

Feb. 20, 1968

W. A. S. BUTEMENT ETAL

3,369,487

PROXIMITY FUZES FOR PROJECTILES

Filed Sept. 23, 1943

4 Sheets-Sheet 1

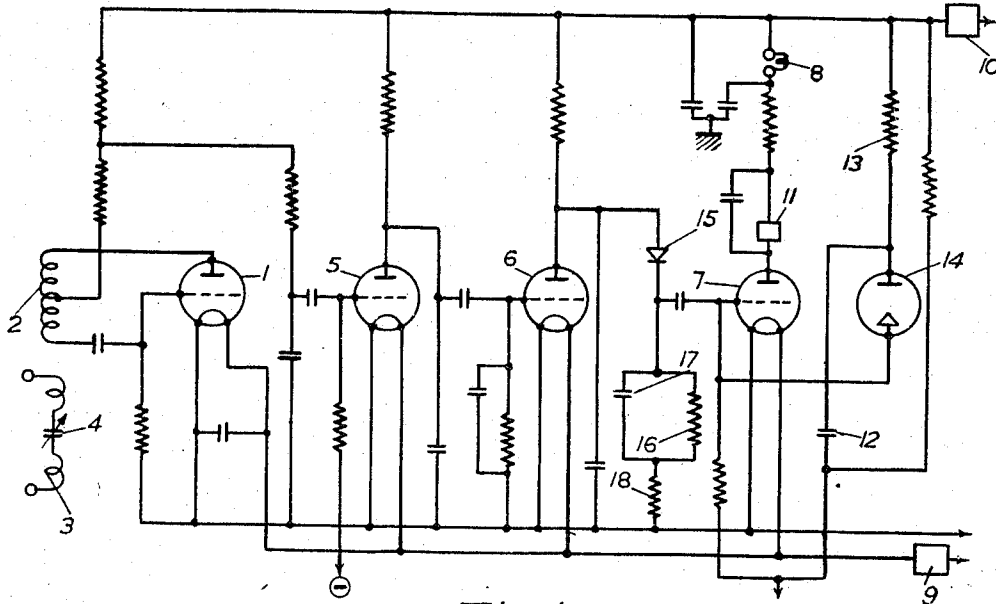


Fig. 1.

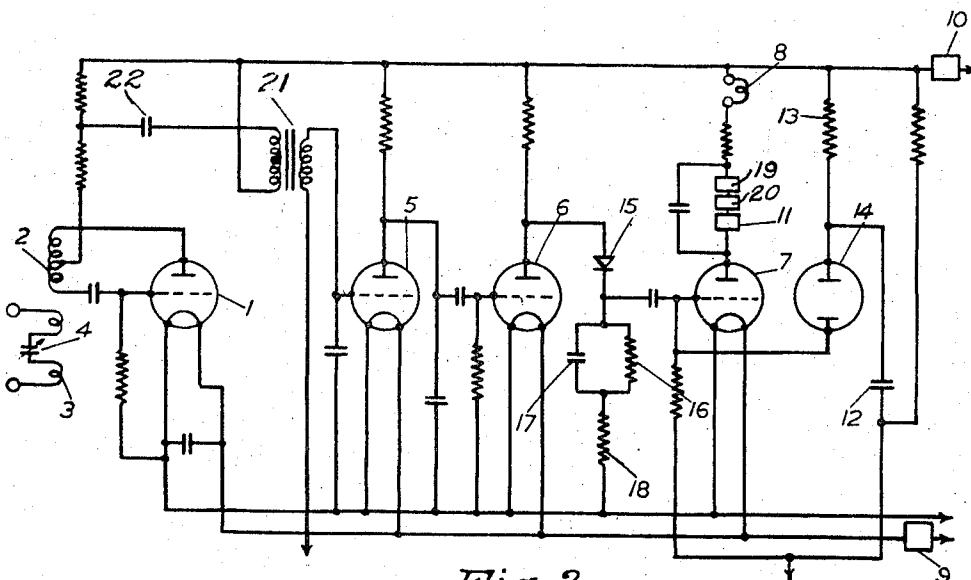


Fig. 2.

INVENTORS
William Alan Stewart Butement
Edward Samuel Shire
Amherst Felix Home Thomson
By
Lloyd Hall Sutton
Attorney

Feb. 20, 1968

W. A. S. BUTEMENT ETAL

3,369,487

PROXIMITY FUZES FOR PROJECTILES

Filed Sept. 23, 1943

4 Sheets-Sheet 2

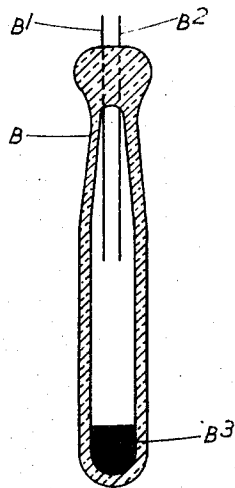


Fig. 4.

