H. H. WIKLE.

BRUSH AND METHOD OF MANUFACTURING THE SAME.

APPLICATION FILED APR. 13, 1918.

1,375,879. **Patented Apr. 26, 1921.**

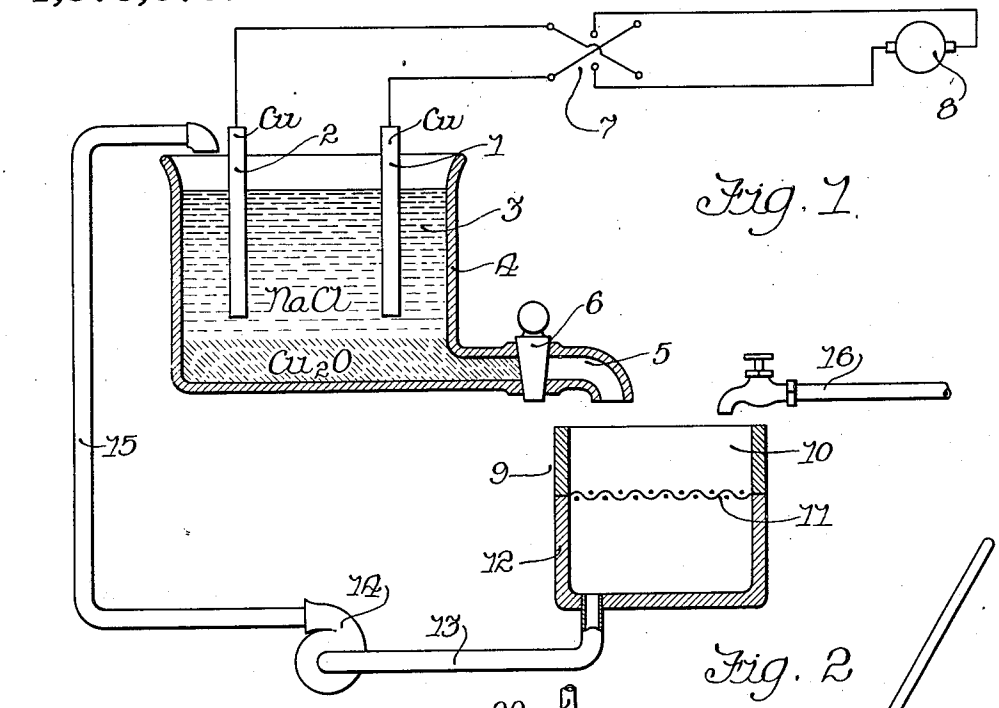


Fig. 1.

