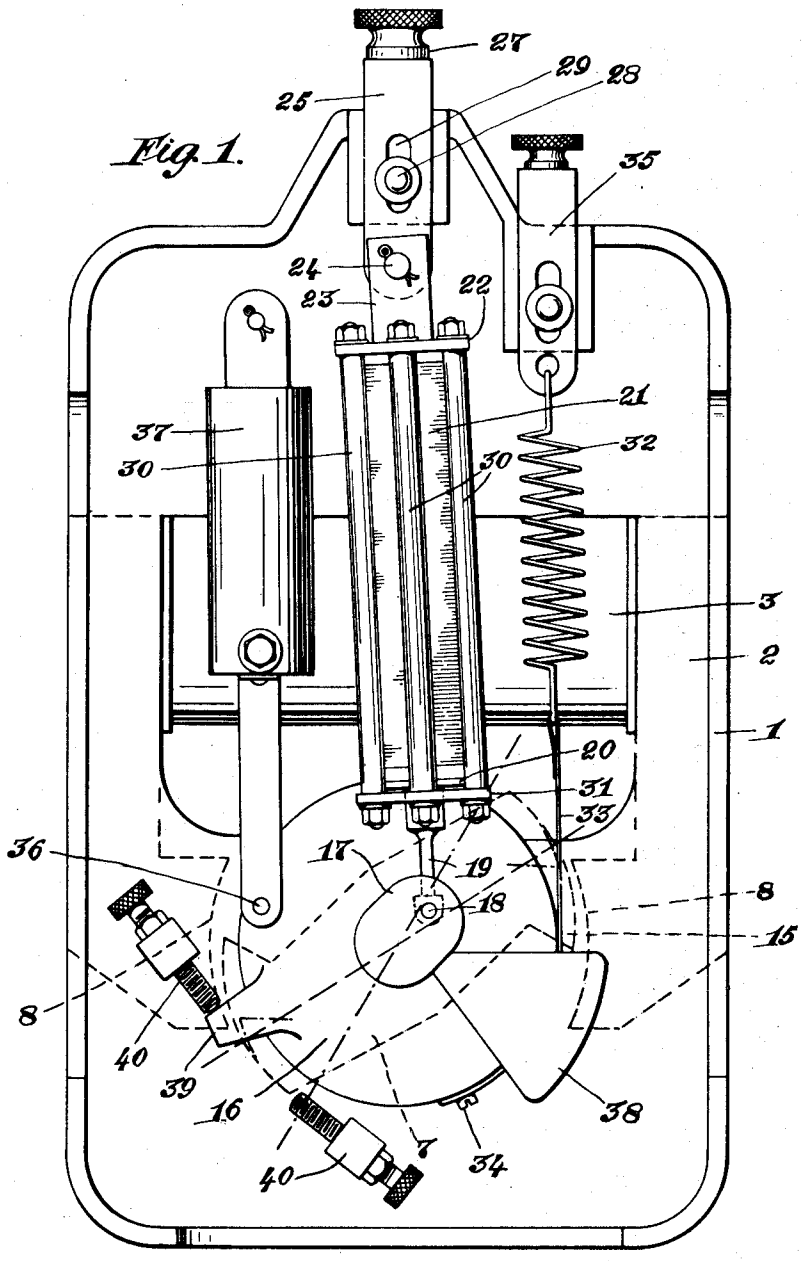
June 19, 1934. A. H. CHILTON 1,963,825

ELECTROMAGNETIC REGULATING APPARATUS

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Fig. 1.



Inventor
Alfred H. Chilton.
By Sommers & Young Attys.

