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[54] **METHOD OF IMPREGNATING A SINTERED POROUS METAL ARTICLE TO MAKE THE ARTICLE LIQUID-TIGHT**

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[51] **Int. Cl.** **B22f 7/00**

[58] **Field of Search** ..... 29/420, 527.2, 527.4, DIG. 31, 29/182.5, DIG. 34; 117/61, 65.2

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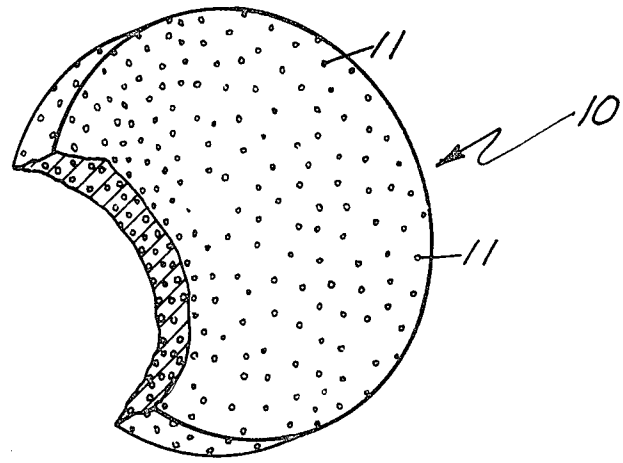
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Primary Examiner—C. W. Lanham
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Attorney, Agent, or Firm—Barlow & Barlow

[57] **ABSTRACT**

An article having a compacted powdered metal body of a desired configuration which is sintered to approximately 75% - 94% theoretical density with some voids therein and the voids are filled with a liquid organic polymerizable impregnant applied under pressure and cured under pressure to prevent any voids in the impregnant.

3 Claims, 2 Drawing Figures



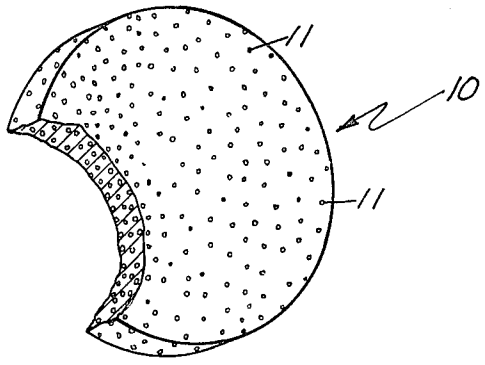

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10
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FIG. 1