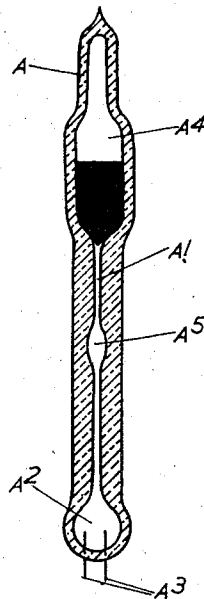


Fig. 3.

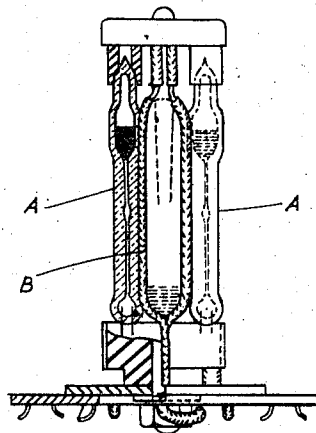


Fig. 5.

INVENTORS
William Alan Stewart Butement
Edward Samuel Shire
Amherst Felix Home Thomson

By
Lloyd Hall Sutton
Attorney

Feb. 20, 1968

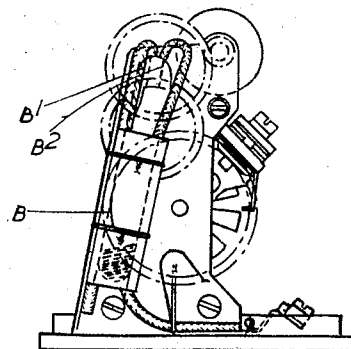
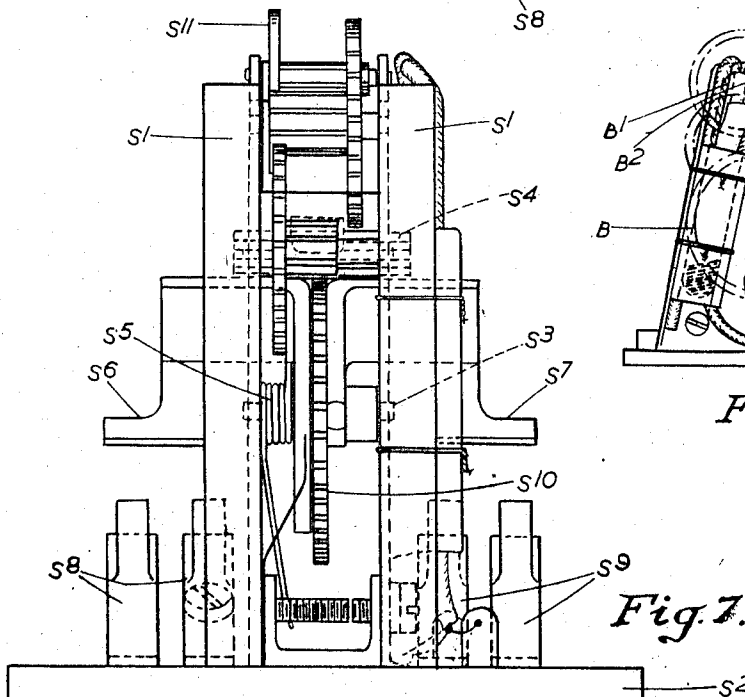
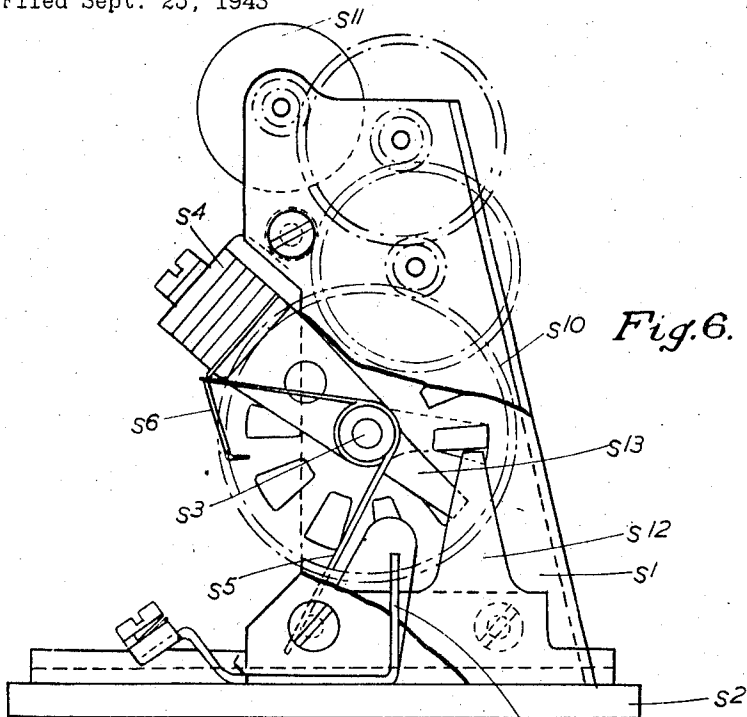
W. A. S. BUTEMENT ETAL