June 19, 1934. A. H. CHILTON 1,963,825

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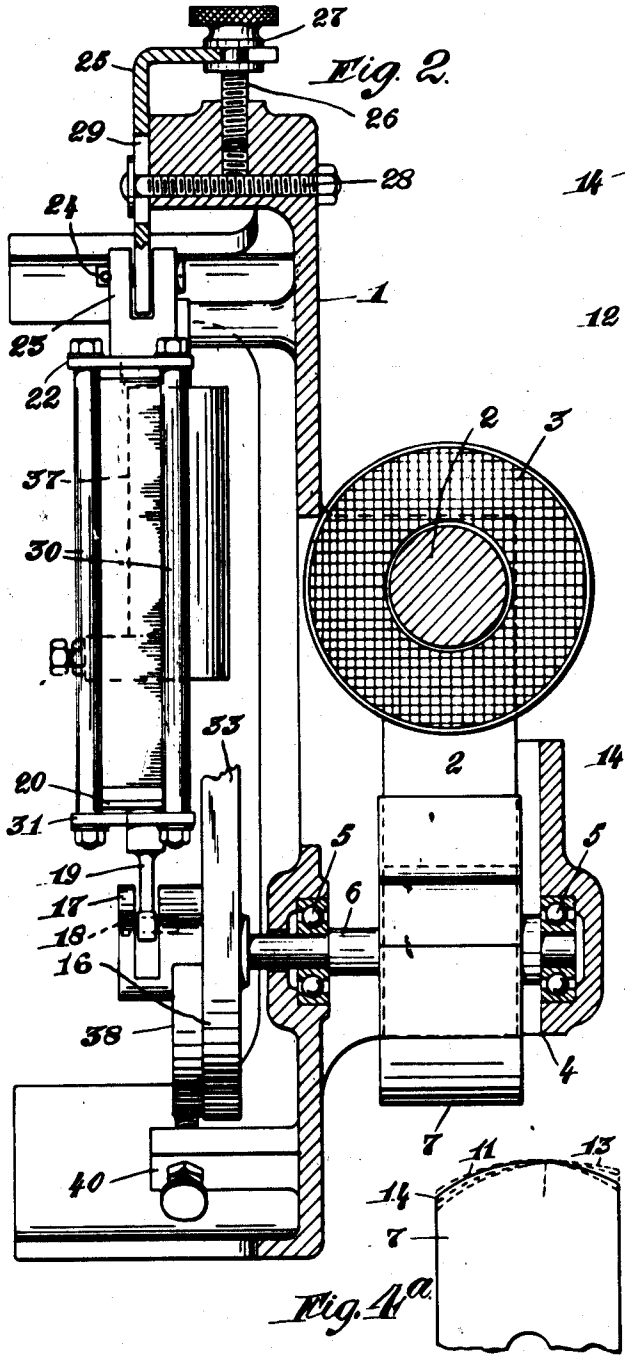


Fig. 2.

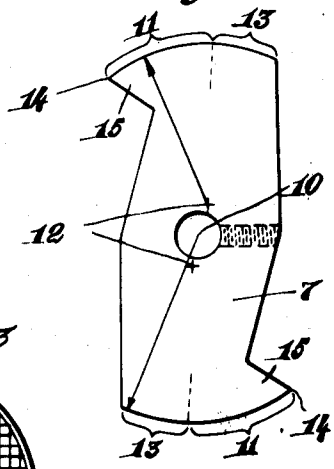


Fig. 3.

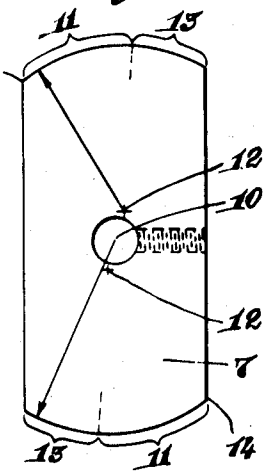


Fig. 4.

Fig. 4a.

