Dec. 14, 1937. B. CHANCE 2,102,511

AUTOMATIC STEERING MEANS

Filed June 21, 1934 3 Sheets-Sheet 1

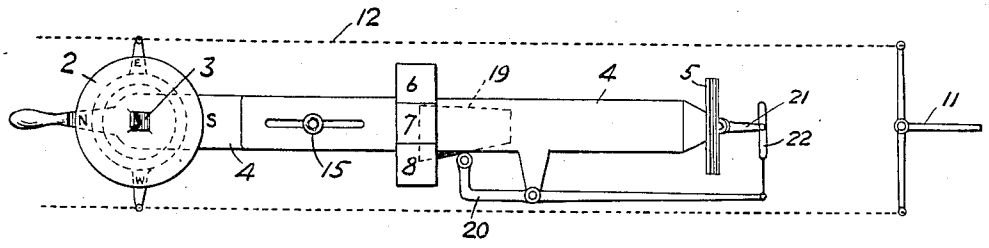


FIG. 1.

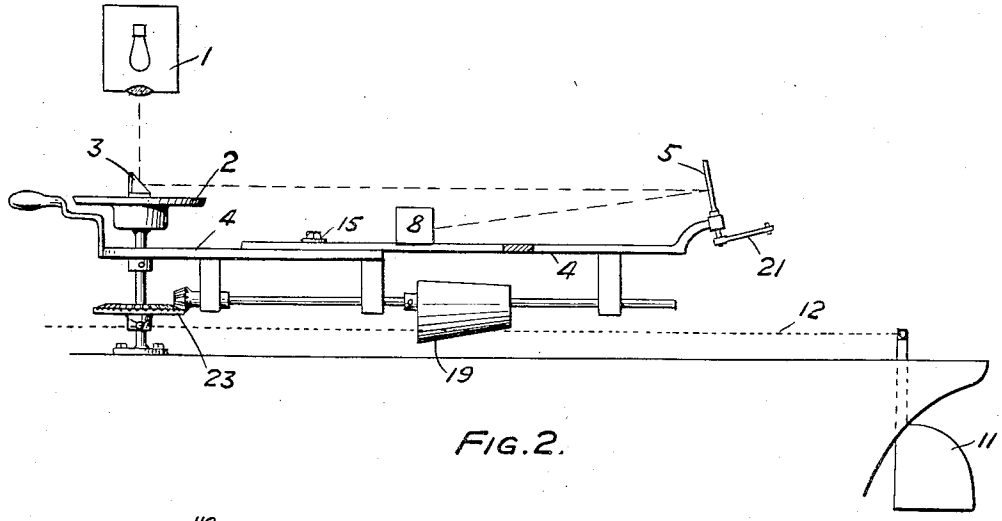


FIG. 2.

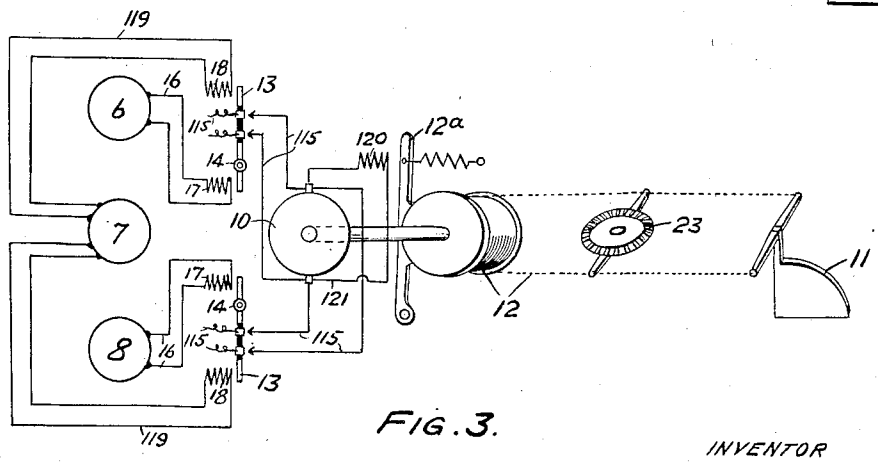


FIG. 3.

