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J. B. BRENNAN
METHOD OF MAKING COMPACT METAL STRIP
AND ELECTRODE PRODUCED THEREFROM
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2,582,744

FIG. 1

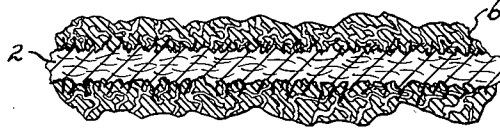


FIG. 2

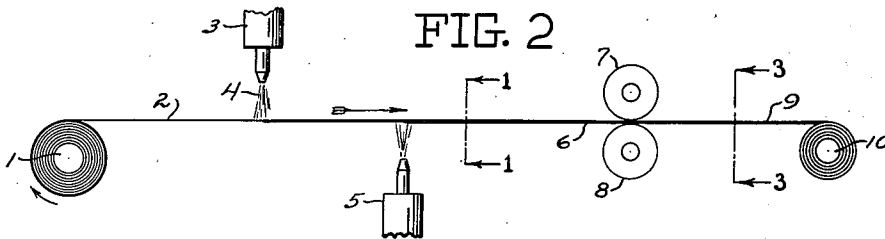


FIG. 3

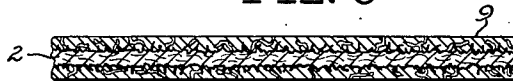


FIG. 4

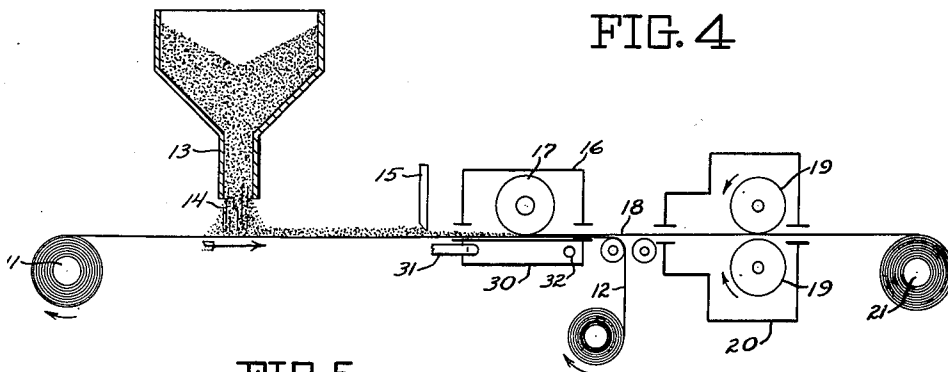
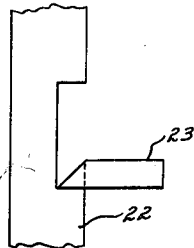


FIG. 5



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UNITED STATES PATENT OFFICE

2,582,744

METHOD OF MAKING COMPACT METAL
STRIP AND ELECTRODE PRODUCED
THEREFROM

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Application August 3, 1948, Serial No. 42,306

5 Claims. (Cl. 175—315)

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This invention, broadly speaking, relates to the formation of compact metal strip, more specifically the invention relates to a method of forming a porous metal strip which thereafter is compacted to produce a uniform, substantially solid metal strip having desirable properties. The invention also relates to electrodes made from the strip of the invention.

Heretofore some efforts have been made to produce electrodes for use in electrolytic condensers wherein the electrode strip may first be produced in porous form and thereafter be compressed slightly so as to form a somewhat compressed or compact metal strip. One disclosure of such a process is found in J. M. Booe United States Patent No. 2,404,824, issued on July 30, 1946. Booe's patent discloses the formation of a porous metal strip by spray depositing aluminum onto a cloth strip as it is moved past a metal spray gun. After this porous strip is so formed, it thereafter is reduced in thickness and Booe says that he may reduce his gauge by as much as 36%. However, Booe also says that the reduction in thickness brought about by the rolling does not reduce the capacity per unit area of the electrode. He also states that the power factor and resistance are not materially altered. In fact, Booe even states that the rolling and compacting of the electrode strip may actually cause an increase in capacity and the increase frequently amounts to 10% or more of the original capacity of the porous strip.