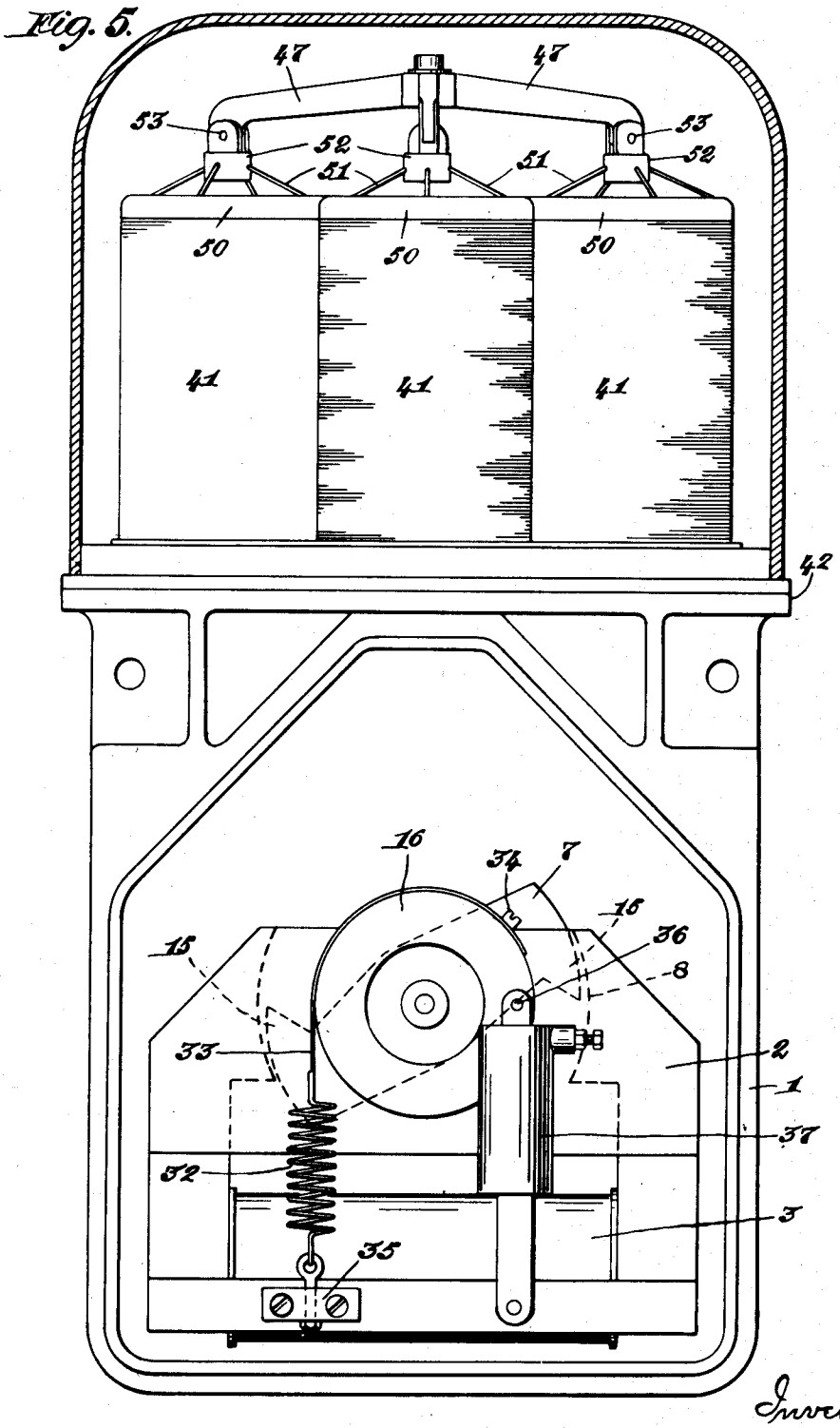
Inventor
Alfred H. Chilton
By Sommers & Young Attys.

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Fig. 5.