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Dec. 14, 1937. B. CHANCE 2,102,511

AUTOMATIC STEERING MEANS

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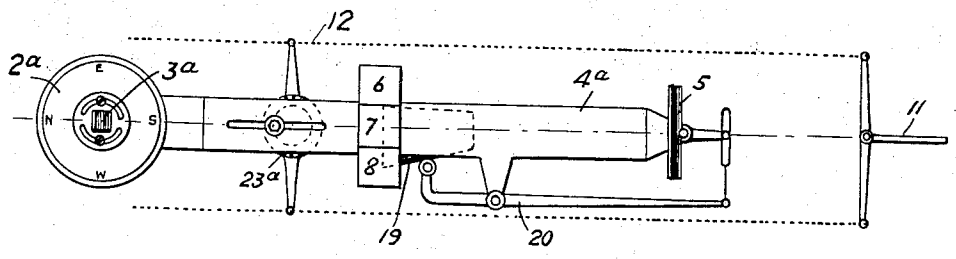


FIG. 4.

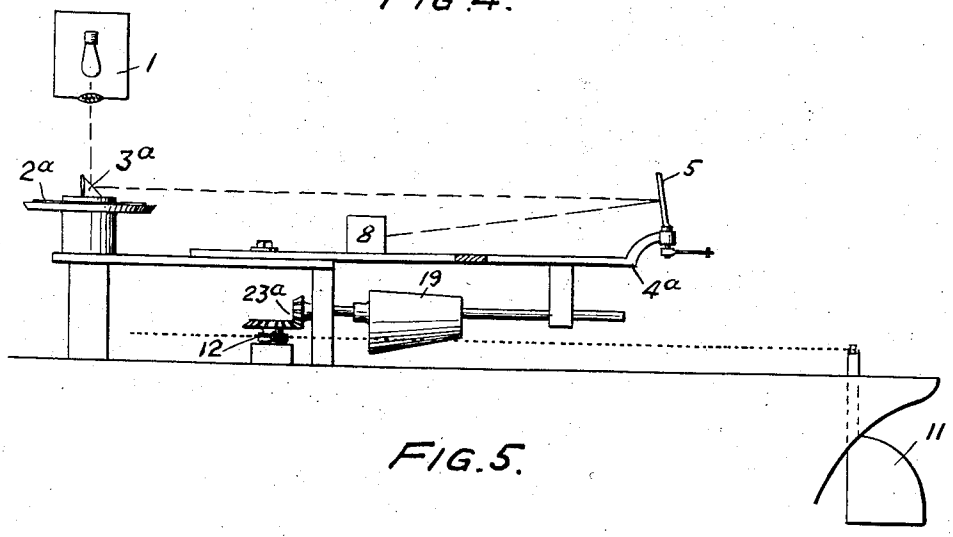


FIG. 5.

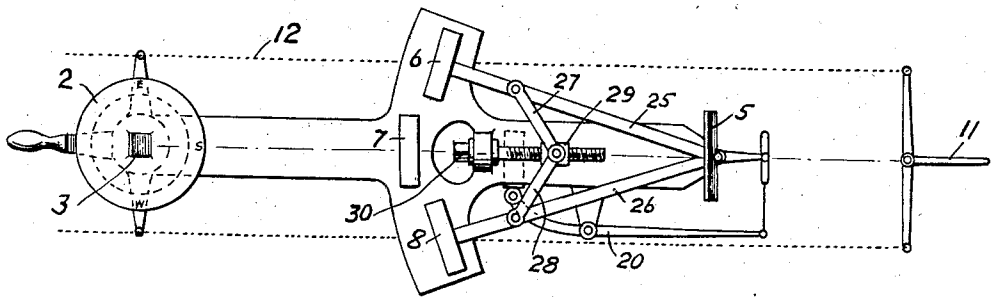


FIG. 6.

