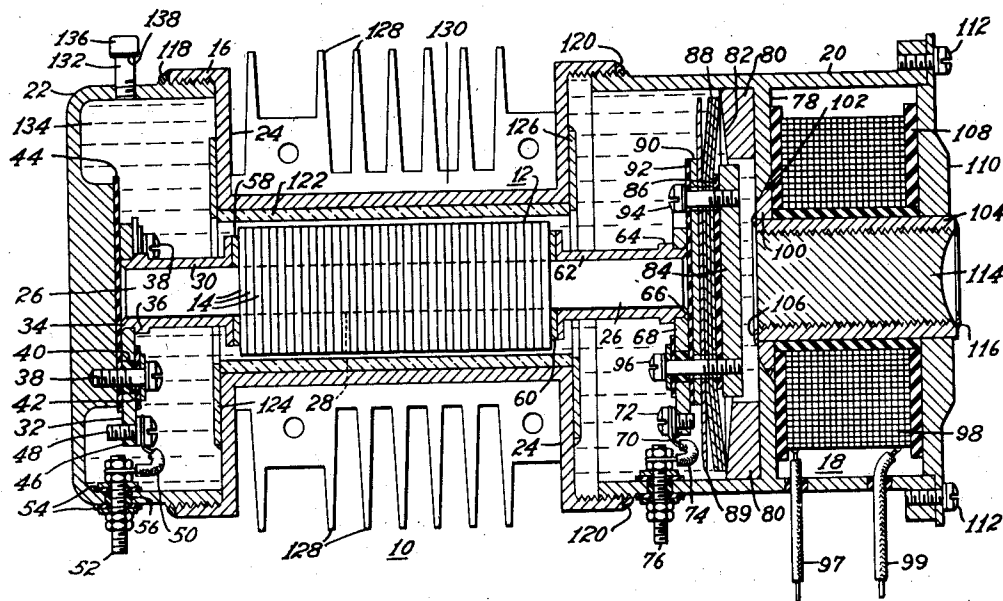


Feb. 5, 1946.

B. O. AUSTIN
ELECTRICAL APPARATUS
Filed Jan. 12, 1944

2,393,952



WITNESSES:

Edward Michaels

INVENTOR

Bascum O. Austin.

BY

James T. Ely
ATTORNEY

UNITED STATES PATENT OFFICE

2,393,952

ELECTRICAL APPARATUS

Bascum O. Austin, Lima, Ohio, assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 12, 1944, Serial No. 517,917

5 Claims. (Cl. 201—51)

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

An object of this invention is to provide a light-weight regulator of the pile type which is stable in operation.

Another object of this invention is to provide for suppressing arcing between the disks of a pile regulator while at the same time providing for an efficient damping of vibrations in the regulator.

A more specific object of this invention is to provide for stabilizing the operation of the movable parts of a pile regulator to dampen vibrations and prevent excessive changes other than controlled changes in the pressure applied to the pile.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawing, the single figure of which is a view in elevation and partly in section of a regulator embodying the teachings of this invention.

Referring to the drawing, this invention is illustrated by reference to the regulator 10 shown therein. The regulator 10 is of the pile type having a stack 12 of aligned disks 14 of high resistance material such as carbon or the like mounted in a sectionalized housing or casing 16 and disposed to be operated by an electro-magnet 18. The casing 16 is formed of a plurality of sections, an end or base section 20 being connected to an end cap 22 by an intermediate constricted section 24.

The stack 12 of disks 14 of high resistance material is assembled in operative relation on a shaft or rod 26 of insulating material such as a ceramic rod, the rod 26 extending through openings 28 positioned centrally in each of the disks for maintaining the disks in aligned relation. One end of the rod 26 is supported in a sleeve 30 of conducting material, the sleeve 30 being secured to a ring 32 of conducting material as by means of the flared end 34 and the shoulder 36 carried at one end of the sleeve for forming a recess into which the ring 32 is fitted. The ring 32 is, in turn, secured to the inner face of the end cap 22 by means of a plurality of screws 38 disposed in spaced relation about the sleeve 30, the screws 38 being insulated from the ring 32 of conducting material by means of the insulating bushings 40 and washers 42. The ring 32 is also insulated from the end cap 22 by means of a sheet 44 of insulating material such as fishpaper or the like.

