

[54] **SYNTHETIC LIGHT-WEIGHT MATERIAL  
AND PROCESS AND SYSTEM FOR  
MANUFACTURING SAME**

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[51] Int. Cl. .... **C08h 17/04**

[58] Field of Search .... **106/288 B, 75, 76,  
106/309, 40 R, 40 V; 423/332; 264/43**

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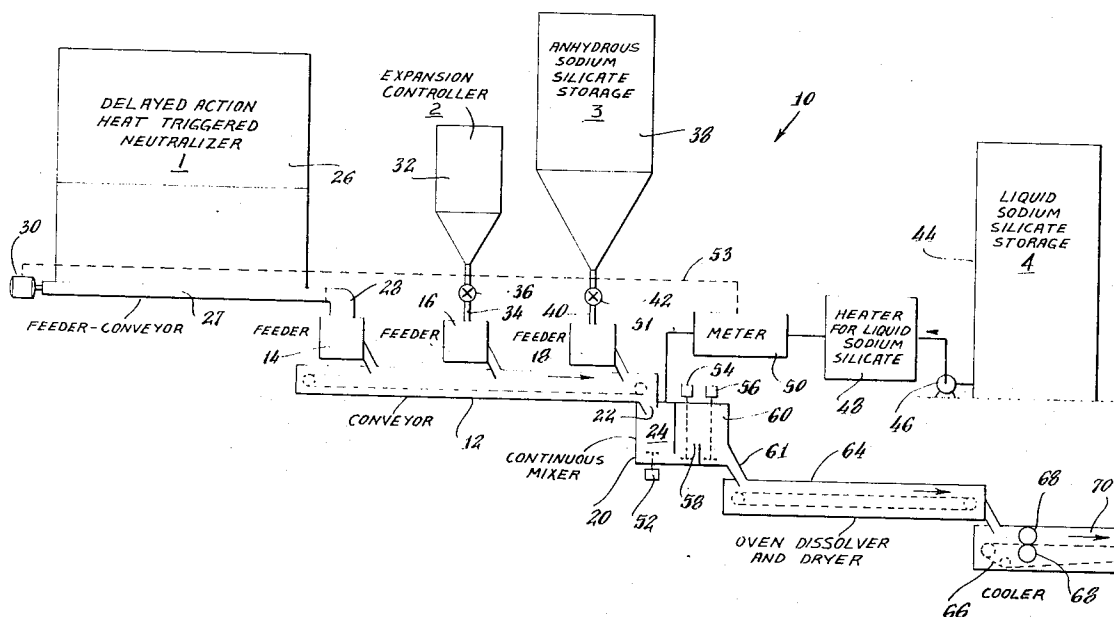
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**ABSTRACT**

Synthetic light-weight material suitable for use in building, construction, building products, packaging, insulation, soil conditioning, and the like, formed of four ingredients in selective quantities depending upon the desired bulk density of the final product, the four ingredients being a delayed-action, heat-triggered neutralizer, an expander controller, anhydrous sodium silicate, and liquid sodium silicate; the expander controller being omittable when extremely light bulk density of less than about 1.5 lb. per cu. ft. is desired. In one final form, the particles are extremely expanded to a low bulk density for use as a very light-weight aggregate for mixture with cement to form light building blocks, having excellent sound-absorbing characteristics, to form fire-resistant partitions, and fire-resistant or sound-absorbent coatings. In another form, the bulk density of the particle aggregate is retained at a high value for ease and economy of shipment to the user's site where it is subsequently passed through a heat expansion to drastically reduce its density to the desired low value for use. The process steps and system of equipment enable the amount of expander controller utilized to be varied dependent upon the severity of the subsequent aggregate-cement mixing so that the light particles are resistant to abrasive and commingling treatment during the mixing.

