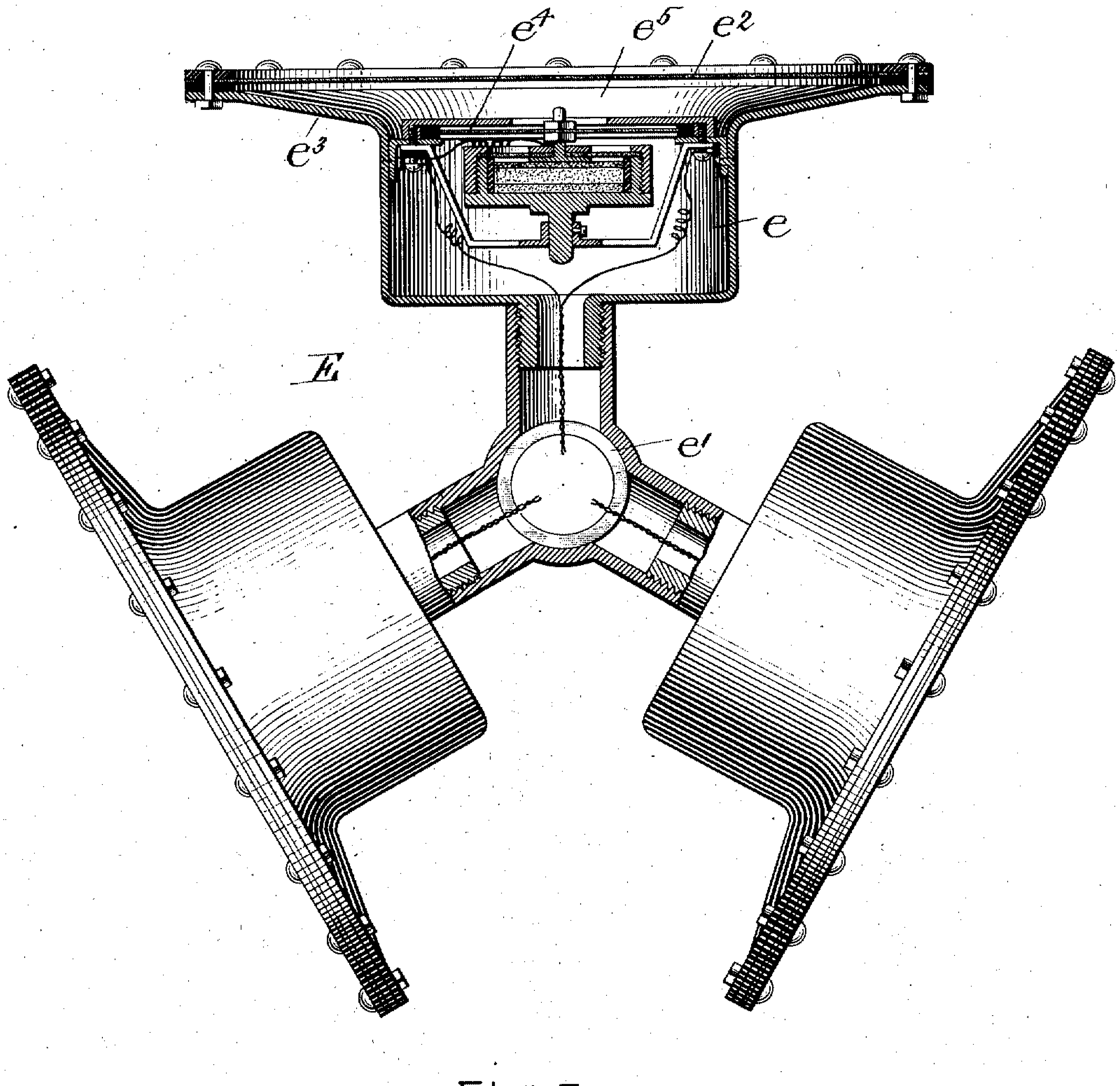

Fig. 3.

