No. 638,388. Patented Dec. 5, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed June 20, 1898.)

(No Model.) 3 Sheets—Sheet 1.

FIG. 1.

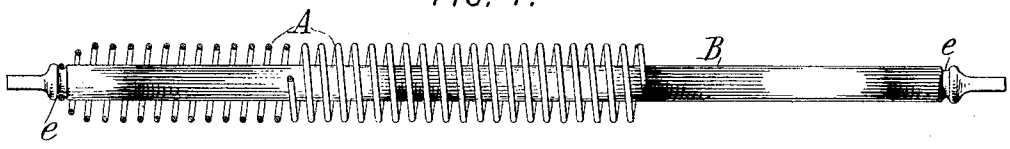


FIG. 2.

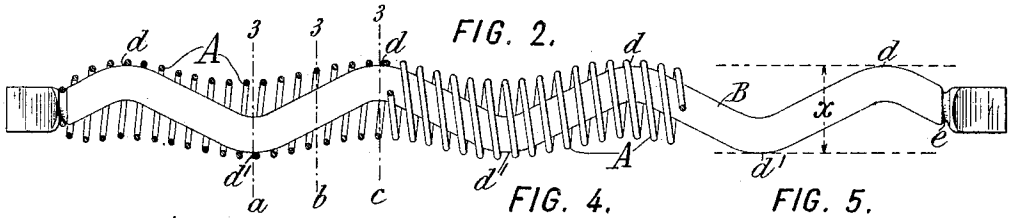


FIG. 4.

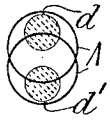


FIG. 5.

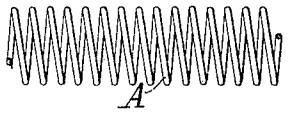


FIG. 3.

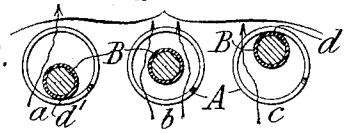


FIG. 6.

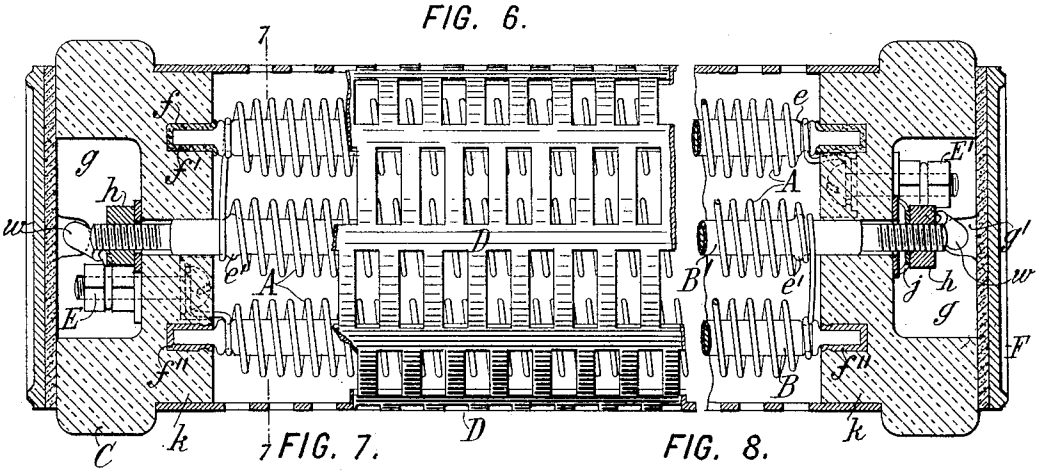
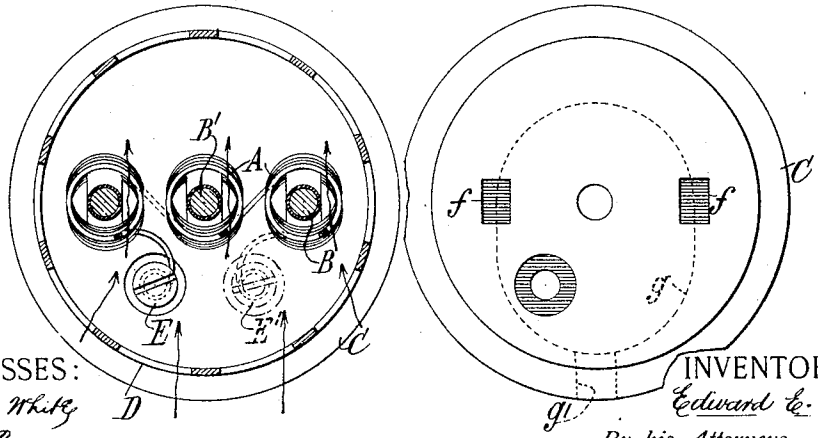


FIG. 7.

