Jan. 2, 1951 W. A. TOLSON 2,536,327

SONIC PROXIMITY FUSE

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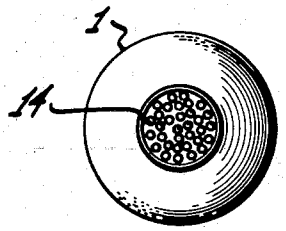


Fig. 1a.

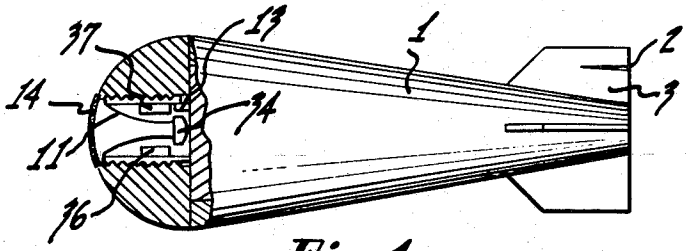


Fig. 1.

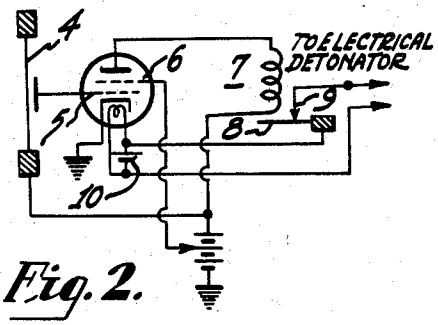


Fig. 2.

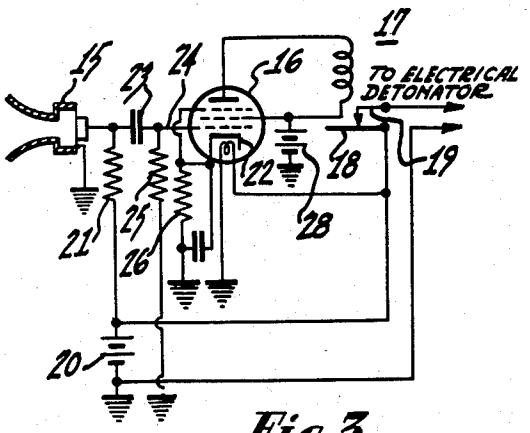


Fig. 3.

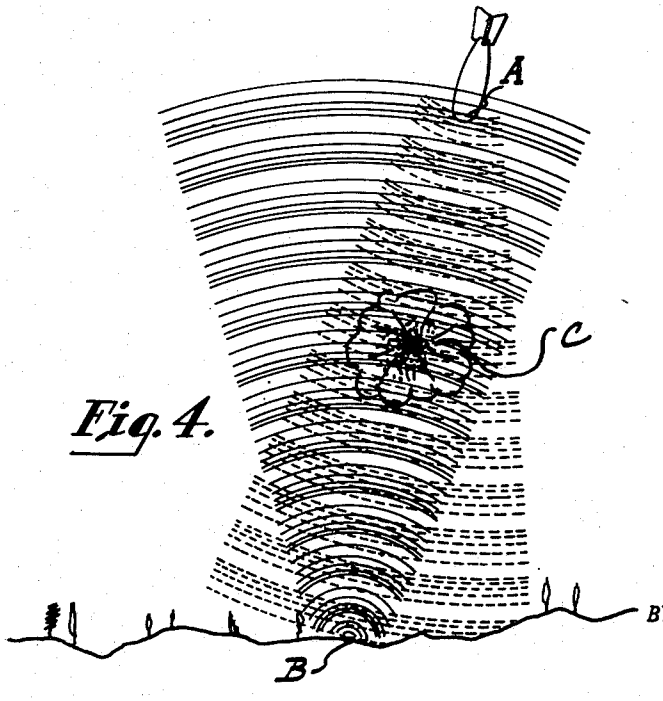


Fig. 4.

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SONIC PROXIMITY FUSE

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10 Claims. (Cl. 102—70.2)

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This invention relates to an improvement in proximity fuses adapted to be used with anti-personnel bombs to be dropped from the air.

It is a well known fact that the type of bomb which explodes upon contact with a solid object is not very effective against enemy personnel who are protected by "fox holes" or narrow slit trenches. Unless a man be subjected to a direct hit or a very near miss his chances of surviving an attack with the contact detonated type of bomb are excellent.

However, another type of bomb has been found very effective against personnel regardless of whether they have taken cover in "fox holes" or not. This is the type which is exploded just before it strikes the target and scatters fragments over a wide area. When this type of anti-personnel bomb is used, a "fox hole" or trench affords but scant protection within a solid angle of about 60° from the center of the bomb's explosion.

Various types of fuses have been proposed which are designed to detonate an anti-personnel aerial bomb at a specified distance above the ground. This invention relates to a fuse which is actuated by the reflection of a sound which the bomb generates as it falls.

