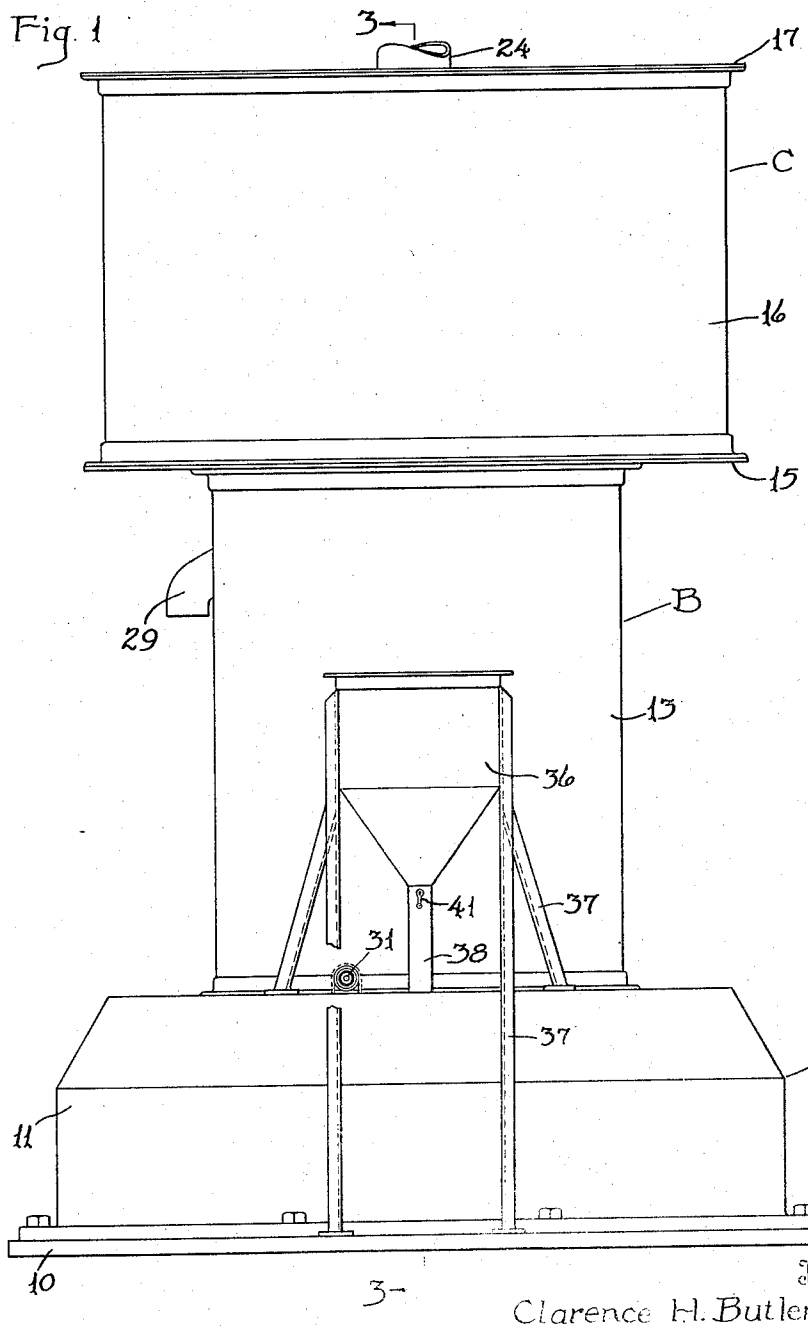
Sept. 6, 1938. C. H. BUTLER 2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Filed Dec. 17, 1936 5 Sheets-Sheet 1

