No. 803,795. PATENTED NOV. 7, 1905.

G. E. STEVENS.

ELECTRIC HEATING DEVICE.

APPLICATION FILED FEB. 15, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

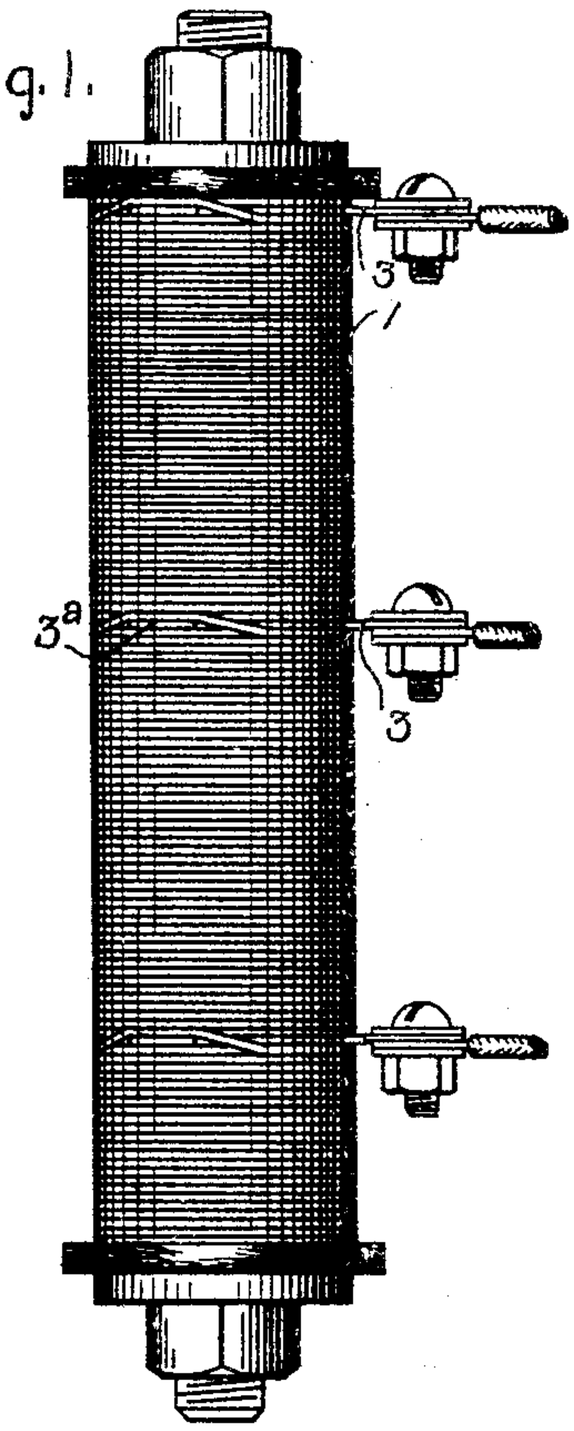


Fig. 2.

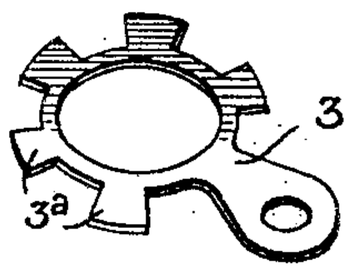


Fig. 3.

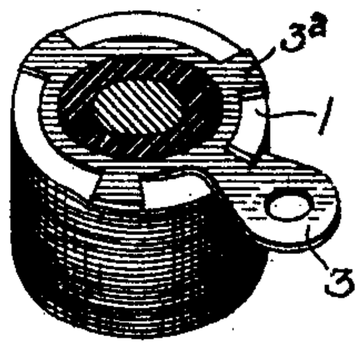


Fig. 5.

