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CONDENSER SERVO MECHANISM

Filed Jan. 15, 1946

FIG. 1

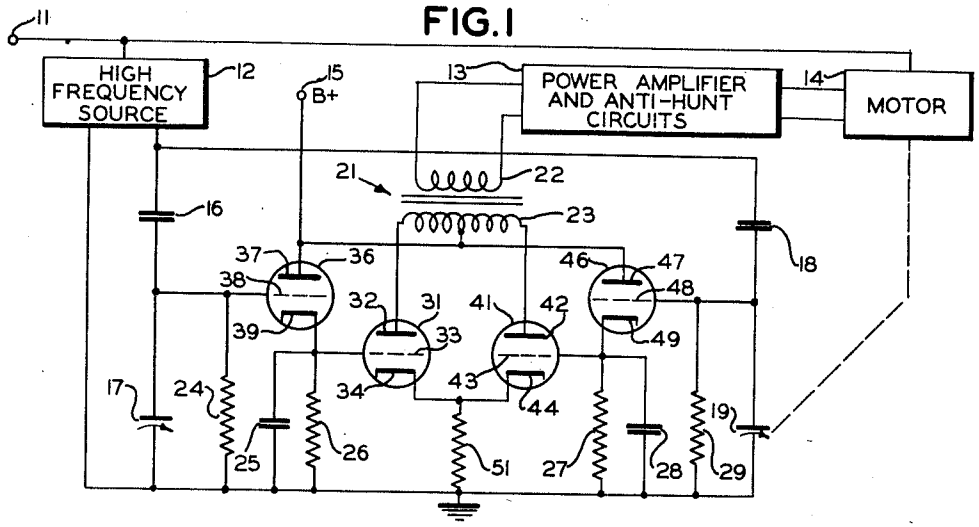
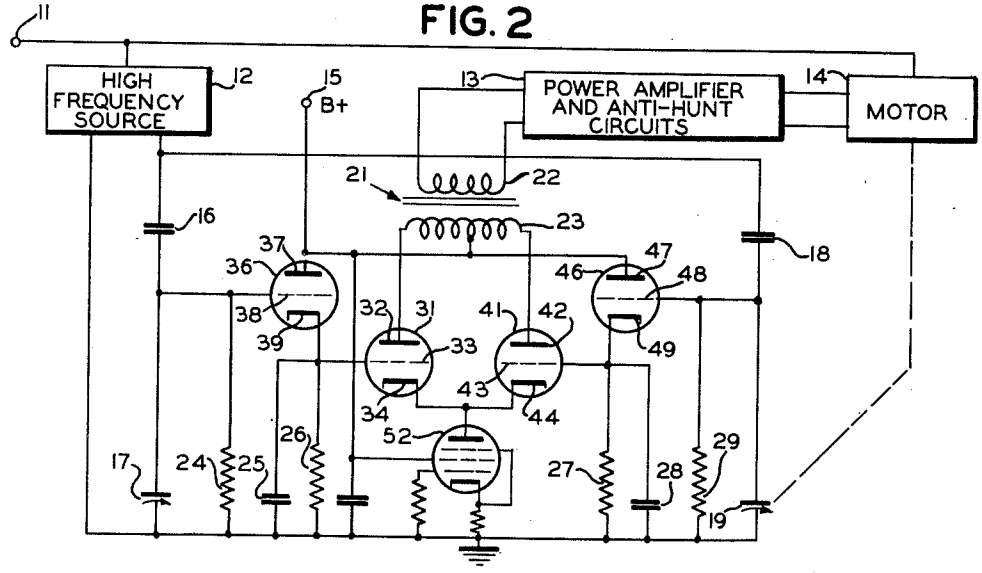


FIG. 2



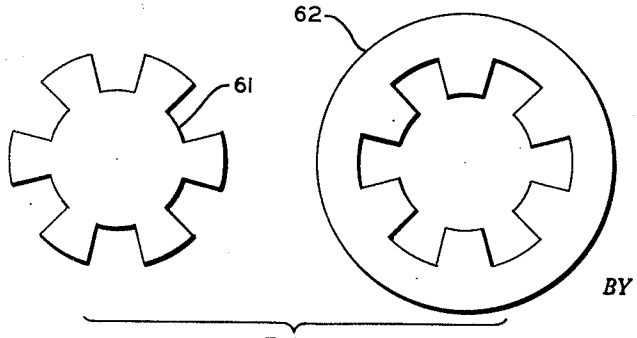


FIG. 3

INVENTOR.
CHALMERS W. SHERWIN

BY

ATTORNEY

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CONDENSER SERVO MECHANISM

Chalmers W. Sherwin, Belmont, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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5 Claims. (Cl. 318—29)

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This invention relates to servo systems and more particularly to servo systems using variable impedance elements.