**13 Claims, 6 Drawing Figures**



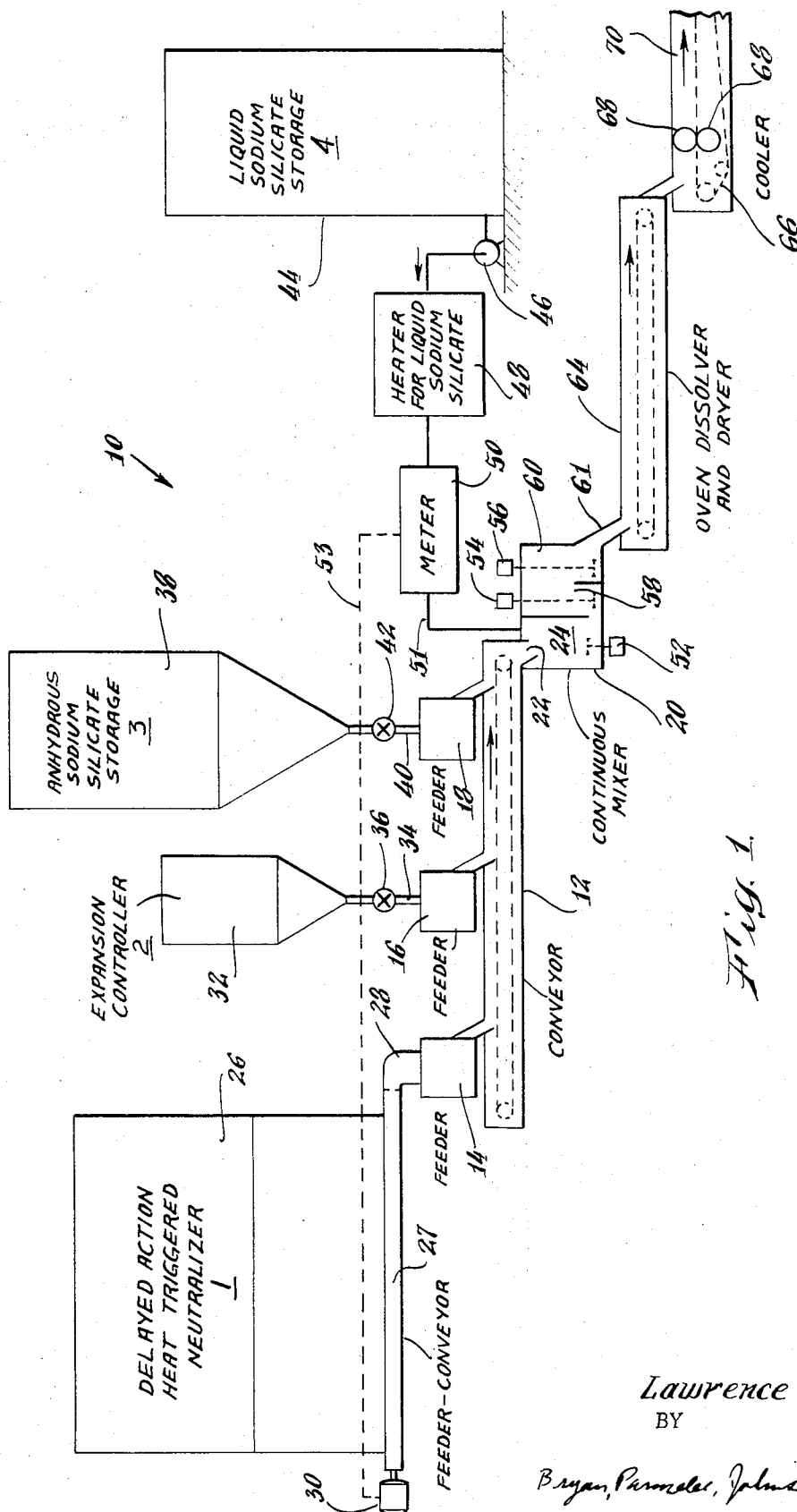
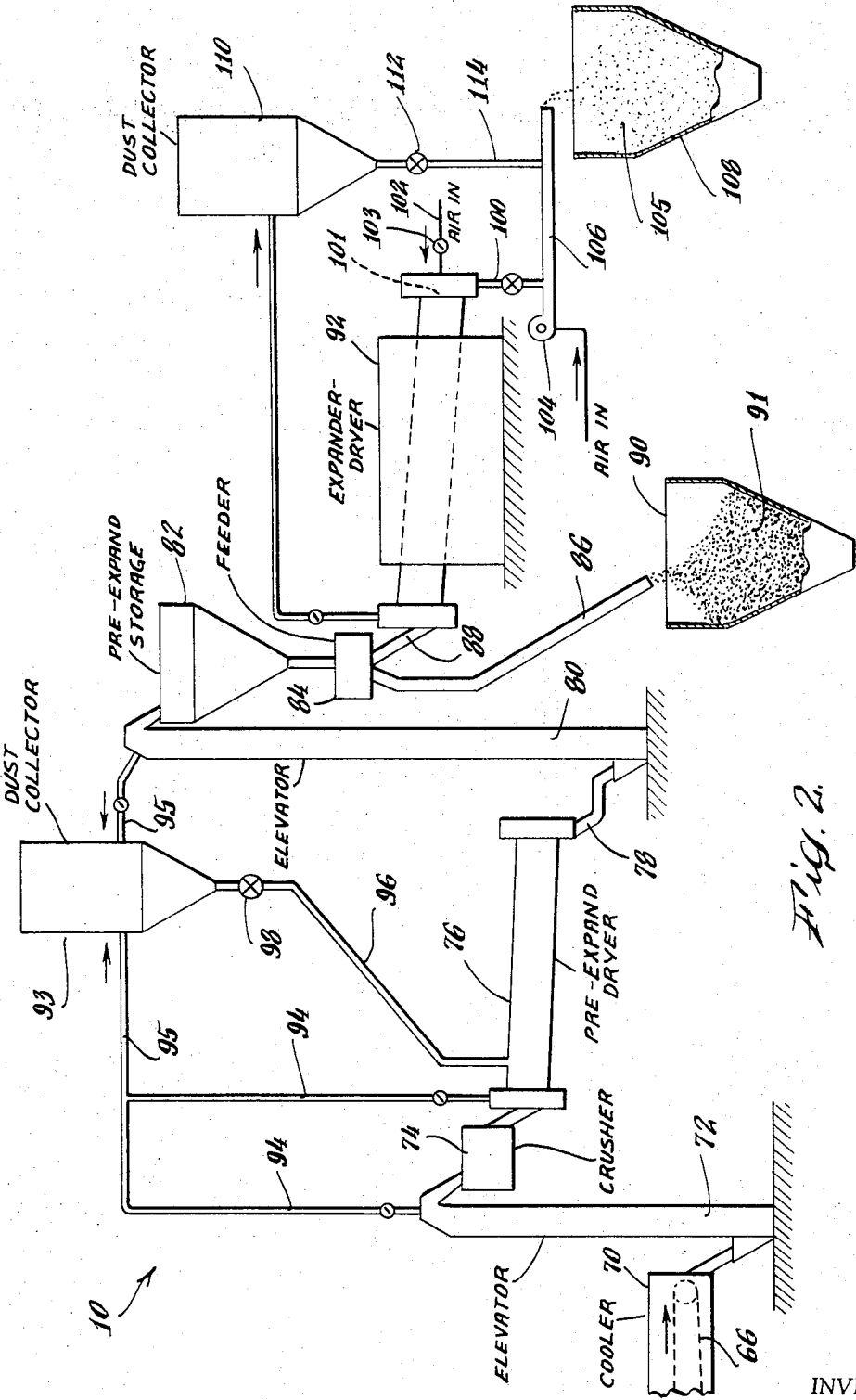


Fig. 1.