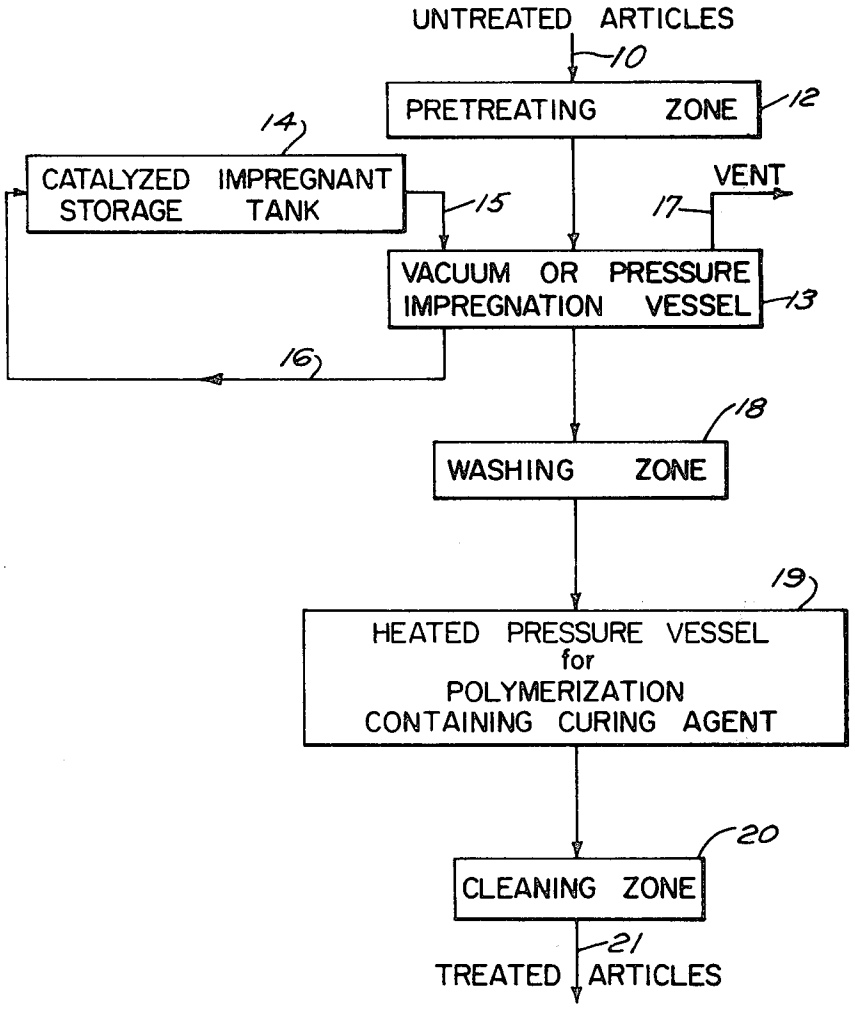

UNTREATED ARTICLES
10
PRETREATING ZONE
12
14
CATALYZED IMPREGNANT STORAGE TANK
15
VENT
17
VACUUM OR PRESSURE IMPREGNATION VESSEL
13
16
18
WASHING ZONE
19
HEATED PRESSURE VESSEL for POLYMERIZATION CONTAINING CURING AGENT
20
CLEANING ZONE
21
TREATED ARTICLES

FIG. 2

METHOD OF IMPREGNATING A SINTERED POROUS METAL ARTICLE TO MAKE THE ARTICLE LIQUID-TIGHT

BACKGROUND OF THE INVENTION

Compacted, powdered metal bodies which have been sintered present a certain theoretical density varying with the compacting but with some voids therein. It has been difficult to fill these voids completely and at times when a treatment is given it is only very thin on the surface and sort of skindeep and machining of the article after it has been treated in this way exposes the metal beneath the treatment which is unsatisfactory. At times the impregnant which is applied is not completely solid but has voids in the impregnant which is undesirable.

SUMMARY OF THE INVENTION

Powdered metal is compacted to the configuration of a body desired and sintered so that there is approximately 75 – 94 percent of theoretical density with 25 to 6 percent voids therein. The voids are filled by subjecting the body to a vacuum to draw gases from the voids and then immersing the body in a liquid organic polymerizable impregnant and applying pressure to the impregnant to force it into the voids. Further the body is removed from the impregnant and then subjected to curing of the impregnant by immersing the body and its impregnant in a heated liquid bath which is inert to the article and to the impregnant but capable of transmitting heat and pressure to the impregnated article and heat and pressure are applied until the impregnant becomes solid so that by this means the boiling point of the impregnant is raised and gasing or the formation of voids in the solid impregnant is avoided.

DESCRIPTION OF THE DRAWINGS

FIG. 1 presents a perspective view of a broken-away disc of a compacted powdered metal in the desired shape which has been sintered and presents certain voids which are to be filled;

FIG. 2 represents a diagrammatic showing of the various steps which are performed in the process of filling the voids of the body.

BRIEF DESCRIPTION OF THE INVENTION

Powdered metal which may be of iron, stainless steel as that more commonly used or of other various metals, such as bronze, brass, aluminum, and so forth, may be compacted into the desired shape of the article to be formed as at **10**, and then is sintered at a temperature depending upon the metal used which will cause some uniting of the particles which go to make up the body. There will then be present about 75 – 94 percent of theoretical density and about **25** to **6** percent voids as at **11**. The voids are then thoroughly filled so as to seal the body against outside pressures and to prevent leakage and also to prevent corrosion in the various pores in the body which exist. The impregnant is injected into the pores to the full length of the pores so that subsequent machining of the article which may take a thin amount off of the surface will not disturb the filling within the pores. Further the filling of the pores provides some lubricating qualities which are of advantage in machining.

After the sintered body has been formed, the articles **10** are passed into a pre-treating zone where they will be cleaned and heated to approximately **248°F.** to expel the moisture from within the pores of a porous article and provide a degreasing step in which the articles are subjected to a suitable cleaning process as shown in the block **12.**

