No. 639,725. Patented Dec. 26, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed June 15, 1898.)

(No Model.) 3 Sheets—Sheet 1.

FIG. 1.

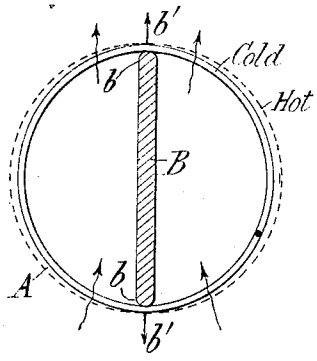


FIG. 2.

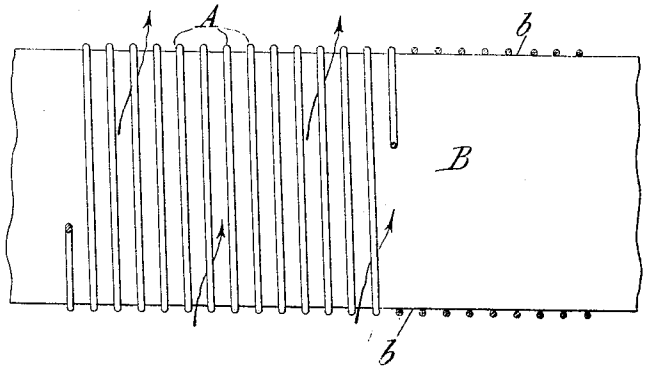


FIG. 3.

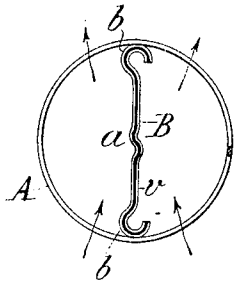


FIG. 4.

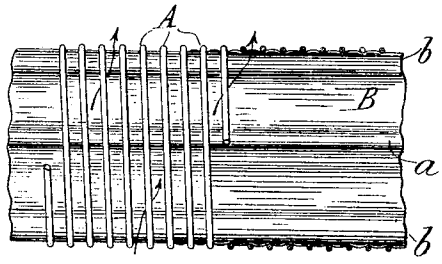


FIG. 5.

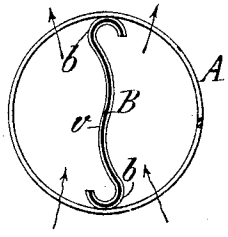


FIG. 6.

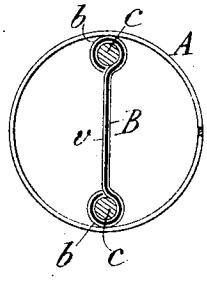


FIG. 7.

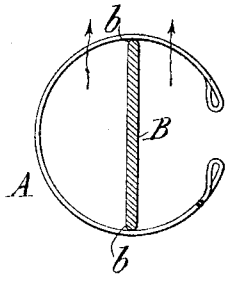
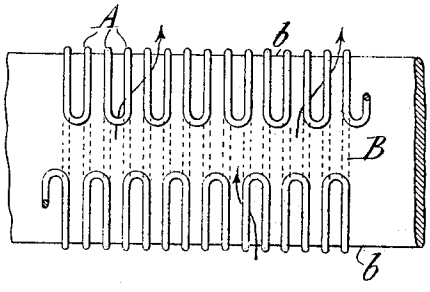


FIG. 8.



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No. 639,725. Patented Dec. 26, 1899.

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(Application filed June 15, 1898.)

(No Model.) 3 Sheets—Sheet 2.

FIG. 9.

