

May 16, 1939.

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2,158,461

METHOD OF MAKING BEARINGS

Filed May 23, 1936

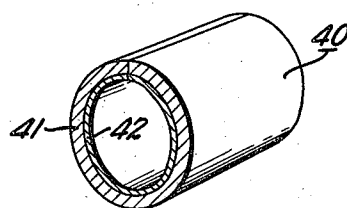
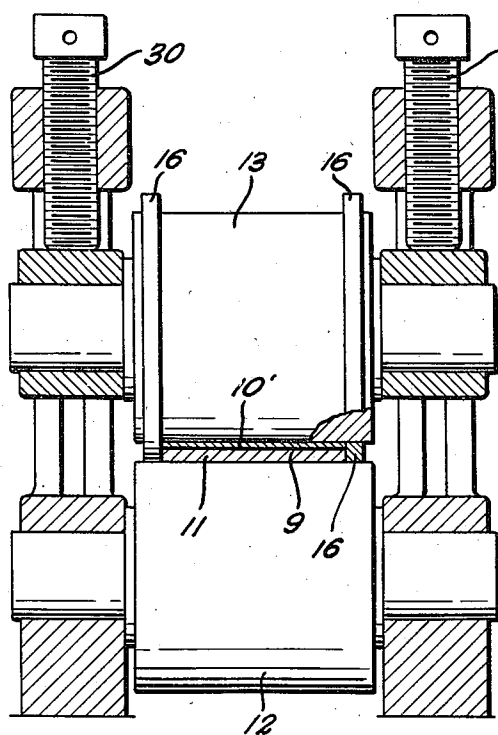
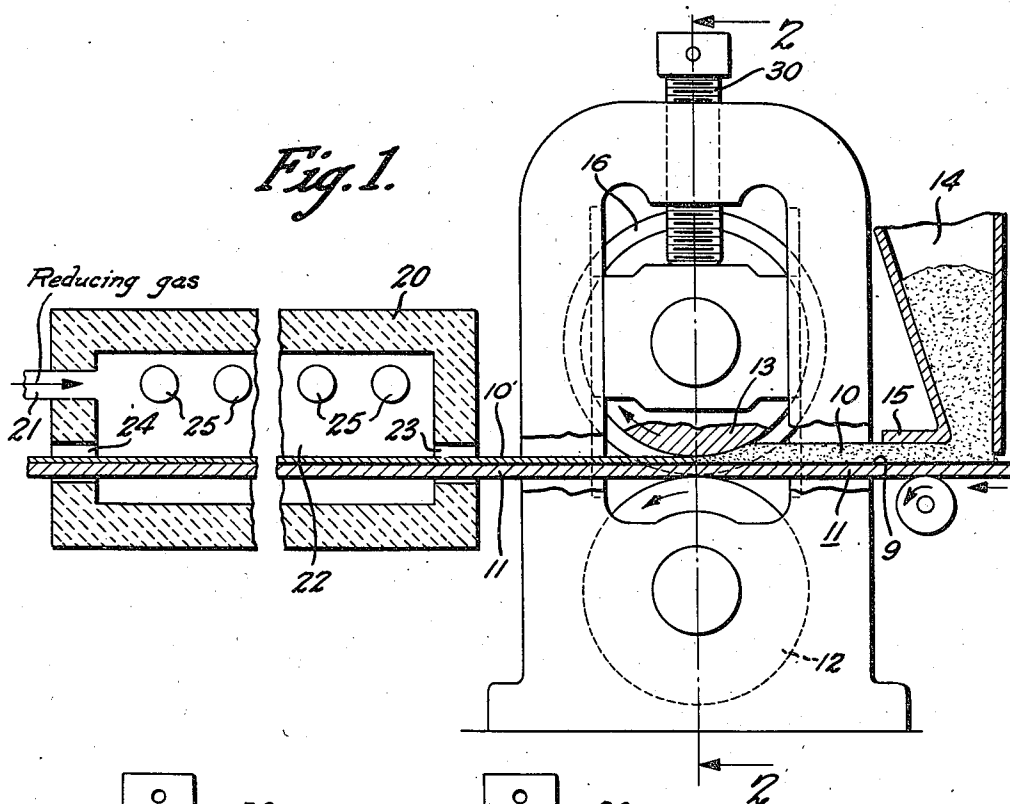


Fig. 2.

