No. 791,691. PATENTED JUNE 6, 1905.

W. S. HADAWAY, Jr.

ELECTRIC HEATER.

APPLICATION FILED AUG. 4, 1903.

Fig. 1.

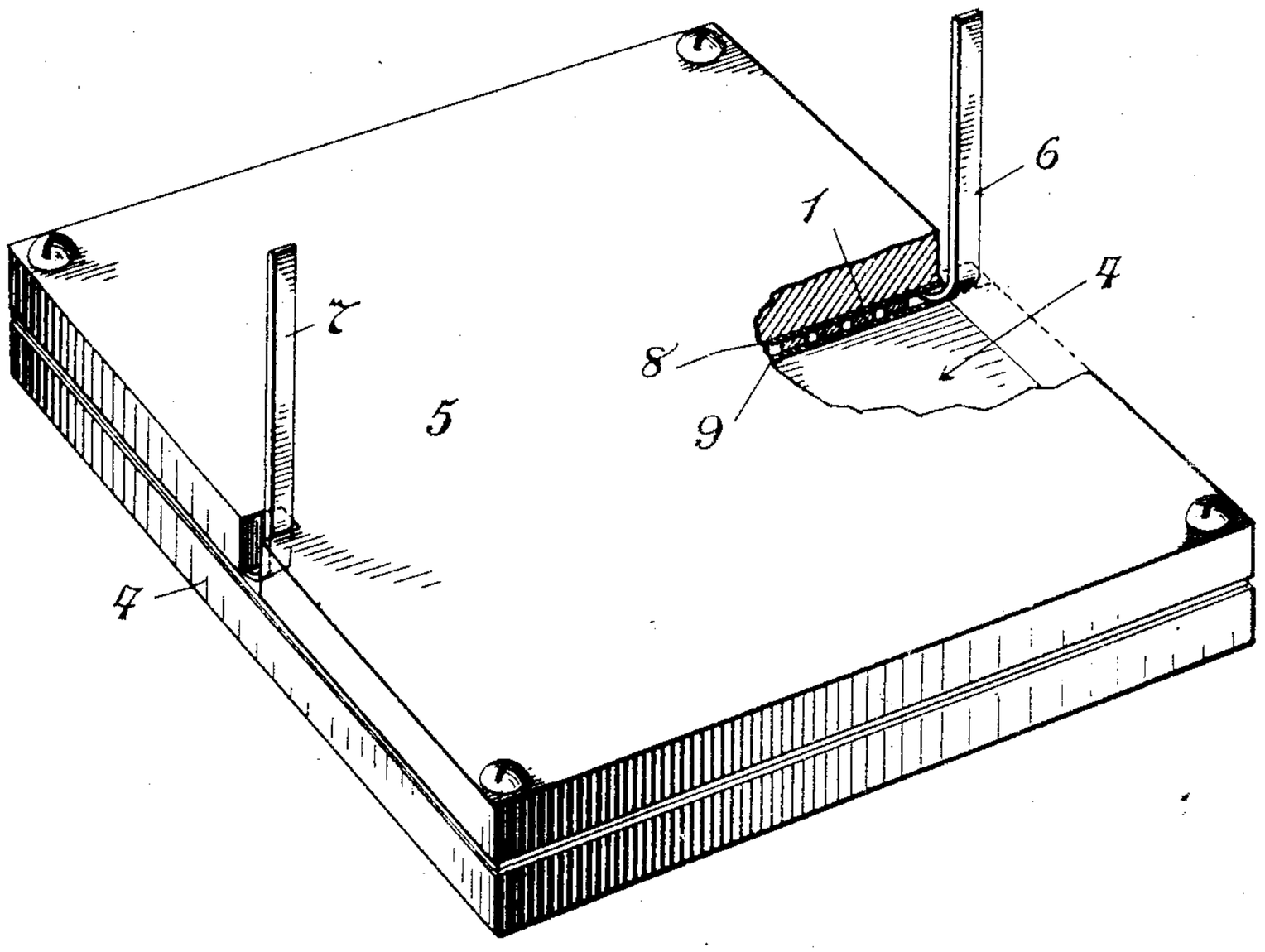
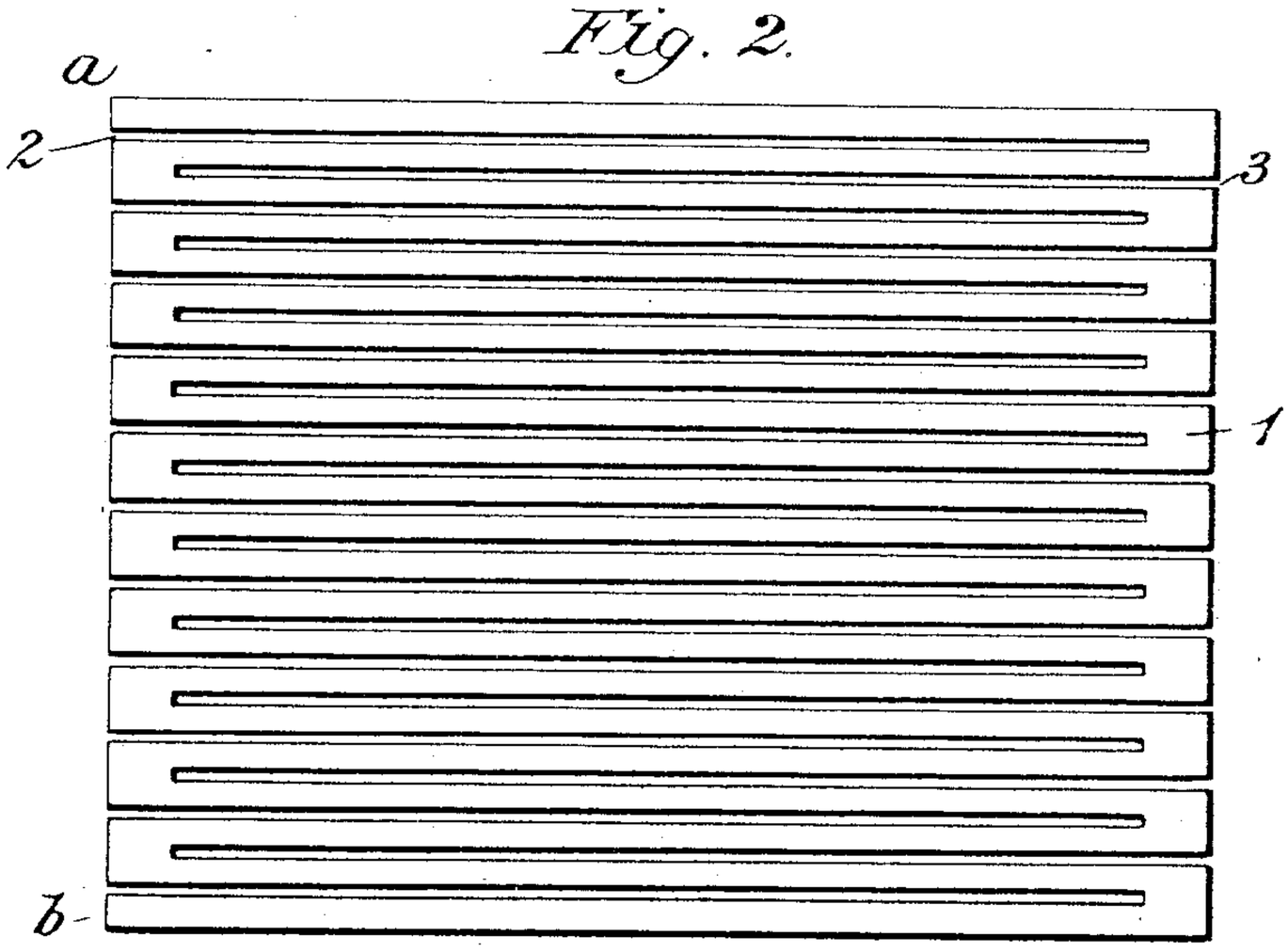