Heretofore servo systems, such as those using synchrons, had the disadvantage that they were bulky, of considerable weight, and required an appreciable torque at the sending end.

A general object of the present invention is to overcome the foregoing difficulties.

Another object of the present invention is to provide a servo system using variable impedance elements.

A further object is to provide a servo system which is light and compact.

A still further object is to provide a servo system which requires very little torque at its sending end.

These and other objects will be apparent from the following specification when taken with the accompanying drawing, in which:

Fig. 1 is a schematic illustration of one form of the invention;

Fig. 2 is a schematic illustration of another form of the invention; and

Fig. 3 is a plan view of the variable condensers.

Referring to the drawings, and more particularly Fig. 1, a servo system is shown having two variable impedance elements, and more particularly a variable condenser 17 at the transmitting end of the system and another variable condenser 19 at the receiving end of the system. A comparatively high frequency voltage source 12 is modulated by a comparatively low frequency voltage source applied at terminal 11. This modulated voltage at 12 is applied to similar voltage divider networks comprising condensers 16 and 17, and 18 and 19, respectively such that variable condensers 17 and 19 have fractions of the modulated voltage across them. Peak detector circuits comprising electron tubes 36 and 46 and their other circuit components detect the modulation envelopes of the fractional voltages on condensers 17 and 19 respectively. A difference amplifier comprising, electron tubes 31 and 41, a common cathode coupling resistor 51, and an output transformer 21, compares the amplitudes of the aforesaid modulation envelopes. The output voltage from transformer 21, being at the same frequency as low frequency voltage applied at 11, is applied to a power amplifier 13 incorporating conventional anti-hunt circuits and the output therefrom is applied to motor 14. The combination of the output from power amplifier 13 and a voltage from a source at terminal 11 causes motor 14 to rotate and drive the rotor of variable condenser 19 so that its capacitance is essentially that of condenser 17.

Referring to Fig. 2 resistor 51 (Fig. 1) may comprise an electron tube 52 and its associated circuit component such that the cathode coupling circuit of the difference amplifier has high dynamic resistance and low static resistance. This provides greater output from the difference amplifier while permitting tubes 31 and 41 to draw sufficient current to operate in their high gain region.

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Referring to Fig. 1, a high frequency or R.-F. voltage source 12 is modulated by a low frequency voltage source applied at terminal 11. This low frequency voltage is also applied to one phase (not shown) of a two phase induction motor 14. In one embodiment of this invention 60 cycle voltage was used for this low frequency voltage source.

The modulated high frequency voltage from source 12 is applied to two similar voltage divider networks comprising condensers 16 and 17 and condensers 18 and 19, respectively, wherein condensers 17 and 19 are rotatable and variable. The use of modulated high frequency voltage permits condensers 16, 17, 18 and 19 to be smaller than if the low frequency voltage had been used directly. This feature of the invention is particularly advantageous if the transmitting end condenser 17 is to be driven by a transmitting device able to furnish only a very small amount of torque or linear motion.

Since this servo system merely compares the amplitude of the fractional modulated voltages across condensers 17 and 19, high frequency detectors circuits are provided, as shown in Fig. 1, to recover the modulation envelopes of these voltages. This minimizes any errors due to phase shifts and also converts back to a frequency suitable for use on the other phase (not shown) of motor 14. The above mentioned high frequency detector circuits comprise, for the signal across condenser 17, and electron tube 36, resistors 24 and 26, and condenser 25, and for the signal across condenser 19, an electron tube 46, resistors 29 and 27, and condenser 28. In one of these detector circuits electron tube 36 has its plate 37 connected to a source of positive potential at 15, its grid 38 connected to a grid resistor 24 and the junction of condenser 16 and 17, and its cathode 39 connected to a high frequency filter circuit comprising resistor 26 and condenser 25 in parallel. The output from this detector is obtained at cathode 39 and comprises essentially only the modulation envelope of the voltage across condenser 17. The other detector circuit is similarly connected and provides at cathode 49 of tube 46 an output voltage comprising essentially only the modulation envelope of the voltage across condenser 19.

The output voltages of tubes 36 and 46 are applied to grids 33 and 43 respectively of the difference amplifier. The electron tubes 31 and 41 comprising this difference amplifier have their

cathodes 34 and 44 respectively connected together and to a common cathode coupling resistance comprising either resistor 51 (Fig. 1) or electron tube 52 and its associated circuit components (Fig. 2). The plates 32 and 42 of tubes 31 and 41 respectively are connected to opposite terminals of primary winding 23 of transformer 21, the centertap of primary winding 23 being connected to a positive source of potential at 15. The output voltage from the difference amplifier is obtained from the terminals of secondary winding 22 of transformer 21, and is proportional to the difference of the voltages across condensers 17 and 19.

