

April 10, 1945.

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2,373,468

APPARATUS FOR MANUFACTURE OF COMPRESSED CLAY BODIES

Filed Aug. 26, 1942

2 Sheets-Sheet 1

Fig. 1.

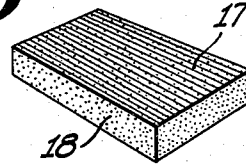


Fig. 2.

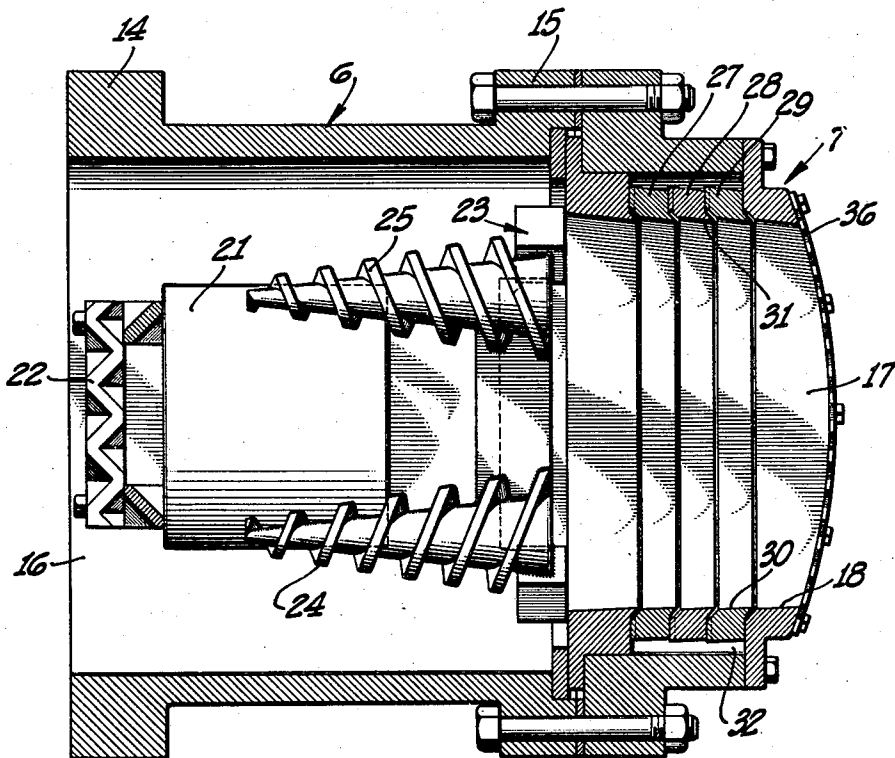
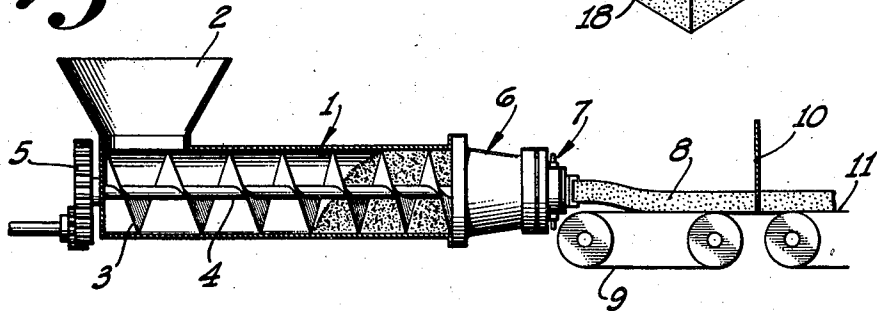


Fig. 3.

