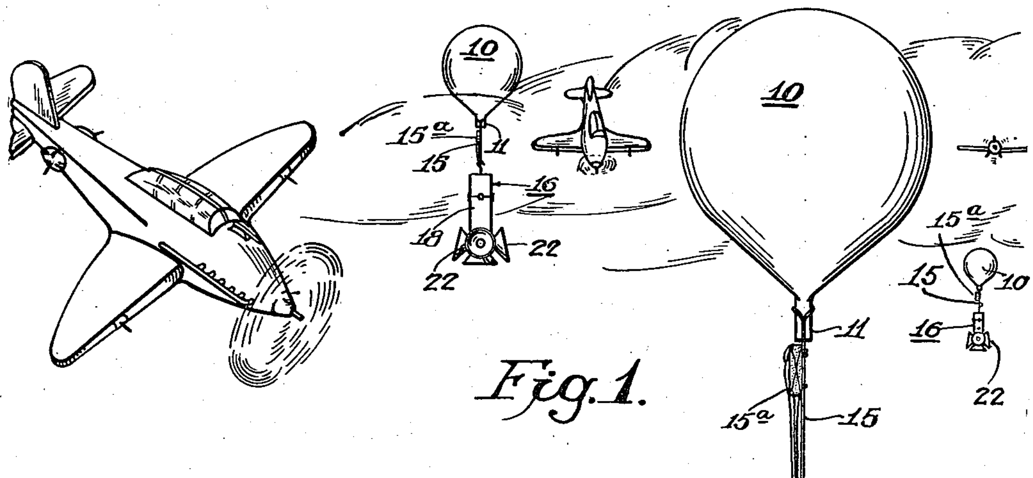
Feb. 8, 1944. J. A. BARKLEY 2,341,351

AERIAL MINE

Filed May 15, 1941 2 Sheets-Sheet 1



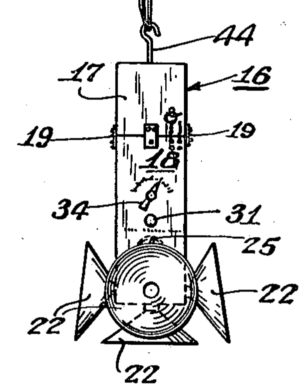


Fig. 1.

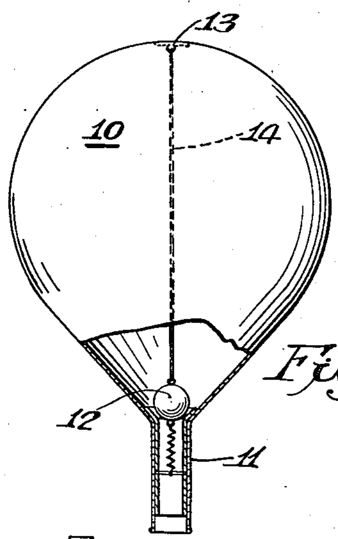


Fig. 6.

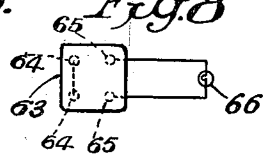


Fig. 8

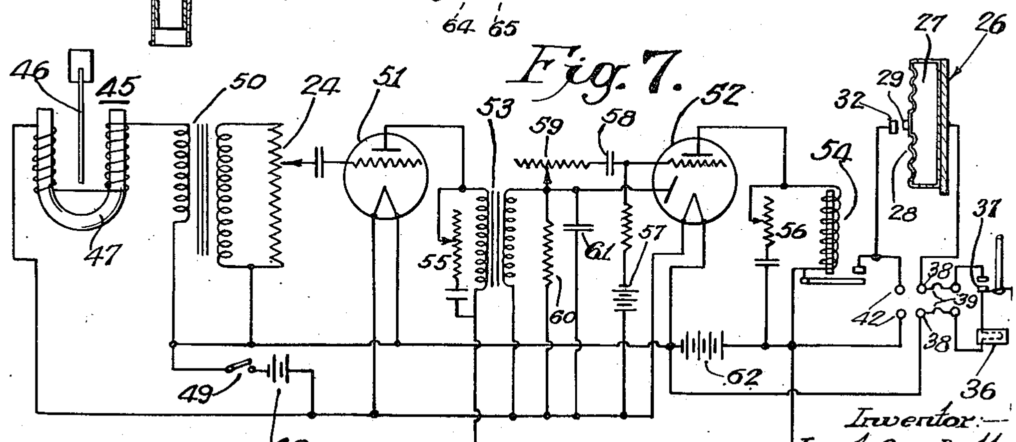


Fig. 7.

