

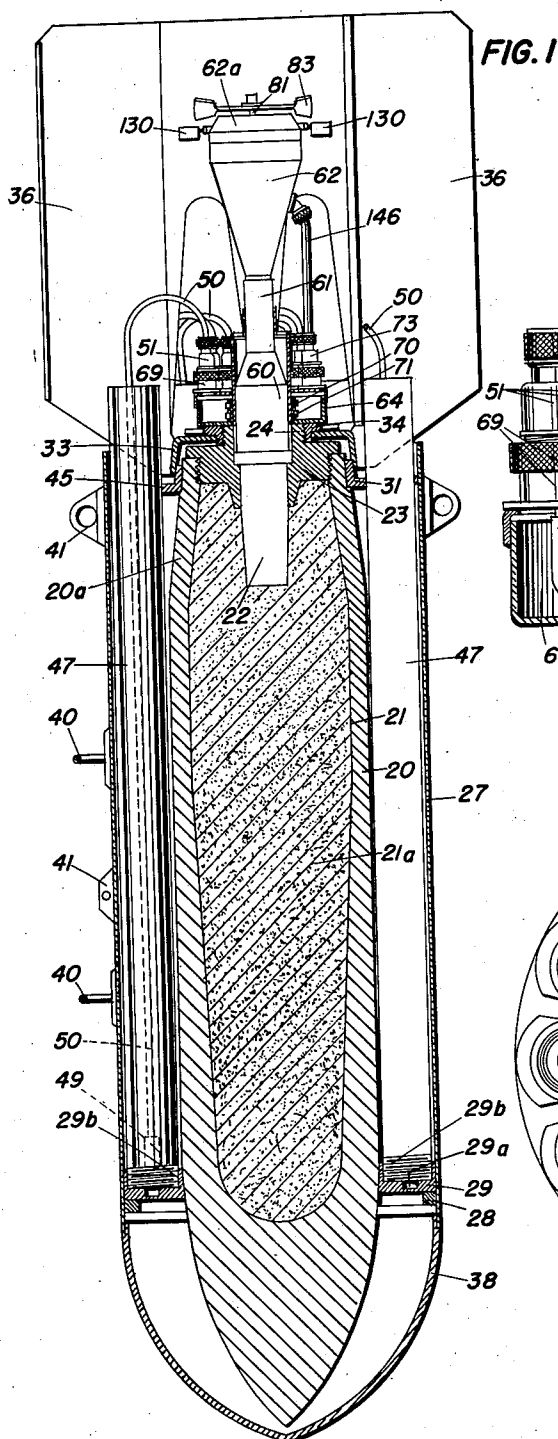
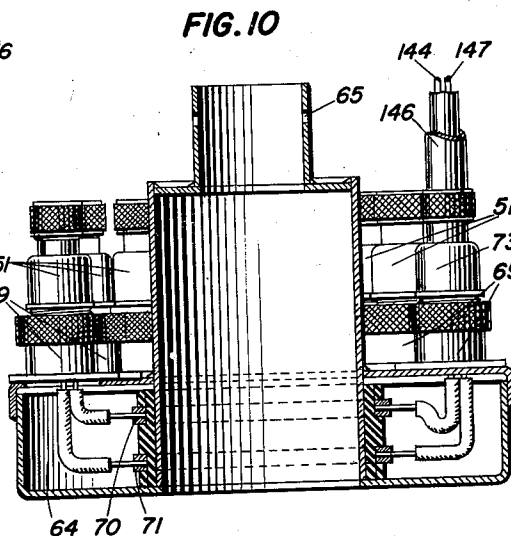
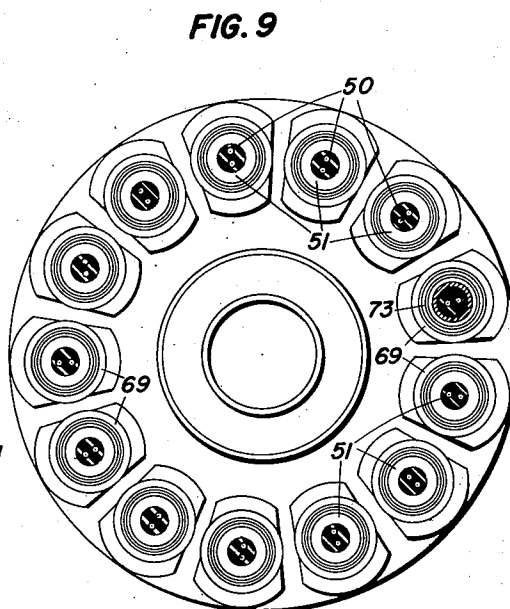
Jan. 17, 1961

