Feb. 15, 1944. R. G. OLT 2,341,739

METHOD OF MAKING POROUS METAL

Filed Aug. 28, 1941

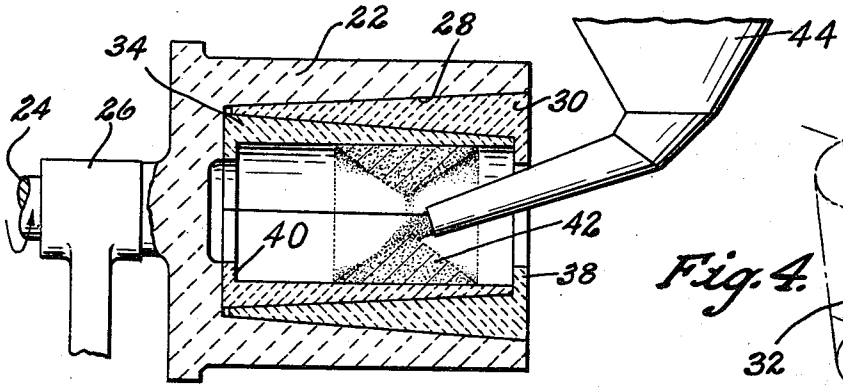


Fig. 1.

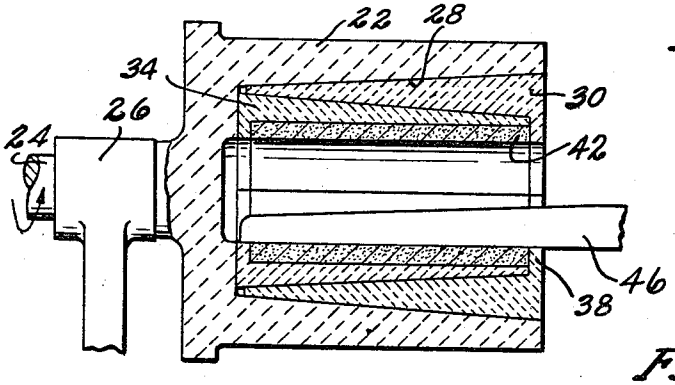


Fig. 2.

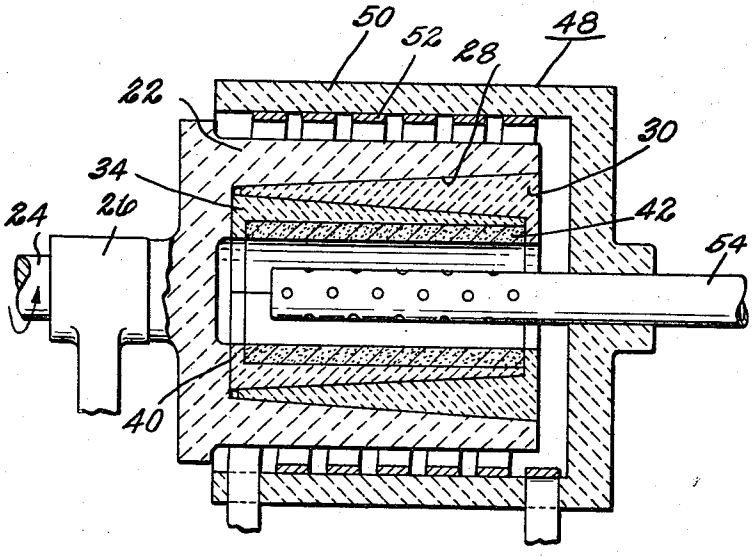


Fig. 3.

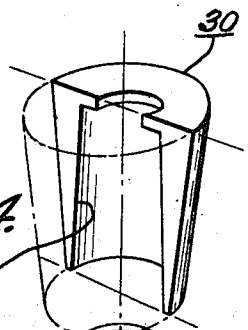


Fig. 4.

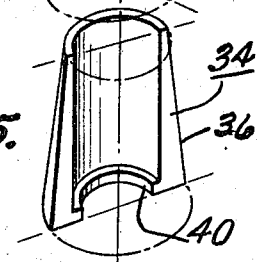


Fig. 5.

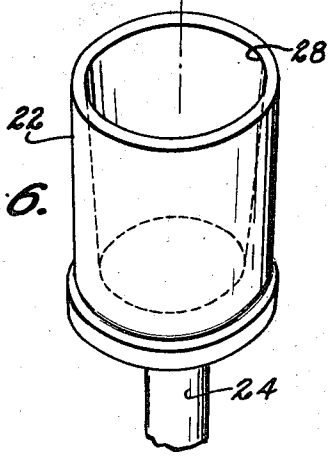


Fig. 6.

