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VOLTAGE REGULATING MEANS

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*Fig. 1*

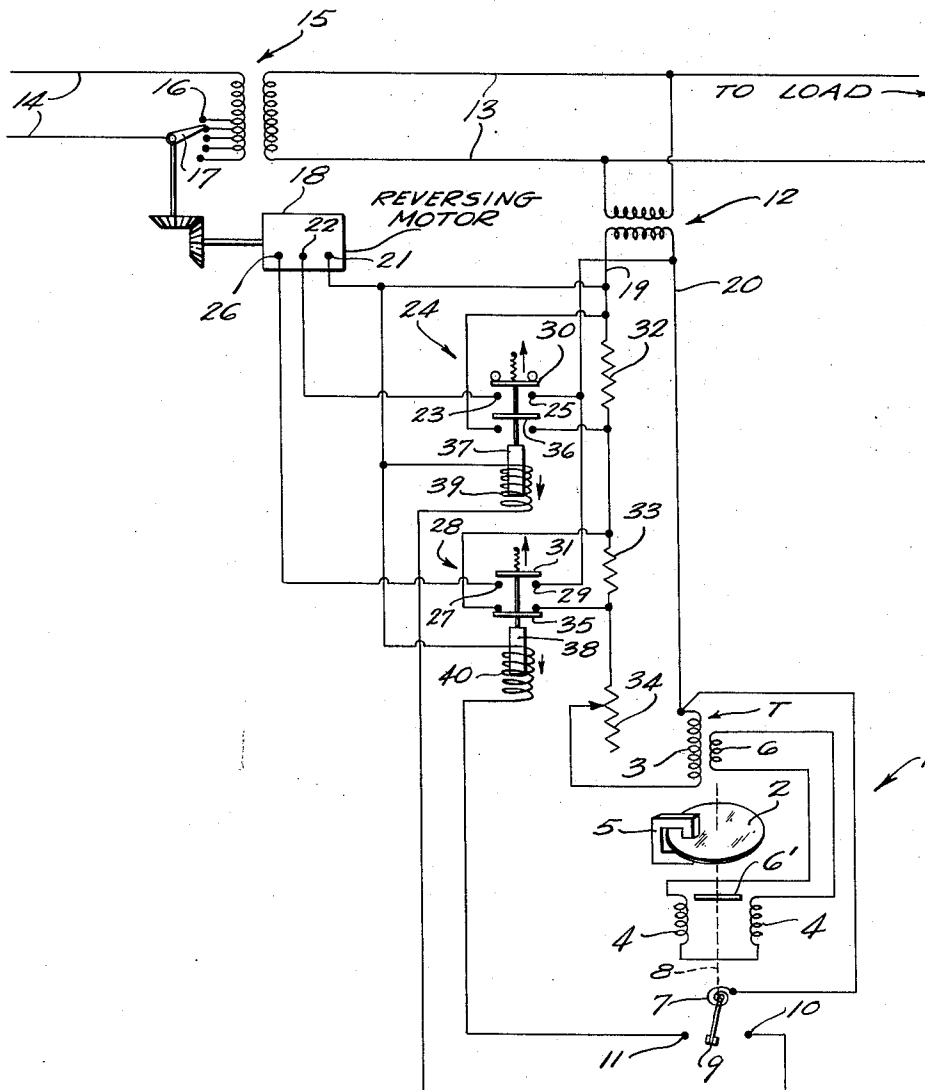
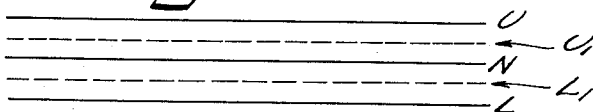


*Fig. 2*



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## VOLTAGE REGULATING MEANS

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1

This invention relates to an automatic regulator control means and is particularly directed to a means for controlling the voltage of a power line.

