

Aug. 11, 1959

J. A. RYAN, JR

2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

Filed Sept. 15, 1955

5 Sheets-Sheet 1

FIG. 1.

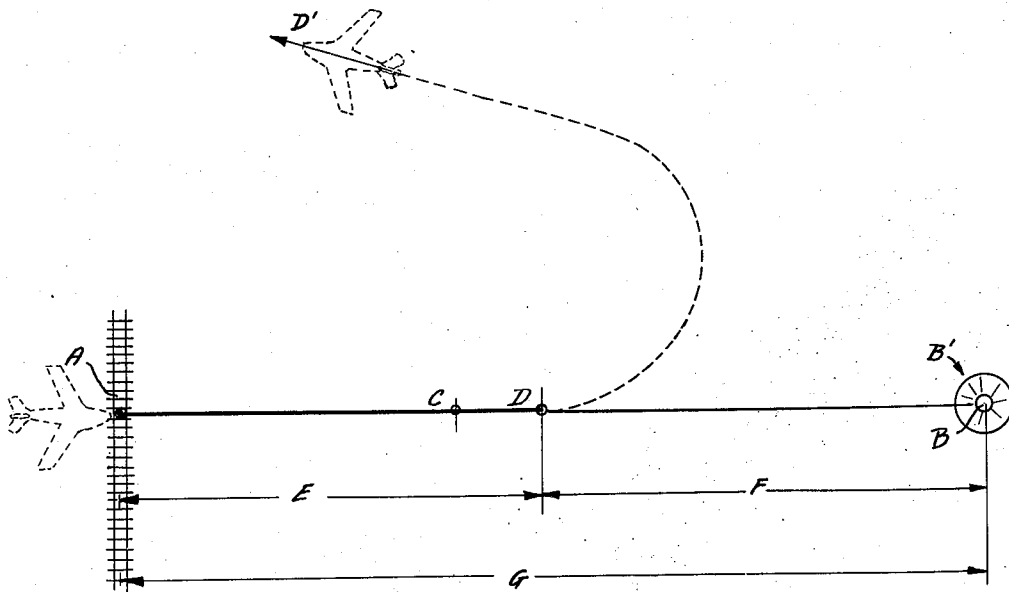
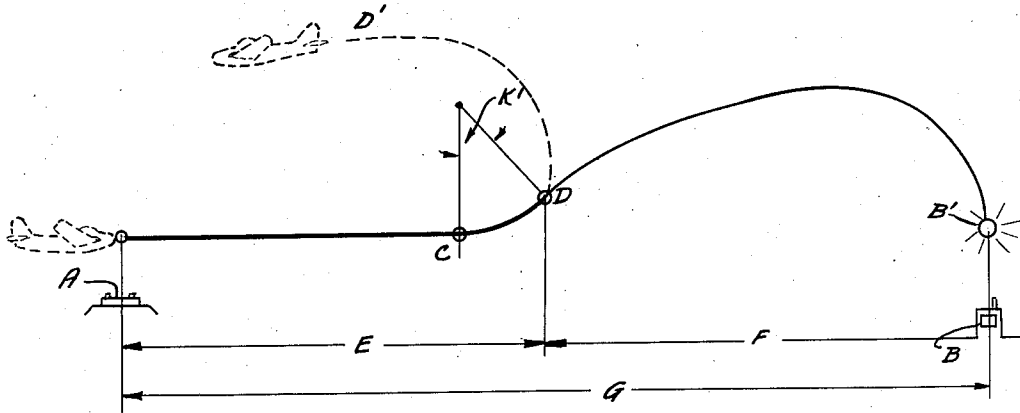


FIG. 2.

