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METHOD OF PRODUCING A LIGHTWEIGHT
FOAMED METAL

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This invention relates to a method of manufacturing a lightweight foamed metal. More particularly, it relates to a method whereby the fluidity of a plastic metal mass is decreased during foaming and the foaming is carried out by the formation of gas from a reaction within the molten metal.

Lightweight foamed metals having high strength-to-weight ratios are extremely useful as load-bearing materials and as heat insulators in elevated temperature systems. Heretofore, these materials have had very limited usage due in part to their high cost and also to the difficulties encountered in manufacturing.

In general, extremely close control of processes for producing foamed metals has been necessary. These methods usually require numerous individual steps to produce a foam metal. Each step, of course, involves precise control techniques.

One of the problems has been to prevent the escape of the gas used to form the cells within the plastic molten metal mass. Unless some method is used to suppress the escape of the gas from the molten metal, the degree of foaming is greatly curtailed.

Two of the most common methods used in preventing the degassing of the molten metal are by carrying out the melting under an artificial high pressure system and utilizing alloys wherein there is a wide difference in the alloy's solidus and the liquidus temperatures, thus permitting the use of a melt having a two-phase, liquid plus solid, system. It is generally helpful in the latter case that the solid phase predominates.

In the production of foamed metal, that is, metal having a plurality of randomly dispersed closed cells throughout a metal matrix, the most common method has been to use a heat decomposable foaming agent to generate the gas to form the cells. This technique is disclosed in U.S. Patents 2,751,289 and 2,983,597.

It is, therefore, an object of the present invention to provide a simple and economical method for producing lightweight foamed metal.

Another object is to provide a simply controlled method of foaming a fusible metal.

Still another object is to provide a method of producing a high strength-to-weight ratio metal having a plurality of closed cells randomly dispersed therein.

Yet another object of this invention is to provide a method for decreasing the fluidity of molten metal during the manufacture of foamed metal.

A further object is to provide a method of generating a gas within a molten plastic metal mass to foam the plastic melt.

A still further object is to provide a method of retaining gases within a mass of molten metal during the manufacture of foamed metal.

Yet another object is to provide a method of producing foamed metal which is inexpensive, yet adaptable for use in the production of foamed metals of different metallic compositions.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description which discloses a preferred embodiment thereof.

The above objects are accomplished by combining

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particles of a siliceous non-metallic aggregate with a fusible metal at a temperature above the solidus temperature of the metal, but below the metal's liquidus temperature. The aggregate is wet by the plastic metal melt and decreases the fluidity of the melt, thus increasing the degree of gas retention by the melt. This decreased fluidity, i.e. thickening, of the melt enables the foaming operation to be relatively prolonged and the foamed melt to be maintained in its heated, fluid condition without collapsing for a relatively prolonged period since the gas bubbles cannot readily escape from thickened melt.

A substance which produces a gas when heated to the temperature of the melt is mixed substantially throughout the molten melt, thereby forming a plurality of gas bubbles throughout the molten melt and forming a molten foam. Thereafter the foamed melt is cooled below its solidus temperature, thus producing a foamed metal having a plurality of closed cells, formed by the entrapped gaseous bubbles, dispersed within a matrix of the fusible metal.

As a preferred or exemplary embodiment of the instant invention, a fusible metal is placed into a suitable receptacle and heated above its solidus temperature, but below its liquidus temperature, thereby forming a plastic mass of the metal. Among the metals which are preferably utilized in this process are aluminum, magnesium, zinc, lead, nickel, copper, and alloys of these metals.

The solidus temperature, at which a solid metal is transformed to a liquid or a liquid plus solid phase, varies considerably. For instance, aluminum has a melting point of 1220° F.; magnesium melts at 1202° F.; copper melts at 1981° F.; zinc melts at 787° F.; lead melts at 621° F.; and nickel melts at 2647° F.

For pure metals, the solidus temperature and liquidus temperature are the same. However, metal alloys will generally have solidus temperatures lower than their liquidus temperature. As used herein, the term plastic connotes an alloy within the liquid plus solid range.

The plastic range for representative metal alloys are as follows:

Major Metal Constituent	Alloy	Solidus Temperature, ° F.	Liquidus Temperature, ° F.
Aluminum	1100	1,190	1,215
Do	3003	1,190	1,210
Do	5050	1,160	1,205
Do	5086	1,084	1,185
Do	7075	890	1,180
Magnesium	AZ61A	977	1,145
Do	AZ80A	914	1,130

When the temperature of an alloy is raised above the solidus temperature, but below the liquidus temperature, it will generally exhibit a lesser degree of fluidity than when the melt is raised to a temperature where only the liquid phase is present. Even in this range, however, the melt will generally show a substantial degree of fluidity.

