

R. L. SEABURY.
PROCESS OF PRODUCING ELECTRICAL CONDUCTORS.
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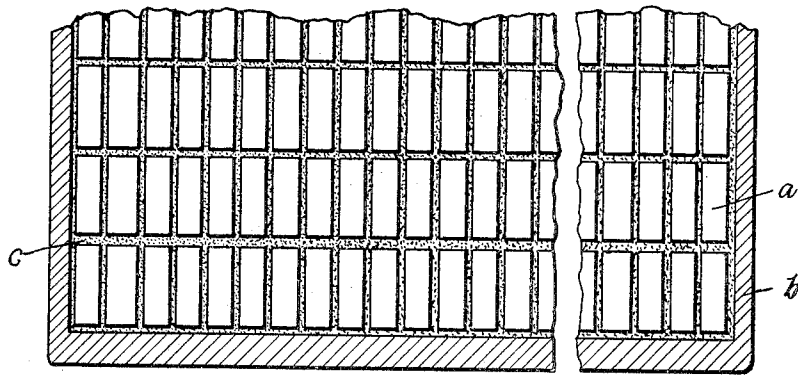


FIG - 1 -

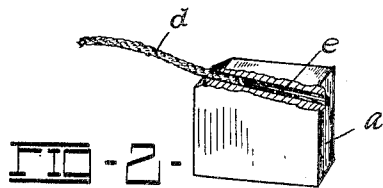


FIG - 2 -

INVENTOR
Ralph L. Seabury.
By Curn, Curn & Crompton.
His attys.

UNITED STATES PATENT OFFICE.

RALPH L. SEABURY, OF TOLEDO, OHIO.

PROCESS OF PRODUCING ELECTRICAL CONDUCTORS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, RALPH L. SEABURY, a citizen of the United States, and a resident of Toledo, in the county of Lucas and State of Ohio, have invented a certain new and useful Process of Producing Electrical Conductors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to a method of producing electrical conductor bodies of a granular nature, such, for instance, as commutator brushes, and has for one of its objects the provision of such a conductor having substantially the same co-efficient of thermal expansion as that of the metal lead, pigtail or conducting element to which connected, which is usually of copper.

Another object of the invention is the production of an electrical conductor which offers a considerably greater resistance to the passage of an electric current in one direction therethrough than in another direction therethrough at right angles to the first, thereby particularly adapting a conductor produced by my process for use as a commutator brush wherein it is desirable to resist the passage therethrough of cross-circuits without effecting the conductivity of the brush for longitudinal flowing circuits.

A further object of the invention is to produce electric conductors of the granular type in a simple, expeditious and comparatively inexpensive manner, and also to produce a commutator brush having enhanced wearing qualities. Further objects and advantages of the invention will be apparent from the following detailed description thereof.

In the accompanying drawings, Figure 1 illustrates in section a baking pot or pan with brushes packed therein in accordance with my invention preparatory to baking, and Fig. 2 is a perspective view of a brush partly in section with a pigtail secured therein.

The customary way of making graphite

brushes, consists of adding pitch to finely pulverized graphite in a quantity of from 45 to 70 per cent. of the weight of the graphite, then molding or compressing the mixture into brushes of the desired shape, then packing the brushes in a furnace, keeping each brush separate from the others by a layer or partition of loose fine granular sand, then baking slowly and gradually raising to a temperature of at least 1500 degrees F. and more generally to a temperature of about 1700 degrees F., the time required to attain these temperatures ranging from 72 to 150 hours or longer. After cooling, the brushes are ready to receive any final machining or grinding to make them of a specific size. I have found that brushes made in this way attain a minimum coefficient of thermal expansion at a temperature slightly less than 1500 degrees F., and that such coefficient is equivalent to nearly one-half the coefficient of thermal expansion of copper. An increase of the baking temperature above 1500 degrees F. does not further materially effect this coefficient of expansion.

The various features of novelty which characterize my invention consist of—

(1) The employment of a much reduced temperature for the baking process, over that formerly used, the temperature employed being less than the temperature which has heretofore been considered absolutely essential for the production of satisfactory brushes.

(2) The employment of a much faster rate of baking for the brushes than has formerly been used, or considered possible to use, to produce a brush free from blisters and cracks, and

(3) The packing of the sand or granular packing material closely and firmly around and between the brushes to provide a firm unyielding separating wall therebetween during the baking process to prevent the brushes from losing their shape and from fusing together.

Another feature characterizing my invention, but not in itself claimed by me as new, consists in the employment of a smaller quantity of binding material than customarily used in mixtures for graphite brushes. The normal mixture ordinarily

comprises an amount of binder which in weight is approximately 50% of the weight of graphite employed.

