May 23, 1933. R. P. HEUER 1,911,152

HIGH PRESSURE PROCESS OF MOLDING REFRACTORY BRICK

Filed Jan. 14, 1929

Fig. 1.

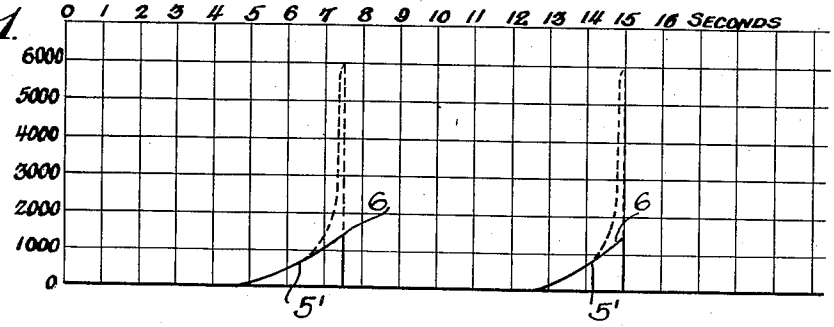


Fig. 2.

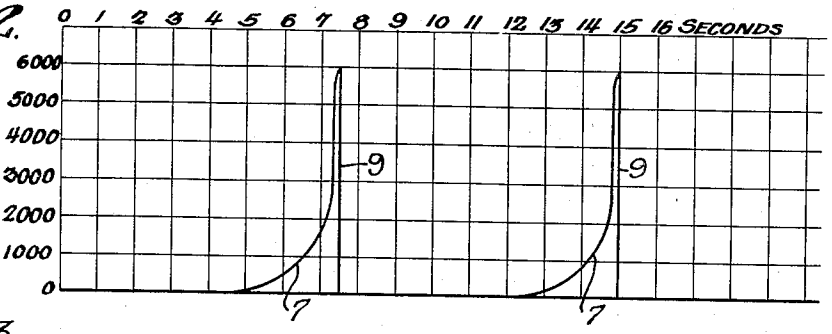


Fig. 3.

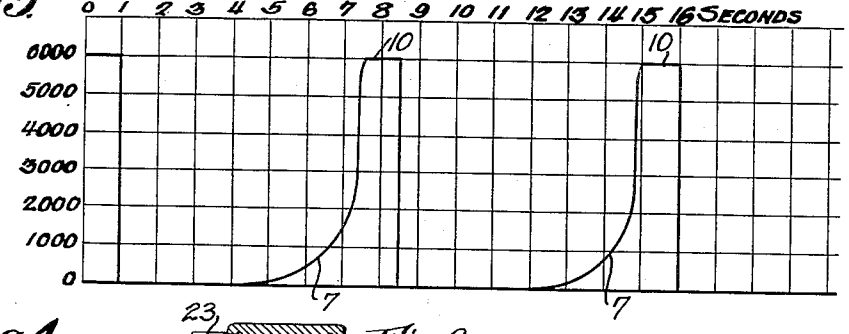


Fig. 4.

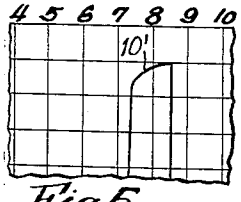


Fig. 5.

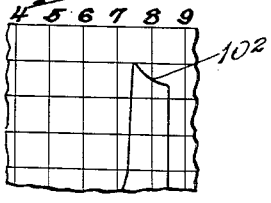


Fig. 6.

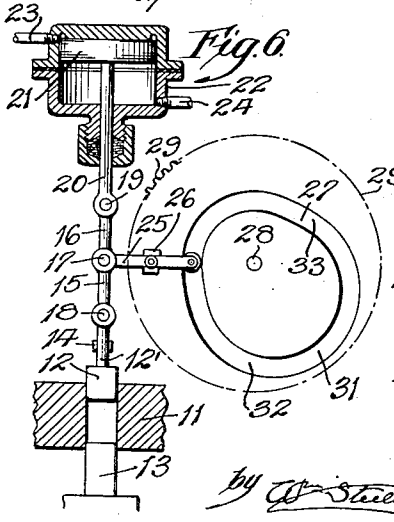
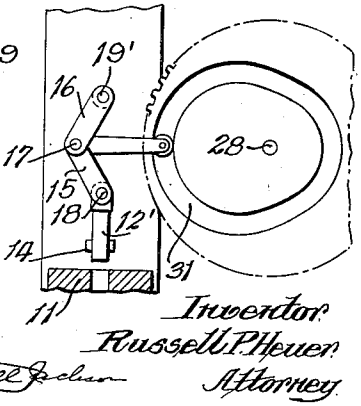


Fig. 7.