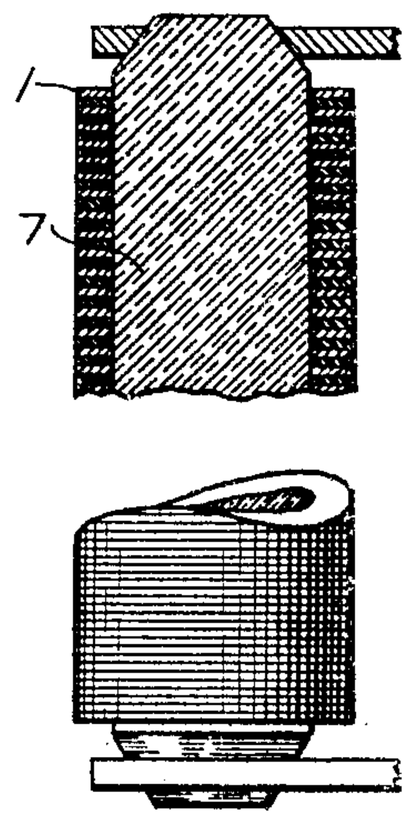


Fig. 4.

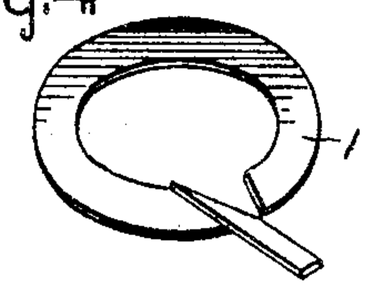


Fig. 6.

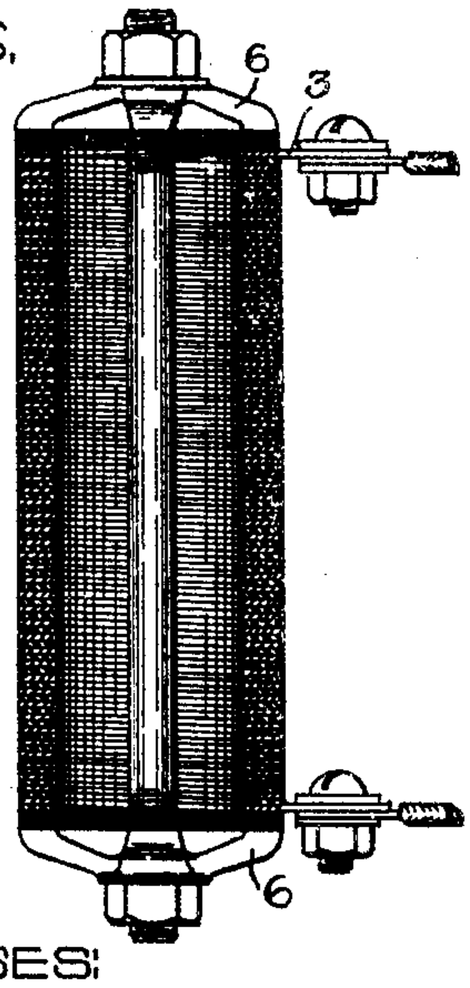
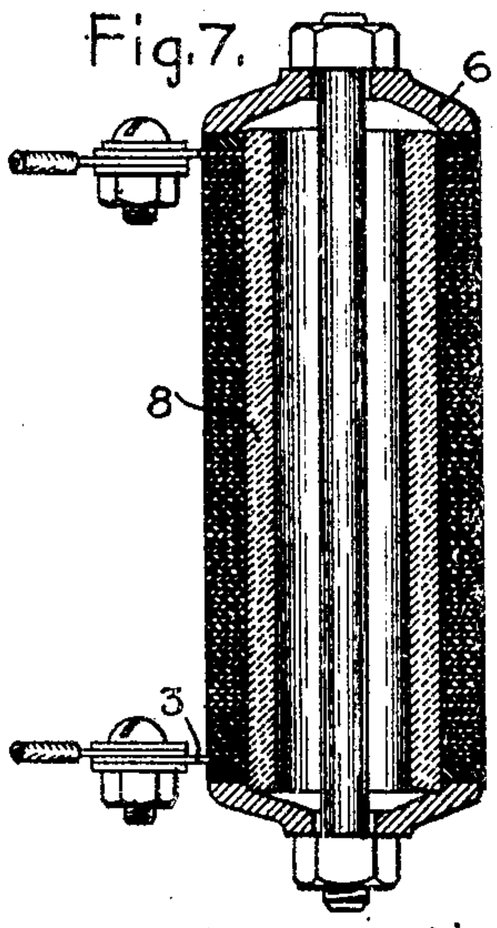


Fig. 7.



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No. 803,795. PATENTED NOV. 7, 1905.

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2 SHEETS SHEET 2.