FIG. 8.



WITNESSES:

Fred Whitty

René Bruine

INVENTOR:

Edward E. Gold,

By his Attorneys.

Arthur O'Brien & Co.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 638,388. Patented Dec. 5, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed June 20, 1898.)

(No Model.) 3 Sheets—Sheet 2.

FIG. 9.

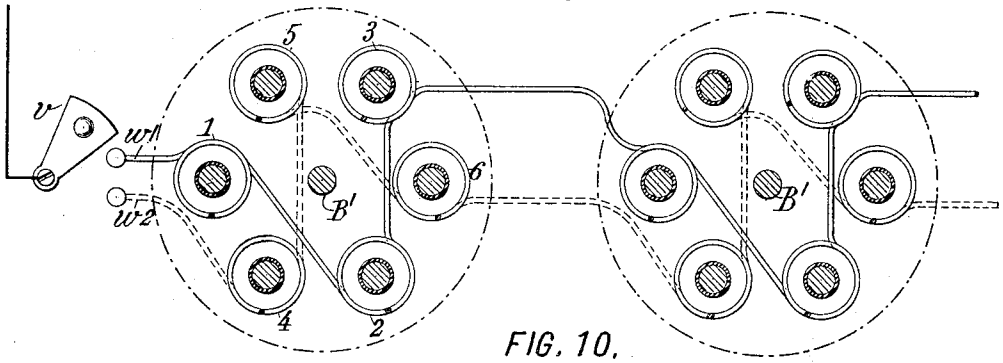


FIG. 10.

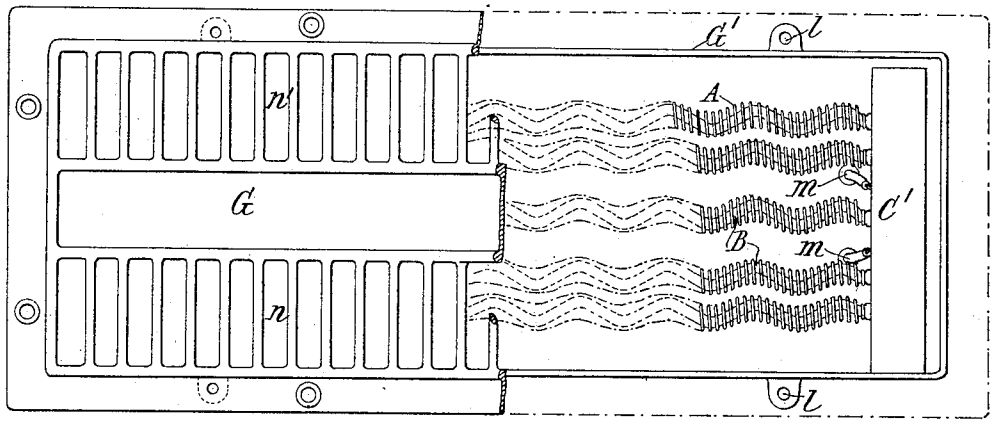


FIG. 11.

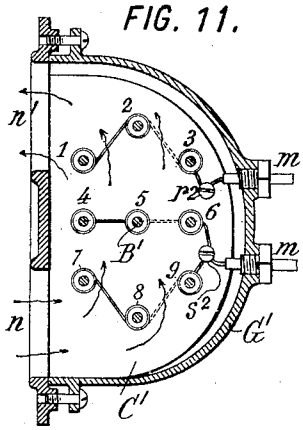


FIG. 12.

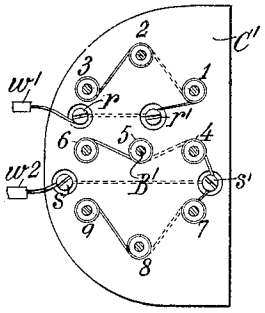


FIG. 13.

