June 5, 1934. J. F. KEY 1,961,767

SOUND SIGNALING METHOD AND APPARATUS

Filed Aug. 17, 1931 2 Sheets-Sheet 1

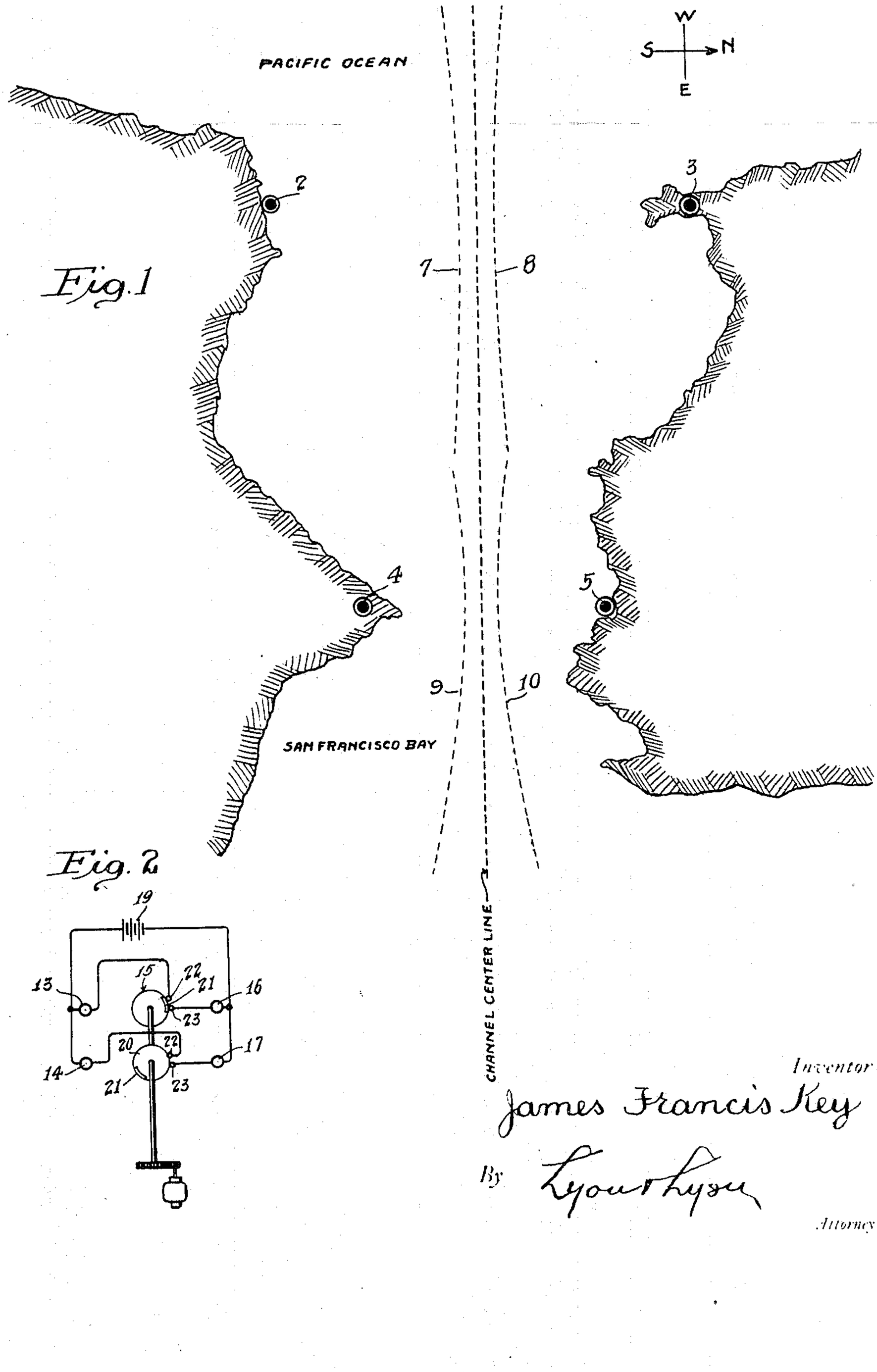

