Dec. 29, 1936. T. S. CURTIS 2,065,566

CONVERTER

Filed June 14, 1935

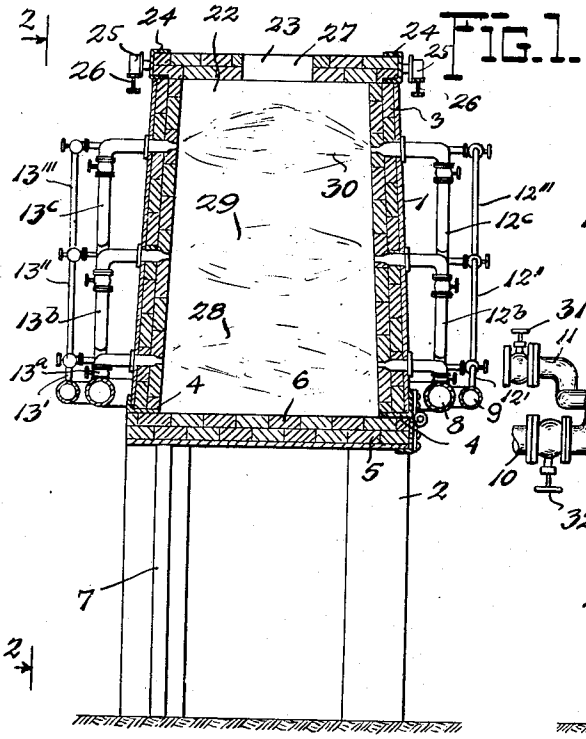


Fig. 1.

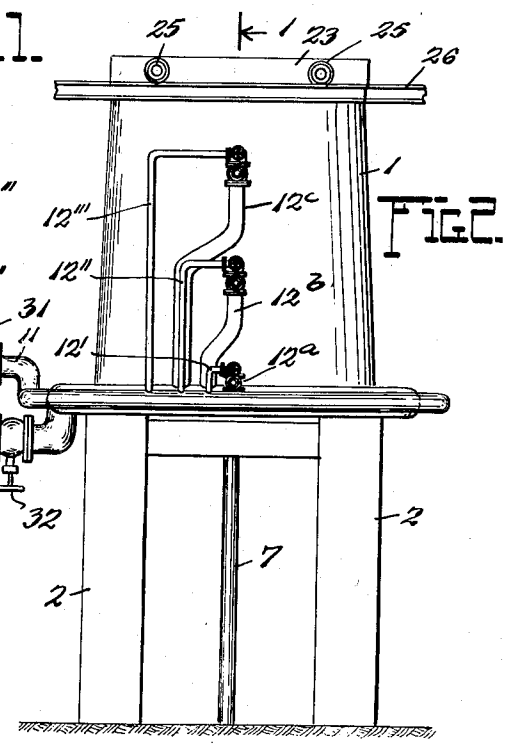


Fig. 2.

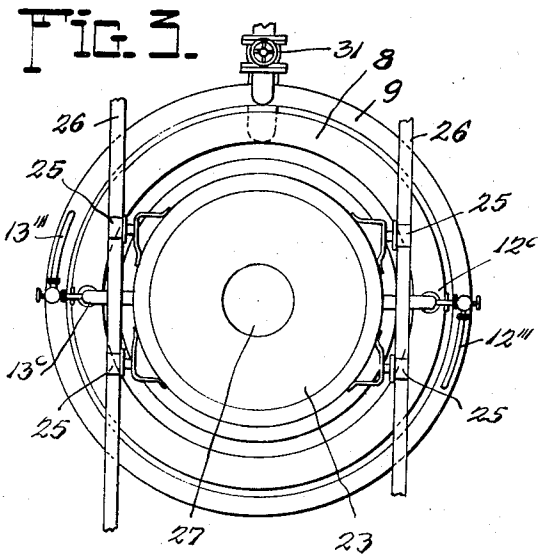


Fig. 3.

