# United States Patent

**Holley, Jr.**

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[54] **RADIO DIRECTIONAL CONTROL SYSTEM**


[72] Inventor: **George M. Holley, Jr.**, 510 Sheldon Road, Grosse Pointe, Mich. 48236



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[58] **Field of Search** ..... 318/293, 294, 681; 343/117



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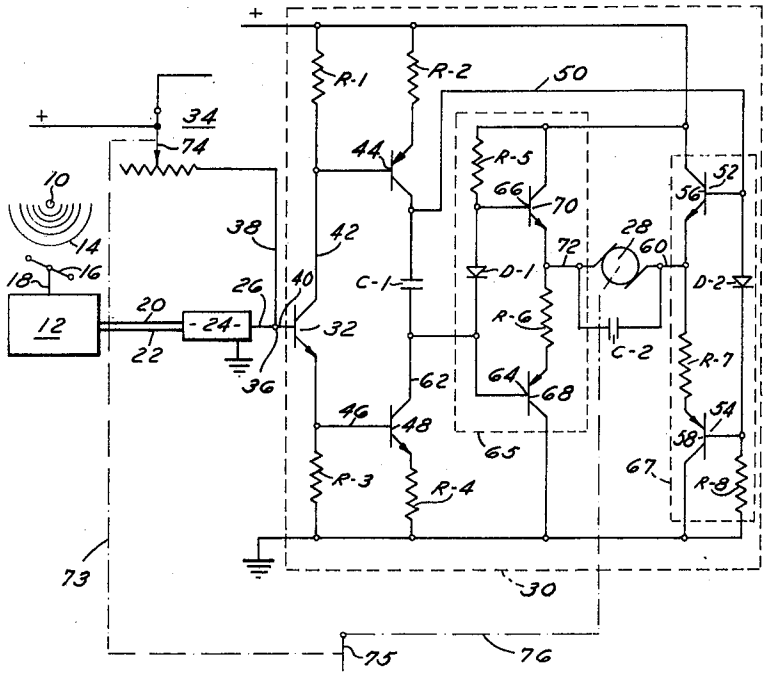
*Primary Examiner*—Benjamin A. Borchelt
*Assistant Examiner*—H. Kinberg
*Attorney*—Burton and Parker

