No. 621,604. Patented Mar. 21, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed Jan. 8, 1898.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

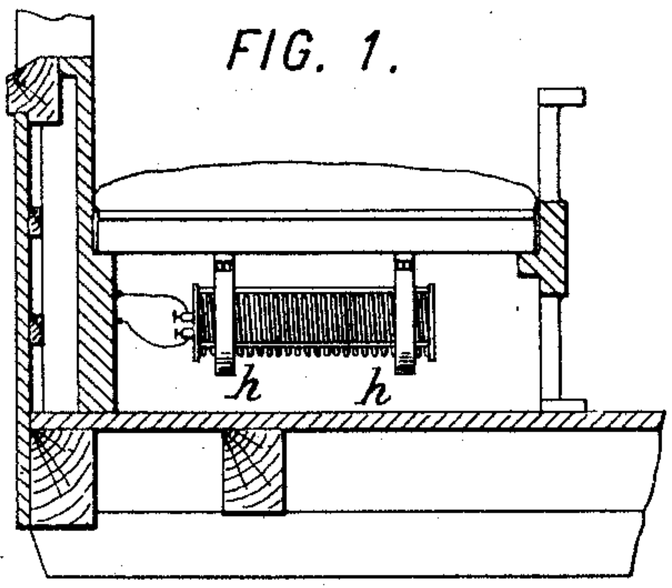


FIG. 2.

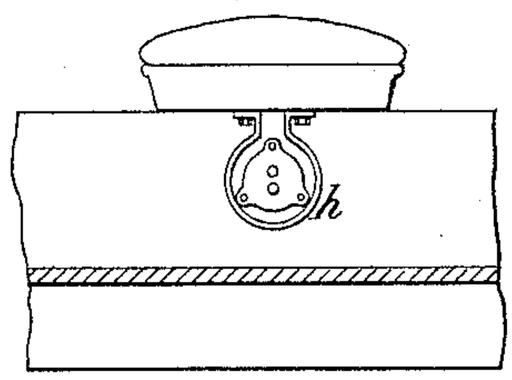


FIG. 3.

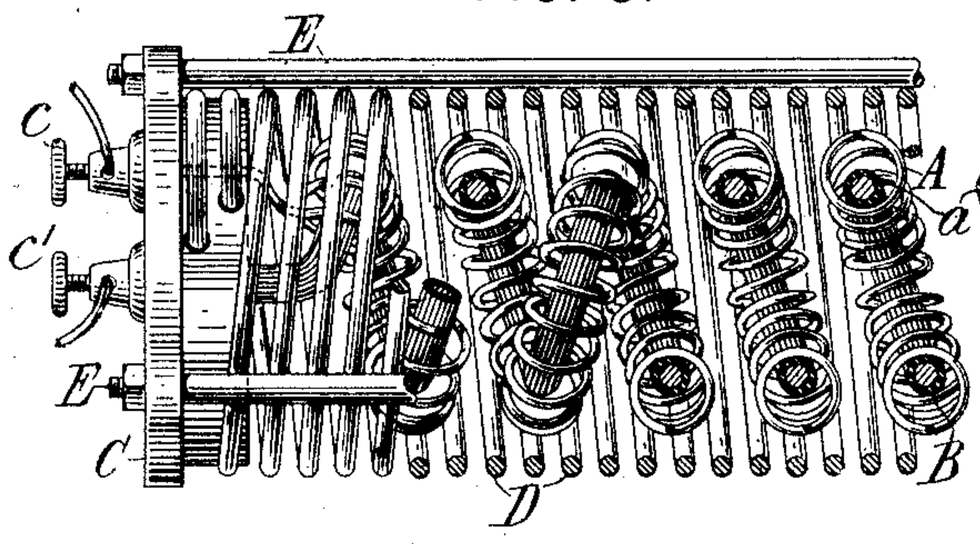


FIG. 4.