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UNITED STATES PATENT OFFICE

2,158,461

METHOD OF MAKING BEARINGS

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Application May 23, 1936, Serial No. 81,432

13 Claims. (Cl. 29—149.5)

This invention relates to a method of making bearings and the like.

An object of this invention is to provide an improved method of fixing a metal layer of sintered finely divided metal powder to a relatively high-melting metal backing such as a ferrous metal backing. A more specific object is to provide an improved method of fixing a lining containing a large percentage of lead to a steel backing strip.

There is now an increasing interest in high-leaded bronzes for bearing purposes and there have been numerous attempts to produce economically high-leaded bronze bearings.

One attempt along this line has been the development of a process wherein the molten leaded-bronze alloy is applied to a strip of steel in special equipment designed for the purpose.

Another attempt has been the sweating together of previously made strips of the leaded-bronze alloy and tin-coated steel.

The method of this invention is fundamentally different from the above methods in that the bearing lining is formed from finely divided metal powders, of the desired composition and proportions, which are compacted directly upon the backing strip and thereafter sintered in situ thereupon, which integrates the bearing lining and simultaneously bonds the same very strongly to the backing strip.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a somewhat diagrammatic view showing both the step of compacting the metal powder upon the backing strip and the step of sintering the compacted layer in situ upon said backing strip.

Fig. 2 is a section taken on line 2—2 of Fig. 1. Fig. 3 illustrates a finished rolled bushing which has been rolled up from a short length of the composite metal strip made by the process of this invention.

Similar reference characters refer to similar parts throughout.

According to this invention a loose layer 10 of finely divided metal powder is applied onto a relatively strong backing strip 11, such as steel, as the backing strip 11 is moved along and passed between the heavy steel rolls 12 and 13 (see Fig. 1). The loose metal powder may be poured into a hopper 14 whose bottom lip 15 is adjustably

spaced above the strip 11 moving along at a slow uniform speed to provide a smooth quite loose layer 10 of uniform thickness. The strip 11 is previously provided with a relatively thin plating 9 of relatively soft metal thereupon. This soft metal coating 9 may beterne plate, lead, tin, or other suitable soft metal alloy plating and is preferably applied by a single dipping of the backing strip 11 in the molten relatively low-melting point soft metal or metal alloy. The thickness of plating 9 is preferably around .0002 inch, but in some cases may be as much as .001 inch.

When the strip 11 with the loose metal powder layer 10 passes between the pressure rolls 12 and 13 the very high pressure compacts the metal powders to a high degree, causing these powders to cohere very firmly together and to adhere very firmly to the soft metal plating 9 on strip 11. The thin plating 9 of strip 11 is soft and as a consequence the metal particles are partially embedded therein by the high pressure. The adherence of the compacted strip 10' (when made from 90 parts copper, 10 parts tin and 20 parts lead) to the plated strip 11 after passing between the pressure rolls is so strong that it has been found that the layer 10' can hardly be chipped off with a knife, nor will it come off by bending a section of the composite strip over a three-quarter inch radius with the layer 10' on the outside. In other words, the compacting pressure is sufficient to provide a composite strip which can be very roughly handled after leaving the pressure rolls and before sintering same.

Preferably the compacted strip, after leaving the pressure rolls 12, 13, passes directly into a sintering furnace 20, as shown diagrammatically in Fig. 1, and is there heated to such a temperature and for such a period as will cause the metal particles of the compacted layer 10' to partially fuse or alloy together and form a strong rigid somewhat porous structure and at the same time be strongly directly bonded to the steel strip 11. During such sintering the plating 9 of soft metal melts and is absorbed into and may be alloyed with the sintered structure, so that in the final product the plating 9 has disappeared as such and no longer forms an intervening stratum between the steel strip 11 and the sintered structure. Hence the final bond between the steel strip 11 and the sintered structure is a direct alloy bond which will not melt loose at the relatively low melting point of the metal of plating 9. This sintering step should take place in a reducing atmosphere within furnace 20. Such re-