In the preferred method of making brushes according to my invention, I add pitch to powdered flaky graphite, in an amount equal to substantially 23 per cent. of the graphite weight, and after thoroughly mixing these together in a heated state, the mixture is allowed to cool and is then pulverized to a fineness which will enable it to pass through a screen having 30 meshes to the inch. The material is then molded into brushes *a* and subjected to a molding pressure of about 16 tons per square inch. The brushes are then packed in an iron pot *b*, which is preferably, but not necessarily, about 20 inches long, 15 inches wide and 8 inches high, care being taken that no brushes are actually in contact with each other. After the laying of each layer of brushes, loose sand *c* is distributed thereover and this readily runs into and fills the spaces between the brushes, being packed firmly therein by tamping or by vigorously jarring the iron pot, thus providing an unyielding wall between brushes and preventing as much as possible the liability of expansion of the brushes when baking. Each successive layer is subjected to the same sand packing operation and sand is also disposed between the layers. An iron cover is also preferably placed over the top of the packed brushes and clamped down to resist expansion of the brushes in an upward direction. It is thus evident that the brushes are forcefully resisted from expanding in any direction during baking. The pot containing the firmly packed brushes is then placed in a furnace and heat applied very rapidly until a temperature of about 1200 degrees F. has been attained, the time required being only about 8 hours. After removing from the furnace and cooling, the brushes are ready to be ground to specified dimensions for use. While it is preferable in practice to raise the baking temperature to approximately 1200 degrees F. it is found 900 degrees will give fairly satisfactory results if the quantity of binder is reduced and by increasing the quantity of the binder the temperature may be raised to approximately 1400 degrees and give good results.

It is found that brushes made in accordance with my invention, as above set forth, possess a coefficient of thermal expansion which very nearly approximates that of copper, and that by baking to a lower temperature than 1200 degrees F., a higher coefficient of expansion will be obtained, while baking to a higher temperature than 1200 degrees F. will give a lower coefficient of expansion. It is also found that a reduction of the percentage of binder in the mixture previous to compression will give an increase in the

coefficient of expansion of the baked brushes, while an increase of the percentage of binder will reduce the coefficient of expansion in the baked brushes for a given final temperature. In order to secure a good conducting brush at such a low temperature as 1200 degrees F., it is advisable not to use a much greater quantity of binder than 25 per cent. of the weight of graphite used, unless powdered copper or other good conducting metal is added to the mixture. It is found, however, that if a reduced quantity of binder, say as low as 15 per cent. of the weight of the graphite, is used and the mixture subjected to a compression of 20 tons pressure per square inch, packed as above described and then subjected to a baking temperature as low as 900 degrees F., that it is possible to get a good conducting body without the use of powdered metal. A variation in the molding pressure is also found to effect a variation in the coefficient of expansion, as an increase of the molding pressure gives an increase of such coefficient, and vice versa.

It is therefore apparent that my process is capable of numerous variations to produce in brushes a variation in the coefficient of expansion, for example, an increase in the coefficient of expansion is produced by decreasing the percentage of binder, or by increasing the molding pressure, or by decreasing the final baking temperature; and, conversely, a decrease in the coefficient of expansion can be obtained by increasing the percentage of binder, or by reducing the molding pressure, or by increasing the final temperature of baking.

It is eminently desirable in the manufacture of electric brushes that the coefficient of thermal expansion of the brush should be approximately the same as that of the metal pigtail or lead extending therefrom, as otherwise the permanency of a good contact between the brush and pigtail or lead is rendered uncertain owing to the fact that when subjected to a change of temperature one expands to a greater extent than the other, thereby tending to loosen the joint of contact between the two, which is especially the case when no solder is used. In dynamo electric machinery, considerable heat is generated at the brushes while in use, and as soon as the machine is stopped the brushes cool off, thereby causing repeated expansion and contraction of the brushes and conductors leading therefrom. It is found that brushes made by the method heretofore employed have a coefficient of thermal expansion which is less than one-half of that of copper, and for this reason considerable difficulty has been experienced in maintaining a permanent joint between the brush and its lead. With brushes made by my process, however, there is no appreciable difference in

the expansion of the brush and that of the pigtail or lead *d* so that there is no tendency of loosening between the two. This absence of relative expansion between the brush and
 5 pigtail permits a direct attachment of the pigtail by simply wedging the pigtail against the wall of a hole drilled at any suitable position in the brush by driving a nail
 10 *e* therein, or a bolt or rivet may be used to connect the two, without the need of electroplating the brush to secure a good connecting joint.

Another important feature of brushes made by my process resides in a much better mechanical structure due to the more firmly packing of the sand or other separating material around the brushes previous to baking than has heretofore been the practice, which renders the brushes considerably
 20 more dense and freer from baking cracks, and the reduced temperature of baking renders the brushes far less brittle and less granular and of considerably greater toughness. This results in a greatly increased
 25 wearing quality, even with the addition of powdered metal incorporated into the mixture previous to molding.

