No. 866,128. PATENTED SEPT. 17, 1907.

E. GRAY.

DEVICE FOR TRANSMITTING SOUND THROUGH WATER.

APPLICATION FILED DEC. 1, 1899.

4 SHEETS—SHEET 1.

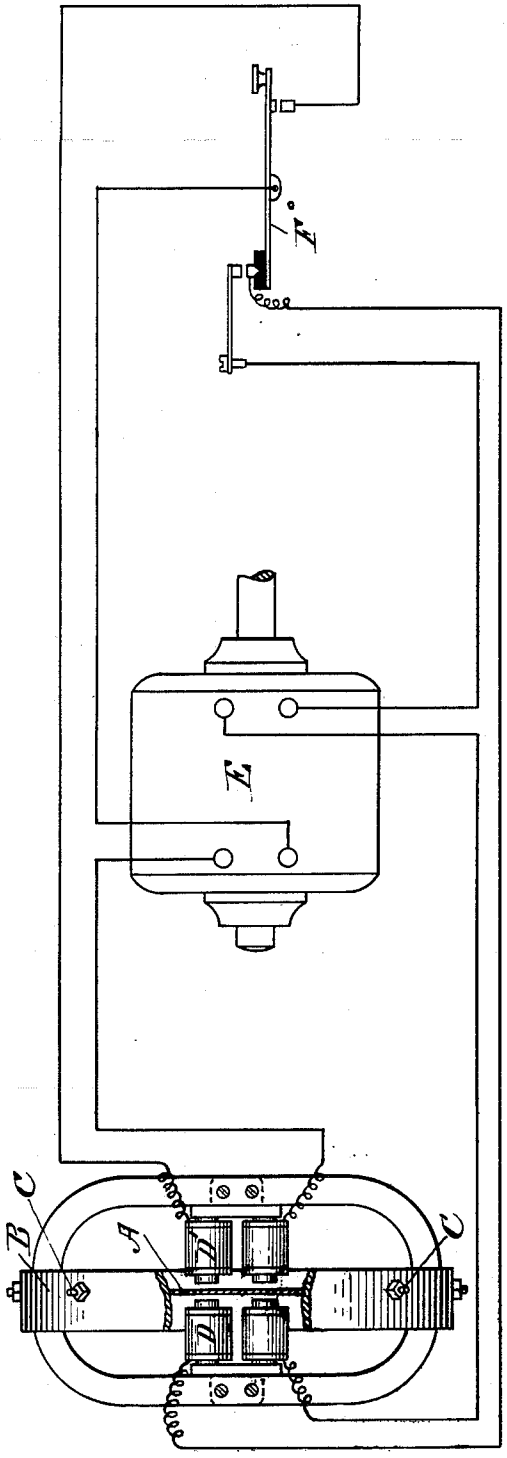


Fig. 1.

WITNESSES
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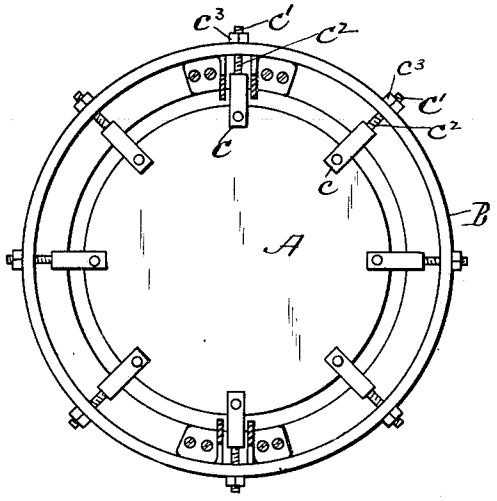


Fig. 2.