3,369,487

PROXIMITY FUZES FOR PROJECTILES

Filed Sept. 23, 1943

4 Sheets-Sheet 3



INVENTORS
William Alan Stewart Butement
Edward Samuel Skire
Amherst Felix Home Thomson
By
Lloyd Hall Sutton
Attorney

Feb. 20, 1968

W. A. S. BUTEMENT ET AL

3,369,487

PROXIMITY FUZES FOR PROJECTILES

Filed Sept. 23, 1943

4 Sheets-Sheet 4

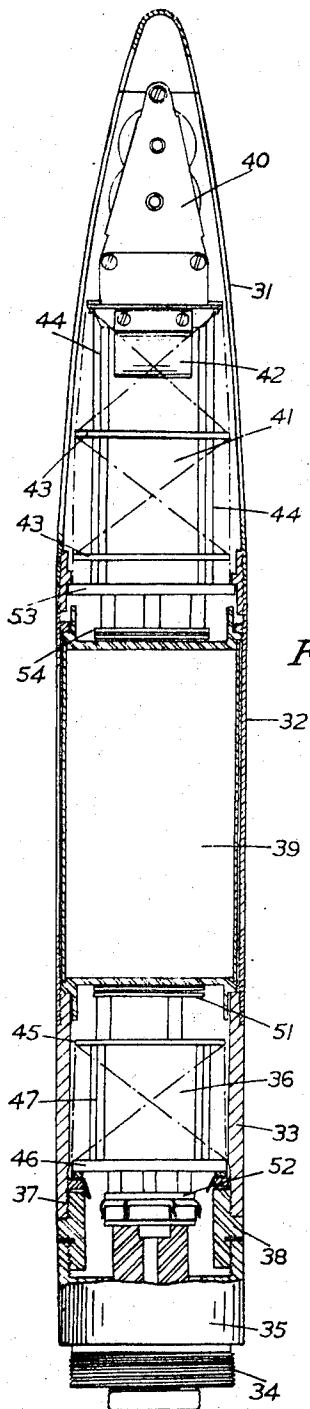


Fig. 9.

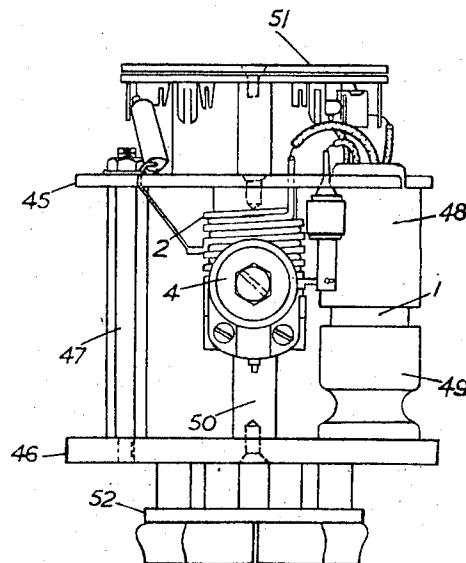


Fig. 10.

INVENTORS
William Alan Stewart Butement
Edward Samuel Shire
Amherst Felix Home Thomson
By
Lloyd Hall Sutton
Attorney

1

3,369,487

PROXIMITY FUZES FOR PROJECTILES

William Alan Stewart Butement, Edward Samuel Shire, and Amherst Felix Home Thomson, London, England, assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy
Filed Sept. 23, 1943, Ser. No. 503,523
13 Claims. (Cl. 102—70.2)

This invention relates to projectiles of the kind which do not rotate to any substantial extent whilst in flight, examples of such projectiles being rockets which are propelled and stabilised by the ejection of gases evolved by the combustion of a fuel charge carried by the rocket. The invention is also applicable to shells or bombs dropped from aircraft or discharged from a non-rifled gun and stabilised by fins or the equivalent and to so-called radio-controlled "Queen Bee" aircraft containing an explosive charge and propelled in any convenient manner.

The main object of the invention is to provide a projectile of this kind with a fuze which will automatically cause detonation of the explosive charge of the projectile at the appropriate distance from the target, for example, an aircraft.

The improved projectile according to the invention has a fuze comprising a transmitter of radio-frequency energy of predetermined characteristics, a receiver responsive to such energy reflected from the target and control means operated by the receiver. Conveniently the transmitter-receiver apparatus controls the initiation of detonation of the projectile. A dipole aerial for the transmitter receiver apparatus may be constituted by a part or the whole of the casing of the projectile, the directional characteristics of the aerial preferably being such that its sensitivity lies within a substantially conical surface defining the limits of a zone of predetermined "look forward" angle within which the target must lie to cause operation of the control means. Preferably means are provided to render ineffective energy radiated by the transmitter and reflected from the ground.

