July 21, 1953 W. F. GOODELL, JR 2,646,530

PLAN POSITION INDICATOR SYSTEM

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FIG. 1

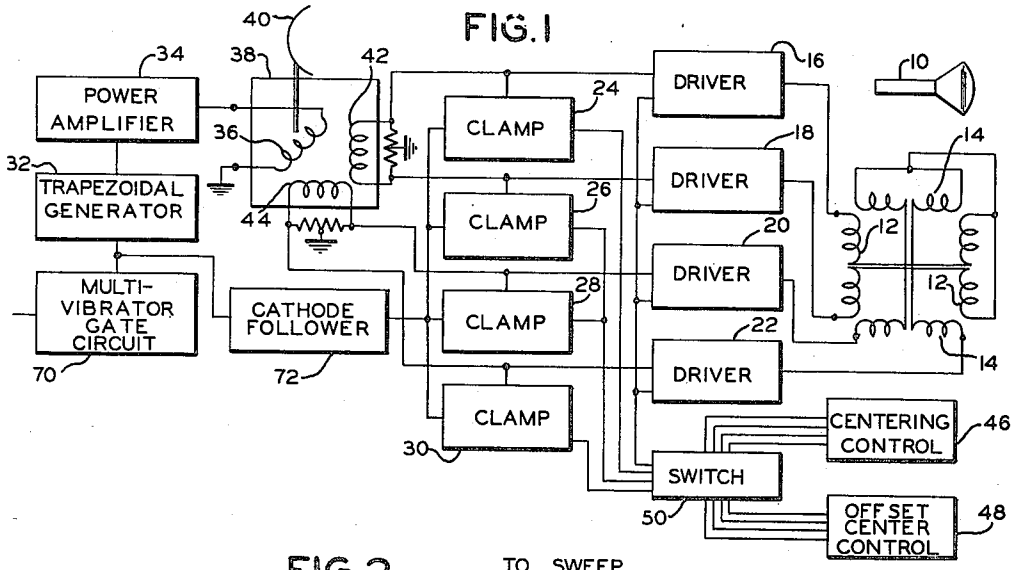
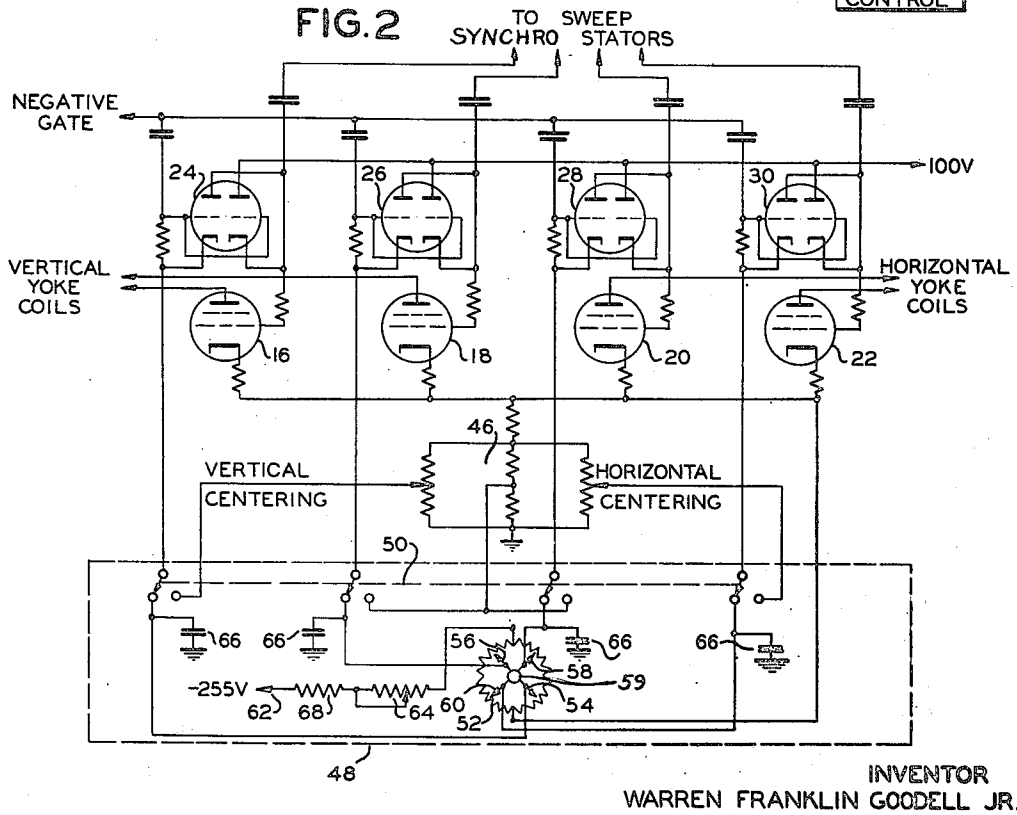


FIG. 2



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PLAN POSITION INDICATOR SYSTEM

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7 Claims. (Cl. 315—24)

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This invention relates to plan position indicator systems (commonly abbreviated PPI), and more particularly to apparatus for obtaining an offset center PPI indication, that is, a plan position indication wherein the origin of the sweep is displaced from the geometric center of the indicator cathode ray tube.