This output voltage is applied to power amplifier 13 which incorporates conventional antihunt circuits and the output therefrom is applied to the other phase of induction motor 14. If there is a difference in the voltages applied to grids 33 and 43 the aforementioned output voltage causes motor 14 to turn so that its output shaft moves the rotor of condenser 19 at the receiving end of the system to make its capacitance essentially equal to that of condenser 17 and thus decrease the difference in the voltage at grids 33 and 43. The above constitutes a servo or follow-up system in which the rotor of condenser 19 at the receiving end is positioned with respect to the rotor of condenser 17 at the transmitting end.

If high angular accuracy is desired over a small angle a condenser such as that depicted in Fig. 3 may be used for the variable condensers 17 and 19. The condenser of Fig. 3 has a toothed rotor 61 and a slotted stator 62 such that a small angular change of rotor 61 with respect to stator 62 will produce a large change of capacitance. Such design eliminates the necessity of any gearing at the transmitting end which would load down the transmitting device. Those skilled in the art will realize that many other condenser designs are possible and it is to be understood that this invention is not to be limited to the condenser shown in Fig. 3.

In order to facilitate initial alignment of condenser 19 with respect to condenser 17, condenser 16 or 18 or both may be made variable so that the difference of the voltages at grids 33 and 43 are zero when transmitter and receiver are aligned with respect to one another. Other methods for producing such alignment will suggest themselves to those skilled in the art.

It will now be apparent that this invention has the advantages of being light and compact and requiring a small amount of torque from the transmitting device. The use of modulated high frequency voltage reduces the size of the variable condensers used. The system is not sensitive to amplitude or frequency changes of the voltages at source 11 or 12.

The invention described in the foregoing specification need not be limited to the details shown, which are considered to be illustrative of one form the invention may take.

What is claimed is:

1. In an electrical positional control system, a circuit comprising two variable voltage dividers each including a variable impedance element and a constant impedance element, a source of alternating voltage of comparatively high frequency, a second source of alternating voltage of comparatively low frequency modulating said first source, means for applying said modulated voltage to said voltage dividers, first and second high frequency peak detectors for demodulating the voltages impressed on said variable impedance elements, a difference amplifier for comparing the amplitudes of the output voltages of said first and second detectors and means for positioning one of said variable impedance elements in response to said comparison.

2. In an electrical positional control system, a circuit comprising two variable voltage dividers each including a rotatable variable capacitor in series connection with fixed capacitor, a source of high frequency alternating voltage modulated by a low frequency alternating voltage, means for applying said modulated voltage to each of said voltage dividers, electron tubes for detecting the modulation envelopes of the voltage impressed across said variable capacitors, two additional electron tubes having a common cathode coupling resistance connected as a difference amplifier for comparing the amplitudes of the aforesaid modulation envelopes, and a motor driven by the output voltage of said difference amplifier, whereby one of said variable capacitors is angularly positioned such as to make the voltages appearing across said variable capacitors substantially equal.

3. The circuit of the electrical positioning control system of claim 2 wherein said common cathode coupling resistance comprises an electron tube having high dynamic plate resistance and low static resistance.

4. In an electrical positional control system, a circuit comprising two variable voltage dividers each including a variable capacitor and a fixed capacitor in series connection, a source of high frequency alternating voltage modulated by a low frequency alternating voltage, means for applying said modulated voltage to each of said voltage dividers, a high frequency demodulator responsive to the potentials impressed on each variable capacitor of said voltage dividers for producing a demodulated output potential, a difference amplifier responsive to said demodulated potentials to produce an output potential proportional to the difference of said demodulated potentials, and means for positioning one of said variable capacitors in response to said output potential to make said output potential a minimum.

5. In an electrical positional control system, a circuit comprising two variable voltage dividers each including a variable capacitor in series connection with a fixed capacitor, a source of high frequency alternating voltage modulated by a low frequency voltage, means applying said modulated voltage to each of said voltage dividers, a high frequency peak detector for detecting the modulation envelope of the voltage impressed on each of said variable capacitors, a difference amplifier responsive to the respective amplitudes of said modulation envelopes for producing an output proportional to the difference of said amplitudes, and motor means driven from said output whereby one of said variable capacitors is angularly positioned to make said output a minimum.

CHALMERS W. SHERWIN.

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