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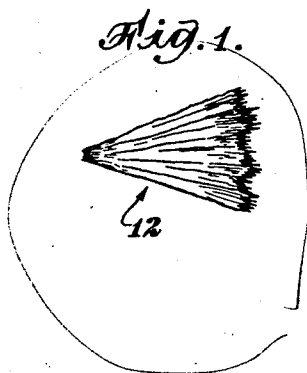
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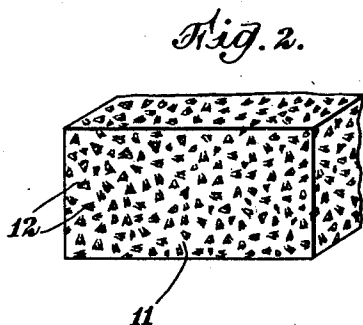
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ARTICLE OF MANUFACTURE AND METHOD OF MAKING THE SAME

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Expanded
Pyrophyllite



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ARTICLE OF MANUFACTURE AND METHOD OF MAKING THE SAME

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This invention relates to an article of manufacture and the method of making the same, particularly, to an article adapted for use as thermal insulation.

It is an object of the invention to provide thermal insulation that may be used without objectionable shrinkage at very high temperatures. Another object is to provide a method of making such a product. Other objects and advantages will appear from the detailed description that follows.

In the preferred embodiment, the invention comprises particles of expanded radial pyrophyllite and a strengthening and binding agent associated with the exterior of the said particles and not only bonding them together into a unitary article but also strengthening the particles at their exterior surfaces. The invention comprises, also, the method of making suitable expanded particles of pyrophyllite and bonded units therefrom, including forming individual rosettes constituted each of a plurality of crystals meeting at a common point within the rosette and then quickly heating the rosettes, to cause expansion, with retention in a substantial proportion of the expanded particles of the meeting point between the resulting flakes of a more or less fan-like but usually somewhat ruptured structure.

The term "rosette" is used herein to describe fan-like foliae or crystal aggregates of radial lamellar pyrophyllite.

A preferred embodiment of the invention is illustrated in the attached drawing and will be described in connection therewith.

Fig. 1 shows a view, partly diagrammatic, of an expanded fragment of a rosette or particle of radial pyrophyllite.

Fig. 2 shows a perspective view of a portion of a shaped composition or article including particles of expanded radial pyrophyllite and a strengthening and binding agent associated therewith.

In the structure shown in Fig. 2, the strengthening and binding agent 11 is adhered to the particles 12 of expanded pyrophyllite, extends between the particles, strengthens the otherwise friable flakes in the exterior portion thereof, and bonds the particles into a unitary product.

In making particles such as shown in Fig. 1, there is first provided pyrophyllite of radial arrangement of the crystals therein. Such a material is available in the form of crystal aggregates, which are radiated lamellar in construction and which occur nearly pure or may be mixed with some non-radial or massive pyrophyllite

with some gangue minerals such as quartz or the like. It is then granulated or otherwise reduced predominantly to individual crystal aggregates (rosettes) constituted of a plurality of crystals meeting largely at approximately a common point within the rosette, preferably, near the center thereof. Thus, pyrophyllite rock may be crushed and then passed through spaced rollers to reduce the material largely to the size of 8-mesh and finer, but to avoid the formation of any substantial amount of fine powder. The reduced material may then be screened, oversize particles being returned to the rollers and excessively fine material discarded, to give, for instance, a fraction that is largely between 8 and 24-mesh.

The rosettes so obtained are then subjected to a sudden rise in temperature to the point of rapid evolution of water-vapor, corresponding to water present originally as water of hydration or constitution within the crystals. Thus, the rosettes may be allowed to fall into a thin layer on the floor of a muffle furnace or rotary kiln at a bright red or almost white heat, down an inclined furnace, or through a baffled vertical furnace, so that the granules are quickly brought to a temperature of the order of 1,900 to 2,000° F. There has been used to advantage a calcination period of total extent not exceeding about three minutes, preferably, two minutes or less, from the time of charging of the rosettes into the calcination zone up to and including the moment of discharge therefrom.

A suitable furnace is one that is inclined and has a draft of gas rising at moderate speed therethrough. This draft floats away the expanded particles, thus removing these particles before they are injured by excessively long exposure to the temperature of calcination, while permitting continuation of calcination of the particles yet to be expanded.

