

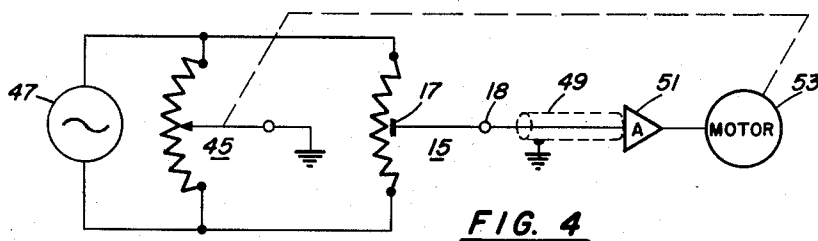
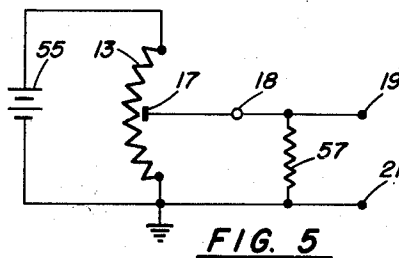
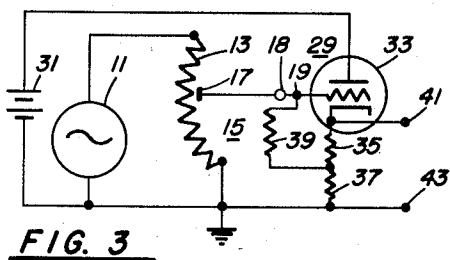
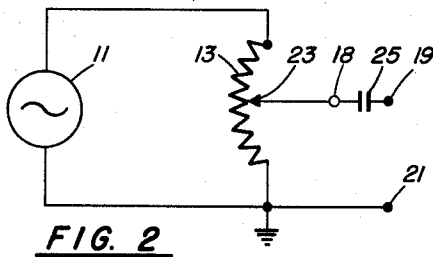
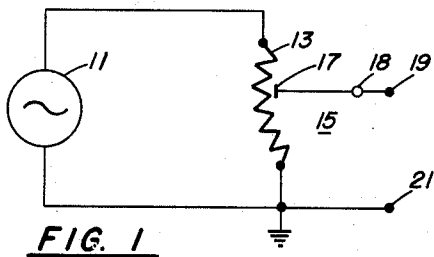
July 22, 1958

J. DIMEFF

2,844,776

SERVOMOTOR CAPACITANCE-COUPLED POTENTIOMETER WIPER CIRCUIT

Filed Nov. 15, 1955



INVENTOR
JOHN DIMEFF

BY

R. J. Tompkins
ATTORNEYS

1

2,844,776

SERVOMOTOR CAPACITANCE-COUPLED POTENTIOMETER WIPER CIRCUIT

John Dimeff, San Jose, Calif.

Application November 15, 1955, Serial No. 547,051

4 Claims. (Cl. 318—29)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to capacitance-coupled potentiometer circuits and more particularly to capacitance-coupled potentiometer circuits in which voltages are tapped off by means of a capacitive arrangement.

Conventional potentiometer circuits utilize a sliding contactor which during change in position maintains contact with the potentiometer element. This sliding contactor produces wear and eventual failure of the potentiometer; and, as a result of the inherent friction of such a device, limits use of the potentiometer to those applications in which friction is not critical.

In the present invention the contactor moves in close proximity to but not in actual physical contact with the resistance element of the potentiometer. The electrical circuit is completed by electrostatic coupling across the gap between the resistance element and the contactor. The application of an alternating voltage to the resistance element of the potentiometer produces an electrostatically-coupled alternating voltage at the contactor which is correlated with the position of the contactor. The application of a direct unvarying voltage to the ends of the resistance element produces an electrostatically-coupled voltage at the contactor which varies only when the position of the contactor varies. This voltage can be correlated to the rate at which the contactor is moved. Due to the small size of the equivalent series capacitance presented by the contactor, the loading of the output circuit is important and in many applications necessitates the use of special circuits to minimize the output current flow and the effects of cable capacitance. The fact that physical contact is eliminated avoids friction wear and decreases forces required to move the contactor. The first of these advantages can result in higher component reliability, and the second can result in application of potentiometer elements to devices in which friction forces might otherwise prove prohibitive. In many applications these advantages far outweigh the disadvantage of the requirement of additional circuits to avoid loading effects.