Fig. 14.

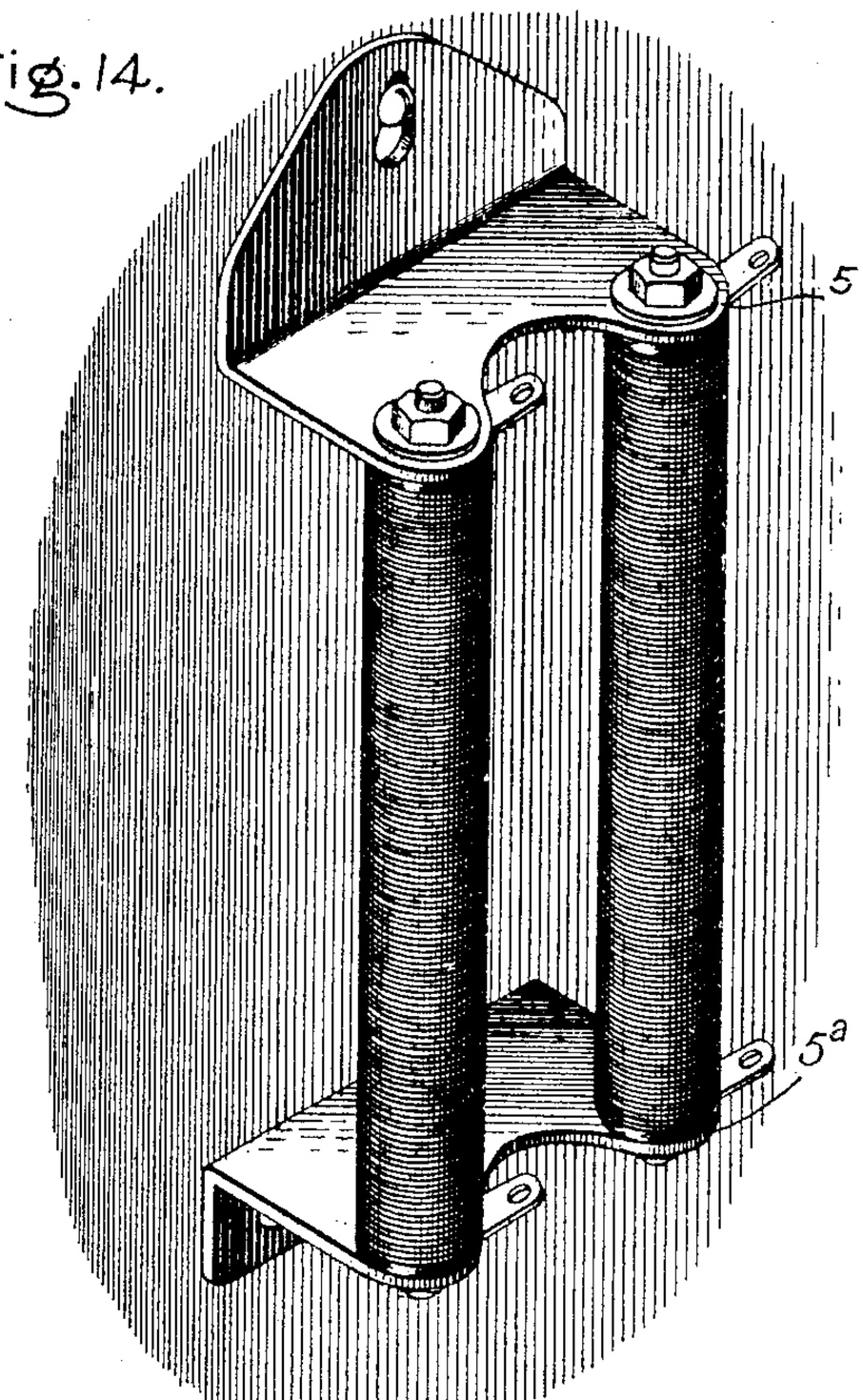


Fig. 8.