L. MAAS, JR., ET AL
JET ACCELERATED MISSILE

2,968,244

Filed May 7, 1948

6 Sheets-Sheet 1



INVENTORS
LEO MAAS JR.
WARREN D. BROWN
A. D. O'Brien
ATTORNEY

BY

Jan. 17, 1961

L. MAAS, JR., ET AL
JET ACCELERATED MISSILE

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FIG. 2

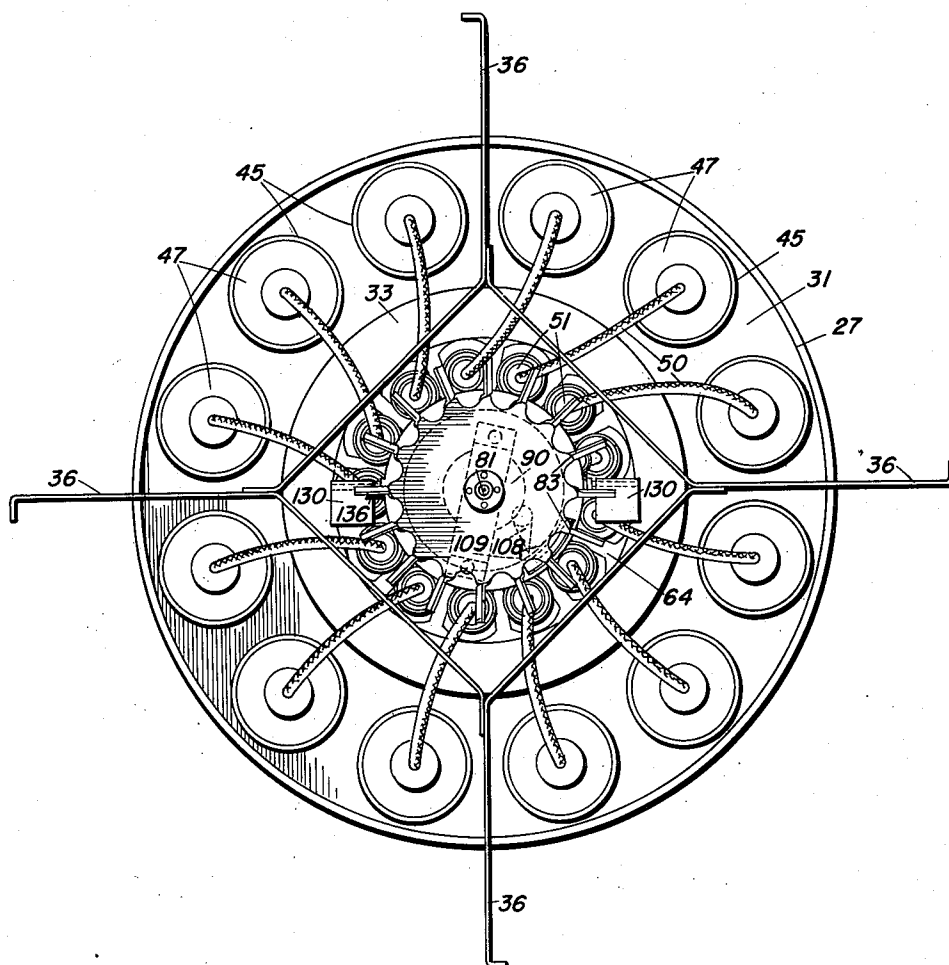
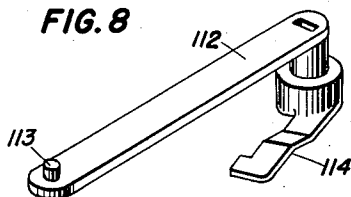


FIG. 8



BY

INVENTORS
LEO MAAS JR.
WARREN D. BROWN
S. D. O'Brien
ATTORNEY

Jan. 17, 1961

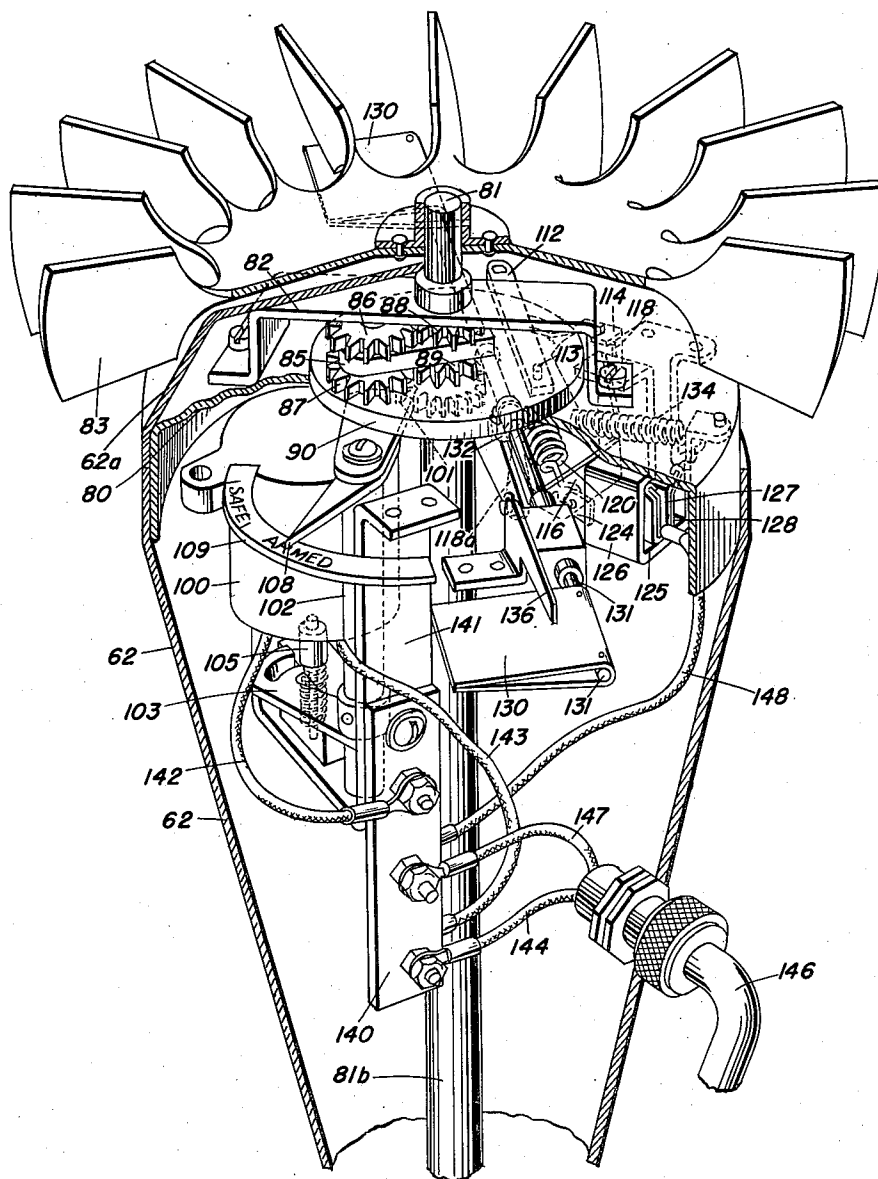
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FIG. 3



