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2,393,748

TOTALIZER

Filed Jan. 25, 1943

2 Sheets-Sheet 1

FIG. 1.

FIG. 2.

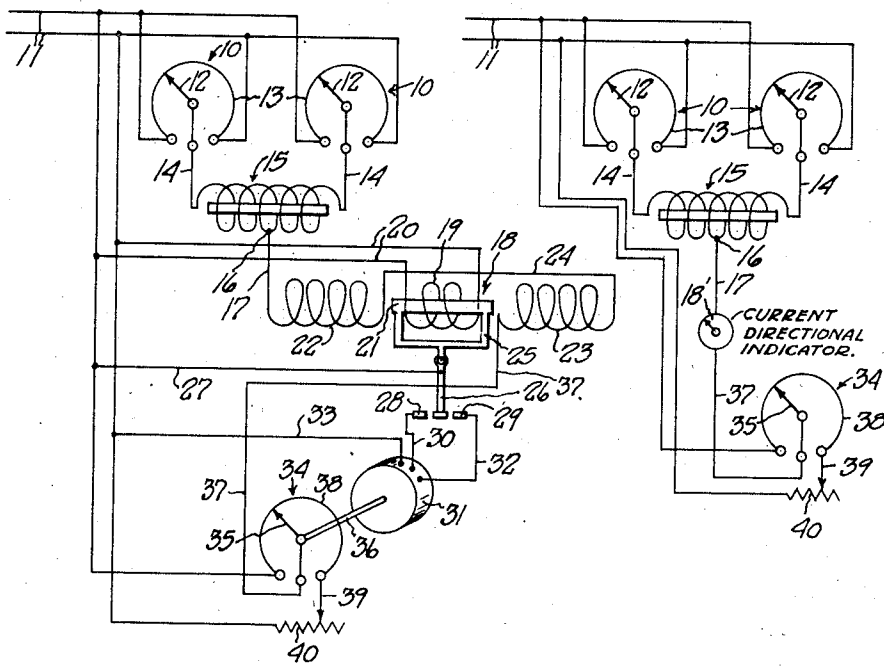
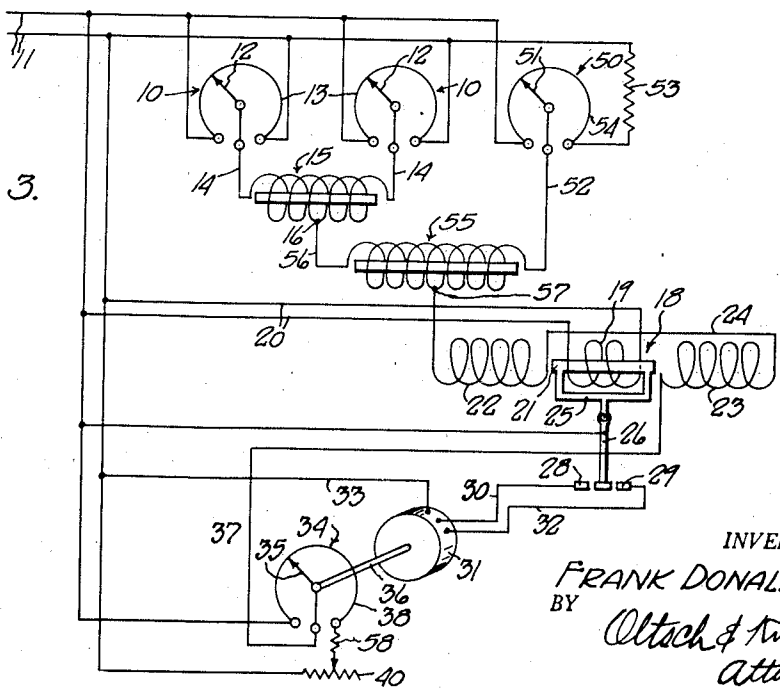


FIG. 3.