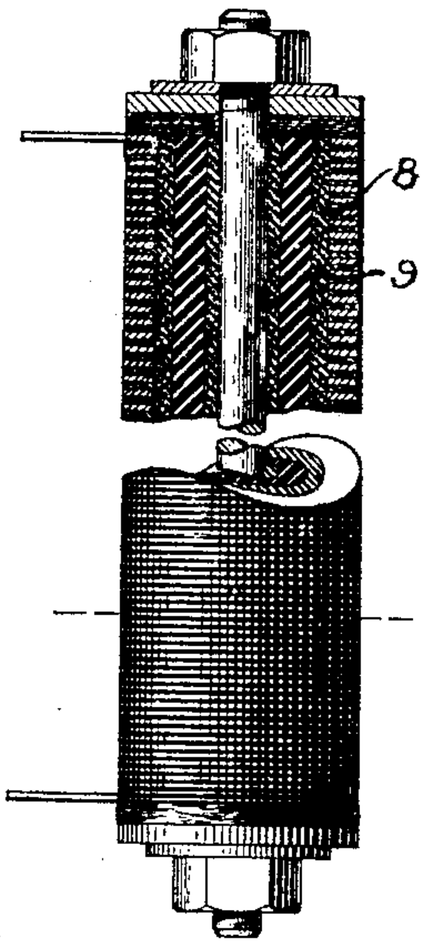


Fig. 10.

Fig. 9.

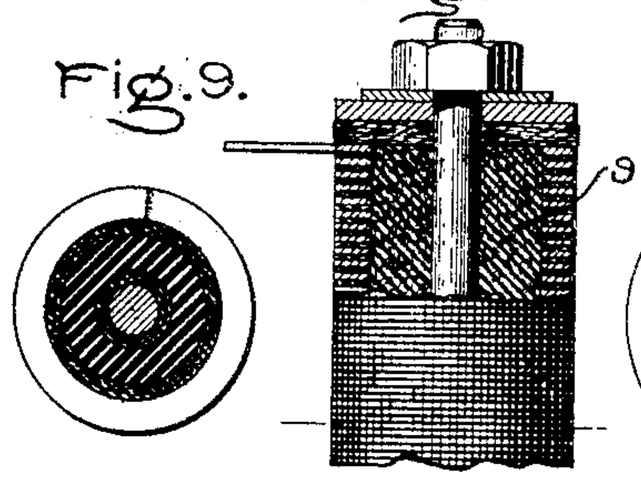


Fig. 11.

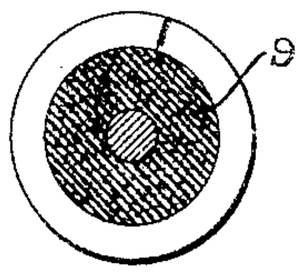


Fig. 12.

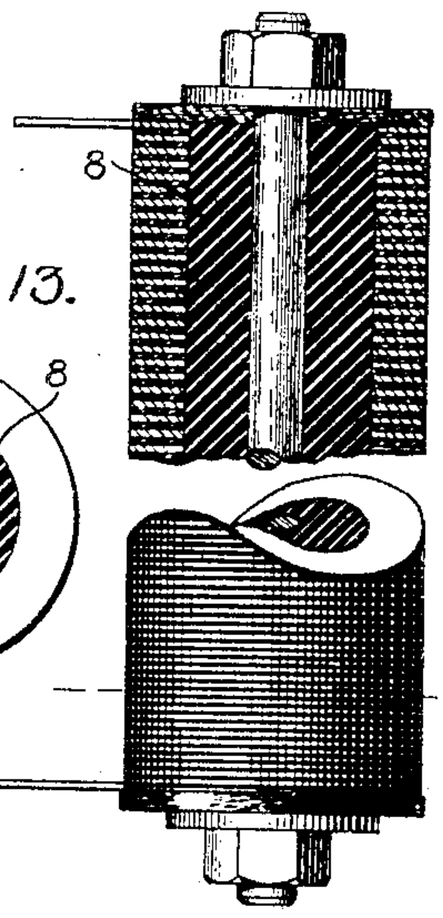
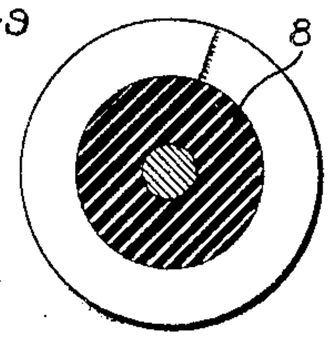


Fig. 13.



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UNITED STATES PATENT OFFICE.