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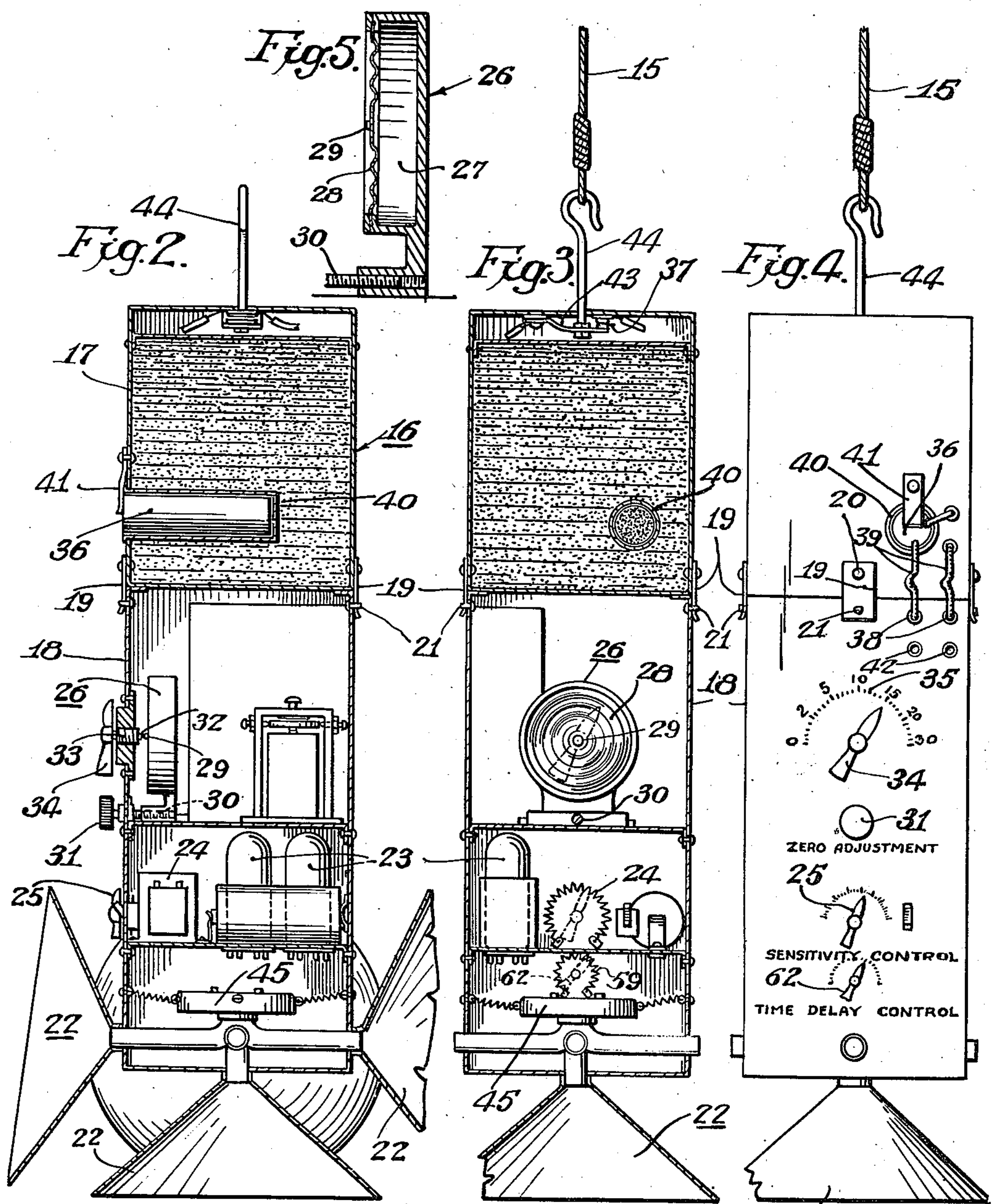

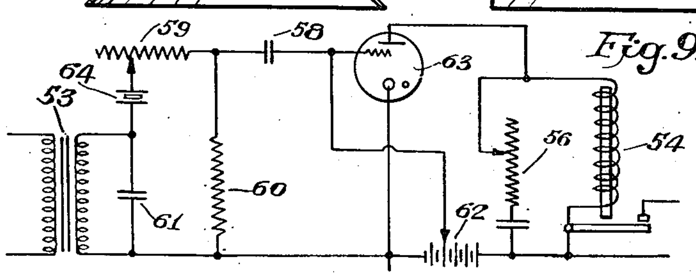

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AERIAL MINE

Joseph Amos Barkley, Silvercroft, Del.