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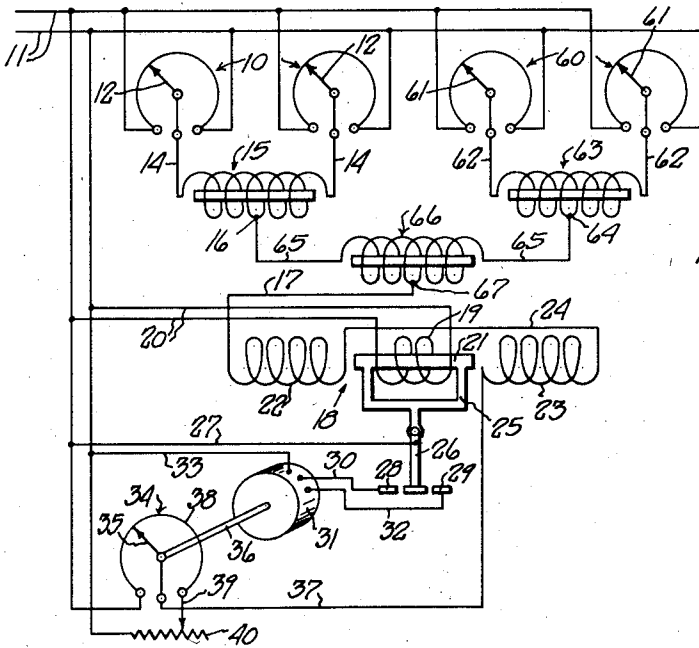
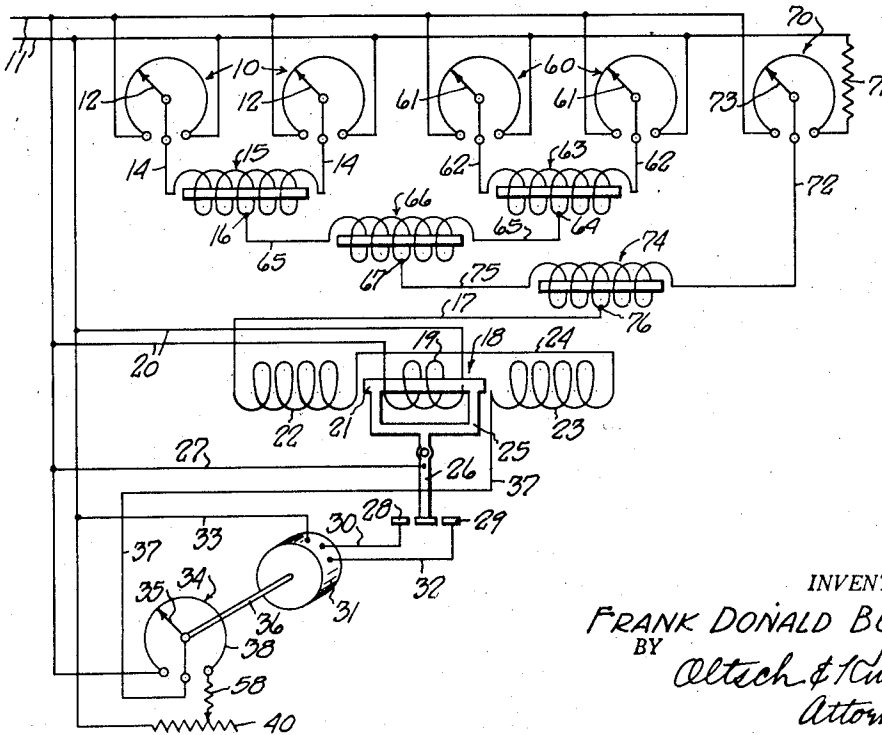


FIG. 4.

FIG. 5.



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UNITED STATES PATENT OFFICE

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TOTALIZER

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11 Claims. (Cl. 172-239)

This invention relates to a totalizer. More particularly, the invention relates to a device by means of which two or more positions or conditions may be totalized or averaged.

The primary object of the invention is to provide a quickly responsive electrically operated device of this character.

A further object is to provide a device for totalizing or averaging a plurality of conditions or positions which are remote from each other.

A further object is to provide a device of this character by means of which any number of positions or conditions may be totalized or averaged.