The primary object of the present invention is to generally improve PPI systems, and particularly offset center PPI systems. A more particular object is to provide a small, simple, lightweight attachment for producing an offset center indication in known PPI systems of the fixed yoke type.

Still another object is to control the location of the indication in terms of polar coordinates, and to do this by electrical means without necessitating extra yoke coils or a rotating yoke. To accomplish the foregoing objects, and other objects which will hereafter appear, the invention resides in the apparatus elements and their relation one to another as are hereinafter more particularly described in the following specification and sought to be defined in the claims. The specification is accompanied by a drawing in which:

Fig. 1 is a block diagram of apparatus embodying features of my invention; and

Fig. 2 is a wiring diagram for the same.

Referring to the drawing, and more particularly to Fig. 1, the stationary deflection coils of the cathode ray tube 10 are indicated at 12 and 14. This stationary yoke is energized in substantially conventional fashion by drivers 16, 18, 20 and 22 having associated clamping circuits 24, 26, 28 and 30. The sweep wave generator or trapezoidal voltage generator is indicated at 32, and its output, after amplification in a power amplifier 34, is supplied to the rotor 36 of a synchro-generator or rotary-transformer 38. Rotor 36 is turned in synchronism with the antenna system 40, which in the present case is shown mounted directly at rotor 36, but it will be understood that the antenna may be located at a remote point and electrically connected to the apparatus by appropriate synchro units. The stators 42 and 44 are located in phase quadrature, stator 42 being connected to the drivers 16 and 18 of yoke coils 12, and stator 44 being connected to the drivers 20 and 22 of yoke coils 14. The conventional circuit further includes a source of gate voltage 70, which is connected through a cathode follower 72 to the clamping circuits 24, 26, 28 and 30. Gate generator 70 also supplies a negative gate to the trapezoidal or sweep generator 32. The known circuit further comprises a centering control circuit 46.

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In accordance with my invention I provide an auxiliary circuit or offset center conrtol, indicated at 48, and a switch 50 for connecting either the conventional centering control 46, or the offset center control 48, to the clamping and driver circuits.

Referring now to Fig. 2, the drivers previously referred to are indicated at 16, 18, 20 and 22. The clamping circuits each include a pair of triode elements indicated at 24, 26, 28, and 30. The conventional centering control is shown at 46, while the auxiliary offset center control is shown in rectangle 48. The switch 50 is also included within rectangle 48, it being a part of the attachment. When the switch 50 is thrown to the left as shown, the offset center control is connected into the circuit, and the regular centering control 46 is disconnected from the circuit.

The offset center control, in the present embodiment of the invention, comprises a sine potentiometer 52 having contact arms connected to the clamping circuits. More specifically there are four arms 54, 56, 58 and 60, connected respectively to the clamping circuits 24, 26, 28 and 30. A source of negative direct potential is supplied to the potentiometer at 62. It will be understood that rotation of the potentiometer, as by means of a control handle or knob, will rotate the electron beam on a conical path, so that the spot or PPI center will move on a circular path. By varying the magnitude of the potential supplied to the potentiometer, the radius of the path will be varied, and for this purpose a variable resistor is provided at 64. Thus the position of the center may be manually adjusted in accordance with polar coordinates. This kind of adjustment is considered more convenient for most purposes than an adjustment in Cartesian or rectangular coordinates, because the scales normally provided on a PPI screen are in terms of polar coordinates.

The potentiometer arms are preferably bypassed by means of bypass capacitors 66, in order to provide a low impedance clamping point.

The switch 50 is preferably a four-pole double-throw switch, and when this switch is thrown from the left hand position to the right hand position, the connections from the clamping tubes 24, 26, 28 and 30 are led to the centering circuit 46, and a normal centered PPI indication is obtained.

A typical operational cycle of the indicating system with switch 50 first in its rightward and then in its leftward position will now be described. The cycle commences with the activation of multivibrator gate circuit 70 and the appearance of a negative pulse at the input circuit

of trapezoidal generator 32. This pulse triggers the generator and the resultant trapezoidal voltage, after amplification in stage 34, is supplied to rotor 36 of rotary transformer 38. Across the stator windings 42 and 44, which are in a quadrature spatial relationship, appear sinusoidally varying voltages, the instantaneous values of which are related to the angular disposition of antenna 40 and mechanically coupled rotor 36. These voltages are subsequently fed, in a push-pull manner, to driver tubes 16, 18, 20 and 22 and then to the various pairs of deflecting coils, 12 and 14, associated with the cathode ray tube 10.

