Sept. 17, 1968 A. SCHÖNHERR ETAL 3,401,599

STABILIZER

Filed May 25, 1966 2 Sheets-Sheet 1

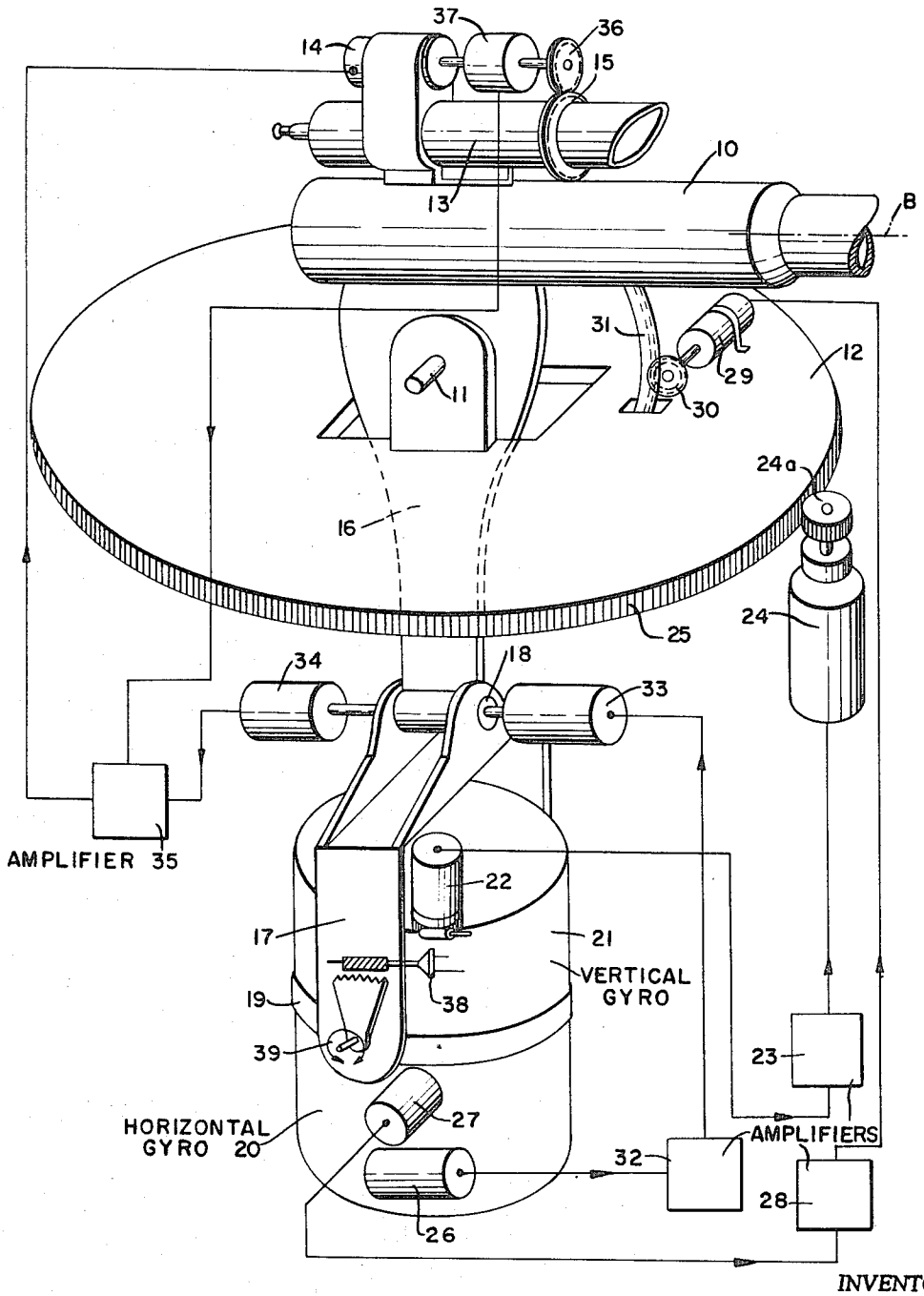


FIG. 1.