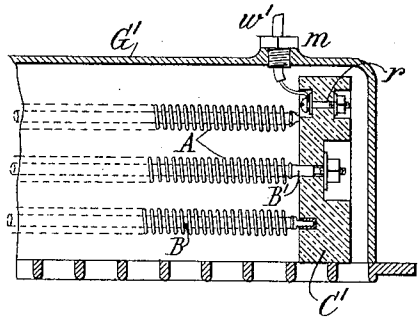
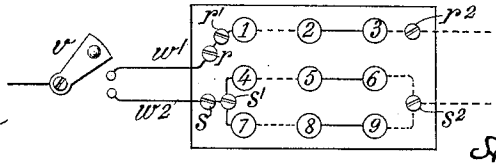


FIG. 14.



WITNESSES:
Fred Whitz
René Bruine

INVENTOR:
Edward E. Gold,
By his Attorneys.
Arthur O'Brien & Co

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 638,388. Patented Dec. 5, 1899.

E. E. GOLD.

ELECTRIC HEATER.

(Application filed June 20, 1898.)

(No Model.) 3 Sheets—Sheet 3.

FIG. 15.

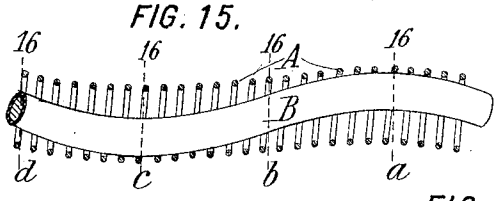


FIG. 16.

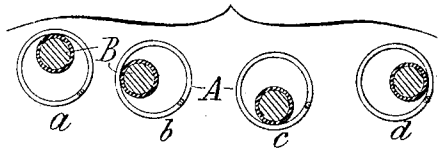


FIG. 17.

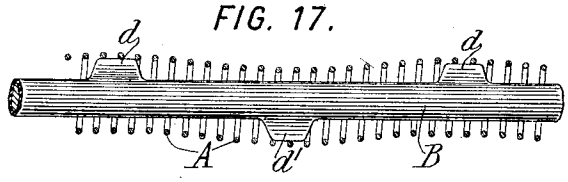


FIG. 18.

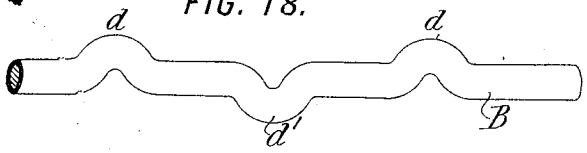


FIG. 19.

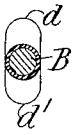


FIG. 20.

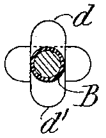


FIG. 21.

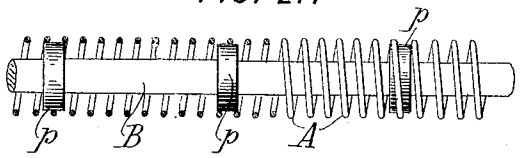


FIG. 22.

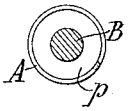


FIG. 23.

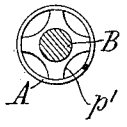


FIG. 24.

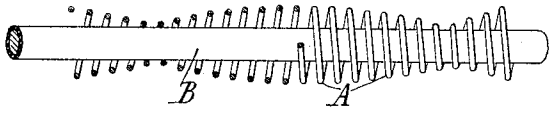


FIG. 25.

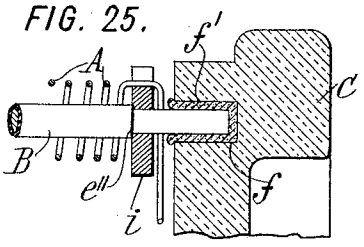
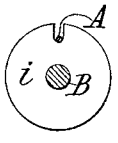


FIG. 26.



WITNESSES:
Fred Whitz
René Bruine

INVENTOR:
Edward E. Gold,
By his Attorneys.
Arthur G. Fraser & Co

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

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

ELECTRIC HEATER.

SPECIFICATION forming part of Letters Patent No. 638,388, dated December 5, 1899.

