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## (54) Apparatus and method for continuously producing sintered metal fiber porous body

(57) An apparatus and a method are disclosed for continuously producing a sintered metal fiber porous body by pressing a metal fiber web (7) between a pair of rollers (1,2) and simultaneously sintering the metal fiber web, wherein the metal fibers of the web are not fused and they do not adhere to any surface of the rollers. The method of the invention includes the steps of pressing a metal fiber web between a pair of current-conductive rollers, the surface of at least one of the rollers being covered with graphite; and simultaneously providing a predetermined electric current between the rollers so that the current flows from one of the rollers to the other through the web.

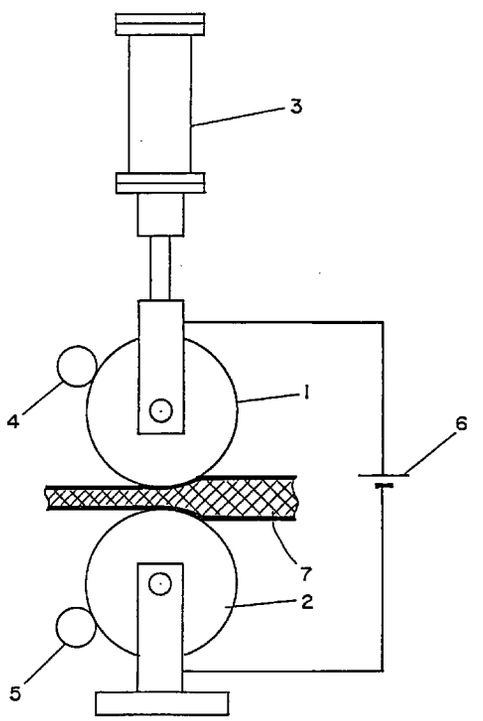


Fig. 1

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## Description

### Field of the Invention

This invention relates to an apparatus and a method for continuously producing a sintered metal fiber porous body by pressing and simultaneously heating a metal fiber web.

### Description of the Prior Art

In the prior art, a method for continuously producing a sintered metal fiber porous body is disclosed in Japanese Patent A 1-215909, wherein a metal fiber web is pressed between an upper and a lower roller and is supplied with an electric current by a power source disposed between the rollers, so that the web is heated and sintered. However, in this method, the metal fibers of the web are fused and adhere to the upper and lower rollers, and the current is not uniformly supplied to the web. Thus the web tends to be partly heated and welded, thereby producing a product of a lower porosity than desired.

### Summary of the Invention

The present invention is conceived considering the above drawbacks. The purpose of the present invention is to provide an apparatus and a method that prevent the metal fibers of the web from fusing and adhering to the upper and lower rollers, and that supply a uniform electric current to the entire web.

To the above end, the method of the present invention, in a first aspect, is one to continuously produce a sintered metal fiber by pressing and simultaneously sintering a metal fiber web, wherein a metal fiber web is continuously inserted between a pair of current-conductive rollers, the surface of at least one roller being covered with graphite, while a predetermined current is supplied between the rollers through the web, thereby press-forming and sintering the metal fiber web.

### Operation

To produce a sintered metal fiber porous body having a desired thickness and porosity, a nip between the rollers is preset, and they are then rotated at a predetermined speed. A power supply is provided between the upper and lower rollers to supply a current between them to sinter the metal fibers of the web. Under these conditions a metal fiber web having a predetermined thickness and porosity is continuously inserted between the rollers. Since the surface of the rollers is coated with graphite, the web does not adhere to the surface. Further, since the current passes from one roller through the web to the other roller, the metal fiber web is heated and sintered. Thus a sintered metal fiber porous body having a desired porosity is continuously produced.

Herein a metal fiber means a fiber made of any current-conductive metal, and that is coated with a stable oxide layer, and that has a cross-sectional area of 10 $\mu m^2$ - 10,000 $\mu m^2$. If the cross-sectional area of the fiber of the web is less than 10 $\mu m^2$, forming a web is difficult. If it is more than 10,000 $\mu m^2$, the fiber does not shrink.

Further, preferably both rollers are coated with graphite. However, at least one roller must be coated with graphite, and the other may be made of a current-conductive metal such as chrome copper, tungsten, a beryllium-copper alloy, etc. When so constructed, a stainless steel wire mesh is used between the web and the roller made of a current-conductive metal. A power source Is provided to supply a predetermined current between the rollers.

Further, the magnitude of the current is determined per the size of the sintered body to be produced, and is also determined considering whether or not it can sinter the metal fibers. Therefore, preferably the value of the current is 4,000 - 20,000 A/8cm (8 cm is the length of the web), and the optimum value is 6,500 - 10,000 A/8cm (web length). If the current is less than 4,000 A/8m, the metal fibers are not sufficiently welded, and if it is more than 20,000 A/8cm, all the fibers are fused.