INVENTOR.
JOHN A. RYAN JR.
BY *Wace Krouy*
Charles H. Wagner AND
ATTORNEYS

Aug. 11, 1959

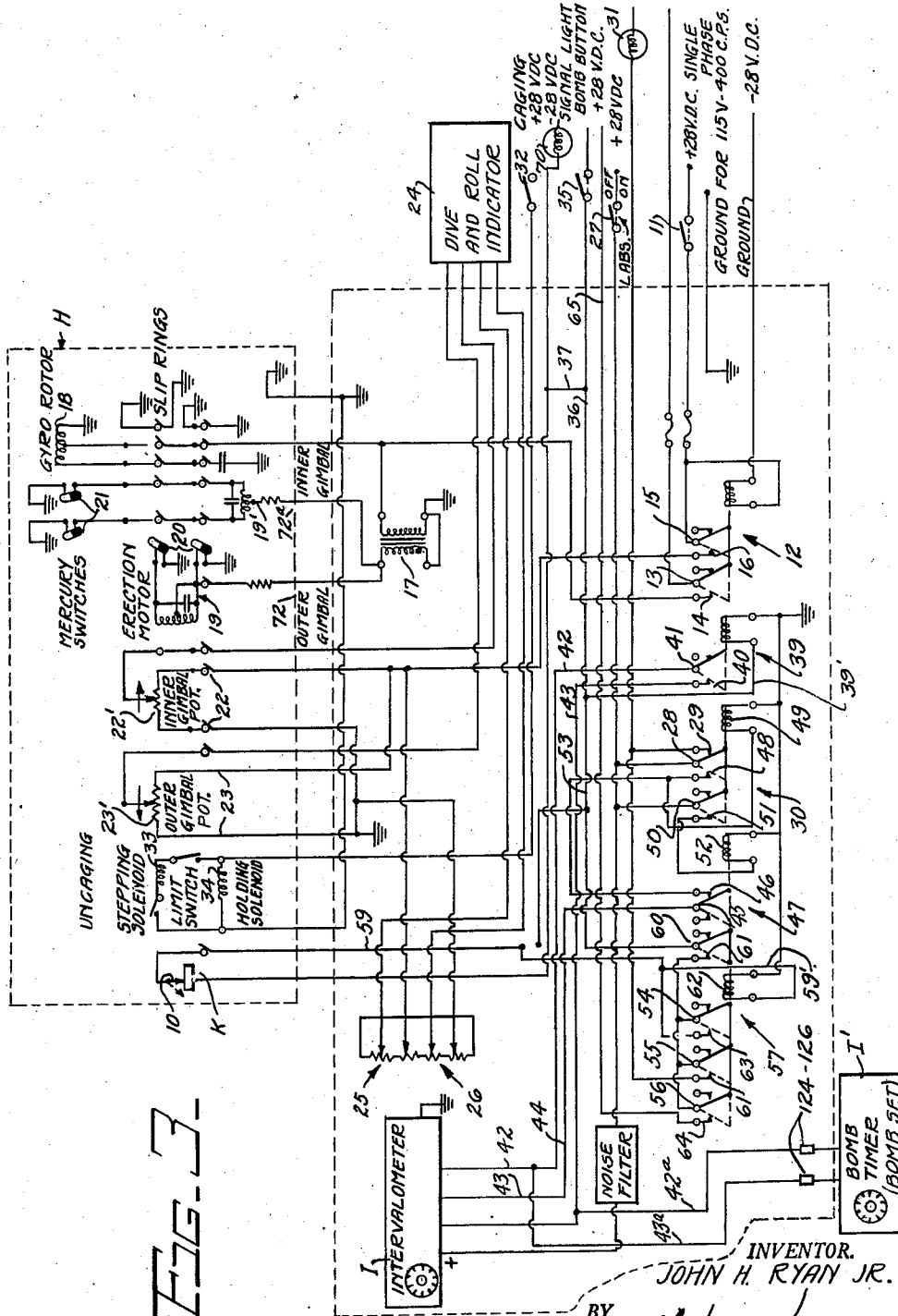
J. A. RYAN, JR

2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

Filed Sept. 15, 1955

5 Sheets-Sheet 2



INVENTOR.
 JOHN H. RYAN JR.
 BY *Wade Rounty*
Charles W. Wagner AND
 ATTORNEYS

Aug. 11, 1959

J. A. RYAN, JR

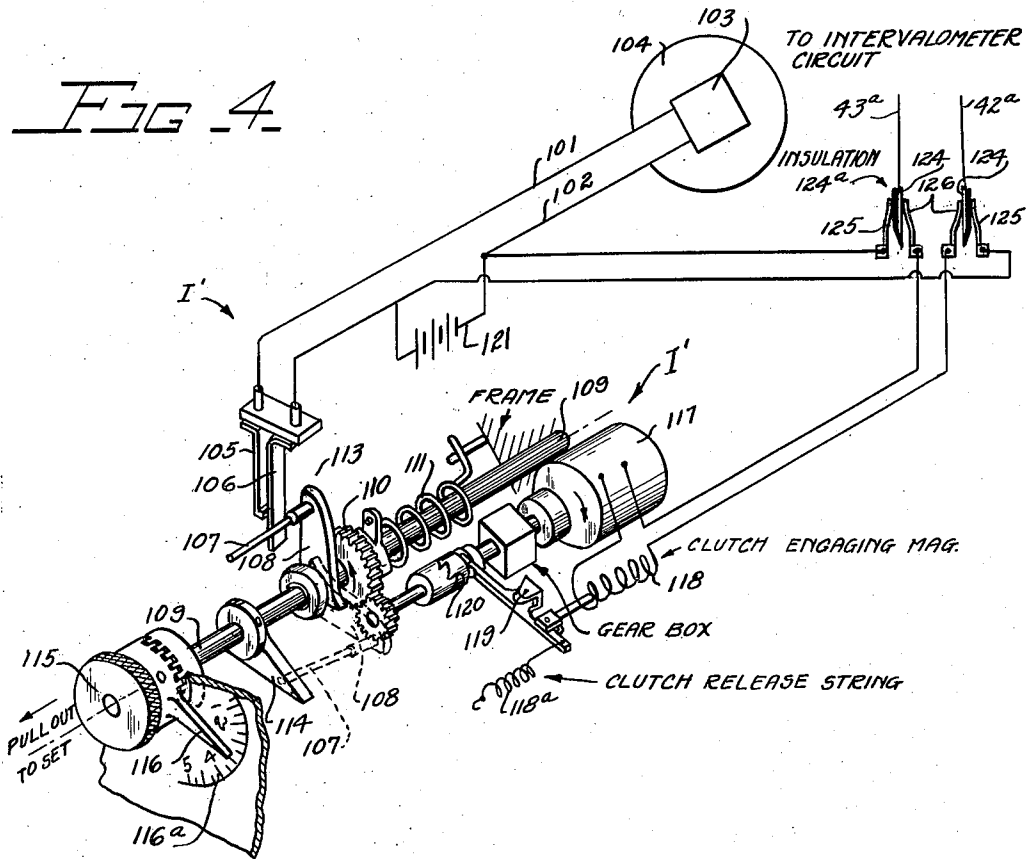
2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

Filed Sept. 15, 1955

5 Sheets-Sheet 3

FIG. 4



INVENTOR.
JOHN A. RYAN JR.
BY *Wade County*
Charles H. Wagoner AND
ATTORNEYS

Aug. 11, 1959

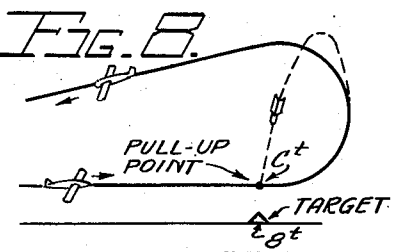
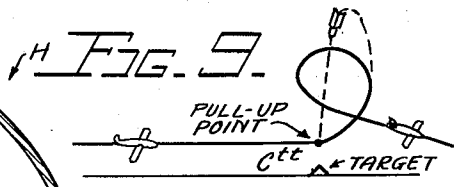
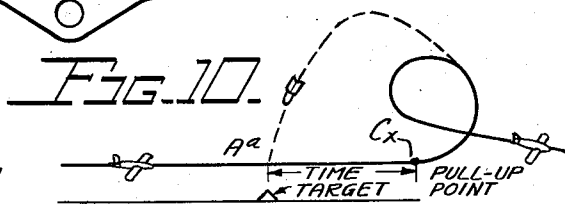
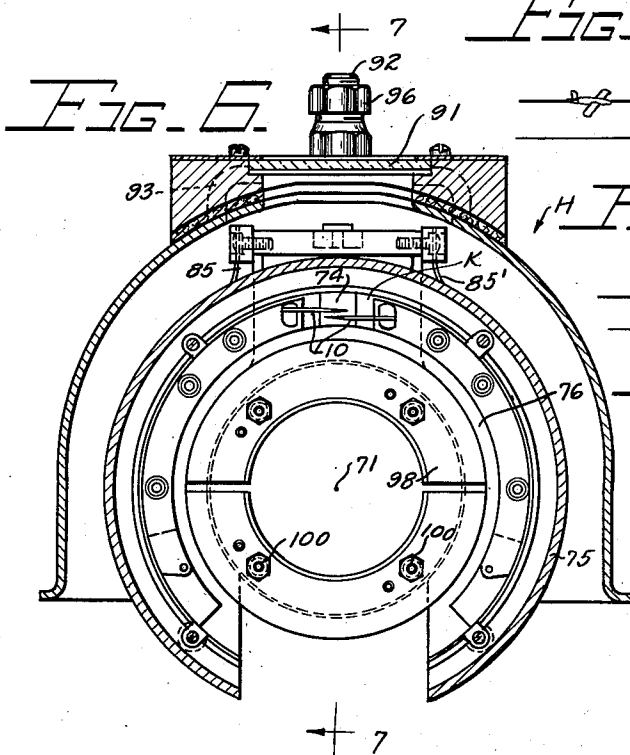
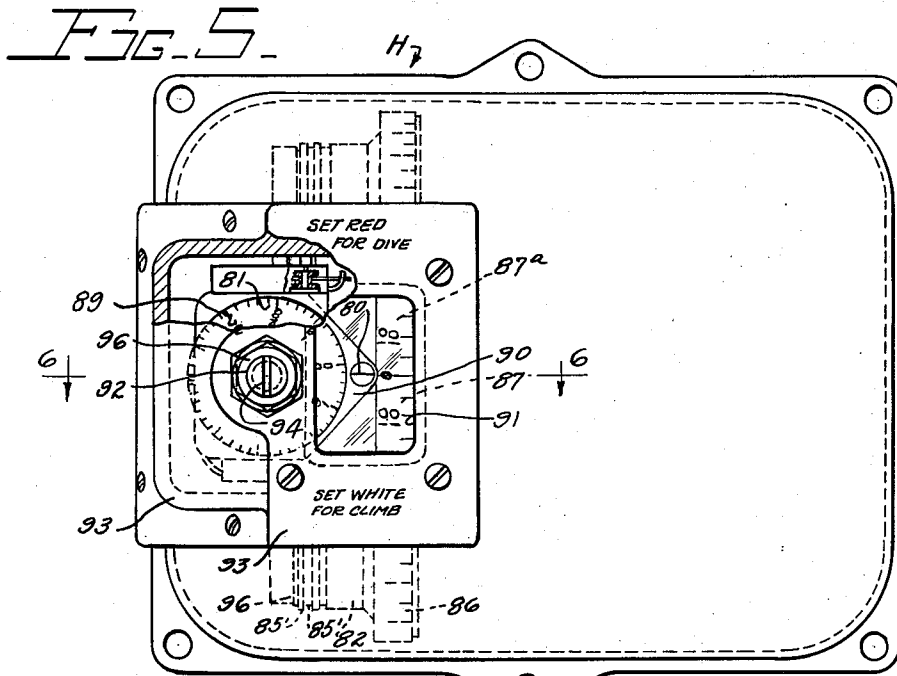
J. A. RYAN, JR

2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

Filed Sept. 15, 1955

5 Sheets-Sheet 4



INVENTOR.
JOHN A. RYAN, JR.

BY *Wade Knott*
Charles H. Wagner
ATTORNEYS

Aug. 11, 1959

J. A. RYAN, JR

2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

Filed Sept. 15, 1955

5 Sheets-Sheet 5

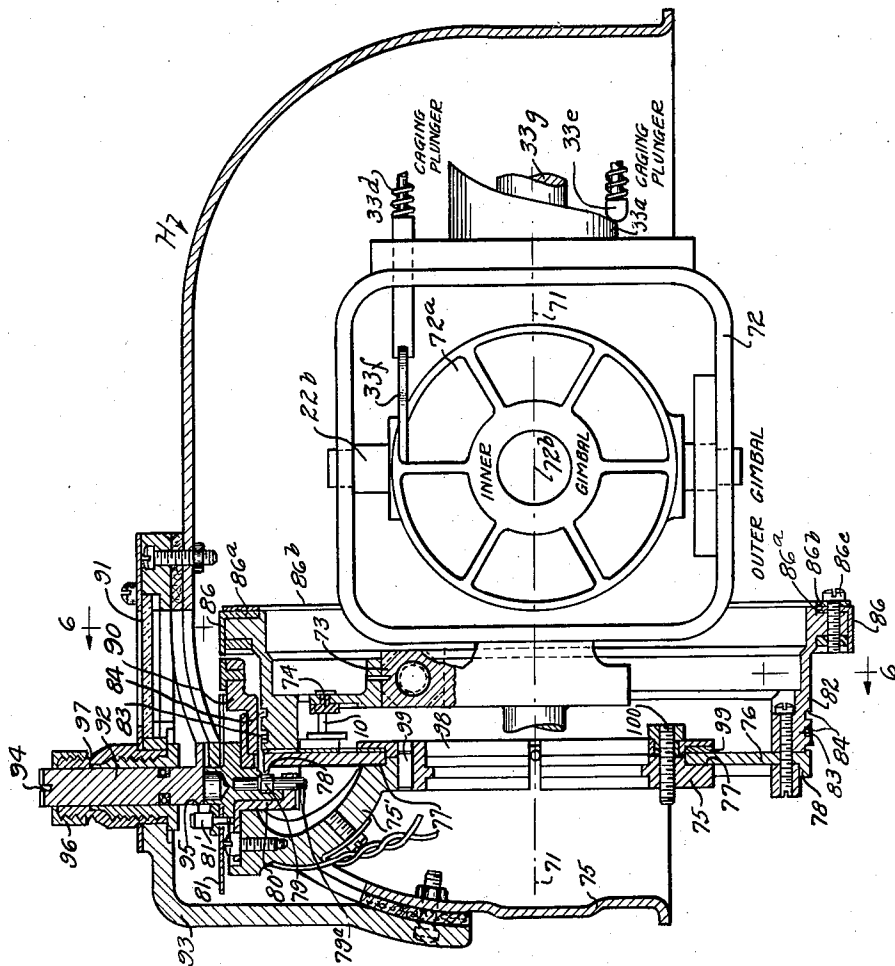


FIG. 7

INVENTOR.
JOHN A. RYAN, JR.
BY *Wade Kunitz*
Charles Wagoner AND
ATTORNEYS

1

2,898,809

LOW ALTITUDE BOMBING SYSTEM AND APPARATUS

John A. Ryan, Jr., Arlington, Va.