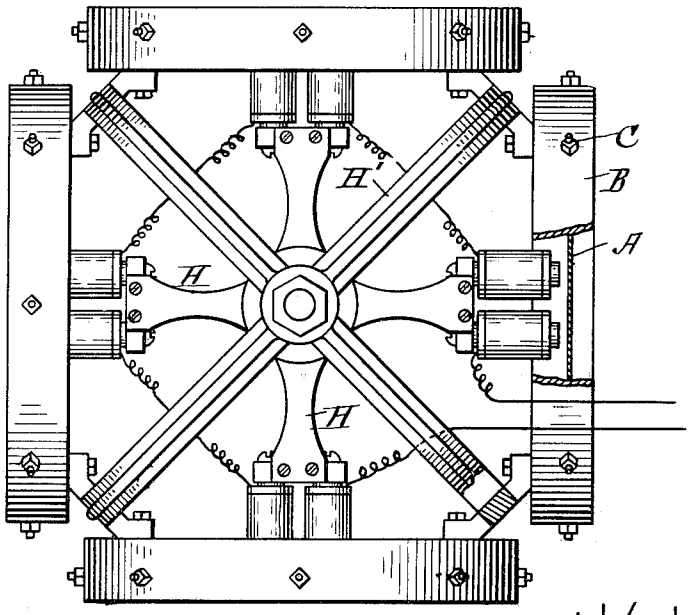


Fig. 3.

WITNESSES

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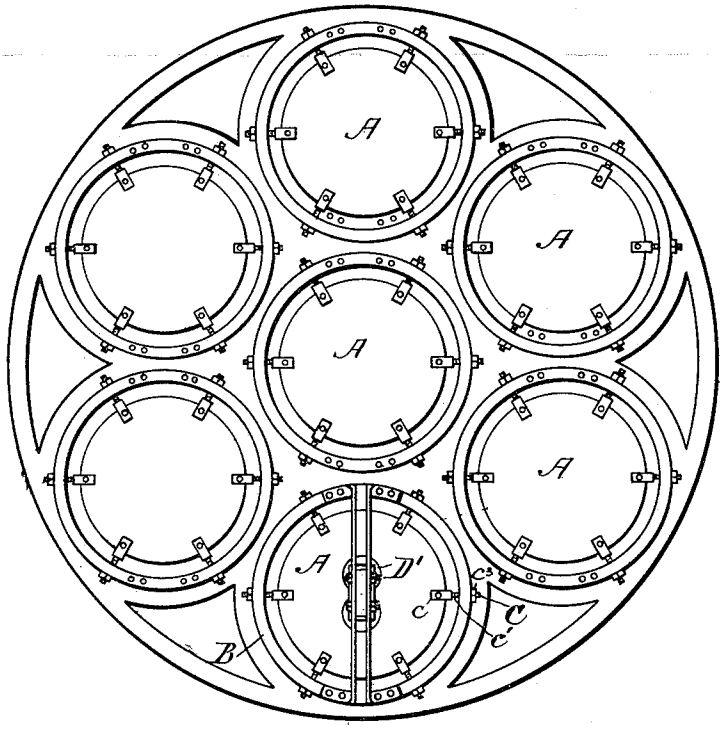


Fig. 4.