During this portion of the cycle, multivibrator circuit 70 also supplies a negative pulse via cathode follower 72 to the control grids of the double triodes 24, 26, 28 and 30, biasing these tubes to cut-off and preventing the clamping circuits from functioning. Consequently, the individual control grids of the driver tubes are free to follow the input trapezoidal voltages obtained from stator windings 42 and 44. In this manner, the linearly varying deflecting currents needed for producing the cathode ray sweep are obtained.

In the interval between adjacent trapezoidal pulses multivibrator 70 is reset to its original condition and with its restoration a positive pulse appears on the control grids of the clamping triodes. Both sections of the double triode clamps 24, 26, 28 and 30 are now rendered conductive. Throughout the duration of this positive pulse these sections perform somewhat like a voltage dividing network to maintain a definite voltage on the grids of the driver tubes. The right-hand sections of the double triodes may be considered variable resistors which regulate the fraction of the 100-volt plate supply that appears across the left-hand tube sections and the resistor network in the grid-cathode circuit of the driver tubes. If for any reason the grid voltage on these drivers should depart from the above value and, for example, tend to increase in magnitude, an equivalent increase appears on the grids of the right-hand tube sections because of the connections established through the left-hand sections. The impedance of the former sections is increased and the voltage on the grids of the driver tubes is consequently returned to normal. In a like manner, a decrease of grid bias on the grids of the drivers is accompanied by a reduction in the bias of the left-hand tube sections and a similar decrease in their impedance; and again the grids are restored to their proper voltage levels. With switch 50 in its rightward position, as viewed in Fig. 2, the aforementioned voltage level which is to be maintained on the grids of the driver tubes is determined in part by the settings of the potentiometers of resistance network 46. As is well known, this network regulates the horizontal and vertical centering of the cathode ray beam by changing the bias on the driver tubes and, hence, the quiescent currents in the deflecting coils. With the quiescent currents equal, the electrical characteristics of the deflecting coils and their relative locations are such that no magnetic field will act on the beam. By disturbing this equality in the manner suggested above, the rest position of the cathode ray beam may be changed rectilinearly.

When switch 50 is rotated to its leftward position, sine potentiometer 52 and its associated voltage supply is substituted for resistance network 46 in the grid-cathode circuit of the various driver tubes. With this potentiometer effective, the control grids of the latter tubes are now

clamped between sweeps to adjustable potential levels determined by the setting of the four arms 54, 56, 58 and 60. By clamping these grids in such a fashion, the quiescent currents through the deflecting coils are now so related in magnitude and phase that the resulting magnetic fields divert the cathode ray beam along a conical path, the radius of which is a function of the magnitudes of these currents and the angular position of which is related to their phase relationships. Thus, by resorting to a sine potentiometer in place of the conventional parallel resistance network, the rest position of the cathode ray beam between sweeps may, by a single adjustment, be readily relocated to any polar position on the face of the cathode ray tube.

Some circuit element dimensions used in this specific case are given hereafter, but this is solely by way of illustration, and not in limitation of the invention. This auxiliary circuit is intended to modify a U. S. Army-Navy "AN/APS15" equipment. This embodies a 5-inch cathode ray tube, of which a screen area about 4 inches in diameter is effective. An offset up to 1½ inches in radius is provided by applying minus 225 volts to the sine potentiometer. The variable resistor 64 is 100,000 ohms in value and is in series with a fixed resistor 68 having a value of 50,000 ohms. The driver tubes 16, 18, 20 and 22 are 6L6 tubes and the clamping tubes 24, 26, 28 and 30 are 6SN7 tubes. The potentiometer arms are bypassed by 1.0 microfarad capacitors. The sine potentiometer is 17,000 ohms in value.

It is believed that the construction and operation as well as the advantages of my improved offset center PPI system will be apparent from the foregoing detailed description. The arrangement provides a readily adjustable offset center which is adjusted in accordance with polar coordinates. The adjustment may be put well off center without affecting the radial sweep. This is in contrast with an adjustment by the regular centering circuit 46, which would not be nearly as suitable for offset centering purposes (even if one were satisfied to adjust in accordance with Cartesian coordinates), because the range would be very limited, and since it is a "single ended" adjustment, the distortion would be greater.