Application filed June 20, 1898. Serial No. 683,924. (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 of that type in which the heating element is a resistant wire wound into an open coil or helix and so mounted as to afford free circulation of air through the coil, the wire being preferably naked and its support insulated. According to my present invention the support is a rod of smaller diameter than the coil and passing through it, the rod and coil being relatively conformed in such manner as to make contact only at intervals, so as to leave one or more complete convolutions of wire between the contact-points, such intervening convolutions being extended through the air out of contact with the rod. The coil or helix is of wire having sufficient stiffness or resilience to render such intervening convolutions self-supporting. In its preferred construction the wire is wound into a straight coil or helix which has sufficient resilience to perceptibly oppose any distortion from its straight direction, and the rod is so shaped that when placed within the helix it will somewhat distort the latter out of its straight direction and impart to it a sinuous or wavy form. Thus only the salient portions of the rod are in contact with the wire, and the rod may be shaped so that these salient portions progress spirally around a common center, so that successive convolutions of the coil shall be touched at points which progress rotatively around it, or preferably the rod may simply be bent back and forth into a slight zigzag, the salient portions of which make contact with the coil on alternately-opposite sides thereof. The degree of deflection or crookedness of the rod is such as to distort the coil sufficiently to cause the wire thereof to press elastically against the salient portions of the rod with a stress that is sufficient in proportion to the weight of the wire to support the latter and prevent it from rattling or becoming displaced in case the heater is carried upon a moving vehicle. Otherwise the wire is quite free from stress, and especially is free from stress in direction longitudinally of the coil, such as would tend to cause its convolutions to mutually approach or recede—that is to say, the coil is wound originally as an open coil, with its convolutions spaced apart to the exact width required in the heater, so that when the coil is placed upon the support it is neither distended nor compressed. This is practically a feature of great importance, as it prevents the spacing of the convolutions becoming unequal after prolonged use of the heater, as is liable to occur whenever the coil is mounted under tension or compression, tending to draw its convolutions apart or force them together. In practice I build up a heater ordinarily by assembling several such resistant coils and their supporting-rods in parallel order between suitable end supports or heads and usually within a suitable casing.

My present application is in part specific to my application Serial No. 682,248, filed June 1, 1898. That application is based upon a construction wherein the support is a straight rod and the coil tends to assume thereon a direction other than straight, so that the coil is self-distorting, and its distortion is restrained by the rod. In the species upon which my present application is based the coil is normally straight and the rod is crooked, so that the coil is distorted by the rod.

In the accompanying drawings, Figures 1 and 2 are elevations looking at right angles to each other, illustrating the preferred construction of my improved heater, both views being partly in mid-section. Fig. 3 includes three transverse sections *a*, *b*, and *c*, taken, respectively, on the lines 3^a, 3^b, and 3^c in Fig. 2. Fig. 4 is a diagrammatic cross-section. Fig. 5 is an elevation of a fragment of the wire coil or helix before being placed upon the rod. Figs. 6, 7, and 8 show a complete heater having three coils, Fig. 6 being a plan the end portions of which are in horizontal mid-section, Fig. 7 being a vertical transverse section, and Fig. 8 being an elevation, of one of the end pieces or heads. Fig. 9 is a diagrammatic transverse section of two similar heaters having six coils and showing their electrical connections. Figs. 10 to 13 show a panel heater adapted for electric cars, Fig. 10 being a front elevation with the front plate partly removed, Fig. 11 a transverse section,

Fig. 12 a transverse section with the case removed, and Fig. 13 a fragmentary horizontal mid-section. Fig. 14 is a diagram illustrating the circuit connections. The remaining views illustrate modifications. Fig. 15 is a sectional side elevation of a modification having a spiral or corkscrew shaped supporting-rod, Fig. 16 including four transverse sections thereof on the lines 16^a, 16^b, 16^c, and 16^d, respectively. Fig. 17 is a sectional elevation showing a modified shape of rod. Fig. 18 is an elevation of a supporting-rod, showing a further modified shape, of which Fig. 19 is a transverse section. Fig. 20 is a similar transverse section showing the rod having bends or humps extending in four different directions instead of two. Fig. 21 is a sectional elevation, and Fig. 22 a transverse section, of a further modification. Fig. 23 illustrates a modification of Fig. 22. Fig. 24 is a sectional side view showing my invention as applied in connection with a straight rod, the coil being of alternately expanding and contracting diameter. Fig. 25 is a fragmentary elevation showing the end of one of the supporting-rods, illustrating a modified end connection for the coils, of which Fig. 26 is a transverse section.

In all the figures, A designates a coil of resistant wire, and B designates a supporting-rod therefor.

The coil A is of wire having sufficient stiffness to retain its coiled form, the wire being resilient, so that when the coil is distorted it tends to return to its original shape. The coil is preferably wound continuously in one direction, so as to constitute a helix, although it may be otherwise wound without departing from my invention. It is preferably a helix wound on a cylindrical mandrel and having a straight direction, as shown in Fig. 5. It is one characteristic of my invention that the coil is wound originally with the degree of openness required in the heater.