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AUTOMATIC STEERING MEANS

Filed June 21, 1934 3 Sheets-Sheet 3

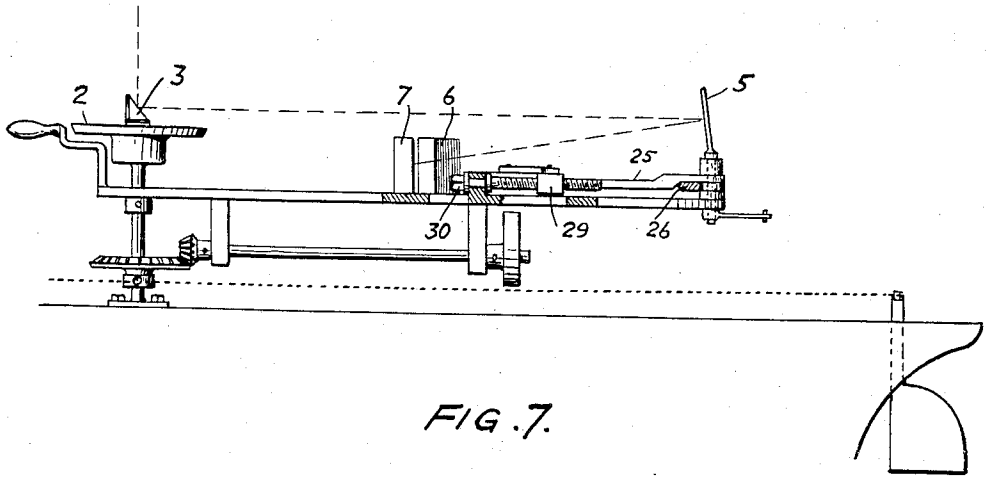


FIG. 7.

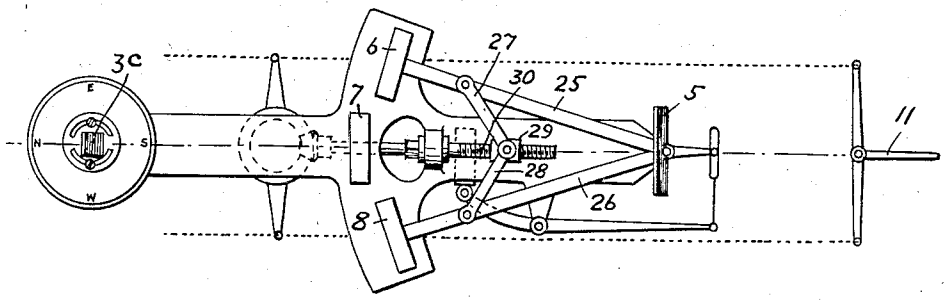


FIG. 8.

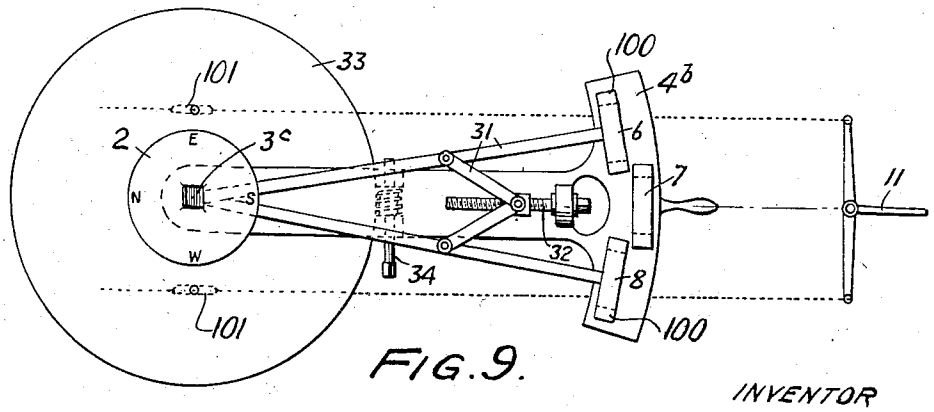


FIG. 9.