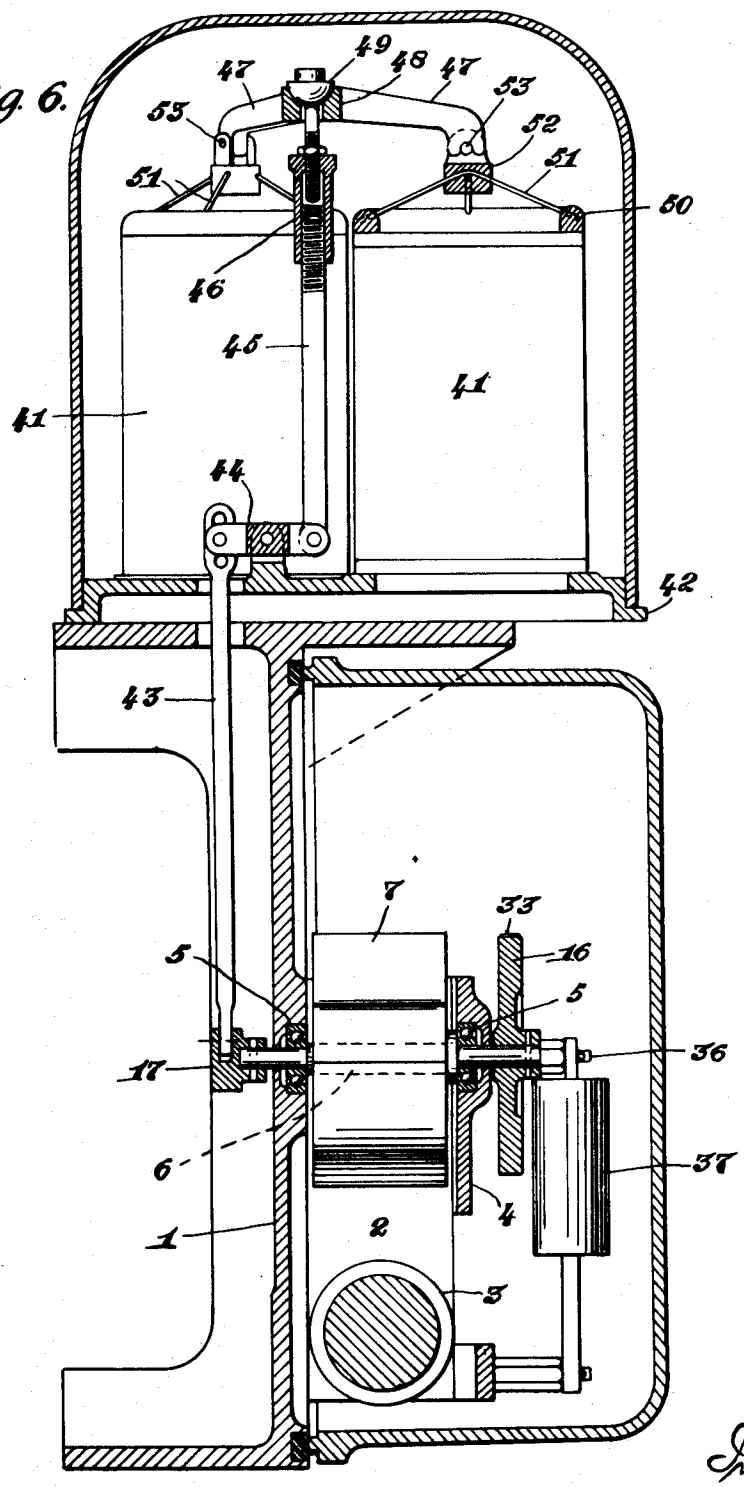
Inventor
Alfred H. Chilton.
By Sommers & Young Attys

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Fig. 6.



Inventor
Alfred H. Chilton.
By Sommers & Young Attys.

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UNITED STATES PATENT OFFICE

1,963,825

ELECTROMAGNETIC REGULATING APPARATUS

Alfred Henry Chilton, London, England, assignor to J. Stone & Company Limited, Deptford, England, a company of Great Britain

Application August 3, 1933, Serial No. 683,558
In Great Britain January 28, 1933

6 Claims. (Cl. 171—229)

This invention concerns improvements in or relating to electro-magnetic regulating apparatus and is more especially concerned with so-called carbon pile regulators such as are commonly employed, for example, in lighting installations on railway vehicles.

In a regulator of this kind, it is necessary that the electro-magnetic actuating force, the reaction of the carbon pile, and the force of the usual spring or equivalent loading means should be balanced over the range of operation of the regulator. As the reaction of the pile, which varies according to a given law, is in general a relatively small component, the required balance involves the matching of the torque/movement characteristic of the electro-magnetic actuating device against that of the spring or other loading means. Thus, if the characteristic of the electro-magnetic device is of a complex or curved nature, as has hitherto been the case, a relatively complicated spring compensation system is required to provide a characteristic that can be matched with it. The principal object of the present invention is to provide a magnet system matched over a wide range with a relatively simple spring system.