Application May 15, 1941, Serial No. 393,617

1 Claim. (Cl. 102—9)

This invention relates to aerial mines, and more particularly, to a mine adapted to operate at a given height above the earth and to explode in response to sound waves or vibrations from a source, such as a hostile aircraft, in predetermined proximity to the mine.

An important object of the invention is the provision in a mine of this character of means for preventing response of the mine to extraneous disturbances, such as the explosion of anti-aircraft fire.

A further object of the invention is to provide a construction preventing response of the mine to even those vibrations to which it is sensitive until it has reached a predetermined height above the terrain from which it is launched.

A still further object of the invention is the provision of means whereby the mine will be maintained at all times at a predetermined level.

Another object of the invention is the provision of means whereby the mine will only explode upon an approach thereto by the aircraft which it is designed to destroy within certain limits.

A further object of the invention is the inclusion in the structure of certain safety devices precluding accidental detonation of the mine during launching or landing thereof.

Other objects and advantages of the construction will become obvious throughout the course of the following description.

In the drawings, wherein for the purpose of illustration I have shown a preferred form of my invention,

Fig. 1 is a pictorial representation of the use of mines constructed in accordance with my invention;

Fig. 2 is a vertical sectional view through the mine unit;

Fig. 3 is a vertical sectional view through the mine unit taken at right angles to the view of Fig. 2;

Fig. 4 is a side elevation of the mine unit;

Fig. 5 is a detail sectional view of the barometric switch;

Fig. 6 is a detail view partially in section of one of the balloon elements;

Fig. 7 is a diagrammatic illustration of the mine-controlling circuit;

Fig. 8 is a diagrammatic illustration of a device used to adjust the barometric switch; and

Fig. 9 is a diagrammatic illustration of a modified form of control circuit.

Referring now more particularly to the drawings, the numeral 10 generally designates a suitable gas-inflated supporting balloon which may be employed either singly or in multiple with the mine unit hereinafter to be described. This balloon element is equipped with means whereby it will move to a selected height and remain at that height. This may be accomplished, for example, by providing the balloon with an outlet neck 11, the upper end of which affords a seat for a spring-seated check valve 12 preventing the escape of the supporting gas therefrom. As at present shown, this check valve is connected to a remote portion of the balloon, indicated at 13, by the flexible element 14, with the result that when the balloon distends beyond a predetermined diameter, as it will when it reaches a sufficiently rarefied atmosphere, the flexible element 14 will lift the valve 12 from its seat, permitting release of a portion of the contents until the balloon is restored to its predetermined maximum size. Since the rarefication of the atmosphere may be at least generally said to be proportional to the distance from the earth, such an arrangement will serve to maintain the balloon at an approximate selected altitude. By adjusting the length of element 14 and the amount of gas in the balloon, the maximum altitude can be regulated.

Suspended from the balloon, as by means of flexible element 15, is a mine unit 16. Preferably a parachute 15*a* is attached to the mine unit so as to lower the same gradually in the event that the balloon should burst. Unit 16 comprises an upper casing element 17 at present shown as adapted to receive the explosive (see Figs. 2 and 3), and a lower casing element 18, detachable from the casing element 17 as by means of quick-detachable fasteners indicated at 19, and at present shown as spring plates rotatable about pivots 20 and engaging pins 21 carried by the elements 18. The bottom casing element 18 carries, preferably at its lower end, a series of vibration-receiving horns or sound collectors 22. This element likewise affords a housing for the electrical control apparatus 23 including a sensitivity control 24 which may be adjusted through an externally disposed knob 25 and a time delay control 59 similarly adjustable by knob 62.

In addition to affording space for the electrical control apparatus hereinafter to be more fully described, the element 18 likewise houses a barometric switch 26. Switch 26 (see Fig. 5) comprises a closed chamber 27, one face of which is in the form of a flexible diaphragm 28 carrying the switch contact 29. The chamber 27 is bodily adjustable toward and away from one wall of the element 18 by means of a screw 30 rotatably mounted in this wall and having at its outer end an adjusting knob 31. The contact 29 of diaphragm 28 is opposed by a contact 32 on the inner end of a screw 33 adjustable through the same wall as that mounting the screw 30 and controllable through a knob 34 coacting with a suitable dial 35 (see Fig. 4) which may be conveniently graduated in thousands of feet.