A further object is to provide a device of this character having a modified Wheatstone bridge circuit including a tapped preventive autotransformer for totalizing or averaging service, said transformer presenting a very high impedance between its terminals and very low impedance between either of said terminals and said tap.

A further object is to provide a device of this character adapted to totalize or average two or more dissimilar conditions by the use, in a modified Wheatstone bridge circuit, of a preventive autotransformer connected with and interposed between said conditions and tapped along its winding at a point proportional to the ratio existing between said dissimilar conditions.

A further object is to provide a device of this character comprising a plurality of sending potentiometers connected with proportionally tapped preventive autotransformer means actuating a differential relay for controlling a reversible motor associated with a receiving potentiometer.

A further object is to provide a device of this character comprising a plurality of sending potentiometers arranged in pairs and each pair connected with a proportionally tapped preventive autotransformer.

A further object is to provide a device of this character comprising an odd number of sending potentiometers connected in pairs with tapped preventive autotransformers, wherein the odd potentiometer has associated therewith a resistance bearing a predetermined relation thereto and to the total number of potentiometers and connected to one terminal of a preventive autotransformer whose opposite terminal is connected with the tap of one of said first named transformers.

Other objects will be apparent from the description and appended claims.

In the drawings:

Fig. 1 is a diagrammatic view of the device arranged to automatically average two positions or conditions.

5 Fig. 2 is a diagrammatic view of the device arranged for manual operation to average two positions or conditions.

Fig. 3 is a diagrammatic view of the device arranged to automatically totalize three positions or conditions.

10 Fig. 4 is a diagrammatic view of the device arranged to automatically average four positions or conditions.

Fig. 5 is a diagrammatic view of the device arranged to automatically totalize five positions or conditions.

15 For purposes of illustration, the device has been illustrated and will be described with reference to its application for totalizing of several fuels to which air is to be proportioned. It will be understood that this use is illustrative only, and not limiting, since there are many other uses for which the device is adapted.

Referring particularly to Fig. 1, a pair of sending potentiometers 10 are connected in parallel with electric lead lines 11 connected to a source of alternating current. Each potentiometer is associated by suitable means (not shown) with a fuel supply in a manner to measure or meter 20 the amount of fuel, or the rate at which fuel is supplied. Thus, means may be provided for controlling the position of the contact 12 along the slide wire 13 proportionally to the fuel level in one source or to the rate of fuel supply from one source.

35 Conductors 14 connect the contacts 12 with opposite terminals of a preventive autotransformer 15. The winding of transformer 15 is tapped at 16 proportionately to the relation existing between the two fuel sources with which the potentiometers 10 are associated. Thus, if these sources are similar, the transformer winding will be tapped at its center, and the voltage at tap 16 will be one-half of the difference in 40 the voltages at contacts 12. Or, assuming it is desired to average or totalize two values differing at their maximum and which are associated with reservoirs having equal rise between high and low levels and associated with the respective potentiometers by the same gearing, but one of 50 which reservoirs has half the surface area of the other, the transformer would then be tapped at the one-third point of its winding. Hence the voltage at tap 16 will be proportional to the 55 total contents of the two reservoirs.

The preventive autotransformer 15 is of the type presenting a very high impedance between its opposite terminals, and a very low impedance between either of its terminals and tap 16. One transformer found to be well suited for this purpose has an impedance of 30,000 ohms between its terminals and an impedance of only 120 ohms between either terminal and the center tap.

Conductor 17 preferably extends from transformer tap 16 to a dynamometer or differential relay 18 of the type illustrated in the MacGeorge Patent No. 2,108,775, February 15, 1938. Relay 18 comprises a centering or polarizing coil 19 connected by conductors 20 to lead lines 11. An armature or solenoid core or bar 21 is disposed within coil 19 and normally held in centered relation in said coil by the alternating current magnetic flux generated in said coil. A deviating or energizing coil 22 is arranged in axial alignment with coil 19 at one end thereof. Coil 22 is connected at one end with conductor 17. A second deviating or energizing coil 23, wound oppositely from coil 22 and connected therewith by conductor 24, is arranged in axial alignment with coil 19 at the opposite end thereof. The deviating coils 22 and 23 produce a push-pull effect upon the armature or core 21, i. e., the reversed windings thereof produce magnetic attraction at one end of the core 21 and a repulsion at the opposite end of the core. A bracket 25 mounts armature or core 21 and is supported on a pivoted lever or contact arm 26.