With this object in view according to the present invention, in electro-magnetic regulating apparatus, and particularly a carbon pile regulator, in which the pile compression is varied by a magnet rotor rocking between opposed magnet pole-faces and attracted by the latter against the effort of a spring with a straight line rising characteristic, the end-faces of the rotor are profiled so that the characteristic of the magnet device is matched as closely as possible with the characteristic of the spring over a wide range, such profiling extending over those portions of the faces which come within the polar embrace in the fully attracted position and also over those portions which remain outside the polar embrace. With such a magnet, the spring may act without even the necessity for a variable lever arm. In one appropriate arrangement, the rotor spindle carries a disc or drum to the rim of which is attached a flexible metal band. The said band, after passing over an arc of the disc or drum, is connected to a tension spring which is thus extended proportionately to the rotor movement, thereby giving the straight line rising characteristic.

Two embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a rear elevation of a carbon pile regulator intended more especially for dynamo regulation purposes in train lighting installations,

Figure 2 a vertical section thereof,

Figure 3 a front elevation of the rotor alone,

Figure 4 a similar view of an alternative form of rotor,

Figure 4a a similar view illustrating modified rotor profiling,

Figure 5 a front elevation of a carbon pile regulator intended more especially for lamp voltage regulation purposes in train lighting installations, and

Figure 6 a vertical section thereof.

Referring first of all to Figures 1–3, the various component parts of the regulator are mounted upon a frame 1. The iron magnet core 2, which is of approximately inverted U-shape and carries the exciting winding or windings 3 upon its yoke portion, is carried in a forward extension 4 of the frame 1. Supported in ball bearings 5 in the main frame 1 and forward extension 4 is a spindle 6 carrying an iron rotor 7 located between the opposed pole-faces 8 of the magnet core. These pole-faces are of a concave substantially cylindrical profile (Fig. 1) concentric with the axis 10 of rotation of the rotor. The convex end-faces of the rotor 7 (Figures 3 and 4) are profiled to give a predetermined rising torque/movement characteristic which is a substantially straight line. The larger leading parts 11 are profiled so as to give a tapered air gap when the rotor is in the attracted position (Fig. 1). The trailing parts 13 are differently profiled to give a predetermined leakage effect, the profiling of such trailing parts having been found to exert an important influence upon the resultant characteristic. In the particular case illustrated, the parts 11 are struck from centres 12 eccentric to the axis 10 of rotation and the parts 13 from said axis of rotation. Each centre 12 is located on that side of the axis 10 which is adjacent the face-part 11 struck from it and, as illustrated, somewhat to that side of the longitudinal axis of the rotor which is remote from said face-part. Consequently, when the rotor is in the attracted position, the air gaps between the pole-faces and the parts 11 of the end-faces of the rotor taper from the leading tips 14 of the rotor towards the trailing tips. With such profiling, the magnet possesses a substantially straight line rising characteristic. The straight line characteristic can be modified by varying the profil-

ing of the face-parts 11, 13. In Figure 4a a series of different profiles of the face-parts 11, 13 is indicated by dotted lines and it is possible by combinations of such profiles to obtain a variety of straight line characteristics. The shape of the body of the rotor may be modified to meet requirements. In Figures 1–3, the rotor, which is rectangular in cross section, is tapered somewhat from the middle towards the ends, and toe pieces 15 are formed thereon at the leading tips. In Figure 4, the rotor is of the shape of an elongated rectangular prism.

An overhanging extension of the spindle 6 on the rear side of the frame 1 carries a disc 16 and a crank 17. The latter is connected by a crank-pin 18 to a push rod 19 carrying a compression plate 20. The pile 21 of thin carbon discs is arranged between the plate 20 and a top plate 22 having an upward extension 23 which is connected by a pivot 24 to a bracket 25. This bracket is mounted upon the top of the frame 1 in a vertically adjustable manner by means of a screw 26 with a grooved head 27 engaged by the forked end of said bracket and is locked in position by means of a screw 28 passing through a slot 29 in said bracket. Insulated pins 30, dependent from the plate 22 and carrying a plate 31 through a hole in which the rod 19 freely passes, constitute a cage in which the pile is guided with a slight degree of freedom. A vertically disposed helical tension spring 32 is connected between a metal tape 33, which after passing around a part of the periphery of the disc 16 is anchored thereto at 34, and an adjustable attachment means 35 which is substantially identical with that 25—27 for the pile. The disc 16 also carries a crank-pin 36, which is connected with a dash-pot 37, a counter-weight 38 and a stop 39 whose movement is limited by two adjustable screw abutments 40.