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2,102,511

UNITED STATES PATENT OFFICE

2,102,511

AUTOMATIC STEERING MEANS

Britton Chance, Haverford, Pa.

Application June 21, 1934, Serial No. 731,640

16 Claims. (Cl. 172—282)

The principal object of the present invention is to provide comparatively simple and inexpensive automatic steering means which shall be accurate, efficient, and reliable in operation. Other objects will appear from the following description.

The invention, generally stated, comprises means for providing a beam of radiant energy fixed in space, a group of at least three discrete electronic valve devices normally bisected by the incidence of said beam and upon angular displacement from such position operative to cause different effects, and follow-back means actuated by such effects and operative to relatively change the angular position of the group and incidence of the beam with a time lag to correlate said effects; with or without provisions for angularly changing the position of the fixed beam in space.

The invention is applicable to dirigible craft of all kinds having rudders, and in the following description reference will be made more particularly to vessels for the sake of explanation and not by way of limitation.

Generally stated, the invention further comprises a craft having a rudder, means mounted on the craft and emitting a beam of radiant energy normally fixed in space, a group of at least three discrete electronic valve devices mounted on the craft and bisected by the incidence of the beam when the vessel is on its course and swept over by the incidence of the beam in response to displacement of the craft from its course, a power multiplying system set in action by the energization of the two outside valve devices for turning the rudder, said power multiplying system responsive to the energization of the inside one of said valve devices for clamping the rudder, follow-back mechanism actuated by rudder movement and operative to relatively shift the incidence of the beam and group of valve devices, a compass card coaxial with the beam, and means for adjusting the beam and group of valve devices relatively to each other and in respect to the axis of the compass card to alter the course of the craft.

The invention also comprises the improvements to be presently described and finally claimed.

In the following description reference will be made to the accompanying drawings forming part hereof and in which,

Figure 1 is a diagrammatic and schematic top view of a device embodying features of the invention.

Figure 2 is a side elevational view of the same.

Figure 3 is a similar view which is extremely schematic and which will be referred to for purposes of description.

Figures 4 and 5 are views similar to Figures 1 and 2 except that the frame is fixed and the compass card mirror is turnable on the compass card.

Figures 6 and 7 are views similar to Figures 1 and 2 and in which adjustment is made by separating the valve devices instead of by elongating the frame.

Figure 8 is a view similar to Figure 6 in which the compass reflector is turnable on the card and the frame is fixed, and

Figure 9 is a plan view in which the frame is movable and in which the compass card reflector is fixed to the card and in which the incidence of the beam falls directly on the valve devices.