Fig. 2.



Witnesses
Edward Rowland,
Henry B. Colwell.

William S. Hadaway Jr. Inventor
By his Attorney H. Mackaye

No. 791,691. Patented June 6, 1905.

UNITED STATES PATENT OFFICE.

WILLIAM S. HADAWAY, JR., OF EAST ORANGE, NEW JERSEY.

ELECTRIC HEATER.

SPECIFICATION forming part of Letters Patent No. 791,691, dated June 6, 1905.

Application filed August 4, 1903. Serial No. 168,134.

To all whom it may concern:

Be it known that I, WILLIAM S. HADAWAY, Jr., residing in East Orange, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Electric Heaters, of which the following is a specification.

I have found that by the use of electric current of fairly low voltage in connection with electric heaters of proper construction and of practicable size the output of energy in the form of heat can be largely increased. By so proportioning my apparatus that the amperes of current shall be about equal in number to the volts of electromotive force I have produced as high an output of energy as forty watts to the square inch of heat of surface, which is far in advance of ordinary usage with currents of high pressure used with ordinary forms of heater. To accomplish these objects, I have found it necessary to seek some form of electrical resistance which should combine a large factor of safety in regard to mechanical and electrical strain with substantial immunity from distortions due to unequal changes of temperature during use or to other causes. In order to attain substantial uniformity of impartivity and to avoid all waste of heat, I have further found it necessary to employ a form of heating resistance which should be conformable with certainty at all times to the layer or wall of heat-transmitting material with which the resistance is associated. Preferably this last requirement reduces itself to the production of a resistance which may be relied upon to remain in a single plane without the application of compressive force and consequent internal strain.

In seeking to attain the high output of heat energy above mentioned I have discovered the necessity for the above-named requirements and have found it necessary to conform to these requirements while employing a material of such a high specific resistance as to permit of the use of auxiliary apparatus, such as switches, conductors, &c., of practicable size and economical cost. In view of the necessity for avoiding all internal strains which affect both the factor of safety and the stability of form of the resistance I have had to avoid the use of resistances made by the bending of wires or bars. In view of the necessity for using material having at once a relatively high specific resistance and a substantially uniform resistance throughout the range of temperature to which the material is subjected I have had to avoid resistances which are cast or molded into form. The form of resistance material which I have found entirely to conform to the above combined requirements and whereby I have produced the exceedingly high output of energy above mentioned is illustrated in the accompanying drawings and hereinafter described.

In the drawings, Figure 1 is a perspective plan view of one preferred shape or form of resisting element coming within my invention, and Fig. 2 is a perspective view of one simple form of heater in which this resisting element may be employed.

I have found that a satisfactory resisting element for converting electrical into heating energy while meeting the requirements above set forth is produced by cutting out of a plate of metal of proper chemical constitution a piece having the exterior form desired in any given instance and then so cutting the piece of plate thus produced as to convert it into a long strip of any desired shape without substantial disturbance of the grain of the metal.

A variety of ways of cutting a metal plate will occur to those skilled in the art for the production of a single metal strip, and I do not limit myself in my broader claims to the specific way of cutting the metal which is shown in the drawings.

As shown in the drawings, a plate 1 is cut out in the shape desired, which in the form shown is a square, and slots are cut from alternate sides, as shown at 2 and 3, so as to produce a single strip extending from *a* to *b* and traversing the plate 1 from side to side in opposite directions on the way. The slots 2 are preferably carried only so far as to leave the plate intact at their ends over a width somewhat exceeding the width of the spaces between the slots. This is done for production of greater strength and firmness in the resist-

ance. The material of the plate can be advantageously nickel-steel or chrome-steel or like high-resistance metal of great toughness and slow of oxidation. The slots 2 are preferably cut, either by a saw or milling-tool, in the direction of the grain of the metal; but I am not limited to cuts made in that relation to the grain as long as the plate when completed has not suffered any material disturbance in the original position of the grain of the metal.

In constructing an electric heater, including the resistance hitherto described, said resistance is placed between appropriate outer plates 4 and 5, its ends being turned up, as shown at 6 and 7, to form terminals for receiving the current. A thin layer of insulation, which may be produced or applied in any desired manner, is provided between the resistance-plate 1 and the two outer plates, as shown at 8 and 9.

I have found that where a resistance-strip is produced in the manner above described it naturally conforms to a substantially perfect plane and is therefore adapted to make perfect contact along its entire surface with the surface of the transmission-plate 3, this contact not being dependent upon any compression of the resistance material, and consequently avoiding all danger of internal strain or of buckling and possible short circuits during use.

By the use of resistances of this character I have been able to produce as high an output as forty watts to the square inch in regular and continuous work at from ten to sixty volts for small constructions, while preserving a large factor of safety and avoiding all accidents detrimental to the life or operation of the heater.

What I claim is—

1. An electric heater comprising a resistance-plate composed of wrought sheet metal cut into a continuous strip and having its original grain undisturbed, substantially as described.

2. An electric heater comprising a resistance-plate composed of wrought sheet metal cut into a continuous strip having its grain substantially parallel throughout, substantially as described.

3. An electric heater comprising a resistance-plate composed of wrought sheet metal having slots cut in it from opposite sides alternately, and parallel to the grain of the metal, substantially as described.

WILLIAM S. HADAWAY, Jr

Witnesses:

H. S. MacKaye,

Florence Peck.