INVENTORS
LEO MAAS JR.
WARREN D. BROWN
L. D. O'Brien
ATTORNEY

BY

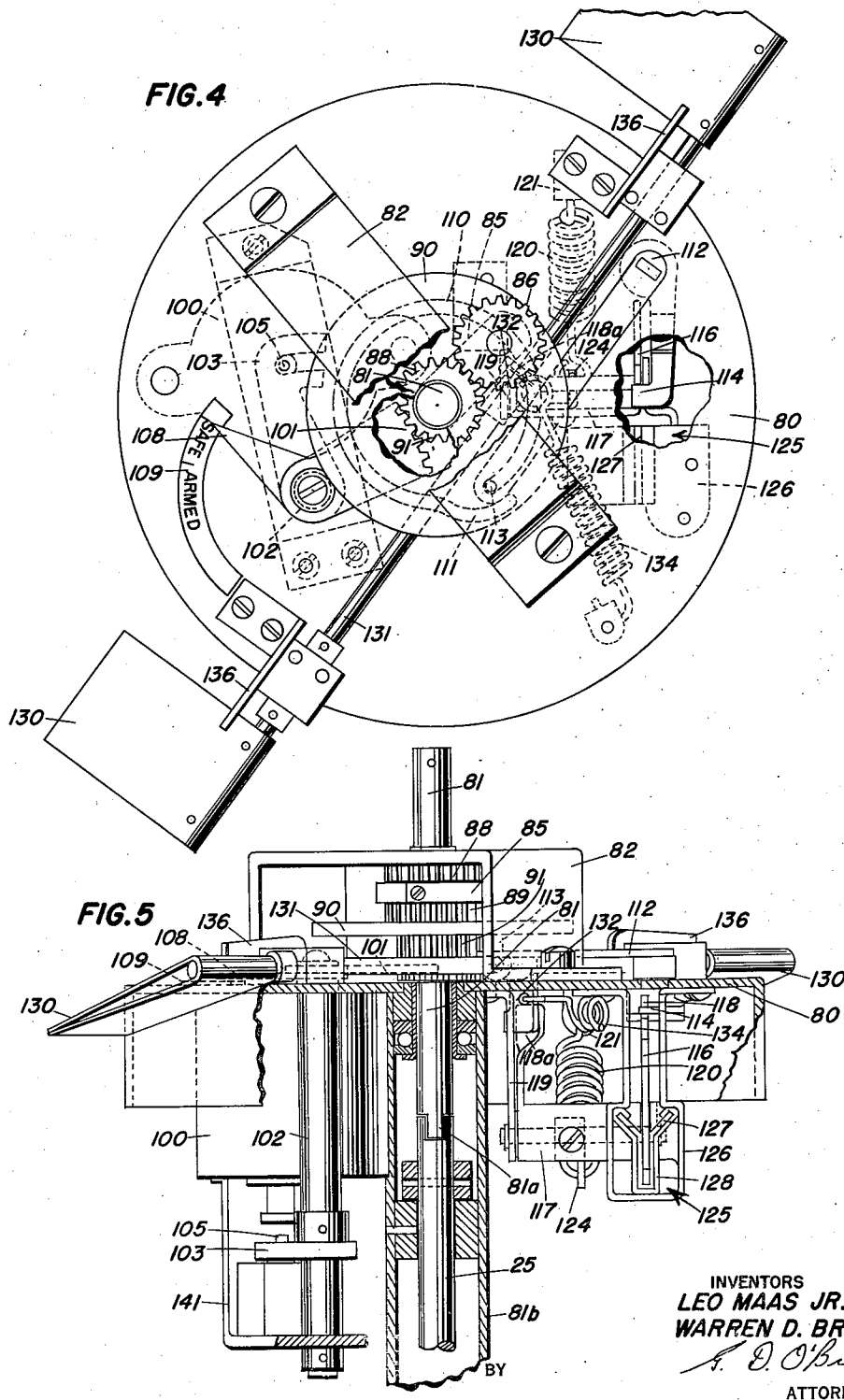
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FIG. 6