Accordingly an object of the present invention is the provision of a potentiometer in which there is no physical contact between the contactor and resistance element.

Another object is to provide a potentiometer having much less repositioning torque and fewer component failures than sliding contact potentiometers.

A further object of the invention is the provision of a potentiometer in which there is no friction or wear between the contact and resistance element.

Still another object is to provide capacitance-coupled contactor potentiometer circuits which are insensitive to different loading effects.

A still further object is to provide output circuits for capacitance-coupled contactor potentiometer circuits for reducing errors produced by the passage of loading currents through the contactor.

2

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 shows a circuit diagram of a preferred embodiment of the capacitance-coupled contactor potentiometer of this invention;

Fig. 2 illustrates a circuit diagram of an equivalent electrical circuit of the embodiment of Fig. 1;

Fig. 3 shows a circuit diagram of one embodiment of the capacitance-coupled contactor potentiometer circuit of this invention;

Fig. 4 illustrates a circuit diagram of another embodiment of the capacitance-coupled contactor potentiometer circuit of this invention;

Fig. 5 shows a circuit diagram of the potentiometer of Fig. 1 as employed with a D. C. source.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 (which illustrates a preferred potentiometer embodiment) an A. C. source 11 connected across resistor 13 which is the resistive element for potentiometer 15. Potentiometer capacitance contactor 17 is joined to one output terminal 19 and moves by means of a pivotal arrangement 18, or the like, at a constant distance from but not in contact with resistor 13. One end of resistor 13 is grounded and is also connected to the other output terminal 21.

In Fig. 2 the components are identical to those of Fig. 1 with the exception of contactor 17 of Fig. 1 which is represented in Fig. 2 by the equivalent electrical circuit of contact 23 and capacitor 25.

In Fig. 3 the potentiometer circuit of Fig. 1 is shown coupled to an impedance transforming cathode follower circuit 29 which, although illustrated in this figure to be of the triode type may be of any form. A D. C. source 31 is joined to the plate of triode 33 and series resistors 35 and 37 are connected to the cathode. Terminal 19 is coupled directly to the grid of triode 33 and indirectly through resistor 39 to the tap between resistors 35 and 37. One output terminal 41 is attached to the cathode of triode 33 and the other output terminal 43 is grounded at one end of resistor 37.

In the circuit shown in Fig. 4, capacitance-coupled potentiometer 15 of Fig. 1 and potentiometer 45 are connected in parallel across ungrounded A. C. source 47. Contactor 17 is joined by means of shielded cable 49 to the input of a follow-up system comprising amplifier 51 and motor 53. The output shaft of motor 53 is mechanically coupled to drive the movable arm of potentiometer 45.

In the D. C. embodiment of Fig. 5, a source of D. C. voltage 55 is connected across resistor element 13. Capacitance contactor 17 is joined to output terminal 19 and also to one end of resistor 57. The other end of resistor 57 is connected to ground and the output terminal 21.

In operation, the A. C. source 11 of Fig. 1 establishes an A. C. voltage across resistive element 13. The position of the movable contactor 17 relative to the ends of the resistance element 13 is sensed by electrostatic coupling, i. e. through the capacitance between contactor 17 and the adjacent section of resistance element 13. Motion of the "capacitance contactor" thus formed toward one end of element 13 causes a change in the voltage electrostatically coupled to that capacitance contactor toward the voltage and phase of that end of the potentiometer. Thus, the output across terminals 19 and 21 is a function of the position of contactor 17 relative to the ends of element 13.

Insofar as the circuit connected to terminals 19 and 21 of Fig. 1 is concerned, the equivalent electrical circuit is that of a capacitor 25 connected to a conventional potentiometer as is shown in Fig. 2, wherein the capacitor 25 has the same value as the capacitance between contactor 17 and element 13. It is thus seen that without a correcting circuit, capacitor 25, which is small, might seriously and erroneously affect the output of the potentiometer circuit.