In voltage regulating systems, it is the practice to use a contact making voltmeter to control a regulating means such as a tap changing regulator or other device to thereby control the voltage. The voltage responsive means, namely the contact making voltmeter, frequently gives trouble due to chattering and burning of the contacts and also due to chattering and burning of the contacts of any contactor controlled from the voltmeter.

This invention is designed to overcome the above noted defects and objects of this invention are to provide an automatic regulator control means in which a contact making voltmeter is employed and so associated with other portions of the system and apparatus that a seal-in or holding effect is produced to prevent chattering of any of the contacts, either of the contact making voltmeter or of any apparatus controlled thereby, and to provide such a holding effect as hereinabove described by electrical means.

In greater detail, objects of this invention are to provide control means for an automatic regulator whose primary or initiating instrumentality is a contact making voltmeter which will close a first pair of contacts when the voltage to be regulated reaches a predetermined upper limit and which will close other contacts when the voltage to be regulated drops to a lower predetermined limit and to so arrange the apparatus that means are provided for immediately selectively shifting the upper or the lower limit as required so that a new upper limit or a new lower limit is instantly provided when the apparatus functions.

Further objects are to provide a novel form of contact making voltmeter in which the potential coil unit acts in the dual capacity of a transformer with primary and secondary windings furnishing current for current coils and in which the potential coil unit also acts as a potential coil, the flux from both the potential and current coils acting on an induction disk, and in which the current in the primary windings is mainly the magnetizing current and in which the current flowing in the secondary winding has only a small effect on the phase angle of the primary current with reference to the voltage impressed on the primary coil.

An embodiment of the invention is shown in the accompanying drawings, in which:

2

Figure 1 is a diagrammatic view showing the automatic regulator control means.

Figure 2 is a chart showing the relation between the normal voltage and the upper and lower limits and the new upper and lower limits which latter are established by the operation of the device.

Referring to Figure 1 it will be seen that the device has been shown as a control means for controlling a tap changing regulator, although it is to be understood that it could be used to control any other voltage regulating means. The contact making voltmeter is indicated generally by the reference character 1 and it will be seen that it consists of an induction disk 2, a voltage coil 3, and a pair of current coils 4. A damping magnet 5 is provided so as to furnish a time delay and prevent the immediate response of the apparatus to any brief fluctuation in voltage. It is also preferable to provide a magnetic shunt 6 between the poles of the current coil, the magnetic shunt being composed of a thermosensitive alloy, such as is commonly employed in watt-hour meters. A customary material is an alloy of nickel, copper and iron, although any suitable thermosensitive alloy could be employed. The operation of this magnetic bridge or shunt is to compensate for change in flux due to change in resistance of the coils as the temperature changes. Its mode of operation is identically the same as that in well known watt-hour meters.

It is to be noted that the voltage coil 3 has wound thereover a secondary 7 which furnishes current to the current coils 4. It will be seen that the flux from the voltage coil 3 and the current coils 4 have a different phase angle and consequently tend to rotate the disk 2. In the illustration chosen, the tendency of the disk is to rotate in a counterclockwise direction but this is resisted by means of a spring 8 which tends to rotate the disk in a clockwise direction. The spring is attached to the shaft 9 of the disk 2 which shaft carries the movable contact 9 which is adapted to selectively engage contact 10 which may be termed the upper voltage or upper limit contact, or a contact 11, which may be termed the lower voltage or lower limit contact.

A particularly important feature of the contact making voltmeter itself is that the current flowing in the secondary 7 has substantially no effect on the phase angle between the current and voltage of the primary 3. In other words, the primary and secondary currents in the windings 3 and 7 are not approximately 180° apart, but instead, the potential coil or primary 3 acts

mainly as an inductive load and the current in such coil is primarily the magnetizing current of the inductive load.