The electrical control apparatus is connected to a detonator 36 and to a switch 37 by means of jack sockets 38 and associated jack plugs on jumper connections 39. The detonator is removably held in a receptacle 40 within the explosive chamber 17 by means of a clip 41. A pair of jack sockets 42 are disposed adjacent the jack sockets 38 for a purpose which will be described later. It will be noted that the detonator is quickly removable merely by operation of clip 41 and removal of the jack plugs electrically connecting it to the other elements. Moreover, the entire explosive charge may be quickly separated from the rest of the mine simply by detaching section 17 from section 18.

The switch 37 is normally biased to its open position, as shown in Fig. 2, for example by the resilience of arm 43 and the weight of hook 44 secured thereto. By means of the hook, the flexible element of the sustaining balloon or balloons is connected to the mine. Thus when the element 15 is not under tension, i. e., when the balloon is on the ground or in the event that the balloon bursts while in the air, the switch 37 is opened and prevents explosion of the mine. When the weight of the mine is sustained by the balloon, switch 37 will be closed. This will, of course, occur immediately upon proper inflation of and release of the balloon, and, under ordinary circumstances, the mine would then be ready for detonation. Any possibility of such detonation is, however, prevented through the barometric switch 26 which, prior to release of the balloon, is set to prevent closure of such switch until the balloon has reached a predetermined elevation above the terrain from which it is released.

Referring now to the electrical system illustrated in Fig. 7, there is provided a suitable vibration-responsive device 45 which is arranged to receive the sound vibrations collected by the collectors 22. This device may take any suitable form, for example, it may comprise one or more vibrative reeds 46 and an associated electromagnet 47 forming a simple electric generator, as will be well understood. This device serves, of course, to translate the vibrations received by the vibrative element 46 into electrical currents. The vibrating reeds may be designed and arranged to vibrate over a predetermined frequency range. By mounting the reed or reeds in rubber, or by damping the reeds in any suitable manner, a wider frequency response range may be obtained.

It will be apparent that the device 45 may take other well-known forms; for example, it may take the form of a microphone. In any case, this device should be designed so that it has a resonance frequency or frequencies of vibration within a predetermined frequency range including the noise or sound frequencies commonly produced by aircraft.

A common battery 48 may serve as a source of energy in the circuit of the device 45, and may also serve to energize the filaments of the electron tubes employed. A manual switch 49 controls the energization of the apparatus.

The voltage produced by the vibration-responsive device 45 may be supplied to a step-up transformer 50 which is preferably peaked to the frequencies above mentioned. The voltage across the secondary of transformer 50, or a desired portion thereof, is supplied to an electron tube amplifier which may comprise as many cascaded stages as may be desired. The sensitivity control device 24, previously referred to, may take the form of a potentiometer interposed between transformer 50 and the first tube 51, as illustrated, and serving to control the gain of the amplifier. Tube 51 may take the form of a simple triode, as illustrated, or it may take any other suitable form. In the specific circuit illustrated, tube 51 is coupled to a diode-triode tube 52 by means of a transformer 53, which is also preferably peaked to the desired frequencies. A by-pass condenser 61 serves to control the frequency response. This condenser may have a capacity of about .002 microfarad. Tube 52 serves to control a relay 54, which in turn controls the energization of the detonator 36, as will be described presently. If desired, suitable filters 55 and 56 may be connected as illustrated in order to further improve the frequency response of the circuit, and each filter may comprise an adjustable resistor and condenser.

While it is preferred to employ the diode-triode tube 52 for reasons which will be apparent later, it is within the contemplation of the invention to employ any suitable single or multistage amplifier. Moreover any suitable type of interstage coupling may be employed; for example resistance-capacitance coupling could be used.

