Feb. 12, 1946. W. A. CROTCH 2,394,753

ELECTRIC REGULATOR

Filed Dec. 13, 1943 3 Sheets-Sheet 1

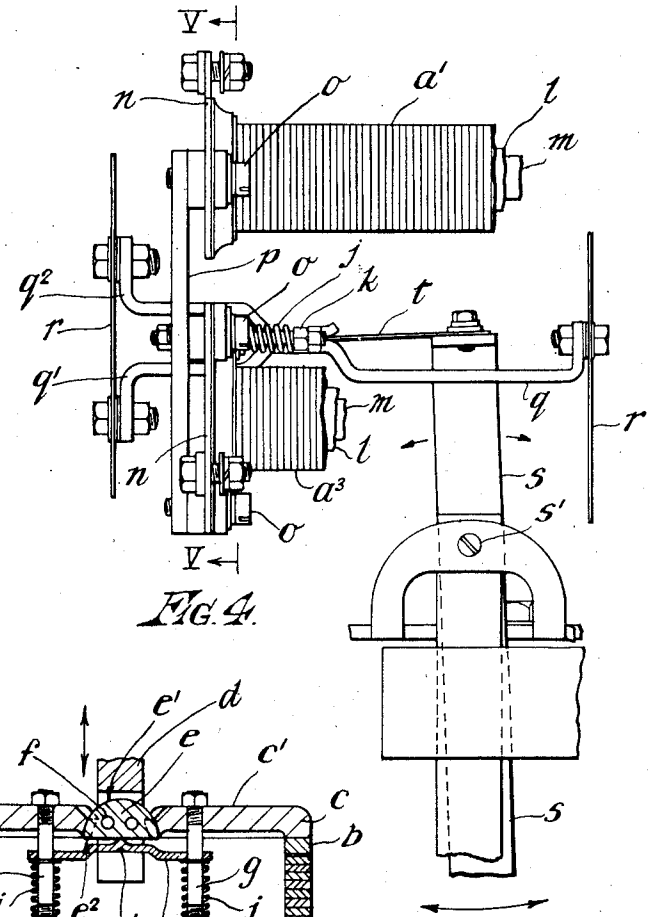


FIG. 4.

FIG. 1.

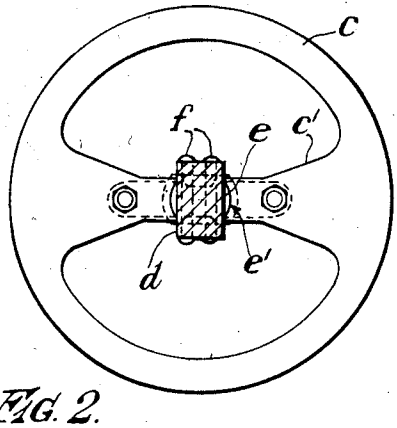


FIG. 2.

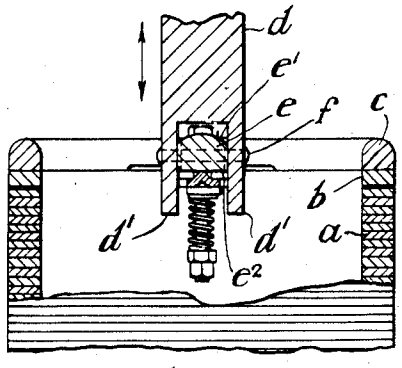


FIG. 3.

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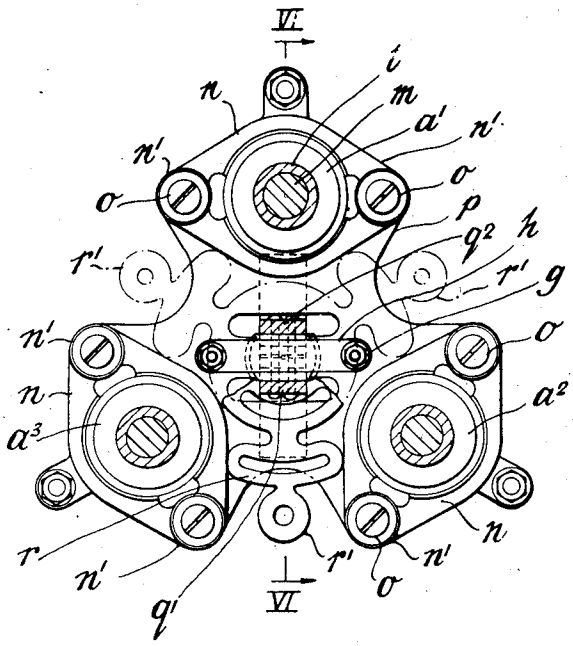


