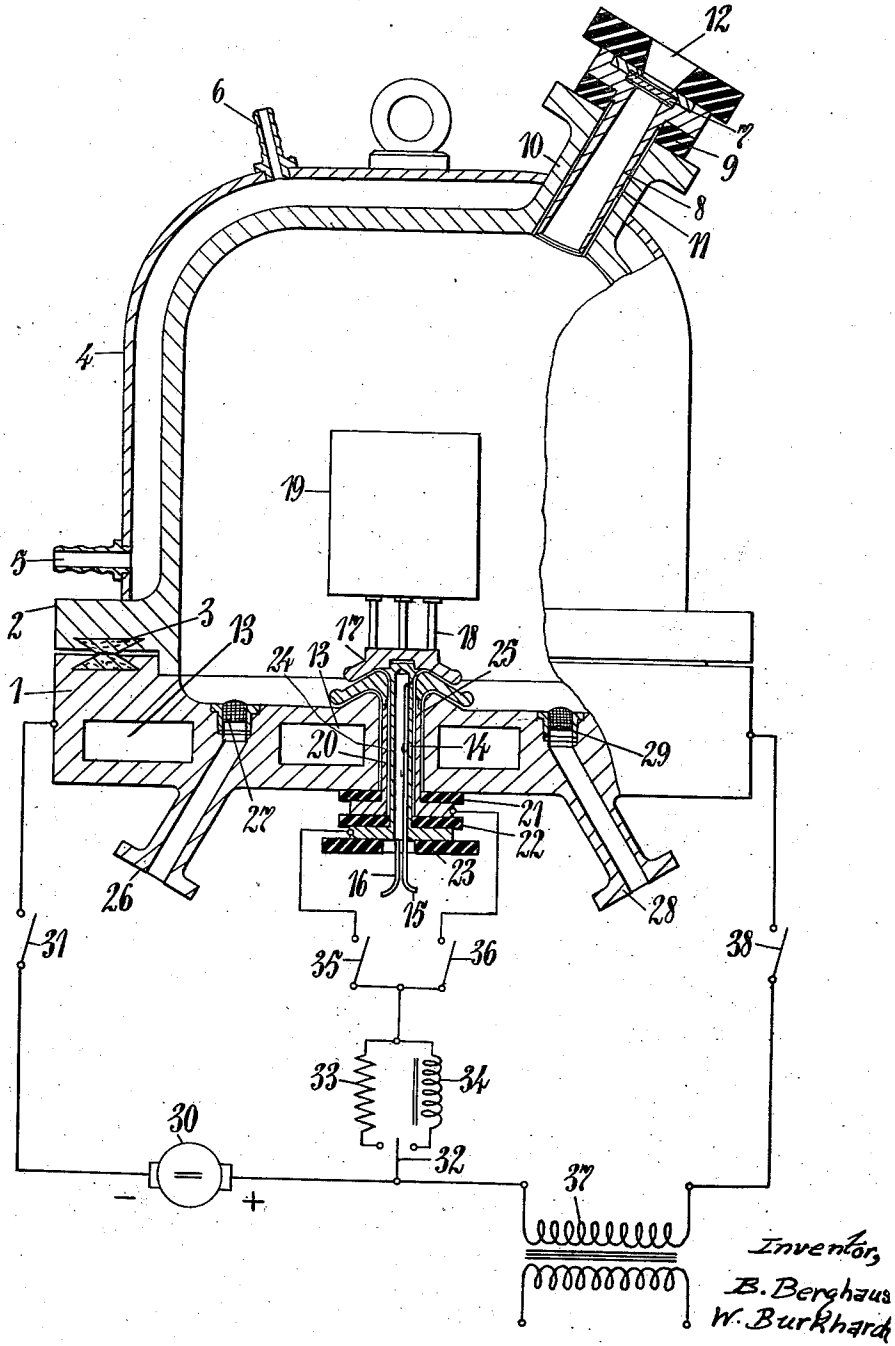


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METHOD OF SINTERING METAL

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METHOD OF SINTERING METAL

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3 Claims. (Cl. 75—22)

This invention relates to a method of manufacture of sintered bodies from metal powders, or from powders of hard material or their mixtures, the characteristic feature of which is that the articles of pressed powders are subjected to an electric gas or glow discharge at reduced pressure or in vacuum, connected as an anode or neutral, for the purpose of being heated.