The supporting-rod B is preferably round or cylindrical, although this shape may be departed from, and has a diameter considerably smaller than the interior of the coil, so that when placed within it it shall not fill the coil, but will leave ample space between its surface and the coil for circulation of air within the latter. The supporting-rod might be of glass or porcelain or other insulating material of sufficient strength; but I prefer a rod of metal, as stiff iron wire, which is coated with a vitreous or insulating enamel.

I will first describe the preferred construction with reference to Figs. 1 to 5. The resistant wire is wound into a straight helix A, the diameter of which is preferably about double that of the enameled supporting-rod B, and has preferably about the degree of openness shown in Fig. 5. The rod B is bent or crimped into a sinuous or slight zigzag form, as clearly shown in Fig. 2, its extreme width between lines bounding its salient portions—that is, the dimension x in Fig. 2—being sufficiently in excess of the internal diameter of the helix A to distort the latter sufficiently out of its normal straight direction to generate the desirable degree of stress at the points of contact between the coil and rod. These points of contact occur at the salient portions d d' of the rod, the coil being freely suspended between these points of contact. The degree of distortion necessary will depend somewhat upon the degree of stiffness or springiness of the wire in proportion to its weight. The distortion should generate sufficient stress so that the weight of the coil which is suspended between two of the upper points d d shall not cause it to sag out of contact with the intervening underneath contact d', but, on the contrary, the stress shall sufficiently exceed the weight of the wire to maintain a firm upward pressure at these lower contact-points. The degree of stress and distortion will also depend somewhat upon the extent of vibration or jarring to which the coil is to be subjected in use and which it is desired that it shall resist to suppress rattling since the greater the jolting or jarring, the greater should be the stress in excess of what would suffice if jarring were absent. Preferably the sinuosities of the rod are developed in a vertical plane, but practically it makes little difference which side up the heating element is placed, since the coil clings sufficiently upon the rod to hold it in place whether it is arranged with its salient portions projecting vertically or horizontally. The proportions shown in Figs. 1, 2, and 3 are such as have given the best results in practice. The coil is here distorted but little out of a straight line, and yet sufficient to cause it to cling upon the rod so as to resist any jarring to which the heater is liable to be exposed. The rod B is shown as bent into a succession of reverse curves, its salient portions making contact usually with two or three of the successive convolutions of wire. It will be understood that with the exception of these two or three convolutions, which touch the rod tangentially at one point in the circumference of each, the wire is entirely out of contact with the rod, its convolutions being looped freely through the air, so as to be most fully exposed to cooling by ventilation. Hence several convolutions intervene between the contact at d and the next contact at d', these convolutions being out of contact with the rod, as shown with respect to the middle one at b in Fig. 3. This construction thus has the advantage of supporting a greater length of resistant wire by fewer points of contact between the wire and its support than in any construction of electric heater yet devised in which any attempt has been made to support the coil in such manner as to restrain it from swinging or displacement. In practice, out of eighteen convolutions of wire only four or five touch the rod at all, and these make contact with it tangentially at spots so minute as to be little more than geometrical points. In practice about thirty inches of wire is thus

firmly supported with only four or five minute points of contact with its support.

When the coil is in place upon the rod, the only tension or stress to which it is subjected is that due to its distortion by the rod and which causes it to press into firm contact with the salient portions *d d'* thereof. The coil is wholly free from any stress tending to cause its convolutions to mutually approach or recede. Prior to my invention electric-heating coils have commonly been applied to their supports by stretching them open in order to impart to the coil the tension desired to cause it to press firmly against its support. This has the disadvantage that when heated by the electric current the variations in electrical resistance and in resilience which are inherent in all wire cause the wire to be heated unequally at different parts and give rise to variations in its tension, the tendency of which is to cause the convolutions where the tension is most impaired to yield and pull apart, and those which have the strongest tension to draw closer together, and these causes, acting repeatedly during the life of the heater, eventually bring about a permanent inequality of spacing of the convolutions, which in time become so extreme that certain convolutions come into actual contact with one another and are short-circuited, thereby reducing the effective length of wire and lowering the resistance of the heater. The same effect follows if the coil is placed upon its support under compressive stress, causing the convolutions to tend to mutually recede. This disadvantage is wholly avoided according to my invention, since the wire is applied on its support without any stress in direction perpendicular to the planes of the convolutions, the coil being originally wound with the same degree of openness that it is destined to have when applied in the heater. Repeated tests of coils thus wound have demonstrated that neither inequalities of resistance nor of resilience existing in any wire that is practically useful in an electric heater can give rise to any perceptible variation in the evenness of the spacing of the convolutions, so that all danger of short-circuiting from this cause is eliminated.