In the circuit of Fig. 3 the contactor 17 is connected directly to the impedance transforming cathode follower 29. The input circuit of the cathode follower presents a high impedance to the contactor, thus minimizing the current flow required to actuate the circuit connected to terminals 41 and 43. Less current through the equivalent capacitor 25 (Fig. 2) means less voltage drop and phase shift in the potentiometer output.

Another circuit for reducing errors produced by the passage of loading currents through the contactor is shown in Fig. 4. The signal produced between the contactor 17 and the grounded center arm of potentiometer 45 is connected through cable 49 to the input of high gain amplifier 51. Motor 53 is energized by the output of amplifier 51 to mechanically drive the movable contact of potentiometer 45 in a direction to reduce the unbalance of the resistance bridge formed by the four resistance sections of the resistive elements of potentiometers 15 and 45. When this bridge is balanced, the alternating potential of the contactor 17 is reduced to ground potential. Since the cable shield is at ground potential, current through the cable capacitance to ground is zero, and loading effects on contactor 17 are negligible.

In the potentiometer embodiment of Fig. 5, the effective series capacitance between contactor 17 and resistance element 13 prevents flow of signal current to the output terminals 19 and 21 if contactor 17 is stationary. When contactor 17 is moved, however, a voltage change is produced which causes a current to flow through contactor 17 and through resistor 57, to the other terminal of source 55. If resistor 57 is small, the voltage across terminals 19 and 21 becomes directly proportional to the velocity of the contactor 17 along the resistor element 13.

As previously stated the present invention produces a typical potentiometer response without the accompanying disadvantages of friction and wear that are present in conventional potentiometers. Thus, the present invention has much broader application, as for example in sensitive angle measuring instruments, than do conventional potentiometers.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A capacitance-coupled potentiometer circuit comprising: input terminals for connection across a source of A. C. potential, a resistor connected across said input terminals, a movable contactor, means for mounting said movable contactor for movement parallel to and at a predetermined distance from said resistor to be thereby capacitively coupled thereto, output terminal means adapted to be connected to an external circuit and means interposed between said movable contactor and said output terminal means operative to prevent loading of said contactor by said external circuit.

2. The device of claim 1 wherein said last mentioned means is a cathode follower circuit including a controllable electron discharge device having the control element thereof coupled to said movable contactor and the cathode circuit thereof coupled to said output terminal means.

3. The device of claim 1 wherein said last mentioned means comprises a conventional potentiometer having the resistive portion thereof connected in parallel with the resistive portion of said capacitance-coupled potentiometer and the wiper arm thereof coupled to a point of reference potential, a high gain amplifier, circuit means coupling the input circuit of said high gain amplifier to said movable contactor, a motor, circuit means coupling said motor to the output circuit of said high gain amplifier, and means mechanically coupling the shaft of said motor to said wiper arm.

4. A capacitance-coupled potentiometer comprising: input terminals for connection across a source of direct potential, a potential dropping element connected across said input terminals, a movable contactor, means for mounting said contactor for movement parallel to and at a predetermined distance from said potential-dropping element, two output terminals, one of which is connected to said contactor and the other of which is connected to one end of said potential-dropping element, and a small resistance connected between said output terminals.

References Cited in the file of this patent

UNITED STATES PATENTS

1,838,987	Cooper	Dec. 29, 1931
2,241,534	Blumlein et al.	May 13, 1941
2,265,291	Knick	Dec. 9, 1941
2,625,633	Warsher	Jan. 13, 1953

OTHER REFERENCES

Electronic Engineering Principles, Ryder, J. D., 2nd ed., p 247, Prentice Hall, 1952.

Fundamentals of Radio, Terman, first edition, p. 96, Fig. 57a, McGraw-Hill, New York, 1938.

Radio Engineers Handbook, Terman, first edition, pp. 204-207, McGraw-Hill, New York, 1943.