Since the spring 32 will be extended proportionately to the rotor movement, the simple spring system shown will have a substantially straight line rising torque characteristic which matches that of the magnet over the wide range of movement permitted by the stop-abutments 40. The adjustable attachment means 26—29 and 35 permit of adjustment of the initial compression and tension respectively in the carbon pile and spring. The manner of operation of such a regulator is well known and need be only briefly referred to: With increasing excitation of the magnet winding or windings 3, connected for example, across the dynamo to be regulated, the rotor 7 tends to be attracted from its initial position (see the position of the leading tips as indicated by a chain line in Figure 1) towards the final position illustrated in Figure 1, this movement being resisted by the spring 32. The said rotor movement, translated through the crank 19 and plate 20 results in the decompression of the carbon pile 21. The resultant increase of the resistance is utilized for regulation purposes by, for instance, disposing the carbon pile in series with the field windings of the dynamo to be regulated. The dash-pot 37 counter-acts any tendency towards jerking or hunting action of the regulator.

As regards the magnet and spring systems, the lamp voltage regulator illustrated in Figures 5 and 6 is essentially similar to that previously described. The disposition of the carbon piles and the means for their control are, however, different. In the present example, the carbon piles 41, of which two, three or more are provided to carry the lamp current, are mounted above the magnet system upon a separate platform 42 secured to the frame 1. In place of the push rod 19 of Figures 1 and 2, use is made of a push rod 43 connected by a see-saw lever 44 to a pull-rod 45 around which the piles 41 are grouped. This pull-rod 45 incorporates a length-adjustment device which takes the form of a turnbuckle 46 but is designed to give a finer adjustment than an ordinary turnbuckle. The turnbuckle 46 has at the two ends threads of the same sense but of somewhat different pitch. Such a device provides a very fine adjustment as the effect of the two threads is differential, i. e. for one turn of the device, the length adjustment is equivalent only to the difference between the pitches of the two threads. The pull rod 45 acts upon the carbon piles 41 through an equalizing spider 47 (a beam if two piles are used) having a part spherical socket 48 engaged by a part-spherical head 49 on the rod 45.

The carbon piles 41, when in use, experience a considerable rise of temperature with attendant expansion which, unless compensated for, may seriously derange the precision of the regulator. According to a further feature of the invention, a compensating device for this purpose comprises a ring 50 of a material which expands with rise of temperature, a number of spokes 51 of a material with a relatively low or negligible thermal expansion, such as mild steel or nickel-steel alloy and a hub 52, the spokes being arranged at an angle of inclination to the plane of the ring. This device is shown interposed between each carbon pile and the equalizing spider 47. The ring 50 which is of a material, for example aluminium, of good conductivity and not too large heat capacity so as to respond readily to temperature changes in the pile, is mounted upon the pile with the interposition of the usual metal contact piece and an insulating disc or washer. The hub 52 is connected pivotally with the spider 47, said hub being extended upwardly and the extension divided by a diametrical slot, whilst holes for a pivot pin 53 are drilled at right angles to the slot. The effect of this compensating device is as follows: The ring 50 will follow the temperature rise of the carbon pile 41 and will expand in diameter. The spokes 51 on the other hand, will expand little or not at all so that their inclination will decrease, causing a decrease in the depth of the device between the hub 52 and ring 50. The size of the ring and initial inclination of the spokes is designed so that the decrease in depth of the compensating device substantially counterbalances the increase in length of the carbon pile itself over a sufficient range of temperature variation. In order to permit of the variation of the inclination of the spokes 51, these may be made of relatively flexible wire, a sufficient number of spokes being provided to take the maximum pressure exerted on the pile.