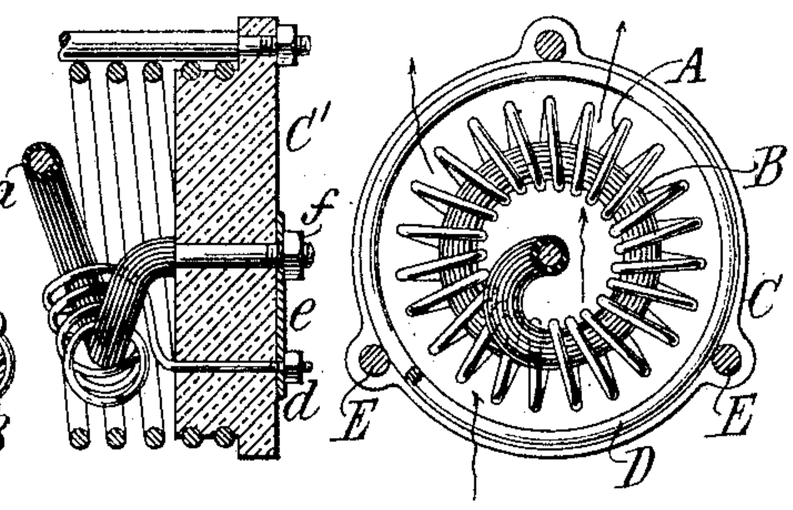


FIG. 5.

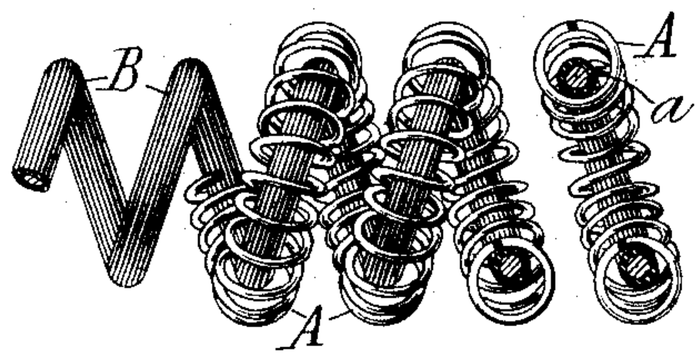


FIG. 6.

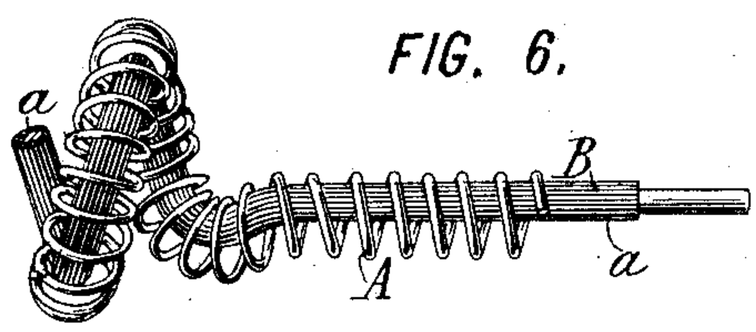


FIG 7.

