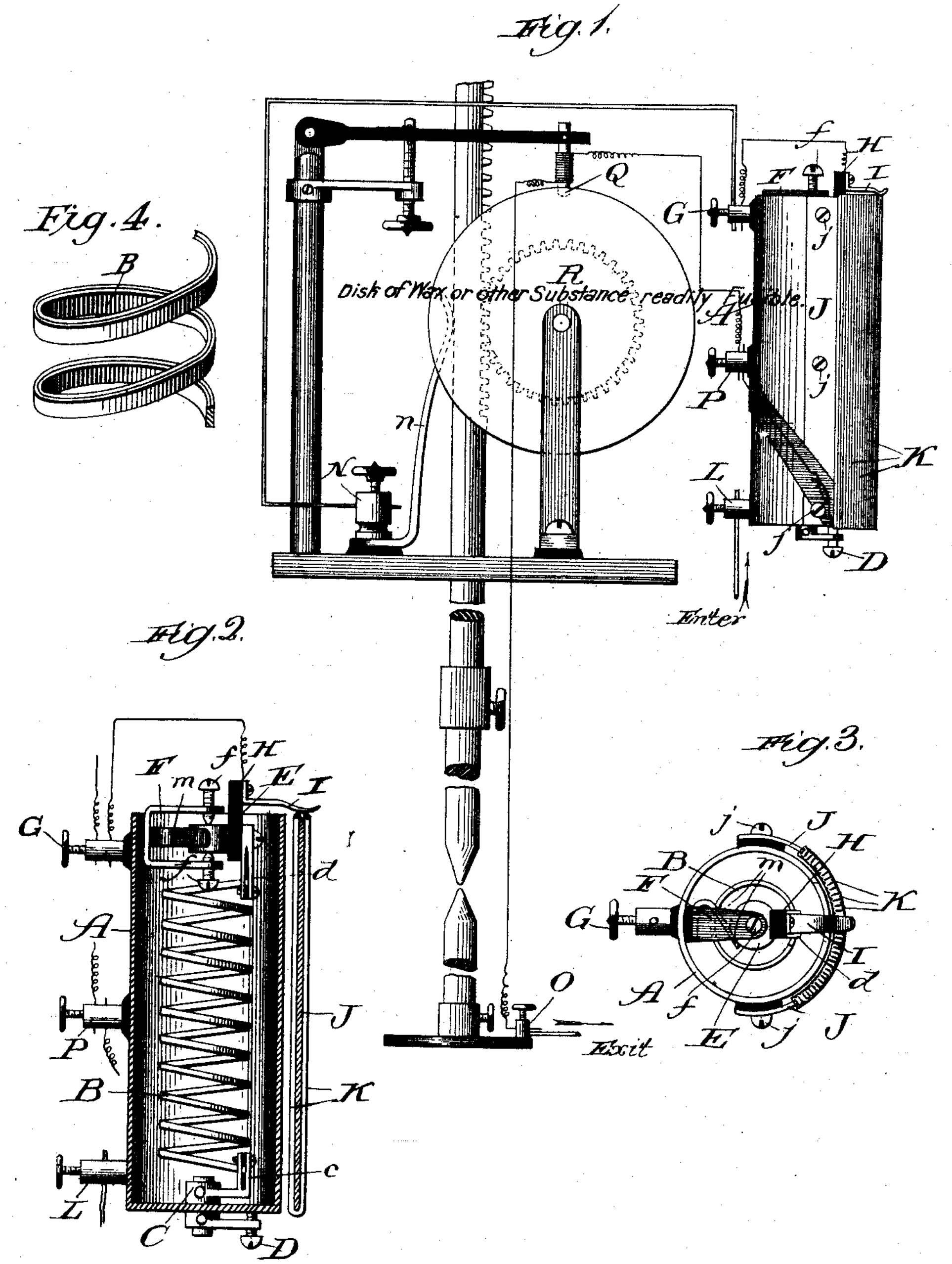
(No Model.)

S. E. NUTTING.

THERMO ELECTRIC RESISTANCE REGULATOR.

No. 421,053. Patented Feb. 11, 1890.



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UNITED STATES PATENT OFFICE.

SAMUEL E. NUTTING, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE NUTTING ELECTRIC MANUFACTURING COMPANY, OF SAME PLACE.

THERMO-ELECTRIC RESISTANCE-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 421,053, dated February 11, 1890.

Application filed August 16, 1889. Serial No. 320,957. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL E. NUTTING, a citizen of the United States, residing at Chicago, Cook county, Illinois, have invented a certain new and useful Thermo-Electric Resistance-Regulator, of which the following is a specification.

The object of my invention, in general terms, is to make and apply an instrument or device that will enable me through variations of heat to regulate or control the resistance to which an electric current is subjected; and my invention consists in the features hereinafter described and claimed.

