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SOUND BEACON

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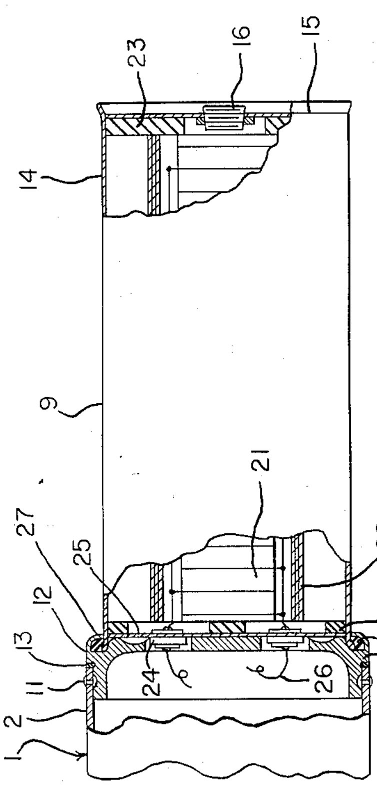

FIG. 2.

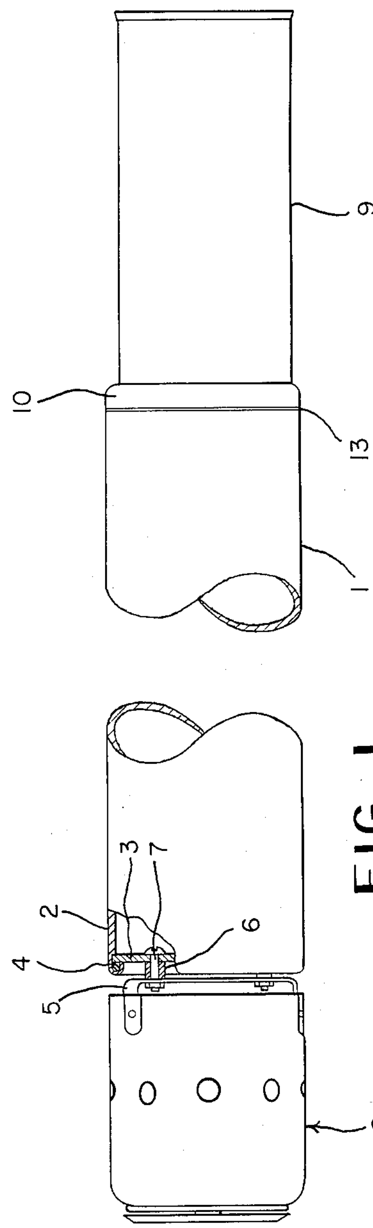

FIG. 1.