Fig. 1



3

Inventor

Clarence H. Butler

By Lawrence & Lagaard

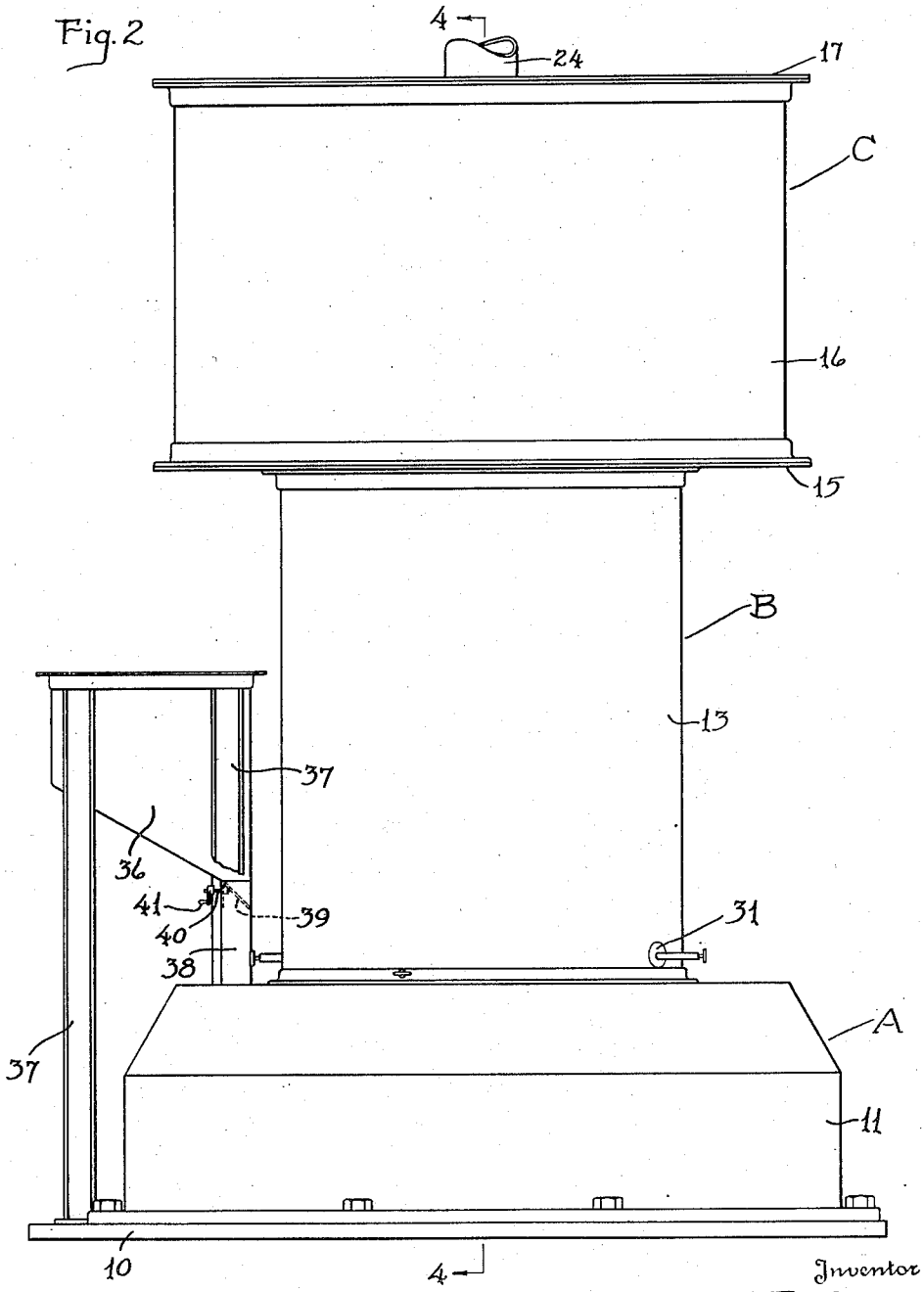
Attorneys

Sept. 6, 1938. C. H. BUTLER 2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Filed Dec. 17, 1936 5 Sheets-Sheet 2