The general object of the present invention is to form a compact metal strip having desirable properties by a new and improved method.

Another object of the invention is to provide a method for forming metal foil by an inexpensive, easily practiced process.

Another object of the invention is to provide an improved electrode which is adapted to have the terminal tab therefor made from an integral part of the original electrode strip.

Another object of the invention is to provide an extremely thin, compact metal foil strip without extensive rolling of the metal.

A further object of the invention is to provide an improved electrode of desired flexibility and with relatively high tensile strength.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

Attention is now directed to the accompanying drawings wherein Figs. 1 and 3 are cross sections taken on lines 1—1 and 3—3 of Fig. 2;

Fig. 2 is a diagrammatic view of apparatus for performing the method of the invention;

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Fig. 4 is a diagrammatic view of modified apparatus for practicing the process of the invention; and

Fig. 5 is a fragmentary plan of an electrode formed in accordance with the invention.

Referring now to the details of the construction shown in the drawings, a storage roll 1 is provided which has a length of a suitable porous base strip 2 wound therearound. The base strip 2 may be formed from gauze, matted fibers, either cloth or paper, threads, textile batts or other suitable porous material adapted to stand the temperatures to which the base strip 2 is exposed. The base strip 2 is led past a spray gun 3 which gun is of any conventional construction and is shown as projecting particles 4 of metal toward the base strip. These metal particles 4 are molten and are sprayed onto the strip 2 in such a manner and at such a speed so that the particles coalesce and form a continuous metal strip which is integrally bonded to the base strip 2. Usually a second nozzle 5 is associated with the strip 2 to spray upon the opposite side of the base strip 2 as the base strip 2 passes the spray gun 3 whereby both surfaces of the base strip will have a metal coating formed thereon. Usually the metal coating upon the base strip has passed therethrough a sufficient distance as to bond the metallic surfaces on the base strip 2 together through the pores of the base strip. Fig. 1 shows that a resultant metallic strip 6 is formed by deposit of metal onto the base strip 2.

As a feature of the invention, at any time after the metal strip 6 is made, it is passed between a pair of rolls 7 and 8 which rolls are of such size and spacing as to compact the particles forming the metal strip 6 and greatly reduce the thickness thereof. Fig. 1 shows that the metallic portions of the strip 6 are quite porous and that the surfaces of the strip are irregular so that it is difficult to gauge the thickness of same accurately. Usually the metal strip 6 may be in the vicinity of from about three thousandths of an inch to about nine thousandths of an inch in gauge at its center. However, after passage of the strip through or between the rolls 7 and 8, the original strip has been effectively compacted so as to form a relatively compact or dense metal strip indicated at 9. This strip 9 has smooth metal surfaces and is of uniform thickness. In one pass of the metal strip 6 through the rolls 7 and 8, the thickness of the strip 6 has been reduced about 50% in its center portion whereas the edges of the strip 6 have only been reduced up to about 20% in forming the

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strip 9. Such a metal strip would have a greater center crown formed thereon than the strip 6 shown in the accompanying drawing since, to obtain the greater center reduction than edge reduction, the center of the strip must have an appreciably greater original thickness than the edge portions of the strip. The strip 9 is then wound upon a storage reel 10 and may be thereafter processed in any desired manner. The rolls 7 and 8 usually are driven in some conventional manner, as is the storage roll 10.

By effecting the major reduction or compacting of the original strip 6 produced by spraying metal particles onto a base strip, applicant has been able to produce an electrode forming strip 9 which has uniform capacity throughout the unit areas thereof and this capacity is appreciably less than the irregular unit capacity of a strip produced in accordance with prior practice, such as the capacity of the metal strip 6. Furthermore, the compacting of the original strip has been so effected as to produce a strip having less electrical resistance per unit of cross section than the original strip 6 and the power factor of the resultant strip when associated with other electrodes is proportionally better than that of a strip like the strip 6.