Contact arm 26 is connected to one of the lines 11 by a conductor 27. A pair of spaced contacts 28 and 29 are positioned in equi-spaced relation to the normal or centered position of the free end of contact arm 25. Contact 28 is connected by conductor 30 with a reversible electric motor 31, and contact 29 is connected with said motor by conductor 32. Motor 31 has a third lead connected by conductor 33 with one of lines 11 to complete the motor circuit, i. e., from line through conductor 27, arm 26, conductor 30 or 32, motor 31, conductor 33 to line. Motor 31 may be connected with a suitable process element, such as an air flow controller (not shown).

A receiving potentiometer 34 has its contact 35 mounted upon shaft 36 of motor 31. Contact 35 is connected by conductor 37 with deviating coil 23 of the differential relay. One end of slide wire 38 is connected with one of the lines 11. The other end of slide wire 38 may be connected with the opposite line 11 by the adjustable contact 39 of a rheostat 40, which may constitute a fuel-air ratio adjustment. Any suitable indicating or recording means may be associated with the receiving potentiometer 34. Thus a pointer (not shown) may be mounted on the pivot arbor of the contact 35 juxtaposed to a suitable calibrated face plate or dial.

Assuming that the positions or conditions being measured by the metering potentiometers 10 are of equal or similar range, capacity, etc., for example, the liquid levels in identical fuel tanks, and that the preventive auto transformer 15 is tapped at its center; then the voltage at the transformer tap 16 will be one-half of the difference between the voltages in conductors 14. A flow of current in the deviating coils 22 and 23 of differential relay 18 will shift the armature or core 21 of said relay away from its normally centered position. This movement of core 21 will pivot switch lever 26 to effect engagement thereof with one of the contacts 28 and 29, thus closing a circuit for operation of motor 31 in the direction selected by

the contact which was engaged. Motor shaft 36 shifts the contact 35 of the receiving potentiometer, operates the air flow controller or other device associated with the controlled system, and also actuates the indicator or recorder until the voltage at the contact 35 of the receiving potentiometer balances the voltage at the transformer tap 16 with which it is connected. Thus the device constitutes a modified Wheatstone bridge circuit, wherein the difference in current flow, obtained by the proportional tapping of the preventive autotransformer, is utilized to automatically average the primary or metered conditions or positions, by means of the controlling differential relay, the controlled motor and the receiving potentiometer. The direction of rotation of motor 31 changes as the voltages in conductors 14 reverse predominance, i. e., predominance in voltage at the contact of one sending potentiometer causes motor operation in one direction, and predominance in voltage at the contact of the other potentiometer causes motor operation in the other direction. This automatically determined average can be used for indicating or recording purposes, or for process control purposes.

In Fig. 2 has been illustrated a modified embodiment of the invention wherein the automatic operation of the device is dispensed with. Thus conductor 17 from autotransformer tap 16 leads to a current directional indicator 18', and conductor 37 connects said indicator 18' with the contact 35 of receiving potentiometer 34. Potentiometer 34 is provided with suitable operating means (not shown) by means of which the contact 35 may be manually adjusted along slide wire 38 in the direction indicated by indicator 18' until the circuit is balanced.