GEORGE E. STEVENS, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC HEATING DEVICE.

No. 803,795 Specification of Letters Patent. Patented Nov. 7, 1905.

Application filed February 15, 1904. Serial No. 193,713.

To all whom it may concern:

Be it known that I, GEORGE E. STEVENS, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Electric Heating Devices, of which the following is a specification.

This invention relates to electric heating devices, the object being to provide a unit device of this character which may be readily connected into circuit singly or in groups to form a rheostat or heating device of desired capacity which may be run very hot without damage and in which the amount of resistance in circuit may be easily adjusted.

One of the principal features of the invention is to provide a unit with which liability to damage or destruction from overheating is greatly reduced or entirely obviated. Devices of this kind have been commonly made by the employment of a fine wire mounted on an insulating-support or in the open air and sometimes protected by an insulating-enamel which helps to dissipate the heat and helps to prevent the wire from burning out. The capacity of these devices relatively to their bulk is greatly limited by the wide space provided between the successive turns, convolutions, or reflexes of the conductor, as the latter must be laid upon the support with sufficient space between the several turns or reflexes to prevent short-circuiting, or a support having grooves or ribs must be initially provided. If an insulating fabric is employed to cover the resistance-wire, the space factor becomes more serious and renders the unit larger than is desired, since the material employed must be refractory in nature and flexible as well, and all known materials which would be suitable for the purpose are poor heat-conductors, a property which limits the dissipation of the heat, and thus lessens the effectiveness of the device either for a heater or a rheostat. So far as efficiency is concerned all electric heating devices stand on common ground, as all energy consumed goes into heat, which means that the conversion is one hundred per cent. efficient; but if a poor heat-conductor be employed to support or space the conductor the heat cannot be diffused and the wire gets unduly hot. It has been found by experiment that a ribbon resistance wound compactly on edge with a heat-refractory spacer in the form of a thin film between successive turns carries away the heat with sufficient rapidity and by reason of its close conformation cannot sag or sink and by permitting the unit to be run continuously at a high heat forms a very effective mode of heating. My unit device embodies this feature and differs from the types commonly employed by permitting a minimum space factor and providing for easy dissipation of heat and permitting the unit to be run for long periods at a red heat without damage to its electric continuity or to its structure in any way. A very common cause of breakdown in heater units is the terminal. It is difficult to make a stable and thoroughly satisfactory joint between the resistance material and the lead or terminal. I construct the unit by forming a thin ribbon of resistance-conductor into a helix by winding it edgewise. It is then mounted in a suitable supporting-frame, the successive turns lying close together side by side with a thin film of refractory insulation between successive turns. The supporting-frame is insulated by washers of mica or other suitable refractory insulation from the edgewise-wound ribbon and is provided with extensions by which the unit may be supported on the frame of a rheostat or electric heater. At two or more points in the length of the helical conductor are placed special terminals which are found to give thoroughly satisfactory results and make a good conductive joint and one which does not deteriorate or burn out. The joint is effected by metal punchings forming a good metallic connection with the ribbon and held solidly in place, projections of the punchings forming points of connection or taps to which circuit-leads may be connected. The refractory spacer between the successive turns which I prefer to employ is a cement which may be applied in a fluid state and baked or otherwise heated to form a solid insulating heat-refractory spacer which binds the successive turns firmly in position and produces a strong rigid structure. I may, however, in some cases provide the ribbon with a coating of non-conducting oxid, either formed chemically on its own surface or laid on mechanic-

ally, as by painting or dipping. A unit of this type is extremely flexible in use and will withstand hard service without deterioration.

In the accompanying drawings, which illustrate my invention, are shown several forms of units embodying my improvements.

Figure 1 shows a side elevation of one form. Figs. 2, 3, and 4 show the mode of connecting a terminal. Fig. 5 shows a modified form of supporting-frame. Figs. 6, 7, 8, 9, 10, 11, 12, and 13 show other modified forms of mounting for the resistance element; and Fig. 14 shows the manner of grouping the units.