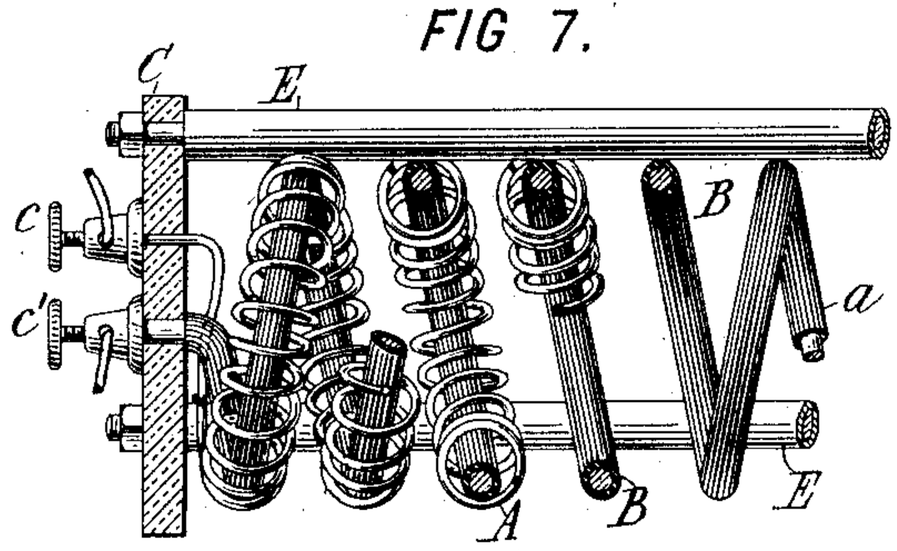
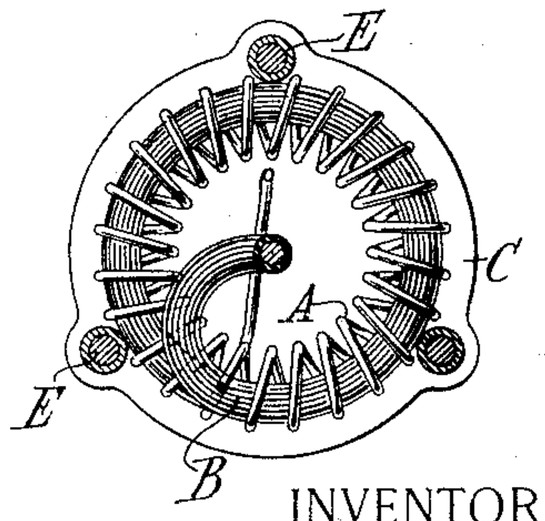


FIG. 8.



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No. 621,604. Patented Mar. 21, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed Jan. 8, 1898.)

(No Model.) 2 Sheets—Sheet 2.

FIG. 9.

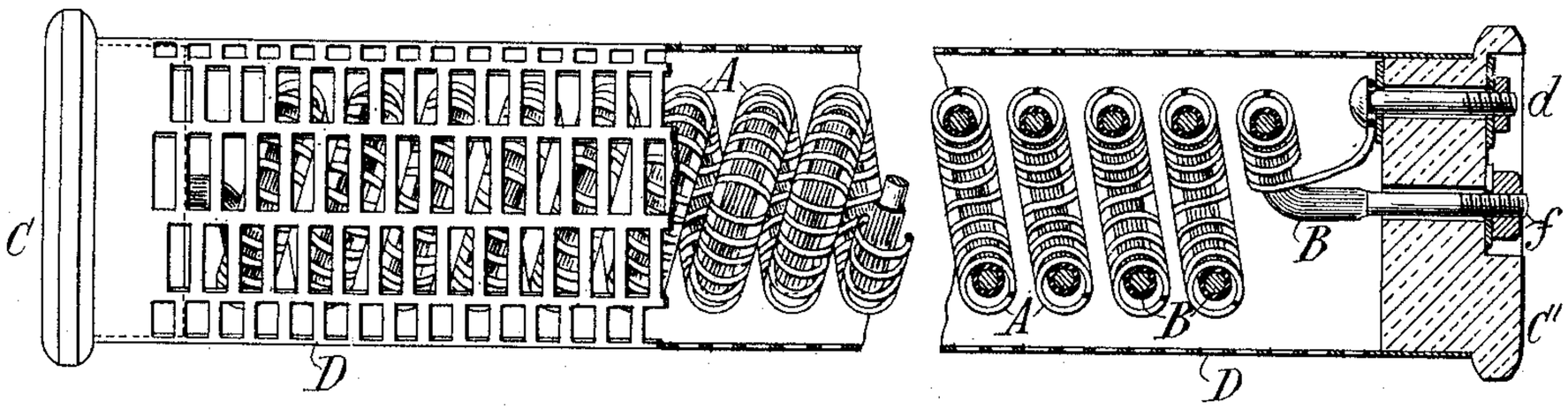


FIG. 10.