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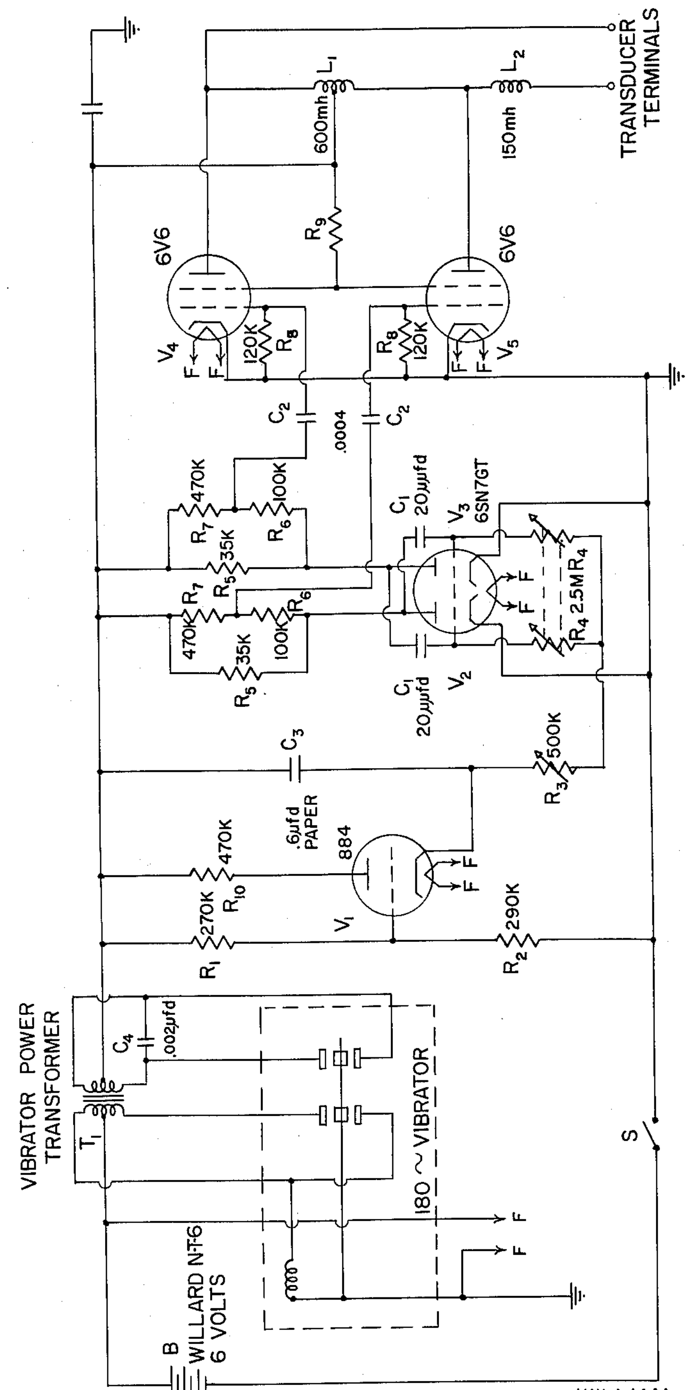

FIG. 3.

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3,209,314
SOUND BEACON

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1 Claim. (Cl. 340—5)

This invention relates to sound beacons and particularly to a device for the production of underwater sound.

The principles of and equipment used in underwater echo-ranging and listening occupy a large place in the art. A large number of systems have been described, each of which has its own peculiarities of design and operation.

The primary use to which most wartime echo-ranging systems are put is the detection of submarines and other underwater bodies, such as torpedoes and mines. As such systems have become more and more efficient, it has been found that there is great need for means and methods for defending against such detection, and it is one of the primary objects of the present invention to provide a device which, when placed in the water, will confuse and interfere with the information obtained by the echo-ranging and/or listening gear on hostile craft.

Another object of the invention is a sound producing beacon designed for use as a practice target for training operators in the use of echo-ranging or listening equipment.

A further object is a sound producing device for defense against sonic-torpedo or submarine attacks, which device may be thrown overboard or towed behind a vessel.

In furtherance of the first object, i.e. the confusion of craft attacking a submarine, the device, in its preferred form, consists of a hollow cylinder containing a power source, an oscillator and an amplifier. It is further provided with a transducer for converting the electrical energy into sound energy and a buoyancy control for supporting the whole unit at a desired depth in the water. It may be carried either within the submarine for ejection from a flare, torpedo or specially constructed tube, or on the outside of the submarine for release from within. When ejected or released, the device begins operation, sending out sound waves which are received by the hostile vessel. One or more of the beacons may be placed in the water by the submarine, and, if they are properly positioned with respect to the attacking vessel, will confuse or sufficiently interfere with the operation of the sound equipment on the attacking vessel as to make detection and/or identification of the submarine very difficult or impossible. It is obvious that the loss of contact for even a few minutes during the critical attack period offers the submarine a badly needed opportunity for taking evasive or escape action. Additionally, it is quite possible that in the resulting confusion aboard the attacking vessel, the attack may be made upon the sound beacon rather than on the submarine.

If the beacon is to be used as a training target, it is provided with essentially the same elements. When it is placed in the water, training ships are guided to its position by the emitted sounds, and may conduct simulated attacks upon it. In this case, it may be desirable to substitute a buoy for the buoyancy control means, in order to suspend it at a predetermined depth and to facilitate retrieving the device when the exercises are completed.

When used as a defense against sonic torpedoes or submarine attacks, it may simply be thrown overboard or towed behind the ship to guide the submarine or torpedo to a position remote from the ship.

In the drawings:

FIG. 1 is a side elevation, cut away for clarity, of one embodiment of the invention.