Further, the pressure applied to the web is determined from the relation between the porosity of a metal fiber material web and the porosity of a sintered porous body produced from it. Preferably, the pressure is 10 - 130 Kgf per cm roll width. If it is less than 10 kgf/cm, the pore size of the sintered porous body becomes large, and the porous body becomes like a sponge. If the pressure is more than 130 kgf/cm, the sintered body is partially fused and welded. Generally, the optimum pressure is about 60 kgf/cm.

### Brief Description of the Drawing

Fig. 1 is a partially cross-sectional view of the embodiment of the present invention.

### Description of the Preferred Embodiments

#### First Embodiment

A first embodiment is now explained by reference to the drawing. Upper and lower rolls 1, 2 are disposed so that they can rotate on a vertical plane. The upper roll 1 is supported for vertical movement by a downward-facing cylinder 3. Each roller is 80 mm in width and 254 mm in diameter, and is made of chrome copper. The surface of each roller is covered with graphite. Further, each roller is designed such that cooling water flows in it. The upper and lower rollers 1, 2 are engaged by drive rollers 4, 5, respectively. A seam welder 6, from Dengensha Seisakusho Kabushikikaisha, which has a power source having a frequency changer (inverter), is electrically connected to them between the upper and lower rollers 1, 2.

Metal fibers of a nominal size of 35 $\mu m$ made by the coil strip cutting method (made by cutting a 50 $\mu m$-thick

thin plate with a lancing of 20 μm/rev) from heat-resistant stainless steel (a ferrite alloy that includes Cr-Al and rare earth elements, such as "liverlite" of Kawasaki Seitetsu Kabushikikaisha, "hekuralloy" of Registalloy Kabushikikaisha, etc.) were shaped to a plate by the roll-cutting method, and metal fiber webs 7, each having a weight of 900 g/m$^2$, a size of 80 mm x 500 mm, and a thickness of 50 mm, were produced.

Then the pressing force of the cylinder 3 was set to 60 kgf/cm, and the speed of the upper and lower rollers 1, 2 was set to 2 m/min. Under these conditions, the drive rollers 4, 5 were driven to rotate the upper and lower rollers 1, 2, and cooling water was made to flow in them. The metal fiber web was continuously inserted between the upper and lower rollers 1, 2 and was provided with a current by the seam welder 6, which was ON for 20 ms and then OFF for 20 ms, in a repeated current-loading-cycle. Webs 7 were tested by varying the current from 10,000 to 18,000 A. With the current being between 10,000 and 18,000 A, the webs did not adhere to the surfaces of the rollers 1, 2, and good sintered porous bodies were obtained.

When the upper and lower rollers were provided with a current by the seam welder 6 that was ON for 40 ms and then OFF for 40 ms, in a repeated current-loading-cycle, sparks were caused between the upper and lower rollers 1, 2, and the web was partly fused.

Second Embodiment

Now the second embodiment of the present invention is explained. In this second embodiment the same apparatus of the first embodiment was used to produce sintered bodies.

Metal fibers made by the coil strip cutting method from heat-resistant stainless steel (a ferrite alloy that includes Cr-Al and rare earth elements, such as "liverlite" of Kawasaki Seitetsu Kabushikikaisha, "hekuralloy" of Registalloy Kabushikikaisha, etc.) were shaped to a plate by the roll-cutting method, and three metal fiber webs 7 of weights of 600, 900, and 1200 g/m$^2$, a size of 80 mm x 500 mm, and a thickness of 60 mm, were produced. The pressing force of the cylinder 3 was set to 60 kgf/cm, and the speed of the upper and lower rollers was set to 2 m/min.

Under these conditions, the drive rollers 4, 5 were driven to rotate the upper and lower rollers 1, 2. The webs 7 were continuously inserted between the upper and lower rollers 1, 2, while the seam welder 6 was ON for 20 ms and then OFF for 20 ms, in a repeated current-loading cycle, to provide a current between the upper and lower rollers. Tests to sinter the webs 7 were carried out by varying the current from 9,000 to 18,000 A. With the current being within this range, the webs 7 did not adhere to any surface of the upper and lower rollers, and good sintered porous bodies were obtained.

Third Embodiment

The third embodiment of the present invention is now explained. In this third embodiment an apparatus similar to that of the first embodiment was used to sinter a metal fiber web 7. This apparatus differs from that of the first embodiment in that the surface of one of the upper and lower rollers was covered or coated with graphite, and the other roller was made of chrome copper. Further, a stainless steel (SUS304) wire mesh (#29) was disposed between the metal fiber web 7 and the roller that was made of chrome copper. Under these conditions, a good sintered porous body was obtained.