With the melt in the plastic range, particles of a siliceous non-metallic aggregate are mixed throughout the molten metal and distributed as uniformly as possible throughout the melt. During mixing, the particles are wet by the melt and, as they are dispersed therethrough, the fluidity of the molten metal is substantially decreased. It is necessary that the particles be dispersed substantially throughout the melt and remain so in order to insure that the fluidity of the entire melt will be substantially uniform.

It has been found that a number of siliceous materials will decrease the fluidity of molten metals, when used as hereinbefore described. These materials have fusion temperatures above the liquidus temperature of metals herein enumerated.

Table I lists siliceous non-metallic aggregates, in their hydrated form, that have been used in decreasing the fluidity of a molten alloy melt. Others that may be used include perlite and silica gel.

TABLE I.—SILICEOUS MINERALS

Mineral:	Composition ¹
Pyrophyllite ----	$\text{Al}_2(\text{Si}_4\text{O}_{10})(\text{OH})_2$.
Talc -----	$\text{Mg}_3(\text{Si}_4\text{O}_{10})(\text{OH})_2$.
Mica group:	
Muscovite ----	$\text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$.
Paragonite ---	$\text{NaAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$.
Lepidolite ----	$\text{KLi}_2\text{Al}(\text{Si}_4\text{O}_{10})(\text{OH})_2$.
Zinnwaldite ---	$\text{KLiFeAl}(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$.
Biotite -----	$\text{K}(\text{Mg,Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$.
Phlogopite ----	$\text{KMg}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$.
Clintonite group:	
Margarite ----	$\text{CaAl}_2(\text{Al}_2\text{Si}_2\text{O}_{10})(\text{OH})_2$.
Chloritoid ----	$(\text{Fe,Mg})_2\text{Al}_2(\text{Al}_2\text{Si}_2\text{O}_{10})(\text{OH})_4$.
Clintonite ----	Fe and Mg partly replace Ca and Al of margarite.
Illitic minerals -- Hydrous micas.	
Vermiculites ----	$(\text{Mg,Fe})_3(\text{Si,Al})_4\text{O}_{10}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$.

¹ Formulas are largely simplified to an ideal type, since most actual compositions are very complex owing to isomorphous substitution.

Although the aggregate particles are preferably added to the melt, they may be added with the solid metal into the heating container and be brought up to heat with the metal. Mixing could then be carried out as soon as the metal enters the plastic range.

Once the siliceous non-metallic aggregate particles have been dispersed substantially throughout the melt, a gas-forming solid, preferably in fine particle form, is introduced into the melt and mixed thoroughly therethrough. During mixing, the melt is preferably maintained at a temperature where the gas-former will be wet by the melt. After mixing is completed, the temperature can be adjusted to that necessary for the formation of gaseous bubbles within the melt.

The generation of bubbles within the melt from the gas-former may be carried out in a number of ways. One of these is the decomposition of an inorganic chemical such as titanium hydride, zirconium hydride, metallic sulfates, and metallic carbonates.

Another technique is the use of a metal or other material which will vaporize at the temperature of the melts, thereby producing the gaseous bubbles within the melt.

Still another method for producing gaseous bubbles within the melt is to add a material that will react with a component of the melt to produce the gas. This type of reaction would be an oxidation-reduction reaction rather than a decomposition or vaporization reaction.

It has been found that if gas-forming solid particles added to the melt contain water, the water will be released in the form of steam as the particles are heated by the melt. It is known that many metals above hydrogen in the electrochemical series will react with steam to form hydrogen gas and metal oxide, following the general oxidation-reduction reaction: $\text{M} + \text{H}_2\text{O} (\text{steam}) \rightarrow \text{MO} + \text{H}_2$ where M represents a metal above hydrogen in the electrochemical series. Depending upon the particular metal, the reaction will take place at different temperatures.