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2 Sheets-Sheet 2

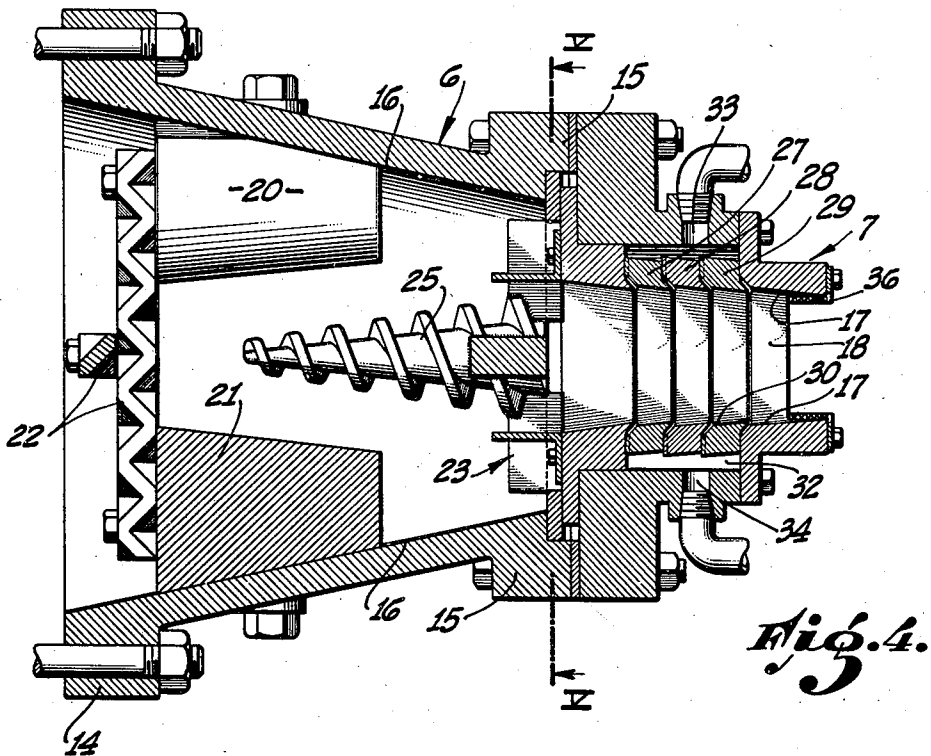


Fig. 4.

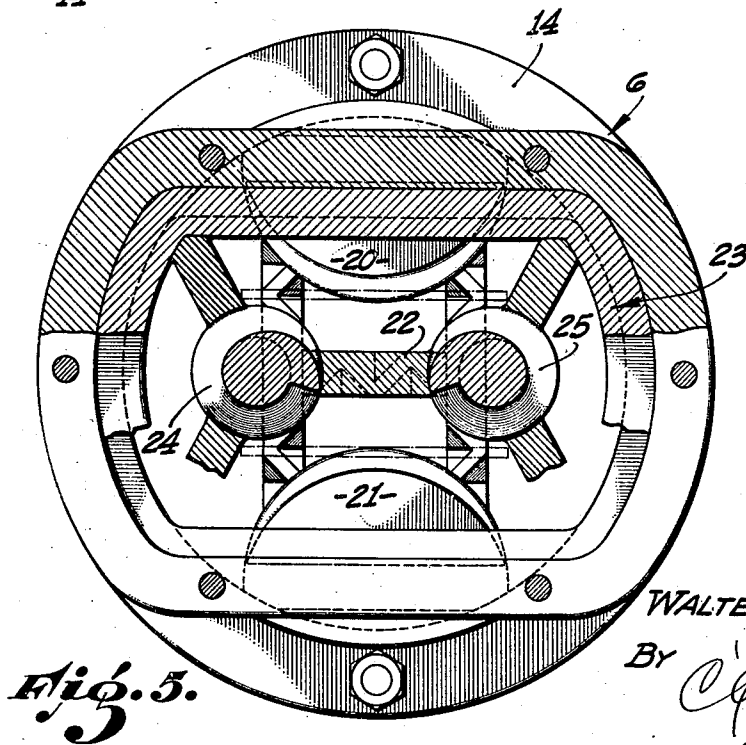


Fig. 5.

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UNITED STATES PATENT OFFICE

2,373,468

APPARATUS FOR MANUFACTURE OF
COMPRESSED CLAY BODIES

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Application August 26, 1942, Serial No. 456,218

1 Claim. (Cl. 25—14)

This invention pertains to a novel, unburned, highly compressed, tough and yielding structural member or block virtually free from laminations, having the ability to absorb and resist penetration by shrapnel, bullets and the like. The invention also pertains to methods and means whereby such structural bodies may be readily and economically produced.