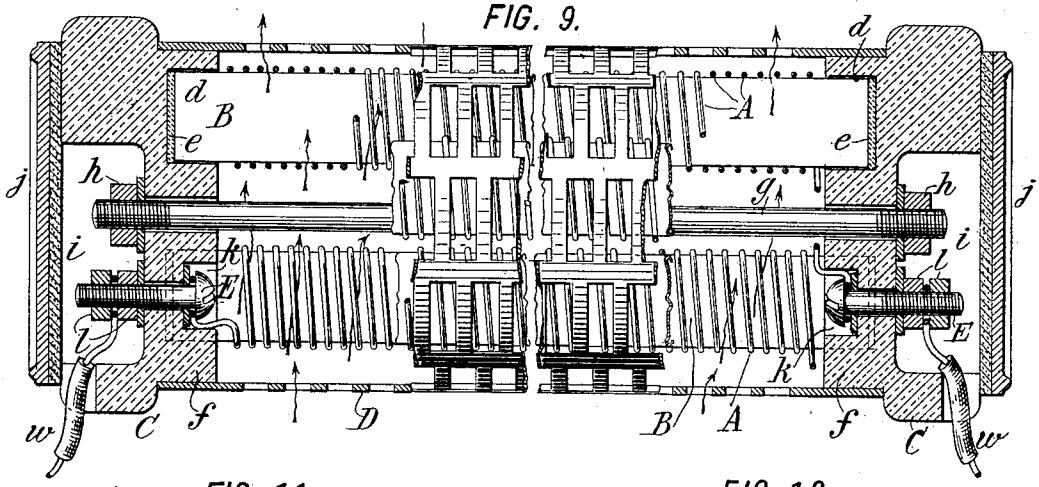


FIG. 11.

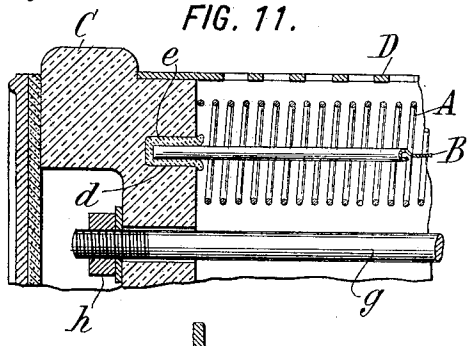


FIG. 10.

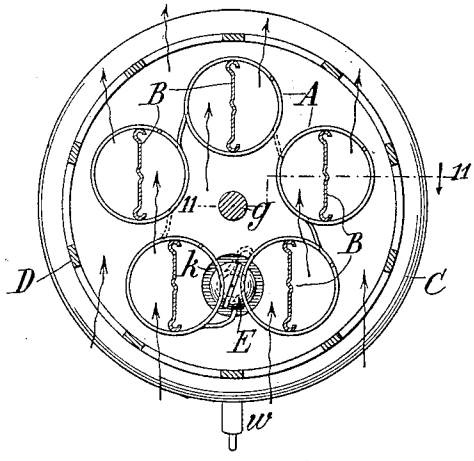


FIG. 12.

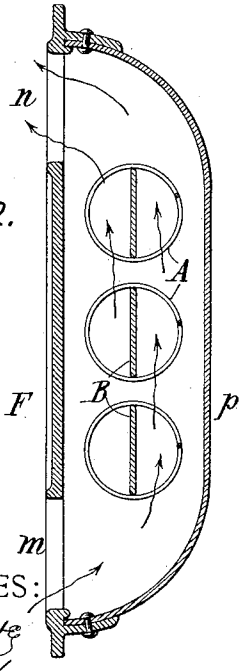
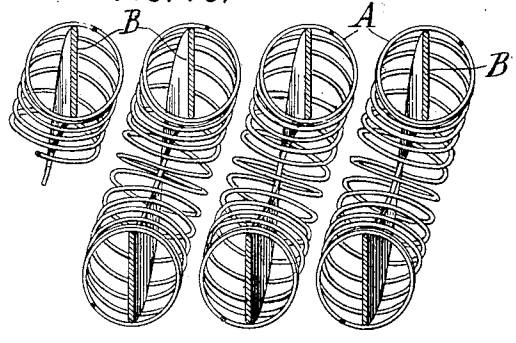


FIG. 13.



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No. 639,725. Patented Dec. 26, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed June 15, 1898.)

(No Model.) 3 Sheets—Sheet 3.

FIG. 14.