Considered as an auxiliary attachment for PPI systems, the present invention has the advantage of being extremely light, simple, and low in power consumption, it being suitable for airborne equipment. There is no need for a rotating yoke on the cathode ray tube. No adjustment of the radial sweep is needed because it is feasible to make this sweep long enough in the first instance to accommodate a 1½ inch displacement from center.

It will be understood that while I have shown and described my invention in a preferred form, changes may be made in the circuit disclosed, without departing from the spirit of the invention as sought to be defined in the following claims.

I claim:

1. An auxiliary polar-coordinate offset center control for a plan position indication system including a cathode ray tube, stationary deflection coils, a sweep wave generator, a synchro, driver tubes energized from the synchro and connected to the deflection coils, clamping circuits, and a centering network, said auxiliary offset center control comprising a sine potentiometer with movable arms connected to the clamping circuits, a source of potential for the potentiometer, a

control handle for adjusting the angle of rotation of the potentiometer and consequently the angular direction of offset, means for varying the aforesaid potential and consequently the distance of center offset, and switch means to connect the plan position indication circuits to either the auxiliary offset center control or to said centering network.

2. An auxiliary polar-coordinate offset center control for a plan position indication system including a cathode ray tube, stationary deflection yoke coils, a sweep wave generator, a synchro having its rotor energized by the sweep wave generator and rotatably responsive to remote means, driver tubes energized from the stators of the synchro and connected to the yoke coils, and clamping circuits each with two sets of tube electrodes, said auxiliary offset center control comprising a sine potentiometer with equally spaced arms connected to the clamping circuits, a source of negative direct potential for the potentiometer, a control handle for adjusting the angle of rotation of the potentiometer arms and consequently the angular direction of offset of the center, and means for varying the potential and consequently the distance of offset of the center.

3. An auxiliary polar-coordinate offset center control for a plan position indication system including a cathode ray tube, stationary deflection yoke coils, a source of negative gate, a sweep wave generator, a synchro having its rotor energized by the sweep wave generator and rotatable by remote means, four driver tubes energized from the stators of the synchro and connected to the yoke coils, and four clamping circuits each with two sets of tube electrodes, said auxiliary offset center control comprising a sine potentiometer with four equally spaced rotatable contact arms connected to the four clamping circuits, a source of negative direct potential for the potentiometer, a control handle for adjusting the angle of rotation of the potentiometer arms and consequently the angular direction of offset of the center, resistor for varying the said potential and consequently the distance of offset of the center, and bypass capacitors for the potentiometer arms to provide a low impedance clamping point.

4. An auxiliary polar-coordinate offset center control for a plan position indication system including a cathode ray tube, stationary deflection yoke coils, a source of negative gate, a sweep wave generator, a synchro having its rotor energized by the sweep wave generator and rotatable by remote means, four driver tubes energized from the stators of the synchro and connected to the yoke coils, four clamping circuits each with two sets of tube electrodes, and a centering network, said auxiliary offset center control comprising a sine potentiometer with four equally spaced rotatable contact arms connected to the four clamping circuits, a source of negative direct potential for the potentiometer, a control handle for adjusting the angle of rotation of the potentiometer arms and consequently the angular direction of offset of the center, a resistor for varying the said potential and consequently the distance of offset of the center, bypass capacitors for the potentiometer arms to provide a low impedance clamping point, and a four-pole double-throw switch to connect the four clamping circuits to either the four arms of the sine potentiometer, or to the regular centering network.

5. A polar-coordinate offset center control for a plan position indication system having stationary deflection coils responsive to driver and clamping circuits, said offset center control comprising a multi-arm potentiometer, a source of potential for said potentiometer, means connecting the contact arms of the potentiometer to said driver and clamping circuits, means for moving the potentiometer arms for determining the angular direction of offset of the center of the plan position indication representation, and means for varying said potential for controlling the amount of displacement of the plan position indication representation.

6. A polar-coordinate offset center control for a plan position indication system having stationary deflection coils responsive to driver and clamping circuits, said offset center control comprising a sine potentiometer having a plurality of contact arms, a source of direct potential for said potentiometer, means connecting the contact arms of the sine potentiometer to said driver and clamping circuits whereby rotation of said potentiometer displaces the center of the plan position indication representation, and means for varying said potential for controlling the amount of displacement.

7. An auxiliary polar-coordinate offset center control for a plan position indication system including a cathode ray tube, stationary deflection coils, a sweep wave generator, a sweep synchro, driver and clamping circuits energized from said sweep synchro and connected to said deflection coils, said auxiliary offset center control comprising a sine potentiometer with arms connected to said clamping circuits, a source of potential for said potentiometer, means for adjusting the degree of rotation of said potentiometer and thereby the direction of the displacement of the center of the plan position indication representation on said cathode ray tube, and means for varying said potential and consequently the amount of displacement of the center.

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