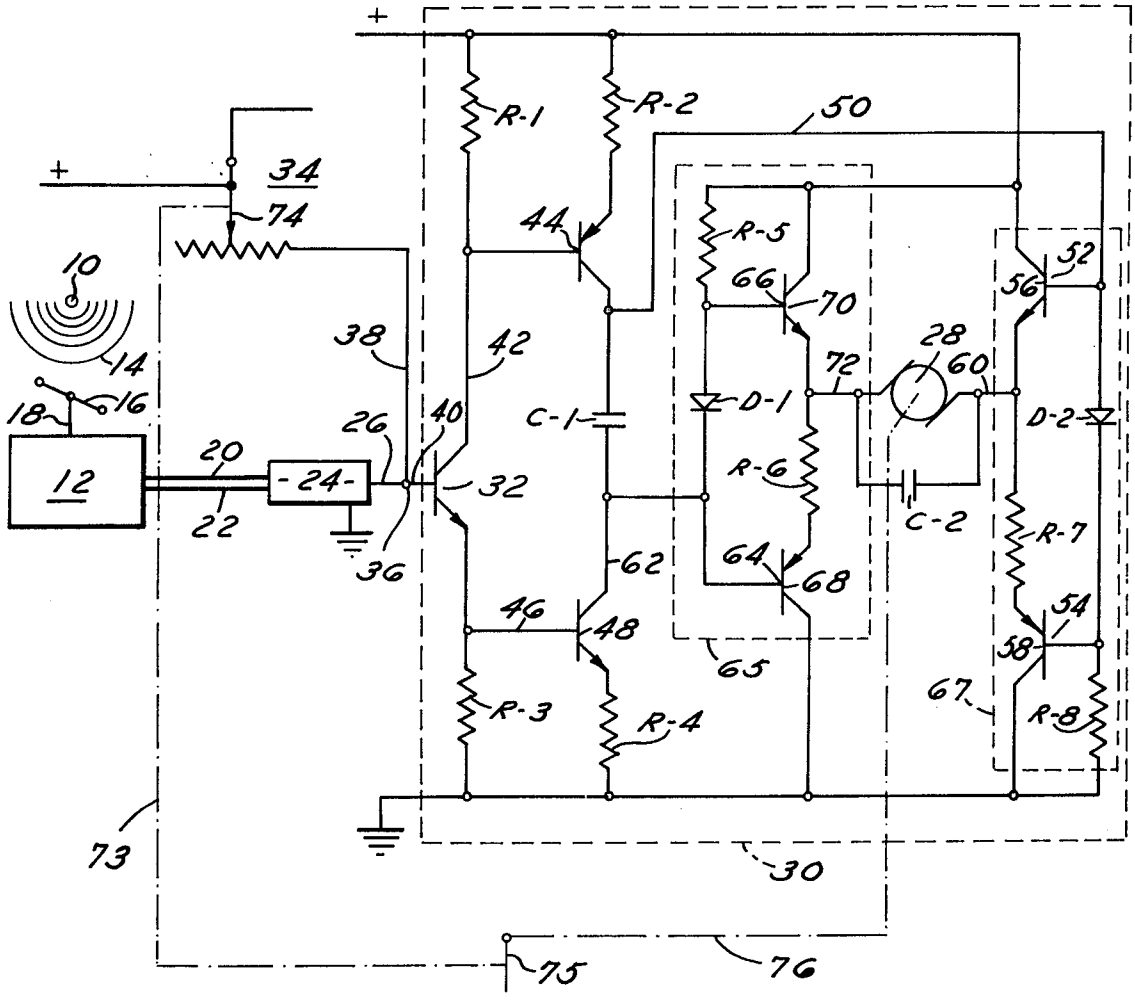


[57] **ABSTRACT**

This disclosure relates to an inexpensive radio directional control system having particular utility for marine applications, and wherein a directional antenna on the vessel is angularly adjusted relative to a fixed distant radio transmitter and thereafter any angular variation from such setting causes the output characteristic of a radio receiver connected to the antenna to increase or decrease in accordance with the direction of such variation, and such output characteristic variation is utilized to control operation of a reversible motor connected to some device, such as the vessel's rudder, or to the directional antenna itself, to effect a correction in the positioning thereof.


**2 Claims, 1 Drawing Figure**






INVENTOR
GEORGE M. HOLLEY JR.
BY
Burton & Parker
ATTORNEYS

# RADIO DIRECTIONAL CONTROL SYSTEM

## SUMMARY OF THE INVENTION

This invention relates to a radio directional control system of particular, though not exclusive, utility in the automatic control of navigational equipment aboard a boat, such as a pleasure craft, and represents improvements on the disclosure of my U.S. Pat. No. 3,419,866.

An object of the invention is to increase the life and reduce the size and cost of a control system of the general character shown in the aforementioned patent. In such patent the output of the receiver, whose directional antenna is disposed at an angle to a distant transmitter to which the receiver is tuned, is compared in a hunting relay with a fixed reference characteristic such that when the receiver output characteristic falls below or rises above the reference characteristic, the relay is tripped one way or the other to correspondingly operate a reversible electric motor which effects a control function in the vessel. The relay is an electro-magnetic device and therefore subject to wear and other factors affecting its useful life, is subject to vessel vibration and shocks tending to cause random tripping of it, does not lend itself to compact construction of the control system, and therefore a system less influenced by these factors, one of lesser cost, and one capable of substantial size reduction is desired.

In the disclosed embodiment the control system may be utilized either to control the rudder of a vessel and thereby provide an automatic pilot, or control the directional antenna itself and thereby provide an automatic direction finder that will continuously point to the distant transmitter. In addition, the disclosed embodiment has application for various other control functions as will be apparent to those skilled in this art.

In the disclosed embodiment a solid state control system is shown wherein the output of the radio receiver is mixed with the output of a source of selectively variable output characteristic to provide a control characteristic whose level is selectively varied by varying the output of said source to provide an initial control level which when impressed on the motor control network of a reversible motor will render the motor inoperative, but when the control characteristic either rises or falls from its initial setting will operate the motor accordingly in one direction or the other. The drawing discloses an electrical schematic representation of a control system embodying the invention.