It is an object of the invention to provide a sonic-actuated fuse for exploding an aerial bomb.

A further object is to provide a fuse which may be adjusted to explode an aerial bomb at some predetermined height above ground.

Another object is to provide a sound-actuated bomb fuse which will be relatively insensitive to sounds other than those to which it is designed to respond.

Another object is to provide a bomb fuse which is simple in construction and operation.

Another object is to provide a bomb fuse which may occupy but a small volume compared to the volume of the bomb.

Another object is to provide an improved bomb fuse which is actuated by sound waves generated by a device on the falling bomb and reflected back to the bomb from the earth.

Another object is to provide an improved bomb exploding mechanism which is actuated by air vibrations set up by an aerial bomb as it falls.

These and other objects will be apparent from the more complete description of the invention which follows.

Fig. 1 is a view of a bomb showing a cross-section of the nose with the fuse mechanism inserted therein.

Fig. 1A is an end view of the outside of the device shown in Fig. 1.

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Fig. 2 is a simplified circuit diagram of one embodiment of the fuse mechanism, using a condenser microphone.

Fig. 3 is a simplified circuit diagram of another embodiment of the invention using a carbon button microphone.

Fig. 4 is a view illustrating how the sound waves travel from the bomb to the ground and back by reflection.

The operation of the device can best be understood with the aid of the above figures. The aerial bomb 1 illustrated in Fig. 1 has a conventional whistling device attached which will cause it to give forth a whistle of a certain frequency f_s when it has attained its maximum speed of fall. This device may be simply a slit or notch 2 cut in one of the stabilizing fins 3. This sound will, of course, travel outward from the source in all directions including downward to the earth. An observer stationed at point B on the ground would hear this whistle but the frequency or pitch which he hears would be higher due to the well known Doppler effect. The frequency of the reflected sound picked up by a detector at A would be still higher since the bomb is travelling toward the reflected sound waves and an increased number of cycles per second reaches the point A. When an observer is in motion, either toward or away from a source of sound, which source is also in motion, the formula for finding the observed frequency is

$$f_o = \frac{V - V_o}{V - V_s} f_s$$

where

f_o=frequency received by the observer
f_s=frequency of the source
V=velocity of propagation of sound in air
V_o=velocity of the observer
V_s=velocity of the source

In the formula, the velocity of sound from the source is taken as having a positive sign. Since the velocity of the observer is, in effect, in a direction opposite to that of the sound from the source, the term V_o is negative. In the formula, the term V_o also has a negative sign; therefore, the net result is to cause the numerical value of V_o to be positive when substitution is made.

If an example is taken in which the sound being generated as a frequency, f_s, of 1,000 cycles per second, and in which V is assumed to be about 1,000 feet per second, and the velocity of the source V_s is taken as 550 feet per second for

the sake of convenience, the substitution would be as follows:

$$f_s=\frac{1100+550}{1100-550}\times 1000=3000$$

In other words, the frequency of the reflected sound waves, as they are picked up by a detector on the bomb A, would be 3,000 cycles per second.

If then, the bomb contains a device set to respond to a sustained frequency of 3,000 cycles per second, which is received at a predetermined intensity, it may be made to explode when the prescribed conditions have been reached. The intensity of the reflected sound received by the detector on the bomb will increase as the bomb gets closer and closer to the reflector, in this case, the earth. The bomb's detonating mechanism may, therefore, be set to respond at an intensity which would be reached when the bomb has reached a desired altitude C above the earth's surface.

Mechanism for accomplishing the controlled detonation is illustrated in Fig. 2. A microphone 4 which may be of the condenser type picks up the sound vibrations. The microphone is preferably adjusted so that it has a peak in its response characteristic at the desired frequency which is to be used to actuate the detonator. The sound vibrations are converted to electrical vibrations of corresponding frequency and intensity and impressed on the grid 5 of amplifying tube 6. This varying electrical potential is then impressed on relay 7, which is connected in the anode circuit of tube 6. A reed 8 associated with relay 7 is tuned to respond to the desired frequency, in the case covered by the example, 3,000 cycles per second, and the gap is adjusted so that the reed 8 makes contact with pole 9 only when a desired intensity of vibration has been reached. When contact is made, current from the heater battery 10 is used to actuate an electrical detonator, not shown, which explodes the bomb at the desired height C above ground level.

The modification of the invention illustrated in Fig. 3 shows how a carbon button type microphone can be used in place of a condenser microphone. Just as in the case of the condenser microphone, sound vibrations are picked up by carbon button microphone 15, changed to electrical vibrations of corresponding frequency, amplified by tube 16, and impressed on relay 17. When the oscillations in the relay are the same frequency as that to which reed 18 is tuned, the reed starts to vibrate and when the proper intensity has been attained the reed will make contact with pole 19. The battery 20 supplies current through resistor 21 to operate the microphone. Battery 20 also may supply current to the detonator circuit and to the cathode heater 22. Condenser 23 prevents D. C. potential from battery 20 from reaching grid 24 and the resistor 25 bleeds off the excess charge which accumulates on the grid. A cathode biasing resistor 26 and a by-pass capacitor 27 are used in the conventional manner. A battery 28 supplies current to the anode circuit.