In order to provide an electrical connection external of the housing or casing 16, the ring

32 of conducting material carries a projection 46 for receiving a screw 48 which is utilized for connecting one end of a conductor 50 to the ring, the other end of the conductor being secured to a conducting bolt 52 which extends through the side wall of the end cap 22, insulating washers 54, and an insulating bushing 56 being provided for insulating the bolt 52 from the end cap 22. As illustrated, a pressure plate 58 is disposed between the other flanged end of the conducting sleeve 30 and the end of the stack 12 of disks 14 for distributing pressure over the face of the end disk.

The other end of the rod 26 projects from the other end of the stack 12, a pressure plate 60 being disposed about the shaft 26 adjacent the end of the stack 12 and a sleeve 62 being positioned about the rod 26 and having a flanged end for seating against the pressure plate 60. The sleeve 62 is similar to the sleeve 30, being provided with a shoulder 64 and a flared outer end 66 for holding a ring 68 of conducting material. The ring 68 is similar to the ring 32 at the opposite end of the stack having a projection 70 for receiving a screw 72 for securing one end of a conductor 74 thereto. The other end of the conductor 74 is secured to the bolt 76 which projects through but is insulated from the section 20 of the casing in a manner similar to the bolt 52.

As illustrated, the section 20 of the housing or casing 16 has an inwardly projecting partition 78 disposed about its periphery approximately midway of the length of the section. On one side of the partition 78, a ring 80 of stainless steel or the like having a sloping or beveled surface 82 is disposed to seat against the outer walls of the section 20 and the partition 78. The ring 80 is of such a size that an armature member 84 may be fitted within the inner diameter of the ring.

The armature member 84 utilized in the regulator 10 is substantially a disk and is carried by the ring 68 which is secured to the sleeve 62. The armature member 84 is preferably faced on one side thereof by a sheet or layer of insulating material 86 which functions to electrically separate the armature member 84 and a spring member 88. The spring member 88 is a leaf spring and may be of star-shape or a circular disk, the ends or outer periphery of which are bent to seat against the sloped surface 82 of the ring 80, the purpose of which will be described more fully hereinafter. Adjacent the leaf spring 88 is a circular diaphragm 89 which has substan-

tial side faces and an outer free edge which terminates closely adjacent the side walls of the section 20 of the casing. The outer free edge of the diaphragm 89 is spaced a distance from the bent end or edge of the spring member 88, the purpose of which will be explained more fully hereinafter.

In order to hold the diaphragm 89 and the spring 88 in the position described, a reinforcing sheet 90 of metal or the like is placed adjacent the surface of the diaphragm 89 opposite the surface in contact with the spring 88, and a layer 92 of insulating material is then placed against the supporting sheet 90. This assembly of the insulating sheet 92, reinforcing plate 90, diaphragm 89, spring member 88, insulation 86, and the armature member 84 are held together as an integral unit by means of the screw 94 and are mounted as an integral unit on the ring 68 by means of the screw 96, the screw 95 being insulated from the ring 63.

As illustrated, a winding 98 having leads 97 and 99 is positioned on the other side of the partition 78 of the section 20 and disposed to be encased in the housing 16. However, before the winding 98 is positioned in the casing 16, a ring 100 of brass or similar non-magnetic material is secured about the inner circumference of the partition 78 as by brazing, as shown at 132, and a metallic sleeve 104 the inner surface of which is threaded is secured to the inner circumference of the brass ring 100 as by brazing at 105, as illustrated. In positioning the winding 98 in the housing, the winding preferably mounted on a spool 108 of insulating material is slipped over the end of the sleeve 104 to a position where the side wall of the insulating spool 108 seats against the partition 78 and the brass ring 100. With the winding 98 in the position shown having the leads 97 and 99 projecting through the casing, an end cap or plate 110 may be secured to the ends of the section 20 of the housing by the bolts 112 which are disposed in spaced relation about the periphery of the end plate 110. The end plate 110 seating against the winding 98 maintains the winding in position about the sleeve 104 and prevents movement of the winding.