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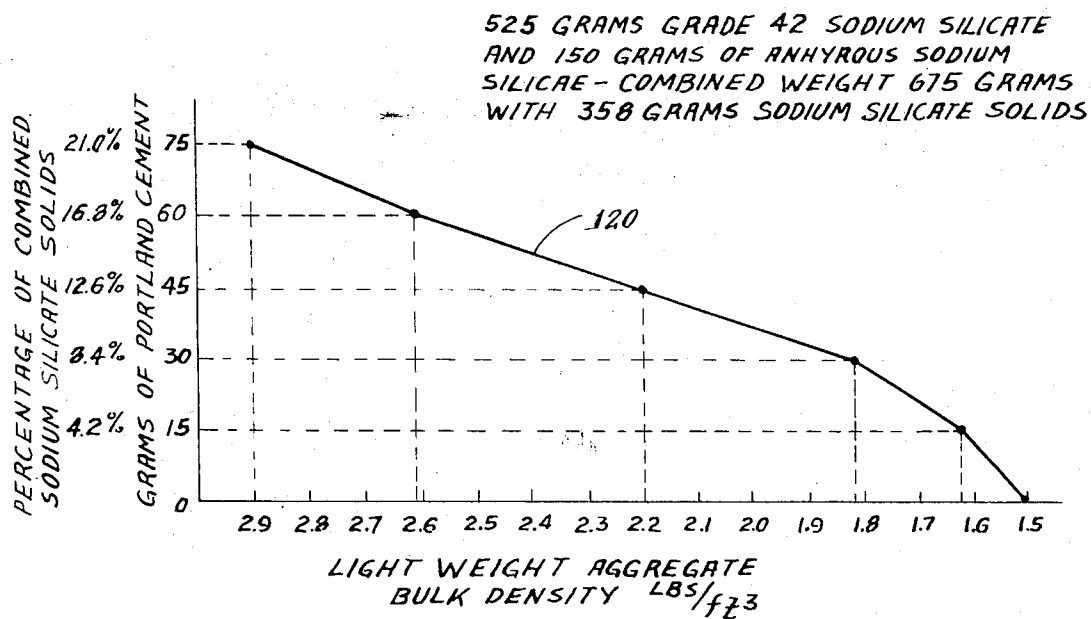


Fig. 3.

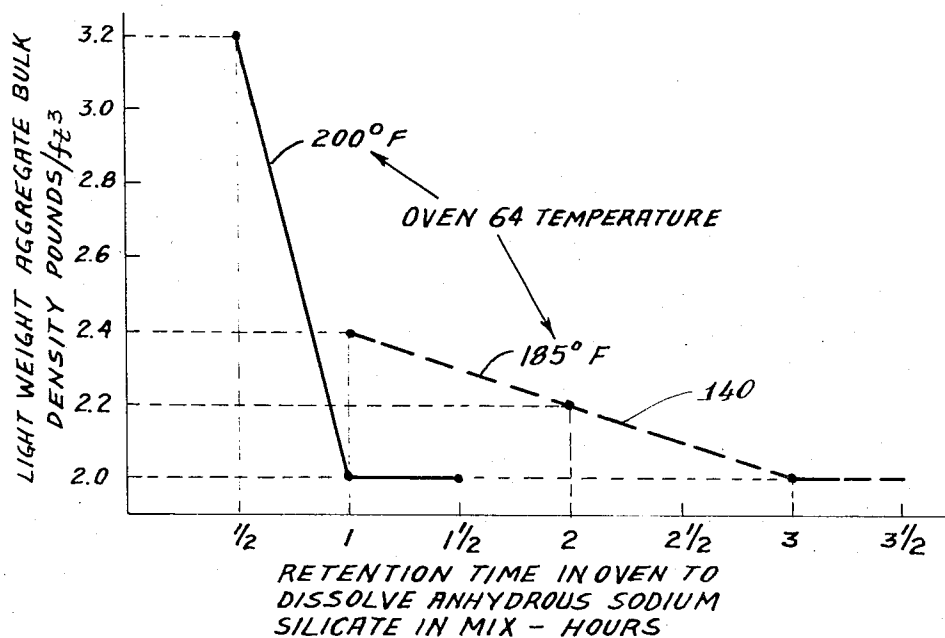


Fig. 4.

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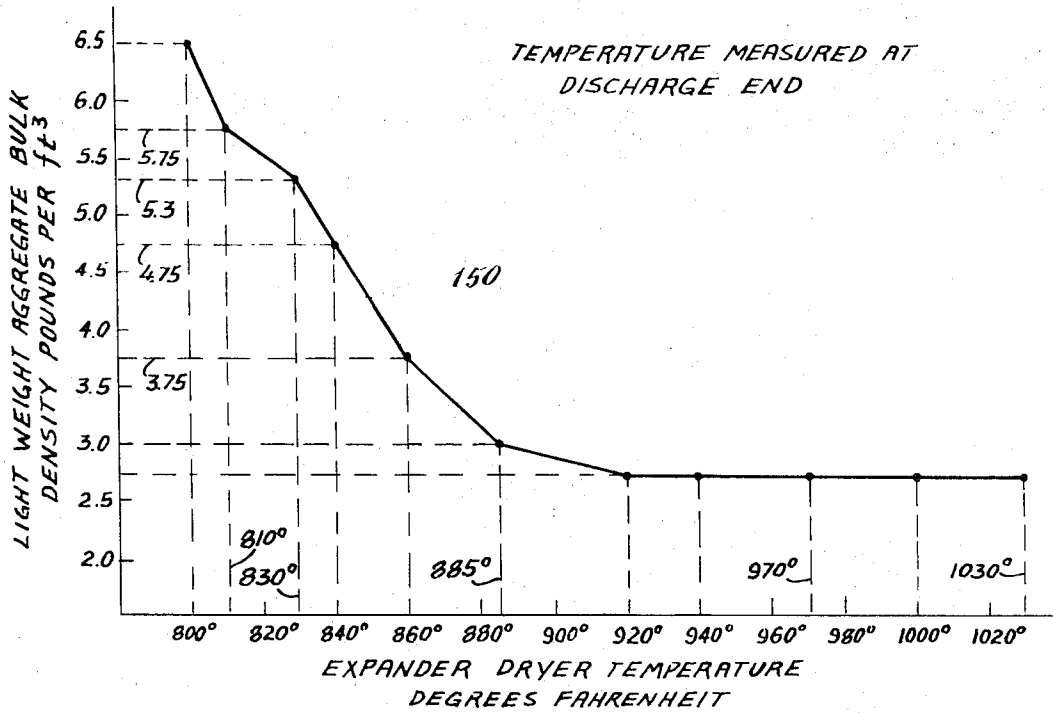