The diode-triode 52 is arranged so that it is normally inoperative or quiescent, and it is adapted to be triggered by incoming vibrations, provided such vibrations are of a sustained nature and are not merely of a transient nature. To this end, the triode section of the tube is biased substantially to plate current cut-off by means of a biasing source 57. The diode rectifier circuit is connected to the control grid of tube 52 through a condenser 58 and a variable resistor 59. The rectified voltage appearing in the rectifier circuit is thus impressed on condenser 58 through variable resistor 59 which controls the rate at which the condenser is charged by the said voltage. Condenser 58 may have a capacity of about 8 microfarads, while resistor 59 may have a resistance of about one megohm. A resistor 60 which is also of very high resistance slowly discharges the condenser. The condenser-charging voltage is polarized in opposition to the negative bias voltage on the grid of tube 52, and, therefore, when the condenser becomes sufficiently charged, it overcomes the negative bias and causes plate current to flow in the triode section of tube 52. It will be apparent that by varying the resistance 59, the time delay or time required to charge the condenser 58 may be varied. By this arrangement, the circuit is caused to discriminate between sustained vibrations and vibrations of short duration, and the discriminating action may be varied by means of resistor 59. Continuous or sustained vibrations will cause the condenser 58 to accumulate a charge until it triggers the tube, whereas transient vibrations will not charge the condenser sufficiently to trigger the tube and any charge due to such vibrations will be dissipated by resistor 60. Thus, the device is caused to operate in response to the sustained vibrations produced by approaching aircraft, and at the same time it is prevented from responding to vibrations of short duration such as may be caused by anti-aircraft fire, the explosions of nearby mines, etc.

It will be apparent also that the circuit may be designed and adjusted to operate at a predetermined noise level corresponding to predetermined proximity of an aircraft. Obviously any desired threshold level may be established by the tube bias and the condenser.

The employment of the particular circuit illustrated also conserves the plate supply battery, since the tube 52 is non-conductive except when it is triggered.

Since the switches 26 and 37 will have been previously closed, as described above, the energization of relay 54 completes an energizing circuit for the detonator 36 which may be energized from the plate supply source 62. The detonator, when thus activated, causes the explosion of the explosive material within the chamber 17.

In order to assure proper operation of the barometric switch 26 and to compensate for surface elevation and local barometric conditions, this switch may be pre-adjusted in the manner now to be described. The jack plugs are removed from jack sockets 38, and a special jack plug 63, as shown in Fig. 8, is inserted in the jack sockets 38 and 42. The prongs 64 of this plug are connected together and serve to bridge sockets 42, while the prongs 65, which are received by sockets 38, are connected to a voltmeter or a lamp 66. It will be seen that this disconnects the detonator 36 and the switch 37 and places the voltmeter, or lamp, in circuit with the battery 62 and the barometric switch 26. The handle 34 is set to zero altitude, and the zero adjustment knob 31 is rotated in a direction to close the contacts of the barometric switch which will be indicated by the lamp or voltmeter. This adjustment establishes the contact 29 in proper position for zero altitude. The knob 34 is then turned until it indicates the altitude at which it is desired that the barometric switch shall close. This adjustment, of course, establishes the contact 32 at a certain distance from contact 29.

It will be apparent to those skilled in the art that other forms of trigger type control circuits may be employed. For example, in Fig. 9 there is shown another form of such a circuit employing a gas filled ionic-cathode glow-discharge tube 63 commonly known as a gas trigger tube. The voltage across the secondary of transformer 53 is applied to a suitable rectifier, such as the oxide rectifier 64. The rectified voltage is applied to condenser 58 which is connected to the starter grid of the gas tube. The starter grid may be maintained at a potential just below the trigger potential of the tube by means of the tap on battery 62. The voltage on condenser 58 is polarized the same as the potential applied to the grid.

In response to sustained vibrations the condenser 58 will acquire a charge sufficient to trigger the tube, causing plate current to flow and thereby energizing relay 54. Transient vibrations, however, will not charge the condenser sufficiently to trigger the tube, and the resistor 60 will dissipate any charges due to such vibrations.

Aside from the above-noted differences, the circuit of Fig. 9 is similar to that of Fig. 7 and operates in the same manner. It should be noted, however, that in the use of the gas tube it may be unnecessary to amplify the voltage generated by device 45, as such voltage may be sufficient to trigger the tube, but it is desirable to employ one or more stages of amplification.

From the above description, it will be seen that the invention provides a novel aerial mine having various novel features. It will be understood, of course, that the invention is not limited to the specific structure illustrated, but is capable of various modifications within the scope of the appended claim.

I claim:

In an aerial mine, an elevating balloon, a mine unit, means for suspending said unit from said balloon, detonating means for exploding the mine, an electrical energizing circuit for said detonating means, vibration-responsive means for closing said energizing circuit, a normally open safety switch included in said circuit and operable by said suspension means to closed position whenever said unit is lifted by said balloon, and a normally open barometric switch included in said circuit serially with said safety switch and operable by predetermined atmospheric pressure to closed position when said unit is lifted by said balloon to a predetermined altitude.

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