

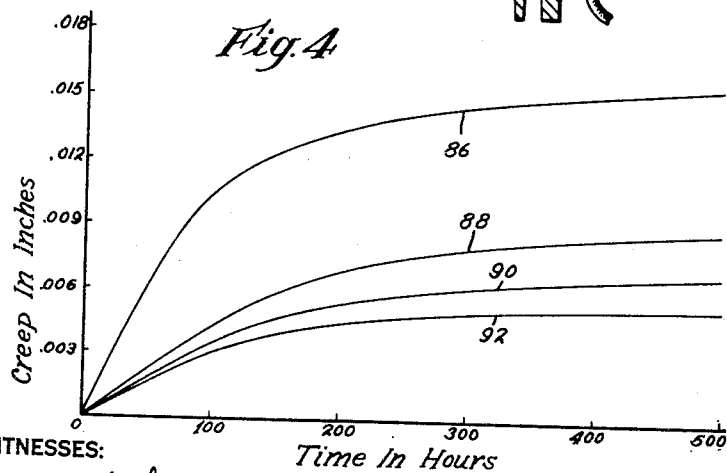
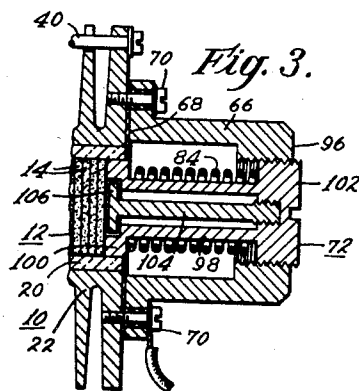
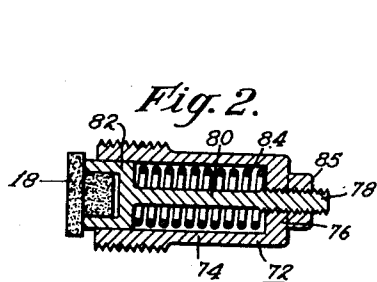
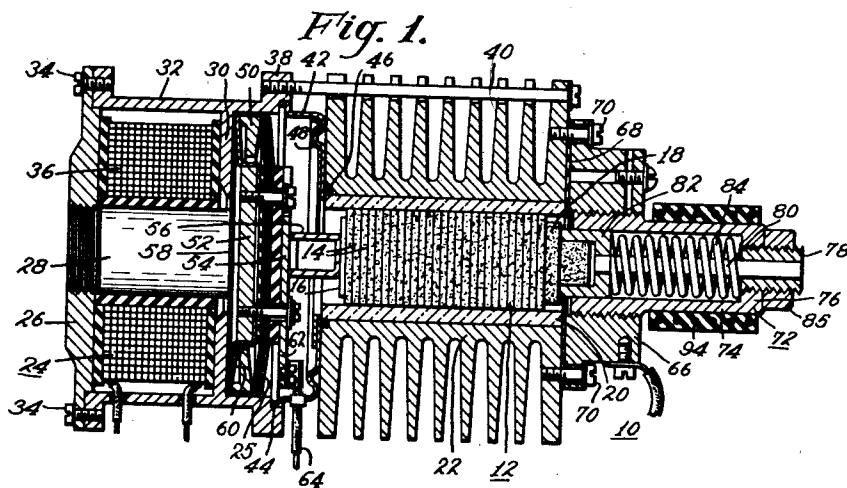
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CARBON PILE REGULATOR

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CARBON PILE REGULATOR

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16 Claims. (Cl. 201-51)

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This invention relates to regulators and, in particular, to regulators of the pile type.

Recently, there has been developed a light-weight regulator of the carbon pile type in which the compression of the pile is varied by a magnet operating against a spring arrangement which is advantageously devised so that its characteristic is substantially matched with the magnetomotive force characteristic. Although these regulators have found wide use in the industry, they have the disadvantage that after being in operation for from fifty to one-hundred hours, it is necessary to adjust the regulator to obtain the efficient operation thereof. This adjustment is necessary because the length of the stack of carbon disks changes slightly as the disks wear under the varying pressure applied thereto. Thus, the change in length of the stack caused by the wear of the faces of the disks gradually shifts the position of the regulator armature so that in time the armature no longer operates at the preferred air gap setting and the spring characteristics and the magnetomotive force characteristics are no longer matched.

An object of this invention is to provide for compensating for the wear of a stack of disks in a pile regulator.

Another object of this invention is to provide a pile regulator having a positive member for compensating for wear on the pile.

A further object of this invention is to provide in a pile regulator, for compensating for the wear of the pile while limiting the extent of compensation.

