

Aug. 20, 1946.

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2,406,293

GYROSTABILIZED BOMB CONTROL SYSTEM

Filed March 16, 1943

5 Sheets-Sheet 1

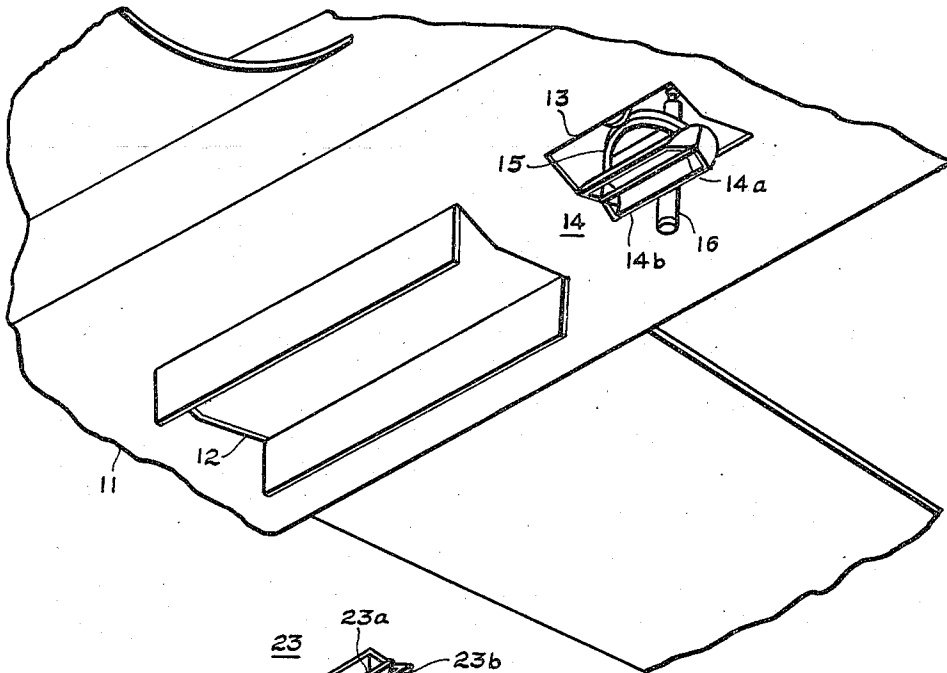


Fig. 1.

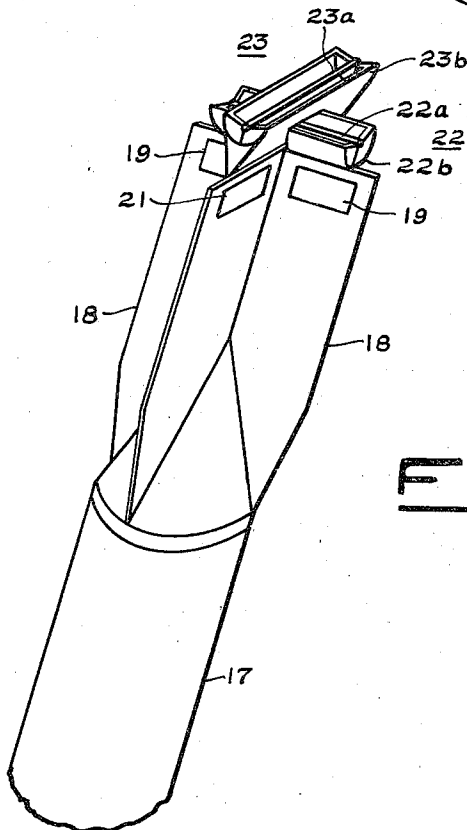


Fig. 10.