Transmitted and reflected oscillations may be combined in the transmitter-receiver apparatus to produce low frequency, preferably audio-frequency, oscillations for influencing the control means. Such low frequency oscillations may be derived from variations in the amplitude and/or the phase of the reflected oscillations, but preferably they comprise beat frequency oscillations formed by a combination of oscillations of the frequency transmitted and the reflected oscillations which differ in frequency from those transmitted due to the "Doppler" effect.

The following is a description, by way of example, of a fuze arrangement according to the invention, and of several modifications thereof, for a rocket projectile.

In the drawings:

FIGS. 1 and 2 are circuit diagrams of preferred forms of transmitter-receiver apparatus;

FIGS. 3-8 illustrate preferred forms of arming switches;

FIG. 9 shows the complete assembly of the fuze; and
FIG. 10 shows the assembly of the oscillator unit.

This fuze arrangement comprises, essentially, an ultra-short-wave wireless transmitter-receiver apparatus by means of which radio frequency oscillations are transmitted towards and received from the target. Any transmitted oscillations which may be reflected by the target are received and caused to produce low-frequency, for example, audio-frequency pulses which are supplied to an electrical relay for initiating detonation of the high explosive charge of the rocket. In addition, arming devices are provided for ensuring that the fuze does not

2

operate during the initial acceleration of the rocket and there is a self-destruction device which operates if the charge is not detonated within a pre-determined time. Automatic operation of the fuze is confined within a desired locus of the target by limiting the "look forward" angle or zone within which an effective operating impulse is produced by the reflected oscillations, the casing of the rocket being used as a combined transmitting and receiving aerial which is preferably energised as a half or full wave dipole.

Referring to FIG. 1, the transmitter-receiver apparatus comprises an oscillator-detector valve 1 arranged as a Hartley oscillator, the electrode capacities of the valve being used to tune the oscillator coil 2 to the required wavelength which may, for example, lie within the wave band of 5 metres to 5 centimetres and is selected to suit the length of the aerial constituted by the casing of the rocket. The coil 2 is coupled to the aerial coil 3 which is tuned by the condenser 4 and is connected to the split casing of the projectile.

The transmitted oscillations are radiated from the projectile and when there is a target within the "look forward" zone, which is determined in a manner which will be more fully described, a low-frequency signal is developed in the oscillator circuit. This low-frequency signal may be regarded as a beat signal set up between the transmitted signal and the reflected signal received from the target, since the reflected oscillations have, due to the Doppler effect, a different frequency from that of the transmitted oscillations. Thus, for example, if the rocket is moving at 1,000 feet per second towards an aircraft approaching at 500 feet per second and the wavelength of the transmitted oscillations is 1.8 metres, the apparent frequency change of the reflected wave will be approximately 500 cycles per second, and this will be the beat frequency. The beat frequency will drop abruptly to zero as the rocket passes the target and will then rise again to approximately the same level.

Alternatively, the production of the low-frequency signal may be regarded as being due to periodic changes in the impedance of the aerial as the rocket approaches the target. Thus the effective dipole impedance will rise and fall alternately as the rocket, approaching the target, passes through successive points spaced at half wavelength intervals. If, therefore, the oscillator is sensitive to small changes in high-frequency load, the mean value of the output current will vary in a manner which will produce the same low-frequency note as is described above.

The low-frequency oscillations are amplified by means of an amplifier having two resistance-capacity coupled stages 5, 6 and the output of the amplifier is used to trigger a three-electrode gas-filled ionic valve relay 7, for example, of the type sold under the registered trademark "Thyratron." Connected in the anode circuit of the relay is a fusible element or "puffer" 8 for electrically firing the detonator, which causes through the usual gaine, firing of the high explosive charge of the rocket.

In order to prevent premature detonation of the charge, for example, by oscillations reflected from the ground during the initial acceleration period, a two-stage arming device is provided, this device consisting of two switches of which the first is operated by the acceleration of the rocket and acts when its contacts 9, 10 close to complete the filament circuits of all the valves, and the anode circuits of the oscillator and amplifier valves. Thus during this initial arming stage the oscillator-receiver apparatus is "prepared." The second stage of the arming device consists of a deceleration switch having its contacts 11 connected in series in the anode circuit of the gas-filled relay so that this relay cannot operate until the rocket begins

to decelerate following complete combustion of its propelling charge.