FIG. 5

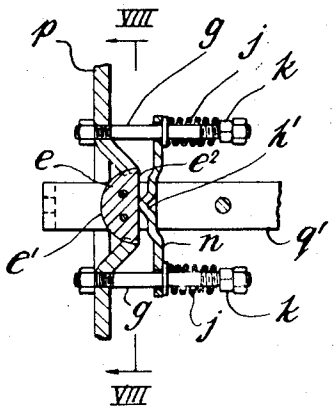


FIG. 7.

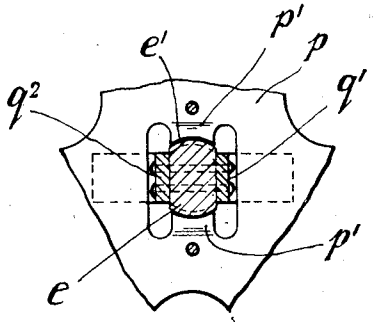


FIG. 8

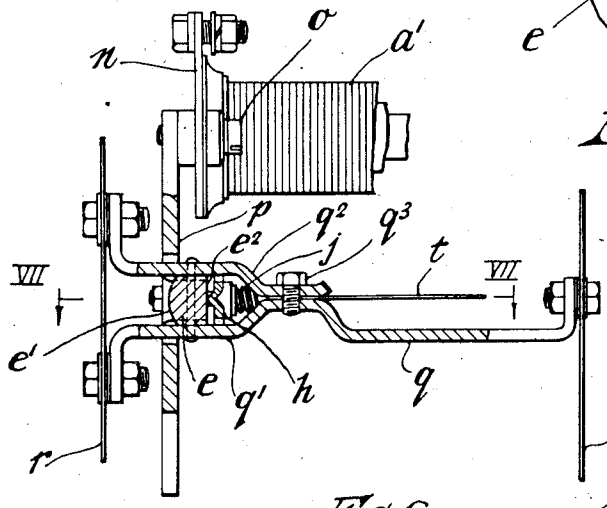


FIG. 6.

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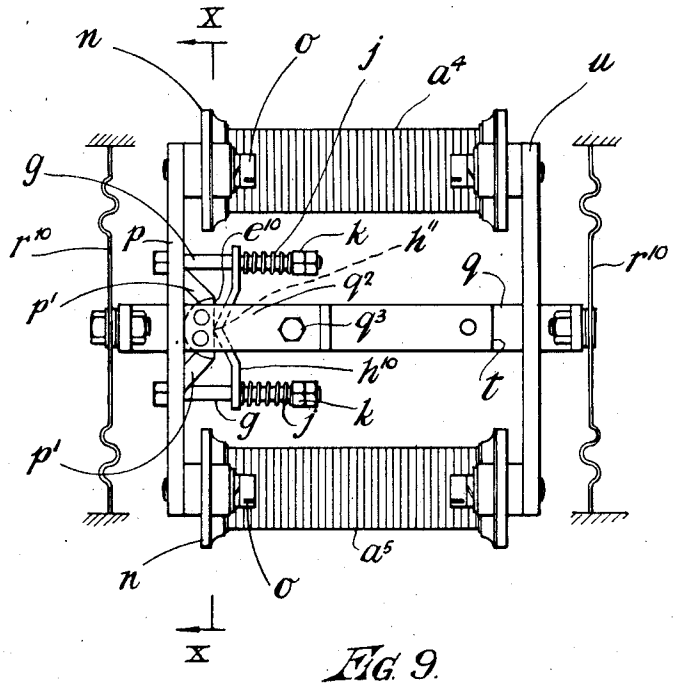


FIG. 9.

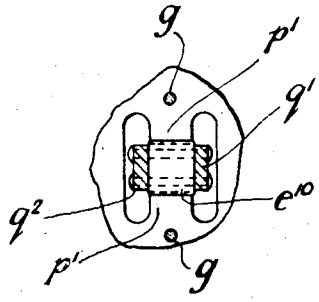


FIG. 10.