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5 Sheets-Sheet 2

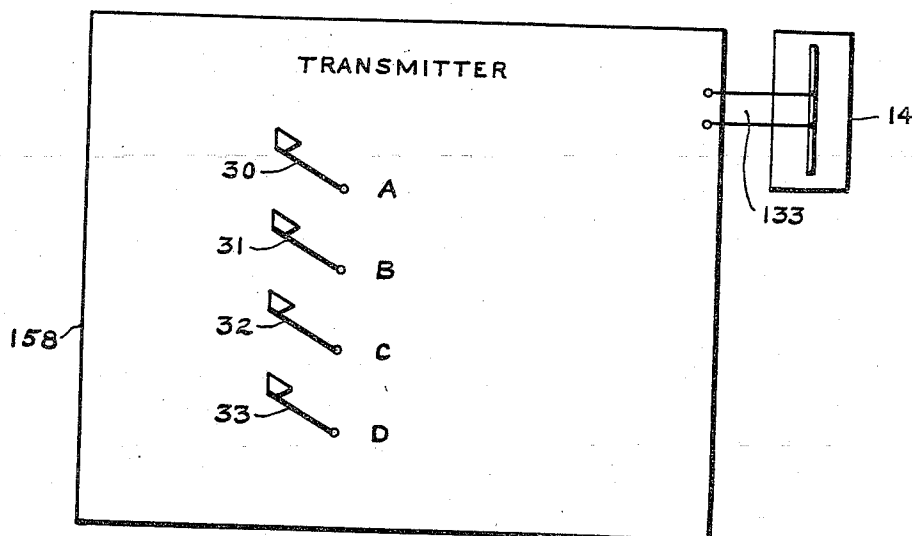


Fig. 2.

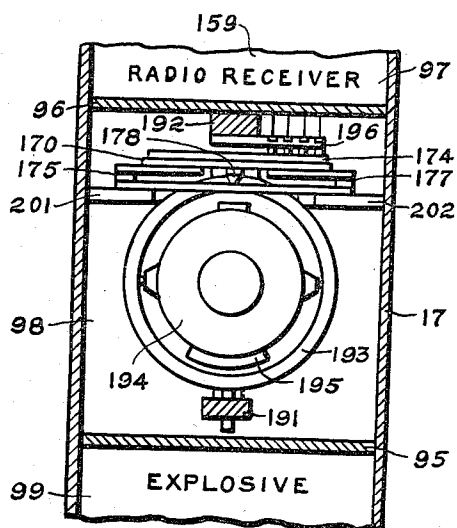


Fig. 7.