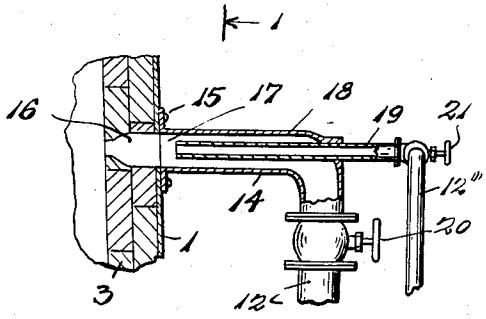


Fig. 4.

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2,065,566

CONVERTER

Thomas S. Curtis, Huntington Park, Calif.

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4 Claims. (Cl. 263—52)

In a furnace for the calcining of refractory materials such as fire clays, or the conversion of still higher refractory materials such as diaspore, kyanite, and the like into their respective end products, corundum and mullite, it has been the practice to light up fragmentary charges of the refractory materials in periodic kilns to which heat would be supplied by any means well known to the art.

My present invention involves an improved calcining machine or converter, wherein is employed the principle of surface combustion in that an explosive mixture of gas and air is admitted through ports or tuyères in the side walls of the vessel which provides the heat treatment or combustion chamber, the combustible mixture thus formed upon burning supplying the necessary heat to the charge contained in the said vessel or chamber. In my present invention I aim to improve upon the constructions of converters or machines such as above referred to, and of which an example is found in my Letters Patent 1,696,794 issued December 5, 1928.

For a full comprehension of my improved machine, it may be stated that it has been found in the employment of converters of the known types above referred to, and the practice of the method described generally above, including the machine or apparatus of my patent hereinbefore identified, that the zone represented by approximately 33⅓ to 50% of the total charge in the vessel is subjected to an extremely high temperature in the lowermost half of the combustion chamber. The rest of the charge is subjected to heat treatment in varying degrees by virtue of the escaping products of combustion which pass through it from the high temperature combustion zone aforesaid.

Heat treatment, according to this principle, while adequate for use in connection with extremely refractory materials, results in the over-firing or slagging of less refractory materials such as fire clay. The field of application of the prior types of converters, therefore, is restricted on the above account to the treatment of materials which will not melt even though subjected to the highest temperatures produced by the combustible gas and air fuel because the zonal heat distribution results in the manufacture of two or sometimes three grades of products in a single charge. This necessitates a sorting of the end product if only one type or grade of product is sought to be produced.

In the prior type of converter or calcining machine to which I have referred, wherein the tuyères are located in the bottom of the vessel, clogging of the gas and air ports in charging the converter is a disadvantage of its use, at times necessitating a dumping of the charge and a refilling of the machine. Likewise, in the prior types of converters which depend upon tilting of the vessel receiving the charge preliminary to tilting, disconnection or breaking of the various large gas and air supply connections is necessitated.

Now in my improved apparatus of this invention I aim to overcome the disadvantages of prior art constructions of converters, one of the primary objects in view being to design my converter structure so that the vessel receiving the charge is stationary, is equipped with a charging opening at its upper end, and provided with discharging means at its bottom or lower end so that the discharge of the highly heated materials in the converter or vessel into a suitable fire brick lined pit beneath the same is facilitated. By the above construction I am enabled to build the shell or vessel on a stationary foundation and am under no restriction, practically or commercially speaking, in reference to the size of the machine so far as structural or mechanical factors are concerned. In smaller machines a single bottom discharge door suffices for practical usage, whereas in larger machines a plurality of such doors may be provided and the general provisions are such that the charge may be delivered vertically from the bottom of the vessel, something of obvious advantage in the practical operation of machines of this type.

Another very important feature of my invention resides in the method of operation and construction features employed by me for the admission of the combustible mixture of gas and air into the improved machine. For this purpose, in the first place, I avail of tuyères or ports which are built into the sides of the shell, cylinder, or vessel receiving the charge of materials, thus entirely obviating the objectionable results of clogging incident to the employment of bottom tuyères or ports, but in addition to the foregoing, I utilize the positioning of the tuyères in the side walls of the vessel or converter in such a manner as to effect a thorough diffusion and dispersion of the total volume of gas and air required for the heat treatment operation, over a relatively large area of the wall structure of the vessel with the result of total elimination of over-firing or melting of refractory materials of lesser pyrometric cone equivalent value, which materials could not be heat treated