In common with my invention claimed in application Serial No. 682,248 my present invention has the advantage over all heaters in which the resistant wire is wound into a compound helix that a much greater length of wire can be concentrated in a given cubical space while still maintaining the same minimum separation of the wire convolutions.

Figs. 6 and 7 show one form of complete electric heater embodying my improved construction. The ends of the rods B are supported in opposite end heads or plates C C, which are preferably of insulating material, as porcelain. These heads are suitably connected together either by means of the rods themselves or by other means. Preferably an open-work casing D is arranged to inclose the rods and coils from head to head. Such casing should be provided with openings of adequate area to give the desirable degree of ventilation. I prefer to use for the casing a tube of perforated sheet metal and to construct the heads C C with bosses *k*, entering the opposite ends of the tube, and to provide some means for drawing the heads against the ends of the tube, preferably a rod or bolt B' passing centrally through the heads and having nuts *h h* screwed on its ends. The rod B' is preferably enameled and constitutes one of the rods B for carrying the coils, although it may, as shown in Fig. 9, be a separate rod used solely as a tie rod or bolt. When the rod B' carries one of the coils, it is liable to be more expanded by the heat than is the casing D, and it is, therefore, desirable to provide an elastic means of taking up the differential expansions and contractions of these members, for which purpose I may introduce a spring-washer *j* between the nut *h* and the head, as shown at one end in Fig. 6. I have shown in Figs. 6 and 7 three coils A A, constituting the heater, mounted on three rods B B' B, of which the center one is longer than the others and passes through the heads for connecting them together, as stated, while the two outer rods have their ends embedded or socketed in recesses in the heads. These ends may be round and enter into round sockets, as shown in Figs. 25 and 26, or they may be flattened, as shown in Figs. 1 and 2, and enter into flat sockets *f f*, as shown in Figs. 6 and 8. As it is somewhat desirable to prevent rotative displacement of the rods, I prefer the use of the flattened ends and flat sockets. To prevent rattling of the ends in their sockets, the ends may be wrapped with asbestos or other packing material, as shown at *f'*, Fig. 6, or plaster-of-paris may be flowed into the sockets around the ends, as shown at *f''*. The open-work casing D may be omitted, if desired, in which case the rods B B will serve to keep the heads apart, the heads being drawn against the ends of these rods by the nuts on the middle rod B'. In these figures I have shown the three coils A A connected serially, preferably by forming them all of one continuous length of wire, the opposite ends of the wire being connected to binding-posts E E', passing through the opposite end heads. The opposite heads are formed with recesses or cavities *g g*, in which are housed the protruding ends of the fastening-rod B' and the binding-posts, these cavities being closed by caps F F. The circuit wires or leads *w* may pass out through notches *g'* at the bottom.

In order to keep the ends of the coils A A against the heads C C and prevent their being displaced therefrom by any endwise jarring, the coils might be wound somewhat longer than the distance between the heads and compressed or closed together slightly in putting

the heater together, so that their ends will exert a sufficient outward pressure against the heads; but for reasons already stated I prefer to leave the coils devoid of endwise stress. With coils free from such stress there would be some liability of their becoming displaced by repeated jarring, causing them to move somewhat along the rods, and thereby forcing their convolutions closer together than they should be. To resist this, it is desirable to provide some way of fastening the ends of the coils so as to hold them in place adjacent to the heads. For this purpose I prefer to groove or indent the rods, as clearly shown at *e* in Figs. 1 and 2, and to pinch the wire sufficiently to cause it to enter and engage these grooves or notches, preferaby by drawing one convolution of the wire to such small diameter that it will lie in these grooves, as clearly shown at the left in Figs. 1 and 2. This construction is shown in Fig. 6 as applied to the two outer rods B B. The middle rod B′ is shown provided with an equivalent construction, consisting of a projecting rib or collar *e′*, engaged in like manner by the wire. A modified way of accomplishing the same purpose is shown in Figs. 25 and 26, where the rod B is formed with a reduced end, leaving a shoulder *e″*, and a washer *i*, preferably of insulating material, is slipped over the reduced end against the shoulder and has a deep notch into which the wire is drawn and is then passed across the outer side of the washer and between it and the head C.