Other objects of this invention will become apparent from the following description, when taken in conjunction with the accompanying drawing, in which:

Figure 1 is a view, in elevation and partly in section, of a pile regulator embodying the teachings of this invention;

Fig. 2 is a view in section of another embodiment of a part of the regulator of Fig. 1;

Fig. 3 is a fragmentary view, in section, of a further embodiment of this invention as applied to a pile regulator; and

Fig. 4 is a graph, the curves of which are representative of the creep rate obtained with the compensators utilized in this invention.

Referring to Figure 1 of the drawing, there is illustrated a regulator 10 of the pile type, having a stack 12 of disks 14 of high-resistance material, such as carbon or the like. The disks 14 are mounted between pressure plates 16 and 18 in a ceramic tube or sleeve 20 maintained in a jacket

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22 of aluminum or the like, which is provided with fins for dissipating heat from the stack. In this embodiment, the pressure plate 18 is formed of a carbon electrode and is considered as the relatively fixed or stationary plate, the support for maintaining it in operating position being described more fully hereinafter.

The pressure applied to the stack 12 through the plate 16 is controlled by operation of an electromagnet 24 in opposition to a spring member 25. The electromagnet 24 comprises an end plate 26 and a central core member 28 threaded therein and an annular pole 30 carried by a body 32 which is secured to the end plate by screws 34 to enclose an energizing winding 33. The pole faces of the central core member 28 and the annular pole 30 are in substantially the same plane, it being noted that the body 32 extends beyond the annular pole 30 and terminates in a flange member 38.

The jacket 22 is mounted relative to the electromagnet 24 by means of spaced bolts 40, only one of which is illustrated, and a dust cap 42 is utilized to seal the moving parts of the regulator from the atmosphere. As illustrated, the dust cap 42 is an annular cup-shaped member having one edge seated against a ring seal 44 positioned in a groove at the end of the body 32, the other edge being disposed to seat against a ring seal 46 carried in a groove in the jacket 22. A spring clip 48 having a substantially clover-leaf shape is disposed adjacent the dust cap 42 to strengthen the dust cap and to project against the end of the ceramic sleeve 20 to maintain the sleeve in its insulating position with respect to the jacket 22.

The spring member 25 is preferably a leaf-spring disk type of spring having its outer edges bent to seat on a beveled or sloped ring member 50 of stainless steel or the like. The spring member 25 carries the armature member 52 which is of substantially disk shape disposed in spaced relation to the core member 28 and the annular pole 30. In addition, the spring member 25 also supports a conducting plate 54 and pusher member 56 for the pressure plate 16, the spring member being suitably insulated from the armature member 52 and the conducting plate 54. A damper comprising a thin disk 58 of magnetizable material and a flexible diaphragm 60 of non-magnetic material, as described and claimed in Patent No. 2,408,188, which issued September 24, 1946, to B. O. Austin, is also provided to damp excessive movement of the armature member 52. As illustrated,

the conducting plate 54 is also provided with a projection 62 to which a lead 64 may be connected to extend through the dust cap 42.

At the opposite end of the stack 12, the pressure plate 18 of carbon or the like is so mounted as to be substantially fixed relative to the movable pressure plate 16. As illustrated, an end plate 66 secured to the jacket 22 but insulated therefrom by a washer 68 of insulating material, being held in assembled position by screws 70. The end plate 66 is provided with a centrally located opening having threaded sides for receiving a plug 72 in threaded engagement.

The plug 72 comprises a cylindrical outer member 74 having an inwardly turned and threaded outer end 76 disposed to receive a threaded end member 78 of a longitudinal member 80 which carries an enlarged cup-shaped member 82 at its other end for holding the pressure plate 18 in a pressure fit. The cup-shaped member 82 has an outer diameter slightly less than the internal diameter of the cylindrical member 74 within which it is mounted. In this embodiment, the end members 78 and 82 are of a different metal than the elongated central rod portion of the member 80 being secured thereto as by brazing. A spring member 84 is disposed about the rod portion of member 80 between the inwardly turned end 76 and the cup-shaped end member 82 to apply stress to the rod 80, a nut 85 being provided for aiding in holding the threaded end member 78 in assembled position.

The rod portion of member 80 is formed of copper or a suitable copper base alloy which, under the stress applied by the force of the spring member 84, will creep at a rate comparable to the wear of the disks 14 of the stack 12 over a period of time to compensate for at least a part of the wear, whereby the armature member will be maintained in the preferred air gap and the magnetomotive force of the electromagnet will be substantially matched with the spring characteristics.