The reactive metal may be present as an alloying element in a melt. Among metallic components within a melt that will react with steam to produce hydrogen gas are magnesium, iron, titanium, nickel, cobalt, tin, calcium, barium, chromium, manganese, and strontium. It is essential that the reactive metal component of the alloy be present at least in an amount that will react with steam to produce H_2 . In the case of 1100 aluminum more than one of the reactive metals is generally present. Iron, manganese, and magnesium are common constituents of 1100 aluminum, and their effect in the reaction appears to be additive. Where the reactive metal is magnesium the

reaction may occur at a temperature as low as 700° F., whereas with iron it generally will not take place, at suitable speeds, below 900° F. The exact temperature may also depend somewhat on the concentration of the reactive metal.

Once the temperature of the fusible metal alloy is in the plastic temperature range, a water-carrying agent is added to the melt. This agent is preferably in small particle form and is rapidly wet by the melt as it is mixed therethrough. As additional quantities of the water-carrying agent are added, the plastic range of the mixture is increased.

The amount and size of the water-carrying agent particles to be added to the melt will, of course, vary, depending upon the degree of porosity and density desired in the final product. In general, it is desirable that the carrying agent contain between one and fifteen percent and preferably three to nine percent water. In those materials used as carrying agents which contain relatively large amounts of water, part of this water may be driven off by preheating the carrying agent to a temperature sufficient to liberate some of the water.

Many water-carrying agents have been found useful in this process. It is, of course, necessary that these materials release their water when the particular alloy being used is above its solidus temperature.

Among the materials that may be employed as water-carrying agents are many siliceous non-metallic aggregates containing water. Examples of these aggregates are enumerated hereinbefore, the principal difference being that when they are dehydrated they act as thickeners only, but if they contain water they may be used both as thickeners and as water carriers.

In addition to these hydrated siliceous aggregates various hydrated inorganic chemicals may be used as water-carrying agents. Among these chemicals are ammonium ferric sulfate, barium hydroxide, barium iodide, calcium chloride, calcium hydroxide, cerium sulfate, cobalt sulfate, cupric sulfate, ferrous sulfate, lithium sulfite, magnesium sulfate, nickel sulfate, potassium chromium sulfate, potassium sodium tartrate, sodium tetraborate, and zinc sulfate.

The water held by the carrying agent, which is released at the elevated temperature to which the agent is subjected, will vary between carrying agent.

In the case of various siliceous non-metallic aggregates, the dehydration temperature will vary between 800° F. and 2250° F. For some of these aggregates there is more than one dehydration temperature. For instance, talc has three temperature levels where dehydration will occur. They are at approximately 1652° F., 1697° F. to 1850° F., and 1886° F.

As soon as the carrying agent is added to the melt, the mass is stirred vigorously in order to uniformly disperse the carrying agent particles throughout the melt. Experimental studies indicate that the method of mixing carrying agents into the melt is not critical. Any technique which results in relatively uniform distribution of the carrying agent within the melt is satisfactory. It is preferable, however, that the mixing not subject the carrying agent to extreme shearing which would tend to change the particle size and possibly affect the rate of foaming.

After mixing, the plastic mixture is maintained at a temperature above its solidus temperature for a time sufficient for the water held by the carrying agent to be released in the form of steam. This time will vary depending upon the temperature at which the fusible metal is held and also the particular water-carrying agent utilized. Generally such time will not be less than 10 seconds nor more than 15 minutes.

As the steam is being released into the melt it chemically reacts with the reactive component of the fusible metal to form hydrogen gas and reactive metal oxide, according to the general oxidation-reduction reaction as hereinbefore described. Since this reaction will take place

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at different temperatures and rates for different reactive metals it may sometimes be desirable to raise the melt temperature to bring it into the liquidus range. This, of course, may not be necessary nor desirable where the oxidation-reduction reaction proceeds at a desired rate within the plastic temperature range of the melt.

Once the foaming is completed, the melt is allowed to cool below the solidus temperature of the molten material. As in melting, this temperature will vary depending upon the fusible metal.

Once cooled below the solidus temperature to the solid state, the lightweight foamed metal may be shaped using conventional tools. If, on the other hand, a particular configuration is desired, the plastic melt may be placed into a shaped mold and the melt may be allowed to solidify in the mold, thus assuming the desired shape. If the melt is placed into the mold it may be desirable to allow the foaming to occur in the mold. However, this is not necessarily essential. Full or partial foaming may be allowed to occur prior to placing the melt into the mold.

Upon cooling the material below its solidus point, the foamed metal will generally have a continuous skin comprised of the fusible metal and random particles of the now anhydrous, or substantially so, carrying agent. The interior of the foamed composition of matter will contain a minor volume of random, substantially uniformly dispersed particles of anhydrous carrying agent and a plurality of discrete closed cells, some possibly being interconnected, substantially randomly dispersed within the solid fusible metal matrix.

