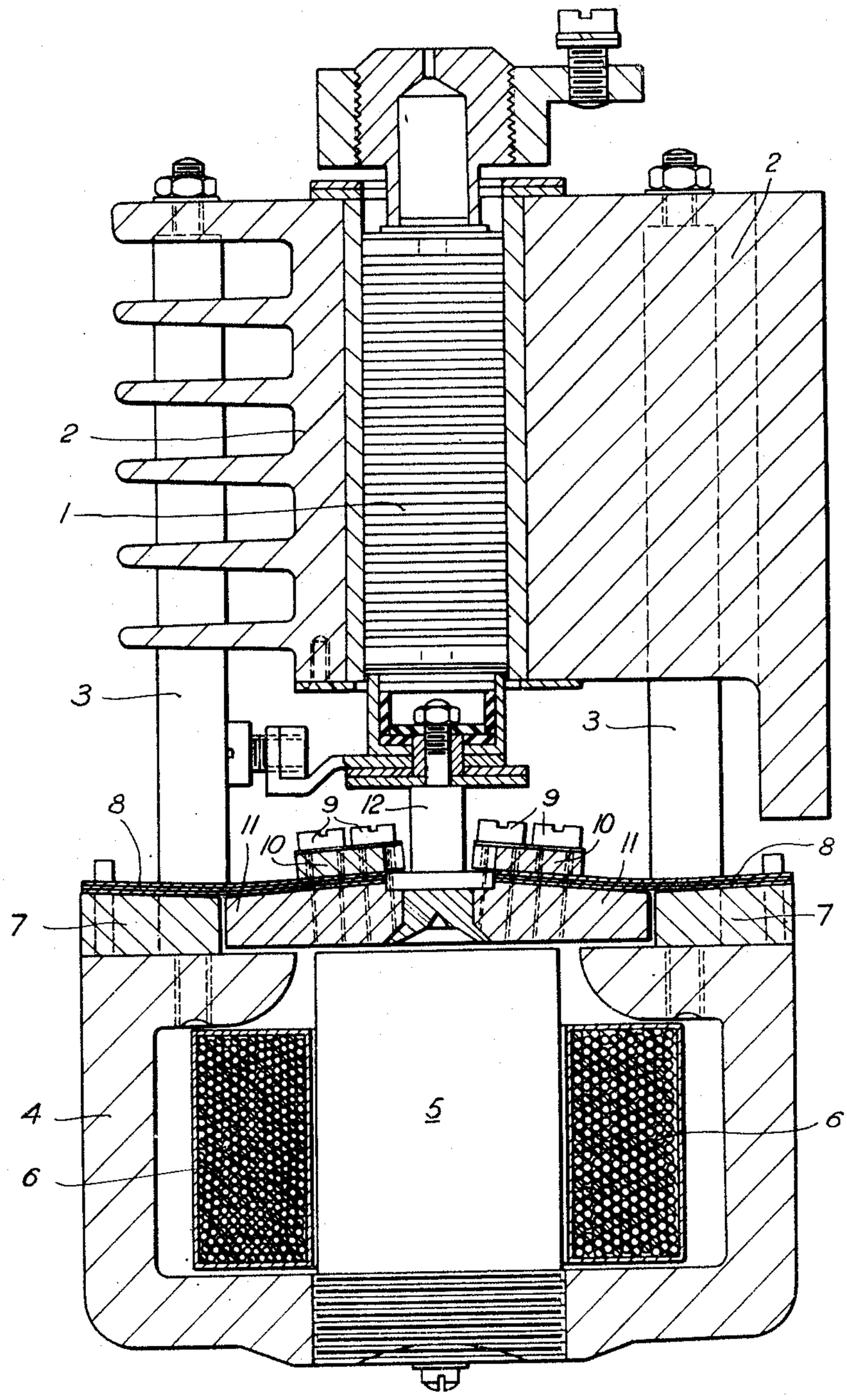
Oct. 31, 1950

F. NEWTON

2,528,164

ELECTRIC REGULATOR

Filed Aug. 23, 1947



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Patented Oct. 31, 1950 2,528,164

UNITED STATES PATENT OFFICE

2,528,164

ELECTRIC REGULATOR

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Application August 23, 1947, Serial No. 770,205
In Great Britain July 11, 1946

Section 1, Public Law 690, August 8, 1946
Patent expires July 11, 1966

8 Claims. (Cl. 201—51)

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This invention relates to electric regulators comprising a carbon pile resistance controlled by the pull of an electromagnet opposed by a spring which wraps upon its abutment, and is thereby stiffened, as it is stressed; such regulators have been described in my Patents Nos. 2,268,718, 2,342,008, 2,363,612 and 2,375,320.

The regulation afforded by such regulators is liable to vary with temperature, because of variation of the resistance of the magnet winding and other factors with temperature, and I have already described a plan for compensating for temperature by making the abutment on which the spring wraps bi-metallic.

According to the present invention I compensate for changes of temperature by making the spring of the regulator bi-metallic, so that its form tends to change with temperature. When the spring is laminated it is sufficient to make one or more of the laminations of two layers of metals which differ in their coefficient of expansion.

Suitable component materials for the bi-metallic laminations are steel and the nickel steel alloy known as "invar."

An embodiment of the invention is illustrated by way of example in the accompanying drawing which is an axial section through an electric regulator.