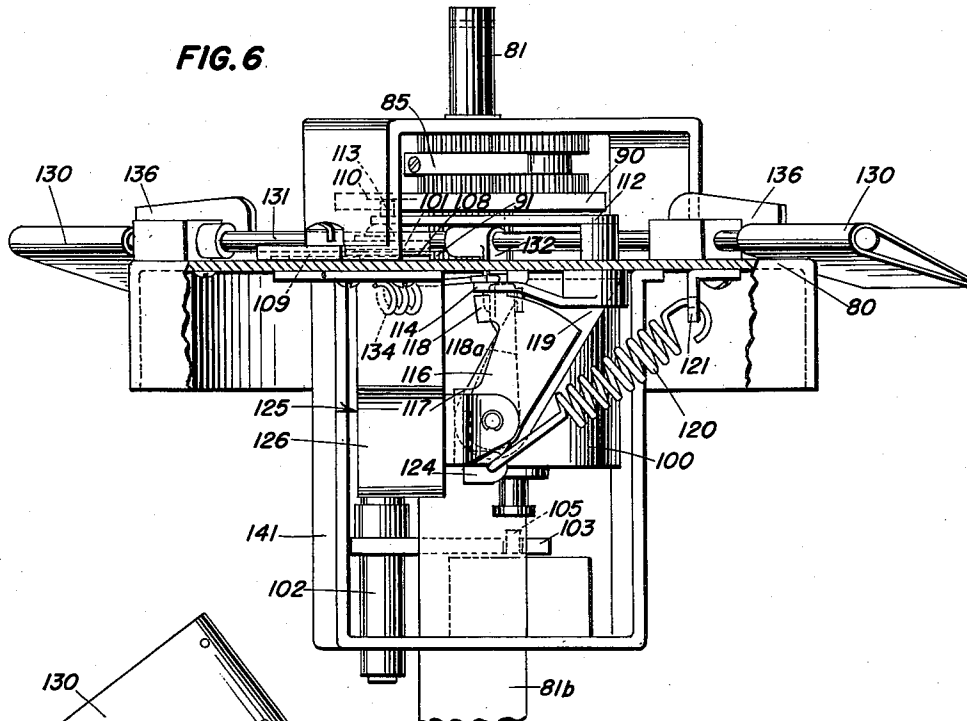
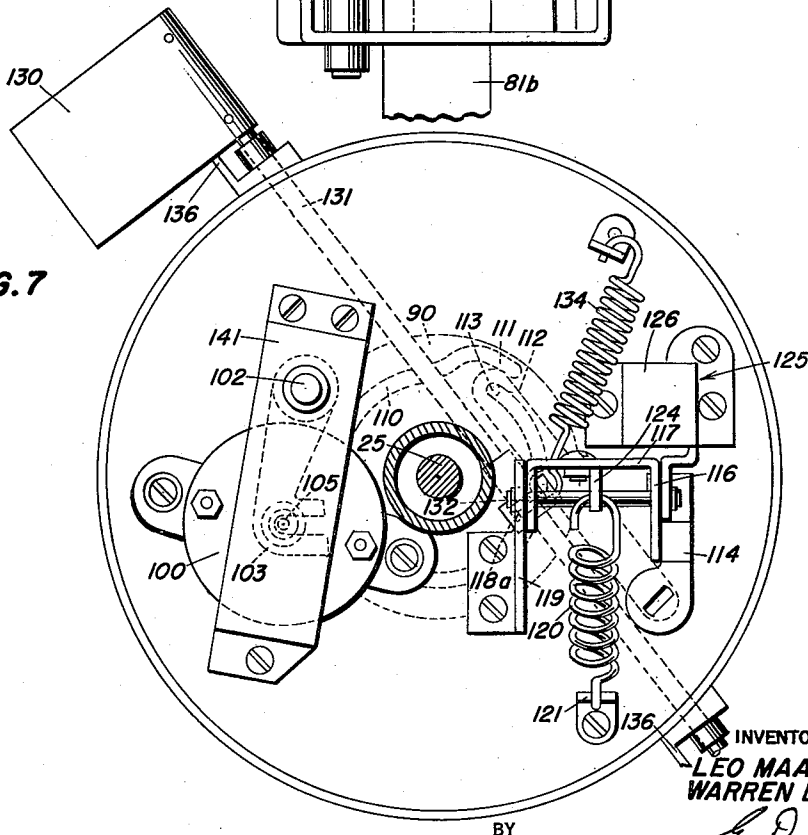


FIG. 7



BY

INVENTORS
LEO MAAS JR.
WARREN D. BROWN
L. D. O'Brien
ATTORNEY

Jan. 17, 1961

L. MAAS, JR., ET AL
JET ACCELERATED MISSILE

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FIG. 12

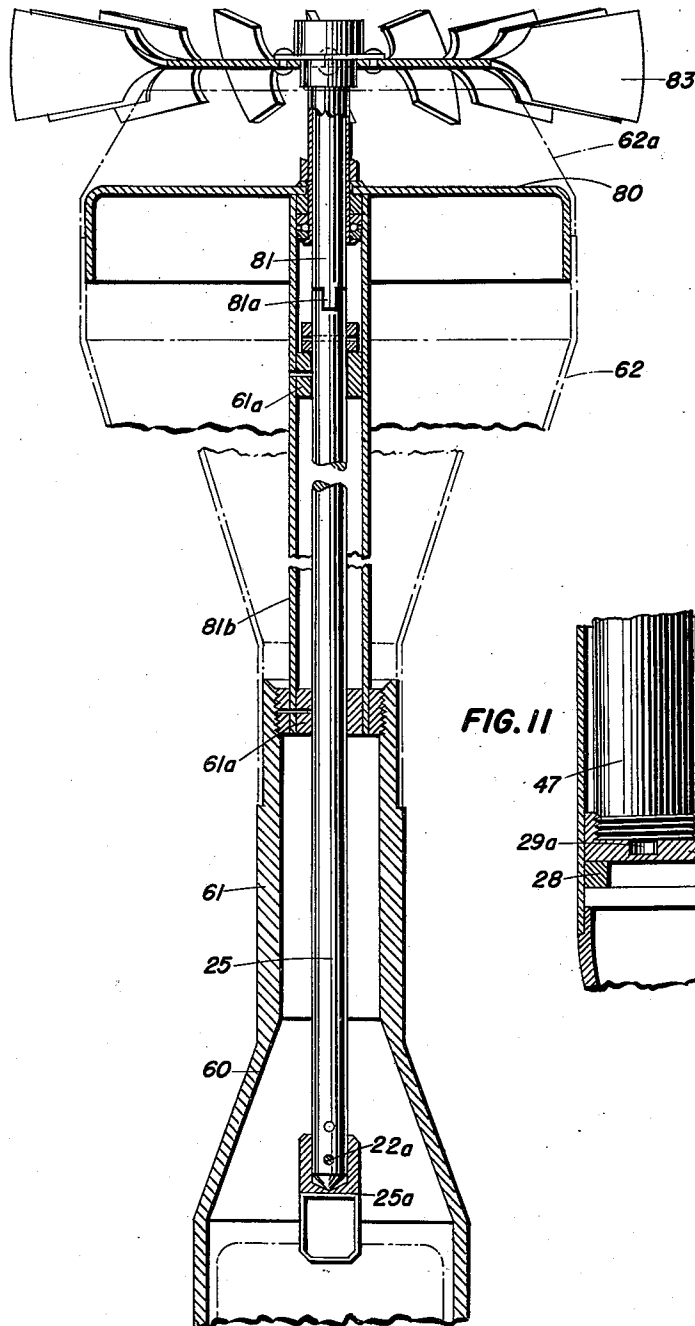
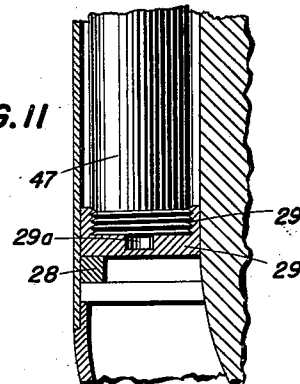