WITNESSES
M. E. Flaherty.
M. V. Foley.

INVENTOR
Delia M. Gray Executrix
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by Dawson(?) ...
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4 SHEETS—SHEET 4.

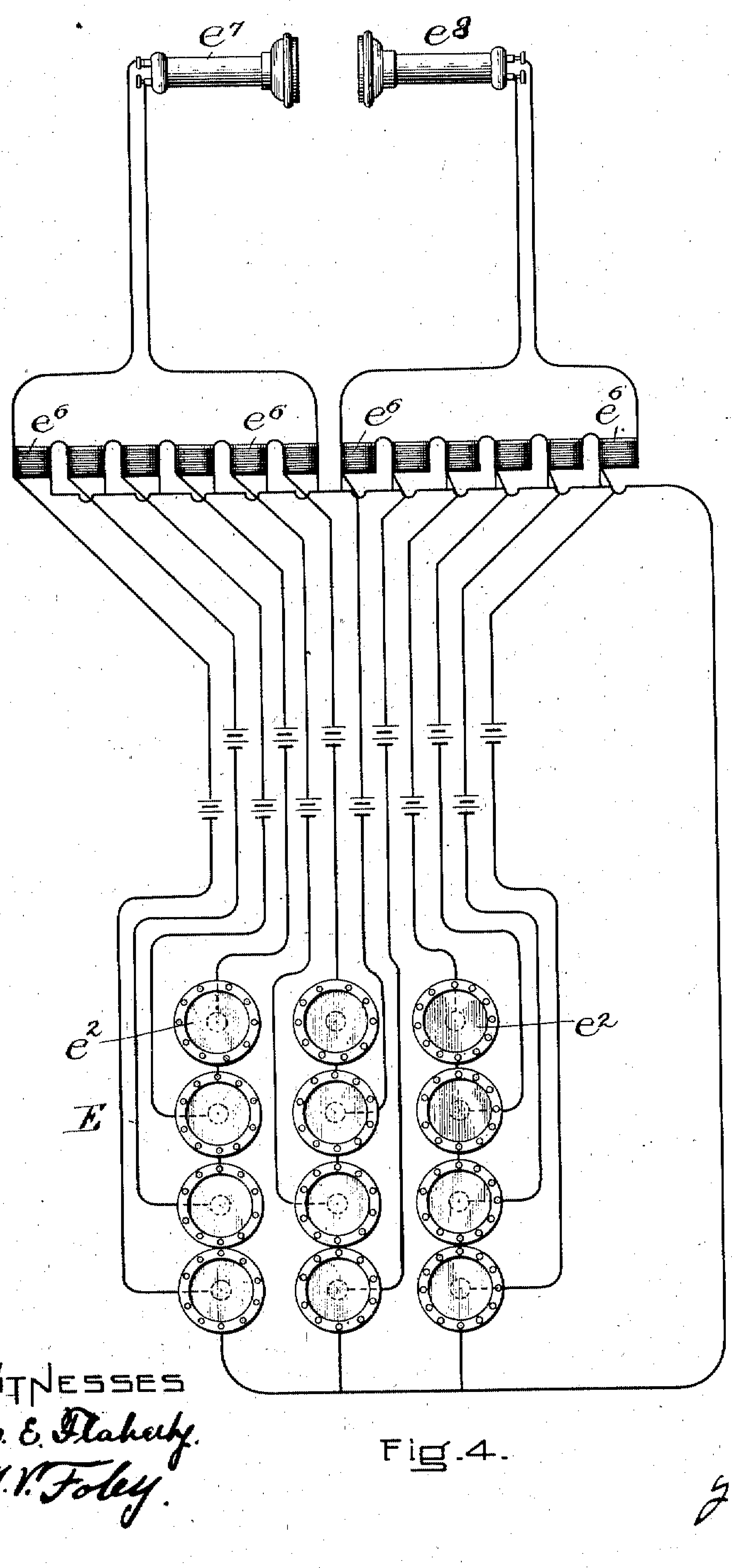

Fig. 4.