Instead of providing a cylindrical heater with three coils, as shown in Fig. 7, it may be provided with a greater number—as, for example, with six coils, as shown in Fig. 9. Instead of connecting the coils serially with one another they may be connected according to any other arrangement that is desired, according to the choice or discretion of the electrical engineer to adapt the heater to any particular use. For example, I have shown in Fig. 9 the six coils connected in two series of three each, these series being arranged to be connected to the main circuit in multiple through the medium of a switch *v*. When this switch touches the first contact, it sends the current through the branch *w′*, traversing coils numbered 1, 2, and 3 in series, and when the switch is moved so that it also touches the second contact the current flows in parallel through the two branches, traversing thus also the second branch w^2, including coils 4, 5, and 6. Thus the heater can be made to give two different degrees of heat, and by a modification of the same principle three or more degrees can be given. For electric cars and other uses where it is desired to control alike the heat given out by a series of heaters the successive heaters are connected in the manner shown in Fig. 9, so that each branch includes in series first three coils (more or less) of the first heater, then in series therewith the corresponding coils of the second heater, and so on, so that one switch B controls the entire series of heaters.

Figs. 10 to 13 show the preferred construction of my electric heater adapted as a panel-heater, to be placed in openings in the uprights or panels beneath the seats of electric cars and adapted for giving three degrees of heat. The casing here consists of a front plate G and a back plate or hood G′, fastened to the front plate by screws through lugs *l l* at intervals and having two holes *m m* at its back at each end for admitting the circuit-wires. The front plate G is screwed to the front of the panel, while the head G′, constituting the body of the casing, projects through an opening therein. The front plate G has grated openings *n* along its lower side for admitting air to be heated and similar openings *n′* along its upper side for the escape of the heated air. In this heater I have shown nine coils A A and supporting-rods B B arranged in tiers of three each, with the ends of the rods supported in opposite end heads C′ C′, preferably of porcelain, the middle rod B′ passing through the heads and having nuts screwed on its threaded ends to draw the heads together against the ends of the other eight rods which are socketed in the heads. The circuit connections are shown diagrammatically in Fig. 14, two branch wires *w′* and w^2 entering the casing at one end and leaving it at the other, the connections at one end of the heater being shown in full lines and those at the other end in dotted lines. The head at the entering or positive end is shown in Figs. 12 and 13, while that at the leaving or negative end is shown in Fig. 11. The entering wire *w′* enters on the inner side of the right-hand head, Fig. 13, and connects with binding-post *r*, which passes through the head, and the wire thence connects across to binding-post *r′*, Fig. 12, and passes again through the head and connects with one terminal of the resistance-wire which wire, traversing the coils numbered 1, 2, and 3 in series, has its opposite terminal connected with binding-post r^2, Fig. 11, to which the outgoing circuit-wire is connected. The incoming wire w^2, Fig. 12, connects to a binding-post *s*, which leads through the head C, and at its outer end is connected by a wire to a binding-post *s′*, which passes through the head, and at its inner side is connected to the ends of two resistant wires, one of which traverses the coils numbered 4, 5, and 6 in Fig. 12 and the other of which traverses those numbered 7, 8, and 9, the opposite ends of both wires being connected at the opposite head to binding-post s^2, to which the outgoing circuit-wire connects. With this arrangement when one degree of heat is required the current is passed through branch *w′* and traverses the three upper coils. When two degrees of heat are required, it is passed only through the lower branch w^2 and traverses the six lower coils. When the third degree

of heat is required, the current is passed in parallel through both branches, so as to traverse all the coils. Thus for three degrees of heat only two circuit branches are required leading from one switch through the entire series of heaters in the manner claimed in my application, Serial No. 636,750, filed March 10, 1897.

I will now describe some modifications of the heating elements shown in Figs. 1 to 5.

Fig. 15 shows a construction in which the rod B instead of being bent into a zigzag is formed in a continuous spiral curve, the spiral being of long pitch and short radius, so that it but slightly deflects the coil A out of its natural straight direction. This construction differs from that first described in that the coil is here continuously supported, as shown, by four successive cross-sections in Fig. 16.

Figs. 17 and 18 show two modified modes of forming the rod with alternately opposite projections *d d'*, the coil being supported on these projections in exactly the same manner as in Fig. 2. In Fig. 17 the rod is straight and has humps formed upon its alternately opposite sides. In Fig. 18 it is formed with oppositely-directed short curves or humps. Fig. 19 is a transverse section showing either of these constructions. The projections or humps in these figures may be directed only on two diametrically opposite sides, according to Fig. 19, or they may be directed in other directions—as, for example, in four directions—giving the cross-section shown in Fig. 20.