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FIG. 2 is an elevation, partially in section, showing one form of transducer and the method of attaching it to the embodiment of the invention shown in FIG. 1.

FIG. 3 is a schematic diagram of an electrical circuit designed for use with the invention.

If size and space considerations are ignored, a preferred form of the invention consists of means for producing high intensity sound at all frequencies likely to be utilized in listening or echo-ranging. This might require that the entire range from 0 to 100 kc. (kilocycles per second) be covered, as the device would obviously serve no useful purpose unless the frequency range of the hostile sound gear was effectively blanketed. Since an opposing vessel might be equipped with several sonic listening and supersonic echo-ranging equipments (operating simultaneously at several frequencies), the device would necessarily be very large in order to incorporate a power supply and generating equipment sufficient to cover the entire range.

These requirements are not difficult to meet when the device is to be used for training purposes or is adapted to be thrown from the deck of a surface ship. In these cases, a very large unit, or a plurality of units may well be used.

But since its most useful function is performed in conjunction with submarine escape or evasive maneuvers and because it is undesirable to attach even small mechanisms to the outer hull of undersea craft, space limitations become exceedingly important. It is thus obvious that a device is desired which may be conveniently stowed in a small space and which can be ejected from existing outlets in submarine hulls. These openings consist of the torpedo and the signal flare tubes; and the most convenient of these is the signal flare tube. In conventional submarines, this tube will eject a cylinder not larger than 3" in diameter and 33" long.

With this space limitation, it is not feasible to attempt construction of a device which will cover the entire frequency range mentioned above. However, it has been found that the effectiveness of echo-ranging and listening gear can be substantially reduced if extraneous sounds covering a frequency range ±2–5 kc. from the mean operating frequency of the gear are present, assuming, of course, that such sounds are produced at sufficiently high intensities. It has also been found that this interference or masking is most easily accomplished when this sound is frequency modulated, as, for example, by "sweeping" this range of frequencies in saw-tooth fashion. Thus, if it be supposed that a hostile ship is echo-ranging at a mean frequency of 24 kc., it is found that at reasonable ranges and bearings, the present invention can effectively mask or so confuse the gear's indicating mechanism that very little valuable information is obtained if it produces sound varying in frequency from 20.5–27.5 kc. at a saw-tooth frequency of about 4 c.p.s. It has further been found that such a device may be constructed to operate from 10–30 minutes even though its physical size is limited to a cylinder 3" in diameter and 33" long, as required above.

A device of this size and type is shown in FIG. 1. It is to be clearly understood that although this form of the invention will be described herein, it may be embodied in a variety of forms, which are determined by the considerations discussed above. In general, it comprises a water-tight container, generally designated **1**. This container, which may conveniently be formed of 1/16" aluminum, comprises a tube **2**, one end of which is countersunk to receive an end plate **3**. The protruding end of the tube is crimped over a neoprene or rubber gasket **4** to provide a water tight fit, as best shown in FIG. 1. A bracket **5** is mounted on the end plate **3** by means of spacers **6** and bolts **7** and supports a buoyancy control device, generally designated **8**. This control may be of any conventional type, but the type disclosed in a patent application entitled, "Buoyancy Control Device," Serial No. 533, 895, filed May 3, 1944, by Raymond D. Atchley now Patent No. 2,793,589, has been found to be most satisfactory and is illustrated in FIG. 1. This mechanism is one which will maintain the unit at a substantially fixed and predetermined level for a given period. This period is dependent upon the amount of active gas producing element contained in the buoyancy mechanism, which need only be sufficient to support the device at the required level until the energy available for operating the electronic equipment is exhausted. After the period has elapsed, the resulting negative buoyancy causes the unit to sink to the bottom of the ocean.

A transducer, generally designated **9**, of any conventional type, such as magnetostrictive, piezoelectric or electro-dynamic, is secured to the opposite end of the container **1**. Any convenient means of securing the transducer may be used, but in FIG. 2, the end of the transducer is provided with a conventional female bayonet fitting **10** adapted to interlock with several male bayonet studs **11** on the inside of tube **2**. The outer diameter of the female fitting **10** is the same as the inner diameter of the tube **2** and it is provided with an external offset, as at **12**. A rubber gasket **13** is placed around this offset and is engaged by the end of the tube **2** to provide a watertight seal when the two are locked together.