As used in this specification, the term "closed cell" means a single pocket formation or a plurality of interconnected pockets sealed within the solid metal. It is not to be construed to mean an open cell structure, as is found in a sponge.

Various other methods, such as the decomposition and vaporization techniques hereinbefore mentioned, may be utilized to generate the gas within the melt for producing the foam.

On the other hand, foaming, using the oxidation-reduction method for producing the gas, may be carried out without the necessity of decreasing the fluidity of the melt, if precise controls are employed in maintaining the melt at the proper plastic temperature range during foaming and then solidifying the foamed melt rapidly before the gaseous bubbles escape.

An alternate technique may be used in adding the water-carrying agent to the metal alloy. In this form of the invention small particles of both the fusible metal and the non-metallic water-carrying agent are thoroughly commingled and then heated in a furnace above the solidus temperature. The plastic melt is then thoroughly blended.

While the water-carrying agent is substantially uniformly distributed throughout the melt, the water is released into the melt in the form of steam, and the oxidation-reduction reaction with the reactive component of the alloy, as described hereinbefore, takes place.

The following examples are by way of explanation and are not to be considered limitations on the invention.

Example 1

100 grams of 5052 aluminum alloy were placed in a crucible and heated to a temperature of 1130° F. thereby transforming the aluminum to the liquid plus solid state. Into the molten aluminum was introduced 3 grams of 100-mesh expanded dehydrated vermiculite. The mixture of aluminum and vermiculite was then mixed thoroughly for a period of 3 minutes. As soon as the vermiculite was dispersed substantially throughout the molten aluminum, 1 gram of No. 4 expanded vermiculite (a mixture of 16-50 mesh) containing 5 percent water was added to the mixture while the melt was heated to 1300° F., during which time the water contained within the second vermiculite addition was released as steam and reacted with magnesium within the alloy to form a plurality of bubbles

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within the melt. The melt was then cooled below its solidus temperature, thereby forming a solid foamed metal.

Example 2

75 grams of 5052 aluminum alloy were cut into small particles weighing about 0.08 gram each. The particles were placed in a furnace that had been heated to 1180° F. Once the metal became plastic, 0.5 gram of 60-mesh silica gel containing approximately 7 percent water were introduced and the temperature raised to 1250° F. Water contained within the silica gel was released as steam throughout the metal and reacted with the magnesium constituent of the alloy. Thereafter the melt was cooled below its solidus temperature thereby forming a foamed metal structure.

Example 3

100 grams of 4043 aluminum alloy were placed in a furnace and heated to 1130° F., thereby transforming the aluminum to the plastic state. Into this molten aluminum was introduced 4 grams of 100-mesh expanded dehydrated vermiculite which was thoroughly mixed and dispersed throughout the aluminum thereby thickening the melt. Into the mixture was added 10 grams of a powdered mixture consisting of 1.5 grams of ZrH_2 in 8.5 grams of an eutectic mixture of aluminum and magnesium. This powder was dispersed throughout the molten melt. Upon reaching approximately 1160° F. each of the ZrH_2 particles decomposed and released a quantity of hydrogen gas bubbles. Thereupon the melt was cooled below its solidification temperature producing a foamed metal having a plurality of dispersed closed cells, substantially filled with hydrogen therein, and particles of vermiculite dispersed throughout the matrix of aluminum alloy.

Example 4

100 grams of an alloy composed of 3.5% magnesium and 96.5% of commercially pure aluminum, having a density of approximately 2.67 grams per cubic centimeter, was melted and maintained in the solid plus liquid plastic range while 7 grams of No. 4 grade expanded vermiculite, containing 4.8% water was mixed into the melt. The addition and mixing of the vermiculite into the molten aluminum alloy took place over a period of 4 minutes. After mixing, the melt was allowed to remain in the furnace for an additional 3 minutes at 1300° F. and then cooled below the solidus temperature. The resulting lightweight foamed alloy had a density of approximately 1.05 grams per cubic centimeter.

Example 5

20 grams of 5086 aluminum alloy having a density of 2.65 grams per cubic centimeter were cut into small crescent-shaped particles weighing about 0.08 gram each. These particles were then mixed with 0.65 gram of No. 4 grade vermiculite containing about 5% water. The aluminum-vermiculite mixture was then placed in a furnace which had been preheated to about 1180° F. and vigorously mixed as the temperature of the mixture rose above 1084° F. After the now plastic mixture had been stirred sufficiently to insure even distribution of the vermiculite throughout the melt, the mixture was allowed to remain in the furnace for an additional 3 minutes. It was then removed from the furnace for rapid air cooling below the solidus temperature. The foamed aluminum structure resulting had a density of approximately 1.3 grams per cubic centimeter.