Fig. 1

Fig. 2

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Fig. 3

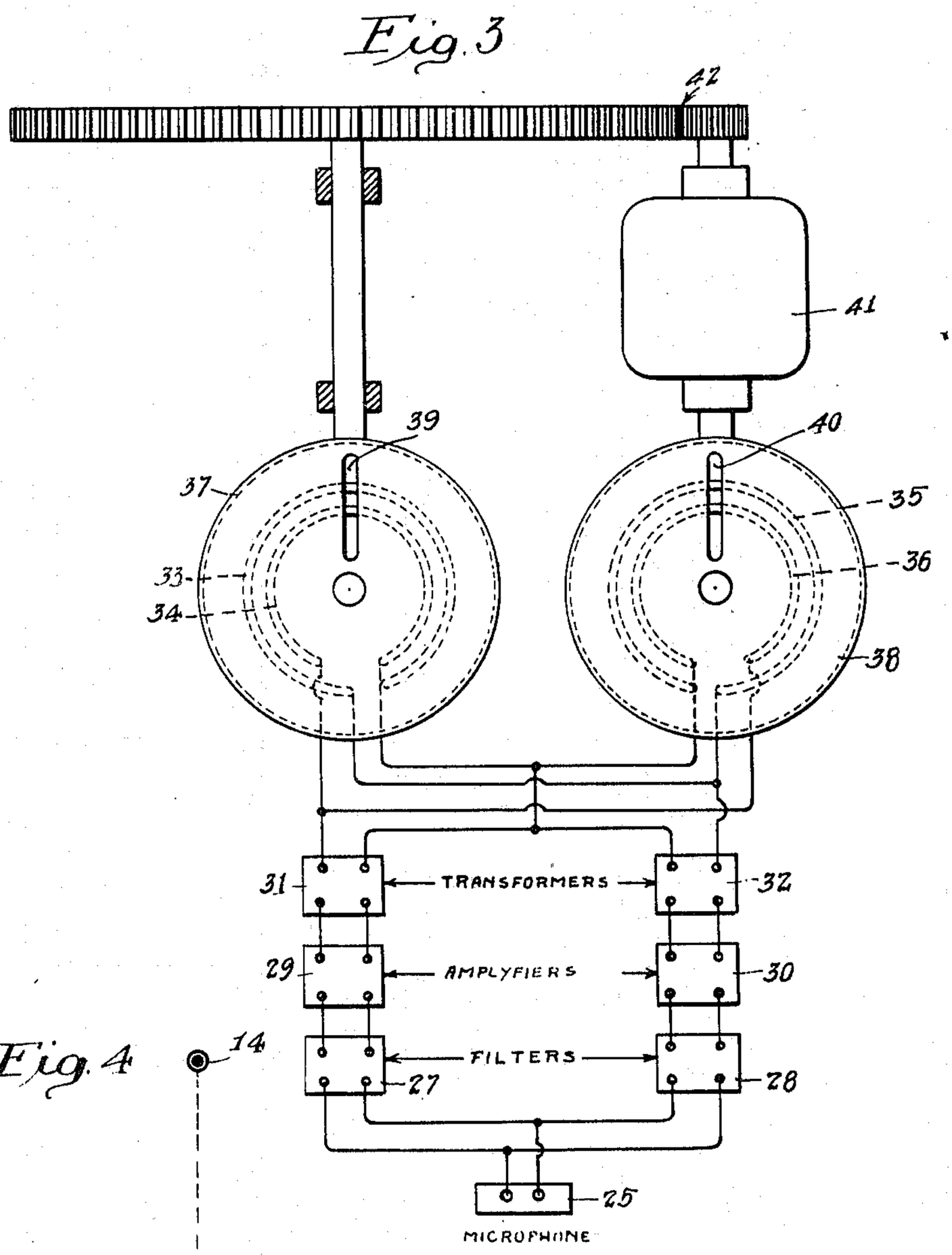
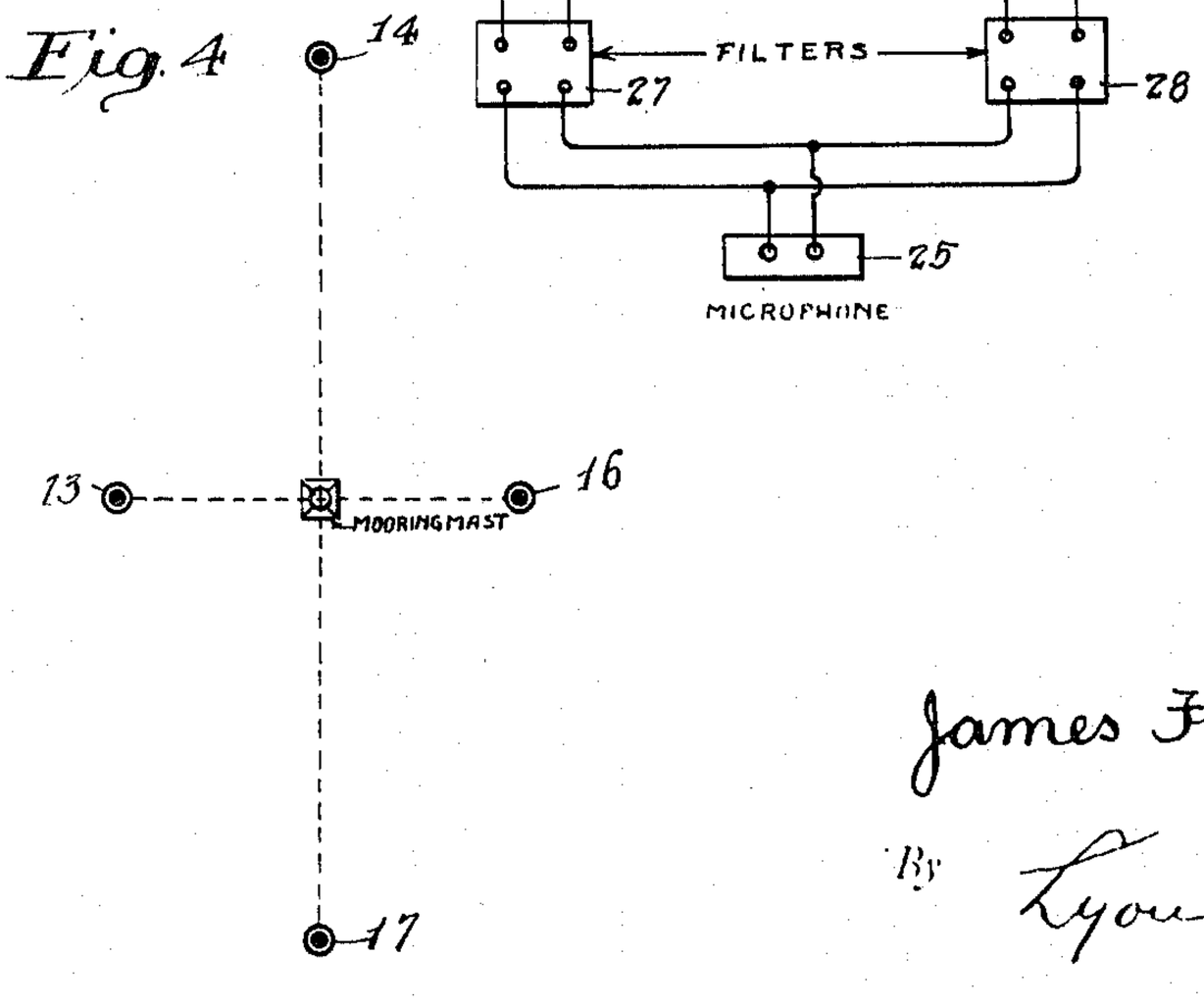