Fig. 5.

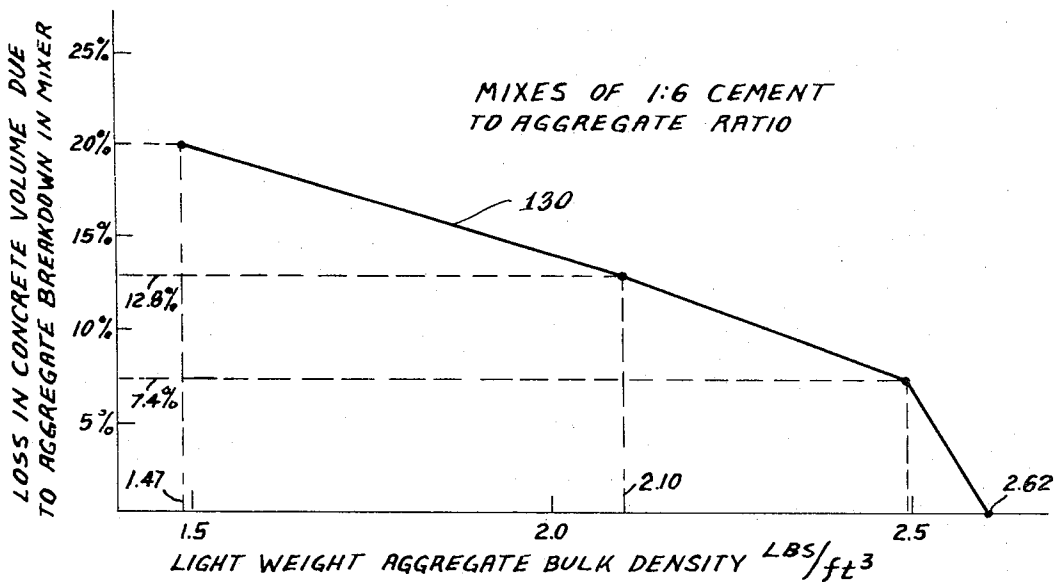


Fig. 6.

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# SYNTHETIC LIGHT-WEIGHT MATERIAL AND PROCESS AND SYSTEM FOR MANUFACTURING SAME

This invention relates to a synthetic light-weight material suitable for use in building, construction, building products, packaging, insulation, soil conditioning, and the like, and also to a process and system for manufacturing the light-weight material.

A light-weight material in accordance with the invention is formed of four ingredients in selective quantities depending upon the desired bulk density of the final product. These ingredients are a delayed-action, heat-triggered neutralizer such as granular boric acid, an expander controller for selecting bulk densities, such as Portland cement, anhydrous sodium silicate and liquid sodium silicate. These ingredients are combined and reacted in an advantageous process to form an inert and boiling-water-proof particle aggregate in selected final states. The expander controller may be omitted when extremely light bulk density of less than about 1.5 lbs. per cu. ft. is desired.

In one final form of the particle material, the particles are extremely expanded so that their bulk density is reduced to a low value for advantageous use as a very light-weight aggregate filler for cement. The particle aggregate may be mixed with Portland cement and the like to form structures such as building blocks for sound proofing, or partition walls, or to form fire-resistant partitions.

In another final form of the particle material, the bulk density is retained at a relatively high value for ease and economy of shipment to the site where it is to be used. The bulk material is then passed through a heat expansion at the site of intended use to drastically reduce its density to the desired low value for use.

When the particle aggregate is employed for use as a filler with cement, it is desirable to control the final bulk density to a level where mixture in conventional cement-forming apparatus does not introduce undue particle aggregate disintegration. In the method of preparing the particle aggregates of this invention, an expander controller material is added to advantageously select and maintain particle aggregate bulk densities to levels where the particles are resistant to abrasive and commingling treatment.

The particle material is particularly adaptable for shipment in pre-expanded dense bulk form to the user's site, where expansion into a low bulk density aggregate may be performed. The particle material has been subjected to a pre-expansion drying process to stabilize the surfaces of the particles such that they can be stored together for weeks, if desired, without coalescing so as to preserve the particle condition of the bulk aggregate. In this pre-expanded state, the particle aggregate includes sufficient free sodium silicate to complete expansion to desired low bulk density levels. In addition, the boric acid is retained in a form which effectively inhibits its neutralizing effect until the final expansion of the particle aggregate. Upon final expansion of the particle aggregate, substantially all of the sodium silicate has been dissolved and the light-weight aggregate neutralized. The boric acid operates as a delayed-action, heat-triggered neutralizer.