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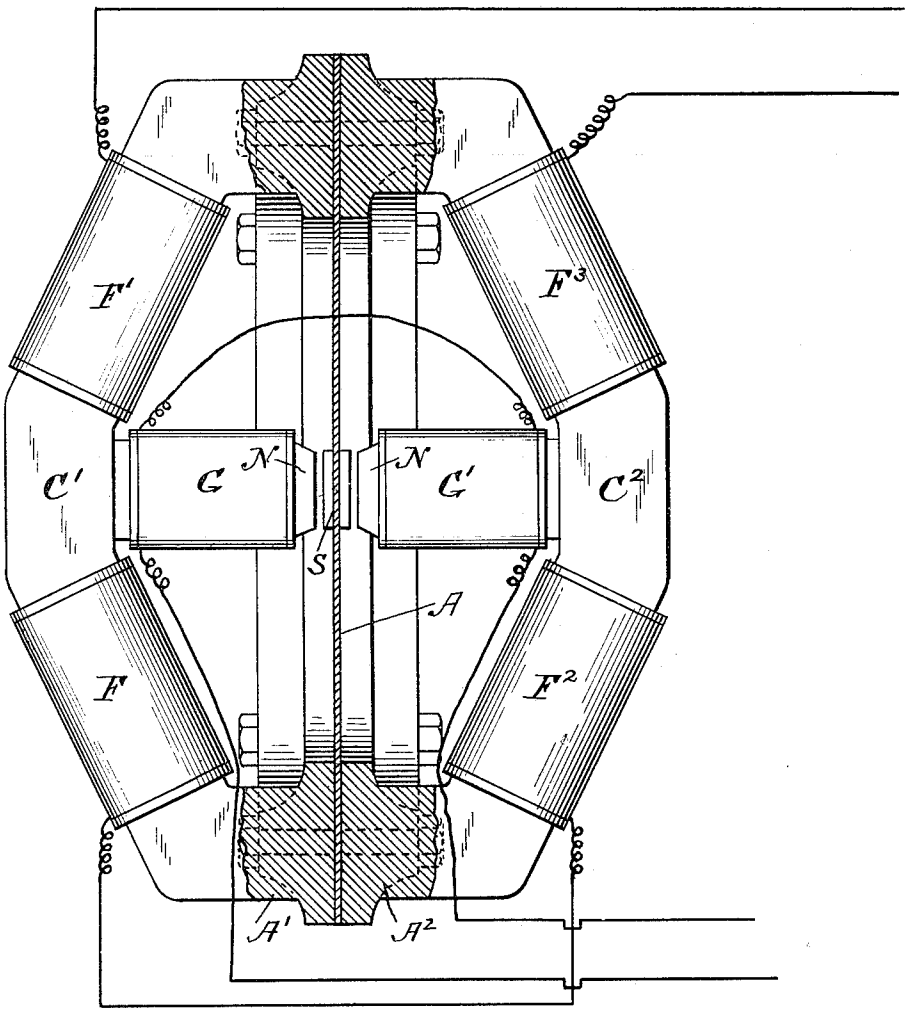


Fig. 5.

WITNESSES

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Mo D Newman

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UNITED STATES PATENT OFFICE.

ELISHA GRAY, OF HIGHLAND PARK, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO SUBMARINE SIGNAL COMPANY, A CORPORATION OF MAINE.

DEVICE FOR TRANSMITTING SOUND THROUGH WATER.

No. 866,128. Specification of Letters Patent. Patented Sept. 17, 1907.

Application filed December 1, 1899. Serial No. 738,796.

To all whom it may concern:

Be it known that I, ELISHA GRAY, a citizen of the United States, residing at Highland Park, in the county of Lake and State of Illinois, have invented certain new and useful Improvements in the art of transmitting sound through water and in devices for carrying the same into effect, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

The invention is an improvement upon the invention of Elisha Gray and Arthur J. Mundy described in their patent, No. 636,519, dated November 7, 1899, and upon that of Elisha Gray, No. 636,520, of the same date. The bell and method of using the same in giving and receiving signals through water, described in said patents, are well adapted for certain purposes and particularly for use on coasts as a means of protection to vessels from dangerous reefs, but lack in responsiveness, so that their employment for transmitting telegraphic messages with rapidity between two ships at sea or between a ship and the shore, as the case may be, is not always as effective as could be desired.

My present invention provides for a greater or quicker responsiveness in the system and is to that extent an improvement. Instead of using in the system, for the originating of sound signals, a bell as originally contemplated, I employ metal plates or other sonorous substances tuned by suitable means to a definite pitch and preferably used in a series.