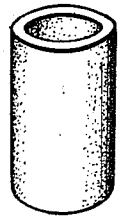


Fig. 7.

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METHOD OF MAKING POROUS METAL

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Application August 28, 1941, Serial No. 408,667

5 Claims. (Cl. 75—22)

This invention relates to a method and apparatus for forming porous metal articles and is particularly concerned with methods and apparatus for centrifugally forming porous metal articles.

An object of the invention is to provide a method for forming cylindrical objects from powdered metal wherein the powdered metal is distributed into cylindrical form and, while being held in place centrifugally, is sintered for forming a porous metal cylinder.

A further object of the invention is to provide an apparatus for carrying out the above object.

Another object of the invention is to provide a method of centrifugally forming objects from powdered metal wherein sintering of the powdered metal is accomplished by the use of inductive heating.

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 view in cross section showing the apparatus as the powdered metal is being filled therein.

Fig. 2 is a view in cross section showing the powdered metal being leveled off into a cylindrical form.

Fig. 3 is a view in cross section showing the heating element in place during the sintering of the powder.

Fig. 4 is a view of the cup which fits in the rotatable receptacle.

Fig. 5 is a view of the complementary cup which fits in the cup shown in Fig. 4.

Fig. 6 is a perspective view of the rotatable receptacle.

Fig. 7 is a view showing a cylindrical part made by the apparatus shown.

When making objects from noncompacted metal powders it is necessary to provide molds into which the metal powder may be filled, which molds with the metal powder therein are heated under suitable conditions for sintering the metal powder. It has been found that when making cylindrical objects it is necessary to put draft on the core portions of the mold and on the wall portion of the mold so that the article may be removed therefrom after sintering, otherwise it is necessary to destroy the mold in order to remove the article therefrom.

The present invention is directed to a method and apparatus wherein cylindrical objects may be formed without the use of cores and wherein the apparatus utilized may be reused any number of times to form cylindrical articles of like shape and dimensions. The invention takes advantage of centrifugal force as a means for distributing the metal powder for holding it in place during sintering. To this end a rotating cylinder having a refractory lining is provided into which a charge of metal powder is placed. The charge may be inserted into the cylinder during rotation thereof or while the cylinder is stationary after which the receptacle is rotated to a speed sufficient to cause the metal powder to remain in place adjacent the wall of the cylinder. Next, the scraper is inserted and the metal powder is leveled off into a substantially uniform cylindrical layer. After the cylindrical layer has been formed the metal powder is heated under suitable conditions to sinter the same whereupon the porous metal article may be removed from the apparatus. In this manner no cores are required and no draft is required on any apparatus since, as will be described hereinafter, suitable mold cups are utilized which may be split to remove the cylindrical objects therefrom.

Referring to the drawing and particularly to Fig. 1, an apparatus **20** is shown which may be used in centrifugally forming cylindrical porous metal articles. Apparatus **20** comprises an outside receptacle **22** which has a shaft **24** extending therefrom. The shaft **24** is preferably journalled in a suitable bearing **26** and the shaft may be connected to motivating means, not shown, whereby the receptacle **22** may be rotated at any desired rate of speed. The walls **28** of cavity within receptacle **22** are tapered outwardly so that the diameter at the outer end of the receptacle is greater than the inner end thereof. Within this cavity is fitted a complementary tapered cup **30** which is preferably made in two pieces and which snugly fits against the walls **28** since the cup's outer walls are of a truncated conical shape complementing the shape of the cavity walls. The inner surface **32** of cup **30** is also of a truncated conical shape and is adapted to receive a split cup **34** made in two portions which are split longitudinally of the cup. The cup **34** has a cylindrical inner surface and a truncated conical outward surface **36** which is complementary to the inner **32** of cup **30**, whereby the two portions of cup **34** may be assembled and slipped within the cup **30** and then the cup **30** may be slipped within the receptacle **22**. The cup **30** and cup **34** include end flanges **38** and **40** respectively thereon which flanges preferably have the same inner diameter. Thus when the

assembly is placed within the receptacle 22 as shown in Fig. 1, a cylindrical surface is presented which is adapted to receive metal powder 42 which is fed from a suitable dispenser 44. The powder is preferably fed into the apparatus while the receptacle 22 is rotated at a high rate of speed. After the dispenser 44 is removed from the apparatus, a scraper 46 is inserted therein and while resting on flanges 38 and 40 scrapes the powder into a substantially uniform cylindrical layer. If a measured quantity of powder has not been supplied to the apparatus excess powder may be scraped outwardly of the cup 34 by proper positioning of the apparatus. In any event, after the scraper 46 has completed its operation, a cylindrical layer of metal powder is apparent within the apparatus which is rotating at sufficiently high speeds to maintain the powder in place.