Fig. 2



Inventor
Clarence H. Butler

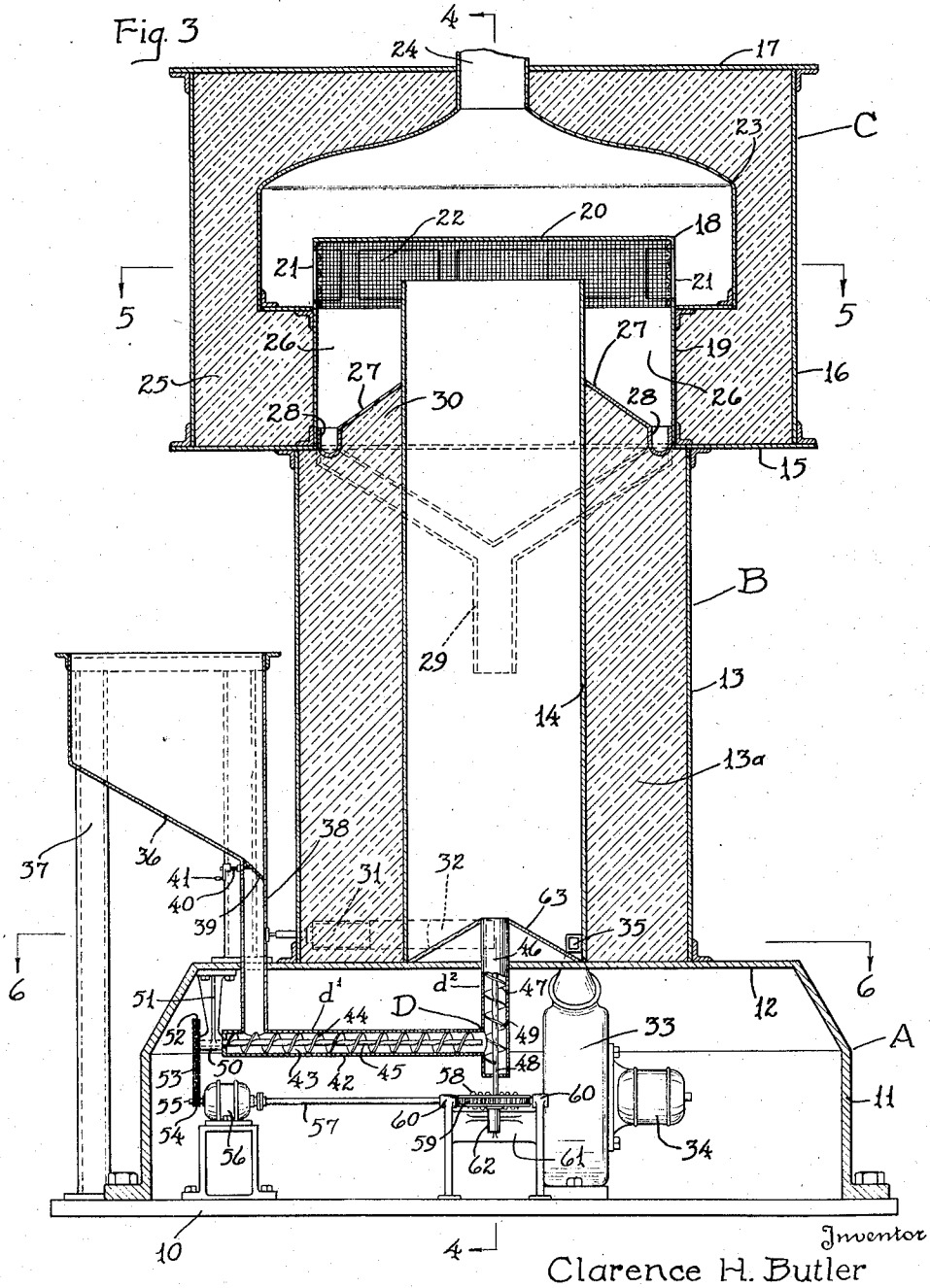
By Bacon & Lagaard
Attorneys

Sept. 6, 1938. C. H. BUTLER 2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Filed Dec. 17, 1936 5 Sheets-Sheet 3