at all in the types of converters and calcining machines heretofore proposed. In reality, I position the tuyères in the side walls at locations one above the other for what may be characterized as the different combustion zones of the combustion chamber, this enabling me to proportion the total necessary fuel over the tuyères disposed for supplying the different combustion zones in such a manner as to obtain the previously referred to diffusion and dispersion of the total volume of the fuel over a relatively large area. The said disposition of the tuyères enables me to establish a series of combustion zones, virtually, one above the other, starting from the bottom of the machine and extending to the top, the products of combustion from each lower zone serving to pre-heat the charge in the zone immediately above, and the fragments of material in each zone upon reaching incandescence serving to pre-heat the entering gas and air to such a degree that temperatures actually higher than theoretical flame temperatures are readily obtained in the improved machine.

Since in my new construction of converter a cover may be readily employed at the upper open end of the charge containing vessel, the heat therein may be confined with a control, which, in conjunction with the capability of thoroughly diffusing and dispersing the gas and air, enables the charge to be heat treated throughout its mass to a uniform degree, with the resultant advantages previously mentioned.

Still another object of the invention has been to provide control or valve means for the gas and air lines individually to regulate the passage of the gas and air therethrough and through the tuyères so that the volumes of fuel supplied to the several combustion zones may be nicely regulated with the result that only the required amount for proper combustion may be availed of, this amount decreasing of course progressively and upwardly since the preheating of the products of combustion of an upper zone by the combustion below the same reduces the amount of fuel required in the upper zones; less and less fuel is necessary the nearer the zones are located to the top of the vessel or combustion chamber.

Further and other objects of the invention will become apparent from the following description and appended drawing, in which—

Figure 1 illustrates a cross sectional view of a converter adapted for heat treatment of refractory materials.

Figure 2 is an elevational view of the structure shown in Figure 1, looking in the direction of the arrows 2—2.

Figure 3 is top view of the converter shown in Figure 2.

Figure 4 illustrates an enlarged detail view of one of the mixing units for the combustible gas and air mixture.

Referring now to the drawing, and especially Figures 1 and 2, 1 indicates a cylindrical shell member which is mounted upon a stationary foundation or base as indicated at 2. The inner wall of the cylindrical shell member is lined with a suitable refractory or heat resistant material indicated at 3. A retaining member or ring 4, connected to the shell member 1 in any suitable manner, is arranged for supporting and retaining the refractory or heat resistant lining in its proper position. The shell member 1 and lining 3 are slightly tapered, as clearly shown in Figure 1, to facilitate the release of the clinkered charge upon discharge of the material within the converter, as will be more specifically shown as the description proceeds.

Hinged to the outer shell member is a circular door 5 which is also lined with heat resisting material 6. Said circular door forms the bottom portion of the converter and is held in closed position by means of a retaining member 7 which may be a removable leg or brace or other equivalent supporting member. Surrounding the shell 1 and supported thereby are air and gas main conduits or bustle pipes 8 and 9 which are connected to gas and air supply apparatus by means of pipes 10 and 11. Leading from the bustle pipes 8 and 9 are air conduits 12a, 12b, and 12c oppositely arranged with respect to air conduits 13a, 13b, and 13c. Similarly arranged and associated with the said air conduits are gas conduits 12', 12'' and 12''', and 13', 13'' and 13'''. The respective gas and air conduits are interconnected with mixing units 14 attached to the outer wall or shell 1 of the converter structure by any convenient means as shown at 15. Tuyères 16 are formed in the walls or refractory lining 3 of the converter, said tuyères being in alignment with the passages 17 of the mixing units.

The mixing units 14 comprise the housing or casing member 18, into which lead the gas jets 19. The air conduits 12a, 12b, 12c, 13a, 13b, and 13c are provided with valves 20 to regulate the flow of air to the mixing unit, and the gas conduits 12', 12'', 12''', 13', 13'', and 13''' are similarly provided with control valves 21 to control the flow of gas to the mixing unit 14. It will be seen, therefore, that by regulating the control valves 20 and 21 the gas and air mixture discharging to the converter compartment 22 through the tuyères 16 may be critically adjusted for purposes explained later on.

