Dec. 15, 1964 H. CHESSIN 3,161,478

HEAT RESISTANT POROUS STRUCTURE

Filed May 29, 1959

FIG. 1

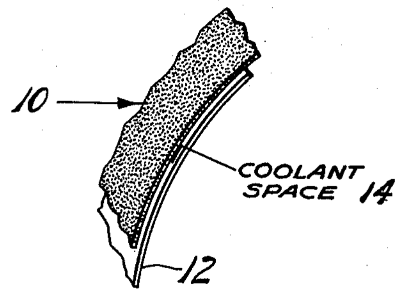


FIG. 2

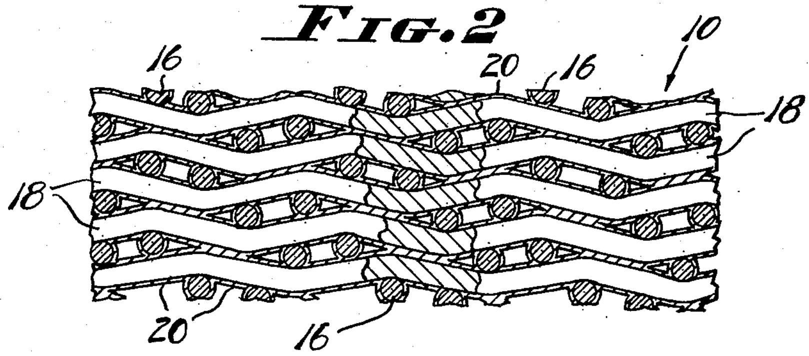


FIG. 3

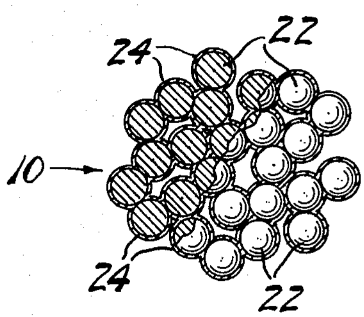
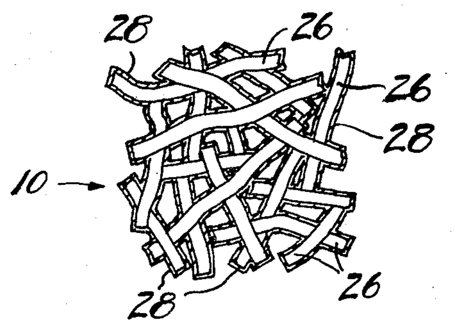


FIG. 4



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HEAT RESISTANT POROUS STRUCTURE

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This invention relates to porous structures and methods for producing the same; and more particularly to the fabrication of high heat-resistant structures such as are porous and thereby adapted to diffuse and transmit fluids therethrough, for use for example in evaporative-cooling applications in nose cones of missiles or rockets or other structures which encounter erosive and/or corrosive high temperature conditions.

Whereas it is known that certain metals retain their strength under relatively high temperature operating conditions, such metals often are relatively easily corroded under elevated temperatures. Hence, for applications as stated hereinabove, it has been heretofore proposed to coat panels of such metals with protective refractory layers composed of ceramics or the like. The problems referred to are typically encountered for example in connection with the missile industry wherein it is a known desideratum to provide nose cones and other air-friction heated skin parts; rocket engine parts; and the like, of such characteristics as to enable them to retain their necessary strength and other structural characteristics at least throughout an operational cycle. To this end the principles of evaporative cooling may be applied to the parts which are subjected to high operational temperatures; and it is a primary object of the present invention to provide an improved structure through which coolant fluids may be diffused in improved manner, and to an improved method for producing the same.

Another object is to provide structures and methods as aforesaid by virtue of which a porous basic structure may be fabricated of any preferred refractory material or the like, the interstitial surfaces of which are uniformly coated in improved manner with a protective deposit functioning at the same time to mechanically reenforce the basic or matrix material; to encapsulate the matrix parts in coatings guarding against excessive corrosion and volatilization of the matrix material; and regulating the through-pore dimensions of the finished structure.