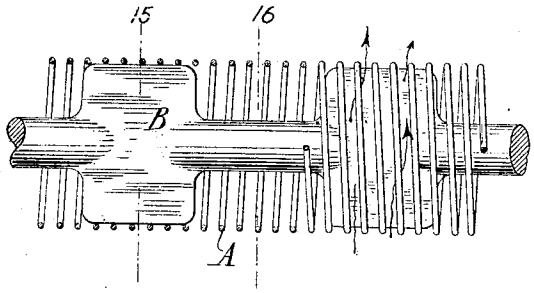


FIG. 15.

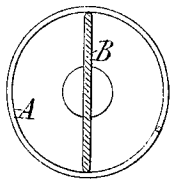


FIG. 16.

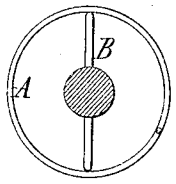


FIG. 17.

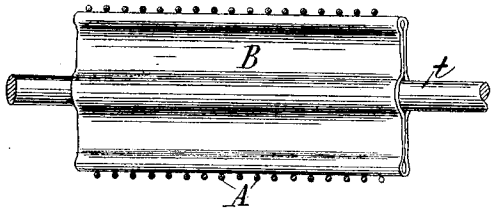


FIG. 18.

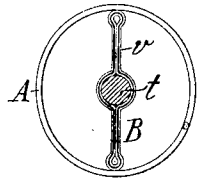


FIG. 19.

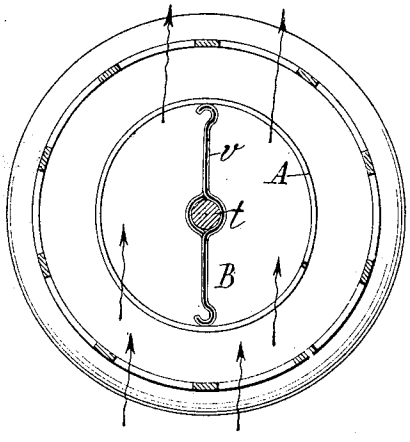
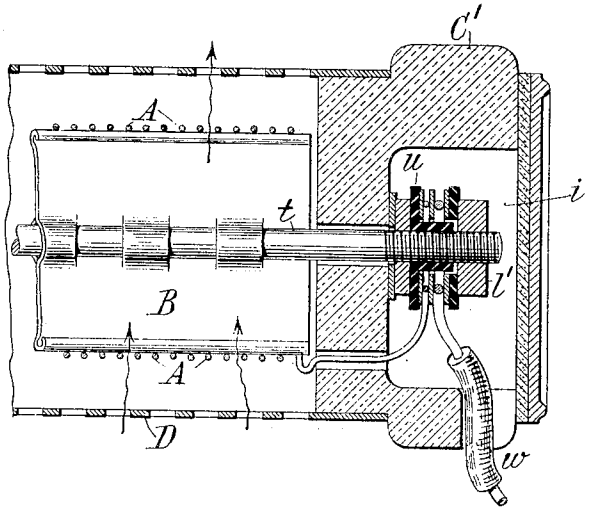


FIG. 20.



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UNITED STATES PATENT OFFICE.

EDWARD E. GOLD, OF NEW YORK, N. Y.

ELECTRIC HEATER.

SPECIFICATION forming part of Letters Patent No. 639,725, dated December 26, 1899.

Application filed June 15, 1898. Serial No. 683,502. (No model.)

To all whom it may concern:

Be it known that I, EDWARD E. GOLD, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Electric Heaters, of which the following is a specification.

This invention relates to electric heaters wherein the heating element is a resistant wire wound into a helix or other coil and supported in the air in such manner as to expose the greater part of the wire to air circulation. My invention aims to provide an improved heater of this type wherein the coil of resistant wire will be more firmly and effectually supported than heretofore.