A removable cover structure 23 of heat resistant material is mounted within a metal frame 24 carrying rollers 25 operatively engaging tracks or I-beams 26 to thereby support said cover structure and to permit movement of the same with respect to the remaining stationary parts of the converter structure. The tracks 26 may be mounted within the frame structure of a building in which the converter is arranged in any suitable manner. The cover member 23 is also provided with a circular opening 27 to permit escape of gases or the like, and said opening may be interconnected by any suitable conduit with the flues of a chimney or the like to discharge the escaping gases outside the building within which the converter is located.

When the door is in its closed position, as shown in Figure 1, and the cover 23 is laterally removed with respect to the converter, the furnace may be charged with materials to be treated, whereupon the cover is moved to closed position and the lowermost air and gas control valves are opened, and the combustible mixture now admitted to the lowermost tuyères into the furnace compartment 22 is ignited and adjusted in a manner later on described. When a perfect combustion in this lower zone of the furnace or converter is accomplished, the next highest set of air and gas control valves is opened and the conbustible gas and air mixture admitted to the zone directly above the first combustion zone is now adjusted to give a perfect combustion in this latter zone, whereupon the uppermost gas and air control valves are opened to admit the combustible mixture in the uppermost

zone of the furnace and the same is again properly adjusted for its most effective combustion in the same manner as previously referred to.

It will therefore be seen that the admission of the combustible mixture of gas and air into the combustion chamber is through tuyères or ports **16** built into the sides of the cylinder, thereby obviating the clogging of the said ports which has been a considerable disadvantage in converters of the prior art where the ports were arranged at the bottom thereof. The positioning of the tuyères in the side walls of the vessel is such as to permit a thorough diffusion and dispersion of the total volume of gas and air required for heat treatment over a relatively large area.

The proportioning of the total necessary fuel over a number of tuyères disposed in the side walls of the machine enables the maintenance of a series of combustion zones starting from the bottom of the machine and extending to the top. These combustion zones have been indicated in Figure 1 of the drawing by reference numerals **28, 29,** and **30.** The products of combustion from each zone serve to pre-heat the charge within the converter in the zone immediately above, and the fragments of material in each zone upon reaching incandescence serve to preheat the entering gas and air to such a degree that temperatures actually higher than theoretic flame temperatures are readily obtained.

Since the temperatures employed for the heat treatment of very refractory materials are so high as to be beyond the range of precious metal pyrometry, no direct thermoelectric method of temperature determination is available. It is possible, and so practiced, to place observation ports in the walls of the vessel, which ports upon being sealed at the end with a transparent window, permit approximate temperature readings to be taken with a pyrometer.

The adjustment of gas and air mixtures and volumes may, however, in view of the peculiar arrangement of a plurality of mixing units of my converter structure, be made through the aid of sound alone.

The operation of the converter of the present application is accompanied by a series of explosions of extremely high frequency forming a continuous detonating sound which is at its peak when the gas and air volume and mixture is at the ideal point. The individual adjustment of the gas and air control valves can thus be so critically made that to the trained operator a difference in the tone emitted by the machine tells him instantly whether the proper combustion conditions are maintained. If desired, however, the control of the admission of the proper volume of gas and air may be derived solely in the size of the orifice in the tuyères or ports, especially if but one material is to be heat treated and its characteristics are understood, but if any change is contemplated from one type of material to another, the individual adjustment of gas and air control valves is of greatest importance for the production of a uniform final product.

In practice the combustion of the converter of the present invention will be regulated as follows: The lowermost gas and air control valves are opened, the combustible mixture is ignited, and the operator may now adjust the gas and air control valves of the lowermost mixing units until the sound emitted by the machine indicates to him that the gas and air volume and mixture is at the ideal point, whereupon the control valves of the next highest mixing units are opened and adjusted in the same manner as previously stated; finally the uppermost gas and air valves are opened and the combustion is also critically adjusted so that when the machine has been started in this manner the combustion in the zones **28, 29** and **30** will be accurately determined. It will therefore be seen that in the heat treatment of less refractory materials, overfiring or slagging of the same will be absolutely eliminated because the temperature of the various combustion zones is so carefully adjusted that no over-heating of the charge in any zone is possible.