Application September 15, 1955, Serial No. 534,630

10 Claims. (Cl. 89—1.5)

(Granted under Title 35, U.S. Code (1952), sec. 266)

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

This invention relates to an improved low altitude bombing system and apparatus for the release of high explosive devices and bombs from aircrafts, and primarily to an improved apparatus, system, and method of "toss bombing" of very high explosives above or on a selected target from a low level approach toward the target and providing a safe escape distance and maneuver for the aircraft after the release of the explosive device or bomb, having for an object the accurate release and tossing of a high explosive device at a predetermined point in a flight pattern relative to the target, calculated in relation to the speed, altitude, and a selected pull up angle of the aircraft, including means for automatically releasing the bomb device at a predetermined angle of climb during the pull up.

A further object is the provision of a bombing system and apparatus for delivery of high explosive devices and bombs for accurate "toss bombing" thereof above, or on a selected target from a low level approach toward the target and providing a safe escape distance and maneuver for the aircraft following the release and tossing of the explosive device or bomb, having for a further object the delivery of time delay fused types of high explosives, timed to explode above the target in relation to speed, altitude, and a selected pull up and release climb angle, including means for indicating to the pilot the time instant of release of the bomb device and the starting of the time for executing the predetermined escape maneuver, so that the aircraft will be flying at a safe remote distance from the bomb device and target area at the time of the explosion of said bomb device, and moving in a direction away from the target, preferably without crossing the projection of the explosive device or bombs trajectory on the ground.

A further object comprises an improved bombing system and apparatus for delivery of high explosive devices and bombs from aircrafts for accurate "toss bombing" of very high explosives above or on a selected target from a low level approach toward the target and providing a safe escape distance and maneuver for the aircraft following the release of the explosive device or bomb without crossing the projection on the ground of the explosive device or bomb trajectory having for a primary object the delivery of predetermined time delay fused types of high explosives timed to explode above or on the target in relation to the speed, altitude, and a selected pull up and climb angle of the aircraft from a predetermined or selected point to be crossed by the aircraft at a known distance from the target, including means for indicating to the pilot the time for the precalculated rate of "pull up" during the approach together with means for automatically releasing of the bomb device at a predetermined angle of climb during the pull up at the pre-

2

calculated safe escape distance from the target area, including also pilot signal means to indicate when the release of the bomb takes place during the "pull up" constituting a signal for the pilot to execute a predetermined "escape maneuver" without crossing the target area so that the aircraft will be at a safe remote distance from the bomb device at the time of the explosion thereof and flying in a substantially radial direction away from the target.

A further object is the provision of an improved aircraft bombing system in which a preset adjustable timer or intervalometer device is provided in the aircraft together with a normally cagable vertical gyroscope, in which the gyroscope is uncaged by the pilot during the approach toward a selected target prior to the crossing of a selected prominent geographical reference point during the approach at a predetermined distance from the selected target, including means under control of the pilot for simultaneously starting the intervalometer timing cycle and the bomb fuze timing cycle, in which the first intervalometer controls a "pull up" or climb signal indicating means for the pilot, to determine the time for execution of the predetermined climb or pull up maneuver at a predetermined number of "g's," and includes release means controlled by the vertical gyroscope for effecting an automatic release of the bomb device at substantially any predetermined or selected angle of climb also including signal means for indicating when the bomb has been released and time for initiating the predetermined escape maneuver in order to provide a sufficient remaining time before the expiration of the time period set in the bomb fuze detonating intervalometer, such as a substantially 180 degree turn, or an "Immelmann" can be executed to enable the bombing aircraft to be flying at a substantially safe distance in substantially the opposite direction away from the target and bomb at the time of explosion, without crossing the projection on the ground of the bomb trajectory.

A still further object of the invention includes a low altitude bombing system and method of low altitude "toss" bombing of very high explosive types of time fused bomb devices by aircraft, in which the aircraft is flown toward a selected target at a prescribed low altitude over a preselected terrain in which some suitable "initial permanent point" or fixed geographical reference point is present and fairly easily discernable, preferably having a long dimension perpendicular to the flight path toward, and at a suitable remote distance from, the selected target, for instance from between 3 to 6 miles, a settable timer or fuze mechanism being provided in the bomb and preset before reaching the initial point for determining the "range" between the initial or prominent point and the desired point of explosion of the bomb device over the selected target, calculated in time in accordance with the expected speed of the aircraft from the initial or prominent point to the calculated "pull up" point, plus the pull up time to the climb angle, during the pull up, at which the bomb is to be released, plus the trajectory or travel time of the bomb from its release point to the point above or on the target where the "burst" is to take place, an intervalometer or timer mechanism being also provided in the aircraft which is adjusted prior to reaching the initial or prominent point to indicate the calculated instant for the "pull up" for effecting the release of the bomb device from the instant of passage of the aircraft over the initial or prominent point in terms of the expected ground speed of the aircraft, the system providing means under control of the pilot for simultaneously initiating both of the timers into operation just as the initial point is crossed, including means for releasing the bomb automatically during the "pull up" at a precalculated angle of climb, with the pull up point

precalculated at a sufficient distance from the target, between the prominent point and the target, to permit the aircraft to execute a substantially 180° turn or an "Immelmann," or a loop and be flying away from the target at a "safe" escape distance from the bomb device at the time that it is exploded by its timer.

A further object is the provision of means under control of the pilot for interrupting the timing cycles of both timers and restoring them to their initial starting position at any time prior to the time of pull up and release of the bomb device.

In one form of the invention the distance between the selected prominent geographical or initial reference point and the target is composed of two time segments, one being the time from the initial point to the pull up point, plus the time required from the pull up point to the bomb release point, and the other is the calculated trajectory time from the release point to the burst point over or on the target, this latter segment from release point being what might be termed as the safe escape time or distance. The timer in the explosive device is set preferably to include both time segments. Since the geographical location of the prominent or initial point with respect to the target will vary depending upon the selected target, while the pull up time plus the escape time period, can be considered at a substantially fixed minimum, for the particular explosive device employed, the first or variable segment is calculated by subtracting the second or minimum distance, or safe time factor plus pull up time from the total distance or time factor, from the initial point to the release point, plus the trajectory time of the released explosive device to the target. The resulting range segment can therefore be easily varied to suit the geographical conditions encountered.

Assuming that a conventional intervalometer is used which can be set for any time interval up to 24 seconds in intervals of .02 second, and that the bomb also has a suitable similar timer or intervalometer therein functioning as a time delay fuze device, then at 546 miles per hour the speed is 800 feet per second and .01 second error is 80 feet and .02 second error is 160 feet. A 4 "g" pull up at the assumed speed represents about 2241 feet or travel and this is precalculated and fixed, but may vary depending on the climb angle in the pull up where release takes place. The trajectory of the bomb device after release depends upon an initial 800 feet per second, plus the fuze time in the bomb if the burst is to take place above ground and the trajectory time can be longer if release (climb) angle is increased. For instance, above 45° climb angle, the "range" may be shorter, although the time between release of the bomb and burst may be increased with safety if desired, also a change in the approach altitude will effect the maximum time of trajectory for a burst in the air at the same elevation above the target.

Assuming that the center of a selected target area from a selected prominent geographical reference point, such as a road, railroad, dam, or bridge running substantially transverse to the flight path toward the target is 17,542 feet, also that no wind is present and therefore no reduction or increase in air speed need be calculated, and calculating aircraft ground speed at 800 feet per second (546 m.p.h.) and also assuming a 4g pull up from level flight to a predetermined climb angle of 20° where the bomb is automatically released is calculated, at a distance of, for example, 10,000 feet from the target, the 4g pull up distance in this instance to bomb release angle will cover 2241 feet ground range. Since total range distance from the initial point to the target is assumed to be 17,542 feet the sum of the distance from the release point to the target is added to the 4g pull up distance and this total is then subtracted from the total distance between the target and the prominent or initial point, hereafter indicated as "I.P.," thus leaving a range distance of 5301 feet from the "I.P." to the pull up

point and this is set on the intervalometer in the aircraft in the form of seconds and fractions of seconds, the intervalometer timing cycle being started by the pilot depressing the bomb button as the aircraft crosses the "I.P.," and as indicated, also determine the time for the initiation of the 4g, for example, pull up or climb, the bomb being released automatically at the selected climb angle as determined by the closing of electrical sector switch contacts in a vertical gyro, the intervalometer or timer in the bomb device or fuze being preset, preferably before take-off for the time period to include the time of flight from the "I.P." to the pull up point plus time from pull up point to the release point, plus the time of flight or bomb trajectory from the release point to the burst point, located at or over the target.

