

Nov. 27, 1945.

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2,389,692

REMOTE INDICATING SYSTEM

Filed Jan. 18, 1944

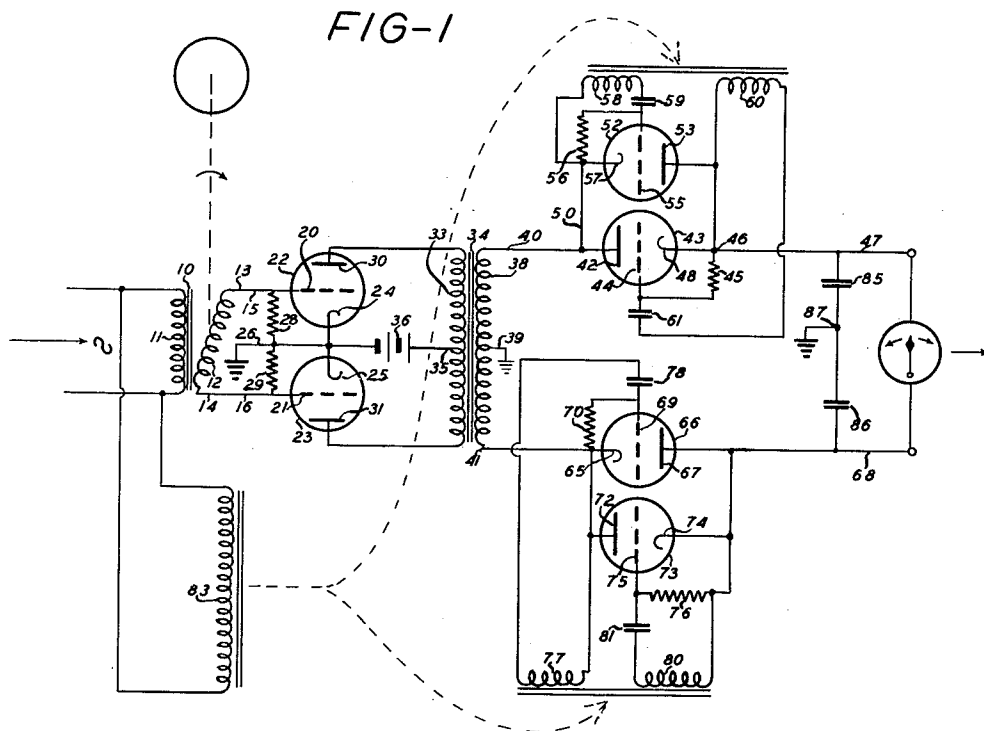
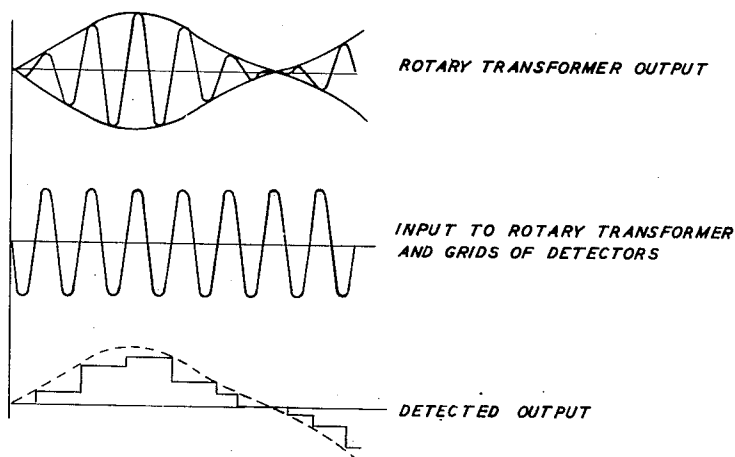


FIG-2

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2,389,692

REMOTE INDICATING SYSTEM

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by mesne assignments, to the United States of
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War

Application January 18, 1944, Serial No. 518,777

4 Claims. (Cl. 177—351)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a remote indicating system and particularly to give position indications at one or more remote stations of apparatus going through cyclic movements.

It is old in the art to have what is in effect a rotary transformer at both sending and receiving stations for transmitting position indications. The rotary transformer at the sending station is coupled to the apparatus whose position is to be transmitted to one or more remote stations. Alternating currents excite both the transmitting and receiving transformers and cause the receiving transformer to assume a position corresponding to the position of the transmitting transformer. Such systems known as Selsyns have been in use for a long time.

These systems are generally used where a remote accurate manual control of apparatus is necessary. There are many instances, however, where a remote indication only of the position of an apparatus is desired and in such instances the complexity, weight and expense of a Selsyn system becomes objectionable.

Thus as an example, it may be desired to rotate a directional antenna array and transmit the instantaneous antenna position to a remote station. Other fields of utility are giving remote indications of a compass, clocks and many other devices.