Referring to the drawings, and more particularly to Figures 1 and 2, 1 is a source of radiant energy and it is placed above the center of a device 2 oriented in space. An example of the device 2 is the card of a magnetic, gyroscopic or other compass; for illustration a repeater of a gyroscopic compass is selected and, therefore, gimbals are not shown. 3 is a reflector located at the center of the device 2, and it serves to provide a ray directionally fixed in space. 4 is a frame or carrier ranging radially in respect to the axis of the device 2 and in use it moves with the craft as the latter deviates in respect to its course or yaws. 5 is a reflector pivotally mounted upon the frame 4 and disposed in a radial line from the axis of the element 2, and it serves to deflect or reflect or bend the ray so that as the ship deviates from and returns to its course the ray sweeps over the three devices 6, 7 and 8, which will be designated valve devices. The row of valve devices is bisected by the radial line, above referred to, and is disposed generally at right angles thereto and is mounted on the frame. The element 5 is turned on its pivot in response to rudder movement, as will be hereinafter described, so that the ray, which normally bisects the row of valve devices, sweeps over the devices 6, 7 and 8 in response not only to deviation of the craft in respect to its course but also in response to rudder movement. The devices 6, 7 and 8 are adapted to cause electrons to flow when the reflected ray sweeps by or rests upon any one of them. In cases where a light ray is employed the element 5 is a flat mirror and the elements 6, 7 and 8 may be photo-electric cells. There is a power multiplying system and it is set in action in response to energization of the devices 6 and 8 and its purpose is to turn the rudder. In Fig. 3, there are duplicate relays which apply current in reverse direction to the motor 10. Each comprises a snap switch member 13 pivoted at 14. The member 13 controls a power circuit 115 to the motor 10 and closes the same in response to energization of the valve 6 or 8 through circuit 16 and electro-magnet 17. The circuit 115 is opened by energization of valve 7 and electro-magnet 18 by circuit 119. When

the power circuit is open electro-magnet 120 in circuit 121, across the motor, is deenergized and spring applied brake 12a is released. The motor 10 is geared to the rudder 11 by means of a cable and drum 12. The element 5 is turned on its pivot in response to rudder movement. This may be accomplished mechanically or electrically. The cam 19 operates upon a lever or follower 20 shown as connected with an arm 21 on the element 5 and there is lost motion between the follower and the arm, as indicated at 22, to provide a time lag between the movement of the rudder and the movement of the element 5. The cam 19 is turned on its axis from the movement of the rudder by means indicated at 23. If desired the element 5 may be turned as described with the rudder through the instrumentality of Selsyn motors.

It must be understood that mechanism which has been described is well understood by those skilled in the art, and that the special reference to certain parts is made merely to facilitate a description of the invention rather than to define the construction of those parts, which are too well understood to require description or illustration.

According to weather conditions the extent of permissible deviation of the vessel from its course is adjusted by means indicated at 15 by which the element 5 is moved toward or away from the element 3, thus changing the optical length. The cam 19 is provided with parts of different effective heights, and generally the cam tapers from the end nearest the reflector 5 toward the other end. The purpose of this is to permit the follower 20 to operate upon an appropriate cam surface as the length of the frame is adjusted.

Before describing the mode of operation of the device it may be said that the motor 10 when started to run in either direction continues to run until checked by the described action of valve 7 or by a limit stop, which is too well understood to require either description or illustration.

When the vessel is on its course the row of devices 6, 7 and 8 are bisected by the beam and the pivotal reflector 5 is disposed at right angles to the beam and centrally thereof. If the vessel yaws to the right or to the left, for example to the right, the motion of the vessel shifts the reflector 5 in respect to the axis of the element 2 so that instead of reflecting the beam onto the element 7, which locks the rudder, the beam is shifted or reflected onto the element 6 which, being energized, causes the motor to turn the rudder into proper position for bringing the vessel back to its course, and the rudder movement turns the reflector 5 on its pivot so that the beam falls upon the element 7 locking the rudder after the mirror deflection. The desired position of the ship in its course may not be attained until after several repetitions of the described operation. If the deviation of the ship from its course were toward the left the same operation would be repeated but in reverse order.

The course of the vessel may be changed by turning the frame 4 about the axis of the element 2 in the desired direction and for this purpose the frame may be lifted in order to disengage the toothed wheels 23 and to reengage them. Inasmuch as the reflector 3 is fast in respect to the compass card 2 the ray or beam remains fixed in space and as the reflector 5 passes transversely of the fixed beam or ray the incidence of the reflected beam or ray is on one of the elements 6 or 8 and sweeps over the same, thus energizing it. The energization of one of the outside valve devices initiates the rudder movement by way of the motor 10, as described, and the rudder movement, acting through the reflector 5 in the manner described, brings the frame back into line with the ray or beam, but since the ship or vessel and the frame have been relatively displaced the ship or vessel is brought onto the new course and displacement from the new course is corrected automatically in the manner that has been described.