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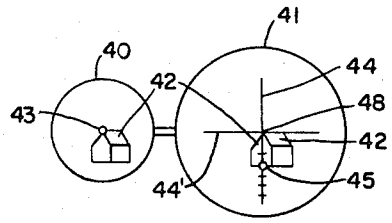


FIG. 2.

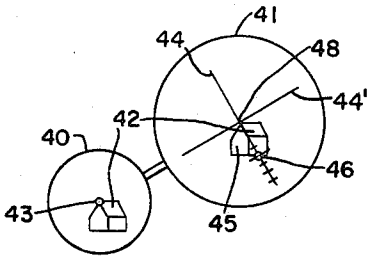


FIG. 3.

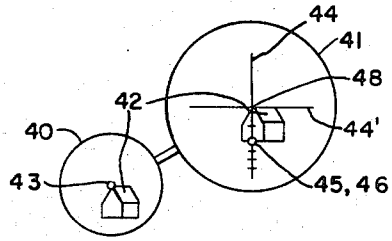


FIG. 4.

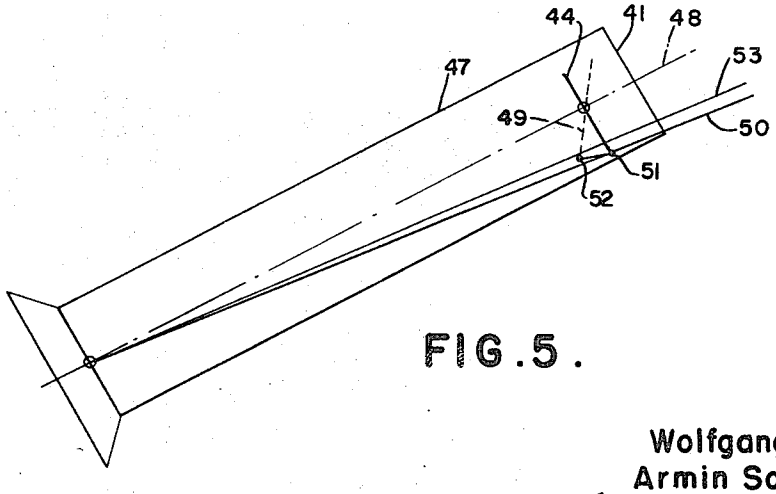


FIG. 5.

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3,401,599

Patented Sept. 17, 1968

3,401,599

STABILIZER

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Filed May 25, 1966, Ser. No. 561,305
8 Claims. (Cl. 89—41)

ABSTRACT OF THE DISCLOSURE

A stabilizing arrangement for a weapon carried on a movable platform. The platform itself is stabilized about a vertical axis and an elevation axis. The sighting device for aiming the weapon, which sighting device is also arranged on the platform, has rotatable line markings. Means are provided for producing a signal which is a function of the movement of the platform about a roll axis, and further means are provided for rotating the line markings in response to this signal, thereby to stabilize the line of sight of the sighting device. In this way, the weapon can be properly aimed, even though the platform on which the weapon is carried is itself stabilized only about the vertical axis and the elevation axis.

The present invention relates to an arrangement for stabilizing a weapon, equipped with an aiming, or so-called sighting device or the like, arranged on a movable platform.

The bore axis of such a weapon is generally stabilized with the help of a so-called reference value generator which determined the instantaneous difference between the actual value and the nominal value, i.e., the difference between the actual position in which the bore axis is directed and the direction in which the bore axis should be directed. The differences which are determined in this way are applied to positioning devices which then see to it that the weapon is returned to the proper position so that—since these movements as such as generally quite small—the position of the weapon remains essentially constant.

Mobile weapons, for example, weapons mounted on tanks or other armored vehicles, have to be stabilized in three axes, that is to say, the weapons have to be stabilized for yaw, pitch and roll in order that the weapon be aimed correctly. This is done with the help of a reference value generator arrangement which incorporates a separate reference value generator for each axis about which the platform is to be stabilized. The signals put out by the reference value generators then control the individual positioning mechanisms which effect the displacement of the weapon about the three axes.