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UNITED STATES PATENT OFFICE

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HIGH PRESSURE PROCESS OF MOLDING REFRACTORY BRICK

Application filed January 14, 1929. Serial No. 332,287.

My invention relates to the manufacture of refractory brick under pressure.

The main purpose of my invention is to provide during the pressing operation for elimination of air from the materials from which the brick is formed, and at the same time to secure higher speed and higher pressure than have previously been permissible.

A further purpose is to press a refractory brick at high pressure from dry material and to retain the maximum pressure for a definite dwell during which the air compressed within the materials of the brick has opportunity to escape.

A further purpose is to secure a combination of speed in attaining full pressure necessary for the most desirable manufacture of refractory brick and of length of dwell required to attain a sufficient approach to equilibrium for the manufacture of good brick, along with a number of operations per minute commensurate with the requirements requisite for high pressure refractory brick manufacture.

Further purposes will appear in the specification and in the claims.

My invention relates to methods of manufacture, independent of the mechanism by which the methods may be carried out.

I have preferred to illustrate my invention by diagrammatic views only in order to make their independence of mechanism more clear.

Figures 1–3 are pressure-time diagrams indicating two cycles of press operation.

Figures 4 and 5 are fragmentary pressure diagrams corresponding generally to the diagrams of Figures 1, 2 and 3, but indicating modified characters of shift of pressure from increasing to decreasing pressure at the tops of diagrams such as are shown in those figures.

Figures 6 and 7 are a diagrammatic sectional view and a fragmentary diagrammatic side elevation illustrative of the manner in which the pressures are secured.

In the drawing similar numerals indicate like parts.

In the so-called dry pressing cycle of brick manufacture, such as is exemplified in Figure 1, it has been customary in the past practice to press four bricks at a time under a pressure of let us say from 1,000 to 1,500 lbs. per square inch pressure for 9 inch brick, the pressure increasing progressively as shown by the curves 5, of which two only are shown for two of the successive cycles. At the maximum position 6 it has been the practice to suddenly release the pressure as shown by the vertical terminal line of each of these curves. As is well known the material of the brick as placed within the mould necessarily contains quite a quantity of air which cannot be eliminated previously in the operation. Some of the air escapes during the pressure upon the brick. The compression is low enough in this case for the entrained air remaining in the brick not to cause any serious trouble and perfect brick have been manufactured by this method continuously with few rejections among the brick.

Efforts have been made to press brick at higher pressure and in practice the same press has been used for this purpose that has been used in pressing four bricks at a time at a pressure of say 1,500 lbs. per square inch. Where this press has been applied to the compression of a single 9 inch brick only, it has been possible to take advantage of the 6,000 lbs. per square inch pressure available by increasing the quantity of raw material, so that at the limit of the pressure by the press the full 6,000 lbs. per square inch is utilized in compression upon the brick. Two full cycles of this compression have been shown in Figure 2 which is also listed as prior art.

In the curves of Figure 2 it will be noted also that the pressure increases progressively from zero to the maximum with a difference from that of Figure 1 that the curve 7 shows a very much more rapid increase of pressure in the pressing of the cycle of Figure 2 than the cycle, curve 5, of Figure 1, with the result that the pressure shown in Figure 2 is increased from 2,500 lbs. to 6,000 lbs. per square inch quite suddenly, in fact almost instantaneously, with an immediate release of pressure following the attainment of the maximum pressure, shown by the vertical line 9. For comparison the curve 7 has been dotted into Figure 1.

In the attempt to press brick one at a time at pressures up to say 6,000 lbs. per square inch, as indicated above, almost all of the brick have proved to be defective, with the result that this cycle has not proved successful in the dry pressing of refractory brick at high pressure.