According to the filling of the oven. In the case of temperatures up to 2000° C. and over 3000° C. up to 50 and more watts per square centimeter of surface of the cathode is required according to the size of the body to be sintered.

The screening around the conductor is essential for the introduction of large energies at the stated voltages. The screens are arranged at such a distance around the conductor that no discharge can take place in the intermediate space between the conductor and the screen. The screen is provided around the conductor over such a distance, and preferably in a labyrinth form, that charge carriers, such as ionised gas particles or vaporised metal from the treatment chamber cannot reach the insulating and sealing material. The insulation and the sealing may be two different materials or use may be made of one material having the two properties. The insulation and sealing are preferably provided outside the treatment chamber between the wall of the vessel and the conductor.

By sintering metal powder according to the present process, blanks can be obtained for subsequent rolling or drawing. More particularly the process lends itself to the manufacture of constructional parts, drawing or cutting tools of metals having a high melting point, such as chromium, titanium, tantalum, molybdenum, vanadium, tungsten and the like, alone, or in admixture with metals having a low melting point, such as light metals, for instance, magnesium, aluminium or heavy metals, such as iron, copper, and cobalt. As regards hard materials, more particularly for cutting tools, hard metal carbides, hard metal silicides, hard metal nitrides, hard metal borides come into question, alone or in admixture with auxiliary metals, such as aluminium, iron, nickel, cobalt and the like. In this case use may be made of any of the mixtures known per se in the manufacture of hard metals.

By evacuating the treatment chamber the articles formed of pressed metal powder are subjected to an extensive liberation of gas before the heat comes into action, the removal of gas being carried out up to the vacuum which can be technically obtained. Upon the voltage being applied to the electrodes and the filling gas for the discharge being introduced into the chamber, which filling gas may have a reducing, carbonising, entangling or indifferent action, the pressed article is heated to the desired temperature, slowly or quickly according to the material. In some cases it has been found an advantage to

The metal wall of the vacuum sintering chamber is preferably connected as a cathode. An electrode introduced in an insulated and screened manner may serve as the anode. The pressed articles or sintered material are preferably arranged on a metal support which is introduced into the vacuum sintering chamber in an insulated and screened manner. The metal support is preferably made hollow and cooled from the inside. The plate or supports on which the sintered material rests may be made of metals having a high melting point, such as chromium, tantalum, titanium, molybdenum, tungsten or the like. The plate or the supports on which the sintered material rests may, however, consist of other materials having a high melting point, such as "sintered earth", for instance beryllium oxide, zirconium oxide, thorium oxide or the like, but also of graphite. The electric gas discharge may be produced by means of a direct or alternating current voltage.

When an alternating current voltage is applied to the path of the gas discharge one terminal of the source of alternating current voltage is connected to the wall of the casing and the other terminal of the source of alternating current voltage to the current lead-in which is in conductive connection with the bodies to be sintered, or to an electrode which is insulated with respect thereto.

The gas discharge required for the sintering is preferably operated at a pressure of 40 to 0.01 and, preferably 5 to 0.1 millimeters of mercury. The filling gas for the gas discharge may, for instance, consist of hydrogen, nitrogen, ammonia, hydrocarbons or rare gases. The voltage which is to be applied to the discharge path may, according to the desired heating-up and the adjusted vacuum, be 400 to 10,000 volts. In most cases voltages up to 5,000 volts suffice. The energy to be introduced is dependent upon the size and the number of the pressed articles to be heated and the temperature to which the articles are to be subjected. In order to obtain sintered temperatures up to 1000° C. a discharge energy up to 5 watts per square centimeter of surface of the cathode may, for instance, be required, ac-

maintain certain definite temperatures and then to further heat the article.

By the heating of the pressed articles according to the invention, the temperatures up to 5. 3000° C. and more necessary for the sintering may be supplied with great economy and good efficiency. Moreover, it is ensured that the pressed bodies will sinter very tightly without cracking and while keeping their shape. In 10 order to obtain porous bodies, such as bearing shells the component which melts at a low temperature may be easily removed by vaporisation, without affecting the shape and the strength of the article.

15 The drawing illustrates a sintering oven for the manufacture of sintered bodies of metal powders or hard materials, in which the articles of pressed powders are subjected to an electric gas discharge at reduced pressure or in vacuum connected as an anode or neutral, for the purpose 20 of being heated.

