

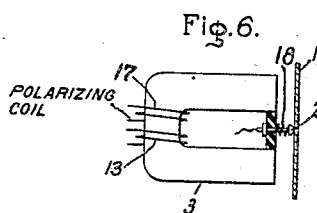
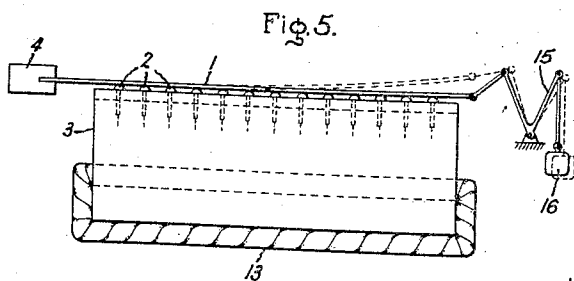
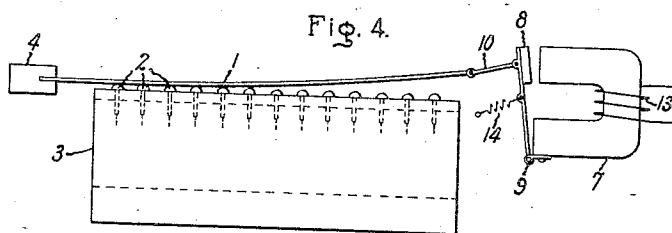
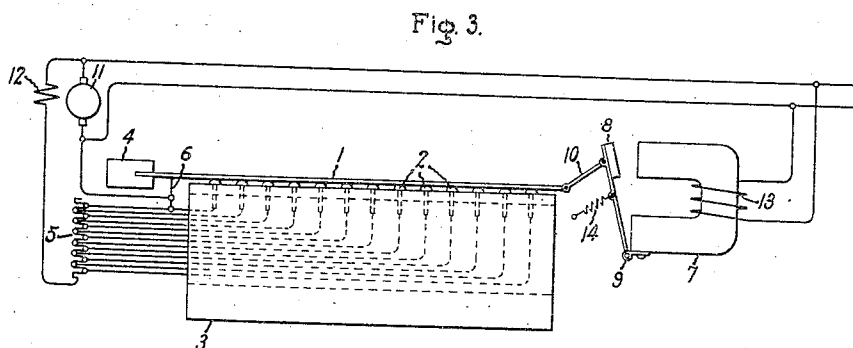
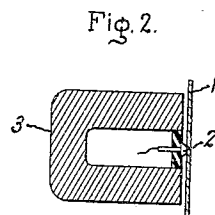
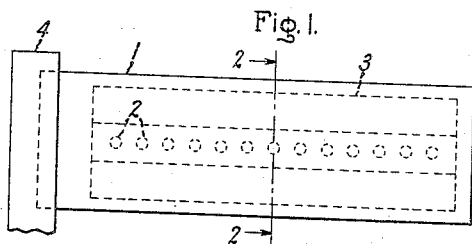
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ELECTRICAL DEVICE

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ELECTRICAL DEVICE

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5 Claims. (Cl. 201—55)

This invention relates to electrical devices and more particularly to improvements in direct-acting automatic electromagnetically operated regulators.

As the term is here used a regulator is an adjustable device whose variable electrical characteristic is used to control an operating condition or quantity of a machine, circuit or other device. A common way of operating such a regulator automatically is by direct mechanical connection to an electromagnet which is energized in proportion to the quantity to be regulated and whose electromagnetic pull is used to vary the electrical characteristic of the regulator.

In accordance with one aspect of this invention there is provided a new and improved regulator of this type in which the adjustable element has an operating force vs. resistance characteristic which substantially matches the pull vs. position characteristic of the controlling electromagnet.

An object of the invention is to provide an electromagnetically operated regulator in which the full regulating range is traversed with a very slight movement of the armature of the operating magnet.