I have designated my invention as a "thermo-electric resistance-regulator." I use these terms because I propose to regulate or control the resistance of the electric current through the intervention of heat and to secure a variation of the resistance corresponding to variations in the heat to which certain parts of the instrumentalities employed by me are subjected either from the current of electricity itself or the natural changes in the temperature of the atmosphere.

I have in the drawings shown my invention as applied to the derived circuit of an arc lamp; but I desire it to be distinctly understood that I do not mean to limit the application of my invention to an arc-lamp or to a derived circuit, as it is equally applicable to all cases in which a current of electricity in any of the useful arts may be subjected to resistance and where it may be desirable to change or vary the resistance through the influence of heat. While therefore I shall, for the sake of simplicity, describe my invention in connection with the particular object to which I have applied it in the drawings, instead of describing it in connection with the multitude of objects with which it may be employed, I wish it understood that I contemplate its use as broadly as above suggested.

In the drawings, Figure 1 represents a side elevation of the main parts of an electric-arc lamp with one of my thermo-electric resistance-regulators applied to it. Fig. 2 is a vertical section of the regulator with its parts somewhat enlarged. Fig. 3 is a plan view of the same; and Fig. 4 is a plan view of a portion of the heat-movable device, showing that it is composed of different kinds of metal.

In making my thermo-electric resistance-regulator I prefer to use a main tube A, made of metal. It is not necessary, however, that the tube should be of metal, nor that it should be of a material that could be used for conveying the current of electricity. The main object of the tube as such is to afford a frame or bearing, in which the various parts may be located and supported rather than to constitute any portion of the electric circuit. In connection with the tube where one is used, and preferably on the inside, I arrange a device B, constructed on the well-known plan of combining different metals of different capacities for expansion and contraction under changes of heat, so that as it is subjected to the heat of the atmosphere or to heat from any other source it will by its contraction and expansion turn or move in the one direction or the other.

Where the heat-movable device is arranged in a tube, as shown in the drawings, the tube should be open at the top or bottom, or otherwise made so as to expose the heat-movable device to the atmosphere. In the drawings such tube is made open at the top, as shown in Fig. 3.

In the arrangement shown in the drawings, the device intended to be moved by the heat forms a portion or section of the electric circuit and is arranged in the form of a coiled spring, which coils and uncoils by the expansion and contraction of the metal. If a coiled spring be used to form the heat-movable section of the circuit or heat-movable device, it is immaterial whether the coiling be caused by the expansion or contraction of the metal. Either arrangement may be used by putting one or the other of the kinds of metal used in the construction of the spring, if that be the device adopted, on the outside of the coils. I wish, however, to make it plain that I do not confine myself to the use of a coiled spring, or, in fact, to any kind of a spring as such to form the heat-movable device, except in the claims, in which I distinctly call for a "spring," as the result aimed at does not depend upon resiliency or springiness, but upon the capacity of a portion or section of the circuit or device heated by the current of electricity in the circuit or by the heat of the atmosphere, whether it be a spring or other thing, to change its position in one one direction or the other constantly and regularly under the influence of heat.

I merely show and describe a spring as a matter of convenience, but mean to include a much broader and more comprehensive instrumentality than a spring, and, in fact, to include anything in the circuit or that may be arranged in such nearness of relation to the circuit as to enable the circuit to impart heat to it or to be operated upon by the heat of the atmosphere, so as to cause it to move in the one direction or the other under the influence of heat.

One end of the spring—for as a spring is shown in the drawings, I will employ language appropriate to the thing illustrated—is attached to a block or piece C, that may be adjusted or turned around in the one direction or the other and held at any determinate position by a set-screw D or other convenient means. To effect the connection between the end of the spring and the adjustable block, I employ a projecting arm *c* to clasp the end of the spring, although any other means of connection may be employed, if desired. After the position of the block has been determined upon and it has been adjusted to such position, it is held fixed by the set-screw, so that the end of the spring connected with it will always be held in a fixed or non-rotating position. The other end of the spring is clasped or held in an arm *d*, which is fastened, preferably, by a screw to the pivoted or rotatable block E. I have shown a piece of insulating material interposed between the arm *d* and the pivoted block, although it is obvious that the arm and the block can be connected directly together, and I merely show the piece of insulating material between them as a convenient arrangement. When the insulating material is used, it will of course be understood that the screw fastening the arm *d* to the rotatable block passes through it, so as to convey the current of electricity to the block and prevent a break in the circuit. The rotatable or pivoted block is arranged so that it may freely turn in the one direction or the other through the means of a **U**-shaped bracket F and screws *f*, whose points project through the arms of the bracket and bear against the opposite sides of the rotatable block. This affords an easy and convenient way of pivoting this block so that it may freely rotate, although any other suitable means may be employed, if preferred. When I use this **U**-shaped bracket, however, I also prefer to use as a convenient means of fastening or holding it in place a screw G, which also operates as a binding-post to afford a proper connection or fastening for the wire composing the circuit, and which passes through the tube A and screws into the bracket, so as to hold it properly and securely in place. The bracket, as shown in the drawings, is insulated from the wall of the tube, as is also the screw G. In the arrangement shown there is fastened to the rotatable block, so as to rotate with it, a piece of insulating material H, which I have before said may be dispensed with, if desired. When it is used, however, it is intended to be turned or moved in the one direction or the other as the rotatable block turns, and has a current-conductor I attached to it, so as to extend out to one side over the top of the tube and turn or move with it. When the insulating-piece is dispensed with, the current-conductor should be otherwise connected through some proper means with the rotatable block, so as to be carried with it as it turns or rotates. As the heat-movable section of the circuit, or the device which the heat of the circuit or of the atmosphere operates upon, moves in the one direction or the other under the influence of heat, it will carry or move the current-conductor with it in corresponding direction and to a distance always proportioned to the distance to which it turns or moves under the influence of heat.