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UNITED STATES PATENT OFFICE

2,394,753

ELECTRIC REGULATOR

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Application December 13, 1943, Serial No. 514,167
In Great Britain December 16, 1942

8 Claims. (Cl. 201—51)

This invention comprises improvements in electric regulators of the carbon pile type. In a regulator of this type there may be a single pile or two or more symmetrically arranged piles. In the case of a single pile, it is essential that the pressure plate, applying pressure at one end of the pile, should be operated in such a manner that it will apply the pressure equally over the surface area of such end of the pile. In the case of two or more piles, it is important that the beam or yoke applying pressure to the several piles should operate in such a manner as to ensure an equal distribution of pressure to the several piles. It is, furthermore, of importance that the aforesaid equalization of pressure, or equal distribution of pressure, should be reliably maintained throughout the range of operation of a regulator and regardless of whether maximum or minimum pressure or zero pressure is being applied to the pile or piles.

It has been sought to secure the desired effect by providing a stiff or sticky ball joint or joints between the rod, lever, beam or yoke and the pressure plate employed for transmitting the pressure to the pile or piles. The stickiness of this joint was intended to preserve the parallelism of a pressure plate with the discs of the pile under minimum or zero pressure conditions. Under higher pressure, or maximum pressure conditions, the stickiness of the joint was overcome by the forces arising so that the pressure plate could satisfactorily adjust itself in relation to the pile. It has been found, however, that when the effects of vibration must be taken into account, if the ball joint is made sufficiently tight or sticky for reliable service under minimum pressure conditions, the danger arises that the forces developed under increased pressure conditions may be insufficient for overcoming the stickiness and producing a resetting of the joint such as may be necessary for equalizing the distribution of pressure. It has to be remembered that a carbon pile, under maximum working pressure, does not constitute a rigid abutment. Consequently, if there is an appreciable frictional torque on the joint when pressure is applied this will cause an out of balance effect either in the application of the pressure to a single pile, or in the distribution of such pressure over several piles.

According to the present invention jointing means in the pressure applying system of a regulator of the carbon pile type are so contrived that under higher and maximum pressure conditions frictional tightness is substantially or wholly removed from the joint, but is restored during the lower part of the pressure range or when pressure is removed. By this means, the joint is perfectly free to set itself for accurate parallelism or alignment during the upper part of the pressure range but is sufficiently stiff to maintain the desired conditions during the lower part, or at the bottom, of the pressure range in spite of vibrational effects. By these improvements, it is possible to arrange for the joint to have great stiffness at zero pressure on the pile so that it cannot possibly be shaken out of position by vibration, and nevertheless to be substantially free of frictional stiffness in the upper part of the pressure range.

In order to enable the invention to be readily understood, reference is made to the accompanying drawings wherein:

Figure 1 illustrates, in central vertical section, the invention as applied between the magnet-operated system of an electric regulator and a single pile composed of superposed carbon rings.

Figure 2 is a plan of Figure 1.

Figure 3 is a central vertical section, the plane of this section being at right angles to that of Figure 1.

Figure 4 is a side elevation illustrating the invention as applied between the magnet-operated system of an electric regulator and three carbon piles symmetrically disposed around a centre.

Figure 5 is a sectional elevation, the section being taken on the line V—V of Figure 4 and as seen when looking towards the left hand.

Figure 6 is a sectional elevation, the section being taken on the line VI—VI in Figure 5 and as seen when looking towards the right hand.

Figure 7 is a plan section taken on the line VII—VII of Figure 6.

Figure 8 is a sectional elevation, the section being taken on the line VIII—VIII of Figure 7 and as seen when looking towards the left hand.

Figure 9 is a diagrammatic elevation illustrating the invention in slightly modified form as applied between the magnet-operated system of an electric regulator and two carbon piles disposed 180° apart, and

Figure 10 is a sectional view of the joint parts, the section being on the line X—X of Figure 9.