Figs. 21 and 22 show a construction in which the coil is supported on the rod at intervals, but without necessarily distorting it out of its natural straight direction. Here the rod is formed with disk-like projections or bunches *p* at suitable intervals,—as, for example, by threading tightly-fitting washers over the rod—these projections being of a diameter just sufficient to freely enter within the coil. This construction has the disadvantage of making prolonged contact with one or two convolutions of the coil at each projection; but between the projections the coil is freely suspended, its own stiffness being relied upon to support it without perceptible sagging. The disadvantage of the prolonged contact in the construction just described may be obviated by partially cutting away the projection, as shown at *p'* in Fig. 23.

Fig. 24 is a further modification of the construction shown in Fig. 21, in which instead of enlarging the rod at intervals into contact with the coil the coil is contracted at intervals into contact with the rod. This has the same disadvantage as in Fig. 21 that at the points of contact the contact is continuous for the distance of one or two convolutions of wire; but between these convolutions the wire is coiled through the air free from contact with its support.

None of the modifications shown in Figs. 15 to 24, inclusive, is believed to be of equal merit with the construction first described.

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

1. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said coil and rod relatively conformed to make contact only at intervals longitudinally of the coil, the convolutions of the latter between the contact-points being extended through the air out of contact with the rod.

2. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said rod formed with projections at intervals longitudinally thereof, adapted to make contact with the coil at such projections, the convolutions of the coil between such contact-points being extended through the air out of contact with the rod.

3. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said coil distorted out of its natural shape by the rod, the rod being shaped to project beyond the natural outline of repose of the coil to so distort the coil, and making thereby tangential contact with the coil at its salient portions.

4. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said coil distorted out of its natural shape by the rod, the rod being shaped with mutually-opposed projections at intervals extending beyond the natural outline of repose of the coil, to so distort the latter.

5. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said coil distorted out of its natural shape by the rod, the rod being formed with alternately opposite projecting or salient portions extending beyond the natural outline of repose of the coil, to so distort the latter.

6. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, said coil distorted out of its natural shape by the rod, the rod being of sinuous form with its salient portions extending beyond the natural outline of repose of the coil, to so distort the latter.

7. In an electric heater the combination with a normally straight coil of resilient resistant wire, of a supporting-rod therefor extended within it and formed with repeated bends adapted to distort the coil sufficiently out of its normal shape to cause it to cling upon the rod.

8. In an electric heater the combination with a normally straight coil of resilient resistant wire, of a supporting-rod therefor ex-

tended within it in generally straight direction and bent repeatedly back and forth to form zigzag sinuosities so as to distort the coil.

9. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within said coil, the rod shaped to distort the coil out of its natural shape, and the coil wound with its convolutions of the degree of openness required in the heater, and applied upon the rod without longitudinal stress so that its convolutions are free from any tendency to vary their relative spacing, to the effect set forth.

10. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended in substantially straight direction within said coil, the coil wound with its convolutions of the degree of openness required in the heater, and applied upon the rod under stress laterally thereagainst to make firm contact therewith, but without longitudinal stress so that its convolutions are free from any tendency to vary their relative spacing, and the coil at the opposite ends of the rod fastened to prevent longitudinal displacement upon the rod.

11. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended in substantially straight direction within said coil, the coil applied upon the rod under stress laterally thereagainst to make firm contact therewith and cause the coil to cling upon the rod, and the wire at the opposite ends of the coil fastened upon the rod at the opposite ends thereof respectively to prevent longitudinal displacement.

12. An electric heater comprising a coil of resilient resistant wire combined with a supporting-rod extended within it, said coil and rod relatively conformed to cause the coil to cling upon the rod, the rod provided near its opposite ends with shoulders for engaging the wire, and the wire at the ends of the coil bent into engagement with said shoulders to prevent longitudinal displacement of the ends of the coil upon the rod.

13. An electric heater comprising a coil of resilient resistant wire, a supporting-rod, extended within the coil, the combined coil and rod extended in substantially straight direction, the coil and rod relatively conformed to cause the coil to cling upon the rod, the rod passing through loops of the coil, and the wire touching the rod only at intervals and looped through the air out of contact with the rod between its touch points, combined with opposite end heads, the ends of the rod seated in sockets in said heads, and means adapted to prevent rotation of the rod, whereby rotative displacement of the coil is prevented.

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

EDWARD E. GOLD.

Witnesses:
FRED WHITE,
ARTHUR C. FRASER.