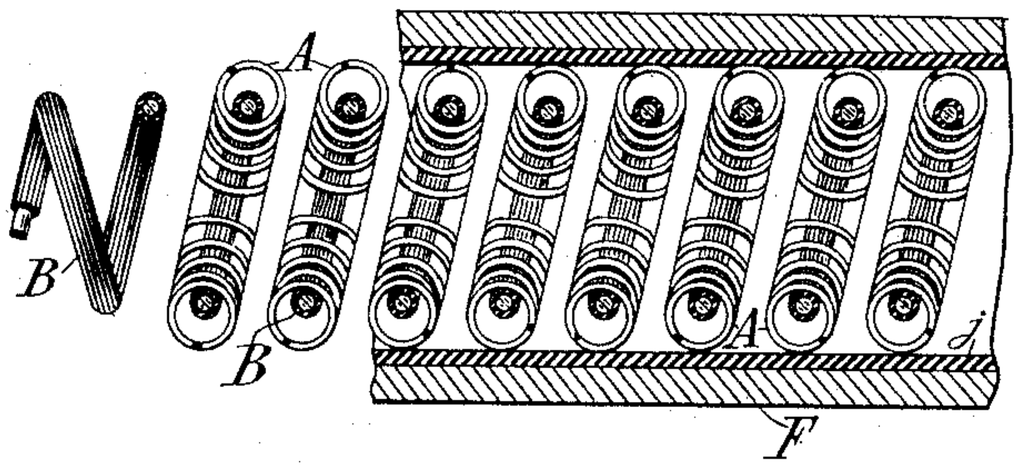
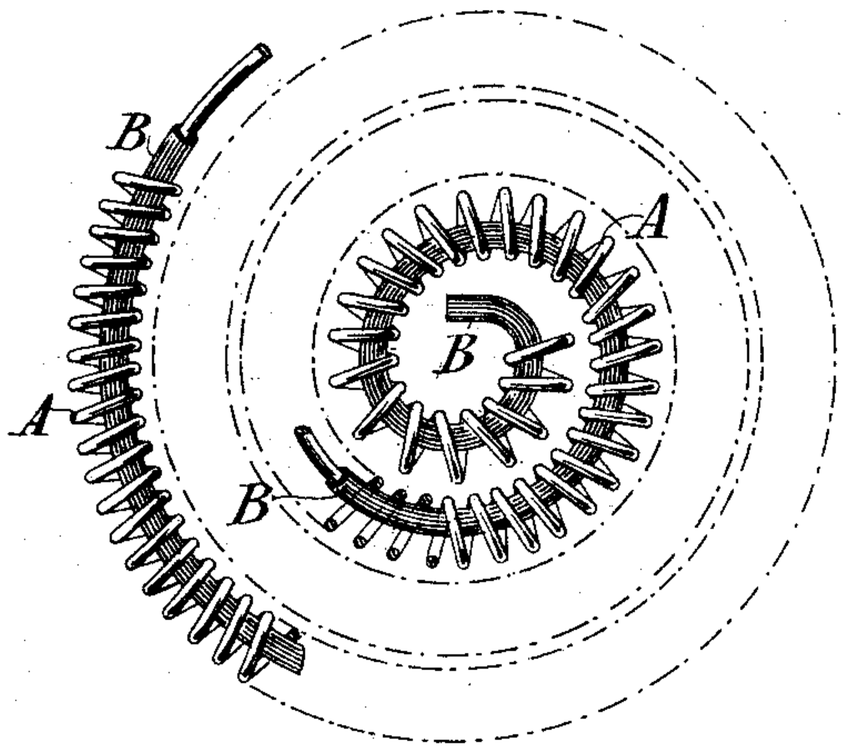


FIG. 11.



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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. 621,604, dated March 21, 1899.

Application filed January 8, 1898. Serial No. 666,024. (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 provides an improved construction of electric heaters of that class wherein the heat is generated by passing an electric current through a coil or helix of resistant-wire which is exposed to the air or other fluid, by the circulation of which the generated heat is conducted away.

My present invention relates chiefly to the means for supporting a helix of resistant-wire, and particularly when such helix is wound or coiled helically.

My invention provides also other features of construction pertaining to electric heaters.