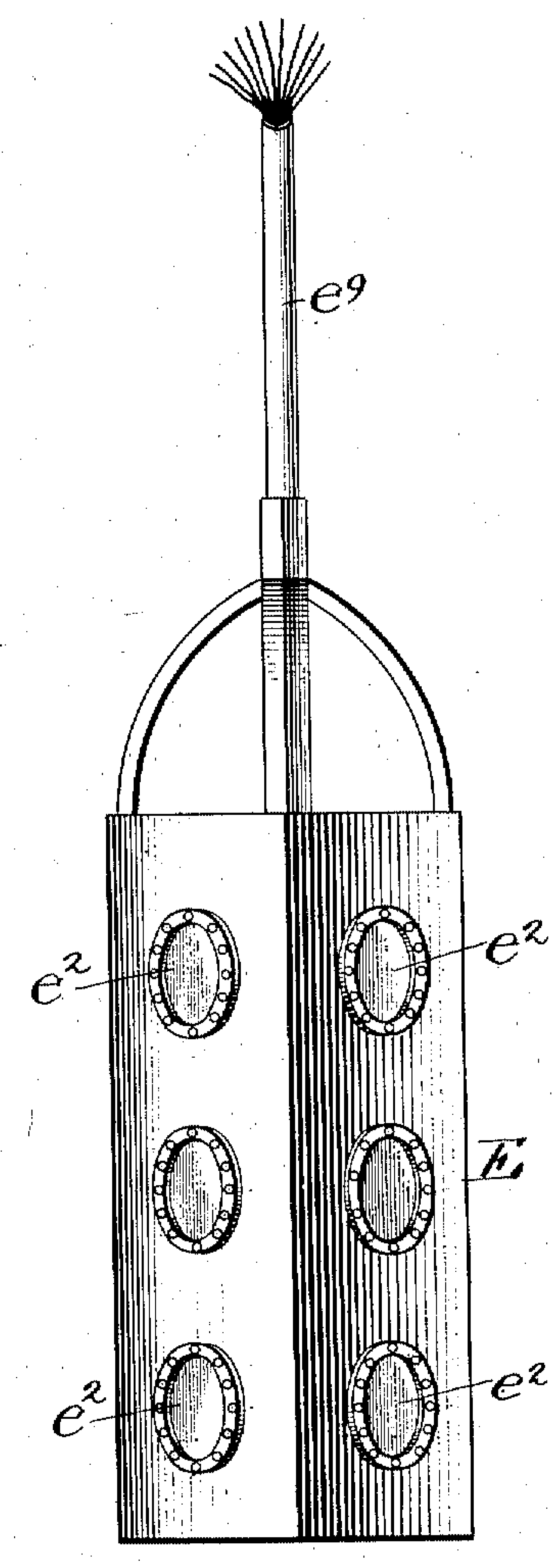

Fig. 5.

WITNESSES

M. E. Flaherty.

M. V. Foley.

INVENTOR

Delia M. Gray Executrix

of the will of Elisha Gray

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her Attorneys

UNITED STATES PATENT OFFICE.

DELIA M. GRAY, OF HIGHLAND PARK, ILLINOIS, EXECUTRIX OF ELISHA GRAY, DECEASED, ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

TRANSMISSION OF SOUND.

985,524. Specification of Letters Patent. Patented Feb. 28, 1911.

Original application filed April 15, 1901, Serial No. 55,935. Divided and this application filed February 21, 1906. Serial No. 302,306.

To all whom it may concern:

Be it known that ELISHA GRAY, deceased, of Highland Park, in the county of Lake and State of Illinois, did invent a new and useful Improvement in the Transmission of Sound, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification in explaining its nature.