Referring to Figures 1 to 3, *a* represents the carbon pile of an electric regulator, the said pile consisting of superposed carbon rings with a collector ring *b* at the top surmounted by a presser ring *c*. The latter is formed with a diametral

cross bar c^1 to which is jointed an axial rod d which is connected with the magnet-operated system of the regulator. Usually, a loading spring is operative for depressing the rod d and thereby causing the presser ring c to apply maximum compression to the pile a. When the electro-magnet of the regulator becomes sufficiently energized it operates against the loading spring to lift the rod d and thereby to reduce the compression of the pile and increase pile resistance. The up and down movement of which the rod d is capable, is indicated by the double headed arrows in Figures 1 and 3. Now, the joint provided by the present improvements between the rod d and the ring c is constructed as follows: The lower end of the rod d is forked and between the prongs d^1 of the fork a small block e is fixed, as by means of the rivets f. The block e is formed with a part spherical surface e^1 presented upwardly in Figures 1 and 3 and with a flat surface e^2 presented downwardly. Thus, the block e may be a half sphere but with flats formed parallel with a diameter such flats being engaged by the flat inner faces of the prongs d^1 as shown in Figures 2 and 3. The cross bar c^1 is divided in the middle and its divided ends are formed as a partially spherical seating for engaging upon the part spherical surface e^1 of the block e, as seen clearly in Figures 1 and 2. In each of the divided parts of the cross bar c^1 there is fixed a small bolt or pin g extending downwardly within the pile. The pins g guidingly support a yoke h, the latter having perforated ends slidingly engaging the pins g. In the middle of its length the yoke h is formed with a dimple providing an upwardly projecting point h^1 which engages with the flat lower surface e^2 of the block e at its pivotal centre. Springs j coiled around the pins g exert upward pressure against the yoke h and keep the point h^1 hard against the block e and the compression of the springs j is adjustable to a desired value by means of the nuts k on the ends of the pins g.

The operation is as follows: When the rod d is fully depressed by the loading spring of the regulator for putting the pile a under maximum compression, such compression is applied by the block e depressing the yoke h and thereby putting the springs j under additional compression. The downward effort of the springs j on the pins g is thus imparted to the presser ring c for putting the pile a under maximum compression. In depressing the yoke h against the action of the springs j, the block e eases or loosens its spherical surface e^1 from engagement with the conical seating surfaces on the divided ends of the cross bar c^1, so that the pivotal joint is now very easy and non sticky. The degree of easing or loosening, of course, corresponds with the degree to which the springs j are additionally compressed by the depression of the rod d. The presser ring c is thus quite free to adjust itself upon the pile a so as to apply pressure equally at all points around the pile rings. This self-adjusting movement is practically a universal movement, first, because the yoke h has only a point engagement with the flat surface e^2 of the block e and, second, because the spherical surface of the block e and the conical seating in the divided ends of the bar c^1 form a species of ball or universal joint. When the electro-magnet of the regulator overcomes the loading spring, the rod d rises a little and the block e permits the yoke h to rise under the influence of the springs j. The latter thus become effective for tightening the ball joint between the spherical surface e^1 and its conical seating in the divided ends of the cross bar c^1. The progressive effect therefore, is as follows: As the electro-magnet commences to overcome the spring loading and the rod d rises a little the ball joint is tightened a little but still permits the presser ring c to adjust itself to the pile a under the appreciable inherent expanding force of such pile. If the electro-magnet strengthens so as to overcome still further the spring loading, the ball joint is further tightened being still in a position in which it engages squarely and evenly on the end of the pile, the expanding force of the latter being by then considerably reduced. With further strengthening of the electro-magnet further tightening of the ball joint and further decompression of the pile occur until maximum de-compression of the pile a is reached. In this condition, the pile has no expanding force but the presser ring c is retained evenly or squarely against the end of the pile by the ball joint which is now in a stiff or sticky condition due to the action of the springs j. The stiffness or stickiness of the joint is such that the retention of the presser ring c in the condition described is preserved in spite of violent vibrations to which the regulator may be subjected, as when installed on an aircraft or a railway vehicle. Preferably, the springs j are initially adjusted so that their combined force is about equal to the maximum compression force applied to the rod d. With this adjustment, the ball joint is quite free when the pile a is under maximum compression, although it is very tight and sticky when the pile is decompressed.