Other objects and advantages of the invention will appear from the specification hereinafter, and the drawing furnished herewith which is illustrative of the invention, and wherein:

FIG. 1 is a fragmentary perspective of a dual wall fabrication including a heat receiving panel, component of the present invention in combination with means providing a coolant supply space at one side thereof;

FIG. 2 is a fragmentary schematic sectional view through one form of a fabrication of the invention; and

FIGS. 3–4 are views corresponding to FIG. 2 but illustrating modified forms of fabrications of the invention.

As shown in FIG. 1, a panel-like structure of the present invention may be fabricated in porous form for example as indicated at **10**, of any desired shape or dimension. Such a panel may be used for example in conjunction with a companion sheet metal plate **12** or the like so as to provide therebetween a coolant fluid supply space as indicated at **14**. Hence, a fluid may be pumped or otherwise delivered into the space **14** for diffusion through the pores of the fabrication **10**. In the case of an evaporation-cooling system it will be understood that the coolant will be arranged to exude through the pores of the member **10** in the region of the high heat applications at the external surface thereof, whereby the evaporation of the coolant will operate to lower the temperature and protect the structure. However, it is to be understood that fabrications of the present invention are equally useful in other applications, wherever it is desired to provide highly heat-resistive structures of porous form, for whatever purposes they may be used.

FIG. 2 shows in greatly enlarged sectional form one form of fabrication such as will provide the member **10** of FIG. 1. In this case the basic component is made by initially superposing any required number of layers of wire-like mesh fabrications comprising interwoven strands **16**, **18** of some heat resisting material such as the metal molybdenum, or the like. It will be appreciated that in order to build the member **10** to the desired thickness and of the desired porosity characteristics, a suitable number of layers of wire mesh material of suitable wire size and relative spacings will be initially stacked in layered form; and then if preferred, the stack may be "settled" or compacted by a pressure application.

The invention provides an improved method for treating the basic porous structure so as to at the same time structurally bond the agglomerated parts together; insulate the parts against excessive evaporation and/or corrosion deterioration under high-temperature conditions; and partially close the interstices leading through the structure. For this purpose the invention contemplates deposition of a suitable metal or metalliferous material throughout the entire interior of the porous basic fabrication but only against the interstitial walls thereof, so as to uniformly coat every basic material surface with a protective material while avoiding closing off the pores through the structure. For example the method of the invention provides an improved structural bonding of the screen elements shown in FIG. 2 throughout the entire interior of the fabrication by means of the protective coating as indicated at **20**, the latter being so applied as to build up progressively against the interstitial surfaces of the fabrication at uniformly equal depths throughout the fabrication. Thus, the internal coating process will be conducted and controlled so as to provide surface coatings resulting in the predetermined desired reduction of pore size throughout the fabrication. At the same time the screen structures are interlocked by the coatings for improved overall structural strength, and the screen strands are encapsulated against high temperature evaporation or corrosion deterioration. By this method porous structures of the desired characteristics for the purposes explained hereinabove may be provided.

Conventionally suggested methods for internally coating and reenforcing the basic structure and reducing the pore size are not suitable. For example, such processes as dipping the basic fabrication in molten metal; spraying molten material against the basic fabrication; or electroplating metal or other material onto the fabrication or the like, would be unsatisfactory. This is because such processes would invariably result only in initially covering the outer surfaces of the fabrication in such manner as to close off the interstices thereof at the outer surfaces of the structure, without getting into the interior of the fabrication. Thus, the objects and advantages of the present invention are not attainable by such methods.

The present invention contemplates deposition of the reenforcing and protective and pore size reducing material interiorly of the fabrication by means of a process such as will operate simultaneously throughout the entire thickness of the porous basic fabrication. For example a method known in the trade as electroless plating may be employed; explanations of such processes being found for example in U.S. Patents Nos. 2,532,283 and 2,532,284. Or in lieu thereof a chemical replacement method may be employed as disclosed for example in U.S. Patents 2,873,214 and 2,873,216. Again in lieu thereof a thermal decomposition method or a vapor deposition method may be employed such as is disclosed for example in U.S. Patents 2,653,879 and 2,815,299. In any case, because of the nature of the method involved, the internal structural reenforcing and surface insulating and pore closing operation will take place simultaneously and uniformly throughout the entire interior of the basic structure, as distinguished from the surface sealing results obtained when attempting to use for such purposes conventional electroplating or molten metal dipping or spraying methods or the like.