Arranged outside of the main tube is preferably a supplementary tube J, which need, however, only be a section of a tube. In Fig. 3, which is a plan view, it will be seen that the supplementary tube is only arranged to encompass the main tube to the extent of one-half its circumference, although it may encompass it to a greater or less extent, as desired. It is preferably fastened to the main tube, with insulating material interposed between, as shown at the screws *j*, although other means of holding it in place may be employed. The supplementary tube is preferably of the same degree of curvature as the main tube, and it is intended to support or have on it a longitudinally-arranged resistance-coil K. The upper ends of this resistance-coil or series of wire are bare or exposed, and the current-conductor rests upon or in contact with them and is adapted to be moved, as before explained, in the one direction or the other over the exposed ends.

I will now describe the operation of my thermo-electric resistance-regulator as applied to the arc lamp shown in the drawings to illustrate how it may be applied and operated in the multitude of uses to which it is applicable in the useful arts. The current of electricity from the circuit enters the regulator at the post L. It then passes to the adjustable block, whence it enters the coil or heat-movable device and passes through it, heating it and causing it to turn or move in the one direction or the other. It then passes into the rotatable block and through the brush M into the screw or binding-post G. It then follows the wire of the main circuit around through the binding-post N and the connecting-piece *n* into the upper carbon, whence it passes down through the arc and out of the lamp at the binding-post O. Going back now to the binding-post G, a derived circuit passes around through the wire to the current-conductor I, which, as before said, is in contact with the exposed ends of the resistance-coil arranged on the supplementary tube. The position of this conductor, as before explained, will be governed by the position of the heat-movable device, which is represented in the drawings by the coiled spring B. The current of electricity will therefore enter the resistance-coil on the supplementary tube at that point where the current-conductor rests. If that point be near the exit end of the resistance-coil, its wire will afford much less resistance to the current than if it be far from its exit end. The amount of resistance, therefore, that will be produced by the wire of the resistance-coil will depend upon the position of the current-conductor, which, as before explained, is governed by the heat acting upon the coil-spring or other heat-movable device. When the current has entered the wire of the resistance-coil, it passes back and forth along the same until it finally passes out of the coil and up to the binding-post P. From this binding-post it passes to a heat-conductor Q. The end of this heat-conductor is embedded in or in contact with a softenable substance R, which softens or liquefies as it becomes heated and permits the upper carbon of the lamp when used in a lamp to gradually move down as it is consumed, so as to always preserve the distance between the points of the upper and lower carbons. The arrangement of the heat-conductor and the softenable material with which it is in contact, or in such relation to as to impart its heat to it, are fully described and claimed in application Serial No. 303,000, filed by me March 12, 1889, and Serial No. 308,922, filed by me April 29, 1889, and need not therefore be described minutely or in detail. From the heat-conductor the derived circuit passes down the wire outside of the arc and enters the binding-post O, where it again joins the main current and passes on its way.