The construction and mode of operation of the modification shown in Figures 4 and 5 are as above described except that the frame 4a is fixed in the lubber line of the ship and to change the course the reflector 3a is turned in respect to the axis of the compass card 2a and in respect to the card. The effect of this is to cause the ray or beam to fall upon and past either of the valve devices 6 and 8 energizing it, thereby actuating the rudder, which in turn actuates the reflector 5, thereby bringing the vessel into the new course. Inasmuch as the frame 4a is fixed the gearing 23a may be located to one side of the axis of the compass card 2a. The described modification is particularly appropriate for use with a gyroscopic compass, whereas the device shown in Figures 1 and 2 is adapted for use with a gyroscopic or a magnetic compass.

The construction and mode of operation of the modification shown in Figures 6 and 7 are as above described except that instead of adjusting the distance between the reflector 5 and the reflector 3 to change the permissible degree of yawing the elements 6 and 8 are movable toward and away from the element 7. For this purpose they are mounted on arms 25 and 26 pivoted to the frame at the axis of the mirror 5, and these arms are connected with links 27 and 28, and the links 27 and 28 are pivoted to a nut 29 adjustable on the turnably mounted screw 30. Obviously the further the elements are spread apart the greater will be the permissible degree of yawing, and the contrary is also true.

The construction and mode of operation of the device shown in Figure 8 is as above described except that in this case the reflector 3c is turnably adjustable on the compass card to change the course and the position of the fixed ray, whereas in Figures 6 and 7 the frame, as a whole, is moved or turned about the axis of the compass card for that purpose, and the ray or beam is always fixed in the same position in space.

The construction and mode of operation of the modification shown in Figure 9 are as above described except that the valve elements 6, 7 and 8 are mounted upon a frame 4b turnable about the axis of the compass card 2 and they are carried by linkage 31 which is controlled by a nut 32, as has been described in connection with Figures 5 to 8. The reflector 3c is fixed on the compass card and the ray or beam falls directly upon the elements 6, 7 and 8. Since in this construction the focal distance between the reflector 3c and the elements 6, 7 and 8 is fixed the ray or beam may be of cone form and focused on elements 6, 7 and 8. This also applies to Figs. 6, 7 and 8. In Figs. 6, 7, 8 and 9 a mirror or prism system, such as used in binoculars, may be interposed between mirror 3 and elements 6, 7 and 8 to secure a compact apparatus with the desired focal length. An adjustment is provided between the toothed wheel 33 actuated by rudder

movement and the frame 4b and the valve elements 6, 7 and 8, and it consists in a worm 34. When the frame 4b is shifted the worm is disengaged from the worm wheel 33 and then reengaged, and in its new position it affords means for slight and accurate adjustment.

From the foregoing description it is evident that in all of the modifications the beam normally bisects the valve devices and that any deviation from that relation sets in motion auxiliary apparatus which produces different described effects, and that there is a follow-back action from the effects which coordinates angular displacements. It is further evident that the required angular adjustment or readjustment may require one or more repetitions of the described operations. It will be apparent that there are two ways of making alterations, first, by shifting the valve devices in respect to the reflector, which in that case is fixed to the compass card, and second, by turning the reflector in respect to the compass card, leaving the valve devices in their original position.

There is another way in which the effective spacing of the elements 6, 7 and 8 can be varied. It is by using walls of different widths for the containers which are frequently made of material not sensitive to the ray. The thickness of the walls is indicated at 100 by dotted lines in Figure 9.

In Fig. 9, the frame, which carries the valves 6, 7 and 8, may be locked to the element 33, which is responsive to rudder movement and the course may be changed by turning the reflector 3c into a new position on the compass card and fixing it in that position, as has been herein described.

The lost motion device which turns the frame 4b and wheel 33 to which the frame is attached is indicated at 101, Fig. 9.