I have found that the size of crystal aggregate or rosette submitted to the calcination, for the purpose of causing expansion, should be controlled within critical limits. Use of rosettes that are larger or smaller than the critical size increases the density of the calcined product beyond the densities that are most satisfactory for thermal insulating purposes.

The critical relationship of the size of particles and the density of the resulting expanded pyrophyllite is illustrated in the following table, the first figure in the first column showing the mesh of finest screen through which all of the particles pass and the second figure showing the

mesh of screen upon which the particles are retained.

Screen size of rosettes charged to the furnace	Overall density of expanded material, pounds per cubic foot
1-2	16
3-4	10
6-8	9
8-10	7
10-20	7
20-40	8
Finer than 60	19

It will be seen that material in the range 6 to 60-mesh is particularly desirable.

In general, the size of aggregate or rosette calcined should have an approximate diameter of about $\frac{1}{2}$ to 1 times the length of the average individual crystal in the aggregate. Thus, the aggregates containing crystals averaging in length about 0.1 inch give the lowest overall density of calcined particles when the original aggregates are between 10 and 24 mesh in screen size, whereas aggregates containing crystals of average length about 0.05 inch give the lowest density of calcined product when the original aggregates are 20 to 24 mesh in screen size.

The temperature of calcination should be about 1,900 to 2,000° F., preferably 1,950 to 2,000° F. Temperatures substantially below this range do not cause complete expansion. Exposure of the pyrophyllite to temperatures substantially above 2,000° F. leads to progressive and undesirable embrittlement of the expanded material.

The expanded rosettes are so light that they may be suspended in a stream of air, for the purpose of air classification. They contain individual flakes or laminae extending generally in approximately fan-shape from a common point, although it is to be understood that many of the particles are broken and may show only a partial fan structure. The individual flakes are frequently curved or feather-like and define between themselves very fine pore spaces or voids.

The expanded rosettes or particles are particularly effective in thermal insulation. Also, they are resistant to very high temperatures, so that they may be used to provide insulation at temperatures of 2,500° F. or higher. On the other hand, the expanded particles are quite soft and friable and, for this reason, the particles are preferably strengthened before use by a material that is adhered to the exterior portions at least of the particles.

The general method of making a strengthened and bonded article including particles of expanded pyrophyllite comprises mixing the particles gently with a hardenable material adapted to strengthen the exterior of the particles and to bond the particles together, shaping the resulting mixture and then hardening the strengthening and binding agent therein. Thus, there may be formed a mixture of the said particles, water, clay and/or bentonite, the proportions of the several ingredients used depending upon the properties desired in the finished product. For instance, there may be used 25 to 75 parts by weight of the particles of expanded radial pyrophyllite for 75 to 25 parts of a fireclay of moderately high maturing temperature, along with water in proportion to give the consistency desired for shaping. For dry-press shaping of the composition, there has been used water in the proportion of 100 to 150 parts by weight to 100 parts of pyrophyllite and clay.

The composition is shaped at relatively low pressure to avoid crushing the particles of pyrophyllite. The shaped article is then dried and fired to a temperature of 2500° F., more or less, in order to strengthen the particles of pyrophyllite at the zones of adherence or contact with the clay binder and to develop a ceramic bond in the said binder. The temperature of firing should be at least as high as within a hundred degrees or so of the maximum temperature to which the product is to be subjected during use.

Bricks have been so made of overall density of 20 to 40 pounds to the cubic foot, the exact density depending to a large extent upon the relative proportions of binder and lightweight particles used.

In order to make a fired article that is of minimized spalling tendency, the ceramic binder, in the finished article, should be non-glassy, yet strong, this condition being produced by selecting the binder and firing, as described above, at a temperature well below the liquefaction point of the clay or binder mixture. Suitable clays of moderately high maturing point are Kentucky #6, Manning Black, and some New Jersey clays.

In making a plastic cement suitable for use as a thermal insulating layer upon furnaces or the like, there may be formed a mixture of particles of expanded pyrophyllite, clay and/or bentonite, skeletonizing fibres of asbestos or the like, various plasticizing agents such as karaya gum, and/or a hydraulic cementitious material. Soap bark in small proportion may be used to increase the plasticity and promote emulsification of air bubbles on frothing or mixing. Before use the composition is mixed with water to a plastic consistency. It is then applied as, for example, by trowelling, to the equipment to be insulated.