As previously stated, the combustible mixture entering the vessel through the lowermost tuyères will be of much greater volume than the mixture admitted through the tuyères located above the same, and this is necessary in view of the fact that the materials located in the second combustion zone are already pre-heated by the heat escaping from the lower combustion zone and no matter how many mixing units are used in connection with the converter described herein, the volume of gas and air admitted will gradually decrease from the tuyères located close to the bottom toward those located at the uppermost portion of the converter. In order to avoid danger of explosion through backfiring through the tuyère into the gas supply line, the gas pressure should be slightly higher than the air pressure. The relation between the gas and air pressure is otherwise of no consequence, as long as the proper explosive mixture is maintained. The position of the gas jets within the mixing unit is also of no consequence provided that the same are in back of the orifice of the tuyères.

The duration of heat treatment with a given gas and air input in cubic feet per hour determines the thoroughness of the conversion. If merely fire clay is to be calcined in order to reduce its shrinkage, a heat treatment of a single hour is usually sufficient since incandescence ensues within a few minutes after the last traces of moisture and water crystallization are removed from the clay. If it is desired to effect a marked physical change in the microstructure of the mineral, the duration of heat treatment and the developed temperature received from a control of the volume of gas and air per hour being burned, may be determined by either physical tests, X-ray analysis, or petrographic analysis of the physical charge to be heat treated; thereafter a duplication of that result becomes a function of gas and air volume per hour against a definite time. Thus, the maintenance of a predetermined physical structure becomes a matter of exact calculation once the characteristics of the material are determined for a given size of converter.

When the process of heat treatment has been finished, the main gas and air control valves **31** and **32** are closed, and the supporting member **7** may be removed, whereupon the door **5** will swing downwardly upon its hinges and will permit the charge to be delivered vertically from the bottom of the vessel into a suitable fire brick lined space or the like. In view of the slightly tapering walls of the converter, all of the materials treated therein will be properly discharged without any likelihood that any residue thereof which may become clogged to the lining of the converter, will remain therein. Upon closing of the door **5,** the converter may be charged again, and by opening the main gas and air valves **31**

and 32 the furnace may be immediately restarted without any re-adjustment of the air and gas control valves 20 and 21. Obviously, instead of the single door 5, a plurality of door sections may be movably mounted at the discharge end of the converter and if desired manual or power operating appliances may be resorted to for controlling the opening and closing movements of said door sections. In larger installations the sectional construction of discharge door means would be preferable as well as the employment of power actuating contrivances of any suitable type.

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

1. A converter for heat treatment of refractory materials, or the like, comprising a combustion compartment having a charging opening at its upper portion and a discharge opening at its lower end, and including side walls, a cover for the charging opening aforesaid, and a discharge door for the discharge opening, a plurality of tuyères in the side walls of said compartment for conducting fuel thereto, said tuyères being disposed one above the other to admit fuel to the compartment in superposed zones thereof, and fuel supply means for the tuyères for varying the amount of fuel supplied to the tuyères to the extent that less fuel is supplied to an upper tuyère than to a lower tuyère in proportion to the preheating effect of the lower combustion zone on the superposed zone.

2. A converter for heat treatment of refractory materials, or the like, comprising a combustion compartment equipped with charging and discharging means, the side walls of the combustion compartment being provided with tuyères located in superposed areas or zones of the combustion compartment, and means for supplying fuel to the tuyères of a lower combustion zone of the said combustion compartment and to the tuyères of a higher combustion zone in the proportion of less fuel to the higher combustion zone than is fed to the lower combustion zone, according to the preheating effect of the lower combustion zone on the higher zone.

3. The method of heat treating refractory materials, or the like, which consists in subjecting refractory materials within a converter to heat of combustions in various zones, and regulating the heat in the various zones in proportion to the preheating action of each zone on its adjacent zone to thereby maintain a uniform temperature throughout the converter.

4. The method of heat treating refractory materials or the like, which consists in subjecting refractory materials within a converter to heat of combustions in various superposed zones, whereby to avail of the preheating action of the products of combustion in the lower zones on the relatively higher zones, and regulating the heat of combustion to progressively lesser degrees from the bottom zone to the top zone to thereby maintain a uniform temperature throughout the converter for the production of a uniform final product.

THOMAS S. CURTIS.