In the accompanying drawings, Figure 1 is a fragmentary section of a railway-car, showing in elevation a seat and my improved electric heater suspended therefrom. Fig. 2 is an end view of the seat and heater. Fig. 3 is an elevation of the heater shown in Fig. 1 on a larger scale and showing it partly dissected away or in section to clearly show its construction. Fig. 4 is a transverse section of Fig. 3. Figs. 5 and 6 are fragmentary elevations of the resistant-helix and its supporting-rod. Figs. 7 and 8 are respectively similar views showing another variation in construction. Fig. 9 is an elevation, partly dissected or broken away in vertical mid-section, showing the preferred construction of my invention. Fig. 10 is a fragmentary longitudinal section of a modified construction. Fig. 11 is a fragmentary plan of a flat coil-heater.

In this specification the word "helix" is used in the sense of a line wound progressively around a cylinder after the manner of the thread of a screw. The word "spiral" is used in its generic sense to include either a helix or a "flat spiral," by which I mean a line winding about any one plane and continually receding from the center.

In all the figures let A designate a helix of resistant-wire, and let B designate a rod or wire support therefor.

My present invention is characterized by the combination, with a helix A of resistant-wire, of a supporting rod or wire B, which is extended parallel with and within the helix A in such manner as to form a continuous support for it by making tangential contact with its successive convolutions. The supporting-rod is of relatively small diameter, so that its tangential contact with the successive convolutions is of very minute area, so that practically the entire surface of the resistant-wire forming the helix A is left free from contact with any supporting part and is surrounded by air or other fluid, which can rapidly conduct off from it the heat which it generates. The supporting-rod is also made much smaller than the internal diameter of the helix, so that it does not fill the latter, nor does it to any material extent obstruct its interior, but leaves it open and free for circulation of air within it.

In its simplest or elemental form my invention comprises merely a supporting rod or wire B, with an open helix A, of resistant-wire, passed over it, as shown in Fig. 6. The supporting-rod B may be straight, as shown at the right in that figure; but ordinarily it is desirable to concentrate a considerable length of resistant-wire into small compass, and to this end the supporting-rod B may be bent into any form that will bring an extended length of it into the desired space without, however, bringing adjacent portions of the resistant-helix so close together as to involve liability of their touching one another and short-circuiting. For this purpose the helical form shown in Fig. 5 is suitable and is easily made. A straight support is suitable where the heater is mounted immovably; but for a heater on a car or moving vehicle it might be open to some degree of objection because of the loose mounting of the resistant-helix. In order to prevent looseness or rattling of the helix upon its supporting-rod and to give it firm support thereon, the supporting-rod is bent or curved (most conveniently into a helix, as shown) and the resistant-helix is wound and confined thereon under tension, either expansive, as shown in Figs. 3, 4, and 5, in Figs. 9 and 10, and in Fig. 11, or contractile, as shown in Figs. 7 and 8, so that in either case firm tangential contact is maintained with one side of the supporting-rod. It is necessary to insulate the resistant-wire A from the supporting-rod B, and this may be done by coating either or both with any suit-

able heat-resistant insulation, preferably enamel. In some cases it may be preferable to coat the resistant-wire A with such enamel; but ordinarily (and in any case where air is the fluid to be heated) this is undesirable, because it impedes the escape of heat from the wire, so that it is preferable to enamel the supporting-rod B. The enamel coating thereof is indicated in the drawings at *a a*. The word "rod" as used herein includes not merely a metal rod, but also any suitable substitute therefor, such as rods of glass or porcelain or any material having sufficient stiffness for the purpose and either an insulator in itself or capable of being effectively coated with insulation.

The preferred form of my invention is that wherein the supporting-rod is bent into a helix, so that the resistant-helix A is itself formed into a larger helix. It has heretofore been proposed to make electric heaters by winding a resistant-wire into a continuous helix (which I will call the "minor" helix) and then coiling this helix helically into a larger or major helix, thus forming what I will call a "compound" helix. In this manner a large amount of wire can be coiled in a comparatively small space without any portion of the wire touching at any point any other portion or convolution thereof, and consequently this form of heater is advantageous in that it forms a compact and concentrated heat-generator. One example of such a compound helix is that set forth in my application, Serial No. 647,950, filed August 12, 1897, (patented March 8, 1898, No. 600,417,) wherein the compound helix is supported exteriorly within a perforated tube.