Typical insulating cement compositions are as follows:

Formula No. 1

	Parts by weight
Expanded pyrophyllite	55
Short fibres of chrysotile asbestos	25
Bentonite	18
Soap bark	1
Karaya gum	$\frac{1}{2}$

Formula No. 2

	Parts by weight
Expanded pyrophyllite	55
Ground diaspore	20
Rex bentonite	10
Asbestos fibres, moderately long chrysotile	5
Calcined grog through 80-mesh	10
Karaya gum	$\frac{1}{2}$

The proportion of water used is illustrated by the fact that Formula No. 2 was used satisfactorily with about 150 parts by weight of water.

When a hydraulic cementitious material is used in connection with expanded pyrophyllite, the said material is suitably Portland cement or a calcium aluminate cement. Plaster may be used for skeletonizing effect during the shaping of a composition, including expanded pyrophyllite and a binder, or used at a low temperature.

The particles of expanded pyrophyllite are adapted to absorb incident sound. If used for sound absorption in a bonded article, the binder therein should be porous or should be used in such small quantities as not to close all spaces between the particles against the entrance of sound.

It will be understood that the details given are for the purpose of illustration, not restriction,

and that variations within the spirit of the invention are intended to be included in the scope of the appended claims.

What I claim is:

5 1. An article of manufacture comprising particles of expanded radial pyrophyllite predominantly of a size between 6 and 60 mesh and a strengthening and binding agent bonding the said particles into a unitary product and adher-
10 ing to the individual spaced laminae of the expanded pyrophyllite.

2. A thermal insulating article comprising spaced particles of expanded radial pyrophyllite predominantly of a size between 6 and 60 mesh
15 and a strengthening and binding agent adhered to the said particles, extending therebetween, and bonding the said particles into a unitary product, the strengthening and binding agent including clay in fired, non-glassy, but strong con-
20 dition.

3. A thermal insulating article comprising spaced particles of expanded radial pyrophyllite predominantly of a size between 6 and 60 mesh
25 and a strengthening and binding agent adhered to the said particles, extending therebetween, and bonding the said particles into a unitary product, the binder including a hydraulic cementitious material in set condition.

4. An insulating cement comprising particles
30 of expanded radial pyrophyllite predominantly of a size between 6 and 60 mesh, asbestos fibres, and a heat-resistant binder composition.

5. An article of manufacture comprising spaced particles of expanded radial pyrophyllite
35 predominantly of a size between 6 and 60 mesh and a strengthening and binding agent adhered to the said particles, extending therebetween, and bonding the said particles into a unitary product, the stiffening and binding agent including a mixture of clay, bentonite, and asbestos
40 fibres.

6. In making expanded pyrophyllite, the method which comprises forming radial pyrophyllite

into rosettes, constituted individually of a plurality of crystals meeting at a point within the rosette and extending generally radially therefrom, and subjecting the rosettes to a sudden rise
5 in temperature adapted to expel quickly water-vapor therefrom and produce thorough expansion, with the development of voids between the said crystals.

7. The method of making a bonded lightweight article which comprises forming a mixture of
10 particles of expanded pyrophyllite predominantly of a size between 6 and 60 mesh, containing each spaced laminae extending generally in approximately fan-shape from a common point, and a hardenable binder composition, shaping the re-
15 sulting mixture with preservation of the spacing of the laminae, and then hardening the binder composition.

8. In making expanded pyrophyllite, the method which comprises forming radial pyrophyllite
20 into rosettes, containing each a plurality of crystals and being predominantly of size between 6 and 60 mesh, and subjecting the rosettes to a sudden rise in temperature adapted to expel quickly water-vapor therefrom and produce
25 thorough expansion, with the development of voids between the said crystals.

9. In making expanded pyrophyllite, the method which comprises forming radial pyrophyllite
30 into rosettes predominantly of size between 6 and 60 mesh, subjecting the rosettes to a sudden rise in temperature to 1,900 to 2,000° F. and then quickly removing the resulting expanded material from exposure to the said temperature.

10. In making expanded pyrophyllite, the
35 method which comprises forming radial pyrophyllite into rosettes predominantly of size between 6 and 60 mesh, subjecting the rosettes to a sudden rise in temperature to 1,900 to 2,000° F. and then quickly removing the resulting ex-
40 expanded material, by air separation, from unexpanded rosettes.

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