ducing atmosphere sintering furnaces are now well known and need not be illustrated and described in much detail herein. For a more complete disclosure of a reducing atmosphere suitable for the sintering step of the method of this invention reference is made to our copending application S. N. 683, filed January 7, 1935. A suitable reducing atmosphere for this method consists of flue gas made by incompletely burning natural gas and having from 1% to 7% CO, 7% to 11% CO₂, 1% to 7% hydrogen, and as little water vapor as is practically possible, for instance, about three-tenths of a pound of water vapor per 1,000 cubic feet of the flue gas. The water vapor in the flue gas should be removed by refrigerating the flue gas and thereby condensing the water and removing it therefrom. The dried flue gas is then passed into the sintering furnace 20 where it is re-heated to the desired sintering temperature, around 1500° F. In Fig. 1 of the drawing, the inlet pipe 21 indicates the duct for continuously leading the flue gas into the sintering chamber 22. The flue gas continuously flows from chamber 22 thru the openings 23 and 24 and this prevents room atmosphere from entering said chamber, and yet permits these openings 23 and 24 to remain sufficiently open for the continuous passage there-thru of the compacted strip being sintered. 25 designates a series of electric heating elements which serve to maintain the sintering atmosphere in chamber 22 at the desired sintering temperature.

As a more specific illustration of the method of this invention the following is given: A long steel strip having an ordinary commercialterne plate coating on both sides thereof may be used as the metal backing strip 11. The loose layer 10 of metal powders may be a homogeneous mixture of finely divided copper (90 parts), tin (10 parts) and lead (20 parts to 100 parts depending on the desired lead content in the final bronze layer). The compacting pressure obtained by the pressure rolls 12, 13 should be such as will reduce the thickness of the loose layer 10 to a compacted layer 10' having about one-third the thickness of the loose layer. The pressure on rolls 12, 13 may be adjusted by means of the adjusting screws 30 to obtain the desired reduction in thickness, as will be obvious from the drawing. Spacer rings 16 may be used on one of the rolls 12 or 13 to limit the thickness of the compacted layer 10 to the exact thickness desired in any given case. Too great a pressure in compacting may result in blisters in the lining 10' after sintering. The formation of such blisters seems to be a function of the pressure used in compacting the metal powder and the furnace temperature. Hence whenever blistering occurs the compacting pressure should be somewhat reduced, or else the sintering temperature should be lessened somewhat. The correct pressure and temperatures can be readily determined for any given case by simple trial. There seems to be a limited thickness of metal powder which can be rolled on for each diameter of pressure rolls used. For instance, when pressure rolls 12, 13 of 2 inch diameter are used, a loose layer 10 of metal powder having a thickness of .024 inch can be successfully rolled down to a thickness of .008 inch. When a greater thickness of layer 10' is desired, larger diameter pressure rolls should be used. With 8 inch diameter pressure rolls a loose layer 10 having a thickness of .075 inch can be successfully rolled down to a thickness of .025 inch. For a still

greater thickness of layer 10' still larger pressure rolls 12, 13 should be used. The speed of rolling is also an important factor, as too fast a speed causes the metal powder to pile up ahead of the rolls 12, 13, or actually tends to blow the powder away. In the case of 8 inch diameter pressure rolls a speed of one revolution per minute is preferred, or a linear speed for the strip 11 of about 2 feet per minute is very satisfactory.

The sintering temperature used in the sintering chamber 22 is preferably about 1500° F. and the time periods for such sintering should be such that the copper and tin powders forming layer 10' will partially fuse and alloy together and form a strong rigid minutely porous bronze structure directly bonded to the steel strip 11. The lead powder present in layer 10' will become fully molten but will not exude therefrom and will be held within the porous bronze structure in uniformly dispersed films due to the molten lead wetting and adhering to the pore surfaces of the solid bronze structure. When layer 10' cools this lead solidifies in its finely dispersed state and hence remains in the bronze structure in its finely dispersed uniformly distributed form. Also during such sintering the originalterne plate coating 9 will melt and become absorbed by the porous bronze structure in a manner similar to that described above for the lead powder content. Terne plate ordinarily is composed of about 3 parts lead and one part tin. During sintering theterne plate coating 9 melts and disappears as such, its lead content being simply added to the other lead and its tin content being simply added to the other tin content in the metals being sintered.