Fig. 4



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SOUND SIGNALING METHOD AND APPARATUS

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This invention relates to a method and apparatus for signaling, using sound, and refers particularly to a method and apparatus by which the location of a channel may be located from a ship by use of the sound signals.

Heretofore, various methods have been employed for indicating channels by sound signals. These methods have been only partially satisfactory, because experience has demonstrated that sound is conveyed through the atmosphere in such an uncertain way that its intensity is not always increased as its origin is approached. Scattering of sound takes place, so that it is frequently impossible to determine the direction of a source of sound, even when it is clearly audible. The sound comes diffused and appears to come from all directions. Particularly is this effect observed in a fog.

It is a general object of the present invention to provide a method and apparatus for signaling by sound, in which two different sound signals are employed, and one locates his distance or position from both sound signals simultaneously by the difference in time interval between the reception of the different sound signals. It has been found that by locating sound signals at predetermined points and actuating the same so that both signals operate simultaneously a ship or other conveyance seeking to locate the channel between the sound signaling stations may readily determine its position by the interval of time elapsing between the reception of the two signals.

The two different sound signals may be transmitted either through the air or in certain cases may be transmitted to the ship through the water and received on the ship by means of microphones connected with the hull of the ship. The present invention, together with various additional objects and advantages thereof, will best be understood from a description of a preferred form or example of a method and apparatus embodying the invention.