In this invention a metal fiber web 7 was inserted between a pair of rollers, the surface of at least one of the rollers being coated with graphite, while a predetermined electric current was made to flow from one roller through the web to the other roller. Thus the web was pressed to be formed and heated to be sintered. Since a processed material and a material that does not react with it are used, no reaction (fusing) due to a high temperature occurs. Thus the metal fibers of the web are not fused, i.e., they do not adhere to any surface of the rollers. Thus the current uniformly passes through the entire web.

**Claims**

1. A method for producing a sintered metal fiber porous body by press-shaping and simultaneously sintering a metal fiber web, comprising the steps of:

   pressing a metal fiber web between a pair of current-conductive rollers, the surface of at least one of the rollers being covered with graphite; and simultaneously providing a predetermined electric current between the rollers so that the current flows from one of the rollers to the other roller through the web.

2. An apparatus for producing a sintered metal fiber porous body by press-shaping and simultaneously sintering a metal fiber web, comprising:

   a pair of opposing upper and lower current-conductive rollers (1, 2) to be rotated in a vertical plane to press the web, at least one of the rollers being vertically movable, and the roller surface of at least one of the rollers being covered with graphite;
   means (3) for vertically moving said at least one roller;
   drive means (4, 5) for rotating the upper and lower rollers; and
   current-supply means (6) for providing a current between the upper and lower rollers through the metal fiber web pressed therebetween.

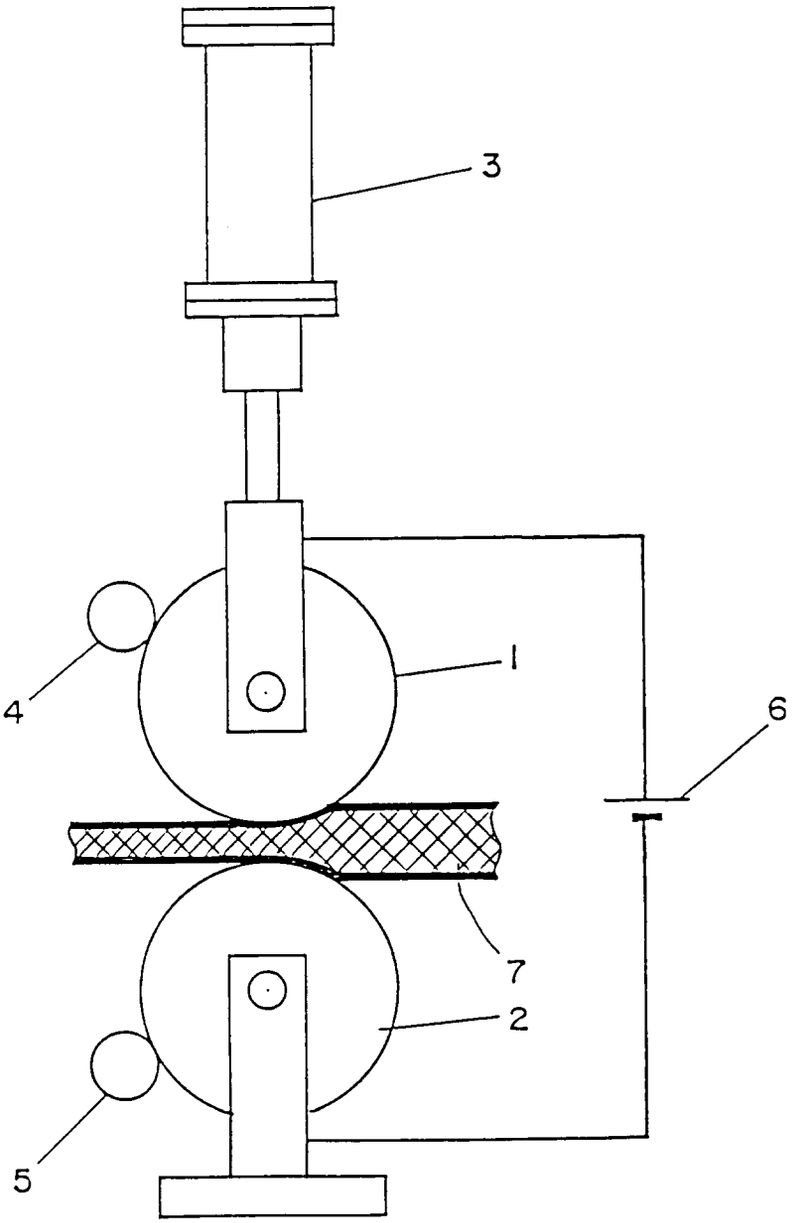


Fig. 1