Feb. 15, 1949. B. J. BAECHER 2,461,511

ELECTRONIC RELAY TRANSMITTER AND RECEIVER SELF-SYNCHRONOUS SYSTEM

Filed Dec. 26, 1945 2 Sheets-Sheet 1

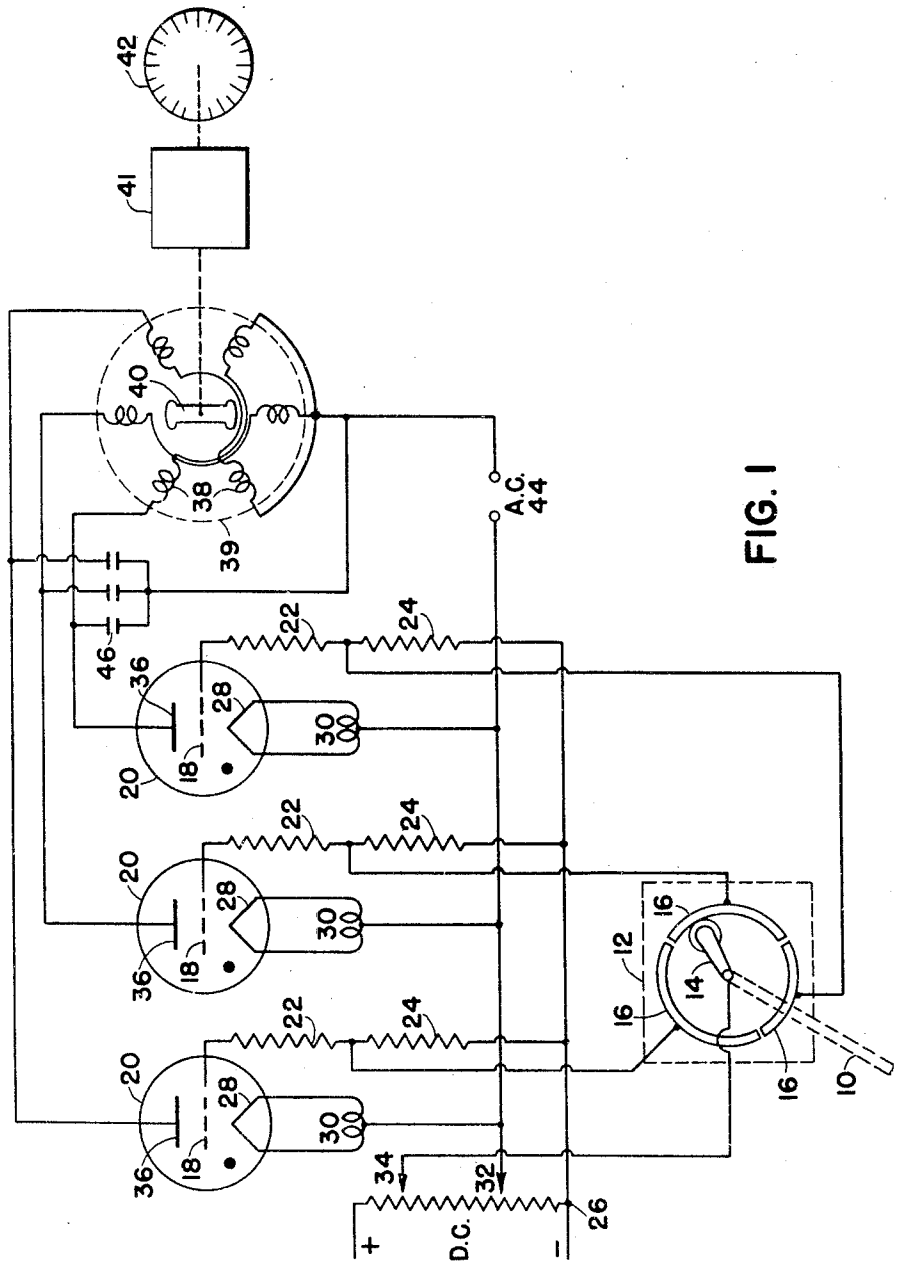


FIG. 1

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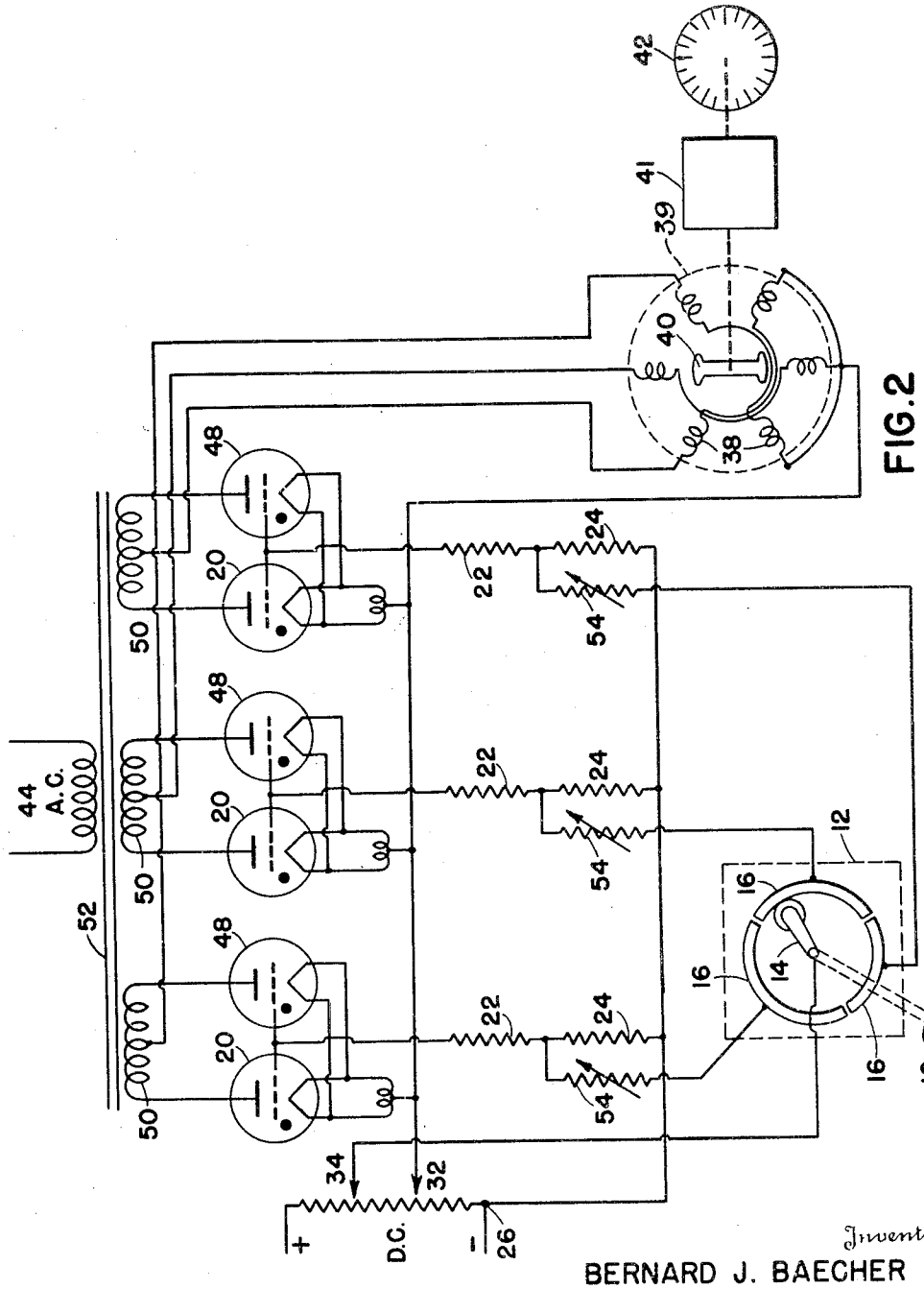


FIG. 2

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ELECTRONIC RELAY TRANSMITTER AND RECEIVER SELF-SYNCHRONOUS SYSTEM

Bernard J. Baecher, Brooklyn, N. Y.

Application December 26, 1945, Serial No. 637,294

1 Claim. (Cl. 318—27)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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My invention concerns a relaying device for a step-by-step remote positioning system. More particularly, my invention relates to the use of grid-controlled rectifiers to enable the use of positioned devices drawing current normally in excess of that supplied by the transmitter switch in a remote positioning system.

A common type of step-by-step positioning system, for example, the type used on shipboard for compass repeater systems, consists of a rotary switch at the transmitting end controlling a rotary magnetic element at the receiving end. In operation potential is successively applied to a plurality of contacts each corresponding to a pair of aligned coils at the receiving end. Energization of a set of such coils causes a rotatable magnetic armature to move toward an aligned position and simultaneously to turn a remote indicating scale.

Where a large number of remote indicating devices must be used, or where the remote device requires a considerable amount of electrical power, the power requirements may exceed that which can be handled by the switch located at the transmitter. While it is possible that a heavy duty rotary switch could be used at the transmitter end in order to handle the required current, this has been found to be impracticable. Building such a switch of an increased rating necessarily increases the amount of mechanical power required to drive it; however, the means generally available to drive the switch are of limited power. Further, the handling of large currents at relatively high voltages results in arcing at the edges of the fixed contacts. Besides increasing the maintenance of such contacts, such arcing is also disadvantageous since it necessitates an increase in spacing of the contact sectors. The latter is undesirable since it increases the proportion of the time during which no positioning coil is energized at the receiver end.