I have discovered that the reason for the high percentage of failure in the use of the higher pressure for dry pressing brick is due to two main causes, the formation of fissures and the setting up of stresses and strains in the brick.

The defective character of the brick is caused by the presence of some trapped air which existed without so much objection in the brick pressed at lower pressure, but which becomes a serious problem when the brick have been subjected to the higher pressure, resulting in the brick having fissures, cracks or laminations which afford partition lines for subsequent breakage or for penetration of molten metal within the individual bricks, and, furthermore, mechanically weaken the brick.

These cracks, fissures and laminations mean that the material of the brick is not homogeneous, and that there is no cohesion between the adjacent parts of the brick across these cracks.

It is difficult to determine how far the pressure set up by the entrapped air causes lack of cohesion in the individual brick, and how far it is due to the second cause of failure, namely, that the material of the brick is under strain due to the rapid development at the high pressure of unequalized or unrelieved stresses in it.

I have further discovered that both causes of failure which I have noted, can be overcome, and perfect brick can be produced at high pressure by maintaining the pressure for a short time, preferably while the pressure is at or near a maximum. The benefit obtained by use of this dwell in high pressure refractory brick manufacture is quite revolutionary, changing the product from one in which a large proportion of the brick are defective to one in which practically every brick is good.

While there may be other benefits which are derived from interposition of this dwell than those outlined I attribute the success attained by use of the dwell to the time given for escape of the air under pressure, thus cutting down or eliminating areas of separation due to air pressure and to the further fact that the strain is relieved during the time given by movement of the material under strain to a position of equilibrium.

I have illustrated two cycles of my improved process of high pressure pressing in Figure 3, in which the portion 7 of the curves may correspond exactly with the corresponding curve in Figures 1 and 2 but in which at the higher pressure a dwell 10 is provided before the pressure is released.

It is not my intention to suggest that the pressure must be uniform during what I have indicated as the dwell at 10. This line is shown as horizontal but this is not essential, and a large part of the benefit of my invention can be secured by an effective dwell which is convex, for example, as at 10′ in Figure 4, or concave and downwardly sloping as at 10^2 in Figure 5. In fact the more gradual completion of the pressure at approximately the maximum as in Figure 4 or a slight downward slope of the curve as in Figure 5 to permit gradual release of the higher pressure before total release of the pressure may have advantages which will justify their definite inclusion by the designer without, however, interfering with the general benefit obtained by the effective dwell between approximately the maximum pressure and the final release.

I have, of course, not made any effort to indicate all of the various ways by which my invention may be carried out, showing in Figures 3–6 the more obvious variations in the curves which may be effective to secure the benefit of rapid increase in pressure to high pressure with maintenance of sufficient pressure for sufficient time to obtain a satisfactory brick product.

The pressure desirable and the amount of variation of pressure which can be permitted during the dwell as well as the extent of dwell which might be desirable will vary according to the ingredients of the brick.

With a magnesite brick I have gotten excellent results with dwells of approximately one second each and have found that good results can be obtained with shorter dwells than this. Except for the interference with the speed of brick pressing the duration of the dwell could be increased to advantage.

It will be evident that my invention can be carried out by any machine which provides for the necessary pressure and the necessary dwell at or sufficiently near that pressure. In order to complete my illustration I have shown diagrammatically two variations of one form of press capable of carrying out the invention showing this form as typical or representative merely and without attempting to illustrate all the different forms of mechanism by which the pressure and dwell can be secured.

In Figure 6 the diagrammatic press and operating mechanism shown comprises a press 11 within which the material to be formed into brick is placed and within which this material is compressed by a plunger 12. The ejector is shown at 13. The plunger movement is made a straight line movement by suitable guides 14 and the plunger is operated by a pair of toggle arms 15, 16 of which 15 is pivoted to 16 at 17, and to the

plunger rod 12′ at 18. At the upper end the arm 16 is pivoted at 19 to the piston rod 20 of a piston 21 which operates in cylinder 22. Pressure is supplied and released through pipes 23 and 24 or vice versa.