In general the radio directional control system disclosed herein comprises a directional antenna connected to a receiver whose output circuit has an output characteristic which varies in accordance with a rotated attitude of the antenna with respect to a distant transmitter to which the receiver is tuned. The antenna is initially set at an angle with respect to the direction of radio wave propagation from the transmitter, as for example 30° from the null position. The output of the receiver is combined with the output of a source of selectively variable characteristic to provide a control characteristic which is not only selectively variable but which also varies as a function of the angular position of the antenna relative to the transmitter. This control characteristic is then fed to switch means in a motor control network which is responsive to a rise or fall of the control characteristic to render a reversible motor inoperative or to operate the motor in one direction or the other depending on the rise or fall of the control characteristic fed to the switch means. With the directional antenna disposed at its initial angular setting, the source of selectively variable characteristic is adjusted to provide an input to the switch means such that the motor will be inoperative. Thereafter as the directional antenna swings to one side or the other from its initial position the control characteristic will rise or fall causing operation of the reversible motor in one direction or the other to effect a correction in the position of whatever device is subject to the motor's operation.



Referring to the drawing, a radio transmitter is schematically indicated at **10**. This transmitter may be a commercial radio station transmitter, or some other transmitter of fixed location which emits a signal which may be picked up by a radio receiver **12** located on the vessel. The wave propagation indicated at **14** from the transmitter **10** should be continuous for the form of control system disclosed herein, though with slight modification which will be apparent to those skilled in the art, the system could be adapted for use with intermittent wave propagation. A continuous broadcast type transmitter is contemplated for the least expensive form of the system. The receiver **12** is provided with a directional antenna **16** mounted in any suitable fashion on the vessel for adjustable rotation relative thereto. In its simplest form the radio and antenna may correspond essentially to the inexpensive type transistor pocket radio which upon being rotated about a vertical axis relative to the transmitter to which tuned is found to play louder or softer depending upon the attitude of the antenna with respect to the station. It is well understood that if the antenna **16** is located so that its plane is substantially perpendicular to a line drawn between it and the transmitter, it will pick up the greatest radiated energy and provide the strongest signal output of the radio, while as it is rotated in the other direction from such position it will pick up decreasing amounts of the radiated energy until when its plane lies coincident of the transmitter it will be in a null position and substantially no signal will be received.

If the antenna is rotated about its vertical axis **18** relative to the transmitter to the position shown in the drawing, in other words where it lies at an angle such as 30° from the null position, further clockwise rotation will reduce its signal strength in the radio while counterclockwise rotation will increase the signal strength.

In its simplest form the invention comprehends a radio receiver having a loop antenna sensitive to the relative rotated position of the antenna to a distant transmitter, with the output circuit of the radio including an amplifier **24** connected to the receiver as by leads **20** and **22**. The output circuit of the receiver provides a voltage or current signal in lead **26** which increases or decreases in accordance with the angular position of the antenna **16** with respect to the transmitter **10**.

The control system also includes a reversible motor **28** which is shown in the drawing as a direct current motor whose direction of rotation is controlled by a motor control network represented by that portion of the drawing enclosed within the phantom line **30**. The control network, as hereinafter more fully explained,

includes a signal responsive switch means in the form of transistor **32** which causes the network to render the motor **28** inoperative, or to operate it in one direction or the other depending on the signal level at the input to the switch means.

The input signal, herein referred to as the control signal, to the signal responsive switch means **32** of the motor control network, comprises a resultant of the combination of the output signal from the radio receiver and the output signal from a source of selectively variable voltage or current, such as potentiometer **34**. These two signals are combined in mixer means, in the form shown comprising simple the junction **36** of the lead **26** and the lead **38** from the potentiometer **34**, and the resultant signal is delivered by lead **40** to the base of the transistor **32**. At a given level of the control signal the motor control network will render the motor inoperative. As a consequence, when initially adjusting the system, and with the directional antenna **16** turned to say 30° from its null position, the potentiometer **34** is adjusted to provide a level of control signal at the transistor **32** which will render motor **28** inoperative. Thereafter, as the antenna swings one way or the other from its initial angular position relative to the transmitter, the control signal level will rise and fall accordingly, a rise causing the control network **30** to operate the motor **28** in one direction and a fall to operate it in the opposite direction.

