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3,020,868

TORPEDO STEERING SYSTEM

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Filed Dec. 27, 1945, Ser. No. 637,385

5 Claims. (Cl. 114-23)

This invention relates to signal translating systems and more particularly to torpedo steering systems of the type disclosed in the applications Serial No. 545,835, filed July 20, 1944, of Alton C. Dickieson and Serial No. 555,523, filed September 23, 1944, of John C. Steinberg, now Patent No. 2,991,742.

In torpedo steering systems of the type disclosed in the applications above identified, the rudder initially, after launching of the torpedo, is under control of a gyroscope to maintain the torpedo upon a preassigned course and subsequently is controlled in accordance with signals, such as propeller and random noise, emanating from a target ship to guide the torpedo toward and against the target. The target signals are detected by hydrophones on the torpedo, amplified and resolved into a suitable signal for controlling the rudder actuating mechanism.

In such systems, the point at which the rudder is transferred from gyroscope to target signal control is determined by a gate element which, for example, is controlled in accordance with the output of the amplifier associated with the hydrophones and is set to effect transfer of rudder control when the level of signals received at the hydrophones is of at least a preassigned magnitude, above the level of signals due to torpedo self noise and random submarine noise. For reasons set forth fully in the above identified application of Alton C. Dickieson, it is advantageous that transfer of the rudder from gyroscope to target signal control occur as soon as the torpedo is within such range of the target that, in the presence of self and random submarine noise, steering can be effected in accordance with signals emanating from the target. Also, for reasons set forth in the applications above-mentioned, the amplifier associated with the hydrophones advantageously is provided with automatic gain control for maintaining the output level of the amplifier substantially constant for inputs greater than that corresponding to the level for which the gate element is set.

It has been found that in some instances in torpedoes having steering systems of the type above described, the gate element did not operate until the torpedo was substantially nearer the target than the maximum range for which the gate was set so that maximum target signal control range was not realized. It has been determined that this action and consequent loss of target signal control range was due to the fact that, because of the high peak factor of noise emanating from some ships, the automatic gain control became effective before the gate element operated and reduced the output level of the amplifier sufficiently to delay operation of the gate element.

One object of this invention is to prevent loss of target signal control range in torpedo steering systems of the type heretofore described. More specifically, one object of this invention is to assure operation of the gate element to effect transfer of the rudder from gyroscope to target signal control at the maximum distance between target and torpedo at which target signal control will be effective to steer the torpedo toward the target.

In accordance with one feature of this invention, means are provided for preventing operation of the automatic gain control until the gate element has operated. More specifically, in accordance with one feature of this invention, the automatic gain control normally is disabled and

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is enabled in response to or upon operation of the gate element.

The invention and the above noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

FIG. 1 is a circuit schematic in functional block form of a torpedo steering system illustrative of one embodiment of this invention; and

FIG. 2 is a detailed circuit diagram of the amplifier, associated gain control therefor and gate element included in the system shown in FIG. 1 and constructed in accordance with this invention.

Referring now to the drawing, the steering system illustrated in FIG. 1 comprises a rudder 10 and an actuator 11 for deflecting the rudder in one or the opposite direction. The direction of deflection is determined by either a gyroscope 12 or a target signal control 13 depending upon the condition of the transfer element 14. Initially, after the torpedo is launched, the transfer 14 is conditioned so that the rudder is under control of the gyroscope 12 and thereby the torpedo is maintained upon a preset course. When the torpedo approaches within a preassigned range of the target, determined by the signal level at the hydrophones, a gate element 15, provided with a lock in 16, operates to condition the transfer 14 so that the gyroscope control 12 is disassociated from the actuator 11 and the latter is associated with the control 13, whereby thenceforth the torpedo is steered toward the target in accordance with signals emanating therefrom.

The target signal control system may be of the construction described in detail in the application Serial No. 491,798, filed June 22, 1943, of A. C. Dickieson and comprises a pair of hydrophones 17 mounted on opposite sides, port and starboard, of the torpedo so that the relative response thereof for signals emanating from the target is determined by the bearing of the target relative to the torpedo. The hydrophones are connected in alternation, by a switch 18, to an amplifier 19, the output of which is converted by a resolving circuit 20 into a control signal of amplitude and polarity determined by the target bearing. The control 13 operates in accordance with this signal to effect deflection of the rudder 10 in the direction to steer the torpedo to the target.

In order that the control signal noted will be proportional only to the relative outputs of the two hydrophones and substantially independent of the absolute intensities of signals received by the hydrophones, the amplifier 19 is provided with automatic gain control 21 for maintaining the output level of the amplifier substantially constant. The gain control is energized in accordance with the output of the amplifier 19 and functions to control the bias upon the control electrode of one or more of the amplifier stages in accordance with this output. Associated with the gain control is a disabler 22 which renders the gain control ineffective until the gate 15 operates. The gate is controlled in accordance with the root mean square output of the amplifier 19 and is set, account being taken of torpedo self noise and random submarine noise, so that it will operate only when the signal level at the hydrophones is such that, in the presence of such noise, the signal responsive control system is capable of effecting steering in accordance with signals emanating from the target.

Details of an amplifier, gate and disabler combination illustrative of one embodiment of this invention are shown in FIG. 2. The amplifier comprises two resistance-condenser coupled stages 23 and 24, the output of the latter stage being tuned to the prescribed operating frequency for the system. The control electrode circuits for both stages include the bias controlling resistor-condenser combination 25, the potential across which is determined by

the feedback circuit including the condenser 26, diode rectifier 27 and resistor 28. As shown in the drawing, the cathode of the diode rectifier 27 is biased positive by way of the potentiometer 29 so that the rectifier will be rendered conductive and, hence, the bias and gain of the amplifier will be controlled, only for inputs to the amplifier and, hence, signal intensities at the hydrophones, above a preassigned level.