It is in the above manner that the bore axis of the weapon is conventionally stabilized, it also being conventional to stabilize the line of sight of the aiming device in this manner. The "line of sight" is the line of the optical system of the aiming device which has to be made to bear on the target and which is a point on the optical viewing image, which point has to coincide with the target when the bore of the weapon is correctly aimed.

In the case of two-axis stabilization, it is no longer possible to maintain the direction of a plane constant, but all that can be done is to maintain the direction of a line constant in space. All other lines which form an angle with this line define a conical surface about the stabilized line. Thus, if a second line, for example, the line of sight, is to be fully stabilized, means have to be provided so as to carry out the requisite compensating movements. If the angle between this second line and the stabilized line is small, then the second line is at least prestabilized by the stabilized line, so that, in order to obtain a complete stabilization of this second line, relatively small compensating movements will suffice.

It is the primary object of the present invention to improve a two-axis bore stabilization by simultaneously maintaining the line of sight stabilized so as to be fixed in space, such that it is no longer necessary to provide a three-axis stabilization of the entire platform. As a result, the particular additional positioning drive does not have to be as powerful as it would have to be if the entire platform were to be stabilized about three axes, instead, a relatively small drive motor which displaces the line marking is sufficient. Here, it will be appreciated that the line of sight will presumably always have to be stabilized inasmuch as if the line of sight and the bore axis were not to coincide, the weapon would be tilted and thus not be accurately aimed at the target.

With the above object in view, then, the present invention resides, basically, in an arrangement for stabilizing a weapon which is equipped with an aiming or sighting device or the like and which is arranged on a movable platform, the bore axis of which weapon is stabilized to the side and elevationally, i.e., for rotation about the vertical axis and the elevation axis, by means of positioning devices that are controlled by reference value generators. According to the present invention, a rotatable line marking is provided for purposes of stabilizing the line of sight of the sighting device, this rotatable line marking being rotated about the roll axis in response to a signal which is a function of movement of the platform about the roll axis. Thus, the weapon itself can be properly aimed, even though the platform on which the weapon is carried is itself stabilized only about the vertical axis and the elevation axis.

In practice, if a levelled reference value generator system is used, the positioning mechanism of the rotatable line marking is controlled by the signal which serves for levelling the reference value generator arrangement.

According to a further feature of the present invention, the line marking is rotated about an axis that is parallel to the bore axis and in a plane which is at right angles to the bore axis.

According to a still further feature of the present invention, the line markings are also positioned vertically, particularly when the weapon with which the stabilizing arrangement is used can be expected to be elevated considerably, e.g., in the case of antiaircraft weapons.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic representation of a stabilizing arrangement according to the present invention.

FIGURES 2, 3 and 4 show fields of view seen through the sighting device and through the bore of the weapon, under different conditions.

FIGURE 5 is a schematic view showing the optics of the arrangement according to the present invention, FIGURE 5 also showing the vertical positioning of the line marking.

Referring now to the drawings, and first to FIGURE 1 thereof, the same shows a gun barrel **10** which can be pivoted about its trunions, one of which is shown at **11**, the weapon being arranged on a movable platform **12**. The barrel **10** having a bore axis B, carries an aiming device **13** which, in accordance with the present invention, is provided with an adjustable line markings **15**, e.g., crosshairs, the position of which line markings can be varied by a drive motor **14**. A yoke **17** is connected to the barrel **10** via a mounting or holding bracket **16**, the yoke **17** being pivotable with respect to the bracket **16** in a bearing **18** in the canting direction, i.e., about a roll axis. The

yoke 17 carries a frame 19 which is pivotable about a transverse elevation axis. The frame 19 carries a horizontal gyro 20 as well as a directional gyro 21. The error signal of the directional gyro 21, which corresponds to a deviation of the side direction, i.e., rotation about the vertical axis, is produced by a signal generator 22, amplified by an amplifier 23, and applied to a positioning drive 24 which, with the help of a pinion 24*a* and a gear ring 25, rotates the movable platform 12 until the directional deviation has been neutralized.