With the winding 98 assembled as described, a core member 114 having an externally threaded surface is threaded into the threaded sleeve 124 to a position where the end of the core member 114 is spaced a predetermined distance from the armature member 84. By adjusting the position of the core member 114, a predetermined position of the core member may be obtained where a required balance between the magnetic pull and the force of the spring member 88 is obtained over an operating range of the regulator. This position of the core member 114 will necessarily depend upon the strength of the spring member 88 which is positioned to apply pressure to the stack 12, it being noted that as the armature member is moved under the influence of the magnetic pull that the effective arm length of the spring member 88 changes since more and more of the spring 88 engages the sloped surface 82 of the ring 80. When the core member 114 is thus adjusted to obtain the required gap between the armature member and the core member, the external end of the sleeve 104 and the core 114 is brazed as at 116 for sealing the threaded joint between the two members. The threaded joints between the end cap 22 and the constricted section 24 is likewise brazed as at 118, and the threaded joint between the constricted

section and the end section 20 of the casing is also brazed as at 120 to provide a sealed casing about the movable elements of the regulator 10.

As will be noted, the constricted section 24 of the casing is of a size determined by the size of the stack 12 utilized in the regulator. Preferably the constricted length of the section 24 has a diameter only slightly greater than that of the stack of disks, spacing being provided, however, for the positioning of a sleeve 122 of insulating material such as porcelain, the sleeve 122 being spaced slightly from the stack 12. As illustrated, the sleeve 122 of porcelain is maintained in position by brazing ring members 124 and 126 to the constricted section 24 at opposite ends of the sleeve 122.

In order to effectively aid in dissipating any heat that may be generated in the stack 12 of disks 14, a plurality of radiating fins 128 are disposed about the constricted section 24 of the casing, the fins 128 preferably being formed of aluminum or the like and being formed on a sleeve 130 which fits about the constricted area. The sleeve and fin assembly may be formed in two half sections which when placed about the constricted section 24 may be bolted together to form a continuous radiating assembly about the constricted section 24.

As illustrated, the end cap 22 is also provided with a vent 132 which may be sealed. After the regulator is assembled, the housing or casing 16 is preferably evacuated, suitable vacuum equipment being attached to the vent 132 for accomplishing this purpose, and when evacuated, a thermally conducting electrically insulating fluid medium 134 is admitted to the housing. The fluid medium 134 may be either gaseous or liquid, the main requirement being that the medium utilized be inert to the material, such as carbon which is utilized in forming the disks 14 of the stack and that it has no chemical effect on the composition of the other movable elements within the casing.

The gases helium and hydrogen are especially suited for use in the casing 16 as they are inert with respect to the disks making it possible to operate the regulator at elevated temperatures without destroying the disks 14. Further hydrogen and helium transmit heat at a rate about six times faster than can be obtained if the thermally conducting fluid medium is not present within the casing. As the gases are inert with respect to the disks of resistance material, a longer life of the disks can be obtained, as the gas prevents frosting or freezing of the disks due to sweating and also prevents deterioration of the disks by excluding oxygen therefrom.

Where a liquid medium is used instead of the inert gaseous medium, it is preferred to employ a permanently liquid dialkyl silicone. Of the known silicones, that silicone liquid which is essentially dimethyl silicone which has been polymerized and is free of mono-methyl silicone groups is preferred. The essentially dimethyl silicones are produced by fractionating a mixture of methyl silicon ethoxides to separate the dimethyl silicon diethoxide as a substantially pure component which is hydrolyzed to the dimethyl silicic acid and then dehydrated with an agent such as sulphuric acid to dimethyl silicones of predetermined molecular size. By fractionating the oily dimethyl silicones, a stable liquid of predetermined viscosity may be obtained. This process and product is described in greater detail in the copending application of J. G. Ford and R. N.