Obviously the space in which the beam is fixed is terrestrial space with reference to the plane of the horizon.

It will be obvious to those skilled in the art, to which the invention relates, that modifications may be made in details of construction and arrangement and in matters of mere form without departing from the spirit of the invention which is not limited to such matters, or otherwise than as the prior art and the appended claims may require.

I claim:

1. The combination of a craft having a rudder, means mounted on the craft and emitting a beam of radiant energy fixed in space, a group of at least three discrete electronic valve devices mounted on the craft and bisected by the incidence of the beam when the vessel is on its course and swept over by the incidence of the beam in response to displacement of the craft from its course, a power multiplying system set in action by the energization of the two outside valve devices for turning the rudder, said power multiplying system responsive to the energization of the inside one of said valve devices for clamping the rudder, follow-back mechanism actuated by rudder movement and operative to relatively shift the incidence of the beam and group of valve devices, and means for adjusting the beam and group of valve devices relatively to each other to alter the course of the craft.

2. In automatic steering means for craft having rudders, means emitting a ray fixed in space, a row of valve devices normally bisected by the ray and over and past which the ray plays, a motor for turning the rudder, a brake for the rudder, relay power means responsive to the outside valve devices for running the motor in either direction and releasing the brake, devices responsive to the middle valve device for tripping said relay power means and applying the brake, and a follow-back mechanism responsive to rudder movement.

3. In combination means for providing a beam of radiant energy fixed in space, a group of at least three discrete electronic valve devices normally bisected by the incidence of said beam and upon angular displacement from such position operative to cause different effects, and follow-back means actuated by such effects and operative to relatively change the position of the group and incidence of the beam with a time lag to correlate said effects.

4. In steering gear for a dirigible craft, the combination of a directionally fixed beam of light, a power mechanism, valve devices, means for moving the valve devices past the beam in response to deviation of the craft from its course, and power mechanism control means selectively positioned by certain of the valve devices to initiate and continue the operation of the power mechanism until the means are repositioned by the energization of another of said devices.

5. In steering gear the combination of a source of light, a directionally fixed element axially aligned with said light source, and a reflector mounted in the axis of said element and adapted to reflect a beam of light from said source in a direction fixed with the respect to said element.

6. In apparatus for steering dirigible craft having a rudder in combination, a source of radiant energy providing a beam of radiant energy fixed in terrestrial space with reference to the plane of the horizon, a group of at least three electronic valve devices bisected by the beam when the craft is on its course and swept by the beam on deviation of the craft from its course, power mechanism responsive to the energization of the outer of said devices to turn the rudder in the appropriate direction to correct the deviation and responsive to the central valve device to clamp the rudder, and variable time lag means for varying the permissible deviation of the craft from the course before the operation of said power mechanism to turn the rudder.

7. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising a compass card, a source of a beam of radiant energy arranged cooperatively with said compass card, means at the axis of said compass card for reflecting said beam in a predetermined direction, means for adjusting said reflecting means to change the direction of the reflected beam at will, means responsive to the reflected beam movable relative to the beam in response to deviation of the craft from its course, means controllable by said beam-responsive means for actuating said element, and follow-back means operable by said actuating means for relatively changing the position of said beam-responsive means and the incidence of the beam thereon to restore the normal relation therebetween.

8. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising means for providing a beam of radiant energy, means responsive to deviation of said craft from its course, including a plurality of devices responsive to said beam and a beam reflector movable together as a unit relative to said beam to cause the beam to sweep across said devices to activate the devices selectively, means

controllable by said devices for actuating said element, and follow-back means operable by said actuating means for moving said reflector relative to said devices to restore the normal relation between the reflected beam and said devices.

9. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising a compass, means for projecting a beam of radiant energy from said compass in a direction fixed with respect to the compass, means responsive to said beam movable relative to the beam in response to deviation of the craft from its course, means controllable by said beam-responsive means for actuating said element, follow-back means operable by said actuating means for moving said beam-responsive means relative to the beam in a manner to restore the normal relation therebetween, and manually operable means for moving said beam-responsive means relative to the beam to change the course of the craft at will.

10. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising a compass, means for projecting a beam of radiant energy from said compass, supporting means movable relative to the beam in response to deviation of the craft from its course, a plurality of devices responsive to the beam carried by said supporting means, means controllable by said beam-responsive devices for actuating said element, follow-back means operable by said actuating means for relatively changing the position of said beam-responsive devices and the incidence of the beam thereon to restore the normal relation therebetween, and manually operable means for varying the relation between said beam-responsive devices at will to thereby vary the permissible yaw of the craft.

11. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising a compass, means for projecting a beam of radiant energy from the axis of said compass in a direction fixed with respect to the compass, means responsive to said beam movable relative to the beam in response to deviation of the craft from its course, means controllable by said beam-responsive means for actuating said element, follow-back means operable by said actuating means for relatively changing the position of said beam-responsive means and the incidence of the beam thereon to restore the normal relation therebetween, and means providing predetermined time lag in the follow-back action.

12. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising a compass, means for projecting a beam of radiant energy from said compass in a direction fixed with respect to the compass, supporting means movable relative to the beam in response to deviation of the craft from its course, a plurality of devices responsive to the beam carried by said supporting means, means controllable by said beam-responsive devices for actuating said element, follow-back means operable by said actuating means for relatively changing the position of said beam-responsive devices and the incidence of the beam thereon to restore the normal relation therebetween, manually operable means for moving said supporting means at will to change the course of the craft, and manually operable means for varying the relation between said beam-responsive devices at will to thereby vary the permissible yaw of the craft.

13. Apparatus for controlling an element on a dirigible craft, such as a rudder, comprising means for providing a beam of radiant energy, means responsive to said beam, means for effecting relative movement between said beam and said beam-responsive means in response to deviation of the craft from its course, a motor for actuating said element, means including said beam-responsive means for effecting energization of said motor when the craft deviates from its course, follow-back means operable in response to actuation of said element for restoring the normal relation between said beam and said beam-responsive means, and means including said beam-responsive means for positively deenergizing said motor and for maintaining it deenergized when said normal relation obtains.

14. Apparatus for controlling an element on a dirigible craft, such as a rudder, comprising means for providing a beam of radiant energy, at least three devices responsive to said beam, means for effecting relative movement between said beam and said beam-responsive devices in response to deviation of the craft from its course, a motor for actuating said element, means including two of said beam-responsive devices for effecting energization of said motor when the craft deviates from its course, follow-back means operable in response to actuation of said element for restoring the normal relation between said beam and said beam-responsive devices, and means including the other of said beam-responsive devices for deenergizing said motor when said normal relation obtains.

15. Apparatus for controlling an element on a dirigible craft, such as a rudder, comprising a compass card, means on said compass card for projecting a beam of radiant energy, a support turnable about the axis of the compass card, a toothed wheel turnable about the axis of the compass card and connected to said support, a group of at least three beam-responsive devices carried by said support, means responsive to the outer ones of said devices for effecting movement of said element, means responsive to the inner one of said devices for interrupting the movement of said element, follow-back mechanism operatively connected to said toothed wheel and responsive to said movement, and means for adjusting the spacing of said outer devices to vary the permissible yaw of the craft.

16. Apparatus for controllably actuating an element on a dirigible craft, such as a rudder, comprising means for providing a beam of radiant energy, means responsive to said beam, means for effecting relative movement between said beam and said beam-responsive means in response to deviation of the craft from its course, means controllable by said beam-responsive means for actuating said element, follow-back means operable in response to actuation of said element for restoring the normal relation between said beam and said beam-responsive means, and means for varying the permissible deviation of the craft from its course before the actuation of said element.

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