In general, this invention provides a remote indicating system wherein only one rotary transformer is used. This transformer is at the transmitting station and may have one winding thereof energized by alternating current of substantially uniform amplitude and frequency, which current may be designated as a carrier current. For practical purposes, such a carrier current may have a frequency in the audible range, such as 5,000 cycles per second, so that iron core transformers may be used efficiently. The secondary of this transformer is adapted to be rotated or turned with the device whose position is to be indicated. The output of this secondary transformer is thereupon fed through a suitable push-pull detecting circuit the output of which yields a low frequency current whose magnitude and polarity are a simple function of the position of the secondary.

For a further description of the invention, reference will now be made to the drawing wherein Figure 1 shows a circuit diagram of the remote

indicating system and Figure 2 shows the wave forms in various portions of the system.

A rotary transformer 10 may be disposed at a transmitting station. Rotary transformer 10 may be of any type whatsoever and is here shown as having an iron core. Transformer 10 has a primary 11 energized from a suitable source of unmodulated alternating current which may for example have a frequency of 5,000 cycles per second. Transformer 10 has a secondary 12 which may be mechanically mounted so that the coupling with the primary may be varied. Secondary 12 may be tied mechanically or in any other fashion to a mechanical device whose rotary position is to be indicated at some remote point.

The output of secondary 12 is fed from terminals 13 and 14 to a suitable transmission line 15 and 16 to a receiving station. Transmission line 15 and 16 feed secondary energy directly to grids 20 and 21 of a pair of vacuum tube amplifiers 22 and 23. Vacuum tubes 22 and 23 have cathodes 24 and 25 connected to a ground 26. Grid resistors 28 and 29 are connected respectively from grids 20 and 21 to ground. Anodes 30 and 31 are connected to primary winding 33 of a push-pull transformer 34, primary 33 having a center tap 35 between which center tap and ground 26 a source of B potential 36 is disposed. It is clear that vacuum tubes 22 and 23 are in push-pull relation.

Transformer 34 has its secondary 38 provided with a grounded center tap 39 and outer terminals 40 and 41 respectively. Terminal 40 is connected to anode 42 of a vacuum tube 43. Grid 44 of this tube is connected through a grid resistor 45 to junction point 46, the latter being in an output lead 47 connected to cathode 48. Terminal 40 is also connected by wire 50 to cathode 57 of a vacuum tube 52 having its anode 53 connected to junction point 46. Grid 55 is connected through a grid resistor 56 to cathode 57. A transformer secondary 58 is connected from cathode 57 through a blocking condenser 59 to grid 55. Another transformer secondary 60 is similarly connected from cathode 48 through a blocking condenser 61 to grid 44.

Terminal 41 of the transformer is connected to cathode 65 of a vacuum tube 66 whose anode 67 is connected to an output lead 68. Vacuum tube 66 has its grid 69 connected through a grid resistor 70 back to cathode 65. Cathode 65 is also connected to anode 72 of a vacuum tube 73 whose cathode 74 is connected directly to anode 67 of vacuum tube 66. Vacuum tube 73 has its grid 75 connected through a grid resistor 76 back to cath-

ode 74. A transformer secondary 77 is connected from cathode 85 of vacuum tube 66 through a blocking condenser 78 to grid 69 of that tube. Likewise transformer secondary 80 is connected between cathode 74 of vacuum tube 73 through a blocking condenser 81 to grid 75 of that tube. Transformer secondaries 58, 60, 77, and 80 are all energized from a primary winding 83 also at the receiving station and connected in parallel to primary 11 of rotary transformer 10. Secondary windings 58, 60, 77, and 80 are identical and so poled as to impress at any instant the same polarity on the grids of the four vacuum tubes to which they are connected.

Across the output leads 47 and 68 there may be connected two condensers 85 and 86 in series with their common junction 87 grounded. The output may be fed into a zero center meter or any other indicating means.

The operation of this system is as follows. Assume that alternating current of 5,000 cycles per second is impressed on primaries 11 and 83 of the two transformers. Due to the action of primary winding 83, there will be impressed upon the grids of vacuum tubes 43, 52, 66, and 73 alternating potentials of 5,000 cycles per second of substantially equal amplitude and all in phase. At the same time, alternating current in primary winding 11 will induce suitable potentials in secondary winding 12. The polarity and amplitude of these potentials will be a direct function of the rotary position 12 with respect to 11.

Let it be assumed that a positive peak of the 5,000 cycle current is being impressed upon primary windings 11 and 83. Let it also be assumed that the position of secondary 12 is such that a positive potential appears at terminal 13 and a negative potential appears at terminal 14. This will result in vacuum tube 22 conducting while vacuum tube 23 will be cut off. Hence space current will flow in the upper portion of primary winding 33 of push-pull transformer 34. This will induce a voltage in secondary winding 38 and this voltage for ease of analysis will be assumed to be positive at terminal 40 and negative at terminal 41. The positive voltage at terminal 40 will result in some space current passing through vacuum tube 43, the amount of space current and the portion of the conducting one-half positive cycle depending upon the bias of grid 44. At this particular instant, however, grid 44, as is true of the remaining grids in this series of tubes, is positive so that vacuum tube 43 becomes conducting. The negative potential at terminal 41 with the positive bias of grid 69 will result in space current flowing through vacuum tube 66. By suitable adjustment of the biasing potentials induced in transformer secondaries 58, 60, 77, and 80, it is possible to have the conducting vacuum tube operate only at the positive peak of the bias cycle on each grid. Thus a short pulse will pass through vacuum tubes 43 and 66 to charge series condensers 85 and 86. Condensers 85 and 86 should be small enough so that during each conducting period of the detector tubes, the condensers become substantially fully charged.