The electronic gear comprising the power supply, oscillator, and amplifier are all conveniently located within tube **2** and connected to the transducer **9** by leads extending through the fitting **10**.

The particular circuit used to supply power to the transducer is naturally determined by the type of output signal desired, which latter may be a fixed signal or one which is amplitude and/or frequency modulated. The main requirement for its production is that the necessary circuit fit into the physical space provided.

The circuit illustrated in FIG. 3 is one which produces a frequency modulated saw-tooth signal and, with the circuit values given, has been found to satisfy both space and operational requirements. It will be described in detail, but it is to be clearly understood that the values given, and the particular arrangement used, are illustrative only; there are other arrangements which will perform equally well.

It comprises, in general, four elements: a power supply, a main oscillator, a sweeper oscillator and an output stage.

The power supply consists of a battery B, which is conveniently a 6 volt Willard N–T–6 (Navy Type CWB 19046), a 180 cycle vibrator and a small vibrator power transformer, T_1, isolated by means of condenser C_4. This circuit delivers approximately 90 ma. at 330 volts. The main oscillator, tubes V_2, V_3, is a conventional multivibrator whose frequency is determined by the value of condensers C_1, C_1 and resistors R_3, R_4, R_4. It supplies essentially a square wave, whose corners are rounded off by the heavy load drawn by the output stage.

The sweeper oscillator, tube V_1, is a gas tube supplying a saw-tooth output. Grid current from the main oscillator tubes V_2, V_3 charges condenser C_3 until the voltage across tube V_1 drops and fires it, causing the condenser to discharge. The cathode of tube V_1 thus has a saw-tooth voltage pattern, the frequency of which is determined by the values of condenser C_3 and resistors R_3, R_4, R_4, and causes the frequency of the main oscillator V_2, V_3 to vary in a similar manner. The firing voltage of tube V_1 is determined by the voltage divider comprising resistors R_1, R_2, and resistor R_{10} serves as a current limiting resistor, protecting the tube.

The resistors R_3, R_4, R_4 (the latter of which are arranged to be varied simultaneously) are made variable so that any one of a number of frequency bands can be chosen for operation and, if desired, may be so arranged that this setting may be made by a switch mounted externally of the unit.

The main oscillator V_2, V_3 is coupled, through resistors R_6, R_6 and condensers C_2, C_2 to the output stage V_4, V_5. In FIG. 3, this is seen to comprise a push-pull amplifier, although one or more power amplifiers, connected in parallel, might be used. It will be noted that the plate resistors R_5, R_5, associated with the main oscillator, are by-passed by voltage dividers composed of resistors R_6, R_6 and R_7, R_7. If the output stage is found not to load the main oscillator to an undesirable extent, these voltage dividers may be omitted and the coupling condensers C_2, C_2 may be tied directly to the plates of tubes V_2, V_3.

The plates of the output tubes V_4, V_5 are supplied through center tapped choke L_1 while the grid bias and screen voltage are supplied through resistors R_8, R_8, and R_9, respectively. Power is supplied to the transducer terminals through a resonating choke L_2. For most efficient operation, choke L_1 should be several times larger than choke L_2.

A switch S is provided in the battery circuit to put the device in operation. Any convenient type may be used, as discussed elsewhere herein, depending upon the time at which it is desired to begin operation. Filament voltage for each tube is supplied from arrow-headed terminals F, F.

If the values given for the various elements on FIG. 3 are used, and variable resistors R_4, R_4 are set at 2.0 megohms, it is possible to apply to the transducer terminals a saw-tooth signal varying in frequency from 20.5 to 27.5 kc. at a sweep rate of about 4 cycles per second. This, however, may be altered as desired by varying resistors R_3 and R_4, R_4. With the 20 Y-cut crystal transducer described herein, successful operation for a period from 20 to 30 minutes is possible.

In the event that it is desirable to vary the frequency of the main oscillator in some other manner, conventional circuits may be used. For example, two or more multivibrators may be used to separately drive a similar number of output tubes. The multivibrators may be made to operate over the same or different frequency ranges and may be swept at the same or different rates.