Fig. 3



Inventor

Clarence H. Butler

By Cowell & Lagaard

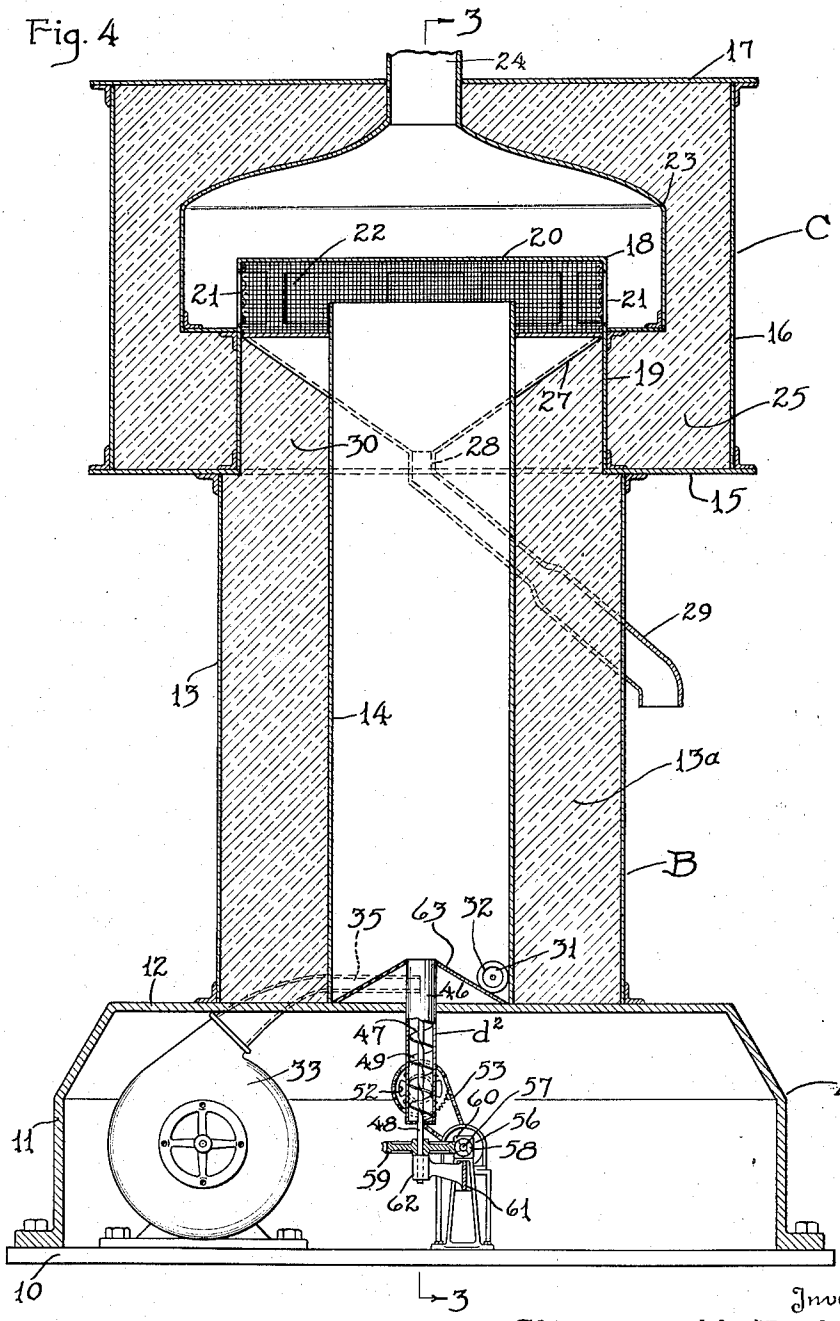
Attorneys

Sept. 6, 1938. C. H. BUTLER 2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Filed Dec. 17, 1936 5 Sheets-Sheet 4

Fig. 4



Inventor

Clarence H Butler

By Cruce & Ragsdale

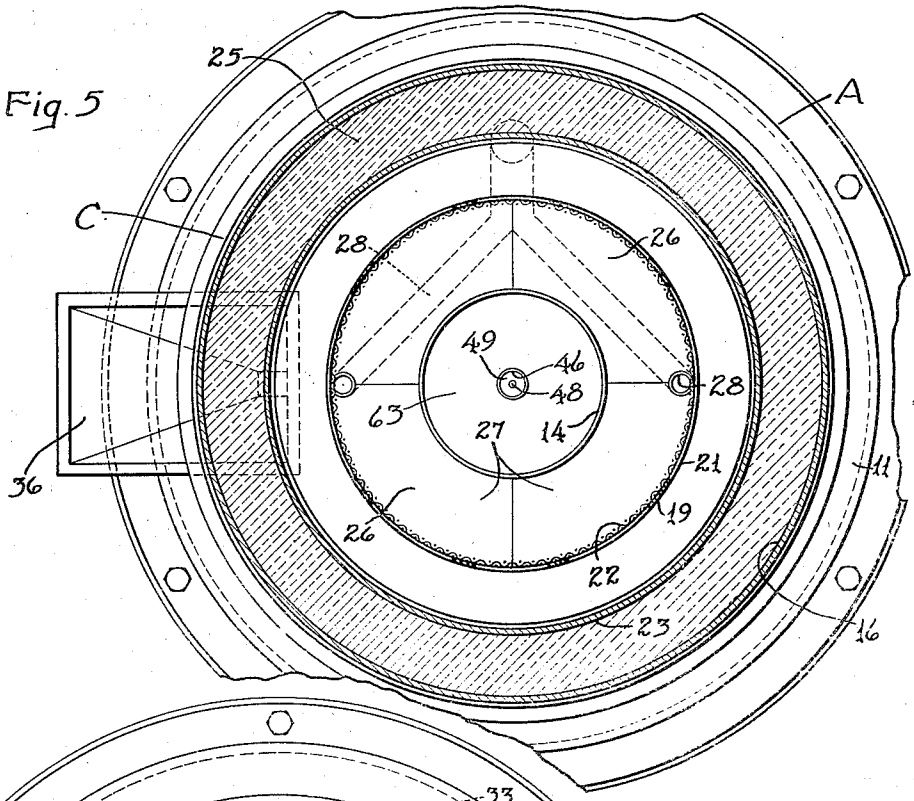
Attorneys

Sept. 6, 1938. C. H. BUTLER 2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Filed Dec. 17, 1936 5 Sheets-Sheet 5