Thus, it will be appreciated that in the case of the present invention a missile nose cone for example may be fabricated of a basic porous structure formed of multilayers of screening made for example of molybdenum, having internal coating applications of tungsten or the like as indicated at 20 (FIG. 2) throughout the interior of the fabrication. Thus, a finished product of controlled pore size is produced which is therefore suitable as a diffuser of evaporative cooling fluid, comprising a base metal fabrication of high heat strength metal structurally bonded together and surface-insulated against excessive erosion and/or oxidation and/or volatilization loss, by means of the coating material 20.

It is to be understood that any suitable material may be employed in the fabrication of the basic structure. For example, in lieu of molybdenum as stated hereinabove, materials such as the various nickel-chromium alloys, tantalum, or ceramic or other refractory fibres or nodules may be employed, according to the operating conditions anticipated. Similarly the internal coating material may be any other suitable metalliferous material in lieu of tungsten as stated hereinabove. For example, cobalt, chromium, gold, or titanium might be employed, according to the operative conditions expected to be encountered. In any case the basic material will be selected in accordance with the required high temperature strength aspect of the problem and the coating material will be selected in view of the high temperature corrosion and erosion resistance requirements. Also, the materials for the basic structure and the coating component will be preferably selected with a view to their team properties. For example, in some instances the combination of molybdenum and tungsten will be clearly indicated. Other preferred combinations might include the nickel-chromium alloys and tungsten; and various ceramic and chromium combinations.

FIG. 3 corresponds to FIG. 2 but illustrates how a fabrication of the invention may be constructed to comprise a porous base structure composed of nodules of high heat strength material as indicated at 22 which have been bonded together and surface-coated for protection against volatilization and/or oxidation and/or other erosive or corrosive conditions by means of an internally deposited coating of material 24; it being understood that the same internal coating methods referred to hereinabove may be applied in the case of FIG. 3 and will function also to control the final pore size of the finished structure as explained hereinabove. FIG. 4 illustrates embodiment of the invention in connection with a fabrication consisting of a porous base composed of fires or strands of basic material as indicated at 26 which have been initially "felted" together to form a tangle of fibres to comprise a porous mass throughout which a coating of material as indicated at 28 has been applied as explained hereinabove. Thus, the fabrication is bonded together and the strands 26 are protected against erosive and/or corrosive deterioration as explained hereinabove.

Although only a few forms of the invention have been illustrated and described in detail hereinabove, it will be understood that various changes may be made therein without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A high heat-resistant fabrication comprising a porous

basic structure consisting of high heat-strength material parts selected from the group consisting of molybdenum and nickel chromium alloys agglomerated to a thickness several times greater than the thickness of any one of said parts interjoined by means of an interstitially deposited metalliferous material selected from the group consisting of tungsten and tungsten alloys bonding said parts together and encapsulating the latter by layers of material of such thicknesses that residual pores of predetermined sizes are provided.

2. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength molybdenum or molybdenum alloy parts, interbonding said parts by means of an electroless process whereby layers of tungsten are bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

3. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength molybdenum or molybdenum alloy parts, interbonding said parts by means of a chemical replacement whereby layers of tungsten are bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

4. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength molybdenum or molybdenum alloy parts, interbonding said parts by means of a thermal decomposition whereby layers of tungsten are bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

5. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength molybdenum or molybdenum alloy parts, interbonding said parts by means of a vapor decomposition whereby layers of tungsten are bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

6. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength nickel-chromium parts, interbonding said parts by means of an electroless plating whereby a corrosive-erosive resistant tungsten alloy is bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

7. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength nickel-chromium parts, interbonding said parts by means of a chemical replacement whereby a corrosive-erosive resistant tungsten alloy is bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

8. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength nickel-chromium parts, interbonding said parts by means of a thermal decomposition whereby a corrosive-erosive resistant tungsten alloy is bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

9. The method of manufacturing a high heat resistant fabrication comprising the steps of agglomerating a porous basic structure of high heat strength nickel-chromium parts, interbonding said parts by means of a vapor decom-

position whereby a corrosive-erosive resistant tungsten alloy is bonded to the interstitial walls of said basic structure thereby bonding together said parts and encapsulating the latter without plugging the through pores of the structure.

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