Referring to Fig. 4, the creep of the member 80 in which the central rod portion was made of copper is illustrated under different conditions. Curve 86 represents the creep obtained where the rod portion is 1½ inches long and was given an initial deformation or stretch of 0.035 inch and then loaded by the spring 84 under a force of 250 pounds at a temperature of 150° C. Curve 88 is representative of the creep obtained where the rod portion of member 80 was given an initial deformation of 0.060 inch and then placed under stress of 275 pounds by the spring 84 at a temperature of 150° C. Curves 90 and 92 are the results obtained under similar conditions except that the initial deformation amounted to 0.088 inch and 0.120 inch respectively, other conditions being constant. Thus, a predetermined creep can be obtained by controlling the initial stretch and the loading.

In one of the regulators constructed in accordance with this invention, the rod portion of the member 80 was initially stretched 0.041 inch and then loaded by the spring 84 to 250 pounds. As the operating temperature of the plug 72 in this case was only approximately 90° C., it was found that the rod portion had a creep of only 0.003 inch in 554 hours of operation. However, the creep was sufficient to offset a portion of the wear on the stack to maintain the armature member in the preferred air gap.

Where it is desired to increase the creep of the rod portion of member 80 to more nearly coincide with the wear of the stack, a resistor 94 which is suitably insulated may be placed around the plug 72 as illustrated in Fig. 1 to develop a predetermined operating temperature of up to 250 or 275° C. for the stressed member 80. Where such a resistor is used, the creep rate is greatly increased. For example, in the previous test just referred to, the creep was found to be 0.006 inch in only 180 hours, where the resistor 94 was used in the embodiment of Fig. 1 to develop and maintain an operating temperature of 170° C. instead of 90° C.

The plug 72 of Fig. 2 is similar to that used in the embodiment of Fig. 1, except that in Fig. 2 the member 80 including the threaded end member and the cup-shaped member is formed of one piece from the copper or copper alloy. Similar results are obtained as the spring 84 maintains the central rod portion under a predetermined load.

In the embodiment of Fig. 3, the end plate 66 is of somewhat different form being a cylindrical member having inwardly turned threaded outer ends 96 for receiving the compensating plug 72. In this embodiment, the plug 72 is formed of a cylindrical longitudinal portion 98 having a pressure ring 100 at its one end for bearing against the stack 12 and a solid flanged end 102 which is threaded to engage the threaded outer end 96 of the end plate 66. The spring 84 is disposed about the longitudinal portion 98 between the ends 100 and 102 to maintain the longitudinal portion 98 under stress as in the embodiments of Figs. 1 and 2, the plug being formed of copper or a copper alloy.

In some cases, it is desired to limit the creep imparted to the plug 72 a predetermined amount so as not to overcompensate for stack wear. In such cases, a stop 104 is utilized as illustrated in Fig. 3, the stop being formed of steel or the like and having one end carried by the end 102 of the plug 72 as by the threaded engagement illustrated, the other end 106 of stop 104 being flanged to project into the path of movement of the longitudinal member 98 to be engaged thereby after the portion 98 creeps a predetermined amount.

In practice, it is found that the life of the regulators constructed in accordance with this invention is from three to ten times the life of regulators which do not embody the compensator for wear on the stack. Prior to this invention, most regulators of the type described herein had a life of the order of 100 to 150 hours of operation; whereas, with regulators embodying this invention, a life of 1220 hours has been obtained.

We claim as our invention:

1. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, and means disposed at the other end of the stack cooperative to maintain the other pressure plate against the stack, the cooperative pressure applying means having a creep rate during the operation of the stack to effect an elongation thereof over a predetermined period of time to compensate for at least a part of the wear of the stack of disks

under the varying pressure applied thereto in operation.

2. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means disposed at the other end of the stack cooperative to maintain the other pressure plate against the stack, and means for applying stress to the maintaining means during the operation of the stack to effect creep thereof over a predetermined period of time to compensate for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation.

3. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a plug of metal selected from the group consisting of copper and copper base alloys disposed at the other end of the stack for maintaining the other pressure plate against the stack, and means for applying stress to the metallic plug to effect creep thereof over a predetermined period of time during the operation of the stack to compensate for at least a part of the wear of the stack of disks under the varying pressure applied thereto.

4. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end disposed with its other end adjacent the other pressure plate to maintain the pressure plate against the stack, and means for applying stress to the longitudinal member to effect creep thereof during the operation of the stack to gradually lengthen the longitudinal member in the direction of the stack over a predetermined period of time, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation.

5. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means disposed at the other end of the stack cooperative to maintain the other pressure plate against the stack, the cooperative pressure applying means having a

creep rate during the operation of the stack to effect an elongation thereof over a predetermined period of time to compensate for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation, and means disposed to limit the elongation of said stressed means to a predetermined amount.

6. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end disposed with its other end adjacent the other pressure plate to maintain the pressure plate against the stack, means for applying stress to the longitudinal member to effect creep thereof during the operation of the stack to gradually lengthen the longitudinal member in the direction of the stack over a predetermined period of time, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation, and means disposed to limit the creep of the longitudinal member to a predetermined amount.

7. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate disposed at one end of the stack, a spring member disposed to apply pressure to the stack through the pressure plate, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end and being disposed with its other end adjacent the other end of the stack to provide a relative fixed stop member therefor, a spring member carried by the longitudinal member disposed to apply stress thereto to effect creep thereof at a predetermined rate during the operation of the stack, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation.

8. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate disposed at one end of the stack, a spring member disposed to apply pressure to the stack through the pressure plate, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end and being disposed with its other end adjacent the other end of the stack to provide a relative fixed stop member therefor, a spring member carried by the longitudinal member disposed to apply stress thereto to effect creep thereof at a predetermined rate during the operation of the stack, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation, and means disposed to

limit the creep of the longitudinal member to a predetermined amount.

9. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate disposed at one end of the stack, a spring member disposed to apply pressure to the stack through the pressure plate, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end and being disposed with its other end adjacent the other end of the stack to provide a relative fixed stop member therefor, a spring member carried by the longitudinal member disposed to apply stress thereto to effect creep thereof at a predetermined rate during the operation of the stack, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation, and means carried by the fixed end of the longitudinal member disposed to extend into the path of movement of the other end of the longitudinal member as it creeps under the influence of the stress applied thereto to limit the creep to a predetermined amount.

10. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate disposed at one end of the stack, a spring member disposed to apply pressure to the stack through the pressure plate, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, a longitudinal member having one end fixed relative to the other end and being disposed with its other end adjacent the other end of the stack to provide a relative fixed stop member therefor, a spring member carried by the longitudinal member disposed to apply stress thereto during the operation of the stack, and means associated with the stressed longitudinal member for maintaining the longitudinal member at a predetermined operating temperature to effect creep thereof at a predetermined rate, the creep of the longitudinal member compensating for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation.

11. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means disposed at the other end of the stack cooperative to maintain the other pressure plate against the stack, and means associated with said cooperative pressure maintaining means to maintain said means at a predetermined operating temperature to effect a predetermined elongation thereof over a predetermined period of time to compensate for at least a part of the wear of the stack of disks during operation under the varying pressure applied thereto.

12. A pile regulator comprising, in combination, a stack of disks of resistance material disposed

to be operated to vary the electrical resistance, a pressure plate at each end of the stack, a spring member disposed to apply pressure to the stack through one of the pressure plates, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means disposed at the other end of the stack cooperative to maintain the other pressure plate against the stack, and a resistor-heater disposed in heating relation with said cooperative pressure maintaining means to maintain said means at a predetermined operating temperature, said means having a creep rate at the predetermined operating temperature to effect an elongation thereof over a predetermined period of time to compensate for at least a part of the wear of the stack of disks under the varying pressure applied thereto in operation.

13. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a spring member disposed to apply pressure to the stack, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, and means automatically operable during the operation of the stack for compensating for at least a part of the changes in thickness of the disks due to the wear whereby the force applied by the spring member to the stack is substantially unaffected by the wear of the disks in operation.

14. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a spring member disposed to apply pressure to the stack, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means automatically operable during the operation of the stack for compensating for at least a part of the changes in thickness of the disks due to wear whereby the force applied by the spring member to the stack is substantially unaffected by the wear of the disks in operation, and means disposed to cooperate with the automatically operable means to limit the extent of compensation to a predetermined amount.

15. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a spring member disposed to apply pressure to the stack, an electromagnet disposed to be energized to control the pressure applied by the spring member to the stack, the disks of the stack being subject to wear during operation, means operable during the operation of the stack for compensating for at least a part of the changes in thickness of the disks due to wear, and means associated with the operable member for maintaining the operable member at a predetermined temperature to control the compensating operation thereof whereby the force applied by the spring member to the stack is substantially unaffected by the wear of the disks in operation.

16. A pile regulator comprising, in combination, a stack of disks of resistance material disposed to be operated to vary the electrical resistance, a spring member disposed to apply pressure to the stack, an electromagnet disposed to be energized to control the pressure applied by

the spring member to the stack, the disks of the stack being subject to wear during operation, means operable during the operation of the stack for compensating for at least a part of the changes in thickness of the disks due to wear, 5 means associated with the operable member for maintaining the operable member at a predetermined temperature to control the compensating operation thereof whereby the force applied by

the spring member to the stack is substantially unaffected by the wear of the disks in operation, and stop means disposed to cooperate with the operable means to limit the extent of compensation to a predetermined amount.

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No references cited.