These time intervals are easily and conventionally calculated and tabulated, and therefore specific times are not given. However, for the example indicated above it would be 23,886 seconds and the timer in the bomb device is set for that time and initiated into operation as the aircraft crosses the "I.P." simultaneously with the "range" timer for indicating the time when pull up point is reached. From the example given it will be seen that the time remaining from the initial point to the release point is 9.486 seconds.

Initial point to pull up point -----	6.626 sec.
Pull up point to release point -----	2.860 sec.

Initial point to release point -----	9.486 sec.
Calculated bomb flight or trajectory time from release point to burst point -----	14.40 sec.

Bomb device timer set at -----	23.886 sec. total.
--------------------------------	--------------------

Assuming that 14.4 seconds is considered a sufficient time to provide a safe "escape" distance for the aircraft by banking and executing 135° ± turn, which in this example causes the aircraft to fly radially outbound from the expected burst point to effect best escape, or by executing an "Immelmann" or a "loop" immediately following the bomb release, so as to be flying away from the burst point, at a distance, for the example given, of approximately 10,000 feet from the burst point over the target area. With faster aircraft, including modern jets the "escape distance" can be increased, or the calculated release point can be moved further from the target, or bomb devices of greater destruction power can be employed.

A further object of the invention is therefore a method and means for delivering a high explosive bomb device with greater accuracy over or on a selected target during a low level approach, without requiring the aircraft to approach too close to or cross the target area.

A further object is the provision of means and a method of utilizing a prominent geographical land mark at a known remote distance from a selected target as a means for calculating a release point at which a bomb should be released from an aircraft flying at a predetermined speed and low altitude and tossed toward the target in order to produce a "hit" at the target, with sufficient time for the aircraft to fly to a remote safe distance from the burst of the bomb device without crossing the target area.

A further object is the provision of a bombing system in which selected target is approached at a predetermined ground speed and low altitude by flying across a selected prominent geographical point at a known remote distance from the selected target and presetting a timer means on the aircraft which is initiated into operation while passing directly over the prominent point to determine a predetermined elapsed time period during flight from the prominent point toward the target in which signal means operated by the timer indicates the termination of the selected time period and the instant when a prede-

5

terminated pull up is to be initiated at a predetermined number of "g's" to cause a subsequent automatic release of a bomb device at a preselected climb angle, the system including vertical gyroscope means having an adjustable climb angle signal indicating contact means incorporated therein, and release means operable by the climb angle signal contact means for releasing a bomb carried by the aircraft at the predetermined climb angle, incorporating signal means for indicating when the predetermined pull up bomb release or climb angle of said aircraft is reached at a pull up of the predetermined number of "g's."

A further object is the provision of a bombing system in which the pilot must close a normally open control switch at the time the aircraft crosses the prominent point and must maintain the switch closed throughout the approach toward the target up to the time when the bomb device is automatically released during the pull up on a selected target during a flight path which is initially a low level approach, and includes means arranged to stop the effective timing cycles of the intervalometer and the bomb timer fuze or timer mechanism and return the timing mechanisms to zero, thereafter requiring a complete repeat cycle of the bombing system and another trip over the prominent point in order to deliver the bomb at the target from a low level altitude and provide a safe escape for the aircraft after release of the bomb without crossing the target area or the projected trajectory on the ground of the trajectory of the bomb.

Other objects and advantages will become apparent from the following description and accompanying drawings in which like parts are referred to by like reference characters in the several figures.

Figure 1 is a diagrammatic side elevation of my improved bombing method and system, the light full line indicating the trajectory of the bomb device after release and the dotted line illustrating the escape flight path of the aircraft after release of the bomb device.

Figure 2 is a diagrammatic top plan view similar to Figure 1 showing the flight track of the aircraft, after release of the bomb device, in dotted lines.

Figure 3 is a schematic wiring diagram of the improved cooperating control system and apparatus for carrying out the bombing method.

Figure 4 is a schematic view, somewhat in perspective of a type of intervalometer or timer which may be used in the explosive device or bomb for fuzing the same.

Figure 5 is a somewhat diagrammatic top plan view of a normally caged vertical gyroscope, incorporating the settable release contact means for effecting a release of the bomb device at any predetermined pull up or climb angle.

Figure 6 is a fragmentary vertical cross sectional view through the portion of the gyroscope shown in Figure 5, more clearly showing the adjustably settable contacts for establishing the release impulse, and taken approximately on the line 6—6 in Figure 5 looking in the direction of the arrow, certain parts being broken away and omitted for clarity.

Figure 7 is a somewhat fragmentary vertical longitudinal sectional view of a portion of the normally caged vertical gyroscope shown in Figures 5 and 6, the section being taken approximately on line 7—7 of Figure 6.

Figures 8, 9 and 10 are diagrammatic views showing a few modifications of the method employed in delivering an explosive device on a selected target from a low level approach, while affording a sufficient escape time or distance for the aircraft, after tossing the bomb device to be flying radially away from the target area at a substantial safe distance at the time the bomb device explodes.

Referring more particularly to the schematic wiring diagram shown in Figure 3, and Figures 1 and 2, the operation is as substantially as follows:

6

Preferably before "take-off" the distance G between some prominent geographical reference point A and a selected target B, as shown in Figures 1 and 2, is determined and converted into time of flight from the prominent point A to a selected point D for release of the bomb during a predetermined climb or pull up C—D in relation to the calculated speed of the aircraft and altitude at the time the pull up C—D is to be initiated. This time is calculated to represent actual ground speed of the aircraft D' and is divided into two segments or sections, the first section E being the time of flight from the prominent point A to the point of "pull up" C plus time from point C of "pull up," for instance, at a 4g's pull up, to point D where release of the bomb is to occur. Since the time interval from point D of release of the bomb, plus the time of flight or trajectory F of the bomb for a given altitude and ground speed, in order to provide a safe "escape" time period and distance for pilot and aircraft, is substantially fixed, this time or distance F is subtracted from the total range time or distance G from the prominent point A to the target B, leaving the aircraft "flight" time from the prominent point A to the pull up point C as a variable, calculated to suit the geographical relation between the selected prominent point A and the target B, in any particular situation.

The vertical erectable gyroscope H employed is of a conventional type for instance, known commercially as Cagale Vertical Gyroscope Model JG7044, manufactured by Minneapolis-Honeywell. These commercial vertical gyroscopes are modified as shown and described hereafter to provide an adjustable segmental contact means or sector switch 10, adjustable for closing a bomb release circuit at any specified "pull up" or climb angle when these switch contacts are placed in the bomb release circuit.

The timer or intervalometer I, employed for indicating the pull up point C may also be of any conventional type, such as, for instance an intervalometer which can be set to provide a circuit energizing electrical impulse after any desired number of seconds and fractional parts of a second, and an energizing electrical circuit means for initiating the intervalometer timing cycle by depression of a "bomb button" is provided. One type of conventional intervalometer I, that may be used in the system is known as a B10 intervalometer (ABRAMS) disclosed in U.S. Air Force publications TO-10A5-6-7-2, Technical Order 10A5-6-7-3, and Technical Order 10A5-6-7-4, all dated November 15, 1951. These intervalometers are adjustable to cover a time period up to 24 seconds in intervals of .2 second.

With the vertical gyroscope H erected to vertical (Figure 3) and the timer or intervalometer I, set for the calculated flight time from the prominent point A to the pull up point C, gyroscope bomb release segmental contacts 10 of the sector switch in the gyroscope H set for circuit closing contact at the calculated pull up or climb angle K (Figure 1) to effect the bomb release, and the timer or intervalometer I in the bomb set for a timing period to include the calculated flight time from the prominent point A to the pull up point C, plus flight time from the pull up point C to the bomb release point D, plus the time of flight F or trajectory of bomb from the release point D to the burst-point B' with respect to the selected target B, the pilot, several minutes prior to crossing the prominent point A at the desired low altitude toward the target, for instance 600 feet, conditions the apparatus shown in Figure 3 for operations in substantially the following manner:

The sight "change-over" switch 11 is closed by moving the same from full line to dotted line position. This energizes relay 12 to move the contacts thereof from "off," shown in full lines, to "on" position as shown on dotted line, closing contacts 13 and 14 and 15 and 16.

Closing contacts 13 and 14 of relay 12 energizes the transformer 17 and starts the gyroscope motor 18 to spin the rotor of the erected vertical gyroscope, illustrated sche-

matically at H, and somewhat in more detail in Figures 5, 6 and 7, with the climb angle closing contacts 10 or sector switch mechanism illustrated more in detail in Figures 6 and 7. The gyroscope inner and outer gimbals are normally erected by any suitable erecting mechanism. Energizing transformer 17 closes the electrical circuits to the two erection motors 19 and 19' for the outer and inner gimbals of the vertical gyroscope H.