Fig. 5



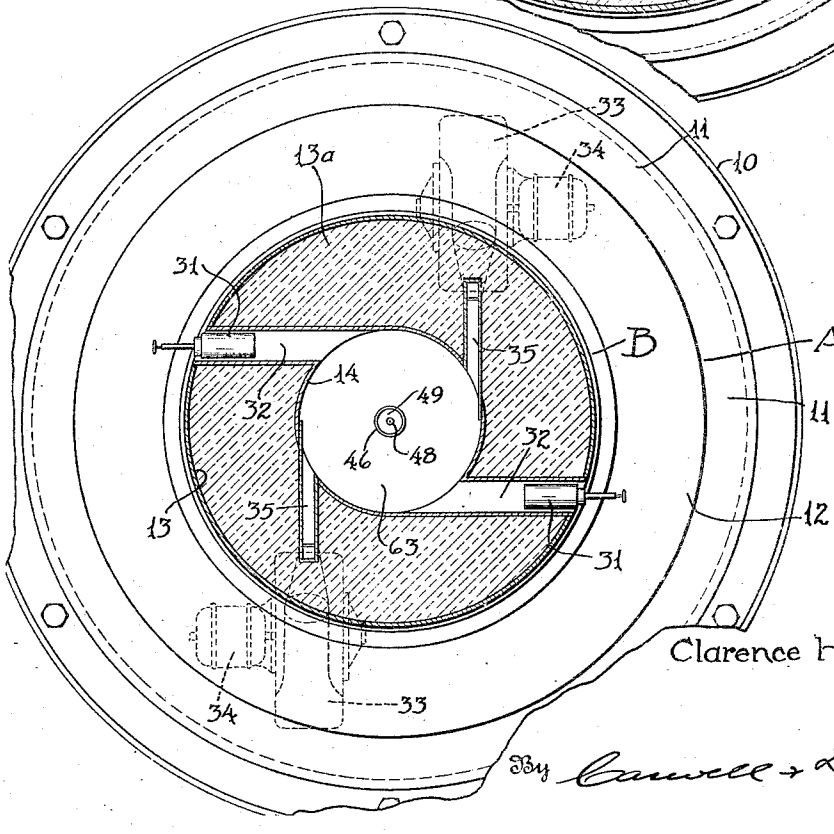


Fig. 6

Inventor
Clarence H. Butler

By Cowell & Lagaard
Attorneys

Patented Sept. 6, 1938 2,129,523

UNITED STATES PATENT OFFICE

2,129,523

MEANS FOR EXFOLIATING VERMICULITE AND SIMILAR MINERALS

Clarence H. Butler, Austin, Minn., assignor to Amalgamated Minerals Corporation, Minneapolis, Minn., a corporation of Minnesota

Application December 17, 1936, Serial No. 116,330

14 Claims. (Cl. 263—21)

My invention relates to improved means for and method of exfoliating vermiculite and similar minerals.

In treating pieces of micaceous minerals of the vermiculite group, it has been found that the pieces will expand at right angles to the planes of their laminae, whereby such pieces are resolved into elongated cellular structures, in which form they may be used to good advantage as heat insulating media or may be readily treated to permit of the practical utilization of their constituents.

The exfoliation of vermiculite has been accomplished heretofore through various methods employing apparatus of various constructions in which the mineral pieces are gradually preheated before being subjected to a temperature gradient sufficient to effect exfoliation and in which such pieces during treatment contact each other by their own weight, and also contact heated surfaces along which the mineral pieces progress. I have found that such contact of the mineral pieces is objectionable. The pieces are not evenly heated throughout, with the result that many of them, upon being expanded, become distorted and oftentimes break into relatively small fragments, which defeats the objective of securing uniformity in the ultimate product. And, too, excessive heating causes the mineral pieces to become objectionably friable or easily crumbled.

In the use of prior methods and apparatus for exfoliating vermiculite, it has been found that because of a number of varying conditions it has been difficult to procure a satisfactory product. The variations in the ore compositions, the sizes of the mineral pieces and the differing moisture contents thereof have been factors leading to underheating, with the attendant lack of maximum exfoliation, or to overheating which results in an objectionably friable or fragile product.

It has been my purpose to provide an effective method of and a simple and economically operated apparatus for exfoliating vermiculite, whereby the objections, heretofore experienced in prior methods and apparatus, are overcome.

More specifically, it is an object of my invention to provide a method of exfoliating vermiculite and an apparatus for carrying out such method, whereby the mineral pieces to be treated are picked up at one elevation by a hot gaseous carrier, wherein the pieces are expanded and carried to a higher elevation for recovery.

Another object of the invention is to provide a carrier for exfoliating pieces of vermiculite, such carrier comprising a maintained columnar vortex of hot helically ascending gases adapted to pick up and sustain the mineral pieces while the exfoliation thereof is initiated and to elevate the pieces to a level for delivery, as the exfoliation of the pieces progresses to completion.

A further object of the invention resides in the provision of a heat treating carrier, as above, for exfoliating vermiculite, in which the ultimately expanded mineral pieces are flung into a receiver by centrifugal force acquired in the vortex.

Other objects of the invention reside in the novel combination and arrangement of parts and in the details of construction hereinafter illustrated and/or described.

In the drawings, Figs. 1 and 2 are angularly related elevational views of a furnace structure embodying my invention in means for carrying out my improved method of exfoliating pieces of micaceous minerals; Figs. 3 and 4 are vertical central sectional views of the structure shown in Figs. 1 and 2, Fig. 3 being taken as on the line 3—3 of Fig. 1, Fig. 4 being taken as on the line 4—4 of Fig. 2, and as on the line 4—4 of Fig. 3; Figs. 5 and 6 are horizontal sectional views of the structure shown in the previously mentioned figures of the accompanying drawings, Fig. 5 being taken as on the line 5—5 of Fig. 3, and Fig. 6 being taken as on the line 6—6 of Fig. 3.