According to my invention I wind the resistant wire preferably into a helix or any similar or equivalent coil, the adjacent convolutions of which are out of contact. I then mount this coil upon a suitable support extending within it and engaging the coil at mutually-opposed points in its perimeter or periphery, the dimensions of the support being such with reference to the coil as to slightly distort the latter by forcing it out of its natural shape, so as to put the individual loops or convolutions of the coil under tension transversely of the wire, so that the effort of the loop or convolution to resume its natural shape causes it to maintain a pressure against the points of support such as to hold it firmly in place, while the loops or portions of wire between the supporting-points being curved through the air and held in place by their own stiffness are free to expand and contract with variations in temperature. The support extends longitudinally of the coil and preferably engages the latter continuously, so that each convolution of the coil is supported and maintained under tension. In the most simple arrangement the points of support are diametrically opposite and constitute lines or ridges parallel with the direction of the coil and are arranged slightly wider apart than the diameter of the coil, so that if the coil be wound upon a cylindrical mandrel so that it tends to assume in cross-section the form of a circle it is forced when applied on the support into slightly elliptical form. The simplest form of the support is that of a strip of metal slightly wider than the diameter of the coil and forced into the coil so as to slightly distend or distort the latter. The support is preferably arranged in a vertical plane, so as to afford the minimum obstruction to the ascending currents of heated air, and thereby promote the most effective ventilation of the heater.

In constructing an electric heater according to my invention it is of course necessary to provide some means of supporting the support. For this purpose I prefer to provide opposite end heads, of porcelain or other insulating material, having recesses or sockets for receiving the ends of the support and preferably constructed to receive a plurality of supports and their coils, a tubular and open-work or foraminous casing adapted to permit free ventilation through it being preferably arranged to inclose the coils and to extend between the heads. Binding-posts are applied to the opposite heads for effecting the circuit connections with the terminals of the resistant wire.

I will now proceed to describe my invention with reference to the accompanying drawings, wherein—

Figure 1 is a cross-section of the resistant coil and its support. Fig. 2 is a side elevation of Fig. 1, partly in section. Fig. 3 is a transverse section showing the preferred construction. Fig. 4 is a side elevation of Fig. 3, partly in section. Figs. 5, 6, and 7 are transverse sections illustrating variations of the construction, Fig. 8 being a side view of Fig. 7. Fig. 9 is a sectional elevation of a complete electric heater embodying my invention, its end portions being shown in vertical mid-section. Fig. 10 is a transverse section thereof. Fig. 11 is a fragmentary horizontal section on the line 11 11 in Fig. 10, except that the rod *g* and support B are shown in plan. Fig. 12 is a transverse section of an upright type of heater embodying my invention. Fig. 13 is a vertical mid-section showing my invention as applied in the construction of a heater having a compound helix of resistant wire. Fig. 14 is a sectional side view of another modification, of which Figs. 15 and 16 are transverse sections cut on the dotted lines 15 and 16, respectively. Fig. 17 is a fragmentary side elevation of another modified construction, of which Fig. 18 is a transverse section. Fig. 19 is a transverse section of a sin-

gle-coil heater and its casing, Fig. 20 being a longitudinal mid-section of one end portion thereof.

In all the drawings, let A designate a coil of resistant wire having sufficient stiffness or resiliency to retain its coiled or helical form and resist somewhat strongly any effort at distortion of such coil.

Let B designate a support for the coil, which must be either of insulating material or be insulated in some suitable way at the points or edges *b b* where it touches the coil.

Referring to Figs. 1 and 2, the coil A is here shown as a helix formed by winding the wire upon a cylindrical mandrel, so that its convolutions tend to assume the form of a circle. The support B is a strip of suitably-stiff material slightly wider than the internal diameter of the helix when at rest and forced into the helix, so as to slightly distort the same out of a true circle and into approximately elliptical form. The distortion is very slight, since the stiffness of the wire is such as to cause it to firmly resist even a slight distortion, and hence when only slightly distorted to press firmly against the opposite edges *b b* of the supporting-strip, thus generating sufficient friction thereagainst to prevent any possible displacement of the convolutions of the coil by reason of jarring or other disturbance to which the heater may be subjected in practical use, even when the tension of the wire is somewhat relaxed by reason of its being highly heated by the passage of the electric current. The coil is wound openly—that is, with its successive convolutions spaced sufficiently apart to prevent any possibility of their touching one another, and thereby short-circuiting any portion of the wire, and also sufficiently to enable the air to freely circulate between them in order to rapidly and efficiently abstract heat from the wire—in order that the heat may be conducted away by the air and in order also to prevent overheating of the wire. The degree of openness shown in Fig. 2 is suitable. The friction generated at the contact of the convolutions of wire with the supporting-strip is sufficient to prevent any displacement of the convolutions toward or from each other. It is preferable to wind the coil with the exact degree of openness required in order that the wire convolutions shall be under no tension causing them to seek to approach toward or recede from one another. In case the coil is arranged horizontally, as shown, the frictional engagement referred to will always be sufficient, and by a sufficient distortion of the coil on its support such friction may be sufficient, even in case the coil is to be arranged vertically and subjected to considerable vibration; but in the latter case, if it is desired to effectually guard against any possible variation in spacing of the convolutions, the edges *b b* of the strip may be corrugated or given a wavy contour approaching to serrations, thereby forming very shallow notches, in which the wires may lie, as shown at the right in Fig. 4, where the wires are in section. This detail forms one feature of my invention, but one which will rarely be useful. With a strip thus corrugated on its edges it may be introduced into the helix by screwing it in.