Closing relay contacts 15 and 16 of relay 12 energizes the potentiometer coils 22' and 23' of potentiometers 22 and 23 on the inner and outer gimbal signal pick-off means to adjust a pitch or climb and roll indicator 24 at the pilot's station to check or indicate the respective relative roll and pitch positions of the inner and outer gyroscope gimbals relative to the altitude of the aircraft, and also to indicate the roll and pitch attitude of the aircraft after the gyroscope is uncaged. Adjustable resistances 25 and 26 are interposed in the pitch and roll indicator input circuits for adjusting the pitch and roll indicator 24 at the pilot's station to "zero," either while the gyroscope H is erected, or just after it is released to allow for any change in flight attitude of the aircraft at the time it passes over the prominent point A toward the target B.

The "LABS (Low Altitude Bombing System) start" switch 27 is now closed by moving the same from full to dotted position to feed a +28 v. D.C. to the "+" terminal of the intervalometer I, starting the intervalometer motor. This circuit is connected through the normally closed contacts 28 and 29 of the relay 30 to light the reticle lamp 31 preferably in the pilot's gun or bomb sight, or it may be a signal device on the pilot's instrument panel, indicating to the pilot that the device is "conditioned" for operation.

Another preliminary step requires the closing of the LABS gyroscope release switch 32 by movement thereof from full to dotted position, thus releasing the gyroscope H in "zeroed" position relative to the attitude and flight path of the aircraft at that time.

Opening of the caging switch 32 to the "caged" or dotted line position opens the caging circuit to deenergize the holding solenoid 34. With the caging circuit closed the device is now in released conditions and ready for subsequent control and indicating operations.

The aircraft should be approaching the prominent point A at the precalculated (ground) speed and low elevation in the selected flight direction toward prominent point A and the selected target B.

Just at the instant that the prominent point A is crossed the pilot presses the "bomb button" 35 to close the bomb button switch and should keep it depressed until the bomb is actually released. Closing of the bomb button switch 35 by the pilot feeds a +28 v. D.C. to conductor 36. The jumper wire 37 from this line 36 lights a warning or signal light 38, preferably on the pilot's instrument panel to indicate that the lead 36 to the gyro sector switch K or contacts 10 are energized, and that the timing cycle has started. The sector switch K in the vertical gyroscope H is open however at this time and will not be closed until a "pull up" to the precalculated climb angle is made at the prescribed subsequent time previously set into the intervalometer I. Depression of the "bomb button" 35 simultaneously energizes the relay 39 through wire 39' moving relay contacts to close contacts 40 and 41, as seen in dotted line position, to close a timing cycle starting electrical circuit over conductors 42 and 43 to the intervalometer I, starting the intervalometer timing cycle, and to the intervalometer I' starting the bomb fuze intervalometer timing cycle.

With the bomb button 35 held depressed the pilot continues "on course" toward the target B. At the end of the precalculated timing cycle the timing contacts of the intervalometer I close, sending an electrical signal impulse from terminal 43, wire 44, across normally closed contacts 45—46 of relay 47 to the contact 48

of relay 30, a shunt or holding circuit being established between contact 48 and relay coil 49 of relay 30, closing contacts 28 and 48 and 50 and 51, and separating contacts 28 and 29 of relay 30, the latter extinguishing the reticle lamp 31. Closing contacts 28 and 48 of relay 30 close the circuit to relay coil 49 of relay 30, and acts as a holding relay circuit, so long as the bomb button 35 is maintained depressed.

Closing of contacts 51 and 40 of relay 30 energizes relay coil 52 of relay 47 to shift the contacts of this relay 47 to dotted line positions, closing contacts 60 and 61 thereof and breaking the contacts 45 and 46 thereof.

Closing contacts 60 and 61 of relay 47 establishes circuits to the conductor 53 connected to terminals 54, 55 and 46 of relay 57. Coil 62 of relay 57 is energized by the closing of the contacts 10 of sector switch K, during the subsequent "pull up" or climb at the time the reticle light 31 goes out.

The separation of contacts 45 and 46 of relay 47 deenergizes the initial energizing circuit in relay 30, however, this relay 30 remains closed due to the holding circuit established through contacts 28 and 48 of relay 30. The opening of contacts 28 and 29 of relay 30 extinguishes the reticle lamp 31 which is a signal for the pilot to immediately execute the prescribed "pull up" indicated at C—D in Figure 1 at the prescribed number of "g's."

As the pilot makes the prescribed pull up at the prescribed number of g's and reaches the climb angle K' as set in the gyroscope H, for instance as shown in Figures 3 to 7, the sector switch contacts 10 close.

The closing of the sector switch contacts 10 energizes the bomb release circuit 59 and again lights the reticle lamp 31, indicating that the bomb device has been released and that the prescribed "escape" pattern or maneuver D—D', Figures 1 and 2, should be immediately executed.

Closing of sector switch contacts 10—10 and 56, feeds +28 v. D.C. from "bomb button" contacts 35 through branch conductor 59' to energize the coil 62 of relay 57, closing the contacts 54 and 63, 55 and 61 and 56 and 64 of relay 57 to establish release circuit through closed sector switch contacts 10, 10 and 56 and 64 of relay 57 to energize release circuit through conductor 65 to the bomb release mechanism or shackles.

Closing contacts 54 and 63 of relay 57 establishes a holding circuit for relay 57, holding this relay closed, so long as the bomb button 35 is maintained depressed.

Closing of contacts 55 and 61 of relay 57, again closes the circuit to reticle lamp 31, again switching it on, indicating that bomb has been released, while closing of contacts 56 and 64 closes the circuit to an electrical bomb release device or bomb shackles, automatically releasing the bomb during the pull up, at the prescribed angle of climb.

The pilot can now release the bomb button 35, and should execute a bank and turn D—D' of approximately 135°—180° while the flight or trajectory of the tossed bomb describes an arc D—B', so to speak, toward the target B, so that the pilot and aircraft are now travelling substantially radially away from the target B, at a "safe" distance from the target and the bomb, when the timing mechanism or fuze in the bomb device explodes the same. The pilot may continue his upward climb after release of the bomb if it is desired to execute an "Immelmann" turn maneuver, instead of a bank and turn, however, this would increase the altitude of the aircraft materially, which might not be desirable in the event of heavy anti-aircraft defense on the ground. He may also complete a loop to be flying away from the target at a lower altitude.

It should be mentioned again that the bomb timer or fuze is preferably started by the initial depression or "pickling" of the bomb button, and this timing mechanism is arranged to discontinue and reset automatically to

zero at any time the bomb button is released, up to the actual release of the bomb during the prescribed pull up, after which the bomb timer would continue and explode the bomb for the initial time interval set, starting from the time when the pilot first depresses the bomb button 35 and keeps it depressed.

A slight modification of the bomb timer fuze device is contemplated, in which the bomb timer, although set before take-off, is set for the time interval of flight or trajectory of the bomb from the release point D in the climb or pull up to the burst point B' over (or on) the target B. In this instance the timing cycle for the bomb intervalometer or fuze device would be initiated by the actual release of the bomb which closes the bomb timer or fuze circuit, and is connected in the release circuit so as to be closed to start the bomb timer with the closing of the contacts 56 and 64 of the relay 57 as the release mechanism or bomb shackles are actuated to release the bomb.

As before mentioned the improved bombing system and method require that the bomb button 35 be depressed or "pickled" just as the aircraft crosses over the prominent point A and maintained depressed throughout the entire ensuing time or until the reticle light goes out, and comes on again as the bomb device is released. Any release of the bomb button restores the cycling mechanism to "zero" and the timing cycle will start over again from the beginning only when the bomb button is again depressed. This, of course, requires the pilot to circle and again cross the initial point A, depressing the bomb button directly over the prominent point A.

Release of the bomb button 35 deenergizes relay 39. Opening contacts 40 and 41 of relay 39 to break the timer starting circuit to the intervalometer I through conductor 44' and extinguishing the warning lamp 70 on the pilot's instrument panel. The holding circuit contacts 28 and 48 of relay 30 will be deenergized, even after the intervalometer I timing cycle has been completed, and even during the pull up, if the bomb button is released before the release point D is reached. Opening of the bomb button switch 35 will deenergize the contacts 60 and 61 of relay 47 to open contacts 54 and 63 to open the circuit to the relay coil 62 and its holding circuit 59', thus preventing the relay contacts 54 and 63, 64 and 56 and 55 and 61 of relay 57 from closing. This restores the system to zero, and deenergizes the bomb fuze or timer I' and also restores the same to zero, making it necessary to return and repeat the system procedure by recrossing the prominent point, depressing the bomb button 35 at time of crossing, and holding the button 35 depressed until the pull up is made and the bomb is released. It should be particularly mentioned that the deenergizing of the circuit to the bomb fuzing intervalometer at any time prior to the release and dropping of the bomb causes the bomb intervalometer timing circuit contacts to also be restored to zero. As the bomb is released in this instance this closes the intervalometer control circuit for or in the intervalometer I' and the same will continue to function after release to explode the bomb at the expiration of the time period, as set into the bomb fuzing intervalometer I'.