In a described process and system for manufacturing the particle aggregate material in accordance with the invention, ingredients of boric acid, Portland cement,

anhydrous sodium silicate and heated liquid sodium silicate are thoroughly blended to form a homogeneous viscous liquid mass. The liquid mass is then passed into an oven whose primary purpose is to dissolve the anhydrous sodium silicate, also some of the water is driven off to produce drying. With the water content in the mass reduced to a desired level, the homogeneous mass is passed between rollers for formation into a thin strip. The thin strip is cooled followed by crushing into small particles. The small particles are heated and pre-expanded dried to form a stable particle material which may be transported to on-site locations where further expansion into the light-weight particle material is obtained as desired for final usage.

The delayed-action, heat-triggered neutralizer advantageously remains dormant until it goes into operation during the final on-site expansion and reduction in density of the particle material. The particle material retains sufficient free sodium silicate to expand into light-weight particles while the delayed-action neutralizer operates to neutralize the resulting light-weight particles. On-site formed light-weight particle material may then be conveniently employed in a variety of ways with cement and the like for formation of building materials, blocks, sound-absorbent partitions, and the like, or may be used loosely as a thermal and acoustical insulation.

Light-weight particle material is obtained with a system in accordance with the invention by passing the small particles into an expander dryer. The small particles are subjected to heat in the expander for a time period sufficient to fully expand the particles to their maximum volume. Substantially no free sodium silicate remains in the resultant light-weight particles which are fully neutralized.

The various aspects, advantages and objects of the process and system for forming a light-weight material, in accordance with the invention, will be understood from the following description in conjunction with the drawings, wherein:

FIG. 1 is a schematic process and system diagram of the first part of a process and system for forming a light-weight material in accordance with the invention;

FIG. 2 is a schematic diagram of the remaining part of the process and system for forming a light-weight material in accordance with the invention;

FIG. 3 is a graphical plot showing the effect of the expander controller on the bulk density of the light-weight material;

FIG. 4 is a graphical plot of oven temperatures and retention times for dissolving anhydrous sodium silicates in the homogeneous mass obtained from the mixer;

FIG. 5 is a graphical plot showing the effect of the temperature of the expander dryer oven on the bulk density of the material; and

FIG. 6 is a graphical plot representative of the effect on bulk densities of the light-weight material when the light-weight material is used as a filler for cement.

With reference to FIGS. 1 and 2, a process and system 10 for manufacturing synthetic light-weight particle material, in accordance with the invention, is illustrated; the material being well suited for use in building, construction, building products, packaging, insulation, soil conditioning, and the like. A conveyor 12, illustrated as a belt conveyor, extends below feeders 14, 16 and 18 which are respectively supplied with a

delayed-action, heat-triggered neutralizer material 1, an aggregate expansion controller material 2, and anhydrous sodium silicate 3. These materials are delivered by the conveyor 12 to a continuously running mixer 20 through an opening 22 feeding into a first mixer compartment 24. A supply of heated liquid sodium silicate 4 is supplied to the first compartment 24 and is thoroughly mixed with the dry materials from the conveyor 12.

The delayed-action, heat-triggered neutralizer material 1, which preferably is in the form of granular boric acid, is stored in a hopper bin 26 and is fed by a conveyor 27, such as a screw feeder, to the feeder 14, passing through a conduit 28. The rate of feed is controlled by a controllable speed drive motor 30 having speed reduction gearing connected to the screw feeder 27. The aggregate expansion controller material 2 is preferably in the form of dry Portland cement which is stored in a bin 32 and is gravity-fed down to the feeder 16 through a conduit 34 and a flow control valve 36. A supply of anhydrous sodium silicate 3 is stored in a bin 38 and is gravity-fed down to the feeder 18 through a conduit 40 and a flow control valve 42.

The liquid sodium silicate 4 is stored in a tank 44 and drawn therefrom by a pump 46 which drives the liquid through a heater 48 and a metering device 50 connected by a pipe 51 to the compartment 24 in the mixer 20. The metering device 50 controls the supply of the other materials as is indicated by the dashed control line 53 interconnecting this metering device 50 with the flow control valves 36 and 42, and with the controllable speed drive 30.

The mixer 20 defines a mixing zone and performs a vigorous mixing action to thoroughly blend the several materials into a homogeneous viscous mass by means of high speed shear type rotary blenders 52, 54 and 56, respectively, located in interconnected compartments 24, 58 and 60. The material is mixed long enough so that solids will not settle out when the resulting viscous homogeneous mass is put in the oven, i.e., such that it will remain a homogeneous mass. If the material is left too long in the mixer 20, then it becomes such a thickened viscous plastic material that it is very difficult to remove from the mixer.

The viscous but still liquid homogeneous mass is permitted to drain through an outlet line 61 onto a conveyor belt 62 passing through an oven dissolver 64. At the end of this dissolving and drying curing cycle the anhydrous sodium silicate is fully dissolved in the homogeneous mass. As the mass comes out of the oven 64, it is in a plastic state; that is, it is stretchable, being preferably at a temperature of about 180° to 200° F. The preferred oven temperature is about 190° to 210° F (see FIG. 4). Advantageously, as soon as the material becomes cooled to room temperature, it is of a composition such that it will become friable and crushable. The plastic mass is delivered onto a cooling conveyor 66 which delivers this mass to a pair of rollers 68 which shape the mass into a thin ribbon strip which can be quickly cooled. The conveyor 66 passes through a cooler 70 to cool the strip into a thin cake in an easily crushable friable state.

As illustrated in FIG. 2, conveyor 66 delivers the strip of caked material to an elevator 72 which raises the easily crushable friable material up to feed into a crusher 74. Crusher 74 reduces the crushable material

into small particles and delivers these to a pre-expander dryer 76.