For this purpose, there is hereinafter described, with reference to the accompanying drawings, a preferred method and apparatus for sound signaling which embodies the present invention.

In the drawings:

Figure 1 is a diagrammatic plan view showing the location of signals suitably arranged for indicating the channel leading into a harbor, such as the channel in San Francisco Bay.

Figure 2 is a diagrammatic view of an apparatus for operating the two different sound signals simultaneously.

Figure 3 is a diagrammatic view of an apparatus which may be used for indicating the interval between the sounds of the different signals when the signals are transmitted through water; and

Figure 4 is a diagrammatic illustration of a modified arrangement of sound signals for use in locating an exact central point for a ship, such as a mooring point for ships or a mooring point or mast for aircraft.

Referring to the drawings, there is indicated a map of the entrance into San Francisco Bay. The dotted line in the figure, marked channel center line, indicates the center line of the channel leading through the gate of the harbor. In accordance with the present invention, it is proposed to locate signals to be used in pairs at substantially equal distances from the center line of said channel. Signals are located at points, for example 2 and 3, which are in the same perpendicular to the channel center line and at equal distances therefrom. The signal 2 is preferably of a different type than the signal 3. For example, signal 2 may be a whistle, whereas the signal 3 may be a siren.

When mention is made of different signals, however, it should be understood that both signals may in certain cases be of the same general type, that is, whistles or sirens, and merely regulated so as to give a distinctly different sound pitch or frequency of vibration so that it can be readily determined from the sound alone from which station the signal is being received. It may also be preferable to locate a number of other pairs of such signals, such as at the points 4 and 5, the points 4 and 5 being on a perpendicular to the channel line and equal distances therefrom. The signals 4 and 5 produce different sounds. Thus, at the point 4 may be located a whistle, and at the point 5 a siren. Where a number of pairs of signals are employed, such as those illustrated in certain cases, it may be desirable to have the pitches of the signals, such as 2 and 3 and 4 and 5, at distinctly different frequencies, so that there is no danger of confusing the sounds set out by these different stations. However, in other cases, the time of operating the pair of signals 2 and 3 may be sufficiently different from that of operating the pair of signals 4 and 5 so that there is no possibility of failing to distinguish the different pairs of signals.

In operation, the signals of each pair are caused to emit sound simultaneously. This may be accomplished by any suitable synchronizing means, preferably electrically controlled, which causes the signals, located for example at points

2 and 3, to operate simultaneously. A ship approaching from the seaward into the harbor will proceed with caution until it hears one of the operations of the pair of signals, located at points 2 and 3. Under certain atmospheric conditions the navigator of the ship may be unable to determine the direction from which the signals are coming, and he may not be able to estimate his distance therefrom. Upon hearing the two signals, however, he hears, for example, the siren first and thus knows that he is nearest that signal. He looks on his chart and sees that the siren is located at the north side of the entrance, that is, he is on the left-hand side of the channel and wants to be on the right-hand side, so he steers south by the compass. As he does so, the two sounds are heard closer together until they are heard at the same instant. He knows then that he is an equal distance from both signals and is somewhere along the channel center line, shown by the dash line on the chart. He proceeds a little farther on his course south, until he hears the whistle just before hearing the siren, and thus knows that he is on the south or right-hand side of the channel center line and close to it. He then steers a compass course parallel to the course of the channel center line, as shown on the chart, and every time he hears the two signals, which may be several times a minute, he knows on which side of the channel he is and how far from the channel center line, as shown by the chart. Being able to keep on the right side of the channel provides a clearance between passing vessels and greatly lessens their chance of collision.

On the chart the curve lines 7 and 8 are hyperbola curves indicating where the vessel will be when it is cruising on a source at one side or the other of the channel line and maintaining itself so that it always hears the two signals at the same time interval apart, such, for example, as one second.

After the vessel has proceeded into the harbor until the sound from signals located at points 4 and 5 are more perceptible than those from points 2 and 3, it may proceed estimating its course and the channel center line from the sounds originating from points 4 and 5 in like manner to that used in connection with the sounds from points 2 and 3. The curved lines 9 and 10 indicate a position at which the sounds from points 4 and 5 will be heard a definite distance apart, such as one second.

Preferably, the signals are each sounded at each interval for a definite period of time, say, for example, of one second's duration. This sounding of the signals for a definite period of time enables the ship's pilot to determine when the two signals are heard at an interval of one second apart, and in this manner he is also enabled to determine substantially the exact distance from the channel line. By sounding the signals for a duration of one second each the pilot may move along a course, represented by the lines 9—7 or 8—10 in the drawings, thereby maintaining the ship at a minimum distance of approximately 550 feet from the channel line.