Wenzel, Serial No. 439,066, filed April 15, 1942, and assigned to the assignee of this invention. The dimethyl silicone insulating medium is especially suited for use in the regulator of this invention, as it is especially stable over wide ranges of temperature, very little change in viscosity being encountered over ranges of from -70°F. up to as high as 500°F.

After the fluid medium 134 is admitted to the housing 16, a cap 136 is placed upon the vent 132 and is brazed or soldered as at 138 for effectively sealing the vent. Thus, all the moving elements of the regulator are enveloped in a fluid insulating medium, and the casing is sealed to prevent loss or contamination of the fluid insulating medium.

In operation, it is found that the regulator described hereinbefore is very stable, the diaphragm and the insulating medium cooperating to damp vibrations of the movable elements. That the diaphragm 89 and the thermally conducting insulating medium cooperate to damp vibrations will be appreciated when it is considered that the diaphragm extends outwardly across the section 20 of the casing with the free edge terminating closely adjacent the side walls of the casing and spaced from the leaf spring member 88. Thus, the fluid medium 134 envelops the diaphragm 89 to provide a cushion against each of the side faces of the diaphragm to resist movement of the diaphragm either towards or away from the stack 12. The resistance to movement is sufficient to prevent excessive movement of the diaphragm and spring assembly and to consequently prevent changes in the pressure applied to the stack except for such changes occasioned by a controlled change in the energization of the electromagnet.

The insulating medium penetrates into every joint within the sealed casing, and where the medium is a liquid, an efficient lubrication of all the moving elements is obtained, the reduction in friction thus obtained increasing the efficiency of the regulator. With the insulating medium filling the casing 16 as described, it is found that a very efficient dissipation of heat generated in the stack 12 of disks 14 is obtained since the insulating medium surrounding the disks provides a continuous thermally conducting path from the disks to the radiating fins 128 carried about the constricted section 24. Further, it is found that although the disks are enveloped by the insulating medium, the insulating medium in no way interferes with the operation of the stack 12, but instead prolongs the life of the stack in that the insulating medium efficiently suppresses arcing between the carbon disks, thereby preventing the deterioration of the disks of resistance material and greatly prolonging the life of the regulator. The cushion of insulating material between the stack 12 and the sleeve 122 of porcelain or the like also functions to cushion any sideways movement of the disks 14 and thereby tends to prevent damage to the disks when the regulator is violently jarred, as it sometimes is in such applications as on aircraft. By providing for efficiently dissipating the heat from the stack as described, the capacity of the regulator is greatly increased over that of a regulator which does not utilize an insulating medium in the manner described hereinbefore without increasing the size of the regulator.

The regulator of this invention will find wide and varied applications and may be used either as a current or voltage regulator and is particularly adapted for use such as the voltage regulator in aircraft. It is lightweight, sturdy in con-

struction, and efficient and stable in operation while having capacities higher than known regulators of comparable size.

While this invention has been described with reference to a particular embodiment thereof, it is, of course, not to be limited thereto except insofar as is necessitated by the scope of the appended claims.

I claim as my invention:

1. An electric regulator comprising, in combination, a stack of disks of resistance material, a spring member disposed at one end of the stack to apply pressure thereto, an electromagnet having an armature member disposed for movement to control the pressure applied in response to the energization of the electromagnet, a casing for the stack and associated spring and armature members for housing them, the casing having sealed joints to render the casing leakproof, an insulating liquid medium disposed within the sealed casing to envelop the stack and associated spring and armature members, and a diaphragm associated with the spring and armature members disposed for movement therewith, the diaphragm having substantial side faces and a free edge, the diaphragm being of a size and being disposed to extend outwardly into the insulating medium and substantially across the housed area within the casing with the free edge of the diaphragm terminating adjacent the side walls of the casing, the insulating medium about the diaphragm providing a cushion therefor to damp vibrations and prevent excessive changes other than controlled changes in the pressure applied to the stack.