The operation of the motor control network **30** may be appreciated from an analysis of what occurs upon rotation of the antenna **16** from its initial angular position. If the antenna rotates relative to the broadcasting station so as to increase the variable signal in lead **26**, then transistor **32** is activated to be less resistant causing an increase in current from its collector to its emitter which results in a decrease in the level of the voltage in line **42** leading to the base of transistor **44**, and an increase in the voltage in line **46** leading to the base of transistor **48**. The decrease in voltage in line **42** causes an increase in the voltage in line **50** causing an increase at the bases **52** and **54** of transistors **56** and **58**. The increase at **52** and **54** causes an increase in voltage in line **60** to the motor **28**. The increase in voltage to line **46** leading to the base of transistor **48** causes a decrease in line **62** leading to the bases **64** and **66** of transistors **68** and **70**. The decrease in voltage to the bases of transistors **68** and **70** causes a decrease in voltage in line **72** leading to motor **28**. Since as a result of an increase in signal at **26** the voltage across the motor **28** has become unbalanced and the voltage at **60** is greater than at **72** the motor turns to drive whatever device to which it is connected so as to tend to compensate for the change in position of the antenna relative to the transmitter and will continue to turn in such direction until the voltage to the base of transistor **32** has decreased to where equilibrium at **60** and **72** is obtained.

If the level of the amplified signal delivered by the receiver output circuit at **26** should decrease, then the reaction in the motor control network is just the opposite and an increase in voltage arises at **72** and a decrease at **60** causing the motor to turn in the opposite direction.

It will be observed from a consideration of the drawing that a pair of complementary transistor control circuits are connected to opposite sides of the motor **28** and operate in push-pull relation, the one being enclosed in the phantom box **65** and the other by the phantom box **67**.

Provision is made for a feedback control to avoid hunting and over control when desired. Such is accomplished by mechanically connecting, as represented at **73**, the adjusting arm **74** of the potentiometer **34** to whatever mechanism is to be shifted by the motor. Such mechanism is schematically shown as a pivoted element **75** which may be representative of the vessels' rudder, or any other device which may require this compensating feature. The mechanical connection between the motor **28** and the device **75** is indicated schematically at **76**. It is apparent that movement of the device **75** under the influence of the motor **28** will change the adjustment of the potentiometer causing a change in the signal level in lead **38** running to the junction **36** and in turn a change in the level of the control signal into the base of the transistor **32**. For example, when an increase occurs in the signal level in lead **26** as a result of the antenna swinging in one direction, the motor **28** will be operated and the device **75** caused to shift and this in turn will cause the potentiometer arm **74** to be readjusted to provide a lower signal level in lead **38** thereby compensating in part for the increased signal in lead **26**.

In addition to the transistors and other elements of the control system heretofore mentioned there are two diodes D–1 and D–2, two capacitors C–1 and C–2, and eight resistors R–1 through R–8. It is believed that the purpose of the diodes and capacitors and resistors will be readily apparent to those skilled in the art and the description of their function is therefore omitted.

What is claimed is:

1. A radio directional control system for automatically positioning a device used in navigation comprising, in combination:

a directional antenna,

a radio receiver connected to the antenna and having an output signal which rises and falls in accordance with the angular position of the antenna relative to a distant transmitter to which the receive is tuned,

a reversible motor for positioning the device to be controlled,

a source of selectively variable signal,

means connected to the output of the radio receiver and to the source of selectively variable signal and providing an output control signal which is the resultant of the receiver output signal and the selectively variable signal of said source,

signal responsive switch means connected to the motor and responsive to said output control signal for operating the motor in one direction of the other in response to a rise or fall of said output control signal,

said signal responsive switch means comprising a transistor whose base is connected to the said control signal and whose emitter and collector are operatively connected to the motor, and a pair of transistor circuits with one connected to the emitter of said transistor and to one side of the motor and the other connected to the collector of said transistor and the other side of the motor,

and said source of selectively variable signal being operable to initially provide a signal which in combination with the receiver output signal provides an output control signal to the signal responsive switch means at an angular position of the antenna such that the motor is inoperative and thereafter variation in such angular position of the antenna causes variation in the control signal to effect motor operation in one direction or the other in accordance with a rise or fall of such control signal.

2. The invention of claim 1 characterized in that the pair of transistor circuits are complementary and connected across the motor in push-pull relation.

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