Example 6

15 grams of magnesium particles were introduced into 60 grams of molten zinc. The temperature of the melt was adjusted to approximately 1040° F. and 8 ml. of 40-60 mesh vermiculite were introduced. The plastic mixture was then stirred sufficiently to insure even distribution of the vermiculite throughout the melt and allowed to foam for approximately 10 minutes. The foamed melt

was then cooled below its solidus temperature thereby forming a solid Zn-Mg foamed alloy.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the steps of the method described and the order of accomplishment without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

We claim:

1. A method of producing foamed metal wherein gaseous bubbles are retained within a mass of molten metal during the foaming, comprising the steps of:

heating a fusible metal and particles of a siliceous non-metallic aggregate above the solidus temperature of said metal, but below the liquidus temperature of said metal, whereby said solid aggregate dispersed within the molten metal decreases the normal fluidity of said molten metal;

introducing a substance which produces a gas when heated to the temperature of the melt into said melt; mixing said substances substantially throughout the melt, thereby producing a plurality of gas bubbles throughout said melt and forming a foamed melt, said gas being retained within said melt due principally to the high viscosity of said melt resulting from said dispersed aggregate particles; and cooling said foamed melt below the solidus temperature of said melt to form a foamed metal having a plurality of closed cells and particles of said non-metallic aggregate dispersed within a matrix of said fusible metal;

2. The method of claim 1 wherein said siliceous non-metallic aggregate particles are selected from the group consisting of vermiculite, perlite, talc, silica gel, pyrophyllite, mica and clintonite.

3. The method of claim 2 wherein said siliceous non-metallic aggregate particles are substantially anhydrous.

4. The method of claim 2 wherein said particles of siliceous non-metallic aggregate comprise less than 50% of said melt.

5. The method of claim 1 wherein said fusible metal is selected from the group consisting of aluminum, magnesium, zinc, lead, copper, nickel, and alloys of said metals.

6. The method of claim 5 wherein said fusible metal is an aluminum alloy.

7. The method of claim 5 wherein said fusible metal is a magnesium alloy.

8. The method of claim 1 wherein said molten metal wets said non-metallic aggregate.

9. A method of manufacturing a substantially rigid lightweight foamed metal alloy, comprising the steps of:

heating a fusible metal having a solidus temperature between 700° F. and 2000° F. to a temperature above the solidus temperature of said metal, thereby forming a plastic melt of said fusible metal, said metal containing at least one metallic alloying element that reacts with steam to form hydrogen;

introducing non-metallic water-carrying agent particles into said melt;

mixing said carrying agent particles into said melt between the solidus and liquidus temperatures of said melt to disperse said particles substantially uniformly throughout said melt;

maintaining the molten mixture at a temperature above the solidus temperature of said mixture until the water held by said carrying agent particles is released in the form of steam, said steam then reacting with said metal alloying element to produce a plurality of hydrogen bubbles throughout said melt, thereby forming a foamed molten melt; and

cooling the melt below its solidus temperature and entrapping said hydrogen bubbles within a matrix

of said fusible metal thereby forming a solid lightweight foamed metal comprising a solid fusible metal matrix, particles of an anhydrous carrying agent dispersed within said matrix, and a plurality of discrete closed cells within the solid fusible metal.

10. The method of claim 9 wherein said molten mixture is maintained between its solidus temperature and liquidus temperature during the release of said water from said carrying agent particles.

11. The method of claim 9 wherein said metal alloying element is selected from the group consisting of magnesium, iron, titanium, nickel, cobalt, tin, calcium, chromium, barium, manganese and strontium.

12. The method of claim 9 wherein said molten melt wets said water-carrying agent.

13. The method of claim 9 wherein said water-carrying agent particles are selected from the group consisting of vermiculite, perlite, talc, silica gel, pyrophyllite, mica and clintonite.