Referring first to the type shown in Figs. 1, 2, 3, and 4, 1 represents the resistance element, which is composed of a thin ribbon of any resistance metal, such as iron, nickel-steel, or other metal or alloy having a high specific resistance. The ribbon is of much greater width than thickness and is wound in a lathe by a suitable tool, such as described in my companion application, Serial No. 140,350, filed January 24, 1903, into a long helix the adjacent or successive turns of which lie closely adjacent. After winding, a sufficient length of this helix to form a unit of the desired value is opened by stretching its ends so that free air-spaces are produced between the several turns and is then coated by dipping in a liquid or semi-liquid bath of kaolin and silicate of soda in aqueous solution. The helix is then closed, so as to bring the several turns into close mechanical contact with a separating-film of the coating compound, and is then baked at a red heat in an oven or raised slowly to a red heat by inclusion in an electric circuit of sufficient voltage, thus forming the ribbon into a solid structure.

The terminals are formed by placing in contact with the ribbon metal punchings 3. (See Fig. 2.) These terminals are provided with ears, as indicated at 3^a in Fig. 2, the ribbon being zigzagged or interlaced with the ears, as indicated in Fig. 3, so that part of the terminal bears against one side of a turn and part against the other side. This construction permits the terminals to be inserted at any point along the resistance-coil after it has been wound either before or after baking. If inserted after baking, the coil is opened at the point of insertion of the terminal and the insulation scraped away, and when the coil is squeezed into engagement the terminals are held in good conductive relation and cannot shift out of alinement. A terminal of this kind has a large surface contact and is always under pressure. It can be of any desired thickness, so that it will not burn out. Moreover, it can be made of a metal not readily oxidizable. A unit thus formed may be supported in a frame by removing the nuts and pushing the bolt through a supporting web or bracket and the nuts then replaced and screwed up against the bracket. Where the ribbon is of considerable cross-section, the end connections may be made by bending the ribbon at an angle, as indicated in Fig. 4, the projecting end being used as a terminal. I prefer, however, to employ the washer type of terminal already described.

A resistance unit having the described structure may be run red-hot for a long time without damage. It is protected from oxidation by the film of refractory insulating material between its consecutive turns, which latter is a fair heat-conductor, increasing the heat diffusion. The coil may be lined with porcelain or other refractory insulating material. For example, in Fig. 5 is shown a structure in which a solid core of porcelain or glass 7 is employed. If the former material be used, the coil may be provided with a core molded *in situ* and then vitrified. If the latter material be used, molten glass may be run into the coil.

In Fig. 14 is shown the mode of mounting units of the kind hereinbefore described. Supporting-webs of metal 5 5^a are secured to the unit and the whole bolted fast to a supporting-frame. In Figs. 12 and 13 is shown a type in which the lining is a tube 8, of porcelain or similar refractory material, held in position with relation to the ribbon by the bolt and end nuts already described. Instead of employing a solid lining I may line the interior with a granular material 9, such as sand, such a construction being illustrated in Figs. 10 and 11. If desired, the porcelain tube may be separated from the rod or bolt and from the resistance-coil by a layer of sand or other slow heat-conductor, as indicated in Figs. 8 and 9, thereby preventing cracking of the porcelain. I prefer to employ a spacer between the rod or bolt and the coil, as it prevents the units from buckling if run at high heat or any relative displacement of the turns. In some cases, however, I do not employ a lining—as, for example, in the type shown in Fig. 6, where there is an air-space between the rod and the ribbon, the end plates being in the form of a spider, as indicated at 6, the extremities of which bear upon the annular washers at the end of the coil. In some cases I may employ a tubular porcelain lining, together with a free air-space, as indicated in Fig. 7. The central supporting rod or core is preferably of copper or other good heat-conductor, which is non-magnetic. This not only conducts away or diffuses the heat quickly to the bracket, which gives a large radiating surface, but when used with alternating current prevents noise due to molecular movement, which occurs when iron is used.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A resistance unit comprising a resist-

ance-ribbon edgewise wound, having successive turns in close mechanical relation to an insulating-film, and an insulating-support forming a permanent part of the unit adapted to be attached to a rheostat or heater frame.

2. A resistance unit comprising a helix of edgewise-wound resistance material having its successive turns in close mechanical relation and separated by refractory insulation, and a clamping-frame insulated from the ribbon and preventing displacement of its turns, said frame having a conformation adapted for attachment to a heater or rheostat frame.

3. A resistance-unit consisting of a helix of edgewise-wound resistance-ribbon having its turns in close mechanical relation and separated by refractory insulation, terminals in conductive relation to the ribbon at different points of its length, and an insulating supporting-frame.