The horizontal gyro 20 has associated with it two reference value generators 26 and 27, the refernce value generator 26 serving to stabilize the yoke 17 about the roll axis, while the signal generator 27 puts out a signal which corresponds to fluctuations in the elevation, the output of the signal generator 27 being applied, via an amplifier 28, to a positioning drive 29 which corrects the elevation of the barrel 10. The positioning drive 29 has a pinion 30 which is in mesh with a gear segment 31.

The reference value generator 26 controls the pivoting about the roll axis, the output of the signal generator 26 being applied via an amplifier 32 to the positioning drive 33 which returns the yoke 17 into vertical position while the movable platform 12 remains in its tilted position. In this way, the horizontal gyro is stabilized in all directions, while the line of sight is stabilized by means of an actual value generator 37 and a nominal value generator 34, the latter converting displacement of the positioning mechanism 33 into an electrical signal, which electrical signal is applied, via an amplifier 35, to the positioning mechanism 14, which rotates the line marker 15 via a gear 36.

It will thus be seen that, in accordance with the present invention, variations from the elevation are sensed by the reference value generator 27 and are neutralized by the positioning drive 29 which changes the elevation of the barrel 10, this simultaneously bringing the horizontal gyro once again into a horizontal position. Nonetheless, the horizontal gyro and the frame 19 carrying the directional gyro can be displaced with respect to the yoke 17 about an axis 39 by actuation of a hand wheel 38. Inasmuch as the frame 19 is always maintained horizontal by means of the positioning drives 24, 29 and 30, the hand drive 38 thus serves for the elevaton adjustment of the barrel 10. The elevation adjustment of the barrel thus corresponds to rotation of the frame 19 about the axis 39 with respect to the horizon.

A roll is sensed by the reference value generator 26 and is compensated for by the positioning mechanism 33 which acts on the yoke 17 as well as by the positioning drive 14 which rotates the line marker 15. It is thus not necessary to move the barell 10.

The movable platform 12 is displaced only if there is a deviation about the vertical axis, which is sensed by the signal generator 22 that is part of the gyro equipment 21 and which serves for controlling the positioning drive 24.

Each of FIGURES 2, 3 and 4 shows a field of view 40 through the barrel, and a field of view 41 through the optical system of the aiming device. It will be assumed that the target is the top of the gable of the house 42. In the field of view 40 through the bore of the barrel, the top of the gable of the house 42 is so drawn as to pass through the bore axis. In the field of view 41, the intersection of the cross-hairs 44, 44', constituting the line marker, is to coincide with the axis point 48, which corresponds to an axis that is parallel to the bore axis 43. FIGURE 2 shows the view which is obtained when the weapon has not been rolled about the roll axis, the impact point coinciding with the aiming point and lying at point 45 at the base of the house 42. The distance between the point 45 and the intersection of the cross-hairs 44, 44' corresponds to the angle of elevation.

FIGURE 3 shows the parts when the barrel and the aiming device are titled with respect to each other. Here, too, the parts are so shown that the weapon is correctly aimed on the impact point 45. However, due to the fact that there is a tilting, the point onto which the barrel is to be aimed must lie at the point 46, that is to say, the aiming point 46 and the impact point 45 do not coincide. But the correct positioning of the weapon is exceedingly difficult, even for a skilled marksman, inasmuch as the distance between the impact point 45 and target point 46 has to be estimated.

If, in accordance with the present invention, a rotatable line marking is provided, which in the illustrated embodiment is constituted by the rotatable cross-hairs 44, 44', it is very simple for the marksman aiming the weapon to aim the weapon correctly despite the tilting, inasmuch as it is easy, due to the rotation of the cross-hairs 44, 44', into a horizontal position, in the field of view 41, to make the target point 46 and the impact point 45 coincide.

Up to now, there has been described aiming the weapon to a target which is approximately horizontal, the cross-hairs being rotated about an axis parallel to the bore axis and in a plane at right angles thereto. FIGURE 5 shows the conditions which prevail if there is an appreciable elevation, the barrel itself not being illustrated in FIGURE 5.