Fig. 2

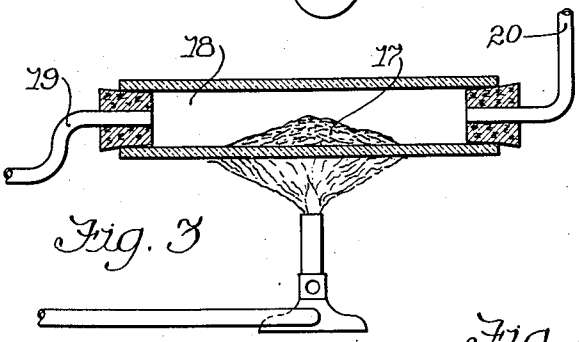


Fig. 3

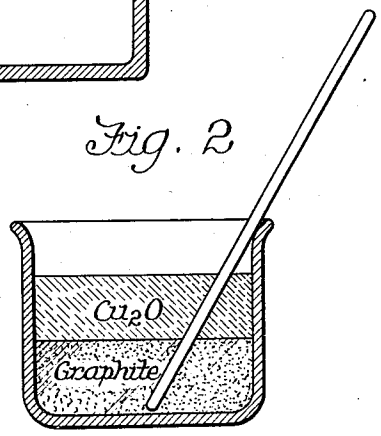


Fig. 4

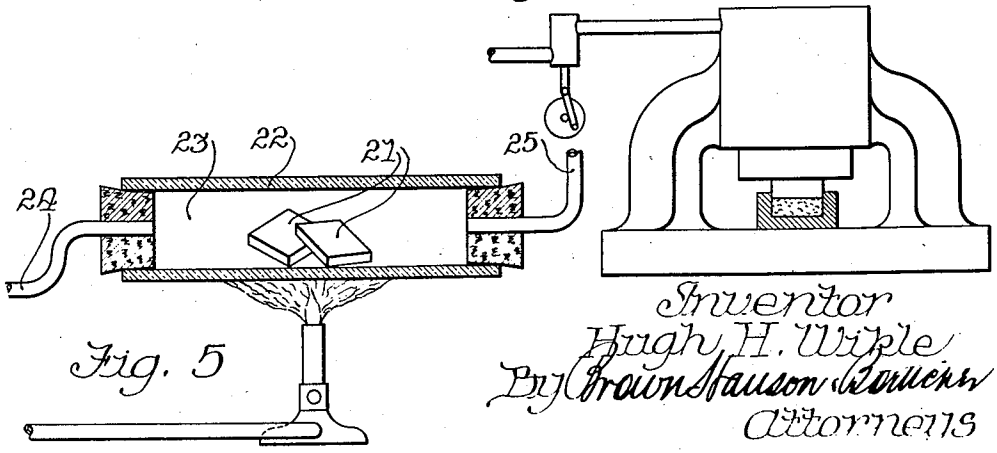


Fig. 5

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BRUSH AND METHOD OF MANUFACTURING THE SAME.

1,375,879. Specification of Letters Patent. Patented Apr. 26, 1921.

Application filed April 13, 1918. Serial No. 228,309.

To all whom it may concern:

Be it known that I, HUGH H. WIKLE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Brushes and Methods of Manufacturing the Same, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to the manufacture of brushes for electrical machinery.

Whereas certain of the steps involved in this invention are novel in and of themselves and may be applied to other purposes, I disclose and claim the same in certain co-pending applications, to-wit, Serial No. 228,310, filed April 13, 1918, and Serial No. 250,416, filed August 19, 1918.

The particular type of brushes to which this invention relates is the rigid or block type of brush formed of a mixture of some metal, preferably including copper and some form of carbon, preferably graphite. These brushes are of two kinds well recognized in the art as the "metal" brush, which consists of a mixture of finely divided metal and graphite with no further binder, and the "metal-graphite" brush, which consists of a mixture of finely divided metal and graphite with a binder.

The metal brush looks much like the metal from which it is formed. It is lighter than metal containing about 90% of metal and 10% of graphite by weight. The metal-graphite brush appears nearly black, though it shows the metal in its structure. The proportions of metal in the brush may vary considerably, according to grade, but they run from 20% to 80% by weight. The binder, which is usually pitch, enters into the batch or mix approximately to the extent of 20% by weight.

Heretofore the manufacture of brushes of this type has been practised by employing mechanically powdered or pulverized metal. Mechanical pulverization is expensive and difficult and provides only a relatively coarse powder.

According to my invention the powdered metal is produced electro-chemically. Not only is this done at less expense, but less labor and difficulty is involved and the resulting powder is much finer and of a more advantageous physical character.

Another advantage is the fact that the danger from flying dust is greatly reduced, if not wholly eliminated.

Certain other advantages and objects will appear from the following specification.

In the accompanying drawings which form a part of the present specification, I have illustrated diagrammatically the steps which enter into the manufacture of a brush according to my invention.

Figure 1 is a diagram of the electrolytic vat and filter for precipitating and separating cuprous oxid.

Fig. 2 diagrammatically indicates the step of mixing the cuprous oxid with graphite;

Fig. 3 is a sectional view of the furnace employed to pre-bake the mix where a hydro-carbon binder such as pitch is employed;

Fig. 4 illustrates a hydraulic press for pressing the mixture into slabs or blocks; and

Fig. 5 is a sectional view of a furnace for baking the blocks or plates to drive off the remaining hydrocarbons and sintering the particles of metal together.