A metal plate may be thrown into vibration by the use of pulsations or currents transmitted to a magnet mounted in close proximity to the plate, but not in contact with it, and when these impulses correspond in rate per second to the natural rate of vibration of the plate when tuned, it will respond and give out a tone not unlike that of a bell. The differences for the purpose of this invention lie chiefly in the fact that the plate will pick up the vibrations instantly and respond at once with full force, and will just as quickly cease to vibrate when the electric current is broken. If the metal plate is a very large one, it will require a longer time to get into vibration after the circuit is closed and the electric current on and will also continue to vibrate for a greater or less time after the electric circuit is broken. Therefore, I prefer to use instead of one large plate a group of plates of comparatively small diameter connected in the same circuit or current, so that their vibrational response to it will be simultaneous, and the extent or amount of vibrating force or power may be varied by adding or taking away plates from the group or series according as may be desired. It will be understood that these plates, being actuated by the same generator and tuned exactly to the same pitch, act simultaneously and, therefore, each will reinforce all the others. The separate magnets that control the various plates may be connected up in series, or in parallel, as circumstances demand. A single key inserted in a circuit or circuits, passing from the electric generator to the magnets, or to the transmitting plates, is sufficient to operate one or any number of plates simultaneously and will, when so operated, produce sounds corresponding to the Morse or any other code, thereby providing means whereby sound signals may be transmitted from the plate or plates through the water to the receiving instrumentality as readily as an ordinary message is transmitted through a wire on land lines. These plates, when used in groups, may be arranged together in such form and on such lines as may be best adapted to the requirements of their special use and the place where used.

In the drawings:—Figure 1 is a view of a single transmitting plate mounted in its holding and tuning frame and showing its vibrating magnets, and also the circuits connecting them with a two phase alternator. Fig. 2 is a view in front elevation of a transmitting plate and its holding frame. Fig. 3 is a top view of a group of four transmitting plates and holders arranged to form a square, that sounds will be transmitted in all directions, and bolted together. Fig. 4 represents a group of seven transmitting plates all tuned to the same pitch and all operated in unison by means of a single key. Fig. 5 illustrates a modified form of a transmitting device, to which reference will hereinafter be made.

A is one of the transmitting plates. It is preferably made of metal and attached to a holding frame B by means of the straining or tuning bolts C, attached at their inner ends c (see Fig. 2) to the transmitting plate and at their outer ends c^1 to the holder by means of threaded shanks c^2, which pass through holes in the holder, and straining nuts c^3, which screw upon the threaded shanks outside the holder and enable the transmitting plate to be tuned to any desired pitch. The number of these plates employed may be determined by the requirements of any special use. If it is desired to raise the pitch of the plates, the nuts of the straining bolts are turned to put more strain upon the plates.

D, D^1 are electro magnets arranged on opposite sides of the transmitting plate A (see Fig. 1, where it is assumed that the transmitting plate is made of magnetic metal). I would here say, however, that I do not confine myself to plates made of magnetic metal, or, in fact, to any metal, but where a non-magnetic substance is used with the construction represented in Fig. 1, it will be necessary to secure to the plates, between the poles of the electro magnets, armatures of soft iron. The transmitting plate or plates may be operated by magnets located on one side only if desired, in which case a single phase generator will be

employed. They are much more powerfully operated, however, by using magnets placed on opposite sides of the plate, each having its own circuit with a two phase dynamo. When the latter is the case, the phases must be so related to each other that one impulse will be half a cycle behind the other, that is to say, if magnet D is energized by an impulse, it attracts the plate A towards its poles, but at the instant the impulse ceases in the magnet D another impulse from the other phase of the dynamo immediately energizes the other electro magnet D^1, which then attracts the plate A in the opposite direction. The metal plate is thus swinging in each direction from a common center of rest and will not be thrown out of tune by being strained more in one direction than the other, the use of the two phase method giving two advantages: First, it provides additional power and, second, it maintains the transmitting plate in tune.