The sintered strip emerging from outlet 24 of the chamber 22 should be cooled in a non-oxidizing atmosphere. Then it may be kept in long straight lengths, or it may be coiled up in large coils, and transported to a machine for cutting and forming bearings therefrom. Short lengths of this strip may be cut off to the proper length and coiled up into a full circular form to form the split bushings 40 shown in Fig. 3, which have an outer relatively strong steel back 41 and an inner lead-bronze lining 42 which is strongly bonded to the steel back by the above-described sintering operation. Or any other desired form of bearings may be made from the strip, for instance, half-round bearings or bearing caps for the crank shaft and connecting rods of automobile engines. In such cases the steel back may be made as heavy as desired and provided with any desired kind of retaining means for properly holding the bearing rigidly fixed in place.

The principles of this invention are obviously not limited to making bearings, but may be used to advantage in forming many articles having one layer of metal having more or less precisely specified ingredients and proportions which layer is strongly and directly bonded to a second and distinct metal layer or backing having other desired characteristics.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The steps in a continuous method of fixing a lining to a ferrous metal back, comprising: providing a thin high lead-content prime coating upon a ferrous metal strip, distributing a uniform layer of powdered bearing metal upon the coated

surface of said strip and compacting it in place thereupon with a high pressure and thereby causing said layer of bearing metal to adhere firmly to said strip, then removing said high pressure upon said compacted lining and subsequently sintering said compacted bearing metal layer in situ upon said strip in a reducing atmosphere and thereby greatly increasing its strength and directly bonding it to said strip.

2. The steps in a continuous method of fixing a lining to a ferrous metal back, comprising: providing a thin prime coating of relatively soft metal upon a ferrous metal strip, applying a uniform layer of loose powdered bearing metal upon the coated surface of said strip and compacting it thereupon by passing said strips with the loose powder thereon between pressure rolls, then subsequently sintering said compacted layer in situ upon said strip in a reducing atmosphere at a temperature and for a time period sufficient to cause the compacted metal particles of the bearing metal layer to partially fuse or alloy together and with the relatively soft metal upon said strip.

3. The steps in the method of progressively providing a lining of a lower-melting metal upon an elongated backing of higher-melting metal, comprising: coating a surface of said backing with a thin coating of relatively soft metal, progressively distributing a loose layer of the lining metal in finely divided form upon the coated surface of said backing, progressively compacting the loose layer of lining metal upon the backing by high pressure and thereby causing said layer to adhere firmly to the soft metal coating upon said backing, then removing said high pressure upon said compacted lining and subsequently sintering said compacted lining in situ upon said backing in a reducing atmosphere and thereby increasing its strength and directly bonding it to said backing.

4. The steps in the method of progressively providing a lining of a lower-melting metal upon an elongated backing of higher-melting metal, comprising: coating a surface of said backing with a thin coating of relatively low-melting metal, progressively distributing a loose layer of the lining metal in finely divided form upon the coated surface of said backing, progressively compacting the loose layer of lining metal upon the backing by passing said backing with the lining layer thereon between pressure rolls, then subsequently sintering said compacted layer in situ upon said backing in a reducing atmosphere and thereby substantially integrating the structure.

5. The steps in a continuous method of providing a leaded-bronze lining on a ferrous metal back, comprising: providing a relatively soft high lead-content coating upon a ferrous metal strip, applying a loose layer of metal powder including finely divided lead and copper upon the coated surface of said strip, compacting the loose layer upon said relatively soft coated surface by high pressure and thereby causing said layer to adhere firmly to said strip, then removing said high pressure upon said compacted lining and subsequently sintering said compacted layer in situ upon said strip in a reducing atmosphere and thereby substantially integrating the structure.

6. The steps in a continuous method of providing a bronze lining containing a high percentage of lead to a ferrous metal back, comprising: providing a thin high lead-content coating upon a ferrous metal strip, applying a loose layer of finely divided bronze-forming metal powder and finely divided lead upon the coated surface of said strip, compacting the loose layer upon said

strip by pressure and thereby causing said layer to adhere to said coating upon said strip, then removing said high pressure upon said compacted lining and subsequently sintering said compacted layer in situ upon said strip in a reducing atmosphere to cause the bronze forming powders to fuse together and to form an alloy bond with the strip and thereby substantially integrating the structure.