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5 Sheets-Sheet 3

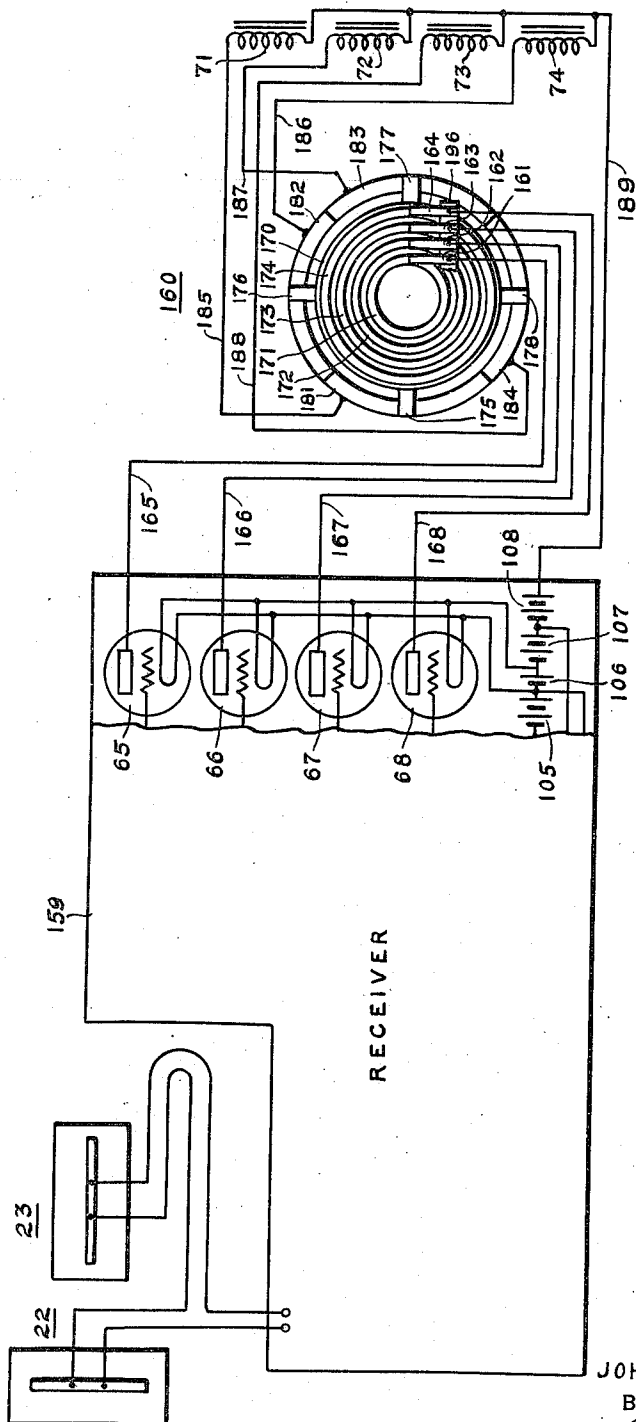


Fig. 3.

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5 Sheets-Sheet 5

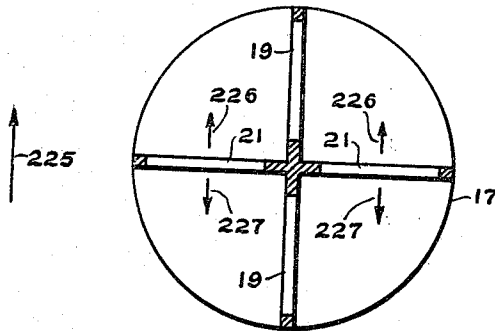


Fig. 8.

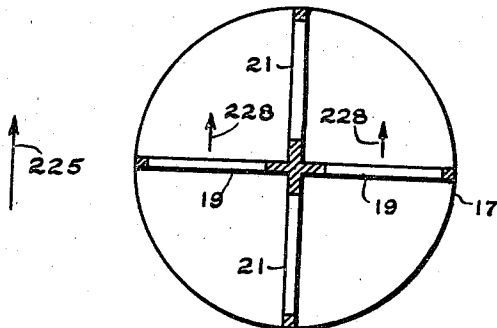


Fig. 9.

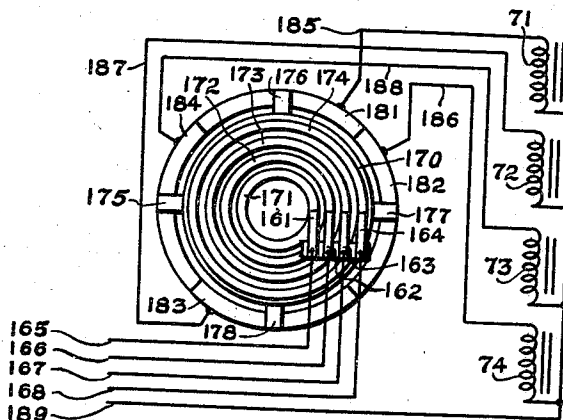


Fig. 10.

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UNITED STATES PATENT OFFICE

2,406,293

GYROSTABILIZED BOMB CONTROL SYSTEM

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Application March 16, 1943, Serial No. 479,312

5 Claims. (Cl. 102—3)

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The invention relates to the radio-dynamic control of aerial bombs and more particularly to a radio control system which can selectively steer the falling bomb in any one of a plurality of directions.