FIG. 11



INVENTORS
LEO MAAS JR.
WARREN D. BROWN

BY

A. D. O'Brien

ATTORNEY

1

2,968,244

JET ACCELERATED MISSILE

Leo Maas, Jr., 758 S. Ardmore, Los Angeles, Calif., and
Warren D. Brown, 13420 Pembroke Ave., Detroit,
Mich.

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This invention relates to an improved jet accelerated armor piercing projectile, such as a bomb, and more particularly to a projectile of this type employing novel jet propellant mounting and igniting means.

Conventional armor piercing bombs must ordinarily be dropped from a very high altitude in order to attain a striking velocity sufficiently large to cause the bomb to penetrate the thick armor of battleships, cement pill-boxes, or other armored targets. However, it is well known that at high altitudes, bombing accuracy decreases because of the high altitude and because of clouds and bad weather, frequently making it impossible to see the target from the high altitude at which ordinary bombs must be dropped if their armor piercing qualities are to be effective. A jet impulse provides a suitable means for increasing the velocity of bombs dropped at relatively low altitudes. Such a jet impulse is effectively produced by the rapid rearward ejection of gases from a fast burning propellant powder carried by the bomb.

In a bomb provided with a jet impulse accelerating device, it is necessary to delay the point of jet initiation in order to assure that the bomb is safely clear of the aircraft or other position from which it is launched before the jet is ignited, and to assure that the jet is initiated at a point in the normal trajectory of the bomb at which the lateral component of the thrust produced by the jet is at a minimum, thereby increasing the velocity of the bomb with a minimum change in its normal trajectory.

It is also desirable in jet accelerated bombs that the increase in size of the bomb over an ordinary bomb of equivalent weight be held to a minimum so that the bombs are usable with aircraft having bomb bays of ordinary dimensions. In previously constructed jet accelerated bombs, the jet acceleration means was positioned to the rear of the armor piercing part of the bomb, resulting in a considerably increased bomb length with the resultant necessity for either increasing the length of the bomb bays of aircraft carrying these bombs or reducing the number or size of the explosive portion of the bombs themselves.

One object of this invention is to provide an improved jet accelerated bomb or other projectile having a novel arrangement of elements whereby the length of the bomb is kept at a minimum without substantially changing the ballistic characteristics of the bomb.

Another object of the invention is to provide an improved jet accelerated armor piercing projectile including novel means for mounting a plurality of tubular rocket propellant grains (commonly known as rocket motors) about the outer periphery of the armor piercing portion of the bomb.

A further object of the invention is to provide an improved jet accelerated bomb having a plurality of rocket propulsion motors attached about the outer periphery of the armor piercing portion of the bomb and having a novel electrical igniting mechanism for initiating action of the rocket propellant.

Another object of the invention is to provide a rocket

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accelerated bomb having a plurality of rocket motors surrounding the outer periphery of the armor piercing portion of the projectile, means for igniting each rocket motor separately, and means for assuring that in case any of said motors is not ignited by said electrical means it will be ignited by an adjacent motor.

A further object of the invention is to provide means for adding rocket propulsion means to a standard projectile such as a bomb without any modification of the projectile itself, thereby simplifying production of the bombs.

A further object of the invention is to provide a rocket propellant igniting device for use with a rocket accelerated projectile which includes a simple indicator from which it can be determined whether the rocket igniting means is in unarmed condition or has been accidentally armed.

A further object of the invention is to provide a jet accelerated projectile having aerodynamically operable electrical means for initiating operation of the jet accelerating means.

A further object of the invention is to provide a jet accelerated projectile having an electrical jet ignition mechanism including a deferred action battery for supplying current to ignite the jet propellant and a normally open switch interposed between said battery and the jet propellant. Aerodynamically operated means are provided for initiating action of the battery and for subsequently closing said switch to ignite the jet propellant means.

The above-mentioned and other objects of the invention will be apparent from the following specification and the accompanying drawings, in which

Fig. 1 is a longitudinal sectional view of the improved jet accelerated bomb;

Fig. 2 is a rear elevational view of the bomb;

Fig. 3 is a perspective view of the propellant igniting device in armed condition with parts of the device broken away for purposes of clarity;

Fig. 4 is an upper end view of the rocket fuze in unarmed condition with part of the frame member broken away for clarity;

Fig. 5 is a side elevational view of the rocket fuze, partly in section;

Fig. 6 is a side elevational view of the device in unarmed condition similar to Fig. 5 but taken from a different angle;

Fig. 7 is a bottom view of the rocket fuze;

Fig. 8 is a detailed perspective view of the cam follower and latch of the fuze;

Fig. 9 is an end view of the electrical terminal box of the rocket firing mechanism;

Fig. 10 is a longitudinal sectional view of the electrical terminal box shown in Fig. 9;

Fig. 11 is a fragmentary detailed cross-sectional view of the manifold in which the rocket motors are mounted; and

Fig. 12 is a longitudinal sectional view showing the means for mounting the rocket fuze and the propeller shaft with most of the fuze elements omitted for clarity.