It will be seen that the primary and secondary windings 3 and 6 and their magnetic core, not shown, constitute a transformer, T, forming a unitary part of the contact making voltmeter and having a high value of primary leakage flux. This transformer T, therefore, performs a dual function and not only acts as a transformer having the characteristics enumerated, but also acts, in effect, as the potential coil unit of the contact making voltmeter.

The potential coil 3 is fed from the secondary of a potential transformer 12 which is connected across the line 13 whose voltage is to be regulated. The line 13 goes to the load and is supplied from the mains 14 through a tap changing regulator indicated generally at 15. The tap changing regulator is provided with a plurality of taps 16 on its primary side, any one of which may be engaged by the movable contact 17, such latter contacts being driven from a reversing motor 18 in any suitable manner through reduction gears, not shown, if desired.

It is to be understood that the movable contact 17 is insulated from the driving mechanism and the movable contact 9 is insulated from the shaft 8.

It is to be noted that the secondary of the transformer 12 supplies the lines 19 and 20 and that the reversing motor has one terminal, for instance the terminal 21, permanently connected to the line 19. One of the other terminals 22 is connected to the contact 23 of a contactor indicated generally at 24 which may be called the upper voltage contactor. The corresponding contactor 25 of the contactor 24 is connected to the other line 20 supplied from the transformer 12. Normally this circuit is open and the motor is idle. Another terminal 26 of the reversing motor 18 is connected to a contact 27 of the contactor indicated generally at 28 which may be called the lower voltage contactor. The corresponding contact 29 is connected to the line 29 supplied from the transformer 12. The arrangement of the motor 18 is such that when the circuit is closed by the movable contact 30 of the upper voltage contactor 24, that the motor runs in such a direction to lower the output voltage from the tap changing regulator and when the circuit is closed by means of the movable contact 31 of the lower voltage contactor, the motor runs in such a direction as to raise the output voltage of the tap changing regulator 15.

It is to be noted from an examination of Figure 1, that three resistors 32, 33, and 34 are connected in series with the potential coil 3 of the contact making voltmeter 1. The resistor 34 is a potentiometer type resistor and may be adjusted so that the contact making voltmeter can regulate or control at different voltage levels. Obviously the resistors 32 and 33 may also be of the potentiometer type if so desired or they may be fixed resistors as shown. It will be seen, as the description proceeds, that the cutting out and cutting in of the resistors 32 and 33 produces a holding or lock-in effect and also determines a new upper and a new lower voltage limit.

It is to be noted that normally the resistor 33 is shorted out by means of the movable contact 35 of the lower voltage contactor 28 and that the resistor 32 is normally in series with the potential coil 3 of the contact making voltmeter and is shorted out only when the contactor 24 op-

erates. This shorting out of the resistor 32 is accomplished by means of the movable contact 35 of the upper voltage contactor 24.

It is to be noted that the contactors 24 and 28 are provided with magnetic plungers 37 and 38, respectively, which are adapted to be drawn downwardly, in the form illustrated, into their energizing coils 39 and 40 when the circuits of these coils are selectively closed by the contact making voltmeter. Each contactor is biased so as to remain normally in the position shown in Figure 1 and is moved from this position to its lowermost position when it is energized.

It is to be noted that the energization of the coil 39 of the upper voltage or upper limit contactor 24 occurs when the movable contact 9 of the contact making voltmeter 1 engages the stationary contact 10 and that energization of the coil 40 of the lower voltage or lower limit contactor 28 occurs when the movable contact 9 of the contact making voltmeter engages the stationary contact 11.