The first step of my invention is a novel method of securing finely divided copper oxid. For the purposes of the present invention the oxid might be obtained in any desired manner, but I shall describe briefly the manner in which I obtain the same, although this particular mechanism and process is described more fully and claimed in my co-pending application, Serial Number 228,310, above referred to.

The electrodes 1 and 2 are of similar metal. I have found that electrodes of copper, brass, bronze or the like may be employed successfully, but I shall limit the present description to the use of copper in commercial form. The copper electrodes 1 and 2 are suspended in an electrolyte 3, which comprises a saturated solution of sodium chlorid. A suitable vat 4, having a draw-off connection 5, controlled by a valve 6, forms the container for the electrolyte.

The electrodes 1 and 2 are connected through a reversing switch 7 to a suitable source of current 8.

A suitable filter 9 is placed so as to receive the discharge of liquid and precipitate from the vat 4. This filter comprises an

open bottomed box 10, having a suitable filter, preferably made of cloth, stretched across the bottom as shown at 11 in Fig. 1. The filter 9 is removable from the box or tank 12, over which it is normally held. The liquid with the precipitate is discharged into the filter 9 and the liquid then passes through into the tank 12 from whence it is conveyed by the pipe 13 and pump 14 back to the vat 4 by way of the discharge pipe 15.

The chemical action of the electrodes and electrolyte is continuous. The electrolyte of sodium chlorid is electrolyzed, the ions of sodium uniting with the water to form sodium hydroxid freeing hydrogen. The chlorin either unites with the water to form hydrochloric acid or directly attacks the cathode where it is freed, forming a chlorid of copper.

The current density and the resistance of the cell are such that considerable heat is generated. In the presence of the heat it appears that the cupric chlorid ($CuCl_2$) in the presence of the metallic copper, forms cuprous chlorid (CuCl).

It appears that the cuprous chlorid is either hydrolyzed directly by the hot water, giving red cuprous oxid (Cu_2O), or it passes through the phase of forming the hydroxid of copper and then into cuprous oxid. It appears that the chlorin which is thus liberated, unites with the hydrogen of the water to form hydro-chloric acid and then combines with the sodium hydroxid to form salt and water, or the chlorin may unite with the sodium in some other manner. The final action is that the water is broken up into hydrogen and oxygen, of which the hydrogen is freed at the anode and passes off into the atmosphere, while the oxygen unites with the copper atoms to form the cuprous oxid.

The cuprous oxid forms a very fine red precipitate which may be drawn off periodically as by opening the valve 6 and permitting a part of the contents of the vat 4 to run into the filter 9. The cuprous oxid is filtered out to a great extent, the liquid then passing into the tank 12 and being pumped back into the vat 4. The cuprous oxid may then be washed off, preferably by hot water from the pipe 16 to free it from salt or sodium and at the same time to replenish the water which has been electrolyzed in the vat 4.

I find that a certain amount of cuprous hydroxid is formed in the electrolytic cell. This is reduced by washing with hot water or is reduced in the cell by the hot electrolyte, to the cuprous oxid. This is more likely to be formed when the electrolyte is cold as when the cell is first started up.

It will be seen that the process is continuous.

The reversing switch 7 is reversed periodically to reverse the polarity of the electrodes 1 and 2. I find that this very greatly improves the operation of the electrolytic cell. The time of reversal may, of course, be varied considerably, and I give the figure of one hour merely as illustrative of a successful manner of operating the device.

The next step in the process consists in mixing the cuprous oxid, in the wet form, with graphite. This step is illustrated diagrammatically in Fig. 2. The wet mixing of the oxid with graphite substantially eliminates flying particles of the graphite or of the oxid. It also permits of a more thorough and even mixture. When it is desired to form metal brushes, the proportion of cuprous oxid to graphite is taken such that when the same is reduced to the metal by firing, as will be described later, the metal will be present in substantially the proportion of 90%.