As it is preferable to employ naked wire in an electric heater, it is necessary that the supporting-strip B shall either be of insulating material or shall be insulated from the wire at its edge portions where it touches the latter. The insulation used must be capable of withstanding the high temperature of the heater and should also be incapable of absorbing moisture. While a wrapping of asbestos would serve, yet in practice I prefer to employ a vitreous enamel. In order that the support may have sufficient strength, I prefer to make it of metal, and in order that the enamel shall properly cover its edges I avoid any sharp corners or angles and make the edges with gently-curved surfaces. The preferred construction of supporting-strip is that shown in Fig. 3, where the strip is made of sheet metal, preferably sheet-steel, with its edge portions *b* bent into a curve and its middle portion *a* strengthened by longitudinal corrugations, the metal thus shaped being then coated with enamel. The curved or semitubular edge portions *b b* not only serve to stiffen the strip transversely, but also, as stated, to facilitate the addition of an even and thick coating of enamel, while the central corrugations *a* contribute to the stiffness of the metal.

Fig. 5 shows a modified cross-section of strip. Fig. 6 shows a further modification in which greater stiffness is attained by wiring the edge portions by bending them around wires or rods *c c*.

In all the constructions described the support B occupies substantially a vertical plane in order to obstruct as little as possible the ascending air-currents, by which the wires are cooled, and which currents are shown by the waving arrows.

My invention is to be distinguished from those constructions of electric heater heretofore proposed in which a thin supple or substantially non-resilient wire has been wound over a flat reel, the same as if, for example, such a wire were wound around the support shown in Fig. 6, being stretched in a straight line between the opposite arms *c c* of the support. With heaters so constructed serious difficulty has been encountered because of the frequent breakages of the wire, due probably to unequal expansion and contraction in heating and cooling. When the current is turned on to an electric heater, the wire thereof, if heated, as it should be, not above a black heat, elongates in the neighborhood of two per cent. With a flat reel-heater, the wire, being first heated, expands and becomes slack upon its support, which endangers the displacement of its convolutions into contact with each other unless confined in notches in

the supporting-reel. Gradually the support is heated and expands, so as to retighten the wire. Then when the current is turned off the wire cools more rapidly than its support and in contracting thereagainst is subjected to severe strain. These operations, succeeding one another at intervals during the use of a heater, are liable eventually to cause the wire to break. My invention is wholly free from this disadvantage. The wire is not stretched between the opposite points of support, but is extended between them in a loop or curve, so that expansion and contraction are taken up in each such loop between the points of support, and the wire, instead of being limp or supple, is stiff and resilient, so that each loop of wire retains its curved form, without liability of its displacement or change of shape, except to the minute extent that each curve or loop enlarges or diminishes according to expansion or contraction, and the force pressing the wire against its support is the lateral springiness of the wire and not the stretch or tautness imparted to it in winding it originally upon its support. Hence the wire cannot become slack upon its support, since its springiness enables it to give or take as the support expands or contracts.