In the position shown the hydraulic piston is at its extreme upper end and the hydraulic pressure is about to be applied.

The toggle is thrown by an arm 25 passing through a guide 26 fixed in space, but which may be free to turn to accommodate the movement of the pivotal point of the arm to movement of the piston rod 21. However, this can be accommodated in other ways.

The arm 25 is shifted and the toggle is thus in fact controlled by revolution of an internal cam 27 about a center 28 as driven by gear 29. The walls of the cam engage a roller 30 mounted upon the end of the arm 25.

Some part 31 of the cam such as that between points 32 and 33 represents substantially a dwell so that the toggle will remain closed during a corresponding part of the revolution of the cam.

In operation with this variation the pressure is raised from atmospheric pressure to any pre-designed intermediate pressure by operation of the toggle and the toggle is maintained in close position seen in Figure 6 while hydraulic pressure is supplied through pipe 23 to add the additional hydraulic pressure. This hydraulic pressure is maintained and the toggle is kept closed during the intended period of dwell while equilibrium is being reached or approached in the material forming the brick. The use of hydraulic pressure results in the pressure being maintained during the period of dwell, notwithstanding some slight diminution in the volume of the brick as air escapes from its mass. It does not make much difference whether pressure be released by opening the toggle or by releasing the fluid pressure except that the mechanical release is more complete and less wearing upon the operating mechanism of the toggle than is the operation of the hydraulic valve upon the hydraulic mechanism involved.

In the form shown in Figure 7 the parts are given the same numbers as in Figure 6 so far as the same parts are shown, except that the "dwell" 31′ of the cam is desirably formed as a slightly advancing cam, just sufficient to follow up the reducing volume of the brick and maintain the pressure. The operation is wholly mechanical and the arm 16 is therefore pivoted to a fixed pivot at 19′ instead of to a pivot movable with a piston rod. The cam and toggle are shown at the extreme open toggle position in this figure.

It will be evident that the dwell need not be long enough for complete equilibrium to be reached, i. e., to secure complete release of the trapped air and complete movement of material under unequal stress to position where the stress has become uniform. My invention does not anticipate that complete equilibrium can be reached in practical operation but merely that a sufficiently close approach to it can be reached to tremendously improve the quality of the brick and to change the process of manufacture of this type of high pressure refractory brick from a failure on account of the poor quality of the brick to a commercial success in view of the nearly 100 per cent good brick secured.

It will be evident that readjustment of the stresses and strains in the brick and/or elimination of air from the brick or water if the "dry" brick contain enough moisture for any of it to be extruded results in reduction in volume during the dwell which rigid pressure is not suited to follow up.

It will further be evident that after a sufficiently high rigid pressure has been reached suddenly the resilient pressure supplementing the rigid pressure permits the brick to be followed up by a substantially maintained high pressure notwithstanding the reduction in volume with the result that the dwell becomes fully effective as would not be true if the resilient pressure were not applied.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to other skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. The method of dry pressing refractory brick, and avoiding injury from trapped air and unequalized stresses in the brick, which consists in suddenly raising the pressure mechanically to a pressure in excess of three thousand pounds per square inch, hydraulically supplementing the mechanical pressure in maintaining the hydraulic pressure while opportunity is given for air escape within the brick and for equalization of stresses and in releasing the pressure, using the hydraulic pressure to maintain substantial uniformity of pressure as escape of air reduces the volume of the brick.

2. The method of dry pressing refractory brick, which consists in suddenly applying rigid pressure upon the brick up to a pressure in excess of three thousand pounds per square inch, in resiliently supplementing the rigid pressure, in maintaining the resilient pressure upon the brick notwithstanding the reduction in volume of the brick, long enough so that the resilient brick will be substantially free from laminations and in subsequently releasing the pressure.

3. The method of dry pressing refractory

brick, which consists in applying rigid pressure until a pressure is reached in excess of three thousand pounds per square inch and substantially below the maximum pressure to be applied to the brick, in applying resilient pressure while maintaining the rigid pressure until a maximum pressure is reached substantially in excess of the rigid pressure alone and in holding both the resilient and rigid pressures before release until reduction in volume of the brick ceases.

RUSSELL P. HEUER.