I will now proceed to particularly describe the preferred construction of my heater with reference to Figs. 3, 4, and 9. The heaters shown in these figures are for heating air, being adaptable to electric cars and to apartments, &c. The inclosing case of the heater has the general form of a horizontal cylinder, its opposite ends being formed by heads or disks C C′, between which is extended a foraminous or barred or graded casing D in the general form of an open-work tube. This casing may be formed of wires *b b*, coiled into a helix, as shown in Figs. 3 and 4, or preferably it is made of perforated sheet metal, as shown in Fig. 9. Within the casing is centrally inclosed the resistant-helix A, supported on its rod B, which is wound into a helix. In constructing the heater proper, A B, the resistant-wire A is first coiled on a mandrel in the usual way, and the supporting-rod B is coiled on a larger mandrel and, being cut to the proper length, has its ends turned outward, so as to pass through holes in the heads C C′, after which the rod B is enameled. The helix A being then cut to the proper length is placed on the rod B by threading the latter through it, after which the heater is put together by inserting one end of the rod A through a hole made for it in one of the heads, placing the outer casing D in position against this head, and then applying the other head against the opposite end and inserting the other end of the rod through a corresponding hole therein. The heads are held at fixed distances apart, which may be accomplished by providing longitudinal tie rods or braces E E, as shown in Figs. 3 and 4, or preferably by drawing the heads tightly against the opposite ends of the casing D, which is itself rigid, as shown in Fig. 9, this being accomplished by screwing nuts *f f* upon the threaded ends of the supporting-rod B in such manner as to stretch this rod, so that it is made to serve both as a support for the resistant-helix and as a tie for drawing together the opposite heads. In the construction shown in Figs. 3 and 4 the tie-rods hold the heads rigidly apart, and being three in number and arranged close against the coiled wires *b b* of the casing these wires are held properly in concentric position. In this construction the helical supporting-rod B is also stretched or distended by screwing the nut *f* upon one end thereof and screwing the base of a binding-post *c′* upon its opposite end. Thus in either construction the rod or helix B is distended, the amount of stretch thus imparted to it being sufficient to render it firm and rigid, so that it shall form a stiff support for the resistant-helix. A similar result can be attained by forcing its ends together, so as to put it under compressive stress; but a distensive stress is obviously preferable.

In the case of heaters of excessive length, or where the supporting-rod is not sufficiently stiff, tie-rods E E may be arranged to directly support the supporting-rod B, as shown in Figs. 7 and 8, where also the heater is shown as devoid of any casing. Otherwise the construction shown in Figs. 7 and 8 differs from that shown in Figs. 3, 4, 5, 6, 9, and 10 only in that the helix A is wound under distensive tension, so that it tends to contract upon the supporting-wire, whereas in Figs. 3, 4, 9, and 10 it is wound under compressive stress, so that it tends to expand. To impart to the wire an expansive tendency, it is wound openly upon a mandrel and is compressed upon the supporting-helix, while to give it a contractile tendency it is wound closely upon the mandrel and it is stretched upon the supporting-wire.

With either of the constructions described all that is necessary to complete the electric heater is to make electrical-circuit connections with the opposite ends of the resistant-wire. For this purpose binding-posts *c c′* may be provided, as shown in Figs. 1 and 3, or the circuit-wires may be connected directly with the nuts *d d*, which clamp the ends of the resistant-wire, as shown in Fig. 9. If it is desired to make both electric connections at one end of the heater, the supporting-rod B may readily be used as an electric conductor, as shown in Fig. 3, where the current is supposed to enter by binding-post *c*, which communicates with one end of the wire helix A,

the other end of which passes through the opposite end and is electrically connected by a conducting strip or yoke *e* to the end of the supporting-rod B, so that the current returns through this supporting-rod, the opposite end of which is connected to the binding-post *c*.