E, Fig. 1, is a plan view of a two phase alternator dynamo driven by any form of motor, governed by the governor shown and described in my Patent No. 636,520. By the use of this governor the impulses sent from the dynamo to the magnets D, D^1 are in constant phase with the natural rate of vibration of the transmitting plate A, as tuned. F^0 is a double pointed operating key so arranged that when it is depressed both of the circuits running from the dynamo to the magnets D, D^1 are simultaneously closed.

In Fig. 3 there is shown an arrangement of four transmitting plates constructed, held and tuned as shown in Figs. 1 and 2, the holding frames C being bolted together in the form of a square by means of the frame H^1. The magnets are held in position by radial supporting arms H, extending from the frame. The view shows magnets mounted upon one side only of the transmitting plates, but the arrangement of Fig. 1 may be followed by mounting magnets upon opposite sides of the plates by supports similar to those shown in Fig. 1. I prefer the latter construction. The outside magnets are not shown, for the purpose of simplifying the drawing.

In Fig. 4 there are shown a number of transmitting plates and their holders arranged upon the same plane in a single metal frame work and so that the sounds from all are simultaneously projected in the same direction.

In Fig. 5 I have shown another way of vibrating the transmitting plates, and it is, perhaps, the most desirable of the three ways described. A^2, A^2 show, in this figure, in cross section, two cast iron frames bolted together and clamping between them the diaphragm A. The diaphragm may be provided with any suitable or desired means for tuning it to the pitch required and such means are not shown in the drawings. C^1, C^2 are bridges of cast iron, forming parts of the frame work A^1, A^2. At four points upon the two bridges are wound coils of insulated wire to form electro magnets F, F^1, F^2, F^3. Attached to these bridges are laminated magnets G, G^1, which are connected to a single phase alternator. The magnets F, F^1, F^2, F^3 are connected in series, the terminals of which run to the source of direct current power. This current is simply a field or charging circuit, and said magnets, F, F^1, F^2, F^3, are so connected together that, when a circuit is passing through them, the polarity (which in this case is north) is developed at the ends N of the magnets G, G^1, next the transmitting plate A. The opposite polarity S is developed at the center of the diaphragm between the poles. It will thus be seen that there are four magnetic circuits centering at the point S in the one case, and at the two ends N—N in the other. If, now, the alternating current is sent through the magnets G, G^1 at a rate corresponding to the fundamental tone of the tuned transmitting plate A, the plate will be thrown into violent vibration, more or less powerful; first, according to the power sent through the magnets and, second, according to the charge developed by the constant direct current.

The operation is as follows: Suppose an impulse is sent from the alternator through the magnets G, G^1 in such a direction as to develop north polarity in the magnet G and south polarity in the magnet G^1. The north polarity already established by the direct current will be intensified in magnet G, while that in the magnet G^1 will be reversed and become a south polarity. This will cause the transmitting plate A to move towards the magnet G. The next impulse will be of an opposite polarity, causing the same thing to take place in the magnet G^1; in other words, the conditions will then be reversed. This method does away with all contending forces and the power is much more economically applied. It is to be understood that any magnetism developed by the direct current at the poles must be equal in power to the greatest magnetism developed by the alternating impulse, in order to use the full power of the latter. By these means a tuned transmitting instrumentality may be vibrated in such a manner as to give off a tone purer than that obtained by the old method and more economically. It will be necessary, when this way is employed, to so construct the alternator that it will give off twice as many impulses per second as were used by the old method. By the old method there was a complete cycle vibration in the sound producing instrumentality for each half cycle of current from the alternator, that is, each alternation produced a complete cycle, whereas by the present method the cycles of the sound producing instrumentality co-incide with a cycle from the alternator.