The invention provides means for controlling the direction of descent of a bomb in connection with a gyroscope or other stabilizing means in which the bomb may be steered in any one of a plurality of directions in azimuth irrespective of the horizontal rotation of the bomb.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Figure 1 is a diagrammatic illustration of a portion of a plane, including the bomb bay;

Figure 1a is a perspective view of a bomb as released from the plane of Figure 1;

Figure 2 is a block diagram of the transmitting circuits on the plane;

Figure 3 illustrates diagrammatically the receiving circuits located in the bomb;

Figure 4 is a partial section thru a bomb illustrating diagrammatically the control apparatus for steering the bomb;

Figure 5 is a section taken on line 5—5 of Fig. 4;

Figure 6 is a section taken on line 6—6 of Fig. 4;

Fig. 7 is a partial section thru the bomb illustrating diagrammatically the control apparatus in the position it will assume during the descent of the bomb;

Figs. 8 and 9 are end views of the bomb; and

Fig. 10 is a plan view of the distributing system.

Like reference characters denote like parts in the several figures of the drawings.

In the following description parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the accompanying drawings and more particularly to Figure 1 the plane 11 is shown as provided with the usual bomb bay 12 behind which is an opening 13 in which is lo-

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cated the antenna system 14 of the transmitter to be described. This antenna system is mounted on suitable means, shown as gimbal rings 15, so that it may be pointed in any desired direction.

A sighting means, shown as a telescope 16, is attached to the antenna system 14 to facilitate following the bomb in its descent. The antenna system 14 is of the type adapted to radiate polarized, directional, short waves in the form of a beam. In the embodiment shown this system comprises a dipole radiator 14a mounted in a reflector system 14b. It is to be understood, however, that any standard type of directional polarized beam short wave radiator may be used.

The bomb 17 is provided with the usual fins 18 in which are located two sets of rudders 19 and 21 whose axes of rotation are at right angles to each other. Mounted on the ends of the fins 18 are two directional receiving antennas 22 and 23 the axes of which are located in planes at right angles to each other, and preferably in the planes of the axes of the rudders 19 and 21. The antennas 22 and 23 are shown as similar in construction to the antenna 14 and are of the type suited to receive polarized short waves from a given direction only. The antennae are shown as comprising wave receiving members 22a and 23a and directional members 22b and 23b which correspond to the reflector 14b. The directional members are suited to make the receiving elements receptive to signals received from above and to shield the receiving members from waves propagated from the ground and from horizontal waves, so that possibility of interference with the control beam transmitted from the plane is eliminated.

Fig. 2 is a diagrammatic illustration of the transmitter 158 which may be similar in design to the transmitter depicted in Fig. 2 of my co-pending application, Serial Number 458,938. The transmitter is of a type to generate a short wave carrier modulated by a control frequency. Four keys 30—33 are connected to vary the control frequency when individually depressed to produce the "A," "B," "C" and "D" control frequencies respectively. The transmitter 158 is connected to the antenna 14 by means of the transmission line 133.

Fig. 3 is a diagrammatic illustration of the receiver 159 which may be similar in design to the receiver depicted in Fig. 3 of my co-pending application 458,938 and is connected to the directive antenna system 22—23. The receiver 159 feeds power tubes 65—68 which are energized by batteries at 105—108. The power tubes 65—68

are connected to four solenoids 71—74 thru a distributing system 160. The distributing system 160 includes four brushes 161—164 which are connected by conductors 165—168 to the plates of the power tubes 65—68. The brushes 161—164 engage four slip rings 171—174 which are mounted on a circular block of insulation 170 to be more fully described hereinafter. Secured to the block of insulation 170 are four brushes 175, 176, 177 and 178 which are electrically connected to the four slip rings 171, 174, 172 and 173 respectively. The four brushes 175—178 engage four quadrant segments 181 to 184 which in turn are connected by conductors 185—188 to one side of the windings of the solenoids 71, 74, 72 and 73 respectively, the other sides of the windings being connected by a conductor 189 to the battery 100.