For heating air my improved heater is arranged horizontally, and if an outer casing D is employed it is made with perforations or air-spaces of ample area for admitting a large flow of air through the heater to conduct away the heat given out by the resistant-helix A. The heater is extended horizontally—that is to say, the axis around which the major helix is wound is a horizontal axis—so that by reason of the major convolutions being arranged somewhat close together practically all the air ascending through the heater is forced to flow through the compound helix, so that the air is repeatedly cut up or subdivided by the hot wires, and thereby is most effectively heated. In my heater the resistant-helix is wound upon a skeleton support which does not oppose the circulation of air, and consequently the air has access to all portions of the helix and conducts away the heat with apparently equal effectiveness from all portions, so that the entire length of resistant-wire remains to all appearance of uniform temperature. In this respect my heater is an important improvement over those heaters having a compound helix supported by being wound about a solid spirally-grooved cylinder, in which not only is a large proportion of each convolution on its inner side in contact with the grooves of the cylinder, but the latter obstructs the circulation of air, so that the portions of the helix lying on top of the cylinder are not effectively cooled and become overheated, and as the helix is necessarily wound in tension on the cylinder the overheated portions yield and permit the convolutions elsewhere to draw closer together, thereby occasioning frequent short-circuiting of the convolutions on the lower sides by their mutual contact. These difficulties are wholly overcome in my heater.

My improved heater is also an important improvement over a construction that has been proposed wherein the resistant-wire is wound into a helix tightly around a supporting-core of enameled rod which extends helically about a vertical axis. That construction loses the advantage of an open helix since the core fills the minor helix so that air cannot circulate within its convolutions, while the vertical arrangement provides a central axial space enabling part of the air to pass through the heater without coming into close proximity to the heated wires.

The supporting-rod B within the minor helix may be of flexible wire, so that the heater can be bent to any shape, and thereby carried into any location desired. For example, it may be drawn into a hose or pipe through which water is passed and this pipe then bent wherever the water is to be led, so that by passing a current through the heater the water may be heated in transit. Such a pipe is shown in Fig. 10 at F. This pipe should either be of insulating material, as in the case of a rubber hose, or else its inner surface should be coated with insulating material, as shown at *j*. Thus an iron pipe internally enameled or glass-coated may be employed. This interior insulation for the pipe may, however, be dispensed with in case the resistant-coil A is of enameled wire or is otherwise insulated. If the compound helix is of the construction shown in Fig. 10, where the helix A tends to expand upon the rod B, it may be made a close fit with the tube in which it is to be drawn, so that it will yieldingly hold itself concentrically therein by means of the elasticity of the wire A. This will in the case of a flexible hose permit of the slight distortion thereof out of a true circle, which is apt to occur when it is flexed.

My invention is not to be understood as limited to a heater in which the resistant-wire is formed into a compound helix, as the helix A, of resistant-wire, may be arranged in other shapes, according to the purpose for which the heater is to be applied. Thus for a flat heater adapted for cooking it may be desirable to carry the helix A around in a flat spiral, as shown in Fig. 11. In such case the supporting-wire B should be carried inside the helix A.

An important advantage of my invention is that the resistant-helix by surrounding the supporting-rod is held thereon with such certainty as to prevent all displacement or escape, so that it is impossible for one of the major convolutions to be displaced into contact with another, and also in the event of breakage of the resistant-wire the severed ends are confined and the helix cannot unwind or escape from its support.

Although it is within my invention to use a plurality of supporting-rods B within the resistant-helix instead of one, and my claims herein are designed to include such a modification of my invention, yet I do not herein claim such construction specifically, having claimed the same in my divisional application, Serial No. 701,493, filed January 7, 1899.

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

1. An electric heater comprising an open helix of resistant-wire having sufficient stiffness or resilience to retain its helical form, and a support therefor consisting solely of a rod or stiff wire extended within said helix, of materially smaller diameter than the interior thereof, so that the helix is interiorly open for free circulation of air within it, and supporting the convolutions of said helix by tangential contact therewith at single points only of their circumference.

2. An electric heater comprising an open helix of resistant-wire having sufficient stiffness or resilience to retain its helical form,

and a support therefor consisting solely of a rod or stiff wire extended within said helix, of materially smaller diameter than the interior thereof, so that the helix is interiorly open for free circulation of air within it, and supporting the convolutions of said helix by tangential contact therewith at single points only of their circumference, and said helix confined on said support under stress in such manner that its convolutions are pressed elastically into such tangential contact therewith.