In the preferred embodiment of the invention as shown in the drawings, the assembly is built around an ordinary 1000 lb. armor piercing bomb 20 having a tapered rear portion 20a and having a cavity 21 filled with a detonating explosive charge. A conventional rotatably armed base detonating fuze 22 is provided for detonating the explosive 21a. The fuze 22 is screwed into the bomb base plug 23 which is attached to the bomb by conventional means such as threads, and which has a rearwardly extending hub 24 having screw threads on its outer periphery. A shaft 25 (see Fig. 12) is secured to the rotating part 25a of the fuze 22 by means of a copper

shear wire 22a and extends rearwardly from the fuze 22 for connection to the rotatable shaft of the rocket fuze as will be explained presently.

A cylindrical metal jacket 27 shorter in length but larger in diameter than the bomb 20, and carrying an integral or welded reinforcing ring 28 near its forward end is supported on the forward end of bomb 20 by an annular manifold 29 which bears against the ring 28 and is welded to the jacket. At the rear end, the jacket is mounted on the bomb by an annular rear support 31 which is welded to the interior of the jacket 27 near its rear end. Twelve openings 45 for supporting rocket motors are provided in the rear support 31. An annular passage 29a in the manifold serves a purpose which will be described presently.

The rear support 31 bears against the tapered rear end portion 20a of the bomb 20, and is maintained in place by the tail support 33 which is annular and of L-shaped cross-section and is adapted to fit over the threaded portion of the bomb base plug 23 and to bear against the rear support 31. The tail support 33 is maintained in place on the base plug by means of the standard tail lock nut 34. Conventional tail fins 36 are welded to the tail support 33 to stabilize the flight of the bomb. A cast aluminum ogive 38 is secured to the forward end of the jacket 27 by suitable means such as screws (not shown). To facilitate handling of the assembled bomb, suspension lugs 40 and hoisting lugs 41 are welded to the exterior of the casing 27. Trunnions (not shown) may also be welded to the exterior of the casing in order that the bomb may be used with conventional dive bombing equipment.

The manifold 29 is provided with twelve threaded sockets 29b which are aligned with the twelve circular openings 45 in the rear support 31 to receive an equal number of rocket motors comprising tubular grains of rocket propellant explosive 47. Each rocket motor is inserted through one of the openings 45 and is screwed into one of the threaded sockets of the manifold 29. Each motor is provided with a squib 49 located near its forward end and with an electrical conductor 50 which extends through the hollow interior of the motor from the squib rearwardly and out of the rear end of the motor where it terminates in a plug 51, the utility of which will be described in more detail presently.

The housing 60 of the fuze 22 extends rearwardly from the fuze and has a rear portion 61 of narrowed diameter which, when the fuze is used with a conventional bomb not having rocket accelerating means supports an arming vane assembly (not shown) for arming the fuze as the bomb falls through the air. To this narrowed portion is attached the housing 62 of the rocket fuze. An electrical junction box 64 shown in detail in Fig. 10 is mounted on housing 60 and is retained in place by means of set screws (not shown) which are positioned in holes 65 in the narrow rear neck portion of the box. The junction box 64 is preferably of light sheet metal and is annular, having a central opening through which passes the housing 60 and the narrow housing portion 61. The forward end of the junction box rests against the rear end 24 of the bomb base plug 23 and the lock nut 34. Thirteen electrical sockets 69 are mounted on the rear surface of the box and extend rearwardly. These sockets are of the conventional two lead type, one lead from each being connected to an insulated conducting ring 70 positioned inside the junction box and the other lead connected to the insulated ring 71 in the junction box by means of short lengths of wire which are housed by the box. A plug 73 connected to the rocket fuze is connected to one of the sockets 69 to supply current to rings 70 and 71 after the rocket fuze is operated, while the other twelve of the sockets 69 are for connection to the plugs 51 carried on the ends of wires 50 which are connected to the squibs in the rocket motors. When all of these connections are made, all of the rocket squibs

are connected in parallel with the two leads from the rocket fuze. In practice, the plugs 51 are usually not plugged into the electrical junction box until shortly before the bomb is to be used, thereby providing an extra safeguard against premature ignition of the rocket motors.

The rocket fuze comprises generally a deferred action or "reserve" battery and means for actuating the battery and firing the rocket squibs after the bomb has fallen through the air for a predetermined period of time.

More particularly, the fuze is built around a mounting plate 80 mounted by screws (not shown) or other suitable means at the rear end of the casing 62 for supporting the various elements of the fuze. A cover 62a encloses the rear end of the rocket fuze. A shaft 81 is journaled in the frame member 80 and in bracket 82 bolted to the frame member, and is connected by a tongue and groove joint 81a to the rear end of shaft 25. Shaft 25 extends forwardly through suitable bearings 61a in a sleeve 81b which is threaded into the narrowed rear end 61 of fuze housing 60 as shown in Fig. 12. The rear end of the shaft 81 carries an arming propeller 83 which is rotated by the air stream as the bomb falls through the air. The rotation of the propeller 83 serves the dual purpose of arming the base detonating fuze 22 of the bomb through rotation of shafts 81 and 25 and of operating the rocket fuze by the mechanism shown in detail in Figs. 3 through 7.