When three sending potentiometers are to be connected, a circuit as illustrated in Fig. 3 is employed. Two of the potentiometers 10 have their contacts 12 connected by conductors 14 with the terminals of preventive autotransformer 15 in the same manner described above. The third potentiometer 50 has its contact 51 connected with a conductor 52. A resistance 53 is interposed in the circuit to potentiometer 50. This resistance will have the following value

$$R = \frac{N-1}{N} x R_1$$

where N is the number of sending potentiometers, and R_1 is the value of the resistance of slide wire 54 of potentiometer 50. Conductor 52 is connected with one terminal of a second autotransformer 55. The other terminal of transformer 55 is connected by conductor 56 with the tap 16 of transformer 15. Assuming equal range or capacity, etc., of the three positions or conditions being measured, transformer 55 will be tapped at its center at 57. Conductor 17 will connect transformer tap 57 with the differential relay 18. The operation of this device will be the same as described above. It will be noted, however, that the use of resistance 53 is not essential, and may be avoided by tapping the transformer 55 proportionally. For example, assuming equal range or capacity, etc., of the three positions or conditions being measured, transformer 55 could be tapped at a point $\frac{1}{3}$ of its length from the terminal connected with conductor 52.

Fig. 3 also illustrates the arrangement required to condition the device for service as a totalizer. A bias resistor 58 is interposed in the circuit of

the receiving potentiometer 34. This resistance will have the following value

$$R = \frac{1}{N} R_2$$

where N is the number of sending potentiometers, and R_2 is the value of the resistance of slide wire 38 of potentiometer 34.

Fig. 4 illustrates the arrangement of the device to obtain the average of four conditions or positions. The sending potentiometers 10 and 60 are arranged in pairs with the contacts 12 and 61 thereof connected by conductors 14 and 62 with preventive autotransformers 15 and 63. The transformers are tapped at 16 and 64, as at their center points. Conductors 65 connect said taps 16 and 64 with the opposite terminals of preventive autotransformer 66. Transformer 66 is tapped at 67, as at its center point, and conductor 17 is connected at this tap and leads to the deviating coils of differential relay 18.

The use of the device with five potentiometers is illustrated in Fig. 5. Here the connection of two pairs 10 and 60 of the sending potentiometers with preventive autotransformers 15 and 63, and the connection of the latter with preventive autotransformer 66, tapped at 67, is the same as in the Fig. 4 arrangement. The odd sending potentiometer 70 has resistance 71 interposed in its circuit. Conductor 72 connects contact 73 of potentiometer 70 with one terminal of preventive autotransformer 74. A conductor 75 connects tap 67 of transformer 66 with the other terminal of transformer 74. Transformer 74 is tapped at 76, as at its center point, and conductor 17 is connected at said tap and leads to the deviating coils of differential relay 18.

The low impedance between either terminal and the proportional tap of the preventive autotransformer is of particular value and importance in this device because it avoids a substantial reduction of power input to the differential relay 18 or to the current directional indicator 18', as compared to a tapped resistor which would necessarily be of a relatively high value compared to the transmitting potentiometers. Other advantages of the device are that it permits totalizing or averaging of conditions which are remotely located, and that its response is very quick and accurate.

I claim:

1. In combination, a pair of sending potentiometers having slide contacts each connected for response to variations of a condition, means interconnecting the contacts of said potentiometers and including a preventive autotransformer, a receiving potentiometer having a slide contact, means connecting the contact of said receiving potentiometer with an averaging tap of said transformer proportioned to the ratio between said conditions, and a current directional device interposed in said last named means.

2. In combination, an alternating current circuit a plurality of sending potentiometers each having a slide contact and responsive to a condition, a receiving potentiometer having a slide contact, said potentiometers being connected in parallel in said circuit at their terminals and averaging means connecting the slide contacts of said potentiometers including a preventive autotransformer connected with the contacts of said sending potentiometers and tapped intermediate its winding at a point proportional to the relative values of said conditions for connection with the contact of said receiving potentiometer.

3. In combination, an alternating current circuit, a pair of voltage transmitting devices connected in parallel in said circuit and each actuated in response to a variable condition, an adjustable potentiometer having a slide contact and connected in said circuit at its terminals, and averaging means connecting said transmitters and the contact of said potentiometer and including a preventive auto transformer connected to said transmitters and tapped for connection with the contact of said potentiometer at a point proportioned to the normal relation between said transmitters.