Figures 4 to 8 illustrate a construction comprising three piles a^1, a^2 and a^3 disposed 120° apart, each pile being composed of carbon rings supported by a central non-conductive sleeve l on a core rod m. At the right hand end, in Figures 4 and 6, the piles a^1—a^3 bear against a rigid abutment on the framing of the regulator in known manner. At the left hand end, each pile is pressed against by a presser ring n formed with two lugs n^1, Figure 5, for enabling it to be secured by screws o to lugs of a presser plate p. The latter is jointed with and operated by a bar q which is supported by having each end bolted to a springy diaphragm plate r. This method of mounting the bar q ensures that it has a substantially straight line movement parallel with the piles in either direction. The diaphragm plates r as seen in Figure 5, are cut out from sheet metal so as to be of skeleton formation to give maximum springiness and so as to have perforated lugs r^1 by means of which they can be bolted to frame parts of the regulator. At one end, the bar q is bent to form one integral prong q^1, a companion prong q^2 having its shank secured by a bolt q^3 to the bar q. Various known means may be adopted for transmitting to the bar q the regulating movements due to the regulator magnet overcoming more or less the loading spring which puts the piles under compression. In Figure 4, the means comprises a two-armed lever s pivoted at s^1 in a bracket on the regulator framing, a metal tape t having one end attached to one arm of the lever s and the other end attached to the bar q, as by means of the clamping bolt q^3, Figure 6. The other arm of the lever s in Figure 4 is swingable as indicated by the double headed arrow, the leftward swing being produced by the loading spring (not shown) for compressing the piles and the rightward

swing being produced by the electro-magnet (not shown) which overcomes more or less the effort of the loading spring in known manner.

Between the prongs q^1, q^2 there is secured by rivets a block e precisely similar to the block e of Figures 1 to 3, this block e, as seen clearly in Figures 6 to 8, having a spherical surface e^1 and a flat surface e^2. The spherical surface is engaged or seated by lugs p^1 struck up from the plate p, the ends of these lugs p^1 being coned so that each limb has an appropriate bearing upon the spherical surface e^1. This is the same construction as illustrated in Figure 2, wherein the divided ends of the bar c^1 are formed so as to provide a conical seating for the spherical surface of the block e. On the plate p are fixedly mounted two pins g guidingly supporting a yoke h, the latter being formed with a dimple to provide a point h^1 for bearing against the flat face e^2 of the block e at its pivotal centre. The yoke h is pressed against the block e by compression springs j, the compression of these springs being adjustable by nuts k as in Figures 1 to 3. The action of the joint is similar to that already described with reference to Figures 1 to 3 but in Figures 4 to 8 the joint enables the presser plate p to adjust itself universally so as to apply pressure equally to all three piles a^1, a^2 and a^3. When the piles are under maximum compression due to clockwise turning of the lever s, Figure 4, the joint is loose and free because, as will be understood from Figures 6 to 8, the block e is forced against the yoke h and loosens itself in its seating in the lugs p^1 when the yoke h recedes and further compresses the springs j. When the lever s turns counterclockwise to decompress the pile, the spherical surface e^1 of the block e is re-tightened in its seating against the lugs p^1 under pressure of the springs j applied through the yoke h. In all other respects, the action of the joint in Figures 4 to 8 is similar to that described with reference to Figures 1 to 3.

Figures 9 and 10 illustrate more or less diagrammatically a twin pile arrangement for a regulator, some of the parts being similar to those described with reference to Figures 4 to 8. For example, the two piles a^4, a^5 which are spaced 180° apart are pressed against at one end by presser rings n secured by screws o to a presser plate p. The plate p is jointed to a bar q which is supported for movement parallel with the piles by diaphragms in this case represented as conventional corrugated diaphragms r^{10}. In Figure 9, the piles a^4, a^5 are shown with their right hand ends rigidly abutted against a frame plate u. The bar q has attached to it one end of a metal strip t, the opposite end (shown with a hole in Figure 9) being attachable to means such as the lever s described with reference to Figure 4. The bar q comprises a detachable prong q^2 which is attached to it by means of a bolt q^3 as described with reference to Figure 6. The modification of the joint in Figures 9 and 10 consists therein that the block e^{10} is a semi-cylindrical block and not a part-spherical block as in the preceding figures, and that the yoke h^{10} is bent to form a knife edge h^{11} for bearing against the flat surface of the block e^{10} at the pivotal axis of the block, this knife-edge bearing taking the place of the point bearing h^1 of the preceding figures. The fact that the block e^{10} is semi-cylindrical can be seen from Figure 10 wherein the edges bounding the upper and lower sides of the block as seen in that figure are straight and not curved. The block e^{10}, like the block e in Figures 4 to 8, is adapted for seating against lugs p^1 struck up from the plate p only in this modification the ends of such lugs are formed with flat faces set at an angle for fitting against the cylindrical surface of the block e^{10}. The yoke h^{10} is pressed against the flat surface of the block e^{10} by springs j coiled around pins g on the plate p, the springs j being adjustable as to compression by means of the nuts k as in Figures 4 to 8. It will now be apparent, without further description, that the pivotal joint between the block e^{10} and the lugs p^1 is eased or loosened when the bar q operates the plate p for applying maximum compression to the piles a^4, a^5 and that the said joint is tightened so as to become sticky as decompression of the piles proceeds under electro-magnetic action. The reason that the block e^{10} may be cylindrical instead of spherical and that the yoke h^{10} may have a knife edge bearing h^{11} against the block instead of a point bearing, is that the plate p needs only freedom to make a see-saw motion in order to distribute compressive force equally to the two piles a^4, a^5 disposed 180° apart.