The invention herein described is adapted to be used in connection with what may be termed long distance transmission of sound in water. Inventions of this character are described in the patent to Elisha Gray and Arthur J. Mundy, dated November 7, 1899, No. 636,519, for transmission of sound, and also in an application of the said Elisha Gray, Serial No. 55,935, filed April 15, 1901, of which the present application is a division.

The present invention relates more specifically to the means whereby the sound which has been generated at a distance is picked up and transmitted in the form of predetermined signals or otherwise to the listener, and for this purpose the apparatus must be such as may be submerged in water at a distance from the sound producing apparatus and perhaps capable of variation in its position in relation to the sound producing apparatus.

An important part of this invention is based upon the fact that water unlike an electric wire conductor receives the sound vibrations or impulses produced at a central point and transmits said vibrations from said point in a rapidly widening circle which also increases in height as it recedes and which, of course, decreases in energy as its distance increases, producing numberless points at which it may be received by a receiving apparatus, that is, while there may be but a single transmitting point, possible receiving points are limitless and the same signal may therefore be received by receiving devices upon all sides of the transmitting point, and which may be separated by distances of at least twenty-four miles, the transmitting vibrations advancing on a continually widening zone or circle which may be tapped at any point by a receiver. The energy of the widening zone or circle of sound vibrations becomes less as it recedes from the initial station or center, and its effectiveness in actuating a single receiver satisfactorily correspondingly diminishes. If, however, instead of employing a single receiving instrumentality for receiving, when so diminished, the sound vibrations, there shall be used a number of receivers separated from each other, but adapted to simultaneously receive vibrations at different points from the same traveling sound zone or wave, and to concentrate or focus them, something of a reverse effect is secured in that faint vibrations thus brought together and finally combined in a single receiver, due to the concentration of a number of individual transmitters each acting independently of the others to receive the sound vibrations from some part of the passing sound zone, and the inventor has discovered by experiment that where a single receiver will not act at a considerable distance from the originating station to deliver a well defined audible signal, a number of receivers acting conjointly at a much greater distance from the said station will receive, combine and deliver a well defined and sufficiently audible signal.

This present application is a division of application Serial No. 55,935, filed April 15, 1901.

In the drawings:—Figure 1 is a view illustrating in a general way the mode of employment of the apparatus. Fig. 2 is a view in elevation of a multiple sound receiver embodying this invention. Fig. 3 is a view thereof on the dotted line 3—3 of Fig. 2, also showing a portion of one of the receivers broken out to illustrate its interior construction. Fig. 4 is a diagrammatic view further illustrating the multiple receiver. Fig. 5 is a view in elevation showing a modified form thereof.

Referring to Fig. 1, A represents conventionally a signal station, B the shore, C the operating station upon the shore, D a vessel and E a multiple receiver suspended from the vessel. The signal station is in relatively deep water and sufficiently removed from submerged sound reflecting surfaces not to be affected by them. It is desirable that the sound bell *a* at the signal station

shall be suspended at least from fifteen to twenty-five feet below the surface of the water. The signal station is connected with the operating station C by the cable *c*. The distance between the two is immaterial. It may be a short distance or it may be a number of miles.

The operating station contains the means, or is connected with the means for energizing an electric motor which actuates the bell hammer a^2 and which is contained in a watertight case a^1 submerged with the bell and in operative relation thereto and with the hammer a^2.

a^3 is a submerged float anchored in place by the anchoring chains a^4 from which the buoy, the bell, etc., are suspended. An indicating buoy a^5 floating on the surface of the water is connected with the float a^3 by a chain a^6 and serves to locate its position.

For the details of the bell and its operating mechanism reference is made to the companion application, Serial No. 55,935, above referred to, details not being given herein as this application relates more especially to the receiver by which the sound waves produced by the bell are collected.

