July 12, 1932. F. RIEBER 1,867,098

METHOD AND MEANS FOR RADIATING VIBRATORY MECHANICAL IMPULSES INTO SOLIDS, LIQUIDS, AND THE LIKE

Filed Sept. 8, 1925

FIG. 1.

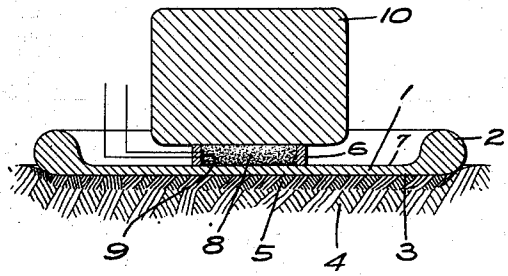


FIG. 2.

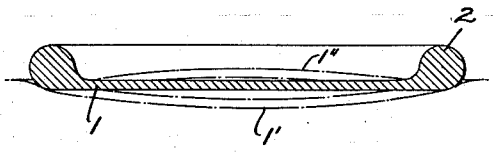


FIG. 3.

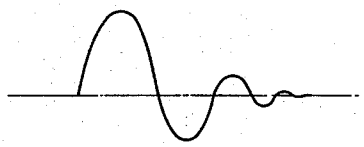


FIG. 4.

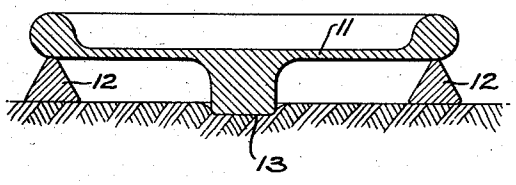
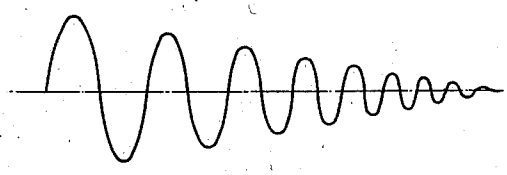


FIG. 5.



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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR RADIATING VIBRATORY MECHANICAL IMPULSES INTO SOLIDS, LIQUIDS, AND THE LIKE

Application filed September 8, 1925. Serial No. 55,203.

My invention relates to the radiation of vibratory compression impulses of any desired frequency into the earth or into a body of water, and has for its object the provision of simple means whereby this result may be accomplished in a reliable and efficient manner.

My invention further provides means whereby the decrement of the wave train so radiated may be made to assume any desired value within certain limits.

Vibrations in a body of water, for the purposes of signaling between vessels, or of ascertaining the depth of the body of water by means of reflections of the said vibrations returned to the ship from the bottom of the water, have customarily been produced by the use of large stiff diaphragms, one surface of which was in contact with the body of water into which sound was to be radiated. These diaphragms have been caused to vibrate by applying thereto, from means located on the opposite side of the diaphragm to the body of water, vibratory energy generated by some electrical means, as for example, an alternating current of the desired frequency passing through a very rigid coil of wire, located so that the turns cut a magnetic field, said coil being rigidly attached to the diaphragm. The result of passing the alternating current through the coil is to create vibrations in a direction normal to the surface of the diaphragm, and the same are thereby imparted by the diaphragm to the water.

This means of radiating energy involves heavy and cumbersome electrical appliances, and the weight of the generator alone which is required to furnish adequate alternating current to create sound waves of any appreciable energy content is very large. Thus the apparatus is not adapted for portable use, nor is it efficient for relatively short periods of emissions of sound, with long rest periods between. This last disadvantage results, obviously, from the fact that the generator and coils must be adequate in size to radiate energy at the desired rate, and these two pieces of apparatus are idle between radiated pulses.