The receptacle portion of the apparatus is heated by suitable means, electrically or otherwise, to a temperature and for a time sufficient to cause the metal powder to sinter together into a porous metal layer. I prefer to use an inductive heating means 48 as shown in Fig. 3 which comprises a cup 50 having an induction heating coil 52 disposed around the inner surface thereof which coil and cup are adapted to fit over the outside of the rotating receptacle 22. At the axis of the cup 48, a tube 54 is provided through which a controlled atmosphere may be admitted to the cavity in which the powdered metal is being sintered. By using inductive heating, it is possible to get very rapid action in sintering, thereby reducing the time required for the operation. After the current is turned off, the controlled atmosphere can be admitted to the cavity for cooling purposes, after which the heating element 48 is removed and the cups 30 and 34 are taken out of the receptacle and disassembled for removing the cylindrical article therefrom. The cups and receptacle may be made from any suitable material such as heat resisting steels wherein the contacting surfaces are treated for preventing adhesion at the elevated temperatures. Similarly the cups may be made from refractory material such as graphite, ceramics or the like. If the inner cup 34 is removed and the inner wall 32 of cup 30 is made straight sided and provided with a bottom it is possible to make articles therein in cupped shapes which have a bottom wall with cylindrical or substantially cylindrical side walls. In this instance, it is preferred to have the cup 30 split so that the article can be removed therefrom without the necessity of draft. When desired, the inductive heating element may be inserted within the cup cavity so as to surround the tube 54. In this case, the tube must be made of a non-inductive material while the outer cups and receptacle may be made from heat resisting steel treated to prevent sticking.

It is apparent that pins, flutes, rings, etc., may be formed on the external walls of the cylinder or cup and likewise annular configuration may be formed on the internal walls by using a properly shaped leveling blade. Also when the term cylindrical is used in the appended claims it is used in a generic sense to include straight sided cylinder or cups, conical cups or any other shape possible to be made centrifugally.

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. In the method of making hollow cylindrical porous metal articles the steps comprising, supplying a measured quantity of powdered metal to a receptacle rotating axially thereof at a speed sufficient to cause the powdered metal to remain in contact with the walls thereof, scraping the powdered metal into a uniform layer within the receptacle for forming a cylindrical body, then heating the receptacle with the powdered metal therein, while the receptacle is rotating at said rate of speed and under suitable conditions of time, temperature and atmosphere for causing the powdered metal to sinter together into a highly porous metal layer, and then cooling the cylindrical article so formed and removing it from the receptacle.

2. In the method of making hollow cylindrical bodies of porous metal in the loose noncompacted condition, the steps of supplying metal powder to a receptacle, rotating the receptacle axially thereof at a speed sufficient to centrifugally distribute the powder adjacent the walls of the receptacle, leveling the powdered metal in the receptacle into a uniform thickness layer, and then, while the receptacle is rotating, heating the receptacle with the metal powder therein under suitable conditions of time, temperature and atmosphere for causing the metal powder to sinter together and form a highly porous cylindrical object which may be removed from the receptacle after cooling.

3. In the method of making hollow cylindrical objects of highly porous metal the steps comprising: centrifugally distributing a charge of metal powder into a substantially uniform layer of cylindrical shape by axially rotating a mold member, and then heating said layer while the layer is being held in place in said member by centrifugal force, said heating being accomplished under suitable conditions of time, temperature and atmosphere to form a highly porous cylindrical body.

4. The method as claimed in claim 3 wherein the heating is accomplished by the use of an inductance coil.

5. In the method of making hollow cylindrical porous metal bodies, the steps of: providing a cylindrical receptacle capable of being rotated, supplying metal powder to said receptacle while the receptacle is being rotated axially thereof at a speed sufficient to hold the metal powder adjacent the wall thereof, leveling the metal powder into a substantially uniform cylindrical layer, inductively heating the metal powder for a time and at a temperature sufficient to bond the particles together for forming a porous metal body, and simultaneously providing an atmosphere suitable for sintering adjacent said metal powder layer.

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