Thus, when the duration of the sounding of the signals is one second apart, the pilot can determine when he hears the finish of one signal simultaneously with the beginning of the other signal that he is then at a minimum distance from the channel line of 550 feet, one-half the distance the sound travels in one second. If the pilot hears the two signals overlapping, he may estimate the fraction of the interval of one signal which was overlapped by the other signal and thus determine proportionally his minimum distance from the channel line. The process apparatus of this invention thus enables, in effect, two lines of travel of the ships to be established by the sounds—one at each side of the channel line, insuring against collision between vessels passing in opposite directions.

Now, referring particularly to Figure 2 of the drawings, I have there diagrammatically indicated an apparatus for actuating the signals at the points 2, 3, 4 and 5.

In the drawings, 13 and 14 indicate whistles to be located at the points 2 and 4, while 16 and 17 indicate sirens to be located at the points 3 and 5. 19 indicates an electrical source connecting with all of the signals at one side, the signals being arranged in pairs and each pair connected with a controller 15 or 20. Both controllers 15 and 20 may be driven by suitable means such as the motor and each controller is provided with contact strips 21 and brushes 22 and 23 which are adapted to energize a pair of the signals simultaneously and which are arranged preferably to actuate the different pairs of signals at different intervals.

Now, referring to Figure 3 of the drawings, I have shown one form of apparatus which may be used where it is desired to receive the sound signals on the vessel through the water. In this form of the apparatus, 25 indicates a microphone which is attached to the ship's bottom so as to receive sound arriving at the ship through the water. The microphone 25 is connected to filters 27 and 28, which are tuned to different frequencies, so that each filter is capable of passing substantially only the current generated on receiving the signal from one of the stations such as 2 or 3. For example, the signal at point 2, which may be an oscillator signal, may emit a frequency of sound of 500 cycles, while that located at point 3 may emit a frequency of 1,000 cycles. From the filters 27, 28 the current is passed through amplifiers 29 and 30, and hence through transformers 31 and 32, respectively, to increase the voltage sufficiently to operate a familiar form of neon tube.

The secondaries of transformers 31 and 32 are connected to the neon tubes 33, 34, 35 and 36. Neon tubes 33 and 35 when operated give a characteristic red light, while neon tubes 34 and 36 are mercury neon tubes, giving the characteristic blue light. Both the red tubes 33 and 35 are energized by transformer 32 and the blue tubes 34 and 36 by the transformer 31.

Interposed in front of the tubes 33 and 34 is a revolving disc 37, and interposed in front of the tubes 35 and 36 is another revolving disc 38. These discs have slots 39 and 40, respectively, through which the light from the tubes may appear. Both discs 37 and 38 are driven by a common motor 41, the motor driving directly the disc 38 and driving the disc 37 through reduction gearing 42. In this manner, the discs 37 are revolved at a slower speed than the discs 38, for example once a second, while the discs 38 revolve ten revolutions per second. In case of some of the larger ships, it may be desirable to use the apparatus shown in Fig. 3 and locate the channel center line accurately with that apparatus.

In operation, using the apparatus shown in Figure 3, the two stations on opposite sides of the channel line are each caused to simultane-

ously emit an oscillating submarine sound signal at intervals, the stations operating simultaneously and each signal being for the same predetermined duration, say, for example, one second. One station emits a wave of a frequency of 5,000 cycles, while the other 1,000 cycles. The microphone 25 is attached to the hull of the vessel so that it receives both sound oscillations from the water and these oscillations are separately filtered through the filters 27 and 28, respectively. A signal of 5,000 cycles frequency, for example, passes through the filter 27, amplifier 29, and transformer 31, and causes the illumination of mercury neon tubes 34 and 36 which give their characteristic blue light. The 1,000 frequency sound signal when received is filtered by filter 28 and the current generated sent through amplifier 30 and transformer 32, energizing the neon tubes 33 and 35, developing their characteristic red light. If the pilot is exactly on the center line of the channel, he will observe both the blue and the red lights energized simultaneously. If he observes one colored light to be extinguished simultaneously with the energizing of the colored light, he will know that he is then on a channel line to one side of the center of the channel at a minimum destination of 550 feet therefrom. By the use of the revolving discs 37 and 38 one may determine from the position one sees the respective red and blue lights through the slots 39 and 40 the extent of overlapping of one sound signal by the other.