Referring to Figures 5, 6 and 7 the adjustable sector switch mechanism K associated with the vertical gyroscope H for determining the bomb release pull up angle is shown in somewhat greater detail in which the tilt axis of the outer gimbal 72 is indicated at 71 and is disposed parallel to the pitch axis of the aircraft. The outer gimbal 72 carries a lug member or arm 73 fixed thereon on which a "movable" contact or "wiper" contact 74 is fixed, the wiper contact 74 being in insulated relation to the arm 73. This wiper 74 remains fixed in space with the outer gimbal 72 relative to the change in pitch of the aircraft during the pull up or climb maneuver from the pull up point C (Figure 1).

The complementary sector switch blades, indicated at

10; are adjustably disposed on or carried by the gyroscope supporting frame or base 75 so that when the climb angle of the aircraft is increased to the "set" climb angle the contact blades 10 simultaneously engage the wiper element 74 and close the "bomb release" circuit, conditioning the bomb release mechanism for operation through the relay 57 at the desired climb angle K.

The frame 75 carries a rotatably adjustable partial ring or plate 76 which is slidably adjustable in an annular channel 77 in the frame portion 75'. The plate 76 is provided with a peripheral gear or rack 78, substantially as shown, meshing with an adjustment pinion 79, fixed on a vertical shaft 79^a carried in suitable bearings in a bracket member 80 supported at the top of the frame portion 75'.

An indexing dial or plate 81 is fixed on the shaft 79^a for the pinion 79 by a projecting pin 81' extending upwardly from a flanged portion of the pinion shaft structure.

The two resilient segmental contact arms 10—10 are overlaid to the ring plate 76 in laterally spaced parallel overlapping relation as shown, being insulated from the plate 76 and from each other with their contact ends disposed substantially in a radial plane from the outer gimbal tilt axis 71. A circular insulating supporting structure 82 is fixed to, and extends axially from: the adjustable plate 76, being formed with annular peripheral channels 83 and 84. In the base of the channels 83 and 84 are contact strips or slip rings, each ring being connected to one of the contact blades 10—10, and wiper elements or contact brushes 85—85 on the frame 75' are located in bomb release circuit to the relay 57 (Figure 3) extending from the segmental contacts 10—10. The inner end of the circular supporting structure 82 carries a circular adjustable index ring 86 having suitable "dive" and "climb" angle indicia 87^a and 87 imprinted in distinctive colors thereon as shown in Figure 4, being adapted to register with a fixed index line or arrow 88 (Figure 5) on a bracket 90 extending from the frame 75'. The smaller indexing dial 81 also has cooperating angle indicia 89 on its upper face registering with the index line 8.

The ratio of the pinion 79 to the large partial ring-gear 78 is preferably such that one rotation of the pinion 79 causes $\frac{1}{36}$ rotation (10 degrees) of the large indexing ring 86, the small index plate 81 being divided as shown, into 10 degrees each degree being subdivided in .02 degree divisions. The large gear ring indicia 87 is indexed in divisions of 5 degrees as shown in Figure 5, and is observed through the window 91, being adjusted by a stem 92 carried on a removable plate portion 93 of the case, the stem 92 being slotted at its upper end at 94 and having a flanged lower end notched at 95 to receive and engage the pin 81', forming a driving connection between the stem 92 and the pinion 79. A lock or jam nut 96 is threaded on the adjusting stem supporting split guide tube 97, carried by the cover plate 93.

The adjustable plate 76 is frictionally held in its adjusted positions on the frame portion 75' by a clamping plate 98, forming one side of the channel 77 with a friction washer 99 therebetween, the plate 98 being "retained" to provide the desired "friction" pressure by the clamping screws 100.

The large circular indexing ring 86 is also adjustable "initially" by the provision of a flange portion 86^a which is clamped between the circular shell or barrel 82 and the clamping partial ring 86^b and retained in the adjusted position by the clamp screws 86^c. Once the initial adjustment is made to dispose the contacting relation of the two contact blades 10 in proper relation to the degree indicia 87 and 87^a on the indexing ring 86 no further relative adjustment of these parts should be necessary.

In adjusting the gyroscope contacts 10—10 for the selected "pull up" or climb angle "K" (Figure 1), the climb angle indicia 87 is utilized and is preferably inscribed in

white. A second set of indicia is inscribed on the dial ring 86 and on the index plate or disk 81 in a different color, for instance red, as indicated at 87^a on the dial ring 87 and at 89^a on the index plate 81. These red indicia marking 87^a and 89^a control the setting of the contacts 10—10 for closing at any prescribed "dive" angle, and are not used, however, in carrying out applicant's bombing method and system.

Preferably, before "take-off" the precalculated climb angle is set substantially as follows. The gyroscope H employed, as before mentioned, is a normally caged type so that the outer and inner gimbals 72 and 72^a are normally caged normal to each other with the rotor spin axis 72^b preferably vertical and perpendicular to the normal pitch axis of the aircraft and the outer gimbal axis 71 disposed perpendicular to the flight axis and parallel to the roll axis. This disposes the inner gimbal tilt axis 72^b in a plane perpendicular to the pitch axis 71 and in a plane parallel to roll axis of the aircraft with the rotor spin axis disposed in a plane perpendicular to the flight axis.

With the gyroscope "caged" a screw driver bit is inserted in the slot 94 and rotated to adjust the climb angle adjustment shaft 92. As the screw driver is turned, observing the registration of the white pull up or climb angle indicia 89 and 87 through the window 91 until the selected pull up angle comes into register with the index line 88. The contact blades 10 are now set at the prescribed climb K (Figure 1) at which the bomb release mechanism, through relay 57, can be energized to release the bomb in carrying out the prescribed bombing method. The contacts 10—10 being thus in angular relation to the wiper contact 74 on the adjustable insulated ring 76 the selector switch K, the circuit 59 will be open until the climb angle indicated is reached during the pull up, following, of course, the conditioning operation of the other relays 12, 39, 30, 47 and 57, in the sequence as set forth in describing Figure 3.

One form of mechanical timer or intervalometer fuze device for exploding the bomb device at the desired time interval which can be employed is somewhat diagrammatically shown in Figure 4, in which the electrical conductor wires 101 and 102 extend to the explosive squib 103 for bomb device 104. Contacts 105 and 106 are provided which are normally open, being closed by a projecting pin 107 on an arm 108 which is loose on shaft 109, the arm 108 carrying an actuating gear 110 and coil spring 111 for urging the arm 108 in the direction 113 and toward the settable stop arm 114 pinned on setting shaft 109, the shaft being settable for any time interval desired by knob 115, the knob being splined or pinned on the shaft 109. A pointer 116 is provided which cooperates with an index dial 116^a for indicating the interval of time or fuze period selected. The reference numeral 117 denotes a motor which is energized simultaneously with intervalometer I for determining the "pull up" period. The motor 117 could be of a clockwork type clutched in by the solenoid 118 if desired.

When circuit is supplied to the solenoid 118 and the motor 117 is energized, a clutch shifter 119 is actuated to engage a clutch 120 and cause rotation of the arm 108 and movement of the pin 107 away from the settable abutment stop arm 114 and toward the spring blades 105 and 106 contacts. When the pin 107 impinges the contact blades 105 and 106 forcing them together the circuit to the primer or squib 103 is closed to explode the bomb device 104.

Current is supplied by a battery 121 and any interruption in the current in the motor circuit 122, before the bomb is released, permits the spring 116^a to disengage the clutch 120, and the spring 111 will reset timing cycle, if it occurs before bomb is released.

When bomb device I is released from the aircraft the bomb intervalometer circuit from the aircraft is broken, of course, however the battery 121 is simultaneously auto-

matically connected to the motor 117 to continue to energize the motor without interruption and explode the bomb at the end of the timing cycle. This may be accomplished by providing a pair of withdrawable contact strips 124 for the energizing circuit from aircraft. These strips 124 are thin and faced on one side with insulation 124^a to open or separate the contact blades 125 in the circuit from the battery 121 from the contact blades 126 in the circuit which are connected to the motor 117.

As the bomb device I is released and dropped the separating contact bars 124—124 are withdrawn from between the complimentary contact blades 125 and 126 allowing the contacts 125 and 126 to first close on the tapered ends of the bars 124 (below the insulated portion) and as they are further withdrawn or pulled out from between the contacts 125 and 126, the contacts 125 and 126 will engage each other without interruption in the motor circuit, closing the second energizing circuit from battery 121 to the motor 117, independently of the former aircraft energizing circuits. The timer or mechanical fuze device will now continue to function until motor 117 rotates the arm 108 sufficiently to impinge and close the contacts 105 and 106, firing the squib or primer 103 to explode the bomb device 104.

Under these conditions the bomb intervalometer timing cycle is initiated by the pilot, through the wires 42^a and 43^a shown in Figure 3, simultaneously with the initiation of the intervalometer I, by the closing of the bomb button or switch 35, at the time the prominent geographical reference point A is crossed (Figure 1).