Within the aiming device 47, there are, in the field of view 41, the cross-hairs 44, 44', the manner in which the same are rotatable about an axis 48 that is parallel to the bore axis having been described above. In order to make it possible to take into consideration an elevation of the barrel which can no longer be deemed to be negligible, the line markings, in the from of the cross-hairs 44, 44', are additionally positioned so as to be vertical, as shown in dashed lines at 49. Without this vertical positioning, there would be obtained an incorrect line of sight 50, if it is assumed that it is the point 51 which is to be directed onto the target. As a result of this vertical positioning, however, the point 51 moves into the point 52, so that the angle of elevation, formed by the correct line of sight 53 and the axis 48 which is parallel with the bore axis, becomes smaller and now assumes a correct value.

It will thus be seen that, in accordance with the present invention, there is provided an arrangement of the above type in which the line of sight of the aiming device is stabilized by providing a rotatable line marking.

The position of the line marking itself can be varied in two ways. In addition to the rotary movement, the line marking is positioned vertically. While the rotary movement is generally sufficient if the weapon is aimed generally horizontally, this is not enough if the angle of elevation is relatively great as, for example, when the weapon is to be used as an antiaircraft weapon. In the latter case, the angle of elevation is very great, and it is then that the line markings are additionally positioned vertically. This vertical positioning contains both a rotation in the above-described manner as well as the subsequent vertical positioning of the line markings.

In many cases, it is advisable to level the reference value generators which produce the signals which neutralize rotation about the vertical and elevation axes, i.e., a signal is needed which corresponds to the rolling of the trunnions. If, however, a directional signal is needed, for example for steering the vehicle carying the weapon, it is not only advisible but in fact mandatory that the reference value generators be levelled, for otherwise the gimbal error for the directional measurement would be too large. In this case, the signal is suited for turning the line markings. Thus, when the reference value generator arrangement is levelled, it is, in accordance with the present invention as described above, also proposed to control the positioning mechanism of the rotatable line marker by means of the roll compensating signal which is used for levelling the reference value generator arrangement. The signal which is needed for levelling the reference value generator thus also serves for positioning the line markings, so that the system as a whole can be constructed at low cost.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. A stabilizing arrangement comprising, in combination:

(a) means forming a movable platform;

(b) means for stabilizing said platform only about a vertical axis and an elevation axis;

(c) a weapon having a barrel arranged on said platform for movement therewith, said barrel having a bore axis;

(d) a sighting device for aiming said barrel, said sighting device also being arranged on said platform for movement therewith and having means that include line markings;

(e) means for producing a signal which is a function of movement of said platform about a roll axis; and

(f) means for rotating said line marking means in response to said signal produced by said means (e) for purposes of stabilizing the line of sight of said sighting device.

2. A stabilizing arrangement as defined in claim 1 wherein said stabilizing means include a reference value generator system for producing stabilizing signals and positioning means responsive to said last-mentioned signals for stabilizing said platform about said vertical and elevation axes, and leveling means for leveling said reference value generator system; said means (e) being connected to said leveling means.

3. A stabilizing arrangement as defined in claim 2 wherein said means (e) are a means for producing a signal which is a function of the difference between the actual and nominal positions of said line markings.

4. A stabilizing arrangement as defined in claim 1 wherein said line marking means is rotatable about an axis parallel to the axis of said bore.

5. A stabilizing arrangement as defined in claim 4 wherein said axis about which said line marking means is rotatable passes through the optical axis of said sighting device.

6. A stabilizing arrangement as defined in claim 1 wherein said line marking means is mounted for rotation about an axis which is parallel to the axis of said bore and in a plane which is at right angles to said bore axis.

7. A stabilizing arrangement as defined in claim 1 wherein said line marking means is mounted for being positioned vertically independently of the elevation of said barrel.

8. A stabilizing arrangement as defined in claim 1 wherein said line marking means includes cross-hairs.

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