I do not confine myself to any special grouping or arrangement of the tuned transmitting plates. It will be obvious that any number of them may be operated simultaneously, and where a very loud sound is required, as in cases where the distance between the transmitting and receiving devices is great, a large number of them may be used and so related to each other that each one will act cumulatingly with all the others. In use it is immersed in the water to any required extent and is operated in conjunction with a receiver of any desired construction. The tuned transmitting plate or plates, when vibrating, produce sound waves in the water which are communicated or transmitted by the water to the receiving device. Like the device of said patents it is adapted to be operated from a point more or less remote to it. When the tuned transmitting plates are used in series or groups they may all be tuned to the same tone or they may be tuned to different tones, bearing a harmonic relation to each other.

I have referred herein to the tuned plate as a trans-

mitting plate; it will be understood, however, that this plate is also a sound producing instrumentality.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States:—

1. In a system of submarine telegraphy a sounding plate in magnetic circuit or circuits, whereby it is maintained in a state of constant polarization, adapted to be vibrated by magnetic lines of force, electrically induced in magnets in close proximity thereto, the polarity of which is alternately reversed.

2. In a system of submarine telegraphy a sounding plate in magnetic circuit or circuits, whereby it is maintained in a state of constant polarization, adapted to be vibrated by magnetic lines of force, electrically induced in magnets in close proximity thereto, the polarity of which is alternately reversed and which magnets are also in magnetic circuit with the transmitting instrumentality.

3. In a system of submarine telegraphy a sounding plate, electro magnets in magnetic circuit or circuits therewith, continuously energized by a direct current from a constant source of electric power, whereby the said instrumentality is maintained in a state of constant polarization, and whereby also the transmitting instrumentality is held in a state of equilibrium, and electro magnets in close proximity to said instrumentality, energized by an alternating current and alternately reversed as to their polarity to induce sound producing vibrations in the said instrumentality.

4. In a system of submarine telegraphy a sounding plate, electro magnets in magnetic circuit or circuits, continuously energized by a direct current from a constant source of electric power, whereby the said instrumentality is maintained in a state of constant polarization and whereby also it is held in a state of equilibrium, and electro magnets in close proximity to said instrumentality, energized by an alternating current and alternately reversed as to their polarity to induce sound vibrations, the said alternating current being pulsated at a rate corresponding to that of the vibrations of the sound producing and transmitting instrumentality in sounding its dominant tone.

5. A sounding plate, means acting thereon to tune it to any desired note or pitch, electro magnets in magnetic circuit or circuits therewith, continuously energized by a direct current from a constant source of electric power, whereby the said instrumentality is maintained in a state of constant polarization and whereby also it is held in a state of equilibrium, and electro magnets in close proximity to said instrumentality, energized by an alternating current and alternately reversed as to their polarity to induce sound producing vibrations therein, the said alternating current being pulsated at a rate corresponding to that of the vibrations of the sound producing and transmitting instrumentality in sounding its dominant tone.

6. The combination of a frame, a sounding plate carried thereby and adapted to be held in a state of constant polarization and equilibrium by the magnets F, F^1, F^2, F^3 and the plate vibrating magnets, G, G^1, all said magnets being connected with sources of electric energy, as specified, and whereby the polarity of the magnets, G, G^1, is reversed.

7. A series or group of strained, sounding plates, arranged in any desired order with respect to each other, tuned to produce different notes bearing a harmonic relation to each other, and adapted to be vibrated by the direct action of magnetic lines of force upon each of the plates, and pulsated at the vibrational rate necessary for producing the tones to which the plates are tuned.

8. A series or group of strained, sound producing and transmitting plates, arranged to face in different directions with respect to each other, and adapted to be vibrated by the direct action of magnetic lines of force, suitably applied to each of the plates, and pulsated at the vibrational rate necessary for producing the tones to which the plates are tuned.

9. A series or group of strained, sound producing and transmitting plates, arranged upon the same plane with respect to each other, and adapted to be vibrated by the direct action of magnetic lines of force, suitably applied to each of the plates, and pulsated at the vibrational rate necessary for producing the tone or tones to which the plates are tuned.

ELISHA GRAY.

Witnesses:
F. F. RAYMOND, 2d,
SAUL SIPPERSTEIN.