L. I. BLAKE.

SUBMARINE SIGNALING.

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1,080,098.

Patented Dec. 2, 1913.

Fig. 1

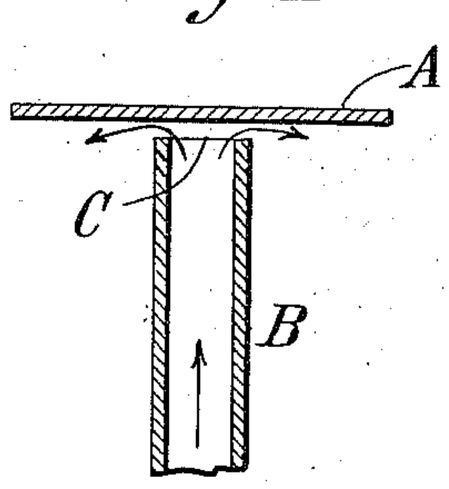


Fig. 2

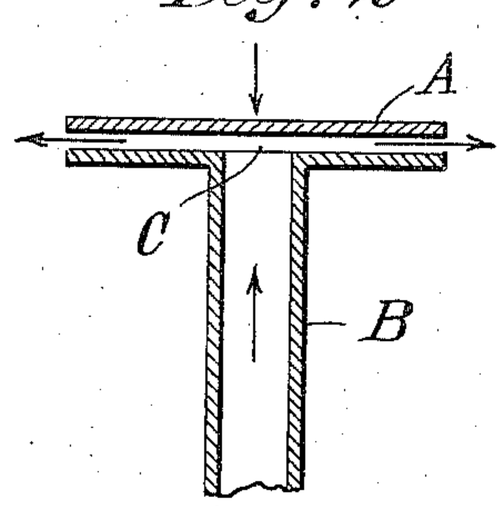


Fig. 3

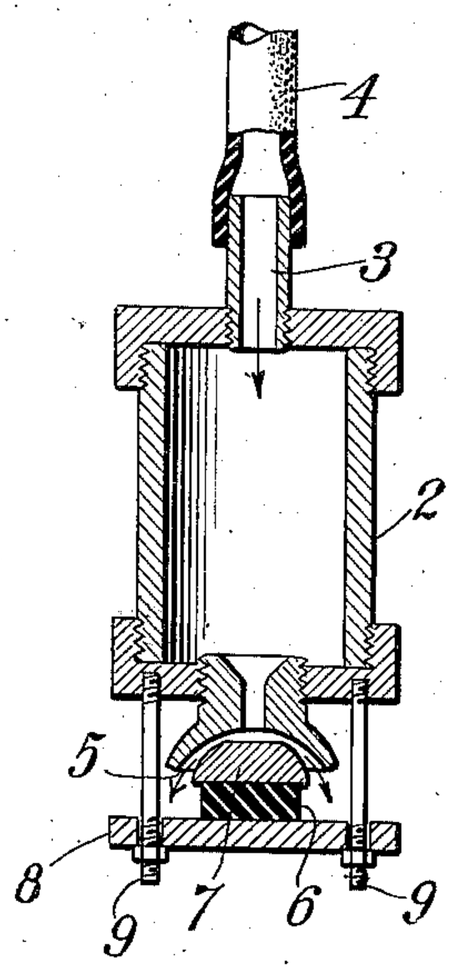


Fig. 4

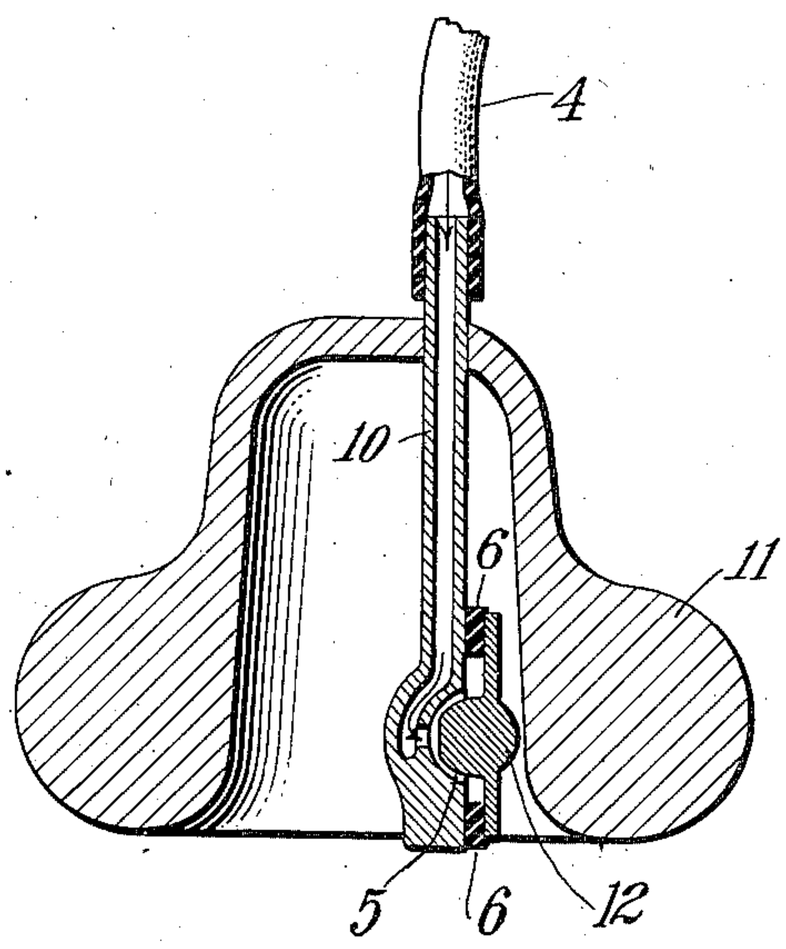
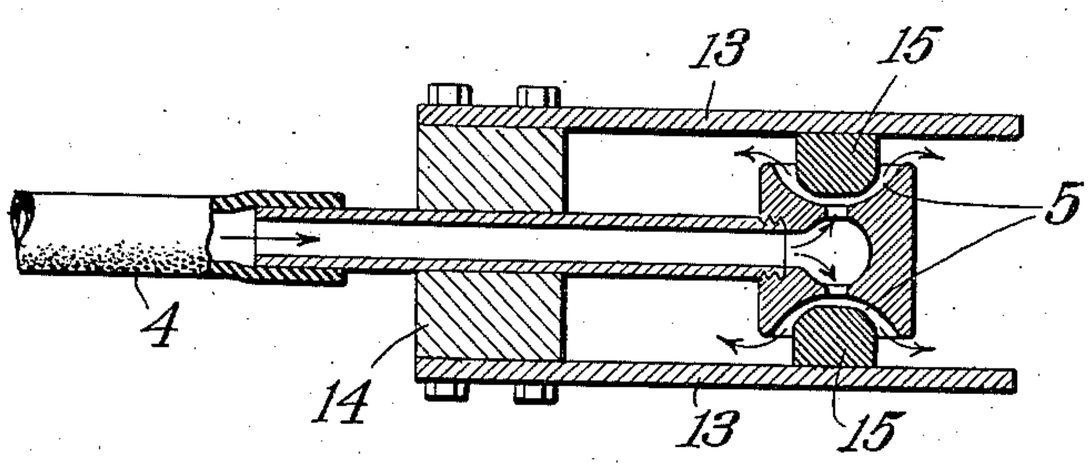


Fig. 5



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SUBMARINE SIGNALING.

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To all whom it may concern:

Be it known that I, LUCIEN I. BLAKE, a citizen of the United States, at present residing at London, England, have invented certain new and useful Improvements in Submarine Signaling, of which the following is a full, clear, and exact description.

For a long period of time the desirability of some means for producing continuous sounds under water practically available, with known instruments, for purposes of sub-marine signaling has been widely recognized, but although the provision of such devices has been the object of strenuous and unremitting effort, nothing fully adequate for the purpose has heretofore been found or proposed.

In my present application for Letters Patent is disclosed an invention which I have found to afford a solution of this problem, and which constitutes a radical departure from previously proposed plans, in that it is based upon a principle hitherto unapplied to this or any similar purpose of which I am aware.

The explanation of the invention and of the principle upon which it depends will be facilitated by reference to the accompanying drawings in which—

Figures 1 and 2 are diagrams illustrative of the underlying principle of operation. Fig. 3 is a part section and side elevation of one specific form or embodiment of the invention, and Figs. 4 and 5 similar views of other such forms or modifications.