Fig. 4 illustrates another method of forming a porous metal strip which may be compacted in accordance with the teachings of the invention. Thus a storage reel 11 is provided for a backing strip 12 which may be formed from smooth surfaced stainless steel, or from other material as desired. In all events, the backing strip 12 moves under a storage hopper 13 from which metallic particles 14 deposit onto the backing strip 12. Thereafter a doctor blade 15 uniformly distributes the particles 14 over the surface of the belt 12 after which the belt 12, carrying the relatively uniform layer of particles 14 thereon is led through a sintering oven 16 which may have a roll 17 therein that serves to aid in bonding or forcing the metal particles 14 into engagement with each other to produce a porous metal strip 18 therefrom. Bonding of the particles 14 to the strip 12 is prevented by a hollow cooling shoe 30 which backs up the strip 12 in the oven 16. The shoe 30 has cooling fluid supplied thereto by conduits 31 and 32. The porous metal strip 18 is pulled from the belt 12 and led between a pair of rolls 19 which are adapted to compact the strip 18 in accordance with the teachings of the invention. Fig. 4 shows that the rolls 19 are positioned inside a chamber 20 which may have suitable heat supply means connected thereto whereby the temperature at which the compacting of the strip 18 is effected may be readily and accurately controlled. Of course, the rolling chamber 20 may be positioned at any desired distance from the sintering chamber 16 to aid in controlling the temperature of the strip when in the chamber 20. Lastly the compacted metal strip 18 is wound upon a reel 21 for storing the resultant compact metal strip.

It will be realized that the porous metal strip 18 produced by fusing or sintering metallic particles together will have the same general construction as indicated for the metal strip 6 disclosed in Figs. 1 and 2. However, there will be no fibrous base material associated with the strip 18 which, after compacting, will generally resemble the metal portions of the metal strip 9.

Fig. 5 shows that a porous, compressed electrode 22 formed in accordance with the teachings of the invention may have a terminal tab 23

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extending therefrom at substantially a right angle thereto with the terminal tab 23 being integral with the electrode 22 and with no fracture of the electrode being produced by production of the terminal tab 23. That is, by cutting or slitting a lateral portion of the electrode 22, the terminal tab can be formed that it may thereafter be merely bent out at right angles to the longitudinal axis of the electrode strip 22. It has been found that processing an electrode in accordance with the present invention so increases the tensile strength of the original electrode that an electrode terminal tab can be bent out from the electrode strip and serve as an integral terminal therefor.

Close examination of metallic strip produced in accordance with the invention, after having only one compression rolling thereof, will have the original porous openings of the strip so compacted and flattened that they are practically all eliminated. While the capacity per square inch has been reduced as much as 10% in some areas, in other areas, usually the lateral or thinner portions of the electrode strip, are not reduced at all. The great increase in tensile strength obtained in the electrode strip permits it to be immersed in boiling electrolyte in order to impregnate same and the difficulties that heretofore have been encountered in the formation of electrodes and in impregnating same are overcome since the weaker prior art strips frequently broke when being drawn through the electrolyte. The improved electrode strip of the invention is also much easier to weld to than previous types of electrodes.

By repeated rollings of a compact metal strip produced in accordance with the invention, extremely thin, uniform gauge, substantially solid metal strips are produced and these strips may be as low as five-ten thousandths of an inch in thickness. Usually the metal strip should be annealed between the rolling operations whereby the thin, non-porous plate or strip is produced.

The invention is adapted to be utilized with a porous metal strip which is produced in accordance with any known method and it includes the processing of a porous metal strip obtained by merely spraying metal particles onto a base member and thereafter removing the solidified metal particles from contact with the base member. In such instances the metallic particles, as usual, coalesce with each other as they are deposited and combined to form a continuous metal strip. One method for producing a porous metal strip in this fashion is described in detail in my copending application Serial No. 767,834, filed August 9, 1947.