Reference being had to the accompanying drawings, it will be observed that the apparatus therein shown includes a base A, body B and head C.

The base A is a hollow structure comprising a floor-plate 10 and an inverted cup-shaped casting consisting of an annular side wall 11 and a top or bed-plate 12.

The body B includes an upright cylindrical shell 13. Within said shell is a stack 14, circular in cross-section, the shell and stack being coaxially related and both thereof supported, on end, on the bed-plate 12 of the base A. The annular space between said shell 13 and stack 14 is filled with a suitable heat insulating material 13a, such, for example, as the product (exfoliated vermiculite) produced in the present apparatus.

The head C of the apparatus includes a shell consisting of an annular supporting plate 15, an upright cylindrical wall 16 of greater diameter than the shell 13 of the body B, and a cover plate 17. The inner marginal portion of said annular supporting plate 15 rests upon the upper edge of the shell 13 of the body B. Within the shell of the head C is a dome 18 consisting of an upright

cylindrical wall 19 and a crown sheet 20. The wall 19 rests at its lower edge on the inner marginal portion of the annular supporting plate 15 and has a series of openings 21 therein near the crown sheet 20, said series of openings completely encircling said wall and being covered with a strip of screen wire 22. Capping the dome 18 is a hood 23 from which extends a flue 24. A heat insulating material 25, such as employed in the body B of the device, is also employed in the head C, this material being packed into the annular space between the dome wall 19, hood 23, flue 24, supporting plate 15, wall 16 and cover plate 17.

The upper portion of the stack 14 extends from the body B into the dome 18, and terminates at the level of the screened openings 21 in the dome. Beneath said level are a pair of semi-circular hoppers 26 which are formed, in part, by the upper portion of the stack 14 and the lower portion of the dome wall 19. These hoppers 26 include sloping bottom walls 27. Each hopper 26 empties into a discharge conduit 28 which branches into a delivery chute 29 issuing from the body B. To assist in insulating the device against the loss of heat, insulating material, as at 30, is added to that of the body B and piled up into the dome 18 to meet the sloping walls 27 of the hoppers 26.

In operation, a columnar vortex of hot, helically ascending gases is provided within the stack 14, the same being created and maintained by introducing blasts tangentially into said stack at the lower portion thereof. In the illustrated apparatus, the use of two burners and two blowers is indicated. Burner heads 31, suitably supplied with fuel oil and air under pressure, are fitted in passageways 32 leading tangentially into the stack 14, there being one head to each passageway and said passageways being diametrically opposed. The hot blasts from the burners 31 are resolved into a columnar vortex within the stack 14, a helical ascension of the gases in the whirling column being caused by the constant replenishment of the hot gases from the burners 31. Blasts from two blowers 33 augment the whirling gases derived from the burners 31 and increase the buoying power thereof. These blowers 33 are located within the base A of the apparatus and are driven by electric motors 34. Each blower 33 connects with a tuyère 35 which is directed into the stack 14 tangentially thereof, and substantially at the level of the burners 31. The two tuyères 35 communicate with the stack 14 at diametrically opposed localities angularly related with respect to localities at which the burner passageways 32 communicate with said stack.

The pieces of mineral to be treated are introduced into the lower portion of the stack 14 by feeding means including a supply hopper 36 supported on legs 37 having their footing on the base structure A. Taking off from the bottom of the hopper 36 is a downwardly directed conduit 38 which extends through the bed-plate 12 of the base A and into the space within said base. A gate 39, playing in said conduit 38 is controlled by means of an adjusting screw 40, threaded through the wall of said conduit and conveniently manipulated by a handle 41. Said take-off conduit 38 leads to a screw conveyor D which, in turn, leads into the stack 14. This conveyor D has two sections d', d_2, section d' being horizontally disposed and consisting of a tubular case 42 within which is enclosed a conveyor screw 43 comprising a helical flight 44 and an axial shaft 45 forming the stem therefor. The section d^2 of said screw conveyor D extends vertically through the bed-plate 12 of the base A and is axially aligned with the axis of the stack 14. This second conveyor section d^2 comprises a tubular casing 46 in which is housed a screw 47 consisting of a shaft 48, and a helical flight 49 encircling the same. The conduit 38 taking off from the hopper 36 connects at its lower end with the conveyor casing 42 near its outer end, and said casing 42 is connected at its inner end with the upright casing 46 near the lower end thereof. The conveyor shaft 45 projects from the casing 42, the projecting portion of said shaft being mounted in a bearing 50 on a hanger 51 depending from the bed-plate 12 of the base A. Secured to said shaft 45 is a sprocket wheel 52 which is connected by an endless chain 53 with a smaller sprocket wheel 54 mounted on the shaft 55 of an electric motor 56. Coupled with the motor shaft 55 is a worm shaft 57 having a worm 58 thereon which meshes with a worm wheel 59 mounted on the conveyor shaft 48. A pair of aligned bearings 60 on a bearing standard 61 receive the worm shaft 57 and a bearing 62 on the same standard receives the conveyor shaft 48.