3. An electric heater comprising a helix of resilient resistant-wire and a support therefor, said support consisting solely of a rod or stiff wire extended within the helix and of materially smaller diameter than the interior thereof so that the interior of the resistant-helix is open for circulation of air within it, and the supporting-rod curved, and the helix confined thereon so that it passes elastically into tangential contact with said supporting-rod.

4. An electric heater comprising a resilient helix of resistant-wire combined with a support therefor of helical insulating-rod extended within said helix, of materially smaller diameter than the interior thereof and making only tangential contact with it.

5. An electric heater comprising a helix of resistant-wire and a support therefor, consisting of a rod extended within said helix, of materially smaller diameter than the interior thereof, so that it touches it tangentially only, said helix and supporting-rod being coiled spirally, and the resistant-helix being confined under stress so that it presses elastically into tangential contact with one side of said supporting-rod.

6. An electric heater comprising a helix of resistant-wire and a support therefor, consisting of a rod extended within said helix, and of materially smaller diameter than the interior thereof, so that it touches it tangentially only, said helix and supporting-rod being coiled spirally, and the resistant-helix being confined under compressive stress so that it tends to expand into a larger spiral and presses outwardly into tangential contact with the inner side of said supporting-rod.

7. An electric heater comprising a minor helix of resistant-wire coiled spirally into a major helix, and a helical supporting-rod extended within said minor helix, and of materially smaller diameter than the interior thereof, so that it touches it tangentially only, the interior of the resistant-helix being open for circulation of air within it.

8. An electric heater comprising a helix of resistant-wire coiled spirally into a major helix, around a horizontal axis, with its major convolutions closely adjacent but out of contact, and a helical supporting-rod extended parallel with said major helix and within and in tangential contact with the convolutions of the minor helix, the interior of the latter and of the major helix being open for circulation of air, whereby air circulating upwardly through said resistant compound helix, is thoroughly subdivided by the convolutions of resistant-wire, and thereby effectively heated.

9. An electric heater comprising a minor helix of resistant-wire coiled into a major helix, combined with a supporting-rod coiled helically and extended within said minor helix, and the latter confined under stress so that it presses elastically into tangential contact with one side of said supporting-rod.

10. An electric heater comprising a helix of resistant-wire coiled into a major helix, combined with a supporting-rod coiled helically and extended within said resistant-helix, and the latter having an expansive tendency, whereby its convolutions bear outwardly against the inner side of said supporting-rod.

11. An electric heater comprising a helical supporting-rod, an open helix of resistant-wire wound spirally into a major helix, said rod extended within said open helix and of materially smaller diameter than the interior thereof, so that the latter is supported by tangential contact with said rod, combined with opposite end heads, to which the ends of said supporting-rod are fixed, and a rigid connection between said heads.

12. An electric heater comprising a helical supporting-rod, an open helix of resistant-wire wound spirally into a major helix, said rod extended within said open helix and of materially smaller diameter than the interior thereof, so that the latter is supported by tangential contact with said rod, combined with opposite end heads, to which the ends of said supporting-rod are fixed, and an open-work or foraminous casing extending between said heads and inclosing said resistant-helix.

13. An electric heater comprising a helical supporting-rod B and a resilient helix A supported thereon, combined with opposite end heads rigidly connected together so that they are held at a fixed distance apart, and the ends of said supporting-helix connected to said heads and drawn apart to put the helix under tension and thereby render it rigid.

14. An electric heater comprising a helical supporting-rod B and a resilient helix A supported thereon, combined with opposite end heads and an open-work tubular casing supported between them, inclosing said helices, and serving as a rigid connection to hold the heads apart, and the ends of said helix B connected with the respective heads, with a screw-thread connection for drawing the supporting-helix and head together, whereby the supporting-helix is distended between the heads and made rigid, and the heads are held together against the casing.

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

EDWARD E. GOLD.

Witnesses:
ARTHUR C. FRASER,
GEORGE H. FRASER.