While the invention is particularly suited for the formation of metal strips from aluminum, it may be used to form metal strips from other desired materials such as copper, zinc, etc. The resultant thin metal sheets may be used for any desired purpose including formation of bearings, transformer laminations, or other articles therefrom.

The present invention provides an inexpensive method of forming thin metal strips since it costs only about five cents a pound to spray pig aluminum which can be purchased for about fifteen cents a pound whereby a compact metal strip can be produced for twenty cents a pound plus the relatively small rolling expense. However, metal strip on the market today costs about fifty cents a pound when formed in accordance with prior practice.

When rolling porous metal strip in accordance with the invention, it may even be desirable to tension the metal strip as it is rolled so as to expedite the rolling action thereon. It is thought that the different results achieved by practice of the present invention in comparison with the results obtained by practicing the teachings of Patent 2,404,824 are due primarily to the fact that the present invention effects a much greater compression of the porous strip so as to achieve a different result. Furthermore, the present invention recognizes and deals with porous metal strips as now produced, i. e., of non-uniform gauge laterally of the strip.

It will be realized that alloys may be treated in accordance with the invention. Also, laminations of the same or different metals can be produced by use of one metal for the backing strip and another one for the deposited material. Or, the backing strip could pass by two or more nozzles that would deposit metal particles thereon. A cooling shoe may be used with the apparatus of Fig. 2 when desired to reduce or prevent adhesion of metal to the backing strip and cooling shoes would not be used when adhesion is desired between deposited material and the backing strip.

While several embodiments of the invention have been disclosed herein, it will be appreciated that modification of these particular embodiments of the invention may be resorted to without departing from the scope of the invention as defined by the appended claims.

Having thus described my invention, what I claim is:

1. A method of making a thin at least substantially solid metal strip comprising the steps of spraying molten metal particles to form an elongate porous metal strip solely composed of sprayed particles, rolling the strip to reduce its gauge and eliminate at least some of the porosity thereof by densifying the strip, such rolling also providing the strip with substantially uniform gauge transversely thereof, annealing the rolled strip, and repeating the alternate rolling and annealing operations until a thin at least substantially solid metal strip of desired gauge is produced.

2. A method as in claim 1 wherein the resultant strip is approximately .0005" in thickness.

3. A method of making a thin at least substantially solid metal strip comprising the steps of spraying molten metal particles to form an elongate porous flexible metal strip therefrom by deposition on a base, removing the so-formed

strip from the base to provide a strip solely composed of sprayed particles, rolling the strip to reduce its gauge and eliminate at least some of the porosity thereof by densifying the strip, such rolling also providing the strip with substantially uniform gauge transversely thereof, annealing the rolled strip, and repeating the alternate rolling and annealing operations until a thin at least substantially solid metal strip of desired gauge is produced.

4. A method of making a thin homogeneous metal strip comprising the steps of spraying molten metal onto a base, forming an elongate porous strip thereon, separating the porous metal strip from the base upon which it was sprayed, rolling the strip for reducing its gauge and increasing the density thereof, annealing the rolled strip, and continuing the alternate rolling and annealing operations until a thin uniform gauge metal strip of desired gauge and density is produced.

5. A method of making a thin homogeneous metal strip comprising the steps of spraying molten metal onto a base forming an elongate porous strip thereon, separating the porous metal strip from the base upon which it was sprayed, rolling the strip for reducing its gauge and increasing the density thereof, annealing the rolled strip, continuing the alternate rolling and annealing operations until a thin uniform gauge metal strip of desired gauge and density is produced, cutting a portion of the so formed strip to form a tab integral therewith, and folding the tab so that it extends beyond the side edge of the strip to form a terminal.

JOSEPH B. BRENNAN.

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