4. A resistance unit comprising a helix of edgewise-wound resistance-ribbon having its respective turns in close mechanical relation to a separating-film of refractory insulation, a rod or frame extending through the helix, and nuts on the rod engaging clamping-washers bearing on the ends of the helix.

5. A resistance unit comprising an edgewise-wound coil having a refractory non-conductor between successive turns, and terminals having an annular surface engagement with the coil and a lateral projection for circuit connections.

6. A resistance unit comprising an edgewise-wound coil having a refractory film insulation and a washer-like terminal held in firm contact with the coil, said terminal having an integral terminal extension.

7. A resistance unit comprising an edgewise-wound ribbon having a refractory film insulation between successive turns, and a clamping-frame supporting the coil and holding it under compression, said unit having means for attachment to a rheostat or heater structure.

8. A resistance-unit comprising an edgewise-wound ribbon having a refractory film insulation binding the coil-turns together, and a clamping-frame forming part of the unit holding the coil from warping.

9. A resistance unit comprising a helix of edgewise-wound ribbon and a washer-like terminal in lateral engagement on both faces with the ribbon, said washer having a lateral projection for making circuit connections.

10. A resistance unit comprising a helix of edgewise-wound ribbon and a washer-like terminal having wings to embrace opposite faces of a ribbon-turn.

11. A resistance unit comprising a helix of edgewise-wound ribbon and a washer-like terminal inserted between the ribbon-turns, said terminal having an integral projection perforated to form circuit connections.

12. A resistance unit formed of a helix of resistance material, and a terminal held under compression in engagement with several turns.

13. A resistance unit comprising a helix of edgewise-wound resistance-ribbon having a refractory insulating-spacer between turns, a bolt extending through the helix, and clamping-nuts on the bolt.

14. A resistance unit comprising a helix of edgewise-wound resistance-ribbon having a refractory insulating-spacer between the several turns, a clamp-frame extending through the helix, and nuts and insulating-washers for holding the coil under pressure.

15. A resistance unit comprising an edgewise-wound helix of conducting-ribbon having a refractory film insulation between turns, a rigid supporting-tube, a core having threaded ends, and clamp-nuts mounted on the core and compressing the ends of the helix.

16. A resistance unit comprising an edgewise-wound helix of conducting-ribbon one layer deep, having its turns insulated by a heat-refractory insulating-film, and a clamping-frame supporting the helix, said frame having extensions for mounting the unit.

17. A resistance unit comprising an edgewise-wound helix of conducting-ribbon one layer deep, having a refractory film insulation, a central core clamping the ribbon-turns together, the ends of the coil being open to permit free radiation.

18. A resistance unit comprising an edgewise-wound helix of conducting-ribbon one layer deep, having a refractory insulation and a central core or support of non-magnetic heat-conducting material.

19. A resistance unit, consisting of a helical insulated conductor having its turns continuously forced together to form a rigid tube.

20. A resistance unit comprising a rigid tube consisting of helical resistance material having insulation interposed between adjacent turns of said helix, and means adapted and arranged to continuously force the turns of said helix together.

21. A resistance unit comprising a rigid tube consisting of a flat strip of resistance material wound in helical formation with the plane of its broad side transverse to the longitudinal axis of the helix, insulation interposed between the helical turns of said material, and means adapted and arranged to force the turns of said material and insulation together.

22. A resistance unit, comprising a rigid tube consisting of insulated resistance material wound in substantially helical formation, a bolt passing longitudinally through said helix and separated therefrom by an air-space, and a nut carried upon one end of said bolt and adapted to continuously force the turns of said helix together between said nut and the head of said bolt.

23. A resistance unit comprising a flat strip

of resistance material wound in helical formation with the plane of its broad side transverse to the longitudinal axis of the helix, insulation interposed between the helical turns of said material, a bolt passing longitudinally through said helix and separated therefrom by an air-space, and a nut carried upon one end of said bolt and acting to continuously force the turns of said helix together between said nut and the head of said bolt to form a rigid tube.

In witness whereof I have hereunto set my hand this 8th day of February, 1904.

GEORGE E. STEVENS.

Witnesses:
DUGALD MCK. MCKILLOP,
JOHN J. WALKER.