

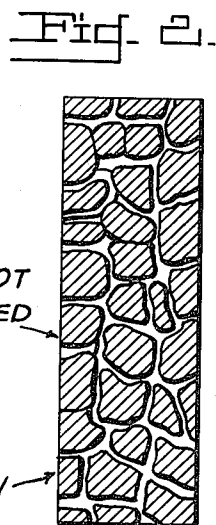
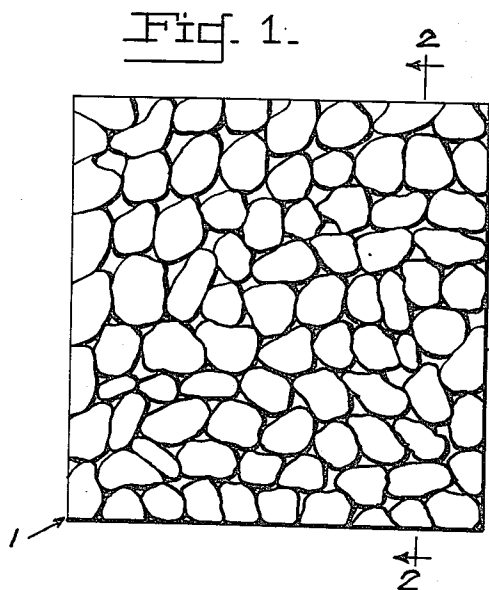
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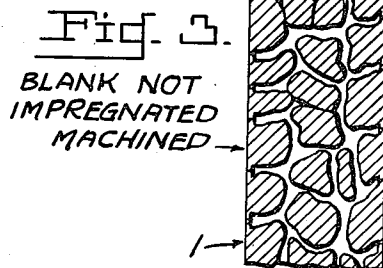
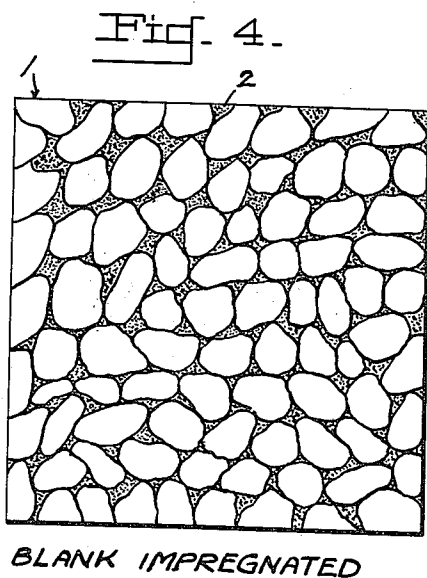
2,663,928

PROCESS FOR MACHINING POROUS METALS

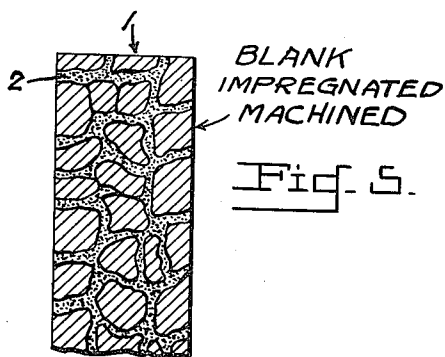
Filed July 13, 1950



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MACHINED



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UNITED STATES PATENT OFFICE

2,663,928

PROCESS FOR MACHINING POROUS METALS

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3 Claims. (Cl. 29-148)

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This invention is directed generally to the metal working art and more specifically to a method of machining porous metals without destroying the surface porosity.

In the machining of porous metals, it has been found very difficult to prevent smearing, i. e., plugging of the surface pores. As the tool cuts through the material, it bends down the thin walls between the pores and often seals the pores entirely, giving the metal a polished, solid-appearing surface. Heretofore it has been customary to etch the surface of the metal for a short time, after machining, in order to remove the sealing surface material. For many applications, e. g., for bearings, this technique is satisfactory, since a slight smearing or unevenness in pore distribution is not critical. For other applications, however, such as sweat-cooling apparatus, it is necessary to have uniform pore distribution and an open surface, and the entire distorted surface must be cleared away; thus a deep etch is required. Examples of sweat-cooling apparatus which require the use of porous metals having uniform pore distribution are combustion chamber, nozzles and turbine blades in rockets, fluid cooled gun barrels, etc. The use of such apparatus is generally accompanied by the production of intense heat sufficient to melt the metals forming the walls. To avoid this melting and subsequent destruction of the apparatus, jacketed walls are used wherein a coolant is forced under pressure in and through the jacket to dissipate the intense heat generated in the apparatus. The metal used is prepared by heating and sintering to obtain the required uniform porosity. It is this porous metal which is used, for example, to form the inner wall of the combustion chamber of a rocket. As the coolant is forced through the jacket it traverses the pores in a direction opposite to the thermal gradient (from the lower temperature of the coolant to the higher temperature in the combustion chamber). When the coolant strikes the zone of intense heat it vaporizes to form gas bubbles which absorb immense quantities of heat, thus the metal wall is isolated from the region of intense heat and is protected against burn-out. This phenomenon is commonly known in the art as sweat-cooling or transpiration, and is analogous to the well known cooling effect of perspiration on the human skin. The prior art technique of restoring the porosity, after the metal has been machined for its intended use and to insure uniform sweat-cooling, is to deeply etch the metal. Deep etching results in a nonuniform surface, and machining tolerances cannot be maintained. Furthermore,