In Figure 4 is shown the apparatus for controlling the rudders 19 and 21 in response to the energization of the four solenoids 71—74 illustrated in Figure 3. The two sets of rudders 19 and 21 are connected by links 81 to piston rods 82 which are attached to pistons 83 which reciprocate in two cylinders 84 and 85. Balanced compression springs 86 are provided for normally holding the pistons 83 and therefore the rudders 19 and 21 in a central position.

The pistons 83 are actuated by air under pressure which is supplied from a tank 87. This tank is shown as being connected by a pipe 88 to a funnel shaped opening in the nose of the bomb 17. A flask containing air under pressure could also be used as a source of compressed air if desired. The tank 87 is connected to the cylinders 84 and 85 by means of conduits 91 and the supply of air to the interior of the cylinders 84 and 85 is controlled by two piston valves 92 and 93 respectively. The valve 92 is operated in opposite directions by means of the solenoids 71 and 72 and the valve 93 is operated in opposite directions by means of the solenoids 73 and 74. Balanced compression springs 94 are provided to maintain the valves 92 and 93 in a central position when the solenoids 71—74 are de-energized.

Two transverse bulkheads 95 and 96 are provided which divide the bomb into three compartments 97, 98 and 99. The compartment 97 contains the control apparatus just described and the radio receiver 159 which is mounted on the bulkhead 96. The compartment 98 contains the gyroscopic apparatus presently to be described and the compartment 99 is filled with a high explosive, such for example as TNT and is provided with the usual fuses, not shown, for detonating the explosive charge when the bomb reaches its target.

In the compartment 98 are mounted two cross members 191 and 192 to which is pivoted a gimbal ring 193. In the gimbal ring 193 is pivoted a gyroscope 194 to the lower part of which is attached a weight 195. Mounted on the gimbal ring 193 is the circular block of insulation 170, already described in connection with Fig. 3, which carries the four slip rings 171—174 which in turn are engaged by the four brushes 161—164. These brushes are mounted on a block of insulation 196 which is secured to the cross member 192. The four quadrant segments 181—184 are mounted on brackets 201—204 of insulating material which are secured to the casing of the bomb 17.

In Fig. 4 the bomb 17 is shown as suspended from the bomb rack 205. For bringing the gyroscope 194 up to speed before the bomb is released a source of A. C. current 206 is provided and is connected thru a switch 207 to a double contact

plug 208 mounted on the bomb rack 205. The contacts of the plug 208 engage the contacts of a receptacle 209 mounted on the bomb 17. Pivotaly mounted in the cross member 191 is an arm 211 the outer end of which engages the top of the gyroscope 194. A spring 210 tends to rotate the arm 211 in a counter clockwise direction. The contacts of the receptacle 209 are connected by flexible conductors 212 to contacts 213 which engage the winding 214 of the gyroscope 194.

Mounted on the end of the arm 211 is a flat spring 215 the end of which is turned up. Pivotaly mounted on the casing of the bomb 17 is a member 216. A spring 217 is provided which tends to rotate the member 216 in a counter clockwise direction. Mounted on the bomb rack 205 is a cylinder 218 in which reciprocates a piston 219 to which is attached a plunger 221 which passes thru an opening in the casing of the bomb 17 and engages the spring 215. A compression spring 222 is mounted in the cylinder 218 and tends to hold the arm 211 in engagement with the gyroscope 194.

Operation

When the bomb is assembled the gyroscope 194 is placed in the position shown in Fig. 4, the arm 211 is moved into engagement with the top as the gyroscope and the member 216 is rotated into the position shown in dotted lines so that it engages the end of the spring 215. When the bomb 17 is placed in the bomb rack 205 the plug 208 fits into the receptacle 209 and the plunger 221 passes thru the hole in the casing of the bomb 17 and engages the spring 215 which is moved downward sufficiently to release the member 216 which is rotated in a counter clockwise direction under the action of the spring 217 into the position shown in full lines.

As the bomber approaches the target the switch 207 is closed which closes a circuit from the generator 206 thru the plug 208, receptacle 209, conductors 212, contacts 213 to the winding of the gyroscope 214. This causes the rotating element of the gyroscope 194 to be brought up to and maintained at speed. The gyroscope 194 is held in the position shown by means of the arm 211 so that during any maneuvers of the bomber the gyroscope 194 will be held fixed in the position shown with respect to the bomb 17.