The porous articles to be impregnated are then placed in a chamber **13** and a high vacuum is applied, preferably not less than **28** inches of mercury. The articles are maintained in this vacuum for about **5** minutes to assure substantially complete exhaustion of all air present in the vessel and the pores of the article, and then without releasing the vacuum an impregnant is flowed into the chamber from a container **14** through a conduit **15.** The impregnant is a liquid thermosetting resin, a material which is liquid at room temperature but which is capable of being changed into a substantially infusible and insoluable product when cured by application of heat or by chemical means. Such a material is an unsaturated polyester resin composed principally of unsaturated polyesters in which the recurring ester groups are an integral part of the main polymer chain and which contain alpha unsaturation which can be cross linked by carbon to carbon bonds. These resins may also be copolymerized with vinyl or allyl monomers, such as styrene or diallyl phthalate. Pressure is applied to the impregnant to force it into the evacuated pores. Such impregnant as remains not used is forced back to the storage tank through conduit **16.** The chamber is then vented as shown at **17** and the article is washed at **18** to clean off the impregnant which adheres to its outer surface.

The article is then placed in a closed vessel **19** and immersed in a curing agent at **275°F.** The curing agent will be any liquid which will transfer head and pressure to the article such, for example, as polyalkylene oxide which has the properties of heat transfer and pressure transfer and is found to be better than mineral oil which can be used. In this chamber **19** with the article immersed in such a fluid, the fluid is heated from **265°** to **285°F.** and preferably **275°F.** and pressure is applied through the use of a gas. Usually the fluid will be a liquid with gas above to which gas pressure is applied. The gas may be air or some other gas which is inert to the fluid which is to transmit the heat and pressure. The pressure is in the neighborhood of **100** pounds to the square inch although this may be varied from **10** – 100 lbs. per square inch or upwards, but this is a substantial pressure and very effective. As this pressure is increased the time of curing may be decreased. The article is allowed to remain in this curing medium for from between **40** to **60** minutes, desirably **50** minutes, at **100** pounds pressure which is less than the time in which is was found desirable to allow an article to be subjected to the curing medium without pressure. Practically no bleed out occurs by the process outlined above where substantial pressure is applied to the curing media.

If no pressure is applied, as the impregnated material is heated the viscosity of the liquid impregnant begins to decrease allowing some of the liquid to leech out of the porous part. Further as the heat absorption of the work is increased and the impregnant begins to change from a liquid to a solid by polymerization, some gas bubbles occur either from air previously absorbed in the liquid resin, or from boiling of the various liquids in the resin formulation. This formation of gas causes leeching out of the impregnant and bleedant on the surface of the porous article. When pressure curing media is used, the pressure tends to counteract the reduction

in viscosity and holds the impregnant completely within the pores. Further the increased pressure raises the boiling point of the liquid and prevents formation of gas from boiling and also keeps any entrapped air in solution until the resin is fully cured. This reduces or eliminates bleed out and insures a solid mass of impregnant within the pores.

After this curing under heat and pressure of the impregnant the article is removed from the curing agent and cleaned and it is found that very little of the impregnant has come out of the pores thus making for less cleaning and a further indication that the impregnant has remained in the pores where it was desired it should be. There is less evidence of gas pockets, less resin on the outer surface of the casing after curing and a higher percentage of non leak castings.

The impregnant has gone deep into the pores of the sintered body and machining may take place of the body and still leave the sintered body sealed as the impregnant is more than skindeep such as some treatments of sintered articles has provided. All of the interconnected porosity which emerges to the surface of the sintered body has been filled completely and no voids are left in the metal body or in the impregnant which fills the voids of the body.

The pressure, of course, is kept on the impregnant until after it gels or becomes solid and also the temperature is kept up.

I claim:

1. In the method of sealing a sintered metal article to make the article liquid-tight under pressure comprising

compacting powdered metal to the configuration of body desired and sintering the body to approximately **75** – 94 percent of theoretical density with some voids therein,

subjecting the body to a partial vacuum to draw gases from the voids therein,

immersing the body in a liquid organic polymerizable impregnant and applying pressure to said impregnant to force it into the voids in the body, removing the body from the liquid impregnant and curing the impregnated body by immersion in a hot liquid bath which is inert to the article and to the impregnant and capable of transmitting heat and pressure to the impregnated article,

said curing bath being kept at a temperature of **265°** – 285°F. with an added pressure of from **10** to **100** pounds per square inch for such period of time until said impregnant polymerizes and becomes solid whereby to prevent its gasing and forming voids in the solid impregnant.

2. The method of sealing a sintered article as in claim **1** wherein the article is subjected to the curing fluid from **40** to **60** minutes at a pressure of **25** to **100** pounds.

3. The method of sealing a sintered article as in claim **1** wherein the article is subjected to the curing fluid for **50** minutes at a pressure of **25** to **100** pounds.

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