Sounds have also been emitted for similar signaling purposes in water from the so-called submarine bell, consisting of a large and exceptionally thick casting of bell form, which is struck in the ordinary way with a modified form of bell clapper; however, this means cannot produce vibratory compression impulses of the energy content which I aim to provide as hereinafter described. By means of apparatus embodying my invention, exceptionally intense excitation may be given momentarily to a vibrating body, the energy being subsequently radiated by the said vibrating body into the surrounding medium. The present invention is especially adapted for use in connection with geological explorations, of the general character described in my copending application, Serial No. 15,528, filed March 14, 1925, although not limited to such use.

The invention possesses other advantageous features, some of which with the foregoing, will be set forth at length in the following description where I shall outline in full that form of the invention which I have selected for illustration in the drawings accompanying and forming part of the present specification. In said drawings I have shown several forms of my invention, but it is to be understood that I do not limit myself to said forms, as the invention as set forth in the claims may be embodied in a plurality of other forms.

Referring to the drawing:

Figure 1 is a sectional view of apparatus embodying my invention.

Fig. 2 is a sectional view of one form of vibrating element employed, the travel of the vibrating surfaces being indicated in broken lines.

Fig. 3 is a curve indicating the general character of the impulses transmitted by an element as shown in Fig. 2.

Fig. 4 is a sectional view of a modified type of vibratory element; and

Fig. 5 is a curve indicating the general character of the impulse transmitted by an element of the character shown in Fig. 4.

In Fig. 1 I have shown a circular disc 1 of rigid material, such as steel, the periph-

ery 2 of which is preferably thickened. The disc 1 in effect constitutes a diaphragm and may assume various forms. In this form of the invention, the lower surface 3 of the disc is in direct mechanical contact with the medium into which it is desired to radiate energy, for example, the earth, as indicated at 4. This contact should preferably be maintained in a manner whereby looseness of the earth, or voids in the same, are prevented so far as possible. For this purpose it is preferable to have the contact surface saturated with water and very tightly tamped, as indicated at 5. A confining ring of steel 6 is placed on the upper surface 7 of the disc 1, within which is placed a charge of suitable explosive material 8, such as tri-nitro-toluol. A detonating cap 9, preferably of the electrical variety, is provided for the explosive, and a mass 10 of properly chosen proportions, rests on top of the ring 6, thereby closing the space within which the explosive is placed. When the cap 9 is detonated, the explosive 8 is set off, causing forces to act in all directions. The lateral force, which it is not desired to utilize, is expended on the ring 6, and may burst the same, provided it is of the proper proportion, without materially affecting the energy of the impulses sent upward and downward. The mass 10 is so proportioned that the amplitude of excursons of the heavy diaphragm 1 are made effectively as large as possible.

The initial impulse of the explosive having caused a downward deflection of the diaphragm 1, energy is thereby stored in said diaphragm as potential energy of deformation, and the diaphragm will then continue to vibrate in accordance with the general laws of the vibrations of elastic solids, as indicated in dotted lines 1′ and 1″ in Fig. 2. It is obvious that the mass 10 will be thrown upwards by the force of the explosion, and it is equally obvious that some checking means may be provided whereby the said mass is not allowed to fall freely on its return, thereby doing damage. The diaphragm 1 shown in Figs. 1 and 2, being once deflected, it will continue its vibrations until the entire amount of energy stored in the diaphragm has been radiated into the medium with which the diaphragm is in contact, or has been absorbed in heat of internal stresses in the diaphragm. By making the diaphragm of suitable material, this loss by internal stress is made very low so that we may deal almost entirely with radiated energy in discussing the rate at which the vibrations of the diaphragm die down.

On account of large surface in contact, the diaphragm will have a relatively high coupling with the material into which the energy is radiated, and the vibrations will therefore die out after a relatively small number of vibrations or oscillations, since a large quantity of energy is extracted from the vibrating body with each vibration or oscillation, due to the large contact area. The vibratory wave train may therefore, in the case of such a body, be illustrated as in Fig. 3, in which a very few vibrations suffice to reduce the amplitude to a negligible quantity.