The Willard-Navy type battery illustrated may be replaced by any other convenient power supply, as for example, one of recent development, called a sea cell, which utilizes sea water as an electrolyte. In this case, the electrodes are positioned to be in contact with the water and suitable leads are provided to supply the circuit elements in the water-tight tube.

As has been stated above, any type of transducer might be used with the invention. However, since the complete device is expendable and because weight is an important factor, the transducer illustrated in FIG. 2 has proven very effective. The unit, generally designated **9**, is housed in a thin metal cylindrical container **14** which, in practice, is simply a can of the type used in canning fruits and vegetables commercially. The container has a bottom **15** fitted with a threaded sleeve to receive a filling plug **16**. The crystal motor comprises a stack of 20 standard Navy Y-cut Rochelle salt crystals **21** connected in parallel, positioned and insulated by corprene spacers **22**. The motor is positioned by means of circular corprene washers **23** (of a diameter equal to the inner diameter of container **14**), glued to its ends. These washers are properly perforated to receive the filling plug **16** and a pair of water tight grommets **24**, positioned in the lid **25**, through which the leads **26** are brought for connection to the transducer terminals on the amplifier. The lid **25** is clamped to the container in the conventional manner and the whole unit is filled with castor oil.

The transducer is mounted on the female portion **10** of the bayonet fitting by providing the latter with a thin, circular flange **27** which is crimped over a gasket **28** to form a water tight seal around the edge of the lid 25. The transducer with the bayonet fitting is thus adapted to be locked into the lower end of tube 2 as described above.

In use, the complete device is ejected from the signal flare tube of the submarine. Immediately on reaching the water, the buoyancy mechanism takes control and brings the unit to rest at its pre-set level, as outlined in the patent application identified above, the buoyancy control mechanism being uppermost and the transducer being lowermost whereby the gas escaping from the buoyancy mechanism will not pass by the transducer and cause blocking of the signals therefrom or otherwise affect said signals.

The electrical circuit may be arranged to begin operation at any one of several times. As shown in FIG. 3, it is controlled by switch S, which may be arranged to be closed manually before the unit is placed in the flare tube, automatically upon ejection from the flare tube, after a certain delay period (as controlled by conventional delay mechanisms or the dissolution of soluble plugs), or at a predetermined depth (as controlled by a pressure-actuated mechanism). It will continue to operate until the available energy of the batteries has been used, and will sink to the bottom when the active element in the buoyancy control mechanism is depleted (as explained in the patent application identified above).

One or more of the units may be used. One unit may, under favorable circumstances, be sufficient, particularly if it is positioned close to the attacking ship and between that vessel and the submarine. At other times, it may be desired to eject several devices to produce further confusion or to create an effective sound mask between the two vessels.

Obviously, when only one unit is ejected, only sound of a predetermined range or ranges of frequencies will be emitted. Depending upon the electronic construction, this may be sound of a constant frequency, a plurality or range of frequencies, or a "swept" range of frequencies, as produced by the circuit shown in FIG. 3. If a plurality of oscillators or separate units are used, several ranges in the sonic and/or super-sonic spectra may be effectively covered by one unit.

The invention may also be utilized in connection with control mechanisms of the type used in torpedoes. If provided with a propeller, rudder, diving vanes and a directional gyro control, it may be made to travel toward a hostile ship; or, directed toward the hostile ship, as

a source of sound, in accordance with principles utilized in the construction of sonic torpedoes. This construction has the advantage of bringing the beacon closer to the hostile sound gear, effectively increasing the observed intensity of its signals, compared to those of the more remote submarine.

Having described our invention, we claim:

An underwater sound beacon adapted to be launched from a water borne body comprising a signal generating means producing a continuous signal, automatic means for varying the frequency of said signal over a predetermined frequency range of about 20.5 to 27.5 kilocycles per second in a saw-tooth fashion, control means for selecting the frequency range of operation of said signal generating means, amplifier means for said signal, a transducer coupled to said amplifier means and operative to transmit said signal directly into a water medium at a high intensity, and gas operated buoyancy means for supporting said beacon at a predetermined level underwater during the life of operation of the sound beacon whereby signals transmitted into the water are operative to interfere with hostile sonar operations.

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