Any convenient forms of acceleration and deceleration switches capable of withstanding the "set-back" forces produced during acceleration of the rocket can be used, and preferred forms of such switches are illustrated in FIGS. 3-5. One form of acceleration switch consists of a group of mercury capillary switches arranged with the capillary tubes substantially parallel to the axis of the rocket, there being one capillary switch for each contact to be closed. Thus there is one such switch in the common low tension circuit for energizing the filaments of the various valves, one in the high tension supply circuit to the amplifier valves. If desired there may also be, so described in connection with FIG. 2, one or more such switches in series with one another (and with the deceleration switch) in the high tension lead to the gas-filled relay as an additional precaution against premature completion of the anode circuit of the gas-filled relay. One such capillary switch A is shown in FIG. 3 and comprises a length of glass capillary tube having a bore A1 of, for example, about 0.1-0.16 millimetre diameter with a small bulb A2 at the end thereof remote from the nose of the rocket. The ends of metal wires A3 in the circuit to be completed project into the bulb and are bridged by mercury which flows down the capillary tube from a storage chamber A4 at the front end of the tube when the acceleration of the projectile is sufficient to overcome the surface tension tending to prevent movement of the mercury along the bore. These capillary switches are not reversible and, as a safeguard against rough usage, may be provided with a mercury "trap" A5 at an intermediate point of the bore.

In an alternative and preferred form of acceleration switch, the capillary tubes are replaced by a mechanical inertia switch illustrated in FIGS. 6-8. This comprises a pair of side plates S1 which are spaced apart and supported edgewise on a circular base plate S2 which is mounted, perpendicular to the axis of the rocket, with the side plates extending forwardly. Pivoted between the side plates is a spindle S3 for an arm carrying at its free end a weight S4, a helical or spiral spring S5 being arranged on the spindle so as to bias that end of the arm carrying the weight towards the nose of the projectile. The arm carries two bridging members S6, S7 co-operating with two pairs of contacts S8, S9 respectively connected in all the filament circuits and in the anode circuits of the photo-electric cell and amplifier valves, these contacts being open when the weight is in the forward position. The spindle S3 also carries a pinion S10 connected through a gear train to a small fly wheel S11. A leaf spring S12 disposed between the side plates has its free end bearing against the end S13 of the arm opposite to that carrying the weight S4 to retain the arm in a position in which the contacts are closed.

When the projectile is fired the forward acceleration causes the weight to lag so that it and the arm swing backwardly, causing rotation of the spindle at a speed determined by the inertia of the weight and by the fly wheel. When the weight has swung rearwardly sufficiently to close the contacts, the leaf spring engages over the end of the arm and locks the switch in its closed position.

This mechanical inertia switch is of sturdy construction and readily lends itself to mass production. Moreover, when the contacts are closed they are locked and will not open when the projectile commences to decelerate. The construction is such that the switch can conveniently be re-set following preliminary tests and will stand up to rough usage without the risk of false operation. The acceleration necessary to cause operation of the switch and the time of operation can be varied as desired by adjusting the magnitude and/or the position of the weight on the arm and also by varying the size of the fly wheel or the ratios of the gearing between the arm and the fly wheel.

The deceleration switch consists, irrespective of the type of acceleration switch used, of a mercury switch B

(FIG. 4) of the non-capillary type with a small bore tube having metal wires B1, B2 projecting into one end thereof so that they are readily bridged by a small globule of mercury B3 which can move freely up and down the tube. The tube is mounted so that it is parallel to the axis of the rocket and has the two wires at the forward end. Thus, during acceleration of the rocket the mercury is moved by inertia to the rear end of the tube and the contacts are open. As soon as combustion of the propelling charge of the rocket is completed and the rocket starts to decelerate, the mercury moves along the tube to its forward end thus completing the contacts of the switch and accordingly the anode circuit of the gas-filled relay 4. The relay is now free to operate as soon as the low frequency pulses from the amplifier output are of sufficient magnitude to trigger the relay. As the mercury in the deceleration switch can move freely backwards and forwards, it will be appreciated that the switch will open in the event of any further acceleration of the rocket due, for example, to recommencement of interrupted burning of the propellant charge. FIG. 5 shows the assembly of the mercury acceleration switches A and the deceleration switch B, whilst FIG. 8 shows the assembly of a deceleration switch B and an acceleration switch of the mechanical inertia type.

The acceleration switch operates during the first half-second of flight and the transmitter starts to radiate. As, however, the anode circuit of the relay 7 is open, any oscillations reflected from the ground are ineffective. This half-armed condition also has the advantage that it prevents premature detonation due to initial vibration and microphony or to any electrical surges following closing of the acceleration switches.

A self-destruction circuit including a condenser 12 is connected to the high tension battery in series with a charging resistance 13 when the contact 10 of the acceleration switch closes. A neon lamp 14 has its anode connected to the junction between the resistance and the condenser and its cathode connected to the grid of the gas-filled relay 7. If the fuze has not detonated within a period of, for example, between 5 and 35 seconds, as determined by the values of the condenser and charging resistance, the condenser voltage will reach a value sufficient to "strike" the neon lamp. The condenser then discharges through the lamp 14 to apply a triggering impulse to the gas-filled relay, the anode circuit of which has in the meantime been completed by closing of the contact 11 of the deceleration switch.