The multiple receiver E is represented as deeply submerged in water and as suspended from a vessel, as represented in Fig. 1 and, while it is desirable when used for receiving sound impulses transmitted by water when the distances are long that it be deeply submerged, it is not always essential that it should be. The multiple receiver may also be employed for receiving and transmitting sound vibrations in the air. It comprises a series of chambers *e* of any desired size—the side and back walls of which may be of any suitable material—preferably held or supported by a common holder or support e^1. One side of the chamber, preferably its face, consists of a taut non-electric diaphragm e^2 attached by its edge to the wall of the chamber in any desired way. In Fig. 3 the chamber wall is shown as flaring outward at e^3 and the diaphragm is shown as attached to the outer edge of its flaring part. The diaphragm may be made of any material capable of vibration. It has one surface in contact with the water and one in contact with the air of the chamber and it is vibrated by the action of the sound waves upon it. All the chambers *e* of the multiple receiver are air-tight when used for submarine purposes and in each chamber there is arranged a sound transmitter which may be like the transmitting mechanism of an ordinary carbon button telephone transmitter. In Fig. 3 such a carbon button telephone transmitter is shown. It is fastened to the wall of the chamber with its diaphragm e^4 facing the non-electric diaphragm e^2 and parallel with it and separated from it by a narrow air space e^5. It is not necessary to further describe this sound transmitter, and the invention is not confined to any especial form of sound transmitter. The sound transmitter in each chamber is connected by a suitable primary circuit with one of the induction coils e^6 (see Fig. 4). There is an induction coil for each sound transmitter and connected with each by an individual primary circuit and these coils are represented in Fig. 4 as arranged in two series of equal number. Each series is connected with a telephone receiver by a secondary circuit which includes all the coils of a series, the coils being connected with each other in series.

The two telephone receivers by which the sound impulses are finally delivered to the ears of a hearer are lettered respectively e^7, e^8. Each primary circuit includes an induction coil, an electric battery in the circuit, a telephone transmitter and the circuit. The winding of all the induction coils is in the same direction and all the electric batteries should be arranged to send their current in the same direction through the coils. All the transmitters are connected with the single main return wire which is also connected with the coils. The wires which connect the transmitters with the coils are assembled in a cable e^9 and the cable may be the means of suspending the receiver in the water from the vessel or other support.

The two series of coils e^6 may be located on the vessel or in any other place or at any distance from the receivers, and the telephone receivers e^7, e^8 may be at any convenient place in the vessel or in any other place or at any desired distance from the coils. Two receivers are represented and both may be used by the hearer, or they may be used by two persons at the same time; only one receiver or more than two may be employed if desired.

The connection of a number of transmitters with induction coils and the inclusion of a number of said coils so connected with separate transmitters in a circuit, including a receiver, focuses, increases or intensifies the sound impulses received by the receiver and delivered by the transmitter. When each receiver circuit includes the same number of coils there will be no difference in the intensity of the sound signals delivered by each receiver, but if the number of coils with each receiver is varied then the intensity of the sound impulses delivered by the receivers will be correspondingly varied.

The chamber *e* and non-electric diaphragm may face in different directions; those represented in Figs. 2 and 3 are arranged to face in three directions. By this it will be understood that the taut or receiving diaphragms are disposed so that some face in one direction, others in another direction and the remainder in a third direction. When

used in the water to receive sound impulses transferred by it, the diaphragms receive the vibrations and set in vibration the air contained in the chambers and the vibration of the air in the chambers in turn causes the diaphragms of the telephone transmitters to be vibrated, thereby actuating the transmitting devices and setting up an impulse current in the electric circuits, which is repeated on the diaphragms of the receivers e^7, e^8.

While one receiver (and there is meant by this a single receiving diaphragm, transmitter, electric circuit and receiver) will answer for short distances, for longer distances it is desirable to employ two or more in circuit with one receiver, and it may be stated as a rule that the greater the distance from their source it is desired to receive the sound impulses the larger the number of individual receivers in circuit with a single receiver should be employed. This is because of the diffusion and the weakening of the sound impulses or waves as they recede from their source; by multiplying the number of receivers and combining or focusing their action the individual, weakened impulses which each receives are so strengthened at the focusing point as to make distinctly audible what otherwise might be uncertain; in other words, each one of the receivers may be likened to a single ear having definite sound-receiving properties, and the group of receivers may be considered a series of individual ears of the same power or capacity. The connection of these ears with a common receiving point provides at that point the sum of the value of each, so that if two ears are used substantially twice the effect of a single one is obtained; if five, five times the effect of a single one, and so on, each ear taking its impulse from a different section of the sound wave common to all.