Magnetic relays have been used to increase the power controlled by the transmitter switch. The use of relays is an improvement since larger currents and higher voltages may be handled than are possible without using relays. Relays, however, suffer from the disadvantage of being of relatively high inductance which appreciably limits the maximum speed of the system to that well below the speed of response of the relay. In addition, the use of relays gives rise to problems of contact maintenance and adjustment. Relays suffer from the further disadvantage that wear of the moving parts tends to change the characteristics with age. The use of relays is further objectionable from the standpoint of noise and vibration. As mentioned above, it is necessary that at least one of the sets of positioning coils at the receiving end be energized at any given instant, requiring a matching of relay characteristics.

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The above disadvantage of using relays I have discovered can be satisfactorily overcome by employing grid-controlled rectifiers as a relaying means.

It is an object of my invention to provide a relaying device which will control comparatively large amounts of electrical power by means of control currents of small magnitude.

In accordance with my invention a remote positioning system is provided which will handle large amounts of electrical power without maintenance problems normally associated with magnetic relays and contacts.

Further in accordance with my invention, a remote positioning system is produced having extremely rapid response as compared to systems in which magnetic relays are utilized.

In accordance with one aspect of my invention, a remote positioning system is produced in which the electrical leads leading from the transmitter to a remote point may be of limited capacity while still enabling the control of a relatively large amount of power at the receiving end.

Further in accordance with my invention, a relaying system for remote positioning is produced having particular applicability to dead-reckoning devices.

My invention also resides in features of construction, combination and arrangement herein described or disclosed.

In the drawings:

Figure 1 shows one embodiment of my invention in which grid-controlled rectifiers connected for half-wave rectification are used in a step-by-step relaying system.

Figure 2 shows another embodiment of my invention in which grid-controlled rectifiers are used in a full wave circuit.

In Figure 1, the number 10 indicates a master shaft connected to any device whose position must be duplicated. Such a device may, for example, be a master compass on shipboard. The shaft 10 controls the operation of a transmitter switch 12, conveniently identified as the home transmitter switch, consisting of a wiper arm 14 cooperating with three arcuate stationary contacts or contact sectors 16. The contacts 16 are respectively connected to the grids 18 of grid-controlled gaseous rectifier or hot cathode thyratron relay tubes

20 through resistances 22. The switch and relay are required to be confined to a limited space due to their use on shipboard. The rectifiers are individually allocated to the respectively possible stepped positions of a positioning device 39, presently mentioned again, thereby affording the advantage of easy replacement in the event any one develops a fault. The use of tube rectifiers has the further advantage of their diminutive size, enabling the emplacement of the entire bank of rectifiers in a space which would be entirely inadequate for rectifiers of other types.

A feature of considerable importance lies in the inherent nature of the rectifier tubes. As indicated in the drawings these are of the hot cathode thyratron type and, being such, are readily responsive to a low potential direct current source for the control of a relatively large current, and desirably so out of consideration for keeping weights down wherever possible. The rapidity with which a thyratron is capable of deionizing after each impulse, due to the low direct current grid potential, makes it particularly well adapted to the instant system wherein it is desirable to have the thermionic relay ready itself promptly for the successive step positions which, in some instances, may be required to occur in fairly quick order. A path is also provided through resistances 24 to a point of zero potential 26. Included within the grid-controlled rectifiers are filaments 28 energized by windings 30 of transformers not shown. The filaments are connected to a variable source 32 of low D. C. potential. The wiper arm 14 of switch 12 is connected to a source 34 of somewhat higher D. C. potential.

The plates 36 of the rectifier tubes are connected to windings 38 of the remote positioning device 39 which act in diametrical pairs to produce radially-aligned flux. Cooperating with the windings 38 is a rotatable magnetic element 40 which is coupled to an indicating or similar device such as a scale 42. The coupling preferably includes suitable gearing 41 whereby one turn of the indicating device 42 corresponds to many turns of the magnetic armature 40. The circuit is completed through a source of alternating current indicated at 44. Condensers 46 may be used, if desired, to help smooth out the D. C. pulses.

In operation, the wiper arm 14 is caused to apply positive potential to the grids 18 of the rectifiers 20. Under conditions when no positive potential is being applied to the grids, the grids are slightly negative with respect to the cathode 28 and no conduction takes place. As positive potential is applied to the grid of a given tube, however, pulses of current flow from cathode 28 to anode 36 during the time that the anode 36 has a positive potential. Upon removal of the exciting grid potential, as the wiper arm passes on to the next segment, conduction in the particular tube will cease immediately that the voltage applied to the anode next passes through zero.