The desired look-forward zone within which detonation takes place is mainly determined by the directional characteristics of the dipole aerial. Thus, for example, in the case of full wave excitation of the aerial, the polar diagram consists (viewed in cross-section) of four lobes which may be regarded as having approximately the form of a pair of butterfly wings in any plane containing the axis of the rocket. The two forward lobes are contained within a substantially conical space bounded by the surface of revolution generated by a line inclined at about 54° to the longitudinal axis of the rocket. Such a zone corresponds closely to the cone of fragmentation of the projectile but is somewhat forward of such cone. Accordingly to compensate for this a suitable time delay device may be provided in the firing train.

The two rearward lobes will tend to cause reflection from the ground but the chance of premature operation of the fuze due to this reflection is mainly reduced by the two-stage arming arrangement described above which prevents full arming until the rocket is sufficiently far from the ground for the intensity of the ground reflections to be very low. In addition, however, a filter circuit may be provided which distinguishes between reflected impulses of diminishing intensity due to ground reflections and those of increasing intensity such as are due to an approaching target. Such a filter circuit may comprise a contact rectifier 15 connected in the amplifier output cir-

cuit in series with a resistance-capacity network 16, 17, 18, the grid of the gas-filled relay 7 being connected to the output circuit between the rectifier and the network. The values of the network resistance and the condenser are so chosen that signals of decreasing amplitude can leak to "earth" whilst signals of increasing amplitude will build up across the condenser to produce a triggering voltage on the grid of the gas-filled relay.

Undesired ground reflection can also be avoided by arranging for the oscillator to radiate pulses, instead of a continuous train of oscillations. Thus the oscillator may transmit a series of pulses each having a duration of the order of two microseconds, the pulse frequency being, for example, 25 kilocycles per second. Under these conditions any reflections from an object more than about 1,000 ft. away from the rocket will be received during the period between successive impulses when the oscillator is dead. Hence reflections from the ground will be ineffective at heights over about 1,000 feet whilst they are, as described above, rendered ineffective up to this height by the two-stage arming arrangement.

Pulsing can be effected in any known manner. For example, the oscillator and its anode load resistance may be connected in one side of an asymmetric multivibrator circuit, a similar valve without any circuit reactance, being connected in the other side of the circuit, such an arrangement being the equivalent of a super-regenerative circuit. Other forms of circuit employing known methods of "squegging" or separate quenching may be used in conjunction with suitable arrangements for reducing the characteristic hiss.

The circuit shown in FIG. 2 is the same as that shown in FIG. 1 except that the acceleration switch has two additional contacts 19, 20 included in series with the contact 11 of the deceleration switch, and that a special coupling circuit for reducing the effects of microphony is included between the oscillator 1 and the first amplifying stage 5. This comprises a loose-coupled transformer 21 and a condenser 22, the arrangement being adapted to act as a band-pass filter which will reject microphonic noises outside the range of signal frequencies.

Microphony of the oscillator itself can be reduced to a minimum by using bridge circuits either on the high frequency side, for example by including the aerial in one arm of the bridge to balance out radio-frequency disturbances, or on the low frequency side by means of a circuit which is balanced against microphonic disturbance but allows the signal frequency output to accumulate.

Apart from such electrical methods of reducing microphony special precautions are taken in the mounting of the valves and other components.

The construction and assembly of the fuze, illustrated in FIGS. 9 and 10, are largely determined by the requirement that it must be able to withstand a very high axial acceleration which may be, in the case of a rocket, of the order of 1,200 feet per second per second. The electrical components are, accordingly, preferably divided into separate units or groups which can readily be assembled within the casing of the rocket head so that the components are spaced along and close to the longitudinal axis, where the applied stresses exercise the least harmful effect and the components are in the most favorable positions for connection to one another.

The valves are flexibly mounted so that vibration and microphony are reduced to a minimum, the oscillator unit 36 being housed in a section separate from that containing the amplifier. In order to reduce the lengths of connecting leads the oscillator unit is arranged close to an insulating ring 38 which divides the outer casing of the entire projectile into appropriate parts for it to constitute the combined transmitting and receiving dipole aerial previously mentioned. This ring is situated at a distance from the nose of the projectile equal to $\lambda/4$ λ being the wave length of the transmitted radiation, and also, approximately the length of the entire projectile.

The outer casing of the fuze (which constitutes the front portion of the complete rocket) is formed in three separate parts 31, 32, 33 which are assembled together end to end, the front part 31 being of suitable tapered or ogive form. The rearmost section 33, which is screw-threaded at 34 to screw into the main body of the rocket containing the explosive and propelling charges, has at the end of the section adjacent to the explosive charge a chamber 35 containing a gaine provided with a centrifugal shutter and a detonator which is electrically fired by means of the fusible element 8 connected in series in the anode circuit of the gas-filled relay 7. The oscillator unit 36 comprises the combined transmitting and detecting valve with its associated circuits and is also mounted in the rearmost section of the casing, this section itself being formed in two parts connected by a strong cylinder 37 of insulating material having on its outer surface the ring 38 which as stated above divides the casing of the entire rocket into two parts for energisation as a dipole aerial.