The gate circuit includes a diode rectifier 30, similar to the rectifier 27 and having its cathode biased positive below the bias upon the cathode of the rectifier 27, which is included in the input circuit of a normally non-conducting electron discharge device 31. The output circuit of this device includes the gate relay 32 which has a pair of armatures 33 and 34 and associated grounded contacts and, as noted heretofore, is provided with a lock in. In order to simplify the drawing, the lock in circuit, which may be of generally conventional construction, is not shown. The relay armature 33 is connected directly to the anode of the rectifier 27; the armature 34 is connected in the energizing circuit for the transfer relay 35 which has an armature 36 and transfer contacts 37 and 38, the armature and contacts being associated with the actuator 11, gyroscope 12 and control 13 as indicated. The construction is such that, as indicated, when the gate relay 32 is released the transfer relay 35 is operated whereby the armature 36 is in engagement with the contact 38 and the actuator 11 is under control of the gyroscope 12 whereas when the gate relay operates, the transfer relay releases and its armature engages the contact 37 to associate the actuator 11 with the target signal control 13.

The operation of the system is as follows: When the torpedo is launched, the gate and transfer relays are in the condition shown in FIG. 2 so that the rudder is under gyroscope control and the torpedo is maintained upon a preassigned course. Inasmuch as the anode of the diode rectifier 27 is connected to ground over the armature 33 and associated contact, the gain control circuit is effectively disabled and the amplifier 19 operates with fixed gain. When the torpedo approaches within such range of the target that the signal level at the hydrophones and, hence, the amplifier output is sufficiently high to overcome the bias upon the cathode of the rectifier 30, the latter becomes conducting and a potential sufficient to render the device 31 conducting is impressed upon the control electrode of the device 31. Thereupon the gate relay 32 operates and locks in. Consequently, the transfer relay 35 releases and the actuator 11 is dissociated from the gyroscope 12 and associated with the control 13 so that the rudder is controlled in accordance with signals received by the hydrophones 17. Also, upon operation of the gate relay 32, the direct connection from the anode of the rectifier 27 to ground is broken and the gain control circuit is enabled.

It will be noted that inasmuch as initiation of operation of the gain control circuit is under control of the gate relay, operation of the latter is entirely independent of the gain control and will occur when the amplifier output reaches the level for which the gate circuit is set. Thus, the rudder will be transferred from gyroscope to target signal control at the maximum effective signal control range irrespective of the peak factor of the noise emanating from the target ship.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A steering system for a moving body comprising a steering member, means for actuating said member, a first control means for controlling said actuating means to steer the body upon a preassigned course, signal responsive control means for controlling said actuating means in accordance with the bearing relative to the body of the

source of the signals received by said signal responsive means, said signal responsive means including an amplifier and normally disabled automatic gain control means for said amplifier, transfer means for selectively associating said actuating means with one or the other of said first and signal responsive control means, gate means controlled in accordance with the output of said amplifier for operating said transfer means when said output is of a prescribed magnitude, and means responsive to operation of said gate means for enabling said gain control means.

2. A steering system for a moving body comprising a steering member, means for actuating said member, a first control means for controlling said actuating means to steer the body upon a preassigned course, signal responsive control means for controlling said actuating means in accordance with the bearing relative to the body of the source of the signals received by said signal responsive means, said signal responsive means including an amplifier and automatic gain control means for said amplifier, said first control means normally being associated with said actuating means and said signal responsive means normally being dissociated from said actuating means, means for normally disabling said gain control means, means controlled in accordance with the output of said amplifier for associating said signal responsive means with said actuating means and dissociating said first control means therefrom when said output is of at least a prescribed magnitude, and means for rendering said disabling means ineffective when said output is of said magnitude.

3. A steering system for a moving body comprising a steering member, means for actuating said member, a first control means for controlling said actuating means and normally associated therewith to steer the body along a preassigned course, signal responsive means for controlling said actuating means to steer the body in accordance with signals received by said signal responsive means, said signal responsive means being normally dissociated from said actuating means and including an amplifier and normally disabled automatic gain control means therefor, transfer means for dissociating said first control means from said actuating means and associating said signal responsive means therewith, and means operable in response to receipt by said signal responsive means of signals of at least a prescribed intensity for operating said transfer means and enabling said gain control means.

4. A steering system for a torpedo comprising a rudder, means for actuating said rudder, a first control means for controlling said actuating means to steer the torpedo along a preassigned course, means responsive to signals emanating from a target for controlling said actuating means to steer the torpedo toward the target, said signal responsive means including an amplifier and normally disabled automatic gain control means therefor, transfer means for selectively associating said actuating means with one or the other of said first control and signal responsive means, gate means controlled in accordance with the level of signals received by said signal responsive means for operating said transfer means when said signal level is of at least a prescribed magnitude, and means responsive to operation of said gate means for enabling said gain control means.

5. A steering system for a torpedo comprising a rudder, actuating means for said rudder, gyroscope means for controlling said actuating means to steer the torpedo upon a preassigned course, said gyroscope means normally being associated with said actuating means, means responsive to submarine signals emanating from a target for controlling said actuating means to steer the torpedo toward the target, said signal responsive means normally being dissociated from said actuating means and including an amplifier and normally disabled automatic gain control means therefor, transfer means for dissociating said gyroscope means for said actuating means and asso-

ciating said signal responsive means therewith, gate means controlled in accordance with the output of said amplifier for operating said transfer means when said output is of at least a prescribed amplitude, and means controlled by and responsive to operation of said gate means for enabling said gain control means. 5

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