Shaft 81 carries an arm 85 which rotatably supports planet gears 86 and 87 so as to move the gears 86 and 87 through a circular path around the shaft 81 as the propeller 83 is rotated by flight of the bomb through the air after its release. Gear 86 meshes with a fixed sun gear 88 which is secured to the under surface of bracket 82 coaxially with the shaft 81. Gear 87 meshes with a gear 89 which is positively attached to a circular cam plate 90 mounted for rotation on the shaft 81. A gear 91 is fixed to the under surface of the cam plate 90 and serves a purpose which will be described presently.

The fixed gear 88 has one less tooth than the gear 89, and gears 86 and 87 have an equal number of teeth so that as the propeller 83 rotates and moves the planetary gears 86 and 87 through their orbits, the gear 89, cam plate 90 and the gear 91 are rotated slowly, each revolution of propeller 83 moving gear 89 a distance equal to one tooth. Assuming that the gear 88 has 20 teeth and the gear 89 has 21 teeth, approximately 230 revolutions of the propeller 83 are necessary to cause the gear 89 and the cam plate 90 to make a complete turn.

In order to provide electrical current for firing the rockets, the rocket fuze includes a delayed action or "reserve" battery 100 which is of the type having a frangible diaphragm or ampule (not shown) which maintains the electrolyte separated from the grid compartment (not shown), it being necessary to rupture the diaphragm in order to allow the electrolyte to flow into the grid compartment to activate the battery. Such batteries are well known in the art and an example is the one shown in U.S. Patent 1,658,142. The apparatus for rupturing the diaphragm comprises a gear 101 which is driven by rotation of the gear 91 and which is keyed to one end of a rotatable shaft 102 which carries at its opposite end a detent 103. In its unarmed position shown in Fig. 4, detent 103 positively retains a plunger 105 out of contact with the battery 100. The plunger 105 is spring loaded so that after propeller 83 has rotated a sufficient number of times to move the gear 101 and detent 103 to their armed positions shown in Fig. 3, the plunger 105 is driven by its spring into contact with the battery to rupture the battery diaphragm and allow the electrolyte to flow into the grid compartment, thereby activating the battery. A pointer 108 mounted on the end of shaft 102 adjacent gear 101 is rotated with the gear 101 to give an indication on the indicator plate 109 of the condition of the fuze. A suitable window is provided in the fuze casing so that the indicator plate 109 and pointer

108 are visible from the exterior of the fuze, thus making the condition of the fuze battery apparent to personnel handling the bomb.

The cam plate 90 has a cam groove 110 in its lower surface, the cam groove being substantially circular in its dwell portion and having an outwardly extending lobe portion 111 at one end. The cam operated arm 112 shown in detail in Fig. 8 carries a cam follower 113 which rides in the groove 110. The arm 112 is pivotally mounted on the frame member 80 and carries a shorter detent arm 114 which normally, that is when the cam follower 113 is in any but the final lobe portion 111 of the cam groove 110, retains a switch member 116 in its open circuit position by its position in the path of switch arm 118.

The switch member 116 comprises a base member 117, a switch arm 118 and a safety arm 118a pivotally mounted on a bracket 119 carried by the frame member 80. A spring 120 anchored at 121 to the frame member 80 is attached to a downwardly projecting ear 124 on the base member 117 and urges the switch arm 118 toward its closed circuit position.

The switch proper denoted generally by the numeral 125 is mounted in a support 126 attached to the frame member 80. The support 126 carries a contact member 127 which is insulated from the rest of the fuze by insulation 128 consisting of rubber, fibreboard, or other suitable material. When switch arm 118 is freed for movement to its closed circuit position by the fuze mechanism, the spring 120 rotates the switch arm 118 into contact with the switch contact 127 to fire the rockets.

As a safety precaution against firing of the fuze prior to release of the bomb, there are provided a pair of vanes 130 mounted on a shaft 131 which is rotatably mounted on the frame member 80. A detent arm 132 is attached to the shaft 131 so as normally to extend into the path of the safety arm 118a which rotates with switch arm 118. A spring 134 anchored to the frame member 80 is attached to the detent arm 132 so as to retain the arm in its detent position until an air velocity of 100 knots is exerted against the vanes 130. As such a large air pressure would not be likely to be exerted upon the vanes until the bomb is launched, this safety device assures against premature firing of the rockets. A pair of vane stops 136 are mounted on the fuze frame to limit the movement of the vanes 130 under the influence of air pressure.

As a further safety measure, a conventional arming wire (not shown) is used in conjunction with the propeller 83 to prevent undesired rotation of the propeller. This arming wire is withdrawn from the propeller when the bomb is launched.

An insulating electrical terminal plate 140 is attached by a bracket 141 to the frame member 80. Attached to mounting posts carried by the terminal plate are a ground wire 142 from the reserve battery 100 and another lead 143 from the battery. The ground lead 142 is grounded to the mechanical elements of the fuze through the bracket 141, while lead 143 is connected to wire 144 to carry current to conducting ring 70 of the terminal box 64. Wire 144 passes through the metallic protective shield 146 which is connected to the junction box 64 by plug 69. Lead 147 which is connected to metallic ring 71 of the terminal box 64 passes through the shield 146 and is attached to a post on the terminal plate 140, the post also being connected to the switch contact 127 by means of wire 148. When the rocket squibs are attached by wires 50 and plugs 51 to the junction box 64, all that is necessary after the energizing of the battery 100 is the release of switch arm 118 for movement into contact with the switch contact 127, thereby connecting the rocket squibs to ground to fire the rockets.

The operation of the device is as follows: When the bomb is loaded into the aircraft, the propeller 83 is retained against rotation by means of a conventional arm-

ing wire (not shown). The arming wire is removed from the propeller when the bomb is released, thus permitting rotation of the propeller by the air stream as the bomb falls through the air.