A further object of the invention is to provide an improved tap changing contact making mechanism for changing the electrical characteristic of the regulator.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, in which like reference numerals designate the same parts throughout the several views, Fig. 1 shows a top view of the novel tap changing contact making mechanism of an embodiment of the invention, Fig. 2 is an end view taken along the line 2—2 of Fig. 1, Fig. 3 is a side view of an automatic resistance regulator embodying the construction of Figs. 1 and 2 and connected for automatically regulating the voltage of a dynamo-electric generator, Fig. 4 is a similar view of the regulator showing the parts in another position, and Figs. 5 and 6 are modifications.

Referring now to the drawing, the adjustable characteristic of the regulator is controlled by means of a flexible strip 1 of conducting material which makes electrical contact on its under side with a plurality of contacts 2 which are arranged in a row along the length of the strip. The strip 1 is preferably silvered on its under

side where it makes contact with the contacts 2 and it is made of steel or other magnetic material. In order to secure firm engagement between the strip 1 and the contacts 2 and for other purposes, as will be explained more clearly hereafter, a permanent magnet 3 having a horseshoe-shaped cross section, as shown in Fig. 2, is mounted on the under side of the strip with its opposite poles on opposite sides of the row of contacts 2. The magnetic attraction between the magnet 3 and the strip 1 holds the strip in firm engagement with the contacts. One end of the strip is permanently anchored to a fixed support 4 of any suitable type.

As shown more clearly in Fig. 3, the contacts 2 are connected to taps in a resistor 5 and the strip is permanently connected to one end of the resistor by a lead 6.

The effective resistance of the resistor 5 is controlled by means of an operating electromagnet 7 having a movable armature 8 pivotally mounted at 9 and connected by means of a pivoted or flexible link 10 to the free end of the strip 1. As will be seen from the drawing, the orientation of the parts is such that the horizontal pull or force between the electromagnet and its armature is converted by the link 10 into a pull on the free end of the strip 1 which has a vertically upward component.

The complete regulator shown in Fig. 3 is connected by way of example as an automatic voltage regulator for a dynamo-electric generator 11 having a self-excited field winding 12 in circuit with which is connected the resistor 5 and across the output circuit of which is connected an energizing winding 13 for the operating magnet 7.

The operation of the illustrated embodiment of the invention is as follows: The parts are shown in Fig. 3 in the positions they assume when the generator is at rest and is producing no output voltage. Assume now that the generator is brought up to speed by any suitable prime mover (not shown). As the strip 1 makes contact with all of the contacts 2 the resistor 5 is short circuited so that the voltage of the generator 11 tends to build up to its maximum value. However, as soon as it reaches a predetermined normal value the pull of the magnet 7 on the armature 8 reaches a value sufficiently high to overcome the pull of the permanent magnet 3 on the strip 1 so that the strip 1 is peeled away from the permanent magnet, this peeling action serving progressively to break the connection between the strip 1 and the contacts 2. This

inserts more and more of the resistor 5 in series with the field circuit 12, thus decreasing the excitation of the generator and eventually checking the rise in generator voltage so that its voltage will be automatically maintained at any desired value.

While the resistor 5 has been shown as provided with a plurality of taps terminating in contacts which are engaged by the strip 1, it will of course be obvious that the resistor itself could be mounted adjacent the strip 1 so as progressively to be short circuited by the strip 1. Furthermore, it is not essential to the invention that there be a limited number of resistor contacts with which the strip 1 makes contact so that, for example, the resistor might have a continuous surface or, in other words, an infinite number of infinitely small contact surfaces which are progressively engaged by the strip 1. Also, a resistor is not essential as the contacts 2 might be connected to taps in a reactor or transformer winding.

As can be seen more clearly from Fig. 4 in which the strip 1 has been peeled away from about half of the contacts 2, the progressive movement of the point of contact between the strip 1 and the row of contacts 2 toward the left progressively changes the angle between the vertically downward pull of the permanent magnet 3 on the strip 1 and the pull of the electromagnet which is transmitted to the strip 1 by the link 10. As the pull of the permanent magnet is constant, this change in angle requires a stronger and stronger force to be transmitted by the magnet 10 in order that the strip 1 be peeled away from each successive contact 2. However, as the peeling action is accompanied by a movement of the armature 8 toward the magnet 7 its air gap progressively decreases so that its magnetic pull for a given constant energization progressively increases. Thus, what may be called the restraining force on the magnet and the effect of the decrease in the length of the air gap substantially match each other so that for a given amount of current in the operating winding 13 the regulator is stable in any position.