The next step after mixing the graphite and cuprous oxid is to fire the same to reduce the oxid to the metal. This is done in a closed furnace as shown in Fig. 3 with a reducing atmosphere 18. The mix 17 is placed in the firing chamber in a current of hydrogen, city gas, or the like, which enters by way of the pipe 19 and passes out by way of pipe 20. The firing chamber is heated to about 1500 deg. F.

Where it is desired to make metal graphite brushes, a binder such as pitch is mixed with the metal graphite mix so that the pitch represents about 20% by weight of the batch. The proportions may, of course, be varied within wide limits. Where the pitch is employed as a binder, I have found it advantageous to give the material a preliminary baking, which I call a pre-bake, to drive off the low volatile constituents of the pitch. The pre-bake drives off a relatively large amount of the hydrocarbons that volatilize at a temperature of between 200 deg. F. and 900 deg. F.

Sufficient hydrocarbons of higher volatilizing temperatures remain to give the necessary binding qualities of the material. This step of pre-baking may also be applied to the manufacture of other forms of brushes where a binder such as pitch is employed.

The batch of material is placed in a closed firing chamber such as that shown in Fig. 3, in a reducing atmosphere which may consist of hydrogen, city gas or the like. A current of such gas is preferably passed through the firing chamber. The chamber is then subjected to a heat of substantially 900 deg. F., to remove the low volatilizing hydro-carbons which were a part of the pitch and at the same time to thoroughly dry the material.

I have found that an inert atmosphere, such as would be furnished by a stream

of nitrogen, could be employed. When the material is thus subjected to pre-baking only the more easily volatile hydro-carbons are driven off and certain others remain to deposit fixed carbon when the brush material is finally fired, as will be described later.

I have found that this step of pre-baking the material is highly useful, not only in the manufacture of composition brushes, but is also of great utility in the manufacture of plain carbon brushes.

When a metal brush is to be made the step of mixing the binder and pre-baking is omitted.

The material, after mixing, reducing and pre-baking is then molded into suitable plates or blocks. If desired, the material may be ground or passed through a sieve to insure that the same is sufficiently pulverized. The material is then placed in a suitable mold and subjected to hydraulic pressure as indicated in Fig. 4 to form the mass into solid coherent form. The pressure applied is approximately 20 tons per square inch. This step is well understood by those skilled in the art. It brings the particles of graphite and of metal, and also the binder when it is used, into very intimate relation.

The blocks or slabs 21 are then placed in the closed furnace chamber 22 and fired in a reducing atmosphere, 23, which is maintained by passing a current of hydrogen or gas in through the tube 24 and out at the tube 25.

In the firing chamber 23 the material is subjected to a heat sufficient to sinter the particles of metal together in the body of the brush. I have found that a temperature of 1600 deg. F. will be sufficiently high to secure this action. This temperature may be varied.

I have found that a denser and more homogeneous brush is produced by the above process than has heretofore been possible. The fineness of the metallic material secures very important results in the different stages of manufacture. The mixture of the wet cuprous oxid with graphite is a very distinct advantage in that the danger and discomfort from the flying dust or powder is greatly reduced, being practically eliminated. Due to the fineness of the material, a better mixing is possible.

The fineness of the copper in the reduced form in the finished brush is of great advantage in providing a smooth compact grain and a more dense and coherent structure than has heretofore been possible. These particles of copper are extremely small, readily passing through a 200 mesh screen. The particles of copper are in octahedral form, which permits the flake particles of graphite to envelop the copper particles much better than if both the graphite and copper were in flake form and thus a better structure and better bonding between particles is secured than in the brushes of the prior art.

The metal graphite brush has a greater density and lower specific resistance than a brush of the same type made according to the prior art for the same metal content. The contact resistance between the brush and commutator remains substantially the same as a brush made by the prior art.

In the case of the metal brush I have discovered that the brush after it is finally baked may be placed back in the die and subjected to substantially the same pressure above mentioned and a very decided increase of density as much as 15% results. This brings the brushes to a uniform size and density and provides a brush of greater current carrying capacity.