The carbon pile 1 is contained within and insulated from a metal casing 2 finned for cooling, and attached by bolts 3 to the core 4 of an electromagnet. The core 4 has a central round limb 5 on which the exciting winding 6 is placed. The pole faces of the core 4, or preferably, as shown, blocks 7 attached to the core and formed with slightly inclined upper surfaces, serve as abutments for springs 8 which are clamped by set screws 9 and a plate 10 to the armature 11 of the electromagnet 4, 5, 6. The armature 11 is attached by the stem 12 to the lower end plate of the carbon pile 1. The springs thus constitute a resilient beam bridging the mutually in clined working surfaces of the abutments, and the pole pieces and armature of the electromagnet constituting two relatively movable members, of which one is connected to the abutments and the other to the mid-point of the resilient beam.

It will be clear that the pile is subject at all times to the difference between the pressure of the springs 8 and the pull of the electromagnet 4, 5, 6 upon its armature 11. As the armature is drawn nearer to its pole pieces the springs 8 are bent and thereby caused to contact over a

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wider area with the mutually inclined surfaces of the blocks 7; the springs are, therefore, in effect, shortened and made stiffer and their mid-point moves further into the angle between the abutment surfaces. By careful design the law of variation of the spring pressure with deformation may be made to agree closely with the non-linear law of variation of magnet pull with displacement of the armature.

But this agreement can only be secured for one temperature unless means is provided for compensating for temperature variation. This the present invention does. The springs 8 as shown in the drawing consist of three layers, of which one is a separate lamination of steel, and the other two are of different metals united to form a bi-metallic lamination, the free form of which varies with temperature.

The laminations of the springs 8 may be initially straight rectangular strips. The pull of the electromagnet causes them to be bent so that their outer ends become tangential to the abutments 7. The mutual inclination of the ends will also vary with temperature. The slope of the abutment surfaces and of the magnet surface to which the springs are clamped may be adjusted, as described in the first of my patents above mentioned, so that under further compression the laminae wrap upon the abutment without sliding motion, their free length being thus reduced. If required the load-deflection characteristic at different temperatures may be modified by tapering either the straight steel laminations or the bi-metallic laminations of which the springs 8 are composed.

I claim:

1. An electric regulator comprising a carbon pile, an abutment attached to one end of said pile having mutually inclined surfaces, a spring, built of two metals of different coefficients of expansion so that the mutual inclination of its ends varies with temperature, exerting pressure between said abutment surface and the other end of said pile to compress the pile and wrapping upon said abutment as the spring is stressed to reduce the free length of the spring, and an electromagnet and armature opposing the action of said spring upon the pile.

2. An electric regulator comprising a carbon pile, an electromagnet mechanically attached to one end of said pile, an abutment upon said electromagnet, a spring including layers of two metals of different coefficients of expansion united to form a bi-metallic lamina resting tangentially against the surface of said abutment,

an armature for said electromagnet, and means connecting said armature and spring together and to the other end of said pile, so that movement of the armature towards the magnet wraps the spring upon said abutment, and the pile is subjected to the difference between the magnet pull and the spring pressure.

3. In a control apparatus, an abutment device having mutually inclined surfaces, a resilient beam bridging said surfaces including layers of two metals of different coefficient of expansion united to form a bi-metallic spring, an electromagnet having pole pieces, an armature, said pole pieces and armature constituting two relatively movable members, one of said members being connected to said abutment and the other member being connected to the mid point of the resilient beam, said members operating upon energization of the electromagnet to force the mid point of the beam further into the angle between the surfaces of the abutment, causing the end portions of the beam progressively to contact the mutually inclined surfaces, progressively reducing the effective length of the beam bridged between them and progressively increasing the resistance to displacement by the electromagnet, and a carbon pile electric resistance having a movable member for varying the compression of the pile actuated by the relative displacement of said electromagnet pole pieces and armature.

4. An electric regulator comprising a carbon pile, an electromagnet mechanically attached to one end of said pile, an abutment upon said electromagnet, a spring resting tangentially against the surface of said abutment, said spring including layers of two metals of different coefficients of expansion united to form a bi-metallic lamina, an armature for said electromagnet, means connecting said armature and spring together and to the other end of said pile so that movement of the armature towards the magnet wraps the spring upon said abutment, and the pile is subjected to the difference between the magnet pull and the spring pressure.

5. A carbon pile regulator comprising an electromagnet having an essentially non-linear characteristic, a carbon pile, an abutment, a spring adapted to engage said abutment for opposing the

force of said electromagnet, said spring including two layers of metals of different coefficients of expansion united to form a bi-metallic lamina.

6. A carbon pile regulator comprising an electromagnet having an essentially non-linear characteristic, a carbon pile, an abutment, a spring for opposing the force of said electromagnet, said spring being arranged to wrap said abutment to change the effective length thereof and to develop an increasing spring force opposing and substantially balancing the pull of said electromagnet, said spring including two layers of metals of different coefficients of expansion united to form a bi-metallic lamina.

7. A regulator of the character described comprising an electromagnet having an essentially non-linear characteristic, an armature for said electromagnet, a carbon pile and spring means, including a lamina built of two metals of different coefficient of expansion, located between said electromagnet and said pile for applying pressure to compress said pile in opposition to the pull of said electromagnet.

8. A carbon pile regulator of the character described which comprises an electromagnet, a carbon pile, an abutment having an inclined working face, laminated spring means adapted to engage said working face for opposing the force of said electromagnet, said spring means including a lamina built of two layers of metals of different coefficients of expansion and also including at least one lamina having an outwardly tapering cross-section providing a yieldable outer end portion for flatly engaging said abutment and accurately wrapping the same.

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The following references are of record in the file of this patent:

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