The apparatus is simple and compact and can be constructed so that it occupies relatively little space in the nose of a bomb. As illustrated in Fig. 1, the curved surfaces 11 represent a horn-like sound collector at the end of which is a microphone 34. Spaced around the fuse cartridge are the various parts of the mechanism such as the relay 37, tube 36, and power supply 13. Miniature batteries may be used in the power supply and the tube may also be of the miniature type.

A tetrode or pentode vacuum tube may be used and it may have any one of several different ranges of characteristics. Fig. 1A is an end view of the bomb shown in Fig. 1 and shows how the cover of the cartridge may have perforations 14 to admit the sound but protect the microphone.

Other advantages of this type of proximity fuse are related to its ability to respond only to the frequency and intensity of sound for which it is set. Since it is a relatively insensitive type of sound responsive apparatus it will not respond to the frequency of the whistle as it is produced on the bomb. Nor will it respond to sudden shocks or explosive sounds which may occur in its vicinity. Even momentary sounds of the frequency to which it is set to respond will not cause the reed to vibrate with sufficient amplitude to close the contact through the detonating circuit since the frequency must be received for an appreciable length of time and with considerable intensity in order to get the reed to vibrate sufficiently.

The height at which the bomb is set to explode may be controlled with a fair degree of accuracy. The frequency of the generated sound may be set very closely and the maximum speed which the bomb will attain when falling may also be accurately predicted. Unlike an object falling in a vacuum, an object falling in air will reach a velocity such that the air resistance encountered will just counterbalance the gravitational effect which tends to accelerate the velocity.

The device is also self-compensating for effects on the intensity of the reflected sound wave such as a forest will cause. A forest area will absorb more sound, thus decreasing the intensity of the reflected wave. The bomb will thus approach the ground surface closer before exploding, which is just the condition desired when bombing enemy troops concealed in woodland.

I claim as my invention:

1. An aerial bomb exploding mechanism of the class described comprising means carried by the aerial bomb for generating sound waves of a predetermined frequency while said bomb is falling through the air, means also carried by said bomb for detecting said sound waves after they have been changed to a different predetermined frequency and for converting said sound waves into corresponding variations of electrical potential, and means selectively responsive to said variations in potential for closing an electrical detonating circuit when said variations have reached a predetermined intensity.

2. An aerial bomb exploding mechanism comprising means carried by the aerial bomb for generating and radiating sound waves of a first predetermined frequency while said bomb is falling toward a target, means, also carried by said bomb, for detecting said sound waves after they are reflected from a surface adjacent said target and for converting said sound waves into corresponding variations of electrical potential, vibratile means tuned to selectively respond to said variations when said variations are of a second predetermined frequency related to said first frequency, and detonating means actuatable by said vibratable means when said vibratable means is actuated at a predetermined intensity.

3. An aerial bomb exploding mechanism, according to claim 2, in which the frequency of sound generated by said sound generating means is proportional to the velocity of travel of said bomb with respect to the air.

4. An aerial bomb exploding mechanism, ac-

cording to claim 2, in which said sound detecting means is a microphone and said vibratile means is a tuned reed.

5. A bomb fuse adapted to explode an aerial bomb at a predetermined height above a target surface, said fuse comprising means for detecting sound vibrations reflected from a surface which includes said target surface and for converting said sound vibrations into corresponding electrical oscillations, vibratile means tuned to a predetermined frequency and selectively responsive to said oscillations when said oscillations are of said predetermined frequency, and a detonator switch actuatable by response of said vibratile means when said sound vibrations are of a predetermined level of amplitude.

6. An apparatus according to claim 5 in which said vibratile means is a tuned reed.

7. An apparatus according to claim 5 in which said sound detecting means comprises a capacitance type microphone.

8. An apparatus according to claim 5 in which said sound detecting means comprises a capacitance type microphone having a peak response at said predetermined frequency.

9. A bomb fuse adapted to explode an aerial bomb at a predetermined height above a target surface, said fuse comprising a microphone, a vacuum tube amplifier for amplifying the output of said microphone, a relay in the output circuit of said amplifier, a tuned reed selectively tuned to vibrate in response to electrical oscillations of a predetermined frequency set up in said relay,

and a detonator switch actuatable by said tuned reed when said reed is caused to vibrate at a predetermined amplitude.

10. A method of exploding a falling aerial bomb at a predetermined height above a target comprising generating sound waves of a first predetermined frequency on said bomb, detecting said sound waves on said bomb after reflection from a surface adjacent said target and causing said sound waves to explode said bomb when said sound waves have been detected at a second predetermined frequency higher than said first frequency.

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