In Fig. 4 I have shown a diaphragm 11 similar to that above described, with the exception that the lower surface is not in its entirety in contact with the material into which energy is to be radiated. A support 12 of some non-vibratory material is placed under the edge of the disc 11, while a small table 13 or protruding flat surface is formed on the lower surface of the disc which is maintained in close contact with the earth or other material into which energy is to be radiated. By virtue of the small area in contact, a relatively smaller amount of energy will be extracted from each successive vibration, and the radiated wave train may in this case be illustrated by a wave as shown in Fig. 5 in which there are a relatively larger number of vibrations before the amplitude has fallen to a negligible value. It is obvious that other forms of vibratory bodies will accomplish the same result which comes from the use of the circular section diaphragm shown herewith and it is not my intention to limit this invention to the use of the form shown, any of the customary forms of vibratory bodies being sufficient to accomplish my invention.

I claim:

1. In apparatus for the generation of seismic vibrations, a diaphragm of heavy metal having a lower surface adapted to make close contact with the ground and a thickened edge surrounding said surface.

2. Apparatus for imparting vibratory energy to the ground comprising a metallic diaphragm having a lower surface in contact with the ground, a thickened edge surrounding said surface, means resting on the opposite surface of said diaphragm for containing an explosive charge and a yielding mass on top of said container.

3. Apparatus for imparting vibratory energy to the ground comprising a diaphragm in the form of a metallic disc having a lower surface in contact with the ground, said surface having a thickened heavy periphery, means resting on the opposite surface of said diaphragm for containing an explosive charge and a yielding mass on top of said container.

4. Apparatus for imparting vibratory energy to the ground comprising a metallic diaphragm having a lower surface in contact with the ground, a thickened edge surrounding said surface, a ring-formed element resting on the opposite surface of said diaphragm

for containing an explosive charge and a yielding mass setting upon said container.

5. Apparatus for generating seismic vibrations comprising a diaphragm in the form of a metallic disc having a lower surface in contact with the ground, said surface having a thickened heavy periphery, a ring-formed element resting on the opposite surface of said diaphragm for containing an explosive charge and an opposing mass setting upon said container.

6. A device for generating seismic vibrations comprising a body adapted to store vibratory energy, said body having one surface in contact with the ground, and means for shock exciting said body to vibrate said body at its natural period of mechanical resonance.

7. A device for generating seismic vibrations comprising a diaphragm adapted to store vibratory energy, said diaphragm being in contact with the ground, and means for imposing the force of a detonation upon the diaphragm to vibrate said diaphragm at its natural period of mechanical resonance, whereby vibratory energy of said period is transmitted thru the earth.

8. A device for generating seismic vibrations comprising a diaphragm adapted to store vibratory energy, the lower side of said diaphragm being in pressure transmitting relationship with the earth, and means for imposing the force of an explosive detonation upon the upper side of said diaphragm to shock excite the same.

9. A device for generating seismic vibrations comprising a diaphragm adapted to rest upon the ground with its lower side in pressure transmitting relationship with the earth, said diaphragm having a definite period of vibration, and means for imposing the force of an explosive detonation upon the upper side of said diaphragm to shock excite the same, said means being constructed and arranged to immediately relieve the detonation force after an exposion.

10. Apparatus for geological exploration comprising a diaphragm adapted to have the lower face thereof in pressure transmitting contact with the ground, a relatively heavy mass secured to the periphery of the diaphragm, a container in contact with the upper face of said diaphragm, the area of the diaphragm covered by the container being substantially less than the area of the upper face of the diaphragm, and a mass disposed on top of the container, said container being adapted to receive an explosive charge.

11. The method of transmitting impulses into the earth which comprises detonating an explosive between a vibratory body and an opposing mass to cause said body to vibrate at its natural period of mechanical resonance and imparting the resulting vibrations to the earth.

12. Apparatus for generating seismic vibrations comprising a vibratory body, a container for an explosive open at two ends resting with one of said ends on said body and a mass adapted to oppose the force of an explosion resting on the other end of said container.

In testimony whereof, I have hereunto set my hand.

FRANK RIEBER.