Referring to Figs. 1 and 2, A represents a plate of any material, such as wood or metal, B a tube connected with a supply of water under pressure, and C a nozzle, which in Fig. 2 is provided with wide flanges giving it the form of a plate with a central orifice.

It is well known that if water be forced through the tube B the plate A of Fig. 1 will be strongly repelled from B, while that in Fig. 2, provided it be, initially, close enough to the plate C, so that the issuing jet from B wets both plates, will be strongly attracted toward B. This is true in both cases whether the device is submerged in water or is in air, but in the case of Fig. 2 if the plate A be removed beyond a certain limited distance from the plate nozzle C it will be repelled from the same.

The phenomenon of attraction peculiar to Fig. 2 is explained by the very old law of Bernouilli, that the hydrokinetic, or the pressure exerted by water in motion, as distinguished from the hydrostatic or pressure of water at rest, varies inversely as the square of its velocity. Applying this law to the device of Fig. 2; it will be seen that the water issuing from tube B, flows outwardly between plates A and C, with a continually diminishing velocity until it reaches the rim of plate A. But since the pressure at the rim must be that of the water in which the plate is submerged, the pressure directed upward at the jet's orifice B must be less than this downward pressure, so that the plate A, as a whole, will be pushed by the hydrostatic pressure downward or toward the plate C.

In experimental investigations of devices of this character I discovered that a plate A, Fig. 2, if held at a certain short distance from C may be caused to vibrate with great force, the period and power of the vibrations depending chiefly upon the pressure and size of the jet, and further that if A be forced so close to C that the orifice is almost closed, the pressure at B becomes for the instant hydrostatic, and therefore greater than the hydrokinetic pressure tending to move the plate toward C, which results in the plate A being repelled from C. Any movement of plate A, however, away from C, permitting the water to flow, results at once in the attraction of A, so that in this case A may act as a rapidly vibrating valve, alternately opening and closing the jet rythmically.

I have found, as a result of my observations of the above phenomena, that by suitably supporting the plate A at a certain short distance from C, the attraction may be unstably balanced, and vibrations maintained that may be ultilized in various ways to produce a continuous sound, well suited for submarine signaling. For example, the sudden checking of the issuing water by the vibrations of plate A produces a "water hammer" effect in the supply pipe, the "hammer" pressure in pounds per square inch being about 50 times the velocity of the water in feet per second, so that it is not difficult to obtain 100 lbs. per square inch in water shocks that may be transmitted as a continuous sound through the water. Again, the vibrations of the plate A or part cor-

responding thereto in a properly organized apparatus, may be utilized to produce a succession of mechanical blows upon such a body as a submarine bell; or the vibrations may be imparted to suitably designed and constructed diaphragms, or utilized in other ways to secure a similar effect or result.

In illustration of the applications of the invention above referred to, I now refer to Figs 3, 4 and 5 of the accompanying drawings, which have been briefly described above.

In Fig. 3 the numeral 2 designates an iron or steel cylinder having an inlet 3 through which water may be introduced by a flexible pipe 4, leading from a suitable source of pressure supply. At the opposite end of the cylinder is a jet orifice or ajutage 5, bowl-shaped or substantially hemispherical, and, supported upon a rubber cushion 6, or other proper resilient seat is the vibrating member 7, a body of wood or metal of substantially the same contour as the jet orifice, except that it has a flat portion opposite and of greater area than the orifice.

The vibrating member 2 is carried by a plate 8, forming part of an adjusting frame 9, by means of which it is adjusted in proper relation to the orifice.

When water under pressure is introduced into the cylinder 2, the jet issuing from the orifice 5, when the nearly rigidly fixed member 7 is in proper adjustment, will be almost completely, abruptly and alternately shut off and opened with high frequency. Powerful shocks, that is, large pressure differences, will thus be delivered against the walls of the chamber 2, and if the latter be submerged in the water, these shocks will be delivered unimpaired through the walls to the surrounding water.

I have found that an iron cylinder 6 inches in diameter, 16 inches long, and with walls one half inch thick, let down into the water, gives with a jet $\frac{3}{8}$ of an inch in diameter and a pressure of only 20 lbs. a loud tone which may be transmitted to great distances through the water and taken up by any of the receiving instruments commonly used in such signaling systems.