Another important feature of my invention resides in the fact that brushes made
 30 thereby show an electrical resistance of from four to six times greater magnitude when measured across the face of the brush than when measured along the length of the brush. I attribute this to the fact that the
 35 brushes being firmly packed with their sides toward each other are forcibly prevented as much as possible from expanding and the rapid rate of baking tends to drive out the volatile portion of the binder along the grain
 40 so rapidly that there is not sufficient opportunity for the grain of the brush to heal thoroughly, whereas, with the ordinary process of baking, requiring many hours, the volatile portion of the binder is driven off
 45 very slowly, with the result that the grain or internal structure of the brush has a better chance to heal together, with the final result that the electrical resistance is not greatly different in whichever direction it is
 50 measured. This high cross-resistance and low lengthwise resistance obtained with my method of packing and baking brushes, is of great advantage in that it will suppress any tendency to spark to a much greater degree
 55 than ordinary brushes, while at the same time the effective current may pass readily along the length of the brush without appreciable loss.

While I have described the best form of
 60 my invention, now known to me, it will be obvious to all those skilled in the art, that changes may be made in the novel features I have disclosed, without departing from the spirit of my invention, and I do not
 65 wish the claims hereinafter made limited to

the exact description I have disclosed more than is made necessary by the state of the art.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is,—

1. The process of packing granular conducting bodies preparatory to baking, which consists in arranging the bodies in spaced relation in a receptacle and forcefully packing
 75 a granular packing material in the interstices to form a substantially unyielding wall between the bodies.

2. The process of packing granular conducting bodies preparatory to baking, which consists in arranging the bodies in spaced relation in a receptacle, distributing a granular packing material in the interstices between the bodies by depositing it there-
 85 over and jarring the receptacle to cause a firm packing of the material in all interstices.

3. The process of preparing a granular conducting body for baking, which consists in confining it within substantially unyield-
 90 ing bounding walls to resist an expansion of the body during baking.

4. The process of baking a graphitic electrical conductor body, which consists in firmly packing it within confining walls and
 95 then subjecting it to a baking temperature which is rapidly raised.

5. The process of baking a graphitic electrical conductor body, which consists in firmly packing it within confining walls,
 100 and then subjecting it to a baking temperature which is rapidly raised to a point not less than 900 degrees F. and not more than 1400 degrees F.

6. The process of baking graphitic electrical conductor bodies, which consists in firmly packing the bodies in spaced relation in a granular packing material, where-
 105 by an expansion of the bodies is resisted with considerable force, and then subjecting them to a baking temperature which is rapidly raised to a point not less than 900 degrees F. and not more than 1400 de-
 110 grees F.

7. The process of packing and baking a
 115 graphitic body to produce an electrical conductor having a greater electrical resistance in one direction than in another direction at an angle thereto, which consists in firmly packing the body in a granular material to
 120 prevent expanding in a direction tending to open up the grain of the body, and then subjecting the packed body to a baking temperature which is rapidly raised to a point not less than 900 degrees and not more than
 125 1400 degrees F.

8. The process of making graphitic electrical conductor bodies, which consists in mixing a subnormal quantity of binder with graphite, compressing the mixture into
 130

blocks, packing the blocks in a manner to permit expansion thereof only under greatest difficulty during baking, and subjecting the packed blocks to a rapid rise of baking temperature.

9. The process of making graphitic electrical conductor bodies, which consists in mixing a subnormal quantity of pitch with flaky graphite, compressing the mixture into blocks under a pressure of many tons per square inch, packing the blocks in a manner to exert a high resistance to an expansion thereof during baking, and subjecting the packed blocks to a baking temperature which is rapidly raised to a point not less than 900 degrees F. and not more than 1400 degrees F.

10. The process of making graphitic electrical conductor bodies, which consists in mixing a subnormal quantity of binder with graphite, compressing the mixture into blocks under high pressure, placing the blocks in spaced relation in a receptacle, firmly packing a granular material in the interstices between the blocks to offer a considerable resistance to an expansion thereof during baking, and then subjecting the packed blocks to a temperature which is rapidly raised to a point not less than 900 degrees F. and not more than 1400 degrees F.

11. The process of making graphitic electrical conductor bodies, which consists in mixing pitch with flaky graphite in a quan-

tity which is less than one-third of the weight of the graphite, compressing the mixture under high pressure into blocks, packing the blocks in a receptacle in slightly spaced relation, forcing a granular packing material in the interstices between the blocks to provide a firm spacing medium to resist expansion, and subjecting the packed blocks to a rapidly rising baking temperature.

12. The process of packing and baking a graphitic body to produce an electrical conductor having a greater electrical resistance in one direction than in another direction at an angle thereto, which consists in firmly packing the body in a manner to prevent expanding as much as possible in a direction tending to open up the grain of the body, and then subjecting the packed body to a baking temperature which is rapidly raised to a point not less than 900 degrees and not more than 1400 degrees F.

13. The process of making graphitic electrical conductor bodies, which consists in mixing pitch with flaky graphite in a quantity which is less than one-third of the graphite, compressing the mixture under high pressure into blocks, firmly packing the blocks in spaced relation to forcefully resist expansion, and subjecting the packed blocks to a rapidly rising baking temperature.

In testimony whereof I have hereunto signed my name to this specification.

RALPH L. SEABURY.