When the bomb 17 is released the plug 208 is disengaged from the receptacle 209 and the plunger 221 is disengaged from the spring 215. This allows the arm 211 to be rotated in a counter clockwise direction under the action of the spring 210 which leaves the gyroscope 194 free in space. If the bomb 17 should rotate about its longitudinal axis while in a horizontal position shortly after leaving the bomb rack the gyroscope 194 will remain in a vertical position due to the action of the weight 195 which will cause the gimbal ring 193 to rotate about its pivot points.

As the nose of the bomb drops and it assumes the vertical position of descent the gyroscope 194 which remains fixed in space, will assume the position relative to the bomb 17 shown in Fig. 7. In this position the four brushes 175—178 will be in the positions shown in Figs. 3 and 5, which when the bomb is descending vertically are plan views looking in the direction of the descent of the bomb.

The four brushes 175—178 will be maintained in fixed positions in space during the descent of the bomb by the action of the gyroscope 194 and are independent of the rotation of the bomb

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about its longitudinal axis. The contact 176 will, therefore, always be maintained in the direction in space in which the bomber 11 was travelling at the time of the release of the bomb 17. The contact 178 will always be pointed in the opposite direction, the contact 175 at 90° to the left and the contact 177 at 90° to the right of the direction of travel of the bomber 11.

In the operation of the transmitter of Fig. 2 a radio frequency is generated which is modulated by the "A," "B," "C" and "D" control frequencies when the keys 30, 31, 32 and 33 are depressed. In this way when any one of the keys 30—33 is depressed a plane polarized wave is radiated from the antenna 14, this wave being modulated at a different predetermined frequency for each key.

The modulated radio wave transmitted from the antenna 14 is received by the antenna system 22—23 of the bomb 17 shown in Fig. 3 and selectively operates the power tubes 65—68 of the receiver 159. The power tubes 65—68 will in turn energize the solenoids 71—74 thru the distributing system controlled by the brushes 175—178.

If the bomb 17 does not rotate about its longitudinal axis it will assume the position shown in Figs. 1a and 8 in which case the rudders 21 will control the direction of motion of the bomb 17 in the plane in which the bomber 11 is travelling as indicated by the arrow 225 and the rudders 19 will control the direction of motion in a plane at right angles to the direction of motion of the bomber 11. If, for example, it is desired to deflect the bomb 17 in the direction in which the bomber 11 is travelling the key 33 of the transmitter 160 is depressed which causes the "D" frequency to be transmitted. The radiated wave is picked up by the receiving antenna 22—23 on the bomb 17 and actuates the power tube 68. The plate of the tube 68 is connected thru conductor 168, brush 164, slip ring 174, brush 176, segment 182 and conductor 186 to the solenoid 74 which is thereby energized. The energization of the solenoid 74 causes the valve 93 to be moved to the left and will allow air under pressure from the tank 87 to enter the left hand end of the cylinder 85. This will cause the piston 83 to move to the right which, by means of the rod 82 and link 81 will cause a rotation of the rudders 21 in a counter-clockwise direction as seen in Fig. 4. As seen in Fig. 8 the rudders will move in the direction of the arrows 226. This will cause the bomb 17 to be deflected in the direction in which the bomber 11 is travelling.

If it is desired to deflect the bomb 17 in the opposite direction the key 32 is depressed causing the transmission of the "C" frequency which energizes power tube 67. As this tube is connected thru the distributing system to the solenoid 73 this solenoid will be energized causing the rudders 21 to be rotated in a clockwise direction as seen in Fig. 4 to deflect the bomb 17 to the rear. As seen in Fig. 8 the rudders will move in the direction of the arrows 227. In a similar manner the transmission of the "A" frequency will cause the energization of solenoid 71 to operate the rudders 19 to deflect the bomb to the left and the transmission of the "B" frequency will deflect the bomb to the right, as seen in Fig. 8.