On the part of the carrier cycle below the positive peak, there will be no conduction in any detector tube since the grids of such tubes will be at or below cutoff. On a reverse or negative part of the modulating cycle, due to reversed polarity of rotary transformer secondary 12, vacuum tubes 52 and 73 will conduct but only at the instant when the grid bias is at the positive peak. This

will result in an output of pulses of negative polarity.

It is evident that output leads 47 and 68 will thus have potentials whose values are constantly changing with reference to ground both in an absolute and algebraic sense. The potentials from leads 47 and 68 may then be amplified or applied to any suitable indicating means such as a voltmeter, for example, with a scale suitably calibrated for the indications to be given.

As shown in Figure 2, the actual output of the system consists of a series of small steps at varying potentials. Each step begins on the time axis at the instant that the detector tubes become conductive and this may be determined by the ordinate of the unmodulated alternating potentials impressed upon the detector tube grids. As previously indicated, the detector tubes are operated in such a manner that the tubes are below cutoff for most of the grid potential cycle except for a short time at which the grid bias is substantially at its maximum positive value. This may be accomplished in various manners such as by a direct biasing potential superimposed upon the alternating potentials or by adjusting the values of the resistors and capacitance in the grid circuit so that the time constant of the grid circuit has the proper value for accomplishing the above.

Thus if the grid bias frequency is 5,000 cycles per second, then each period is 200 microseconds. If the time constant of the grid circuit, i. e. product of grid resistance and blocking condenser with grid to cathode tube resistance assumed infinite, is large compared to 200 microseconds, then the grid potential variations will remain small during most of the cycle. At the positive peak of grid bias the grid rises above cutoff and the grid to cathode resistance is small, compared to the grid resistor, so that the time constant of the grid circuit is now comparatively small. When a detector tube conducts, the blocking condenser in the grid circuit of such tube will become rapidly charged within a few microseconds. This will of course occur only during the existence of the positive potential peak on the grid. At the end of the short charging period of the blocking condenser, the full difference in potential induced in the secondary winding supplying the grid with bias potential will now be impressed across the blocking condenser. The grid side of the blocking condenser will be negative when the charging is complete, it being understood of course that this terminal of the condenser drops in potential during the charging process. The difference in potential across the blocking condenser should be sufficient to bias the grid to cutoff. When the tube is thus cut off, the grid resistor completes the condenser circuit. As the potential impressed upon the condenser from the secondary winding drops, the blocking condenser discharges with the grid still remaining below cutoff. The reversal of potential on the blocking condenser will have no effect on the grid cutoff potential due to the long time constant of the condenser circuit. Thus by making the time constant about three or more periods, i. e. something of the order of 600 microseconds or longer, the blocking condenser cannot become charged sufficiently to raise the grid above cutoff.

By choosing a sufficiently high frequency for the unmodulated alternating potentials applied to the system, the time duration of each detected step may be reduced since each step has a time duration of one period. Thus the action of the system will tend to average the output so that

a close approximation to the original input to the indicating system may be obtained.

What is claimed is:

1. An indicating system comprising a transformer having windings relatively movable to vary the coupling from a maximum through zero to another maximum, said winding movement being mechanically connected to an apparatus whose position is to be indicated, means for impressing an unmodulated alternating current on the primary, connections from said secondary to a push-pull detecting system, said system having two rectifiers in each leg thereof, said two rectifiers being in parallel with the cathode of one connected to the anode of the other, means for rendering all rectifiers conductive simultaneously only during the peak value in one algebraic sense only of each cycle of said unmodulated alternating current and means for utilizing said detected output to give indications of the condition of said transformer.

2. The system of claim 1 wherein said connections include a stage of push-pull amplification controlled from said transformer secondary.

3. The system of claim 1 wherein said rectifiers are three element vacuum tubes and wherein the means for rendering said rectifiers conductive consists of means for applying said unmodulated alternating current on the grids of said vacuum tubes with the tubes operating in such a manner that said tubes are at cutoff except during the positive peaks of the potentials impressed on said grids.

4. The system of claim 1 wherein said rectifiers consist of three element vacuum tubes, wherein said means for rendering the rectifiers conductive consists of means for applying said unmodulated alternating current on the control grids of said tubes, said tubes operating in such manner as to remain at cutoff at all times except when the grid bias potential has its maximum positive value and wherein condensers across the output of said detector are provided, said condensers being adapted to be charged during the conductive portions of the alternating current cycle.

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