In all constructions, the spherical or cylindrical surface of the block e or e^{10} is made of adequate radius and the seating faces of the parts c^1 or p^1 engaging it are given such a suitable formation or angular setting that the force available from the spring loading of the yoke plate h or h^{10} produces a pivotal joint which is very firm or sticky when the effort exerted by the rod or bar d or q is minimum.

I claim:

1. In an electric regulator of the carbon pile type, a carbon pile, a pressure-applying system operative for compressing the carbon pile, presser means engaging the pile, and a friction-tight pivotal joint between said presser means and the pressure-applying system, said joint having means for easing the friction tightness thereof upon transmission of maximum compression forces thereto and for restoring said frictional tightness as the compression forces applied thereto are reduced.

2. A regulator as claimed in claim 1 and in which said pressure-applying system includes a bar, the presser means being formed with a joint seat, a block having a rounded surface located between the presser means and said bar, said rounded surface being adapted for making joint with the seat of said presser means, said block being fixedly mounted on said bar, and a spring-loaded yoke mounted on said presser means and pressing said block towards its seat.

3. A regulator as claimed in claim 1 and in which said pressure-applying system includes a bar, the presser means being formed with an angular joint seating, a block having a cylindrical surface located between the presser means and said bar, said cylindrical surface being adapted for making joint with the seat of said presser means, said block being fixedly mounted on said bar and also having a flat surface, and a spring-loaded yoke mounted on said presser means and pressing said block towards its seat, said yoke being formed with a knife-edge projection engaged by the said flat surface of said block.

4. A regulator as claimed in claim 1 and in which said pressure-applying system includes a bar, the presser means being formed with an angular joint seating, a block having a spherical surface located between the presser means and said bar, said spherical surface being adapted for making joint with the seat of said presser

means, said block being fixedly mounted on said bar and also having a flat surface, and a spring-loaded yoke mounted on said presser means and pressing said block towards its seat, said yoke being formed with a pointed projection engaged by the said flat surface of said block.

5. A regulator as claimed in claim 1 and in which said pressure-applying system includes a bar, the presser means being formed with a joint seat, a block having a rounded surface located between the presser means and said bar, said rounded surface being adapted for making joint with the seat of said presser means, said block being fixedly mounted on said bar, a spring-loaded yoke mounted on said presser means and pressing said block towards its seat, and means for adjusting the spring loading of the yoke.

6. In an electric regulator of the carbon pile type, a carbon pile, a collector for applying pressure to the carbon pile to vary its electrical resistance, actuating means for the regulator, a joint between said actuating means and the collector, said joint including a seat facing in the general direction of the collector considered with respect to the direction of transmission of forces tending to compress the pile, a block for frictionally engaging said seat, said block being connected with the actuating means so that the actuating means tends to move the block away from the seat and reduce the friction therebetween upon increase of force tending to compress the pile to enable said block to adjust itself relative to said seat upon increase of said force, and means for yieldingly connecting said block to the collector to transmit said force thereto.

7. In an electric regulator of the carbon pile type, a carbon pile, a pressure-applying system operative for compressing the carbon pile, presser means engaging the pile, a pivotal joint between said presser means and the pressure applying system, and resilient means interposed between said presser means and said system and constantly tending to maintain friction tightness in said pivotal joint, said system being connected with a member of said joint so as to oppose the tendency of said resilient means when said system is operative for producing compression of said pile.

8. In an electric regulator of the carbon pile type, a carbon pile, presser means engaging one end of said pile, a pressure applying system operative for controlling the compression of said pile, a pivot joint member connected with said system, a cooperative pivot joint member on said presser means, and spring means constantly tending to maintain friction tightness between said joint members but in opposition to said system when the latter is operative in the direction for compressing said pile.

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