At the bottom of the stack 14 and resting upon the bed-plate 12 of the base A is a frusto-conical deflector 63, through which the upper portion of the conveyor case 46 extends. Thus, it will be seen that the section d^2 opens into the stack 14 at the level of the top of the deflector 63 which is above the level of the burner passageways 32 and blower tuyères 35. Said deflector 63 causes the blasts from the burners 31 and blowers 33 to be inclined upwardly in the stack 14, the degree of inclination depending upon the particularly selected pitch of the deflector.

In the use of the illustrated apparatus for treating micaceous minerals, a supply of small pieces of such mineral is placed in the hopper 36. The burners 31 and blowers 33 are started and, likewise, the screw conveyor D. With the hopper gate 39 opened, more or less, according to the ability of the apparatus to accommodate the particular mineral stock employed, the mineral pieces gravitate in a stream from the hopper 36 to the horizontal section d' of the conveyor D, wherein said pieces are advanced to the vertical section d^2 of said conveyor. Through said vertical conveyor section, the mineral pieces are thence gradually progressed, being ultimately caused to issue from the upper end of the conveyor case 46 in uninterrupted flow. Upon being exposed to the upwardly inclined whirling blasts from the burners 31 and blowers 33, the mineral pieces are picked up in the vortex of hot gases, the force of the combined blasts being sufficient to sustain the raw mineral pieces in suspension and the temperature gradient of said blasts being sufficient to initiate the transmutation of such mineral pieces. As the mineral pieces expand the surface area thereof increases with the result that the expanding pieces are elevated in the helically ascending gases of the vortex, the speed of their elevation depending upon the degree of expansion attained. Though the buoying force of the whirling gases in the vortex near the top of the stack 14 is relatively diminished, it is sufficient, by design, to raise the expanded or exfoliated mineral pieces to the lip of said stack over which such pieces are thrown by centrifugal force. While the gases, issuing from the stack

14, pass through the screened openings 21 of the dome 18 and thence through the hood 23 to the flue 24, the expanded mineral pieces ejected from said stack are caught within the dome 18, whence they gravitate into the receiving hoppers 26 and through the same to the discharge conduits 28 which lead to the delivery chute 29.

The diameter and length of the stack 14 and the capacities of the burners 31 and blowers 33 (the quantity and pressure of the air and the temperature gradient of the blasts considered) are such that the mineral pieces, fed into the stack, will be picked up in the hot vortex, then gradually elevated concurrently with their expansion, and finally will be tangentially ejected from the top of the stack 14 upon becoming fully exfoliated.

In my improved method, I economically accomplish the creation and maintenance of a columnar vortex of helically progressing, heated gases, which picks up mineral pieces, advances and treats the same, in suspension, and ultimately ejects the expanded pieces. In this method, the time element is automatically regulated, since the quicker the expansion of any individual piece, the quicker its progress from the zone of greatest heat in the gaseous vortex carrier. Thus, the method is highly efficient. The product resulting therefrom is substantially uniform, without appreciable distortion, and is fully transmuted without being rendered friable and easily crumbled through overheating.

Changes in the specific form of my invention, as herein disclosed, may be made within the scope of what is claimed without departing from the spirit of my invention.

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

1. In an apparatus for heat treating pieces of material, a structure forming a stack, means for directing a heated blast into the stack, tangentially thereof, to create in the stack a columnar vortex of hot, helically ascending gases, means for feeding the pieces to be treated into the vortex at one elevation, and means for recovering the heat treated pieces from the vortex at a higher elevation.

2. In an apparatus of the character described, a base, a stack supported on end by said base, a frusto-conical deflector in the lower portion of the stack, blast passageways leading into the stack tangentially thereof at a level between the base and crest of said deflector, burners for supplying heated blasts to said stack through said passageways, tuyères directed tangentially into the stack, blowers for discharging air blasts into the stack through said tuyères, a hopper for the supply of pieces of material to be treated, feeding means to carry the pieces from the hopper into the stack, said feeding means including a screw conveyor extending upwardly through said deflector axially thereof and serving to feed said pieces into the stack at a point adjacent to the crest of said deflector, the blasts from said burners and blowers being upwardly deflected by said deflector and adapted to create in the stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces, heating and elevating the same, a dome capping the upper end of the stack, said dome permitting the gases received from the stack to escape therefrom, but serving to intercept the treated pieces flung from the vortex at the top of the stack, and delivery means associated with the dome for receiving the treated pieces intercepted thereby.