In many instances it is highly desirable to erect barriers, revetments, protecting walls and other structures for the purpose of protecting ammunition dumps, airplanes, anti-aircraft batteries, machinery, exposed valves and piping, and many other devices, objects or groups of personnel from air attack, bombs, shrapnel and the like. Usually, sand bags have been employed but these are destructible and do not last. The use of burned, common red brick is unsatisfactory because the erection of walls or barriers of brick is expensive and time consuming. Moreover, burned brick have a tendency to shatter under the impact of shells, shrapnel, bomb fragments and the like, the splinters or pieces of burned brick being substantially as dangerous as the shell or bomb fragment which has caused such splintering.

The present invention is directed toward an inexpensive, unburned clay block of a relatively large size so that barriers may be readily constructed therefrom without the necessity of using mortar. Moreover, the unburned clay blocks of the present invention are virtually free from laminations and have the ability to absorb fragments of shrapnel or bombs, and to resist penetration by bullets, shell and the like without fracturing or splintering.

It has been deemed impossible heretofore to produce large, virtually unlaminated streams or ribbons of clay body by means of clay-extruding machinery known heretofore. The extrusion of a clay ribbon having a cross-sectional area of more than eighteen square inches has not been accomplished heretofore. Ordinarily, clay-extruding machines are capable of extruding a ribbon or stream of clay of only about ten square inches in cross section. Larger die openings give rise to ribbons or streams of clay composition which are laminated and which fall apart, exfoliate or expand upon drying. Re-pressing of stiff or soft mud brick has been practiced, even though such brick are of small size, the re-pressing operation attempting to reconsolidate the individual brick cut from a ribbon extruded from a clay-extruding machine.

One of the objects of the present invention is to disclose and provide a method of handling

clay bodies whereby a thoroughly consolidated, homogeneous, highly compressed ribbon may be extruded continuously, the ribbon being of an unusually large cross-sectional area so that large blocks, each having a volume of more than one-sixth of a cubic foot and preferably in excess of one-third of a cubic foot, may be continuously produced.

Moreover, the means and methods of the present invention assure the resulting large blocks to be tough, virtually free from laminations, and to have the ability to absorb and resist penetration by shrapnel, bullets and the like.

An object of the present invention, therefore, is to disclose and provide as a new article of commerce, an unburned, highly compressed block of large size, the block being substantially free from laminations and having the ability to absorb and resist penetration by shrapnel, bullets and the like.

Another object of the invention is to disclose and provide a method of tempering, processing and extruding clay compositions in the form of continuous ribbons or streams having a cross-sectional area in excess of ten square inches.

A further object of the invention is to disclose and provide an apparatus for attaining the objects hereinbefore stated and for consolidating a clay body or composition into a homogeneous mass virtually free from laminations so that blocks made therefrom have a high strength even in the unburned state.

These and other objects, uses, advantages and modifications of the invention will become apparent to those skilled in the art from the following description. In order to facilitate understanding, reference will be had to the appended drawings, in which:

Fig. 1 is a perspective view of a typical block made in accordance with the process of and by means of the apparatus herein disclosed.

Fig. 2 is a side elevation, partly diagrammatic, of an extrusion machine and cutting table which may be employed in the performance of the process.

Fig. 3 is an enlarged horizontal axial section taken through the pressure chamber and head.

Fig. 4 is a vertical section taken through the pressure chamber and die.

Fig. 5 is a transverse section taken along the plane V—V of Fig. 4.

The preparation of clay bodies or clay mixes for use in clay working machinery, such as an ordinary auger type extrusion machine, need not be described in detail since it is well known in

the art. Ordinary grinding, milling and pugging machinery may be employed. The block of the present invention need not be made of the more expensive ceramic clays, such as ball clay, kaolin, or the like, ordinary semi-plastic clays such as are used in the manufacture of common red brick being well adapted for use in the process of the present invention. Clays having unusually high drying shrinkage should be avoided, however.

In view of these facts, blocks of the present invention may be manufactured from clays readily available in all sections of the country. The fineness of subdivision or the extent of grinding to which the clay is subjected is not critical, a reduction of the clay so as to pass an 8 or 16 mesh sieve being sufficient.