The operation of the apparatus is as follows:

Assume that normal voltage exists between the mains 13. This is represented in Figure 2 by means of the full line N. Under these conditions, the torque exerted on the induction disk 2 of the contact making voltmeter just balances the force of the spring 7 to hold the movable contact 9 in its neutral or approximately middle position. If it is assumed that there is a voltage rise, for example to the upper limit indicated in Figure 2 by the full line U, the contact making voltmeter operates to close its upper limit upper voltage contacts, that is to say to move the movable contact 9 into engagement with the stationary contact 10, the torque on the induction disk 2 overcoming the force of the spring 7. As soon as the contact 9 engages the contact 10, the upper limit contactor 24 shorts out the resistor 32, placing a higher voltage on the voltage coil 3 of the contact making voltmeter and materially increasing the torque exerted on the disk 2 and thereby sealing in or holding in the upper limit contacts of the contact making voltmeter or, in other words, holding the movable contact 9 more firmly against the stationary contact 10. This prevents any possible chattering and burning of either the contacts 9 and 10 of the contact making voltmeter and any chattering and burning of the contacts of the upper limit contactor 24. It will now be found that the device has established a new and lower upper limit or upper voltage level indicated in Figure 2 by the dotted line U<sub>1</sub>. The motor 18 operates to lower the voltage controlled by the tap changing regulator 15, but this voltage must now be lowered below the new upper limit U<sub>1</sub>, see Figure 2. When this occurs, the contact making voltmeter operates to open its upper limit contacts and immediately the upper limit contactor 24 opens and reinserts the resistor 32 in series with the potential coil 3 of the contact making voltmeter 1 and thus re-establishes the old or initial upper limit U, see Figure 2. It is apparent, therefore, that there can be no chattering and burning of the contacts of the contact making voltmeter and those of the upper limit contactor 24.

If the voltage drops to the lower limit indicated at L in Figure 2, the contact making voltmeter 1 operates to close its lower limit contacts or lower voltage contacts by causing the movable contact 9 to engage the stationary contact 11. The lower limit contactor 28 immediately oper-

5

ates and inserts the resistor 33 in series with the potential coil 3 of the contact making voltmeter and thus establishes a new and higher lower limit L<sub>1</sub>, see Figure 2. The motor 18 in this instance operates in such a direction as to raise the voltage impressed on the line 13. The insertion of the resistor 33 in series with the potential coil 3 of the contact making voltmeter 1 seals in or holds in the lower limit contacts of the contact making voltmeter and consequently prevents chattering and burning of these contacts and those of the lower limit contactor 28.

It will be seen that a novel form of automatic regulator control means has been provided in which there can be no chattering or burning of the contacts of either the contact making voltmeter or of the contactors controlled thereby. It is to be noted further that an automatic seal-in or holding effect is produced by electrical means by the insertion or removal of the resistors in series with the contact making voltmeter, thereby establishing a new upper or a new lower limit as required.

It will also be seen that a time delay effect is provided by the drag magnet of the contact making voltmeter and that the device will not respond to transient fluctuations but will respond to a change in voltage which persists a predetermined length of time.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

I claim:

1. Means for regulating the voltage of an electric line comprising adjustable voltage varying means for varying the voltage of said line, motor means for adjusting said voltage varying means, a contact making voltmeter having means including a coil supplied from said line and contact means having a first and a second position corresponding to an increase or decrease in line voltage, respectively, and arranged to connect said motor means with a source of power to thereby operate said voltage varying means to respectively lower or raise the voltage impressed on said line, and means controlled by said contact making voltmeter for respectively raising or lowering the voltage impressed on said coil when said contact making voltmeter occupies said first or said second position independently of the action of said voltage varying means and independently of said motor means.

6

2. Means for regulating the voltage of an electric line comprising adjustable voltage varying means for varying the voltage of said line, motor means for adjusting said voltage varying means, a contact making voltmeter having means including a coil supplied from said line and contact means having a first and a second position corresponding to an increase or decrease in line voltage, respectively, and arranged to connect said motor means with a source of power to thereby operate said voltage varying means to respectively lower or raise the voltage impressed on said line, a first resistor normally connected in series with said coil, a second normally ineffective resistor, and contactor means controlled by said contact making voltmeter for respectively shorting out said first resistor or placing said second resistor in series with said coil when said contact making voltmeter occupies said first or said second position.

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