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2,763,058

PROCESS OF PRODUCING STEEL-ALUMINUM BI-METAL STRIP

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In the manufacture of precision-type interchangeable bearings it is sometimes desired to produce a bearing in which the bearing surface is a layer of aluminum alloy, with the aluminum layer supported by a steel backing. The present invention is a process of producing steel lined with aluminum alloy suitable for forming into bearings. This product will be referred to herein as "bi-metal."

The present invention is an improvement on the process disclosed in U. S. Patent No. 2,277,023 to Steiner et al., which covers broadly the process of rolling a layer of aluminum bearing alloy to a ferrous base under combined heat and pressure. According to the present invention certain steps are taken to insure a reliable bond between the aluminum alloy and the steel when the process is used on a commercial scale, thus making it a more reliable production process and reducing the percentage of defective material.

In carrying out the process of the invention we prefer to use steel of the type known commercially as SAE 1010, of proper thickness and width for the type of bearing to be made from the completed bi-metal. If the bearings are to be relatively thin and narrow, of the type sometimes called "strip" bearings, the steel will have corresponding dimensions. If the bi-metal is to be formed into heavier bearings commonly known as the "flanged type," the steel strip will of course have to be heavier and wider.

The aluminum alloy lining may be of any suitable aluminum alloy having good bearing properties, those containing tin being especially useful for the purpose. An aluminum alloy preferred by us has the following composition; magnesium 2.5%, tin 2.0%, aluminum, balance.

Preparation of steel

The steel strip is first cleaned in any preferred manner to remove grease and dirt. The surface to be bonded to the aluminum is then roughened slightly, as by grit blasting, and is nickel-plated to a thickness of .0003 to .0005 inch. This coating of nickel permits the subsequent formation of an interlayer of nickel between the steel and the aluminum. This interlayer of nickel prevents the formation of the extremely brittle iron-aluminum compound which, if present, impairs the strength of the bond between the steel and the aluminum alloy. The nickel bond is sufficiently ductile to permit bending the edges of the bi-metal strip over into right-angle flanges if necessary. The layer of nickel must be thin, of the size indicated, to give these desired properties.

It has previously been proposed to use a copper interlayer between steel and aluminum, but it has been found that when a bi-metal piece having a copper bond is held for prolonged periods at elevated temperatures, as in an internal combustion engine (at approximately 400° F.) the copper diffuses into the aluminum, thereby weakening the bond. Under similar circumstances the nickel bond is not adversely affected.

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Preparation of aluminum

A strip of the aluminum alloy of the proper width and thickness for the proposed bearing is prepared by brushing with a wire brush to remove aluminum oxide.

Pre-heating the strips

The preferred aluminum alloy mentioned above which contains 2% tin may be bonded to the steel strip at temperatures of 1020 to 1040° F. under the pressures specified below. Both the steel and aluminum strips are heated to these temperatures before subjecting them to the bonding operation.

Aluminum alloys containing higher percentages of tin may be pressure bonded at lower temperatures. Thus, alloys containing approximately 6% tin may be pressure bonded at temperatures of 920–940° F.

Protective atmosphere

During the heating and bonding operations the materials should be kept in a suitable protective atmosphere to prevent the formation of oxide, which interferes with the forming of a good bond. From the standpoint of cost, it is of course advisable to use the cheapest protective atmosphere that will give adequate protection with safety. It is possible to use dissociated ammonia.

We prefer to use partially combusted natural gas, because of its availability and low cost. Care must be taken however, to prevent the formation of carbon in the muffle chamber, since the finely divided carbon will deposit between the steel and aluminum strips, where it impairs the quality of the bond. To prevent the precipitation of carbon the CO₂ content should be sufficiently high to prevent the reaction $2\text{CO} \rightarrow \text{CO}_2 + \text{C}$. At the temperatures disclosed herein the gas should contain approximately one volume of CO₂ for two volumes of CO. Percentagewise, the ratio should be approximately 4 to 5% CO₂ and 10% CO.

The presence of moisture at the high temperatures involved would cause oxidation, and hence moisture in the protective atmosphere should be reduced to a minimum, as by the use of an electro-dryer.

Oxygen should be removed from the gas by converting it to water vapor prior to passing the gas through the electro-dryer.

Pressure rolling

In order to bond together the steel and aluminum strips, prepared and heated as described above, they are brought into contact with each other and passed through pressure rolls which apply sufficient pressure to cause a reduction of from 33% to 40% in the thickness of the aluminum. This amount of pressure is sufficient to firmly bond the aluminum strip to the nickel-plated steel strip.

Ideally the pressure should be applied while the strips are still in the protective atmosphere, but since it is mechanically difficult to operate high pressure rolls within a chamber containing the protective atmosphere, the rolls should be located as close as possible to the point of exit from the chamber, and preferably the exit from the chamber should be formed with a nose or other device to extend the atmosphere to, or close to, the point of rolling.

In the case of bi-metal for large bearings the steel and aluminum strips may be in the form of individual pieces of suitable length. In the case of thin bi-metal for light bearings, both the steel and aluminum strips may be in the form of coils, and the process may be carried out as a continuous process.

According to the provisions of the patent statutes, we have explained the principles of our invention and have described what we now consider to represent its best embodiment. However, we desire to have it understood that,

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within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. The process of producing a bi-metal strip of steel and aluminum alloy suitable for being subsequently fabricated into bearings, said process comprising: plating one side of a steel strip with a thin layer of nickel, mechanically cleaning one side of a strip of aluminum alloy comprising a small amount of a hardening agent and a small amount of a lubricity agent, pre-heating the two strips in a protective atmosphere substantially free of moisture, oxygen or carbon, bringing the heated strips together with the strip of aluminum alloy in contact with the nickel-plated side of the steel strip, and bonding the two heated strips to each other by pressure which causes a reduction of between 33% to 40% in the thickness of the aluminum strip.

2. The process set forth in claim 1 in which the aluminum alloy contains approximately 2% of a hardening agent, and up to 6% of a lubricity agent.

3. The process of producing a bi-metal strip of steel and aluminum alloy suitable for being subsequently fabricated into bearings, said process comprising: plating one side of a strip of steel with nickel to a thickness of 0.0003 to 0.00005 inch, mechanically cleaning one side of a strip of aluminum alloy containing approximately 2% of a hardening agent, and approximately 2% of a lubricity agent, pre-heating the two strips to temperatures between 1020 and 1040° F. while maintaining them in a protective atmosphere substantially free of moisture,

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oxygen or carbon, bringing the heated strips together with the strip of aluminum alloy in contact with the nickel-plated side of the steel strip, and bonding the two heated strips to each other by passing them through pressure rolls which cause a reduction of between 33% to 40% in the thickness of the aluminum strip.

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