The central section 32 of the fuze casing contains a high tension battery 39 for providing anode current for the oscillator and amplifier valves and for the relay, this battery preferably being of the layer type so that it will readily withstand the setback forces during acceleration. If desired, however, the battery may consist of miniature secondary cells connected in series to provide the requisite voltage. When secondary cells are used, insulated terminals may be exposed through suitable apertures in the casing so that the battery can be tested and, if necessary, charged.

The forward section 31 of the fuze casing contains the arming switches 40, and the amplifier unit 41 comprising the valves 5, 6 and associated circuits and the gas-filled relay 7. These valves and the associated circuit components are assembled between two discs 43 supported by pillars 44 secured to a supporting disc 53. All the valves are mounted with their axes parallel to the axis of the rocket and are protected by rubber caps, as described in connection with FIG. 10. Also secured to the pillars 44 is a low tension battery 42 for energising the filaments of all the valves. Annular distributor discs or rings such as 51, 52, 54 are provided at the ends of the several units so that the units can, after assembly in the several casing sections be easily electrically connected, these distributor discs having the appropriate number of sets of contacts so asymmetrically arranged that they cannot be incorrectly connected.

The oscillator unit, shown in detail in FIG. 10, is supported mainly between two circular discs 45, 46 which are spaced apart by a pair of hexagonal pillars 47. The combined oscillator and detector valve 1 is mounted between the discs so that it is parallel to the longitudinal axis of the projectile, the valve being protected from vibration by means of supporting rubber caps 48, 49 which fit over the ends of the valve and are forced into apertures in the discs. The connecting leads to the valve are brought out through an aperture in one of the end caps. Also mounted between the discs is a former 50, preferably of low-loss synthetic insulating material, such as that sold under the registered trademark "Trolitul," which carries both the oscillator coil 2 and the aerial coil 3, this former being mounted, like the valve, with its axis parallel to the longitudinal axis of the projectile. The aerial coupling coil which consists of a single turn is divided into two parts connected by a variable coupling condenser 4 which is preferably of the "trimmer" type, having for example a dielectric of low-loss porcelain. The remaining circuit components including the necessary coupling resistances and condensers are arranged in suitable positions between the two supporting plates. Contact discs 51, 52 are provided on the outer sides of the two plates, these discs being provided with the appropriate contacts for connecting the oscillator output to the am-

plifier, the filament and anode circuits to the appropriate switches, and the aerial coupling coil to the aerial.

In order to ensure adequate energisation of the aerial the two parts of the casing which are separated by the insulating ring may each be provided, in the inside, with several terminals which are connected in parallel with one another to the appropriate end of the aerial coupling coil.

It is to be understood that the above description is by way of example only, and that the arrangement and selection of the various parts of the fuze can be varied to suit the shape and calibre of that part of the projectile within which it is housed.

We claim as our invention:

1. In a projectile, a proximity fuze comprising a radio transmitter and receiver, a common aerial for said transmitter and receiver, and a relay arranged to initiate operation of the fuze on receipt of triggering energy, said receiver being responsive to radio frequency energy transmitted from said aerial to and reflected back to said aerial from a target to trigger said relay.

2. In a projectile, a proximity fuze comprising a radio transmitter and receiver, a casing for said projectile which constitutes a common dipole aerial for said transmitter and receiver, and a relay arranged to initiate operation of the fuze on receipt of triggering energy, said receiver being responsive to radio frequency energy transmitted from said aerial to and reflected back to said aerial from a target to trigger said relay.

3. In a projectile, a proximity fuze comprising an aerial, a radio transmitter-receiver including a thermionic valve oscillator connected to said aerial and arranged to act as an oscillator-detector, an impedance in the anode circuit of said oscillator, and a relay arranged to initiate operation of the fuze on receipt of triggering energy, said relay being responsive to the audio frequency oscillations which occur across said impedance when radio frequency energy transmitted from said aerial is reflected by and received from a target.

4. In a projectile, a proximity fuze comprising an aerial, a radio transmitter-receiver including a thermionic valve oscillator connected to said aerial and arranged to act as an oscillator-detector, an impedance in the anode circuit of said oscillator, a grid-controlled gas filled discharge relay, a thermionic valve amplifier responsive to the audio-frequency oscillations which occur across said impedance when radio-frequency energy transmitted from said aerial is reflected by and received from a target and connecting said transmitter-receiver to said relay and a fusible element in the anode circuit of said relay to cause operation of the fuze.

5. In a projectile, a proximity fuze comprising a radio transmitter and receiver, a common aerial for said transmitter and receiver, a relay arranged to initiate operation of the fuze on receipt of triggering energy, said receiver being responsive to radio frequency signals transmitted from said aerial and reflected back to said aerial from a target to trigger said relay, and a filter circuit between said receiver and said relay including a condenser and a leakage resistance so arranged as to build up a triggering voltage from signals of increasing amplitude only.