Release of the bomb button or opening the switch 35 at anytime before the bomb device 104 is dropped resets the bomb timer fuze device shown in Figure 4, similar to the resetting of the intervalometer I.

Breaking of the circuit to the conductor wires 42^a and 43^a deenergizes the clutch engaging the holding solenoid 118, after which the clutch release spring 118^a disengages the clutch 120, allowing the torsion spring 111 to return the abatement 107 (and its supporting arm 118) back against the settable timing stop arm 114, fixed on the time interval setting shaft 109.

Closing of the contact springs 125 and 126 connect the end terminals of the battery 121 to the motor 117 so that the motor, formally driven by current from the wires 42^a and 43^a will now be driven directly by the battery 121. A suitable reduction gear train drive is interposed between the motor 117 and the timer drive gear 110.

In Figure 8 the selected target is indicated at B^t, and the pull up point at C^p is selected directly above the target. In this instance the pull up point becomes the "initial point" at which the timer for the bomb device is started by the depression of the bomb button, the climb angle bomb release contacts having been set to close and release the bomb device at a calculated angle of climb which is slightly greater than 90°, so that upon release, with the pilot starting his pull up from a point directly above the target at a predetermined calculated number of g's and continuing in order to execute an "Immelmann."

The trajectory of the bomb device will be upward, backward, and then downward toward the target, with the aircraft passing under the bomb device. In this instance the intervalometer for timing the flight from the initial point to the pull up point would be set at zero time (or not used).

In Figure 9 the timing for indicating the pull up instant is also initiated by the pilot when passing directly above the target C^t, and the maneuver is substantially the same as in Figure 8, the primary difference being that the pilot, instead of executing an "Immelmann" now flies an "inside loop," the release of the bomb device occurring at the pre-set climb angle (which is greater than 90°). The aircraft is "looped" under the tossed bomb device while the bomb device is tossed vertically and slightly backward.

then falling toward the target, as the aircraft is escaping in a direction radially away from the target area.

In Figure 10, however, both intervalometers are used. However, the "initial point" and (point directly above) the target coincide. The initial point is indicated A^a and the pull up signal timer is set for a calculated distance from E^a to the pull up point C^x and the climb angle bomb release contacts are set for a calculated release or climb angle that is somewhat greater than in Figures 8 and 9 so that the expected upward and backward toss of the bomb device will have a trajectory directed toward the target located below the initial point A^a. In this case the bomb device timer is started preferably at the initial point A^a and is timed to explode at the end of its expected or calculated trajectory above, or on the target. The aircraft, like that in Figure 9, executes a tight inside loop under the upwardly tossed and rearwardly tossed bomb device.

Another modification which is not shown involves setting the release contacts for a climb angle of 90° and calculating the pull up point (from the initial point) and the number of g's required for the pull up flight path sufficient to dispose the release point directly above the target. The bomb device, upon release, would then be tossed vertically upward and fall directly (vertically) back toward or on the target and the aircraft would bring a (predetermined) choice of continuing the pull up into an "Immelmann" or completing the loop below the level of the upwardly tossed bomb device, so as to be flying away from the bomb device and target at a low level when timer for the bomb device initiates the explosion above or on the target, or if an impact fuze is used, at the time the bomb device strikes the target.

While the above description and accompanying drawings set forth one embodiment of the invention it is not intended to limit the scope of the invention to the exact details as described and illustrated but only by the scope of the appended claims, and any changes and modifications that come within the scope of those claims.

I claim:

1. A low-altitude bombing system for a bombing aircraft comprising, a normally cageable vertical gyroscope having a supporting frame fixed in the aircraft, an outer gimbal journaled on said frame for tilt on an axis parallel to the pitch axis of the aircraft, an inner gimbal tilttable in the outer gimbal on an axis perpendicular to said outer gimbal tilt axis, a rotor journaled in the inner gimbal on an axis perpendicular to said inner gimbal axis, spring actuated caging means for normally caging said inner and outer gimbals normal to each other, a stepping relay uncaging device for disengaging said caging means, angularly adjustable contact means carried by said frame for angular adjustment about said outer gimbal tilt axis, climb angle indexing means carried by said frame for adjusting said contact means angularly about said axis from a fixed reference point to any selected predetermined climb angle, cooperating contact means fixed on said outer gimbal for establishing circuit closing contact with said first mentioned contact means when the aircraft pulls up, reaches said predetermined climb angle, relay means including an energizing circuit therefor connected to said contact means, bomb release means operatively connected to said relay means, pull up signal means in the aircraft for indicating the time instant for initiating the pull up, an intervalometer device carried by the aircraft for closing said pull up signal means at the end of its timing cycle to indicate the instant for pull up, relay means including an energizing circuit for initiating said intervalometer into operation, manually operable relay circuit closing means for closing said last relay means to start the intervalometer timing cycle, and means for deenergizing said last mentioned relay means when said manually operable relay circuit closing means is opened.

2. Apparatus as claimed in claim 1 including a bomb

device carried by and adapted to be released from the aircraft by said bomb release device, a second intervalometer device carried by said bomb device adapted to be set for a time interval exceeding the time interval setting of the first mentioned intervalometer relay means, an energizing circuit electrically connected to the first intervalometer timing cycle initiating circuit whereby both of said intervalometers are initiated into operation simultaneously and means for deenergizing and resetting said second intervalometer to zero automatically at any time prior to the closing of said gyroscope contacts when said manually operable relay circuit closing means is opened.

3. In an improved low altitude aircraft bombing system for lobbing a time fused bomb device on a selected target at a predetermined air speed, low altitude and distance from a selected target sufficient for the aircraft to turn and escape to a remote safe distance from the target by the time the bomb device reaches the target, in which a direct predetermined flight direction toward the selected target is established which transversely crosses a prominent elongated geographical land mark reference point at a known remote distance from the target which exceeds the time of trajectory of said bomb device when released from the aircraft during a pull up at a predetermined number of g's from a predetermined low altitude and airspeed at a predetermined angle of climb, sufficient to enable the aircraft to execute said predetermined turn immediately following release of the bomb device and be flying away from the target at said safe remote distance by the time said bomb device reaches the target area; said system comprising; a bomb device; an aircraft releasably carrying the said bomb device; a preset timer carried by the bomb device and set for exploding the bomb device at the termination of a time period equal to the time of flight of the aircraft between the instant of crossing of said reference point and the instant of release of said bomb device plus the time of trajectory of the bomb device between said instant of release and the target; a second preset signal timer carried by said aircraft preset for the time of flight from the instant of crossing said reference point to the point of pull up for indicating the instant time for said pull up for the aircraft from the crossing of said reference point; single means for simultaneously initiating both of said timers into operation at the instant of crossing said reference point, and means carried by the aircraft for releasing said bomb device automatically at said predetermined angle of climb only after the termination of the time interval determined by said second signal timer; and means for interrupting the timing cycle of both of said timers at any time prior to the termination of the timing cycle of said second signal timer after said second timer has been initiated into operation.

4. In a low altitude aircraft bombing device as set forth in claim 3 in which the means for initiating said timers into operation includes an energizing circuit and a manually operable switch means for closing said circuit at the instant that said reference point is crossed; means for normalizing said circuit and automatically resetting said circuit and both of said timers at any time after the timing cycle has started, prior to the release of said bomb device, so as to require a return and recrossing of said reference point on a subsequent flight toward the target and closing of the switch means again above said reference point and maintaining said switch means closed from the time of crossing of said reference point to said pull up and point of release of the bomb device in order to effect a release of the bomb device following the crossing of said reference point.

5. A low altitude toss bombing system for a bombing aircraft comprising a normally cageable gyroscope having a supporting frame fixed in the aircraft, an outer gimbal journaled on said frame for tilt on an axis parallel to the pitch axis of the aircraft, an inner gimbal tilttable in

said outer gimbal on an axis perpendicular to said outer gimbal tilt axis, a rotor journaled in said inner gimbal on an axis perpendicular to said inner gimbal axis, caging means normally caging said inner and outer gimbals normal to each other, an uncaging device for disengaging said caging means, angularly adjustable contact means carried by said frame for angular adjustment about said outer gimbal tilt axis, climb angle indexing means carried by said frame for adjusting said contact means angularly about said frame from a fixed reference point to any selected predetermined climb angle, cooperating contact means fixed on said outer gimbal for establishing circuit closing contact with said first mentioned contact means when the aircraft pulls up and reaches said predetermined climb angle, an energizing circuit therefor connected to said contact means, bomb release means operatively connected in said energizing circuit, pull up signal means in the aircraft for indicating the time instant for initiating the pull up, an intervalometer device carried by the aircraft for actuating said pull up signal means at the end of its timing cycle to indicate the instant for pull up including an intervalometer timing cycle initiation energizing circuit for initiating said intervalometer into operation, manually operable circuit closing means for closing the last mentioned energizing circuit to start the intervalometer timing cycle, and means for deenergizing said last mentioned circuit and returning said intervalometer to zero when said manually operable circuit closing means is opened.