The rotation of the propeller 83 first arms the base detonating fuze 22 of the bomb through rotation of shafts 81 and 25 so that the base detonating fuze is armed after the bomb has fallen a predetermined distance through the air. The copper shear wire 22a which attaches shaft 25 to the rotating part of base fuze 22 is sheared after the base fuze is armed and the rotating parts freeze, thereby assuring that propeller 83 and shaft 81 are free to continue their rotation and operate the rocket fuze.

Rotation of the propeller actuates the rocket fuze in the following manner: when the bomb is released, detent arm 103 is in its retaining position as shown in Fig. 4 in which it positively retains the plunger 105 separated from the deferred action battery 100. Pointer 108 points to "Safe" to indicate that the battery and fuze are unarmed. The switch arm 118 is positively retained in its open position by means of detent 114 operable by the cam plate 90, and is further secured in its open circuit position by detent arm 132 which cooperates with safety arm 118a of the switch.

After the bomb is dropped from the aircraft, the vanes 130 are immediately moved against the vane stops 136 since the velocity of the bomb is over 100 knots. In so moving, the vanes safety arm rotate shaft 131 and move the detent arm 132 out of the path of switch 118a, and since the bomb is falling through the air, the detent 132 remains in the armed position. Rotation of the propeller 83 rotates the planetary gears 86 and 87 around the shaft 81 and due to the difference in the number of teeth in gears 88 and 89, the gear 89 with the attached cam plate 90 and gear 91 is slowly rotated. When the gear 91 has rotated far enough to move the gear 101 to the armed position as shown in Fig. 3, the detent arm 103 is moved out of the path of the plunger 105 which is then driven against the battery 100 by its spring, thereby fracturing the diaphragm of the battery and permitting the electrolyte of the battery to flow into the battery grid compartment and activate the battery.

As the propeller 83 continues to rotate, the gear 89 and cam plate 90 continue rotating slowly until, after a total of approximately 230 revolutions of the propeller, the lobe 111 of the cam groove moves the cam follower 113 outwardly away from the central shaft 81 and thereby removes the detent 114 from the path of the switch arm 118. As soon as this occurs, the spring 120 moves the switch arm 118 into contact with the switch contact 127 to ground the wire 147 connected to the rocket squibs and thereby fire the rockets. In case any rocket fails to fire electrically, the hot gases from an adjacent rocket ignite the unfired rocket through the annular passageway 29a in manifold 29. The manifold also aids equalization of pressure of the rocket thrust to give a more uniform thrust and more normal trajectory.

In assembling the bomb, the ordinary 1000 lb. AP bomb 20 is placed upright, nose downward, in a metal base, and the jacket assembly 27 including manifold 29 and rear support 31 is slipped over the tail end of the bomb. The tail fin assembly 33, 36 is then placed in position and the tail lock nut 34 secured. The rocket motors 47 are then slid into the openings 45 in the rear support 31 and are screwed into the manifold 29. The base detonating fuze 22 is then screwed into the bomb base plug 23, and the electrical junction box 64 and the rocket fuze 62 are attached to the cover 64 of the base detonating fuze. The assembled bomb is then lifted from its supporting base and laid on its side, after which the ogive 38 is slipped in place and secured by screws (not shown). When ready for firing, the plugs 51 are plugged into the mating sockets 69 on the junction box 64.

Due to the great space savings brought about by assembly of the rocket motors about the body of the bomb

rather than at the rear thereof, the rocket bomb is easily carried in conventional bomb bays and released by conventional bomb releasing equipment.

It is to be understood that the rocket fuze may be arranged so that the rocket action is initiated at any desired point in the trajectory of the bomb. If desired, the rocket fuze may be used on other types of projectiles in which it is desired to delay the ignition of the propellant for a predetermined period of time after launching.

Although one specific embodiment of the invention has been described and shown in the drawings, the invention is not to be construed as limited to that embodiment. The various features of the device may assume various other forms without departing from the scope of the invention as defined by the appended claims.

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

We claim:

1. A rocket accelerated missile comprising a projectile having a tapered rear portion, a base plug mounted in the rear end of said projectile and having a rearwardly extending threaded boss, a casing surrounding said projectile, an annular forward spacing member mounted on the interior of said casing, a rear spacing member fixed to said casing and having a rearwardly flanged central opening adapted to fit tightly on said tapered portion of the projectile, a plurality of rocket motors mounted between said projectile and said casing and supported by said spacing members, a retaining washer positioned on said boss and having a forwardly extending flange fitting over said first-mentioned flange, and a lock nut positioned on said boss, whereby said nut retains said casing and said rocket motors against rearward movement with respect to said projectile.

2. A rocket accelerated missile comprising an elongated hollow projectile containing a high explosive and

having an armor piercing nose portion, detonating means for said explosive contained in the base portion of said projectile, a plurality of elongated rockets mounted peripherally of said projectile and having their longitudinal axes generally paralleling the axis of said projectile, separate electrically operated ignition means for each of said rockets positioned at the end thereof adjacent said nose portion; means for producing electrical energy for said ignition means, a distributor connector positioned adjacent the base of said projectile and concentric with said detonating means, for connecting each of said electrical operated ignition means in parallel, and a switch for connecting said electrical energy produced by said means to said distributor.

3. The combination defined in claim 2 characterized further by the addition thereto of aerodynamically operated means for rendering active said electrical energy producing means, for operating said switch and for arming said detonating means.

4. The combination defined in claim 2 characterized further by the addition thereto of a manifolding means for communicating each of said rockets at said end whereby to equalize the pressure in said rocket and to provide alternate, ignition means for an individual rocket in the event of failure of its individual electrically operated ignition means.

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