3. In an apparatus of the character described, a stack, means for feeding pieces of material into said stack, means for introducing a hot blast into the stack tangentially thereof to create in the stack a columnar vortex of hot, helically ascending gases adapted to heat the fed pieces and elevate the same, a dome capping the upper end of the stack and having screened outlets permitting the gases from the stack to pass out of the dome, but preventing the escape therefrom of the heat treated pieces flung from the vortex at the top of the stack, a hood to catch the gases escaping from said dome, a flue leading from the hood, hoppers about the stack for receiving the treated pieces entering the dome, and delivery conduits taking off from said receiving hoppers.

4. In an apparatus of the character described, a stack, means for feeding pieces of material into the stack, means for introducing a hot blast into said stack tangentially thereof to create therein a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, a dome capping the upper end of the stack, said dome permitting the gases received from the stack to escape therefrom, but serving to intercept the heat treated pieces flung from the vortex at the top of the stack, and delivery means associated with the dome for receiving the treated pieces intercepted thereby.

5. In an apparatus of the character described, a stack, a deflector in the lower portion of the stack, a blast passageway leading into the stack tangentially thereof substantially at the level of said deflector, means for feeding pieces of material into the stack substantially at the elevation of said passageway, a burner for supplying a heated blast to said stack through said passageway to create in the stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recovering the heat treated pieces from the gaseous carrier.

6. In an apparatus of the character described, a stack, a frusto-conical deflector in the stack coaxially disposed with respect thereto, means for feeding pieces of material into the stack through the deflector axially thereof, a blast passageway leading into the stack tangentially thereof substantially at the level of said deflector, a burner for supplying a heated blast to said stack through said passageway to create in the stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recovering the heat treated pieces from the gaseous carrier.

7. In an apparatus of the character described, a stack, a blast passageway leading into the stack tangentially thereof, means for feeding pieces of material into the stack substantially at the elevation of said passageway, a tuyère directed tangentially into the stack substantially at the elevation of said passageway, a burner for supplying a heated blast to said stack through said passageway and a blower for discharging an air blast into the stack through said tuyère to create in said stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recovering the heat treated pieces from the gaseous carrier.

8. In an apparatus of the character described, a stack, a blast passageway leading into the stack tangentially thereof, means for feeding pieces of material into the stack substantially at the elevation of said passageway, a tuyère directed tangentially into the stack, a burner for supplying a heated blast to said stack through said passageway and a blower for discharging an air blast into the stack through said tuyère to create in said stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recoving the heat treated pieces from the gaseous carrier.

9. In an apparatus of the character described, a stack, blast passageways leading into the stack in diametrically opposed relation tangentially of said stack and at substantially the same level, tuyères directed tangentially into said stack in diametrically opposed relation and substantially at the elevation of said passageways, said tuyères and passageways alternating about the periphery of the stack, means for feeding pieces of material into the stack substantially at the elevation of said passageways and tuyères, burners for applying heated blasts to said stack through said passageways and blowers for discharging air blasts into the stack through said tuyères to create in said stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recovering the heat treated pieces from the gaseous carrier.

10. In an apparatus of the character described, a stack, a blast passageway leading into the stack tangentially thereof, means for feeding pieces of material into the stack substantially at the elevation of said passageway, a burner for supplying a heated blast to said stack through said passageway to create in the stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, a dome capping the upper end of the stack, said dome permitting the gases from the stack to pass therethrough, but serving to catch the heat treated pieces flung from the vortex at the top of the stack.

11. In an apparatus of the character described, a stack, blast passageways leading into the stack tangentially thereof at substantially the same level, tuyères directed tangentially into the stack substantially at the elevation of said passageways, means for feeding pieces of material into the stack, burners for supplying heated blasts to said stack through said passageways and blowers for discharging air blasts into the stack through said tuyères to create in said stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the top of the stack for recovering the heat treated pieces from the gaseous carrier.

12. In an apparatus of the character described, a stack, means for feeding pieces of material into the stack, a blast passageway leading into the stack tangentially thereof, a burner for supplying a heated blast to said stack through said passageway to create within the stack a columnar vortex of hot, helically ascending gases for picking up the fed pieces and heating and elevating the same, and means at the upper portion of the stack for recovering the heat treated pieces from said vortex.

13. In an apparatus for heat treating pieces of material, a tubular member, means for feeding the pieces to be treated into said member at one locality therealong, means for directing a heated blast tangentially into said member to create therein a whirling gaseous carrier for heating the fed pieces and helically progressing the same along said member, and means for recovering the heat treated pieces from said gaseous carrier at a locality along said member removed from said first locality in the direction of progression of said carrier.

14. In an apparatus for heat treating pieces of material, a tubular member, means for directing a heated blast into said member tangentially thereof to create therein a whirling body of gases progressing helically along the same, means for feeding the pieces into said gaseous body at one locality along said member, and means for recovering the heat treated pieces from said gaseous body at a locality along said member removed from said first mentioned locality.

CLARENCE H. BUTLER.