6. Apparatus as claimed in claim 5 including a bomb device carried by and adapted to be released from the aircraft by said bomb release device, a second intervalometer device carried by said bomb device adapted to be set for a time interval exceeding the time interval setting of the first mentioned intervalometer device, a second intervalometer timing device energizing circuit electrically connected to the first intervalometer timing cycle initiating circuit for initiating both of said intervalometers into operation simultaneously, and means for deenergizing and resetting said second intervalometer to zero automatically at any time prior to the closing of said gyroscope contacts when said manually operable circuit closing means is opened.

7. A low altitude aircraft high explosive bombing apparatus for bombing a selected remote target on a bombing run directly toward said selected target which transversely crosses an elongated geographical landmark reference point at a predetermined flight time from the target which is in excess of a predetermined safe escape distance from the target at the time the bomb device is exploded at the target following a pull up and release of the bomb device at a predetermined low altitude, speed, and angle of climb sufficient to permit the aircraft to turn and fly to said safe remote distance from the target by the time the bomb device reaches the target, said apparatus comprising; a bombing aircraft; a high explosive bomb device releasably carried by said aircraft, pull up signal means carried by said aircraft; settable time controlled means carried by said aircraft for operating said pull up signal means to indicate a pull up signal to the operator of said aircraft; settable bomb release means carried by said aircraft for releasing said bomb device during said pull up at a predetermined angle of climb following the actuation of said pull up signal means by said settable time control means in which said settable time control means includes an intervalometer and manual means for initiating said intervalometer into operation at the instant of crossing said prominent reference point in a bombing run toward the target, including a second settable time controlled intervalometer for exploding said bomb device, set for a time period equal to said time of flight from said prominent point to said pull up point plus the time of flight from said pull up point to said release point at said angle of climb at a predetermined number of g 's plus the trajectory time of

said bomb device from said release point to a burst point at the target, including means for simultaneously starting both of said intervalometers including a common intervalometer starting circuit therefor and an energizing bomb button switch for said circuit adapted to be closed by the pilot at the instant of crossing said prominent reference point in a bombing run toward the target.

8. A low altitude aircraft high explosive bombing apparatus for bombing a selected remote target on a bombing run directly toward said selected target which transversely crosses an elongated geographical landmark reference point at a predetermined flight time from the target which is in excess of a predetermined safe escape distance from the target at the time the bomb device is exploded at the target following a pull up and release of the bomb device at a predetermined low altitude, speed, and angle of climb sufficient to permit the aircraft to turn and fly to said safe remote distance from the target by the time the bomb device reaches the target, said apparatus comprising; a bombing aircraft; a high explosive bomb device releasably carried by said aircraft, pull up signal means carried by said aircraft; settable time controlled means carried by said aircraft for operating said pull up signal means to indicate a pull up signal to the operator of said aircraft; settable bomb release means carried by said aircraft for releasing said bomb device during said pull up at a predetermined angle of climb following the actuation of said pull up signal means by said settable time control means, in which said settable time control means includes an intervalometer and manual means for initiating said intervalometer into operation at the instant of crossing said prominent reference point in a bombing run toward the target, including a second settable time controlled intervalometer for exploding said bomb device set for a time period equal to said time of flight from said prominent point to said pull up point plus the time of flight from said pull up point to said release point at said angle of climb at a predetermined number of g 's plus the trajectory time of said bomb device from said release point to a burst point at the target including means for simultaneously starting both of said intervalometers including a common intervalometer starting circuit therefor and an energizing bomb button switch for said circuit adapted to be closed by the pilot at the instant of crossing said prominent reference point in a bombing run toward the target, including means in said energizing circuit controlled by said bomb button; arranged to open said circuit upon release of said bomb button; and means for restoring both of said intervalometer timing devices to zero when said energizing circuit is opened.

9. A low altitude aircraft high explosive bombing apparatus for bombing a selected remote target on a bombing run directly toward said selected target which transversely crosses an elongated geographical landmark reference point at a predetermined flight time from the target which is in excess of a predetermined safe escape distance from the target at the time the bomb device is exploded at the target following a pull up and release of the bomb device at a predetermined low altitude, speed, and angle of climb sufficient to permit the aircraft to turn and fly to said safe remote distance from the target by the time the bomb device reaches the target, said apparatus comprising; a bombing aircraft; a high explosive bomb device releasably carried by said aircraft, pull up signal means carried by said aircraft; settable time controlled means carried by said aircraft for operating said pull up signal means to indicate a pull up signal to the operator of said aircraft; settable bomb release means carried by said aircraft for releasing said bomb device during said pull up at a predetermined angle of climb following the actuation of said pull up signal means by said settable time control means, in which said settable time control means includes an intervalometer and manual means for initiating said intervalometer

into operation at the instant of crossing said prominent reference point in a bombing run toward the target, including a second settable time controlled intervalometer for exploding said bomb device set for a time period equal to said time of flight from said prominent point to said pull up point plus the time of flight from said pull up point to said release point at said angle of climb at a predetermined number of g 's plus the trajectory time of said bomb device from said release point to a burst point at the target including means for simultaneously starting both of said intervalometers including a common intervalometer starting circuit therefor and an energizing bomb button switch for said circuit adapted to be closed by the pilot at the instant of crossing said prominent reference point in a bombing run toward the target including means in said energizing circuit controlled by said bomb button; arranged to open said circuit upon release of said bomb button; and means for restoring both of said intervalometer timing devices to zero when said energizing circuit is opened in which said pull up signal means includes an energizing circuit therefor; relay means for closing said last mentioned circuit and means for energizing the last mentioned relay means from the first mentioned intervalometer at the expiration of its timing cycle.

10. A low altitude aircraft high explosive bombing apparatus for bombing a selected remote target on a bombing run directly toward said selected target which transversely crosses an elongated geographical landmark reference point at a predetermined flight time from the target which is in excess of a predetermined safe escape distance from the target at the time the bomb device is exploded at the target following a pull up and release of the bomb device at a predetermined low altitude, speed, and angle of climb sufficient to permit the aircraft to turn and fly to said safe remote distance from the target by the time the bomb device reaches the target, said apparatus comprising; a bombing aircraft; a high explosive bomb device releasably carried by said aircraft, pull up signal means carried by said aircraft; settable time controlled means carried by said aircraft for operating said pull up signal means to indicate a pull up signal to the operator of said aircraft; settable bomb release means carried by said aircraft for releasing said bomb device during said pull up at a predetermined angle of climb following the actuation of said pull up signal means by said settable time control means, in which said settable time control means includes an intervalometer and manual means for initiating said intervalometer into operation at the instant of crossing said prominent reference point in a bombing run toward the target, including a second settable time controlled intervalometer for exploding said bomb device set for a time period equal to said time of flight from said prominent point to said pull up point plus the time of flight from said pull up point to said release point at said angle of climb at a predetermined number of g 's plus the trajectory time of said bomb device from said release point to a

burst point at the target including means for simultaneously starting both of said intervalometers including a common intervalometer starting circuit therefor and an energizing bomb button switch for said circuit adapted to be closed by the pilot at the instant of crossing said prominent reference point in a bombing run toward the target including means in said energizing circuit controlled by said bomb button; arranged to open said circuit upon release of said bomb button; and means for restoring both of said intervalometer timing devices to zero when said energizing circuit is opened in which said pull up signal means includes an energizing circuit therefor; relay means for closing said last mentioned circuit and means for energizing the last mentioned relay means from the first mentioned intervalometer at the expiration of its timing cycle in which said settable bomb release means includes a normally caged vertical gyroscope device carried by the aircraft; means for uncaging said gyroscope just prior to crossing said prominent reference point; adjustable bomb release circuit closing contacts carried by said gyroscope adjustable for closing at any predetermined angle of climb of the aircraft; a bomb release circuit including the last mentioned circuit closing contacts; said contacts being angularly spaced and including a first contact adjustably fixed relative to the attitude of the aircraft in pitch and a second cooperating contact fixed in space by the gimbal means of said gyroscope and adapted to contact said first contact when the climb angle of the aircraft reaches the predetermined climb angle for the release of the bomb device; bomb release means; and relay means in said bomb release circuit for actuating said bomb release means when said bomb release circuit is energized; a second relay means in said bomb release circuit normally maintaining said bomb release circuit open; and an energizing circuit for said last mentioned relay means operatively connected to said bomb button energizing circuit for maintaining the bomb device release circuit operative only during the time that the bomb button energizing circuit is closed by said bomb button.

References Cited in the file of this patent

UNITED STATES PATENTS

2,609,729	Wilkenson et al. -----	Sept. 9, 1952
2,712,269	Garbarni et al. -----	July 5, 1955
2,736,878	Boyle -----	Feb. 28, 1956
2,758,511	McLean et al. -----	Aug. 14, 1956
2,805,601	Morton -----	Sept. 10, 1957

FOREIGN PATENTS

1,005,077	France -----	Dec. 12, 1951
-----------	--------------	---------------

OTHER REFERENCES

Court of Claims of the United States, No. 43,055, Robert V. Morse v. The United States, Report of Commissioner.

Aircraft Engineering, September 1942, Notes on Enemy Bombsights, pp. 244-247.