materials such as stainless steel, and chromium, nickel, and molybdenum alloys in general, which are essentially noncorrosive, cannot be etched satisfactorily. My method eliminates these disadvantages by permitting the usual machining operations to be employed without destroying the porosity of the stock.

It is a broad object of my invention to provide a novel method of metal working.

It is a more specific object of my invention to provide a means whereby a porous material may be machined without destroying the surface porosity thereof.

It is a still more specific object of my invention to provide a method of machining a porous material which includes the filling of the pores of the material with a substance which is solid and hard at room temperatures, is fluid at reasonably low temperatures and can be easily removed from the porous specimen after machining.

With the foregoing and with other objects in view which will become evident as the following specification develops, reference is made to the accompanying drawing forming a part of the specification and wherein:

Figure 1 is a porous metal blank, not impregnated.

Figure 2 is a section on line 2-2 of Figure 1.

Figure 3 illustrates a blank not impregnated, after machining.

Figure 4 illustrates the blank of Figure 1 after it has been impregnated and

Figure 5 is the blank of Figure 4 after it has been machined.

In carrying out the above objects I impregnate the porous material 1 with a substance 2 which (1) is solid at room temperature, (2) is sufficiently hard and strong to back up the particles of the material, and (3) can be readily removed from the porous material, either by heating the material, by the action of water or steam, or by means of other solvents.

I have found that sodium chloride or other metallic salts (e. g., potassium chloride, or a eutectic mixture of salts such as 60 per cent sodium nitrate and 40 per cent sodium nitrite) are satisfactory fillers; also, because of the tendency of molten salts to react with copper, oxalic acid, which is chemically reducing, is of particular value as a filler with copper.

The method is carried out by submerging the porous material in a molten bath of the impregnating material for approximately 20 minutes. When sodium chloride is used as the impregnating material, a temperature greater than 1450° F.

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s required. With oxalic acid, a temperature between 200-260° F. is sufficient. After the porous material is impregnated and allowed to cool in air, machining, shaping, milling, grinding, drilling or other operations may be carried on in the usual way. It is essential that sharp tools be used and heavy cuts avoided. No cutting compounds should be used.

After the machining operations, the filler may be removed from the specimen by dissolving in water or by the use of steam. Oxalic acid, which decomposes at 125° C., may be removed by heating.

It should be noted that when sodium chloride or other salt whose melting point is higher than that of soft or silver solder is used, the impregnated porous material may be soldered to a solid section of metal.

By means of the techniques described above, complex shapes, such as turbine blades and rocket motor nozzles, may be completely machined from simple shapes which are easy to press and which may be sintered without excess warpage.

It will be understood that the particular embodiment described is for illustrative purposes only. Many modifications will readily suggest themselves to those skilled in the art and the invention is therefore not to be deemed as limited except within the scope of the appended claims.

I claim:

1. A method of machining a porous metal for use in sweat-cooling apparatus which comprises filling the pores of the said metal with fluid oxalic acid at a temperature between 200-260 degrees Fahrenheit, cooling the said metal whereby the said oxalic acid solidifies, machining the said metal, and removing the said oxalic acid by heating.

2. A method of protecting the porosity of metals machined for use in sweat-cooling apparatus which comprises, filling the pores of said metal with fluid oxalic acid at a temperature between 200-260° F., cooling the said metal whereby the oxalic acid solidifies within the pores thereof to present a solid surface for machining, machining said metal, and removing the said oxalic acid from the pores of said metal by heating after machining.

3. A method of preserving the porosity of porous metals to be machined for use in sweat-cooling apparatus which comprises, submerging the metal in a molten bath of oxalic acid for 20 minutes and with a bath temperature ranging between 200-260° F., cooling the impregnated metal to present a smooth surface for machining, machining said metal, and dissolving the impregnating material from the pores of the metal after machining, with heat at 125° C.

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