2. An electric regulator comprising, in combination, a stack of disks of resistance material, a spring member disposed at one end of the stack to apply pressure thereto, an electromagnet having an armature member disposed for movement to control the pressure applied in response to the energization of the electromagnet, a casing for the stack and associated spring and armature members for housing them, the casing having sealed joints to render the casing leakproof, a thermally conducting fluid medium disposed within the sealed casing to envelop the stack and associated spring and armature members, the fluid medium having the characteristic of being inert with respect to the disks of resistance material, and associated spring and armature members, and a diaphragm associated with the spring and armature members disposed for simultaneous movement therewith, the diaphragm having substantial side faces and a free edge, the diaphragm being of a size and being disposed to extend into the fluid medium and substantially across the housed area within the casing with the free edge of the diaphragm terminating adjacent the side walls of the casing to oppose movement of the spring and armature members, the inert fluid medium about the diaphragm providing a cushion therefor to damp vibrations and prevent excessive changes other than controlled changes in the pressure applied to the stack.

3. An electric regulator comprising, in combination, a stack of disks of resistance material, a pressure plate at each end of the stack of disks, a spring member associated with one of the pressure plates mechanically disposed to continuously apply pressure to the stack, an electromagnet comprising a core member, a winding and an armature member which is mechanically connected to the spring member, the armature mem-

ber being disposed for movement in response to the energization of the electromagnet to control the pressure applied by the spring member to the stack, a casing for the stack and associated spring and armature members for housing them, the casing including the core member of the electromagnet and having sealed joints therewith to render the casing leakproof, the casing having a constricted section disposed about the stack, an insulating liquid medium disposed within the sealed casing to envelop the stack and associated spring and armature members, and a disk type of diaphragm carried by the spring and armature member assembly disposed to extend substantially across the unconstricted section of housed area within the casing with the free edge of the diaphragm terminating adjacent the side walls of the casing whereby the diaphragm is enveloped by the liquid medium and cooperates therewith to damp vibrations of the assembly and prevent excessive changes other than predetermined changes in the pressure applied to the stack.

4. An electric regulator comprising, in combination, a stack of disks of resistance material, a pressure plate at each end of the stack of disks, a spring member associated with one of the pressure plates mechanically disposed to continuously apply pressure to the stack, an electromagnet comprising a core member, a winding and an armature member which is mechanically connected to the spring member, the armature member being disposed for movement in response to the energization of the electromagnet to control the pressure applied by the spring member to the stack, a casing for the stack and associated spring and armature members for housing them, the casing including the core member of the electromagnet and having sealed joints therewith to render the casing leakproof, a thermally conducting fluid medium disposed within the sealed casing to envelop the stack and associated spring and armature members, the fluid medium having the characteristic of being inert with respect to the disks of resistance material

and associated spring and armature members, and a disk type of diaphragm carried by the spring and armature member assembly disposed to extend substantially across the housed area within the casing with the free edge of the diaphragm terminating adjacent the side walls of the casing whereby the diaphragm cooperates with the inert fluid medium to damp vibrations of the assembly and prevent excessive changes other than controlled changes in the pressure applied to the stack.

5. An electric regulator comprising, in combination, a stack of disks of resistance material, a pressure plate at each end of the stack of disks, a spring member associated with one of the pressure plates mechanically disposed to continuously apply pressure to the stack, an electromagnet having an armature member mechanically connected to the spring member, the armature member being disposed for movement in response to the energization of the electromagnet to control the pressure applied by the spring member to the stack, a casing for the stack and associated spring and armature members for housing them, the casing having sealed joints to render the casing leakproof, a thermally conducting fluid medium disposed within the sealed casing to envelop the stack and associated spring and armature members, the fluid medium having the characteristic of being inert with respect to the disks of resistance material and associated spring and armature members, and a diaphragm associated with the spring and armature members disposed for movement therewith, the diaphragm having substantial side faces and a free edge, the diaphragm being of a size and being disposed to extend substantially across the housed area within the casing with the free edge of the diaphragm terminating adjacent the side walls of the casing, the diaphragm cooperating with the inert fluid medium within the casing to damp vibrations of the assembly and prevent excessive changes other than controlled changes in the pressure applied to the stack.

BASCUM O. AUSTIN.