It will be apparent on reflection that a coiled spring or other heat-movable device, when arranged as shown in the drawings, where it is adapted to be heated by electricity, will be influenced by at least two sources of heat—that of the atmosphere and that of the electric current. Where the regulator is intended to be applied, as shown in the drawings, to regulate the amount of current supplied to a heat-conductor in contact with a softenable substance to soften or liquefy the same, I prefer to subject the heat-movable device to heat additional to that contained in the atmosphere, so that a sufficiency of current will always be insured to soften or melt the softenable substance. When, however, it is applied to other purposes, the heat contained in the atmosphere alone will be sufficient to cause the heat-movable device to move in one direction or the other and so to regulate the amount of resistance offered to a current of electricity by the resistance-coil. I wish this distinctly understood, as I shall frame some of my claims broad enough to cover a regulator in which the heat-movable device is intended to be moved and controlled by the heat contained in the atmosphere, and also by such heat supplemented by an additional amount imparted by electricity. Where the heat-movable device is intended to be operated upon by both sources of heat—that of the atmosphere and that of the electric current—it should be arranged under atmospheric heat in such position as to cause the conductor to rest upon the resistance-coil at that point where the resistance afforded by its wire will be less than the resistance needed to reduce the current passing from it to barely the amount necessary to do the work required, allowing the additional heat imparted by the current of electricity to the movable device to move the current-conductor a sufficient farther distance to secure the additional resistance desired. To illustrate this, it may be supposed that the amount of resistance desired to permit just enough of the current of electricity to pass through the derived circuit to the heat-conductor to soften or liquefy the softenable material with which it is in contact on the day the regulator is put into operation may be represented by fifty, and that the heat imparted by the current of electricity to the movable device will cause the current-conductor to move over the resistance-coil far enough to add twenty. The current-conductor in that case should, under atmospheric heat, be placed at that point where the current leaving it and passing through the resistance-coil would meet with a resistance equal to thirty by the time it left the coil and passed on its way to the heat-conductor. We would thus have a resistance gaged at thirty under the heat of the atmosphere on the day when the regulator was started and brought to fifty by the additional heat of the electric current. Of course the position of the current-conductor will be constantly varying to correspond with the variations in the heat of the atmosphere; but as the softenable substance to be operated upon will correspondingly be affected by the heat of the atmosphere, so as to require a greater or less amount of current to soften or liquefy it, so that the parts can operate, and as the heat of the current of electricity remains a certain quantity ascertained and provided for in the original adjustment of the regulator, the resistance of the resistance-coil will be constantly just that amount that will enable just that quantity of the electric current to pass through the derived circuit and operate upon the heat-conductor as will soften or liquefy the softenable substance and permit the parts to operate. When the temperature of the atmosphere is high, so that the softenable substance will be easily melted, the resistance afforded by the resistance-coil will be great, permitting but a slight quantity of the electric current to pass through the derived circuit and operate on the heat-conductor, while, when the temperature of the atmosphere is low, so that the softenable substance will be harder to soften or to liquefy, the resistance afforded by the resistance-coil will be correspondingly less, so that a greater quantity of the electric current will pass through the derived circuit and operate on the heat-conductor. In this way a constant compensation for the variations of the atmospheric temperature is secured or effected, so that whether the temperature be high or low the softenable substance will always be acted upon just to the extent desired to secure the successful operation of the parts.

What I regard as new, and desire to secure by Letters Patent, is—

1. The combination of an electric circuit, a heat-movable device, a variable resistance, a current-conductor connected to the movable device and carrying a current of electricity to the variable resistance, means for adjusting the movable device to the atmospheric temperature on the day it is set in operation, and a device or object which is itself affected by atmospheric changes of temperature and is operated upon by the regulated current, substantially as described.

2. The combination of an electric circuit, a heat-movable section of such circuit, a variable resistance, a current-conductor connected to the movable section and conveying a current of electricity to the variable resistance, means for adjusting the movable section to the atmospheric temperature on the day it is set in operation, and a device or object which is itself affected by atmospheric changes of temperature and is operated upon by the regulated current, substantially as described.

3. The combination of an electric circuit, a spring movable in one direction or the other by the agency of heat, and a resistance-coil, a current-conductor connected to the spring and conveying a current of electricity to the resistance-coil and moved to different positions on the coil as the spring is moved, substantially as described.

4. The combination of an electric circuit, a spring coilable or uncoilable by the agency of heat, a resistance-coil, and a current-conductor connected to the spring and conveying a current of electricity to the resistance-coil and moved to different positions on the coil as the spring is coiled or uncoiled, substantially as described.

5. The combination of an electric circuit, a heat-conductor to which heat is imparted by the circuit, a softenable substance adapted after being softened to harden in an operative position in contact with the heat-conductor, and means for regulating the amount of heat imparted to the heat-conductor to compensate for variations in the temperature of the atmosphere, substantially as described.

6. The combination of an electric circuit, a heat-conductor to which heat is imparted by the circuit, a softenable substance adapted after being softened to harden in an operative position in contact with the heat-conductor, a heat-movable device, a resistance-coil, and a current-conductor connected to the movable device and conveying a current of electricity to the resistance-coil and moved to different positions on the coil as the movable device is moved, whereby the amount of heat imparted to the heat-conductor is regulated to compensate for variations in the temperature of the atmosphere, substantially as described.

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