The particles in the pre-expander dryer are subjected to a quick partial drying which is selected to effectively stabilize their external surfaces. Hence, when the particles emerge from the pre-expander dryer 76 at conduit 78, they may have attained a slight partial expansion and yet they retain a sufficient bulk density for convenient shipment to other locations where expansion can be completed. The surface stabilization of the particles during this preexpansion drying step advantageously prevents the individual particles from re-coalescing into a homogeneous mass while they are stored in hoppers at 82 or 90, or in other containers for transportation to remote locations. Such storage may continue for several weeks, if desired.

The pre-expanded particle material is fed through conduit 78 to an elevator 80 which raises the particles up to an elevated storage hopper 82. The storage hopper 82 supplies the pre-expanded particle material to a feeder 84 which is operatively connected by conduits 86 and 88, respectively, to a storage bin 90 and to an expander dryer 92.

The stabilized pre-expanded particles 91 in the storage bin 90 are ready for shipment to any desired user's site, which is equipped to expand them into their final light-weight particle form. Alternately, the particles are fed from the feeder 84 through the duct 88 into the expander dryer 92 where the final expansion takes place.

Dust formed in the elevator 72 and at the output of the crusher 74 as well as in the elevator 80 is drawn up into a dust collector 93 through suitable conduits 94 and manifolds 95, and the collector 93 may return the dust to the input of the pre-expansion dryer 76 by means of a conduit 96 under control of a flow control valve 98.

The expander dryer 92 preferably is in the form of a rotary calciner which is downwardly inclined to pass the particles under gravity feed action to the discharge conduit 100. Heated air at elevated temperatures is supplied to the expander dryer 92 through a supply line 102 and a control valve 103.

The fully expanded light-weight particle aggregate 105 is withdrawn from the rotary calciner 92 by entrainment with a flow of air from an air blower 104 driving air through a conduit 106 connected to the discharge conduit 100. The light-weight aggregate 105 is blown through the duct 106 into a storage bin 108. Dust is drawn from the input to the expander dryer 92 through a conduit 94 to a dust collector 110 which serves to return the collected material to the light-weight aggregate stream in conduit 106 through a flow control valve 112 and a conduit 114.

In the event that particle aggregate 91 is removed from the system before complete expansion in the expander dryer 92, the expansion is completed using an expander dryer, such as that described, located at the user's site where the light-weight particle aggregate is to be utilized.

In one example of the manufacture of light-weight aggregate in accordance with the invention, a delayed-action, heat-triggered neutralizer material 1 in the form of granular boric acid was used. The expansion controller 2 utilized was Portland cement. Thirty grams of granular boric acid was combined with 45 grams of Portland cement and with 150 grams of anhydrous sodium silicate 3 composed of 3.22 parts of sodium oxide

( $\text{Na}_2\text{O}$ ) by weight to one part of silicon oxide ( $\text{Si}_2\text{O}_3$ ). These ingredients were thoroughly mixed with 525 grams of preheated liquid sodium silicate (water glass) 4 of 42° Baume-rating. The liquid sodium silicate was preheated to a temperature of approximately 180° F., at which temperature it was mixed with the other ingredients and thoroughly blended by hi-shear mixing action into a homogeneous slurry-like mass with the solid materials sufficiently dispersed so that they will not settle out during the subsequent steps of the process.

After mixing, the homogeneous mass in the mixer outlet 61 was passed through an oven 64 having a temperature below the boiling point of water but sufficiently high to dissolve the anhydrous sodium silicate. Preferably, the temperature in the oven was maintained at about 200° F., and the homogeneous mass was retained in the oven for a period of about one hour during which the material gelled into a plastic stretchable state indicative that the anhydrous sodium silicate was dissolved. This retention time of one hour produces a gelled mass which is capable of the desired full expansion later on (see FIG. 4). The temperature in the oven 64 is carefully controlled to remain below the boiling temperature 212° F. so that boiling of the water in the sodium silicate is carefully avoided to prevent foaming and separation of the sodium silicate solids and the liquid sodium silicate. If desired, the temperature of the oven 64 can be reduced to 180° F., but then the retention time must be increased to about 2 hours to produce a gelled mass which is capable of the desired full expansion, as described. A reduction of the oven temperature to 160° F. required approximately a 4 hour retention time to reach the desired results, thus approximately 200° F. is preferred, i.e., between 190° F. and 210° F. because this range produces the desired results in the least time.

After oven treatment, the homogeneous mass is cooled to a friable and crushable state. Preferably as described with reference to FIG. 1, the homogeneous oven heated mass is flattened into thin cake whose large surface area enables an efficient cooling until the mass is friable and easily crushed.

After such cooling of the homogeneous mass to a friable and easily crushed state, it was broken into small particles having a size of approximately one thirty-second to one-eighth of an inch in diameter, preferably being about one-sixteenth of an inch in diameter. These particles were then partially dried in an oven dryer 76 which subjected the particles to a turbulent, heated air stream at a temperature of about 350° to 400° F. for a time period measured in minutes. A four minute retention of the crushed particles in the preexpander dryer was sufficient to stabilize the surfaces of the individual particles and prevent their coalescing together or agglomerating together after being packaged for shipment. This heating step may be accompanied by a partial expansion of the particles to form a pre-expanded particle material 91 having a bulk density of the order of about 67 pounds per cubic foot.

A particular pre-expander which has been used to advantage include a metal bed plate on which the particles are agitated and containing numerous small holes one-eighth of an inch to three thirty-second of an inch in diameter up through which the hot air is blown.

A substantial proportion of the particle material 91 is in the form of moisture being approximately 30 percent by weight. Completion of the particle expansion

may be performed at a remote user's location or may be performed at the particle manufacturing site, as illustrated in FIG. 2.

Full expansion of the particles was obtained by passing them through an expander dryer 92 wherein the particles were turbulently exposed to heated air of a temperature generally in the range between 880° and 1,100° F., and preferably between 880° and 1,020° F. (See FIG. 5). The particles were retained in the expander dryer for about 5 to 20 minutes.

During this expansion heating and drying step most of the moisture was driven off and the particles were expanded to their maximum volume to form a light-weight particle having a bulk density of about 2.62 pounds per cubic foot with the moisture content generally less than 10 percent by weight.

The fully expanded particle material became fully neutralized during this high temperature expansion, and very little free sodium silicate remained. The fully expanded particles exhibited a cellular structure with the individual cells being closed and isolated one from another to form light, buoyant, water insoluble, and water impervious particles.

The light-weight aggregate of 2.62 pounds per cubic foot density was machine mixed with cement in the ratio of 1:6 (by weight) of cement to aggregate in a revolving blade mixer, known as a Hobart Mixer, for several minutes. The resulting concrete produced showed that there was no measurable loss in volume due to breakdown, i.e., attrition of the light-weight aggregate in the machine mixer.

FIG. 3 illustrates a curve 120 representative of the effect of the amount of expander controller cement 2 by weight. The weight of cement in grams and its percentage by weight relative to the combined silicate solids are plotted along the ordinate axis. The resulting bulk density of the light-weight aggregate is plotted along the abscissa axis. With 21.1 percent of Portland cement by weight of the combined anhydrous sodium silicate and liquid sodium silicate of 42 degree Baume grade, the resulting bulk density of the light-weight aggregate was 2.9 pounds per cubic foot. The curve reveals that the bulk density may be accurately controlled to one-tenth of a pound per cubic foot or less by controlling the amount of Portland cement passed by flow control valve 36 (FIG. 1).

The selection of the light-weight bulk density is determined by its desired final use. For instance, without the use of an expander controller such as Portland cement, the bulk density is so low as to result in a fluffy aggregate advantageous for sound-proofing purposes, fire-proofing purposes, thermal installation, and the like.

When the light-weight aggregate is to be employed as an aggregate material for machine mixing with cement, the bulk density is selected at a value which results in sturdier aggregate particles capable of withstanding abrasive treatment occurring when the aggregate material is machine mixed with cement.

FIG. 6 illustrates a curve 130 representative of the volume yield losses occurring as a result of machine mixing of cement with light-weight aggregate. These volume losses were determined using mixtures of one part cement to six parts of aggregate by volume, by comparing machine mixed concrete volumes with those concrete volumes obtained by hand mixing. It was found that light-weight bulk having densities gener-



ally in excess of about 2.62 pounds per cubic foot could withstand machine mixing treatment without subsequent loss in volume.

In the preparation of the mix of ingredients it is desirable that the anhydrous sodium silicate become fully dissolved while the mix becomes a plastic stretchable homogeneous mass. The amount of sodium silicate solids (including sodium silicates in both anhydrous and liquid states) affects the processing time through the oven 64 at a temperature of 200° Fahrenheit to obtain a friable material which could be crushed to the desired particle size. About 53 percent by weight of sodium silicate solids of the combined weight of water and sodium silicate solids were found to permit an optimum minimum retention time in the oven 64 of about an hour while still providing an easily crushed mass that yielded a fully expanded light-weight aggregate.

With 56 percent by weight of sodium silicate solids of the combined weight of water and sodium silicate solids, one hour retention in oven 64 yielded a friable mass, but full particle aggregate expansion was achieved only by extending retention time in oven 64 to about 2 hours.

The temperature maintained in oven 64 affects the retention time for the mass from mixer 20. As shown in FIG. 4, curves 140 and 142 show the effect of temperatures of the oven 64 on the light-weight aggregate bulk density. Curve 140 illustrates that an oven temperature of 185° F. requires a retention time of three hours or more to achieve full expansion of the light-weight aggregate at a bulk density of 20 lbs./ft.<sup>3</sup>. On the other hand, temperature of 200° F. in oven 64 permits a shortened retention time of about one hour to achieve full expansion of the light-weight aggregate as is illustrated by curve 142. Hence, a higher oven 64 temperature reduces the retention time. Yet, too high a temperature would produce a boiling of water in the mix with the result of foaming and a settling out of the liquid silicate. The preferred oven temperature of approximately 200° F., i.e. in a range from 190° to 210° F., provides optimum conditions assuring full dissolving of the anhydrous sodium silicate and producing a plastic cake that may be easily worked between rollers 68 into an efficiently cooled friable ribbon or strip.

Curve 150 in FIG. 5 illustrates the effect of temperature in the expander dryer 92 on the light-weight aggregate bulk density. The temperature indicated along the abscissa were measured at the outlet port 101 where the light-weight aggregate is discharged from the rotating cylinder of the expander 92. Generally, expander dryer temperatures above about 880° F. up to about 1,100° F. and preferably 980° F. to 1,020° F. were found advantageous to achieve full expansion of the light-weight aggregate.

The delayed action heat-triggered neutralizer 1 is preferably hydrated boric acid ( $H_3BO_3$ ), commercial technical granular grade, which is conveniently delivered in bulk. While it is possible to use anhydrous boric acid ( $B_2O_3$ ) as the delayed action heat-triggered neutralizer, the latter is much more difficult to handle and to work with, because it must be delivered in sealed conditions and because it is exothermic in reaction when introduced into the mixing zone 20, which undesirably tends to raise the temperature therein above the boiling point. Accordingly, it is my preference to use the former which has worked to advantage for me in the process and system, as described.

Advantageously, for a plant to produce 100 cubic yards of light-weight aggregate per hour, only 5.3 cubic yards per hour of raw materials are required.

I claim:

1. The process for producing a particle material capable of being fully expanded into a resulting light-weight material suitable for use in building, construction, building products, insulation, and the like, such expansion being provided by the application of heat, said process comprising the steps of commingling into a homogeneous mass anhydrous sodium silicate, liquid sodium silicate, and a delayed-action heat-triggered neutralizer material selected to operate during expansion of the particle material to the desired bulk density of the resulting light-weight material, the amount of anhydrous sodium silicate commingled being such that when it is fully dissolved in the homogeneous mass the mass is of a composition such that it is friable at room temperature, subjecting the commingled homogeneous mass to a dissolving and drying curing cycle by heating it at a temperature below the boiling point of water but sufficiently high to dissolve the anhydrous sodium silicate, cooling the homogeneous mass to a friable cake, crushing the cake into particles of a desired size, and heating the crushed cake particles to partially dry the particles into a stable particle material capable of being stored and capable of delayed full expansion by application of heat into a resulting light-weight material suitable for such building and construction uses and for use in building products.

2. The process of producing the particle material as claimed in claim 1, wherein said commingling step includes commingling granular boric acid as the delayed-action heat-triggered neutralizer material.

3. The process of producing the particle material as claimed in claim 2, wherein said boric acid is commingled in an amount constituting between about 5 percent to about 25 percent by weight of the sodium silicate solids in the homogeneous mass.

4. The process of producing the particle material as claimed in claim 1, wherein the commingling step includes the addition of Portland cement as an expansion controller.

5. The process of producing the particle material as claimed in claim 1, wherein the cooling of the homogeneous mass into a friable cake is preceded by the step of pressing the heated commingled homogeneous mass into a thin strip for efficient cooling.

6. The process of producing the particle material as claimed in claim 1, wherein said liquid sodium silicate is preheated before it is commingled with the other constituents.

7. The process of producing a particle material capable of being fully expanded into a resulting light-weight material suitable for use in building, construction, building products, insulation, and the like, such expansion being provided by the application of heat, said process comprising the steps of combining anhydrous sodium silicate with liquid sodium silicate in a mixer with the sodium silicate solids constituting between 50% and 56 percent by weight of the mix of the anhydrous and liquid sodium silicate, and combining into said mix a delayed-action heat-triggered neutralizer material in the form of boric acid and an expansion controller material in the form of Portland cement, mixing the combined materials into a homogeneous mass with the solids in the mix thoroughly distributed for retention in

the mix, heating the mixed homogeneous mass for a time period and to a temperature below the boiling point of water selected to dissolve the anhydrous sodium silicate, pressing the heated mix of homogeneous mass into a thin strip, cooling the thin strip of material to a friable and crushable state, crushing the strip of cooled material into small particles, and supplying heat to the crushed strip particles for pre-expansion drying thereof and surface stabilization to form a particle material capable of being stored for at least several weeks storage and capable of delayed full expansion upon subsequent application of heat into a resulting light-weight material.

8. The process of producing a light-weight aggregate material comprising the steps of combining anhydrous sodium silicate, liquid sodium silicate in a mixer combining a delayed-action heat-triggered neutralizer material and an expander controller material to the mix of anhydrous and liquid sodium silicates, mixing the combined materials into a homogeneous mass, heating the homogeneous mass for a time period and to a temperature selected to dissolve the anhydrous sodium silicate, the temperature being below the boiling point of water but sufficiently high to dissolve the anhydrous sodium silicate cooling the homogeneous mass to a friable cake, crushing the friable cake into particles of a desired size, and heating the particles to a temperature and for a time period sufficient to attain full expansion thereof into a light-weight aggregate having a bulk density determined by said expansion controller material and neutralized by said delayed-action heat-triggered neutralized material.

9. The process of producing a light-weight aggregate material as claimed in claim 8, wherein the crushing step is followed by a pre-expansion drying of the particles with a heating thereof to a temperature and a time period sufficient to stabilize the particles and prevent a subsequent coalescing of the particles while they are being stored, if desired, for a period of several weeks.

10. The process of producing a light-weight aggregate as claimed in claim 8, wherein the heating of the particles comprises exposing the particles to air at a temperature in the range offrom about 880° to 1,020°

F.

11. The process of producing light-weight aggregate as claimed in claim 10, wherein said combining step includes the step of mixing boric acid as the delayed-action heat-triggered neutralizer.

12. The process of producing a light-weight aggregate as claimed in claim 8, wherein the combining step includes the step of mixing Portland cement as the expander controller material in an amount commensurate with the desired bulk density of the light-weight aggregate.

13. The process of producing a light-weight particle material suitable for use in building, construction, building products, insulation, and the like, comprising the steps of introducing into a mixing zone liquid sodium silicate and anhydrous sodium silicate, the sodium silicate solids being present in an amount between 50 and 56 percent by weight, introducing into said mixing zone a delayed-action, heat-triggered neutralizer material in the form of granular boric acid in an amount constituting between about 5 and about 25 percent by weight of the sodium silicate solids in said mixing zone, and also introducing into said mixing zone an expansion controller material in the form of Portland cement in an amount constituting between about 8 percent and about 25 percent by weight of the sodium silicate solids, providing a vigorous mixing action in said mixing zone in the presence of heat to mix the contents thereof into a homogeneous mass, the heat being sufficient to produce in the mass a temperature below the boiling point of water but sufficiently high to dissolve the anhydrous sodium silicate therein, removing the mass from the mixing zone, cooling the mass into a friable and crushable state, crushing the cooled mass into small particles, heating the particles to pre-expand and dry the surfaces of the particles such that their surfaces are stabilized to be capable of being stored together for weeks, if desired, without coalescing between stored particles, and subsequently heating the stabilized particles to a temperature in the range from about 880° F. to about 1,020° F. to produce the desired expansion thereof.

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