Subsequent application of positive grid potential to the other tubes will cause current to flow in the anode circuit and consequently through the coils 38 of the positioned device. The outer periphery of the rotatable element 40 is formed so that the transfer of flux from one diametrical set of coils to the adjacent set of coils results in smooth rotation of the magnetic element.

It is unnecessary that the angular relationship of the wiper arm 14 of the switch 12 and the rotatable element in the positioned device be maintained exactly, it is necessary merely that the step-by-step action take place in a positive manner. While the sudden transfer of current from one set of coils 38 to an adjacent set of coils will cause a stepped rotational movement of the element 40, since the indicator 42 is normally geared down with respect to the rotatable element 40, such irregular movement will not be noted in the indicator device.

Figure 2 is the modification of the device shown in Figure 1 in which the full wave rectification is utilized. In this modification, additional grid-controlled rectifiers 48 are connected in push-pull relation with respect to the rectifiers 20. Alternating potential is applied to the anodes 36 of the rectifiers 20 and 48 by means of separate center-tapped coils 50 on anode supply transformer 52.

In Figure 2 are also shown variable resistances 54 connected to the grids of each of the pairs of rectifier tubes. Such resistances are used to match the characteristics of each of the three pairs of rectifier tubes and to compensate for any difference between the voltages produced by the anode supply windings 50.

The operation of this modification is practically the same as that already outlined in connection with Figure 1. In this case, however, application of positive potential to the grids of a pair of rectifiers 20 and 48 will cause a fully rectified pulsating direct current to flow in the line associated with the pair of rectifiers. The cooperative operation of rectifier tubes 20 and 48 to produce full wave rectification is well known to one skilled in the art. An advantage gained by full wave rectification is the more constant energization of the coils 38 in the positioned device 39 and consequently greater torque capabilities.

It will be noted that the contact sectors 16 of the control switch 12 are located in closely adjacent relation. Such close spacing is possible because of the extremely low voltage and current required by the grids of the rectifier tubes. This close spacing together with the use of a roller type wiper arm insures that one of the sets of the coils 38 in the positioned device will be energized at all times. Also, because of the low voltage and current required to be handled by the control switch 12, the moving parts of such switch may be made extremely light thus putting a very small friction and inertia load on the master shaft 10.

The use of the remote-positioning relaying system disclosed enables conductors leading from the transmitter switch 12 to the positioned device 39 to be of extremely light cross section, provided that the grid-controlled rectifiers are located near the remote or receiver portion of the device.

It will be seen from the above that I have provided a remote positioning system which will handle large amounts of power, which is rapid in response since it involves no moving relay parts, and which entails a minimum of maintenance and adjustment.

While I have shown and described but two embodiments of my invention, it will appear to those skilled in the art that various changes and modifications may be made without departing from my invention, and I therefore aim in the appended claim to cover all such changes and modifications as fall within the true scope of my invention.

The invention described herein may be made or used by or for the Government of the United States for governmental purposes without the

payment to me of any royalties thereon or therefor.

I claim:

In a system for actuating a device to a position determined by the setting of a remote object, a tap switch having a movable arm mechanically connected with said remote object and a plurality of spaced contacts, a like number of electronic tubes each having an anode, a cathode, and a control grid, a like number of pairs of electromagnetic devices each having thereon an energizing coil and the energizing coils of each of said pairs being serially connected, the electromagnetic devices in each of said pairs being diagonally and radially disposed about an axis, the said several pairs being in consecutive sequence and at equiangular positions relative to each other, with the inner ends of the said electromagnetic devices tangent to a circle enclosing a circular area about said axis, means connecting corresponding ends of said serially connected energizing coils to one terminal of a source of alternating current, means connecting the remaining ends of said serially connected energizing coils to the anodes of said electronic tubes, respectively, means connecting the cathodes of said electronic tubes to the other terminal of the source of alternating current, biasing means for

rendering said electronic tubes normally nonconducting, a source of potential of sufficient magnitude to render said tubes conducting connected between the cathodes of said tubes and the movable arm of said switch, means connecting said spaced contacts of said switch to the control grids of the tubes respectively in consecutive order, a magnetic armature supported within the circular space between the inner ends of said electromagnetic devices and pivoted about the axis thereof, and means mechanically connecting said armature with the device to be positioned, whereby the magnetic armature is caused to assume a position determined by the tube rendered conducting by said switch.

BERNARD J. BAECHER.

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