While the magnet 3 has been shown and described as a permanent magnet, it will of course be obvious that it could be an electromagnet. However, for the sake of simplicity and reliability a permanent magnet is preferable.

The characteristic peeling action of the regulator permits it to go from a position in which all the contacts and all the resistances are short circuited to a position where the strip 1 is out of contact with all of the contacts 2 and therefore all of resistance 5 is in circuit with a very small accompanying movement of the armature 8. This is a desirable feature in that it minimizes the problem of designing the restraining spring member and the shape of the pole pieces of the magnet 7 so as to obtain suitable characteristics with movement. The restraining spring referred to is shown at 14.

In the modification shown in Fig. 5 the control winding 13 is mounted on the magnet 3 so that its mmf combines with that of the magnet 3 so as to cause a change in the resultant flux acting on the flexible strip 1. The control magnet 7 has been replaced by a mechanical linkage 15 which is acted upon by a weight 16. The force transmitted by the weight 16 to the linkage is such as to cause the strip 1 to be peeled away from the contacts 2 in the same manner as

in the previous figures. As this peeling action takes place the lever arm through which the weight 16 acts increases thereby to approximate the effect of the reducing air gap of the control magnet 7. It will, of course, be obvious that a spring could be substituted for the weight 16 if desired.

In Fig. 6 an electromagnet is substituted for the permanent magnet and the polarizing is produced by a polarizing coil 17 which in conjunction with the coil 13 controls the resultant flux produced by the magnet and acting on the flexible strip 1.

In order to compensate for wear of the fixed contacts, they are made adjustable in this figure by means of individual springs 18. Thus, the pull of the magnet 3 on the flexible strip 1 causes these springs 18 to be compressed so that there will always be firm engagement between the contacts 2 and the strip 1 even though the contact surfaces may wear down.

The contacts 2 need not all be mounted in a straight line and they may be staggered so as to provide adequate spacing between a large number of contacts in a short length of magnet 3, as viewed in Figs. 3, 4 and 5.

While there have been shown and described particular embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A regulator comprising, in combination, an electrical device having a plurality of contact surfaces, a flexible magnetic strip, a magnet arranged directly to clamp said strip into contact making engagement with all of said surfaces, and means attached to one end of said strip for peeling said strip away from said magnet whereby said strip progressively disengages said contact surfaces.

2. A regulator comprising, in combination, an electrical device having a plurality of contact surfaces, a flexible magnetic strip, a permanent magnet arranged directly to clamp said strip into contact making engagement with all of said surfaces, and an electromagnet having a movable member attached to one end of said strip for peeling said strip away from said magnet whereby said strip progressively disengages said contact surfaces.

3. A regulator comprising, in combination, an electrical device having a plurality of contact surfaces, a flexible magnetic strip, a permanent magnet arranged directly to clamp said strip into contact making engagement with all of said surfaces, and an electromagnet having a movable member attached to one end of said strip for peeling said strip away from said magnet whereby said strip disengages said contact surfaces, said peeling action causing such a progressive change in angle between the forces said magnets exert on said strip that the effects of accompanying changes in the air gap length in said electromagnet are substantially compensated for.

4. In combination, a plurality of serially-connected impedance elements, a plurality of contacts connected respectively to the terminals of said elements, a flexible conductor, magnetic

means for directly clamping said conductor against said contacts so as to short circuit said impedance elements, and controllable magnetic means for causing said flexible conductor progressively to disengage said contacts.

5. In combination, a resistor, means including a flexible magnetic strip for short circuiting said

resistor, means including a magnet for directly attracting said strip and holding it in short circuiting relation to said resistor, and means for progressively peeling said strip away from said magnet so as progressively to open the short circuit of said resistor.

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