4. In combination, a pair of transmitting potentiometers each having a contact actuated in response to a condition, a preventive autotransformer connected to said contacts and having a voltage-averaging tap at a point proportioned to the ratio between said conditions, a current directional relay connected with said transformer tap, a receiving potentiometer having a contact connected with said relay, and means controlled by said relay for adjusting the contact of said receiving potentiometer, said potentiometers being connected at their terminals in parallel in an operating circuit.

5. In combination, a pair of transmitting potentiometers each having a contact actuated in response to a condition, a preventive autotransformer connected to said contacts and having a voltage averaging tap at a point proportioned to the ratio between said conditions to regulate the output voltage at said tap in proportion to the difference between the voltages applied thereto, a current directional relay connected with said transformer tap, a receiving potentiometer having a contact connected with said relay, a reversible power member for adjusting the contact of said receiving potentiometer, and a reversing switch controlled by said relay and controlling said power member, said potentiometers being connected in parallel in an operating circuit.

6. In combination, a pair of transmitting potentiometers each having a contact actuated in response to a condition, a preventive autotransformer connected to said contacts and having a voltage averaging tap at a point proportioned to the ratio between said conditions, a receiving potentiometer having a contact connected with said transformer tap, a normally balanced differential relay interposed between the contact of said receiving potentiometer and said transformer tap and including a reversing switch and a reversing power member controlled by said switch for adjusting the contact of said receiving potentiometer, said potentiometers being connected at opposite terminals thereof in parallel in an operating circuit.

7. In combination, a pair of transmitting potentiometers each adapted to be actuated in response to a condition, a preventive autotransformer connected to said potentiometers and having an averaging tap at a point proportioned to the ratio between said conditions, a third transmitting potentiometer adapted to respond to a third condition, a second preventive autotransformer connected to said third potentiometer and to the tap of said first transformer, said second transformer having an averaging tap at a point proportioned to the ratio between said first named conditions and said last named condition, a receiving potentiometer connected with the tap of said second transformer, and a current directional device interposed between said last named tap and said receiving potentiometer.

8. In combination, a plurality of transmitting potentiometers each adapted to be adjusted responsive to variations of a condition, means connecting said potentiometers in pairs including a preventive autotransformer having an averaging tap at a point proportioned to the ratio between the conditions to which the associated potentiometers respond, means connecting said transformer taps and including at least one preventive autotransformer having an averaging tap at a point proportioned to the ratio between the preceding groups of conditions, a receiving potentiometer, means connecting the tap of the last named transformer and said receiving potentiometer, and a current directional device in said last named connecting means.

9. In combination, a plurality of sending potentiometers of odd number, each adapted to respond to variations of a condition, means connecting said potentiometers in pairs including a preventive autotransformer having an averaging tap at a point proportioned to the ratio of the conditions to which the potentiometers associated therewith respond, a resistance associated with the odd potentiometer and proportioned to the slide wire resistance of said odd potentiometer and to the total number of potentiometers, means connecting said odd potentiometer with a transformer tap of the first connecting means including a proportionally tapped preventive autotransformer having an averaging tap, a receiving po-

tentiometer, means connecting said receiving potentiometer with the tap of the last named transformer, and a current directional device interposed in said last named connecting means.

10. A totalizer comprising an alternating current circuit, a pair of voltage transmitting devices connected in said circuit in parallel and having an adjustable element responsive to similar conditions, a center tapped preventive autotransformer connecting the adjustable elements of said transmitters to average the voltage thereof, and a receiving potentiometer having a contact connected to the tap of said transformer and terminals connected in parallel to said transmitters.

11. A totalizer comprising a plurality of voltage transmitting devices connected in parallel in an operating circuit and each having an adjustable element responsive to a condition, a preventive autotransformer connecting said adjustable elements and having an averaging tap at a point proportioned to the ratio between said conditions, and a receiving potentiometer connected in said circuit in parallel at its terminals and having a contact connected with said transformer tap, and a totalizing bias resistor in series with said receiving potentiometer and proportioned to the total number of transmitting devices and to the slide wire resistance of said potentiometer.

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