Fig. 1 illustrates the principle of my invention. The support B resists the tension of the wire coil in the direction of the arrow-heads at b' b'. The wire when cold takes the form of a distorted circle, as shown by the full line, and when heated may expand outwardly, as shown to an exaggerated extent by the dotted line.

While it is preferable to make the coil by winding the wire continuously in one direction, thereby forming a helix, yet my invention is not confined to this mode of winding the wire, as the latter may be carried back and forth in alternated or zigzag loops, an example of which is shown in Figs. 7 and 8, which show the wire alternated back and forth in **C** form in cross-section and having an internal support similar to Fig. 1.

Figs. 9, 10, and 11 show a complete heater embodying my invention in its preferred form. The supports B are the same as shown in Fig. 3. These are supported at their opposite ends in two heads C C, preferably of porcelain. These heads have upright recesses d d to receive the ends of the supporting-strips, and to prevent rattling a packing of asbestos or other suitable soft material e is folded around the end of each strip, as shown in Fig. 11. The heads are held apart in any suitable manner, preferably by means of an intervening open-work tube D, constituting a ventilating-casing. This is preferably made of perforated sheet metal, as shown, and preferably its ends fit over bosses f f, formed on the heads. The heads are drawn tightly together against the ends of the tube or casing D by means of a central bolt g, having screw-threaded ends, on which nuts h h are screwed. The heads are preferably formed with recesses i in their outer sides, covered by cap-plates j, in which recesses the bolt ends and nuts are sunk. Binding-posts E E are arranged to pass through the opposite heads, the heads of these posts being preferably sunk in recesses k, where they make connection with the opposite ends of the resistant wire, while their threaded shanks receive ends l l, located in the chambers i, between which nuts is clamped the end of the circuit-wire w, which passes out through a notch in the head. I have shown five coils A inclosed within the casing, although any other number of coils may be used as may be desired. I have shown the coils connected in series, the wire being continuous in all the coils; but this is not essential, since any suitable electrical arrangement may be employed, the coils being connected in series or in multiple, as may be desired. The construction of heater shown is very compact, introduces a great length of wire into a cylindrical casing of comparatively small size, and by hanging this casing horizontally beneath a car-seat or in other location, so as to permit the air to freely circulate through it, a large volume of air may be efficiently heated.

Where a panel-heater is desired—as, for example, for location in the panel-board under the longitudinal seats of electric cars—I may employ the construction shown in Fig. 12, where I have shown three coils A arranged one above another in a casing which is constructed of a front plate F, having grated air inlet and outlet openings m n, a curved back plate p, which may be of sheet metal, being arranged to close the back of the heater.

My invention is applicable to those heaters in which the wire is wound into a helix, which in turn is itself wound helically, thereby constituting a compound helix, although this construction is less advantageous than that first described. Here the supporting-strip B is bent into the form of a spiral blade (see Fig. 13) such as are used in screw conveyers, whereby it is given all needed stiffness and whereby for a horizontal heater each portion of the supporting-strip occupies a vertical plane affording the minimum obstruction to the ascending air. In short, this is the heater shown in Fig. 1 developed into a helix.

It is not essential to my invention that every convolution of the coil shall be in contact with the support. Instead the contact may be intermittent—that is to say, one, two, or more convolutions may be in contact with the support, the next one, two, or more convolutions may be out of contact, and the convolutions next succeeding those may again be in contact, and so on. In such case only the supported convolutions are distorted out of their natural shape, the intervening or unsupported convolutions retaining their natural shape. Such construction will be practical, provided the intermittent support makes contact at sufficiently close intervals with the coil so that the unsupported convo-

lutions do not contain so great a length of wire as to permit them to sag or vibrate to an inadmissible extent. Such a construction is shown in Figs. 14 to 16, where the support consists of a rod flattened at intervals, the flattened portions being of a width equal to that of the strip B in Fig. 1 or slightly exceeding the natural diameter of the coil. Such a rod, if of metal, should, of course, be enameled.