In the preferred composition embraced by the present invention, I employ a relatively short fibre. The fibre may be either vegetable or animal in origin. Short cellulosic fibres such as may be obtained from disintegrated chipboard, cardboard or the like, constitute an inexpensive form which may be used to good advantage. By the term "relatively short fibre," reference is made to fibre the major proportion of which is less than $\frac{1}{4}$ inch in length. Cotton linters, wood pulp, ground wood bark, asbestos and the like may be employed. When fibres are employed, the fibrous material is preferably added to the pug mill by means of a carding machine to make certain that the fibres are well dispersed. The fibres are added to the clay in amount sufficient to constitute from between about 0.2% and 1% by weight, good results being attained by the use of 0.5% of cellulosic or wood fibre.

The amount of water added to the clay or to the clay-fibre mixture should be kept relatively low, that is, between about 6% and 20% by weight of the clay, and preferably between about 8% and 14%. It is to be understood that clay as ordinarily mined, ground and furnished to the pug mill contains water of combination or water of crystallization, which is not ordinarily removable by air drying. For this reason, reference is here made to the percentage of added water since the amount of total water (including combined water in the mixture) may be somewhat in excess of the percentages herein given.

Instead of water, solutions or emulsions may be employed. Emulsions of road oil, asphalt and the like may be used with great advantage. Solutions of casein or lignin can also be advantageously employed. In some instances a part of the aqueous medium used may be sprayed directly onto the fibre at the time that the fibre is being added to the clay while another portion of the aqueous medium may be added directly to the clay either before or after the introduction of fibre. It has been found that the atomization of asphalt emulsions directly onto wood fibre appears to exert a highly desirable effect upon the strength and texture of the finished blocks.

A mixture of the character described may then be fed to an auger type extrusion press of the character shown in Fig. 2. As there shown, the machine includes a cylindrical body 1 provided with a hopper inlet 2 adapted to receive the mixture of clay, water and fibre. Extending through the body 1 is an auger or screw 3 carried by a shaft 4, the shaft being driven in any suitable manner, as for example by means of the gearing 5, from a source of power not shown. The pitch of the screw 3 ordinarily decreases as it approaches the outlet from the body 1, thereby causing the clay to be consolidated, the screw

discharging a continuous stream or ribbon of clay into a pressure head, generally indicated at 6, such pressure head carrying the outlet die, generally indicated at 7.

It is to be understood that in the usual auger type extrusion press the die holder 7 is attached directly to the end of the body 1 and no provision is made for a pressure chamber 6. In the apparatus employed by me, the auger or screw 3 discharges into the pressure chamber 6 and does not extend thereinto.

The extruded clay composition is in the form of a continuous ribbon, generally indicated at 8, and is received by a suitable conveyor 9 which permits the ribbon to be advanced to a suitable cutoff mechanism 10, such as a wire cutting machine. The blocks cut off by the wire cutting device are then moved as by conveyor 11 to a suitable dried. Drying under controlled humidity conditions is to be preferred. The blocks produced in the manner may, for example, measure 4" x 12" x 18" and when dried such blocks will weigh about 50 pounds each and have a compressive strength of about 100 pounds per square inch.

In order to produce a continuous ribbon of clay composition, such ribbon having a cross-sectional area of say 48 square inches, it has been found necessary to employ the pressure chamber 6 for the purpose of reconsolidating the stream of clay composition fed thereto by the auger 3. Attention is called to the fact that the stream of clay composition discharged by the end of auger 3 into the pressure chamber 6 is in effect a ribbon or stream of composition of a cross-sectional area determined by the radius of the screw 3 and the distance between opposing faces of flights of the screw at the end thereof. Rotation of the screw 3 produces what are known as "slickensides" to this ribbon or stream of clay, these polished or shiny surfaces being caused by the friction of the screw against the body of clay. Even when these surfaces are brought into contact with one another as they pass through a die opening, they are not bonded together and upon drying laminations or exfoliation of the object takes place along planes established by these adjacent surfaces.

In accordance with the process of the present invention, therefore, a consolidated stream of clay mixture is mechanically forced into an enlarged pressure chamber such as the chamber 6, for the purpose of destroying the stream form of the clay body and to reconsolidate the clay mass into a body of greater cross-sectional area than that of the stream entering the pressure chamber and of greater cross-sectional area than the cross-sectional area of the die.

The reconsolidated clay mass is then discharged through the die opening, this discharge being accomplished by pressure applied to the stream of clay mixture entering the pressure chamber. The auger or screw 3 therefore feeds clay mixture into the pressure chamber 6 and applies sufficient pressure thereto to cause reconsolidation and subsequent discharge through the opening in the die head 7.