While I have indicated a special apparatus for use on certain ships and taking sound signals from the water, I believe that the signals received through the air are of equal accuracy. A large advantage of the present invention resides in the fact that no apparatus is required on the ship itself in order to make use of the sound signals for locating the channel. Thus, the signalling apparatus is just as available to a small fishing boat as it is to the largest ocean liner. When the ship proceeds along a course such that it hears the signals at intervals of one second apart, it is certain to have ample clearance with ships proceeding in the opposite direction by the channel, because in such a case the two ships will pass each other with a minimum clearance of over a thousand feet.

While a wind will have some effect upon the location of the center of the channel line by the process and apparatus of this invention, unless corrected for, it has no substantial effect upon the clearance maintained between two ships which are passing in opposite directions and each seeking to maintain themselves at different sides of the channel line by the pilot on courses where they hear the termination of one signal simultaneously with the beginning of the other. In such case, the ships will always be at a minimum distance of 1100 feet apart when the sound signals are sounded for one second's duration.

The process and apparatus of the present invention makes it unnecessary to judge the source of the sound from the air, because this is determined readily from the interval of time between the two signals enabling the pilot to immediately recognize which side of the channel line he is on.

Now, referring to Figure 4 of the drawings, the process and apparatus of the present invention permits not only a line, such as a channel line, to be located by a craft from the sounds of different pairs of signals, but by an arrangement of signals, as shown in Figure 4, an exact point may be located. Thus, in Figure 4, I have shown the signals 13 and 16 arranged in one pair and the signals 14 and 17 arranged in another pair so that a straight line drawn through the latter pair of signals will be perpendicular to the center point of a straight line between signals 13 and 16. At the intersection of these lines a mooring mast for a craft, such as a dirigible, may be located and this mooring mast may be located from the sound signals as follows:

The pilot of the aircraft proceeds, listening to the signals from points 14 and 17 and 13 and 16 until he hears, for example, both signals from points 14 and 17 at the same time. Then he knows that he is on the line between signals 13 and 16. He proceeds on a course such that will cause him to hear signals 14 and 17 simultaneously until the sound from signals 13 and 16 is also heard simultaneously. At this time he is exactly at the mooring mast.

While the particular form, process and apparatus herein described is well adapted to carry out the objects of the present invention, it is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and I do not wish to be limited in the practice of the invention, nor in the claims, to the particular embodiment set forth.

I claim:

1. A method of indicating a channel line to a ship, which comprises simultaneously operating two sound signals at opposite sides of the channel line and at equal distances therefrom on a common perpendicular to the channel line, said signals being operated to emit distinguishably different sounds whereby the pilot of the ship is enabled to determine the channel line as a line at which he hears both signals simultaneously, and sounding the signals for a definite period of time relative to the velocity of sound in the transmitting medium and to the width of the channel whereby a ship's pilot may be able to determine when he is on a course at one side of the channel line by hearing the termination of one signal simultaneously with the beginning of the other.

2. A method of indicating the channel line, which comprises simultaneously operating two sound signals at opposite sides of the channel line and at equal distances therefrom on a common perpendicular to said channel line, said signals being operated to emit distinguishably different sounds, the signals being sounded for a definite interval, having a predetermined relation to the velocity of sound in the transmitting medium and to the width of the channel, whereby the pilot of a vessel moving along the channel line but to one side of said channel line may determine by hearing one signal commencing coincident with the end of the sound received from the other signal that the vessel is on a hyperbola curve and close to a definite distance to one side of said channel line.

3. A method of guiding ships along a channel line, which comprises simultaneously operating two sound signals at opposite sides of the channel line and at equal distances therefrom on a common perpendicular to said channel line, said signals being sounded to produce distinguishably different sounds, and causing the ships passing in one direction along the channel line to maintain their positions so that their pilots hear one signal slightly in advance of the other signal and the pilots of ships passing along the channel

line in the opposite direction hear the latter signal before the first signal, thereby the ships passing in opposite directions along said channel line are maintained on opposite sides thereof with definite clearance, and sounding the signals on each operation for a definite duration of time having a predetermined relation to the velocity of sound in the transmitting medium and to the width of the channel so that the pilots of said ships when they hear one signal commence the sound at the termination of the receipt of sound from the other signal may recognize their minimum distance of clearance from the channel line.

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