While the different receivers or ears are represented in the figures as somewhat closely assembled and pointing in different directions, it is not meant that the invention should be limited in these respects, as they may be arranged much farther apart and may point only in one direction. Neither is it intended that the invention shall be confined to a structure in which taut diaphragms act to receive the sound impulses, for any instrumentality which will receive such impulses and by its own vibration cause or set up vibrations in the diaphragms of one or more telephone transmitters adjacent thereto or to air interposed between it and telephone transmitters, may be used, and in this connection it should be noted that the shell or frame of a vessel may constitute a receiving diaphragm for taking impulses from sound waves and that the telephone transmitters may be arranged with respect to the said shell or frame to take up its vibrations and transmit them to a central and common delivery point. It should be further noted that the multiple receiving and transmitting devices, associated to separately or individually receive sound impulses of any kind and to transmit and combine them at a central point or station, may be used in air and for any purpose where it is desired to receive separate sound impulses, whether faint or otherwise, and combine them by aggregating them at a single station.

By experiment in deep sea water it has been found possible by means of the multiple receiver described, to plainly hear sound signals or impulses transmitted by the water at a point twelve miles from their source.

In Figs. 2 and 3 the individual receivers are represented as exposed to the water upon all sides, the taut diaphragms being in forward and exposed positions. In Fig. 5 the non-electric diaphragms are represented as arranged in the sides of a box-like structure, having a single chamber for all the said diaphragms.

The advantages of the invention are apparent and do not need further explanation. The uses to which it may be put are many and very important. Air signals are of relatively short range, uncertain and unreliable. Artificial light signals are useful at night only when the weather is clear, while wireless telegraphy alone requires too fine adjustment and apparatus for ordinary every day protective or commercial uses.

I have shown the best and simplest way of embodying my invention now known to me, but it is evident that there are many expedients and methods known to electricians which may be utilized in accordance with the instructions given in the specification to accomplish results of a similar character. I do not therefore desire to describe them in full, but would state that I do not limit my invention to the particular apparatus described herein.

The invention being thus fully described, what is claimed and what is desired to be secured by Letters Patent of the United States is as follows:—

1. In a system for the transmission of sound, a series of receptacles facing in a number of directions each having a diaphragm in one side thereof forming an airtight chamber in each receptacle, a series of transmitters one located in each of said chambers, a hollow airtight support for said receptacles, a receiver, and conductors located within said support and connecting said transmitters with said receiver.

2. In a system for the transmission of sound waves, a series of airtight receptacles each having a flaring mouth and a diaphragm closing the outer end of said mouth, a hollow air tight support for said recep-

tacles, a transmitter located in each receptacle, a receiver and conductors between said receiver and said transmitters located in said support whereby the vibrations received on said diaphragms are guided to said transmitters and thence conducted to said receiver and said transmitters and said conductors are protected from injury by water, as described.

3. In a system for the transmission of sound by water, a submergible, watertight box, a non-electric diaphragm forming one face to the air-chamber to the box, an electric sound transmitter contained in said air-tight box, fastened to the box, having its diaphragm arranged to receive and transmit the impulses of the non-electric diaphragm, but not in contact therewith, a hollow support for said box, the cavity of which is connected with the airtight chamber in combination with a telephone receiver and wires forming an electric circuit therewith passing from said box through the cavity of said hollow support.

DELIA M. GRAY,
Executrix of the estate of Elisha Gray, deceased.

Witnesses:
JAMES BOWDEN,
BESSIE CHEVERTON.