If during its descent the bomb 17 should rotate about its longitudinal axis, for example, 90 degrees into the position shown in Fig. 9 the rudders 19 will then control the deflection of the

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bomb in the direction of the arrow 225 and the rudders 21 will control its deflection at right angles thereto. The gyroscope 194 however, together with the brushes 175—178 will remain fixed in space. Due to the rotation of the bomb 17 thru 90 degrees the segments 181—184 will be rotated into the position shown in Fig. 10.

If it is desired to deflect the bomb 17 in the direction of the arrow 225, the key 33 of the transmitter 160 is depressed causing the "D" frequency to be transmitted. This as already described actuates the power tube 68. The plate of this tube is now connected thru conductor 168, brush 164, slip ring 174, brush 176, segment 181 and conductor 185 to the solenoid 71, as shown in Fig. 10, thus energizing solenoid 71. The energization of solenoid 71 causes the valve 92 to be moved to the right as seen in Fig. 4 thus allowing air to enter the right hand side of the cylinder 84. This will cause the piston 83 to move to the left which, by means of the rod 82 and link 81 will cause the rudders 19 to move in the direction of the arrows 228 as shown in Fig. 9. This will cause the bomb 17 to be deflected in the direction of the arrow 225 as desired.

It is thus seen that by depressing the key 33 the bomb 17 will always be deflected in the direction of the arrow 225, that is in the direction in which the bomber 11 is travelling, no matter how much the bomb 17 may have rotated about its longitudinal axis because the brush 176 will always be held fixed in space by the gyroscope 194 and will therefore engage the proper one of the segments 181—184 so as to energize the proper solenoid 71—74 to cause the bomb to be deflected in the direction of the arrow 225. In a similar manner, by depressing the key 32 the bomb 17 will always be deflected in the opposite direction. By depressing the keys 30 and 31 the bomb will always be deflected to the left or right regardless of how much it may have rotated about its longitudinal axis during its descent.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not limited to any specific construction but may be embodied in various forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A bomb control system comprising in combination, a carrier borne signal transmitting apparatus including means to transmit selective control signals, and a bomb having signal receiving means responsive to said signals, rudders to control the path of descent of said bomb, rudder control mechanisms, selector mechanism mounted to turn freely in said bomb, gyro stabilized mechanism connected to stabilize said selector mechanism in azimuth regardless of the rotation of said bomb, means connecting said selector mechanism to select the rudder control mechanism which bears a predetermined azimuth position with respect thereto, and means selectively responsive to said received signals to actuate the selected rudder control mechanism for deflecting said bomb in a direction determined by the control signal.

2. A bomb control system comprising in combination, a carrier borne signal transmitting apparatus including means to transmit selective control signals, and a bomb having signal-receiving means including channels selectively re-

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sponsive to said control signals, rudders to control the path of descent of said bomb in two directions, rudder control mechanisms therefor, selector mechanism mounted to turn freely in said bomb, gyrostabilized mechanism connected to stabilize said selector mechanism in azimuth regardless of the rotation of said bomb, means connecting said selector mechanism to select the rudder control mechanism which bears a predetermined azimuth position with respect thereto, and means selectively responsive to said received signals to actuate the selected rudder control mechanism for deflecting said bomb in a direction determined by the control signal.

3. A bomb control system as set forth in claim 1 in which the signal transmitting apparatus is

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adapted to transmit radio signals and in which the receiving means on said bomb is responsive to said radio signals.

4. A bomb control system as set forth in claim 1 in which said receiving means on said bomb comprises means responsive only to signals received from above whereby interference by ground signals is eliminated.

5. A bomb control system as set forth in claim 1 in which a pair of crossed rudders is provided to control the path of descent of said bomb in two directions at right angles to each other and said gyrostabilized mechanism selects the rudder control mechanism having a position in space suited to deflect the bomb in the desired direction.

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