Figs. 17 and 18 show a construction in which the supporting-strip B is carried on a central rod *t*, which may be concentric with the coil. The strip B is shown as made of sheet metal folded around the rod and suitably corrugated, being, of course, enameled. Figs. 19 and 20 show a one-coil heater of substantially the construction just described. The metal strip B is of the same construction shown in Fig. 3, except that its middle portion is slitted and opened out to opposite sides to form an eye, through which the rod *t* is passed. The ends of the strip B may extend close to, but need not be embedded in, the porcelain heads C', while the rod *t* passes through these heads, its screw-threaded ends entering the recesses *i* in the respective heads. As shown, the end of the rod constitutes not merely the means for holding the heads together against the casing B, but also takes the place of the binding-posts for connecting the wires, the end of the resistant wire being carried out through a hole in the head and looped around the end of the rod, while insulated therefrom by a bushing *u*, and the end of the wire *w* being similarly looped around this bushing and clamped against the resistant wire by a nut *l'*.

In the drawings the letter *v* designates the coating of enamel.

The present application is in part specific to my application, Serial No. 682,248, filed June 1, 1898, and I make no claim herein to anything claimed in that application.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. An electric heater comprising an open coil or helix of resilient resistant wire and an internal support therefor making contact with it at opposed points in its perimeter and arranged to press its convolutions wider apart at said points than its natural shape, whereby it maintains a pressure against said support at said points while its intermediate portions are free to expand and contract.

2. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and a support B therefor consisting of a strip within said coil touching it at mutually-opposed points in the perimeter of the coil.

3. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and a support B therefor engaging it at mutually-opposed points in the perimeter of the helix, said support arranged vertically to permit free access of ascending air-currents to all portions of the coil.

4. In an electric heater, the combination with an open coil or helix A of resilient resistant wire, and a support B therefor consisting of a strip arranged within the coil in a vertical plane and touching the coil at its opposite edges, the coil and support being extended in substantially horizontal direction.

5. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and an internal support B therefor engaging it at mutually-opposed points in the perimeter of the helix, curved at said points of contact, and having said curved contact portions coated with enamel.

6. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and an internal support B therefor consisting of a strip of sheet metal having its opposite edges *b* curved or beaded and coated with enamel and said edges engaging the coil at mutually-opposed points in the perimeter thereof.

7. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and an internal support B therefor consisting of a strip of sheet metal stiffened by longitudinal corrugations and coated with enamel at its opposite edges, and said edges engaging the coil at mutually-opposed points in the perimeter thereof.

8. In an electric heater, the combination of an open coil or helix A of resilient resistant wire, and a support B therefor having its opposite edges indented at intervals corresponding to the pitch of the coil, the support inserted within the coil adapted to press its convolutions apart at its points of contact therewith, whereby the coil maintains a pressure against the support at said points, and receiving the convolutions of the coil in such indentations.

9. The combination of an open coil A of resilient resistant wire, a supporting-strip B therein with its edges touching the interior of the coil on opposite sides, and end supports or heads C engaging the ends of said strip.

10. The combination of an open coil of resilient resistant wire, a longitudinal support therefor within the coil engaging it at mutually-opposed points in the perimeter of the coil, opposite heads supporting the opposite ends of said support, and means connecting said heads to prevent their separation.

11. The combination of an open coil of resilient resistant wire, a longitudinal support therefor within the coil engaging it at mutually-opposed points in the perimeter of the coil, opposite heads supporting the opposite ends of said support, and an open-work casing inclosing the coil and support between said heads.

12. The combination of resilient resistant coils A A, internal supports B B therefor, each support engaging its coil at mutually-opposed points in the perimeter of the latter

and arranged vertically to permit free access of ascending air-currents to all portions of the coil, and end heads C C, to which the ends of said supports are fastened to uphold them and maintain their vertical arrangement within the coils.

13. The combination of resilient resistant coils A A, internal supporting-strips B B therefor, their edges touching said coils at opposite points therein, and said strips arranged each in a vertical plane to permit free access of ascending air-currents to all portions of the coil, and opposite end heads C C having recesses receiving the ends of said strips to support them and retain them in said vertical planes, and means for connecting said heads to prevent their separation.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

EDWARD E. GOLD.

Witnesses:
FRED WHITE,
THOMAS F. WALLACE.