The manner of operation of such a lamp voltage regulator is well known and requires no detailed description here. The most usual arrangement is that the magnet winding 3 is subject to the lamp voltage whilst the carbon piles 41 constitute a resistance in series with the lamp load. The separate piles are connected in parallel with each other. Upon the lamp voltage tending to rise, the regulator acts to relieve the pressure upon the piles and thus to increase their resistance and so maintain the voltage upon the lamps themselves constant. The initial setting of the

regulator is effected by the adjustment means 35 and 46.

I claim:—

1. Electro-magnetic regulating apparatus, particularly a carbon pile regulator for use in train lighting installations, comprising a controlled element, a spring acting upon said controlled element and having a rising straight-line characteristic, and a magnet system consisting of a magnet with opposed pole-faces and a rotor mounted to rock between said pole-faces and acting, under the attraction thereof, upon said controlled element in opposition to said spring, the end-faces of said rotor being profiled so that the characteristic of the magnet system is matched as closely as possible with the characteristic of the spring over a wide range, such profiling extending over those portions of the faces which come within the polar embrace in the fully attracted position and also over those portions which remain outside the polar embrace.

2. Carbon pile regulator, comprising a carbon pile, a magnet system consisting of a magnet with opposed pole-faces and a rotor mounted to rock between said pole-faces and operative when attracted thereby for varying the compression of said carbon pile, and a spring system operative upon said rotor with a constant leverage in opposition to the magnet attraction, said spring system having a rising straight-line characteristic and the end-faces of said rotor being so profiled that the characteristic of the magnet system is matched as closely as possible with the characteristic of the spring system over a wide range, such profiling extending over those portions of the faces which come within the polar embrace in the fully attracted position and also over those portions which remain outside the polar embrace.

3. Carbon pile regulator, comprising a carbon pile, a magnet system consisting of a magnet with opposed pole-faces and a rotor of rectangular cross-section mounted to rock between said pole-faces and operative when attracted thereby for varying the compression of said carbon pile, and a spring system operative upon said rotor with a constant leverage in opposition to the magnet attraction, said spring system having a rising straight-line characteristic and the end-faces of said rotor being so profiled that the characteristic of the magnet system is matched as closely as possible with the characteristic of the spring system over a wide range, such profiling extending over those portions of the faces which come within the polar embrace in the fully attracted position and also over those portions which remain outside the polar embrace.

4. Carbon pile regulator, comprising a carbon pile, a magnet system consisting of a magnet with opposed pole-faces and a rotor mounted to rock between said pole-faces and operative when attracted thereby for varying the compression of said carbon pile, and a spring system opposing the magnet attraction and consisting of a rotatable arcuate part concentric with its axis of rotation and connected to said rotor, a spring whose force is substantially proportional to its elongation, a flexible member which is connected at one end to said spring and at the other end is wrapped over and anchored to said arcuate part, the end-faces of the rotor being so profiled that the magnet system has a rising straight-line torque-characteristic which can be readily matched with the characteristic of the spring system over a wide range, such profiling extending over those portions of the faces which come within the polar embrace in the fully attracted position and also over those portions which remain outside the polar embrace.

5. Electro-magnetic regulating apparatus, comprising a magnet system with a rotor rockable between opposed pole-faces and having its end-faces profiled so that the magnet system has a rising straight-line torque-characteristic, a carbon pile, a link constituting an operative connection between said rotor and carbon pile, and a fine length adjustment device for said link in the form of a differential turnbuckle.

6. Electro-magnetic carbon pile regulator consisting of a carbon pile and a magnet system comprising a magnet and a rotor operatively connected with the carbon pile and mounted to rock between the opposed pole-faces of the magnet, the said rotor having its end-faces profiled in such manner as to obtain a rising straight-line torque-characteristic for said magnet system, the leading parts of said end-faces, which come within the pole-faces in the attracted position of the rotor, being eccentrically profiled so that the air gaps taper from the leading tips of the rotor, and the trailing parts of said end-faces, which remain outside the pole-faces, being substantially concentrically profiled for the purpose set forth.

ALFRED HENRY CHILTON.