The sintering oven consists of a lower metal part 1 and a removable upper metal part 2, which 25 are connected together in a vacuum-tight manner by the sealing 3 which consists, for instance, of two packing rings. The removable upper part is provided with a cooling jacket 4 to which a medium is supplied through the pipe connection 5, being discharged through the pipe connection 30 6. The upper part is provided with an insulated and screened inspection window 7 arranged in a metal sleeve 8, which is insulated with respect to the pipe connection 10 by means of washer 9. The metal sleeve 8 is spaced from the pipe 10 35 to provide a narrow protective gap 11. The inspection window is secured in position by the ring 12 of insulating material and by means of screws, not shown.

The lower metal part is provided with cooling 40 passages 13 and supports a central metal lead-in 14 which is insulated and screened and capable of being cooled and to which a cooling medium is supplied through the pipe 15, being discharged through the pipe 16. The lead-in 14 carries an 45 electrically conducting or insulating screening hood or plate 17, for instance of metal or insulating material, which serves to support the material 19 to be sintered, for instance through the interposition of metals or insulating bars 18. 50 The material 19 to be sintered may be connected as an anode or remain neutral. The oven is provided with an auxiliary electrode 20 which includes two parts and is introduced in an insulated and screened manner. The conductor 14 and the 55 auxiliary electrode structure 20 are sealed and insulated with respect to the housing by means of insulating and packing rings 21 and 22. The insulating and sealing assembly is provided with a disc 23 of insulating material by which the assembly may be clamped to the housing with 60 screws (not shown). Between the metal lead-in 14 and the auxiliary electrode 20 and between the latter and the metal wall of the bottom there are provided narrow screening gaps 24 and 25.

65 The pipe connection 26 serves for the supply of a filling gas, such as hydrogen, nitrogen or the like in a regulated amount. The sieve 27 pre-

vents the gas discharge used for the heating or sintering from breaking through into the supply pipe. The pipe connection 28 serves to connect a vacuum pump by means of which a pressure of 40 to 0.01 and, preferably 10 to 0.1 millimeters of 5 mercury, is maintained in the sintering oven. The sieve 29 prevents the gas discharge from breaking through into the pipe leading to the vacuum pump.

The source 30 of continuous current is connect- 10 ed with the negative terminal thereof to the metal wall of the chamber of the oven through a switch 31 and with the positive terminal through a switch 32 and a resistance 33 or an inductance coil 34, either through the switch 35 to the cur- 15 rent lead-in 14 for the sintered body or through the switch 36 to the auxiliary electrode 20. If a source of alternating current is employed for creating the glow discharge, the secondary 37 of the supply transformer is connected at one end 20 through the switch 38 to the metal wall of the sintering oven and at the other end to the switch 32. The alternating current voltage may be impressed across the metal wall 1 and the lead-in 14 or the auxiliary electrode 20 by closing the 25 switch 39 and either of the switches 35 or 36.

What we claim is:

1. A method of manufacturing relatively hard metal articles from metal powder which com- 30 prises, pressing the metal powder into the desired article shape, supporting the shaped metal powder within and insulated with respect to a sealed electrically conducting housing, evacuat- ing the housing to remove gases therefrom, in- 35 troducing an inactive gas into the housing, and impressing a voltage across the housing and an electrode within the housing to create a glow discharge around the pressed powder to sinter the shaped articles.

2. A method of manufacturing relatively hard 40 metal articles from metal powder which comprises, pressing the metal powder into the desired article shape, supporting the shaped metal powder within and insulated with respect to a 45 sealed electrically conducting housing, evacuat- ing the housing to remove gases therefrom, introducing an inactive gas into the housing, and impressing a voltage across the housing and the article with the housing serving as a cathode and 50 the article serving as an anode to create a glow discharge within the housing which envelops the article to sinter the pressed metal powder.

3. A method of manufacturing relatively hard metal articles from metal powder which com- 55 prises, pressing the metal powder into the desired article shape, supporting the shaped metal powder within and insulated with respect to a sealed electrically conducting housing, evacuat- ing the housing to remove gases therefrom, in- 60 troducing an inactive gas into the housing, and creating a glow discharge within the housing with the housing connected as a cathode for the glow discharge whereby the glow discharge envelops the shaped metal article to sinter the pressed metal powder.

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