6. In a projectile, a proximity fuze comprising an aerial, a radio transmitter-receiver including a thermionic valve oscillator connected to said aerial and arranged to act as an oscillator-detector, an impedance in the anode circuit of said oscillator, an amplifier, a relay arranged to initiate operation of the fuze on receipt of triggering energy, and a band-pass circuit coupling said oscillator to said amplifier, the audio-frequency oscillations which occur across said impedance when radio frequency energy transmitted from said aerial is reflected by and received from a target being passed by said coupling circuit, amplified and utilized to trigger said relay, whilst undesired frequencies lying outside the frequency range of said

audio-frequency oscillations are rejected by said coupling circuit.

7. In a projectile, a proximity fuze comprising a radio transmitter and receiver having a common aerial, a relay arranged to initiate operation of the fuze on receipt of triggering energy, said receiver being responsive to radio frequency energy transmitted from said aerial to and reflected back to said aerial from a target to trigger said relay, a non-reversible arming device adapted to operate during acceleration of the projectile and to lock itself in the operative position and a reversible arming device adapted to operate during deceleration of the projectile and to return to the inoperative position during further acceleration, the fuze being fully armed only when both devices are in the operative position.

8. In a projectile, a proximity fuze comprising a radio transmitter and receiver having a common aerial, a relay arranged to initiate operation of the fuze on receipt of triggering energy, said receiver being responsive to radio frequency energy transmitted from said aerial to and reflected back to said aerial from a target to trigger said relay, normally open feed circuits for said transmitter, receiver and relay, a non-reversible arming switch adapted to close during acceleration of the projectile to partially complete said feed circuits and to remain closed thereafter, and a reversible arming switch adapted to close during deceleration of the projectile to wholly complete said feed circuits and to open again during any further acceleration.

9. A proximity fuze according to claim 8 wherein the non-reversible arming switch comprises a plurality of capillary tubes, a bulb at one end of each tube, a pair of contacts in each bulb and a mercury reservoir at the other end of each tube, the tubes being arranged with their axes parallel to the axis of the projectile and their bulbs remote from the nose of the projectile.

10. A proximity fuze according to claim 8 wherein the nonreversible arming switch comprises a pivoted arm, a weight at one end of said arm, a flywheel, a gear train between said arm and said flywheel, a plurality of pairs of contacts, bridging members carried by said arm and adapted to bridge each pair of contacts when the arm swings into the operative position due to an acceleration of the projectile, and means for locking the arm in the operative position.

11. A proximity fuze according to claim 8 wherein the reversible arming switch comprises a tube, a pair of contacts at one end of the bore of said tube, and a globule of mercury adapted to move freely up and down the bore in response to accelerations and decelerations of the projectile.

12. In a projectile, a proximity fuze contained in a casing forming the head of the projectile, said casing comprising a front tapered section, a central section and a rear section, an insulating ring splitting said rear section into two parts electrically insulated from one another, a thermionic valve oscillator housed in said rear section and connected to said casing to act as a transmitter-receiver, a supporting framework in said front section, a relay secured to said framework, electrical components carried by said framework and connected to form a circuit linking said oscillator with said relay, a fusible element in the bottom of said rear section and connected in the output circuit of said relay, and a high tension battery in said central section.

13. In a projectile, a proximity fuze contained in a casing forming the head of the projectile, said casing comprising a front tapered section, a central section and a rear section, an insulating ring splitting said rear section into two parts electrically insulated from one another, a thermionic valve oscillator housed in said rear section and connected to said casing to act as a transmitter-receiver, transverse discs and longitudinal pillars forming a supporting framework in said front section, said framework carrying a gas-discharge relay, a

thermionic amplifier connecting said oscillator and relay, an electrical timing circuit connected to said relay and serving as a self-destruction device, arming switches responsive to accelerations and decelerations of the projectile and a low-tension battery providing filament current through one of said arming switches for said oscillator, relay and amplifier, a fusible element in the bottom of said rear section and connected in the output circuit of said relay, and a high tension battery in said central section connected through other of said arming switches to said oscillator, relay and amplifier.

References Cited

UNITED STATES PATENTS

1,841,983	1/1932	Ruhlemann	-----	102—70.2
2,255,245	9/1941	Ferrel	-----	102—70.2

FOREIGN PATENTS

91,592	2/1938	Sweden.
376,987	12/1939	Italy.
5 Ad. 20,620	6/1918	France.
		(Addition to No. 486,109)
552,351	4/1943	Great Britain.

SAMUEL W. ENGLE, *Primary Examiner.*

LEO P. McCANN, EDWARD J. MICHAEL,
ALEXANDER BISHOFF, SAMUEL BOYD,
BENJAMIN A. BORCHELT, *Examiners.*

15 H. L. MARTIN, E. E. FULLER, L. H. MYERS,
Assistant Examiners.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,369,487

February 20, 1968

William Alan Stewart Butement et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 19, for "respective" read -- responsive --.

Signed and sealed this 15th day of July 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents