June 12, 1934. E. R. POWELL 1,963,030

METHOD OF FORMING CELLULAR CERAMIC BUILDING MATERIAL

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FIG. 1

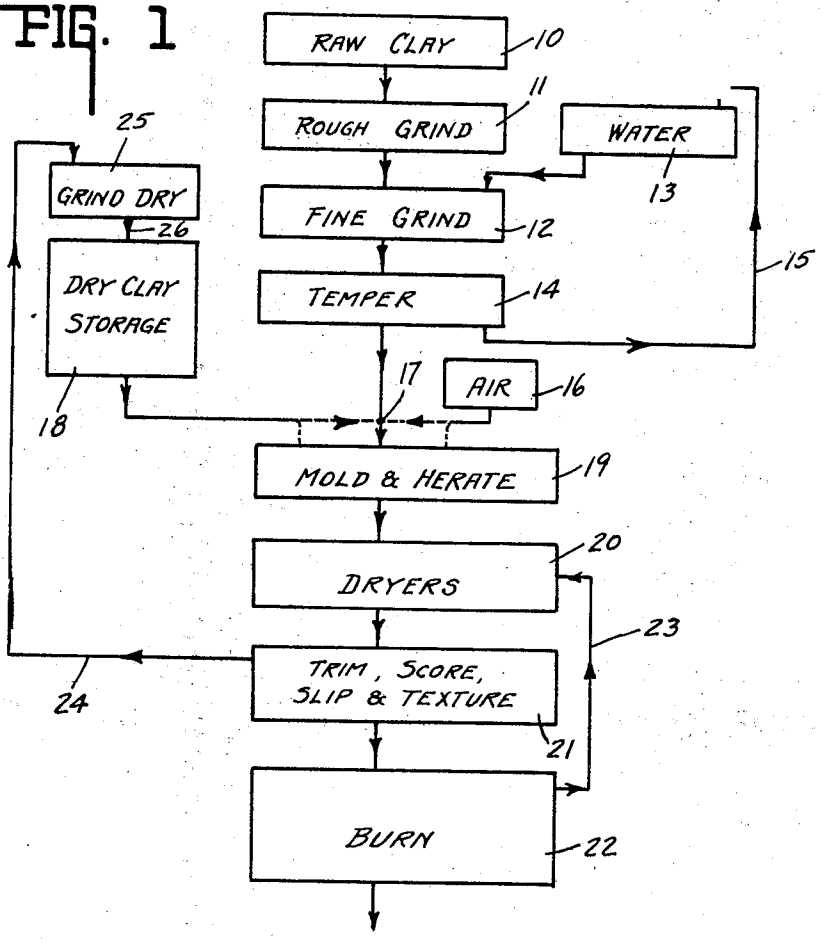


FIG. 2

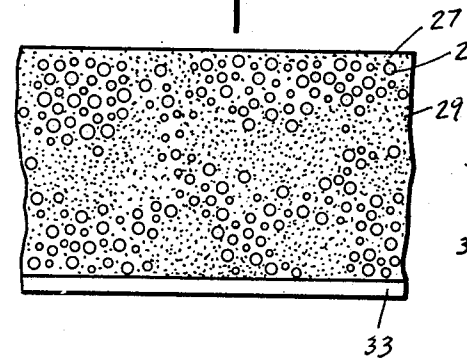
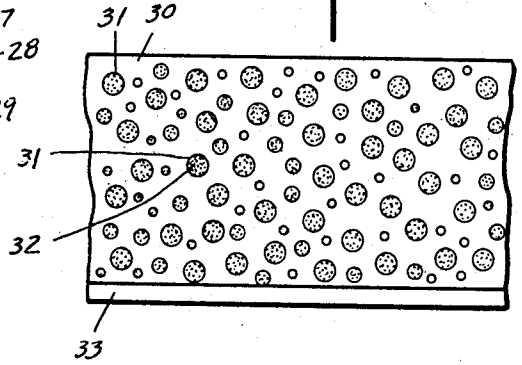


FIG. 3



INVENTOR.
EDWARD R. POWELL.

BY
Lockwood Lockwood Goldsmith & Galt
ATTORNEYS.

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FIG. 5

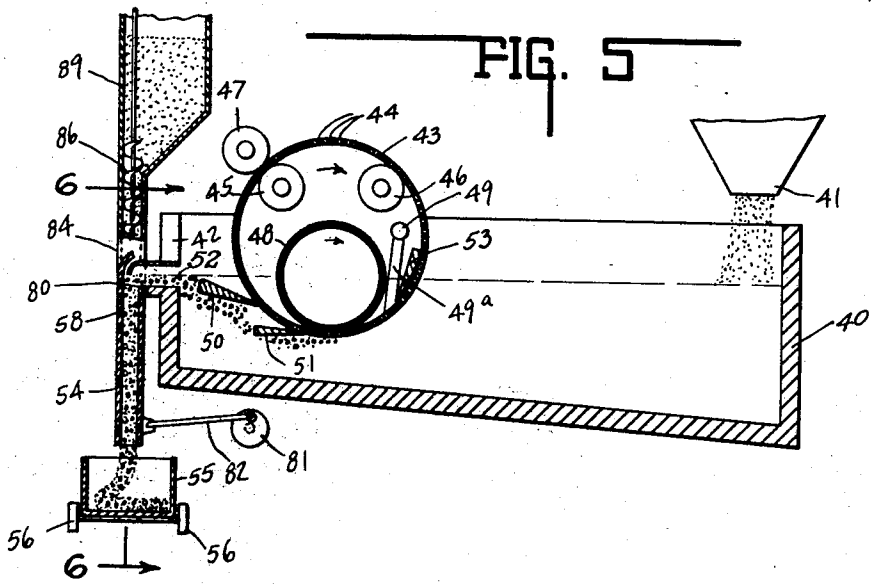


FIG. 4

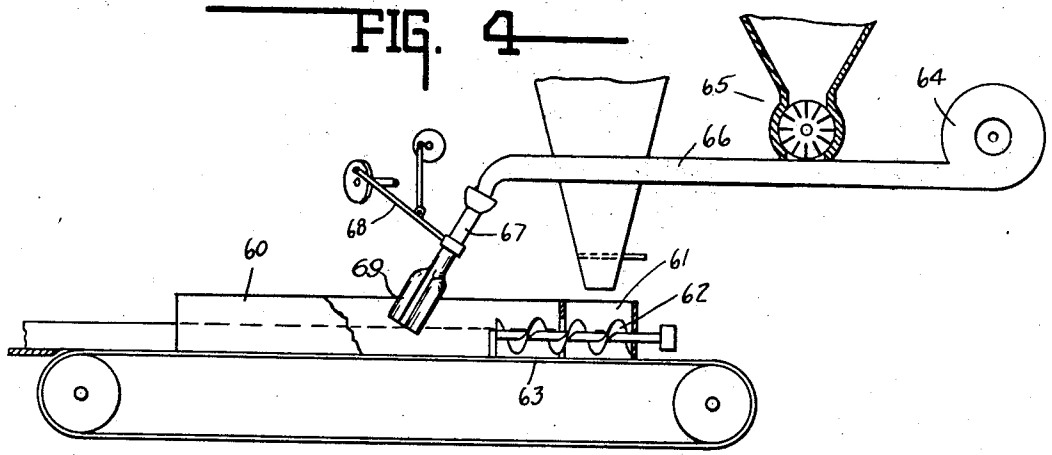
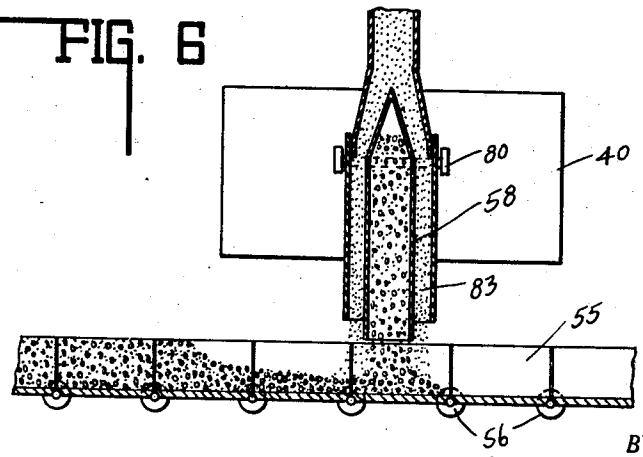


FIG. 6



INVENTOR.
EDWARD R. POWELL.

BY
Lockwood Lockwood Goldsmith & Galt

ATTORNEYS

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METHOD OF FORMING CELLULAR CERAMIC BUILDING MATERIAL

Edward R. Powell, Alexandria, Ind.

Application March 21, 1932, Serial No. 600,115

17 Claims. (Cl. 25—156)

This invention relates to the formation of a light weight structural ceramic material suitable for brick, tile and the like.

The chief object of the invention is to form a material of the aforesaid character from relatively inexpensive local materials such as clay and shale.

This is accomplished by first forming a cellular structure in the material constituting the stock and then applying treatment to fix and preserve this cellular arrangement. The advantages of this material, as will be explained, result from this cellular structure and the consequent lightness and adaptability.

Bricks or like ceramic materials formed from the same sort of raw material but having a dense solid structure generally have a weight of approximately one hundred twenty to one hundred fifty pounds per cubic foot of volume and have a thermal conductivity of between eight and fifteen B. t. u. per square foot of surface per hour per degree for each inch of wall thickness.

The typical brick or like ware formed by the process which is embodied in this invention weighs between thirty and fifty pounds per cubic foot and has a thermal conductivity of about 1 to 3 B. t. u. per hour per square foot per degree for each inch of wall thickness. Or, if desired, denser ware may be manufactured which has properties intermediate between the ranges which are given above.

Due to its relatively low weight, the ware resulting from the employment of the process embodying the invention can be made in larger sizes, thus permitting the building of walls with a smaller number of brick or units, thereby materially reducing the cost of handling and laying thereof. In other words, the ware may be made three or four times as large as the present ware and not be objectionable on the grounds of unit weight or of weighing more than the present brick.

The light-weight brick ware will also be suitable for building heat insulating walls because of the low rate of transmission of heat therethrough. For tall structures, the light-weight material is desirable because of the smaller load which it imposes on frame and foundation.

The presence of air cells in the ware also makes it more adaptable and permits easier drilling, cutting, and in the lighter weights, driving of nails and screws into it without difficulty or rupture.

The chief advantage which is obtained as a result of the type of process employed is that the light-weight high thermal insulating product is obtained by mechanical rather than chemical means.

While cellular ceramic products have been manufactured by the use of granulated coal, cork or other combustible, or by the use of chemical setting agents such as plaster of Paris in considerable proportion, it is characteristic of process of the present invention that it proceeds with the additional employment of little if anything other than the local clay.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

In the drawings, Fig. 1 is a diagrammatic flow sheet or diagram of operations.

Fig. 2 is an enlarged sectional view through one form of finished product.

Fig. 3 is a similar view of another form of finished product, the difference occurring in the method of handling the materials.

Fig. 4 is a transverse sectional view of one form of apparatus suitable for forming the wet stock from which brick are subsequently cut and formed, such stock being shown in Fig. 3, parts being diagrammatically illustrated.

Fig. 5 is a view of a modified form of apparatus capable of producing the form of product shown in Fig. 2, parts being diagrammatically illustrated.

Fig. 6 is a view of part of the same apparatus shown in Fig. 5 taken on section plane 6—6 of Fig. 5.

In Fig. 1 of the drawings, a flow sheet or diagram illustrates the steps of the process employed. The raw clay is mined in conventional manner and stored or used as required. This step is indicated at 10. The raw clay is ground one or more times to a very fine powder or dust. These steps being indicated at 11 and 12 and the fine grinding may be accomplished with the addition of water or may be a dry grinding. Herein water is supplied at 12 from a source or reservoir 13 until the desired consistency is obtained. This is about the consistency of heavy cream and the same constitutes a stock that is aeratable. This step or condition is indicated at 14. All surplus water may be returned as indicated at 15 to reservoir 13.

The cream like liquid clay is then aerated with gas bubbles, which supply is at a rapid rate and the bubbles are of suitable size, that is not too large nor too small, and sufficient in amount to obtain an aerated stock. A source of air is indi-

cated at 16, being connected to the system so that it is supplied to the clay liquid at 17.

The aerated stream of liquid clay is then thickened by the addition of a water absorbing material. Such a material is finely ground or pulverized dry clay. The storage receptacle therefor is indicated at 18 and this clay is supplied to the stream either independently of the air but after the air is supplied, or simultaneously therewith. Herein the receptacle 18 discharges to the stream at 17 or simultaneously with the air or subsequently.

The clay stream upon the addition of dried clay becomes thick and relatively stiff and can be handled in about the same manner as the "wet-mud" process clay in standard brick manufacturing. The thickened aerated clay is then molded and aerated as at 19 and then passed through driers 20. The dried or green ware is then trimmed, scored, and otherwise surface treated to give it the proper slip, texture and/or glaze as at 21 and then burned as at 22, producing a cellular light weight product.

The heat from the kilns for burning preferably is directed, as indicated at 23, to the driers for use therein. The dried trim formed at 21 is conveyed, as indicated at 24, to a grinder 25 which grinds and forms a dry clay powder and discharges at 26 to the dry clay storage 18 for subsequent use in thickening the cream clay stream.

In Fig. 2 of the drawings, 27 indicates the clay body, 28 the air bubbles or holes, and 29 the water absorbing dust. In this form of stock, the dust is outside of the air bubbles. Such a stock is formed by introducing dry clay dust into the stream after the clay liquid has been aerated.

In Fig. 3 of the drawings, 30 indicates the clay body, 31 the air bubbles or holes and 32 the water absorbing dust. In this form of stock the dust is included within some or all of the bubbles. Such stock is formed by introducing the dry clay dust simultaneously with the air. Either form of product may have an impervious layer 33 applied as a glaze or left unaerated. The ware may be of any desired shape.

In Fig. 5 there is diagrammatically illustrated one form of apparatus suitable for aerating and thickening the thin liquid clay. Herein 40 indicates a reservoir supplied with liquid clay. The supply may be intermittent but preferably is continuous, as shown, 41 indicating the incoming liquid and 42 the outlet of the reservoir. A perforated cylinder 43, perforated throughout with holes such as 44 is rotatably supported on rubber rolls 45 and 46 and is positively driven. Herein hold-down roller 47 may constitute such a drive. Also roller 47 acts as a stripping roll. Cylinder 43 is immersed in the liquid clay. Rotatably mounted in cylinder 43 is a squeezing roll 48. Air is supplied by pipe 49 and passes through the longitudinally elongated passage 49*a* beneath the level of the clay. Swinging the pipe 49 permits adjusting the position of the discharge outlet 49*a*. As the perforations 44 of cylinder 43 move past passage 49*a*, the air is blown through them a limited time, thus limiting the size of the bubbles. Squeezing roll 48 has the effect of forcing clay through the cylinder perforations 44 and forcing out the air entrapped therein. Scrapers 50 and 51 scrape off the aerated clay liquid which flows over the wier 52. An interior stationary scraper 53 may be employed if desired.

The aerated clay liquid indicated at 54 discharges into a trough 55 formed of a series of molds carried on wheels or rollers 56. The discharge spout 58, which carries the aerated clay, is pivoted at point 80 and is oscillated by connecting rod 82 and crank 81. This spout also carries passage 83 for dry powdered clay which is fed through passage 84 from storage box 85 by means of screw feed 86. In this way the wet aerated clay and the clay dust are mingled in streaks or layers. To build up the product in layers, the molds may be run back and forth past the spouts 58 and 83 several times until the desired thickness or depth therein is obtained.

The thickened stream is held confined against laterally slumping by the trough 55. As soon as the dry dust accomplishes its function, the strip of clay may be separated into units and emptied onto pallets. The clay is then ready for drying, trimming and burning as described.

In Fig. 4 of the drawings, there is illustrated one form of continuous molding. In said figure, 60 indicates a trough adapted to receive the thin clay liquid at station 61. 62 indicates a screw feed therebeneath to force the clay in the desired direction. Screw 62 may also serve as a mixer to incorporate small amounts of aerating chemicals. The bottom of the trough consists of the endless belt 63. The blower 64 constitutes an air supply and the pipe therefrom is adapted to introduce ground dried clay dust into the stream. 65 indicates the dust supply and 66 the discharge therefrom. The nozzle 67 is mechanically reciprocated by mechanism 68. The motion of the nozzle is gyratory. The nozzle terminates adjacent a series of small pipes 69. The result of this arrangement is that the dust laden air is blown into the soft creamy clay, forming air bubbles therein, the walls of which become stiffened by absorption of water from the surrounding clay.

It shall be understood that the invention is not limited to the combinations shown but that either method of stiffening may be used with any means of expanding or aerating a wet liquid clay. Other means of accomplishing the results may also be devised without departing from the spirit of the invention, the examples given being as illustrations and not in a limiting sense.

The liquid clay for aeration must be fluid enough to form bubbles readily. It should have sufficient surface tension to retain the bubbles for a few minutes. Fine grinding of part of the clay is nearly always necessary to obtain proper consistency. Sometimes it is advisable to use a small percentage of extract of soap bark to improve the frothing properties. The extract from one ounce of bark is usually ample for a gallon or more of the water. A small fraction of an ounce of karaya gum sometimes helps to make the froth more permanent. It is usually best to start with the clay liquid at higher than air temperature so that it will be cooling and forming gels after aeration. An excess of water must be avoided as it is very difficult to stiffen a very thin slip of clay. Preferably the clay should be given the proper acid or alkaline reaction in which it will be fluid with minimum water content. This is sometimes called its deflocculated condition.

The aeration, when done mechanically as a separate operation, must involve small bubbles and little agitation. A large volume of air pumped into the liquid simply escapes in the form of large bubbles. Also, too much agitation tends to make the small bubbles combine into large ones and escape. The apparatus of Fig. 5 is accordingly designed to produce bubbles of predetermined size with little agitation.

Some clays, especially if they contain more than 1 or 2 per cent carbonates, may be aerated by the addition of dilute sulphuric acid. The acid constituent and the carbonate constituent must be brought into contact relatively rapidly and left relatively undisturbed while they react. This is accomplished in some cases by adding the dry powdered clay to acidulated water and stirring rapidly for a second or more. It may, however, be advisable to have the ingredients in liquid condition and mix rapidly and continuously.

Regardless of how the preliminary aeration is carried out, the problem of preserving the structure remains. This has been accomplished in some prior processes by the use of considerable percentages of plaster of Paris or silica gel. In my process, the aerated mass is stiffened by the addition of part of the clay itself in powdered form. The dry powder or dust acts as a dehydrating agent. In some cases it is desirable to add diatomaceous earth or powdered lime to the dust to increase the dehydrating effect, but ordinarily the clay dust itself is satisfactory. In one form of the process as shown in Fig. 4, the dust-laden air which is blown in produces a further aeration as well as a stiffening action. This may, if desired, be the only aeration but usually a previous aeration is desirable. In another form (Figs. 5 and 6) the dust performs a stiffening function only.

After the moisture content of the clay mass has been partly absorbed by the dry clay, and is approximately equalized throughout the mass, it is ready for drying. The blocks or slabs of wet clay are formed somewhat larger than the final size to allow for shrinkage. The shrinkage may be somewhat uneven and therefore it is usually necessary to trim the blocks after drying to accurate dimensions by means of saws, planers, etc. of more or less conventional design. The material removed in this operation is called the trim. It is ground to a powder and thereafter performs the stiffening function already explained. An average amount of this trim is perhaps 20 per cent of the weight of the block. For maximum economy in this process, this amount should be controlled to just as much as needed for the stiffening operation previously set forth.

The invention claimed is:

1. In a process for making light weight ceramic ware, the steps of introducing gas bubbles into a liquid clay which is capable of retaining them an appreciable time, adding powdered material in sufficient quantity to form a stiffened mass, drying and burning the mass.

2. A process for making light weight ceramic ware comprising blowing dust-laden gas into a liquid clay so as to form a stiffened expanded structure, drying and burning the product.

3. A process for making light weight ceramic ware which includes obtaining dust for stiffening purposes by trimming a dried clay block, reducing the trim to dust, bringing the trim-dust into contact with wet aerated clay for drying the same to form a stiffened mass suitable for clay block formation, and drying and burning the mass.

4. A process for making light weight ceramic ware which includes expanding a liquid clay by means of gas bubbles of controlled size, stiffening the expanded clay by means of powdered clay, drying and burning the expanded clay.

5. A process for making light weight ceramic ware which includes expanding liquid clay by means of small proportions of gas-forming chemicals, retaining the expanded structure of the clay by means of powdered material associated therewith, drying and burning the expanded material.

6. A process for making cellular ceramic ware which comprises aerating wet liquid clay having a foam-preserver included therein, introducing powdered clay into the aerated liquid to form a stiffened aerated mass, drying and burning the mass.

7. A process for making cellular ceramic ware which includes preparing a warm liquid clay in deflocculated condition with a minimum practical proportion of water, forming the liquid clay into stiffened clay shapes with the aid of powdered clay as a stiffen-medium, drying, turning and burning the shapes.

8. A process for making light weight ceramic ware which includes obtaining dust for stiffening purposes by trimming a dried clay block, bringing the trim dust into contact with wet aerated clay for drying the same to stiffen the mass suitable for clay block formation, and drying and burning the mass.

9. In the process of forming a light cellular building product, the combination of forming a liquid clay, introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for at least an appreciable period thereafter, and then rapidly changing the bubble included liquid clay to a thicker plastic mass with the entrapped bubbles therein to permanently fix the same therein.

10. In the process of forming a light cellular building product, the combination of forming a liquid clay, introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for at least an appreciable period thereafter, and then rapidly reducing the moisture in the bubble included liquid clay to a thicker plastic mass with the entrapped bubbles therein to permanently fix the same therein, and by adding powdered water absorbing material.

11. In the process of forming a light cellular building product, the combination of forming a liquid clay, introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for an appreciable period thereafter and a powdered water absorbing material in an amount sufficient to rapidly reduce the moisture content of the clay, shaping the mass including the bubbles and powdered material, and then drying the shaped mass.

12. In the process of forming a light cellular building product, the combination of forming a liquid clay, simultaneously introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for an appreciable period thereafter and a powdered water absorbing material in an amount sufficient to rapidly reduce the moisture content of the clay, such simultaneous introduction including within the bubbles the powdered material without destruction of the bubbles, shaping the mass including the bubbles and powdered material, and then drying the shaped mass.

13. In the process of forming a light cellular building product, the combination of forming a liquid clay, separately introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for an appreciable period thereafter and a powdered water absorbing material in an

amount sufficient to rapidly reduce the moisture content of the clay, such simultaneous introduction including within the bubbles the powdered material without destruction of the bubbles, shaping the mass including the bubbles and powdered material, and then drying the shaped mass.

14. In the process of forming a light cellular building product, the combination of forming a liquid clay, forming therein bubbles of wetted dust and gas bubbles, shaping the dust included and bubbled clay, and then drying the same to permanently fix a cellular structure therein.

15. In the process of forming a light cellular building product, the combination of reducing the clay to a liquid by grinding the same with water, introducing therein a plurality of relatively small gas bubbles at such a rate that the maintenance of the bubbles is not destroyed for an appreciable period thereafter and a dry powdered clay, shaping the bubbled and powdered clay to form a blank, drying the same, trimming the dried clay blank, finishing the blank, and grinding the dried trim for subsequent introduction into the liquid clay as dry and powdered clay.

16. In the process of forming a light cellular building product, the combination of forming a liquid clay, introducing gas bubbles therein, applying the bubble containing liquid in successive layer formation to build up the stock, and introducing a water absorbing powder between the stock layers for rapidly drying and stiffening the clay to form a mass of relatively stiff clay for blank formation and for fixing the bubble structure therein to permit permanent incorporation as a cellular formation.

17. In the process of forming a light cellular building product, the combination of continuously supplying a stream of liquid clay of substantially cream consistency, introducing therein for distribution throughout the creamy mass a water absorbing powder and a plurality of small gas bubbles of such size that surface tension is normally effective for retaining bubbles as a cellular formation for an appreciable length of time and at such a rate that such maintenance is not destroyed, the water absorbing powder stiffening the clay cream into a relatively stiff mass with the bubble formation included therein, and then forming blanks from the stiffened cellular stream for subsequent treatment.

EDWARD R. POWELL.