14. A method of manufacturing a substantially rigid lightweight foamed metal, comprising the steps of:

mixing particles of a fusible metal having a solidus temperature between 700° F. and 2000° F. with particles of a non-metallic water-carrying agent, said metal containing at least one metallic alloying element that reacts with steam to form hydrogen;

heating said mixture to a temperature above the solidus temperature of said fusible metal but below the fusion point of said water-carrying agent, thereby forming a plastic mass;

mixing said plastic mass between the solidus and liquidus temperatures of said mass until said carrying agent particles are dispersed substantially uniformly throughout said melt;

maintaining the molten mixture at a temperature above the solidus temperature of said mixture until the water held by said carrying agent particles is released in the form of steam, said steam then reacting with said metal alloy element to produce a plurality of hydrogen bubbles throughout said melt, thereby forming a foamed molten melt; and

cooling the melt below its solidus temperature and entrapping said hydrogen bubbles in the matrix of fusible metal, thereby forming a lightweight foamed metal comprising a solid fusible metal matrix, particles of an anhydrous carrying agent dispersed within said matrix, and a plurality of discrete closed cells within the solid fusible metal.

15. The method of claim 14 wherein said metallic alloying element is selected from the group consisting of magnesium, iron, titanium, nickel, cobalt, tin, calcium, chromium, manganese and strontium.

16. The method of claim 15 wherein the fusible metal melt wets said particles of non-metallic water-carrying agent.

17. The method of claim 15 wherein said water-carrying agent particles are selected from the group consisting of vermiculite, perlite, talc, silica gel, pyrophyllite, mica and clintonite.

18. In a method of producing a closed cell foamed metal whereby a gas-producing substance different from said metal is utilized to produce a plurality of randomly dispersed closed cells within a molten melt of said metal and said melt is then cooled below its solidus temperature to form a solid foamed metal comprising a solid metal matrix and a plurality of closed cells dispersed substantially therethroughout, the step of:

wetting dispersed particles of a solid non-metallic siliceous aggregate within said melt of said fusible metal at a temperature above the solidus temperature of said metal, but below the liquidus temperature of said metal and below the fusion temperature of said aggregate, whereby said dispersed solid aggregate decreases the normal fluidity of said molten metal, thereby increasing the gaseous retention prop-

erties of said melt for a period of time during subsequent foaming.

19. The method of claim 18 wherein said siliceous non-metallic aggregate particles are selected from the group consisting of vermiculite, perlite, talc, pyrophyllite, silica gel, mica and clintonite.

20. The method of claim 19 wherein said siliceous non-metallic aggregate particles are substantially anhydrous.

21. The method of claim 18 wherein said particles of siliceous non-metallic aggregate comprise less than 50% of said melt by volume.

22. In a method of manufacturing a substantially rigid lightweight foamed metal wherein a molten melt of fusible metal at a temperature above the solidus temperature of said metal is foamed by the dispersion of gaseous bubbles therethrough and the melt is then cooled below its solidus temperature whereby said gaseous bubbles are entrapped within a matrix of fusible metal, thereby forming a solid lightweight foamed metal comprising a solid fusible metal matrix and a plurality of discrete closed cells dispersed within said matrix, the steps comprising:

adding particles of a gas-producing substance which chemically reacts with at least one component of said molten melt in an oxidation-reduction reaction to form a gas;

mixing said particles into said melt between the solidus and liquidus temperatures of said melt to wet and disperse said particles substantially uniformly throughout said melt; and

maintaining the molten mixture above the solidus temperature of said mixture while a chemical oxidation-reduction reaction occurs between said particles and said component of said melt to produce said gaseous bubbles, thereby foaming said melt.

23. The method of claim 22 wherein said oxidation-reduction reaction produces hydrogen gas bubbles.

24. The method of claim 23 wherein said hydrogen gas bubbles are produced by an oxidation-reduction reaction between steam and said component.

25. The method of claim 24 wherein said component is a metallic element selected from the group consisting of magnesium, iron, titanium, nickel, cobalt, tin, calcium, barium, chromium, manganese and strontium.

26. The method of claim 24 wherein said gas-producing substance is a water-carrying non-metallic inorganic chemical.

27. A metal foam body, comprising:
a metal matrix having dispersed therethrough a plurality of completely closed cells substantially filled with gas;

and solid non-metallic siliceous particles dispersed within said matrix wherein said solid non-metallic siliceous particles comprise less than 50 weight percent of said foam body.

28. The foam body of claim 27 wherein said gas is hydrogen.

29. The foam body of claim 27 wherein said siliceous particles are selected from the group consisting of vermiculite, perlite, talc, silica gel, pyrophyllite, mica and clintonite.

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BENJAMIN HENKIN, *Primary Examiner*.