I have found that instead of copper, alloys of copper may be employed under substantially the same conditions as outlined in the above. I am not able to state definitely what the chemical reactions of the zinc, tin, nickel, etc., of the alloy are, but I find by actual trial that the alloys may be handled in all respects like the copper without any variation in the divided metal with the exception of a small loss in the case of tin which appears not to go out of the electrolyte in quite the same degree as the other metals.

It is possible, as I have found, to apply the same electrolytic process to the manufacture of oxids of other metal, particularly manganese.

Finely divided metals, such as copper and zinc or tin, etc., secured from any source, may be mixed and fired in a reducing atmosphere to substantially 1500 deg. F. to secure finely divided or powdered alloy without the necessity of melting into a mass and repulverizing. This is an important feature of my invention and may be practised with or without an excess of carbon.

I do not intend to be limited to the precise details or ranges set out in the above specifications as considerable latitude is permissible and considerable variation is possible while still gaining the benefits of my invention.

I claim:

1. A brush of the class described consisting of a mixture of finely subdivided metal containing copper, with powdered graphite, said mixture being bonded together solely by pressure.

2. A brush of the class described, consisting of a mixture of metal containing copper, said metal being in the form of minute crystals capable of passing a 200 mesh screen, and powdered graphite, said metal crystals entering into the mixture in substantially the proportion of 90% and the graphite en-

tering in proportion of substantially 10%, said mixture being compacted under pressure to bond together into a dense, close grained, coherent mass having substantially the appearance and color of the metal.

3. The method of making brushes for electrical machinery which comprises electrically precipitating cuprous oxid, then mixing the cuprous oxid in a wet condition with powdered graphite, and then firing the mixture in a reducing atmosphere to reduce the oxid to the metal.

4. The method of manufacturing brushes of the rigid block type, which consists in mixing cuprous oxid with powdered graphite in substantially the final proportion of 10% graphite to 90% metal by weight, then firing to reduce the cuprous oxid to copper, then compressing the mixture to cause cohesion.

5. The method of manufacturing brushes of the rigid block type, which consists in precipitating cuprous oxid, mixing the same wet with graphite, then firing the same to reduce the cuprous oxid to the metal, then compressing the mixture.

6. The method of forming finely divided metal for the manufacture of brushes, which consists in precipitating an oxid of copper from a solution of a chlorid of copper to produce a finely sub-divided oxid, then firing the same to reduce the oxid of copper to finely divided copper.

7. The method of making a brush which comprises mixing precipitated metal oxid with graphite in finely divided form, firing to reduce the oxid to elemental metal, then compressing the mixture to bond.

8. The method of making a brush which comprises mixing precipitated metal oxid with graphite in finely divided form and firing the same in a reducing atmosphere to reduce the oxids to elemental metal.

9. The method of making a brush which comprises electrolytically precipitating an oxid of a metal, then mixing the same with an excess of carbon in powdered form and then firing to reduce the oxid to the elemental metal within the mass of carbon.

10. The method of forming a brush of the class described, which comprises precipitating an oxid of a metal, mixing the same with graphite, firing the mixture in a non-oxidizing atmosphere to reduce the oxid of the metal to finely divided particles of the metal, compacting the mixture into a dense coherent mass, again firing the mass in a non-oxidizing atmosphere, and again compressing the mass to increase the density thereof.

11. The method of making a brush of the above described type, which comprises, mixing cuprous oxid in minutely sub-divided form while wet with powdered graphite, then firing the mixture to reduce the cuprous oxid to metal in the form of exceedingly finely crystals throughout the mixture, and then compressing the mixture to cause the particles of graphite and the crystals of metal to bond, and firing the compressed and bonded mass.

12. A brush of the rigid block type, comprising a mechanical mixture of graphite in powdered form and exceedingly fine particles of metal comprising copper, said crystals of metal being produced by reducing a precipitated oxid of the metal within the mass of graphite before the brush is molded.

In witness whereof I hereunto subscribe my name this 4th day of April, A. D. 1918.

HUGH H. WIKLE.