In the device shown in Fig. 4 the application and use of the vibrating member as the clapper of a submarine bell is illustrated. Obviously there may be a great many modifications of this plan, but that which I have found the most practicable is the following: The flexible pipe 4 is connected with a metal tube 10 extending alongside of or through the wall of a standard submarine bell 11, shown in section. The ajutage 5 of the same character as in the preceding figure is arranged at the lower end of the tube 10 and is confronted by a vibrating member 12 of corresponding contour to that employed in said figure, supported on the tube 10 by rubber cushions 6. The member 12 in this case is an iron or steel body in close proximity to the rim of the bell 11, and serves as a clapper to deliver a succession of powerful blows with great rapidity and regularity against the rim of the bell. I have found that in this way a bell can be made to give out a continuous ringing tone, particularly marked in its high overtones which are best suited for submarine signaling. Thus undamped vibrations originate without an initial percussive blow as with ordinary bells, and code signals may be propagated even by a bell, by manipulating a suitable valve in the supply pipe.

Another application of the invention is shown in Fig. 5. In this device 13, 13 represent metal plates in the nature of diaphragms secured to a suitable support 14, through which latter extends the pipe 10. At its end this pipe is provided with a double bowl-shaped ajutage, and the vibrating members corresponding to those previously described are segmental hemispherical bodies 15, secured to or integral with the diaphragms 13.

From the foregoing explanation of operation, that of the device of Fig. 5 will be readily understood, it being observed that the elasticity of the plates, together with the hydrostatic pressure during the instant the jets are shut off or checked opposes the attraction so that vibration of the plates results.

The above described method of and apparatus for originating sonorous vibrations available for submarine signaling are not only highly efficient, but are much more simple and economical than those now in use.

It is obvious that the devices for carrying out the invention may be very greatly modified, and I have shown such typical forms only as seem to illustrate the principle and its application to specific cases.

What I claim is:

1. A sound producer for submarine signaling, comprising in combination, two rigid bodies with parallel opposing surfaces maintained out of contact, but in close elastic relation, means for introducing, under pressure, a jet of fluid between the opposing surfaces of said bodies so that it may flow with diminishing velocity from its entrance into, to its exit from the space between the same, and means for producing sonorous tones by the vibrations thereby imparted to said bodies.

2. An automatic vibrator for submarine sound producing apparatus comprising in combination, a vessel adapted for connection with a source of water under pressure, an ajutage for the same and a solid body having its surface confronting and corresponding in contour to the inner surface of the ajutage and held in close elastic relation thereto, whereby it will be alternately attracted and repelled by variations of pres-

sure due to the diminishing velocity of the flow of water from its entrance to its exit between the said body and the ajutage.

3. An automatic vibrator for submarine sound producing apparatus, comprising in combination, a vessel adapted for connection with a source of water under pressure, an ajutage for the same of bowl-shaped form, and a solid confronting body having a surface of a contour corresponding to that of the ajutage and held in close elastic relation thereto, whereby it will be alternately attracted and repelled by the flow of water from the ajutage.

4. An automatic vibrator for submarine sound producing apparatus, comprising in combination, a vessel adapted for connection with a source of water under pressure, an ajutage for the same of bowl-shaped form and a solid confronting body having a surface of a contour corresponding to that of the ajutage but with a flat portion opposite to and of greater area than the discharge opening of the same, and held in close elastic relation to the ajutage, as and for the purpose set forth.

5. An automatic sound producer for submarine signaling, comprising, in combination, a cylindrical vessel, a tube for connecting the same to a source of water under pressure, an ajutage inserted in the wall of the said vessel, and a vibrating member having a surface confronting and corresponding in contour with the inner surface of the ajutage, and held in close elastic relation thereto, whereby it will be attracted and repelled by the flow of water from the discharge opening of the ajutage, as set forth.

6. An automatic sound producer for submarine signaling, comprising in combination, a vessel with rigid walls, a tube for connecting the same to a source of water under pressure, a bowl-shaped ajutage for said vessel, and a vibratory member confronting and having a surface of contour corresponding to that of the ajutage but with a flat portion opposite to and of greater area than the discharge opening of the same, and held in close elastic relation to the ajutage, as set forth.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

LUCIEN IRA BLAKE.

Witnesses:
O. J. WORTH,
J. J. WILLIAMS.