7. The steps in the method of making bearings, comprising: providing a thin adhering coating of relatively soft metal upon a long steel strip, distributing a uniform layer of powdered metal upon the coated surface of said strip and progressively passing said strip together with said loose layer of metal powder thereon endwise between pressure rolls and thereby compacting said layer and causing it to adhere to the soft metal coating upon said strip, then subsequently passing the composite strip thru a sintering chamber in a reducing atmosphere and thereby substantially integrating the metal structure thereof, then cutting said strip to short lengths and individually bending the blanks thus formed into curved shape to form bearings.

8. The steps in a method for continuously applying a porous metal lining comprising at least two different metallic constituents upon a ferrous strip, which strip may subsequently be cut into short lengths to be used in the formation of bearings, comprising: providing a long length of ferrous strip material, coating a surface of said strip with a thin coating of soft metal, progressively distributing a uniform layer of powdered metal upon the coated surface of said strip, compacting the layer of powdered metal in place upon the strip and thereby partially embedding the powdered metals into the soft metal coating upon the strip to cause the layer to firmly adhere to the strip, and then subsequently sintering the compacted powdered metal layer in situ upon the strip in a reducing atmosphere and at a temperature above the melting point of the lowest melting constituent metal and below the melting point of the highest melting constituent metal in the powdered metal layer and thereby form a strong and rigid alloy layer which is bonded to the said strip by an alloy bond.

9. The steps in a method for continuously applying a porous bronze lining having lead dispersed within the pores thereof upon a metal strip of higher melting point than that of any of the metal powders in the bronze lining comprising: providing a long length of strip material, coating one side of the strip material with a thin coating of metal of high lead content, progressively applying a uniform layer of powdered bronze-forming powders to the coated surface of said strip, compacting the bronze-forming powders on the surface of the strip by passing the strip with the bronze-forming powders thereon between pressure rolls, subsequently sintering said compacted layer in situ upon said strip in a reducing atmosphere, and at a temperature intermediate the melting points of the constituent metal powders contained in the powdered metal layer for a time sufficient to cause the powdered metals to alloy and thereby form a strong rigid bronze structure and simultaneously cause the metal powders to absorb the high lead content coating, said bronze layer being thereby directly bonded by an alloy bond to the metal strip.

10. The steps in a method for continuously applying an alloy metal lining comprising at least two component metals upon a metal strip which

has a higher melting point than any metal in the lining comprising: supplying a long length of strip material, coating the surface of said strip material with a relatively soft metal, progressively applying a uniform layer of powdered metals on the coated surface of said strip, compacting the metal powders on the surface of the strip by passing the strip with the metal powders thereon between pressure rolls, subsequently sintering said compacted metal powders in situ upon said strip in a reducing atmosphere and at a temperature above the melting point of the lower melting point metal powder in the powder layer and below the melting point of the highest melting point metal powder in the powder layer for a time sufficient to cause the powdered metals to alloy together and thereby form a strong rigid alloy structure which absorbs the soft metal coating and which is directly bonded by an alloy bond to the said metal strip, and then cooling said lined strip under nonoxidizing conditions.

11. The steps in a continuous method of providing a lining of lower melting metal upon a higher melting point metal back, comprising: providing high melting point metallic strip material, distributing a uniform layer of powdered metal of lower melting point upon the surface of said strip material, compacting the powdered metal in place upon the strip by the application of pressure, then subsequently sintering said compacted layer of powdered metal in situ upon the strip at a temperature and for a time sufficient to cause the powdered metal particles in

the compacted layer to fuse together in situ on said strip and simultaneously cause the sintered layer to bond to the surface of the strip, thereby greatly increasing the strength of the layer.

12. The steps in a continuous method of fixing a bearing lining to a strong metal supporting back, comprising: providing non-porous metallic strip material, applying a uniform layer of powdered bearing metal upon said strip, compacting the layer of bearing metal while on the strip, then subsequently sintering said compacted layer in situ upon said strip under suitable conditions and at a temperature sufficient to cause the compacted metal particles of the bearing metal layer to fuse or alloy together and simultaneously cause the sintered metal layer to alloy bond to the metallic strip material.

13. The steps in a continuous method of making strip material suitable for use in the subsequent production of bearings, comprising: providing strong non-porous metallic supporting strip material, applying a layer of powdered metal thereon, compacting the powdered metal layer upon said strip, heating the strip with the compacted layer supported thereon under non-oxidizing conditions and at such a temperature and for such a time as to cause the powdered metal particles to sinter together and form a strong porous layer, and then cooling the porous metal layer and the strip. •

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