In the exemplary form of apparatus illustrated herein the pressure chamber 6 is provided with a flange 14 adapted to be connected to the end of the cylindrical body 1 of the extrusion machine. The outer end of the chamber 6 is provided with a recessed flange 15 to which there is connected by suitable bolts the die head 7. The interior of the pressure chamber 6 may have the surfaces

16 inclined somewhat toward the die head 7. The die head 7 is provided with a rectangular opening or outlet port having upper and lower relatively long surfaces 17 and the shorter vertical side openings 18. The walls of the pressure chamber 6 leading toward the horizontally disposed edges 17 of the die opening are preferably provided with curved lugs 20 and 21 adapted to retard the flow of clay through the center of the pressure chamber, increasing the amount of clay passing through the horizontally disposed sides of the chamber. A breaker grill or bar 22 may be positioned between the lugs 20 and 21 and adjacent the end of the auger for the purpose of breaking up or disrupting the stream of material being fed into the chamber by the feeding auger.

Mounted upon a frame or spider 23 carried within the recessed flange 15 of the pressure chamber are reconsolidating cones 24 and 25 with their pointed ends facing the incoming clay mixture and their bases directed toward the die head 7. These reconsolidating cones 24 and 25 may be provided with spiral vanes oppositely inclined for the purpose of causing the clay mass to rotate, in part at least, around each of these reconsolidating cones and to mix and be compacted into a more homogeneous structure.

It will be noted, therefore, that the pressure chamber includes means for breaking up the incoming stream of clay body (such as, for example, the breaker bar 22 and lugs 20 and 21) and also includes means for reconsolidating the material, such as for example, the conical members 24 and 25. It is also to be noted that the open or available cross-sectional area through the pressure chamber is materially greater than the feeding area of the auger. Considerable pressure needs be exerted by the auger to force the clay through the pressure chamber and it has been found desirable to provide the exterior surface of the pressure chamber with a cooling jacket through which cooling water may be circulated since the movement of the clay mass through the pressure chamber generates considerable heat.

The construction of the die head 7 may be varied within wide limits. In the drawings, the die head is shown provided with a plurality of elements 27, 28 and 29 adapted to nest one within the other and to delineate the surfaces of the discharge opening through the die. The inner surface 30 of each of these elements is slightly tapered toward the outlet so that the surface 31 of element 28 slightly overlaps the surface 30 of the element 29. The clay mass passing through this series of stepped planes is therefore

repeatedly compressed and permitted to expand as it passes through the die head 7. The elements 27—29 may be surrounded by an annular space 32 supplied with a lubricant under pressure through ports 33 and 34. A dilute soap solution has been found to act as an effective lubricant although oil emulsions may also be employed. It is to be understood that minute channels may be formed in the edges of the elements 27, 28 and 29 in order to permit the lubricant to be discharged onto the inner surfaces 30, 31 and the like of such elements. A scorifying plate 36 is shown attached to the outer surface of the die head for the purpose of forming a plurality of parallel score lines on at least one surface of the ribbon of clay mixture discharged from the machine.

It will be found that the blocks discharged from the die head 7 are at superatmospheric temperature due to the high pressures employed and the high degree of reconsolidation obtained. As a result, the blocks may be readily dried and the drying or curing time is appreciably shortened. Infrared heaters placed along a continuous conveyor on which the formed blocks are carried have been found to expedite drying and produce an extremely uniform product.

Although in the example given blocks having a crushing strength of over 10,000 pounds per square foot have been reported, the present invention is not limited thereto. For most purposes, a block having a crushing strength of 6,000 or 7,000 pounds per square foot is deemed to be satisfactory. The amount and type of fibre employed affects the strength somewhat.

Although the machine and process herein disclosed have been described as they pertain to the manufacture of unburned clay blocks, the invention is not limited thereto since the machine may be employed with other compositions capable of being extruded. All changes and modifications coming within the scope of the appended claim are embraced thereby.

I claim:

In an extrusion machine of the auger type including a feeding auger and a die head, the combination of a pressure chamber positioned between the feeding auger of the die head, said pressure chamber having an open cross-sectional area greater than the feeding area of the auger, and means within the pressure chamber to mix said material and compress the same together, and reconsolidating means comprising a pair of conical elements with their apices directed toward the feeding auger.

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