Sept. 3, 1940. D. BROWN 2,213,381

EQUIPMENT FOR PLASTICIZING

Filed Oct. 24, 1939 4 Sheets-Sheet 1

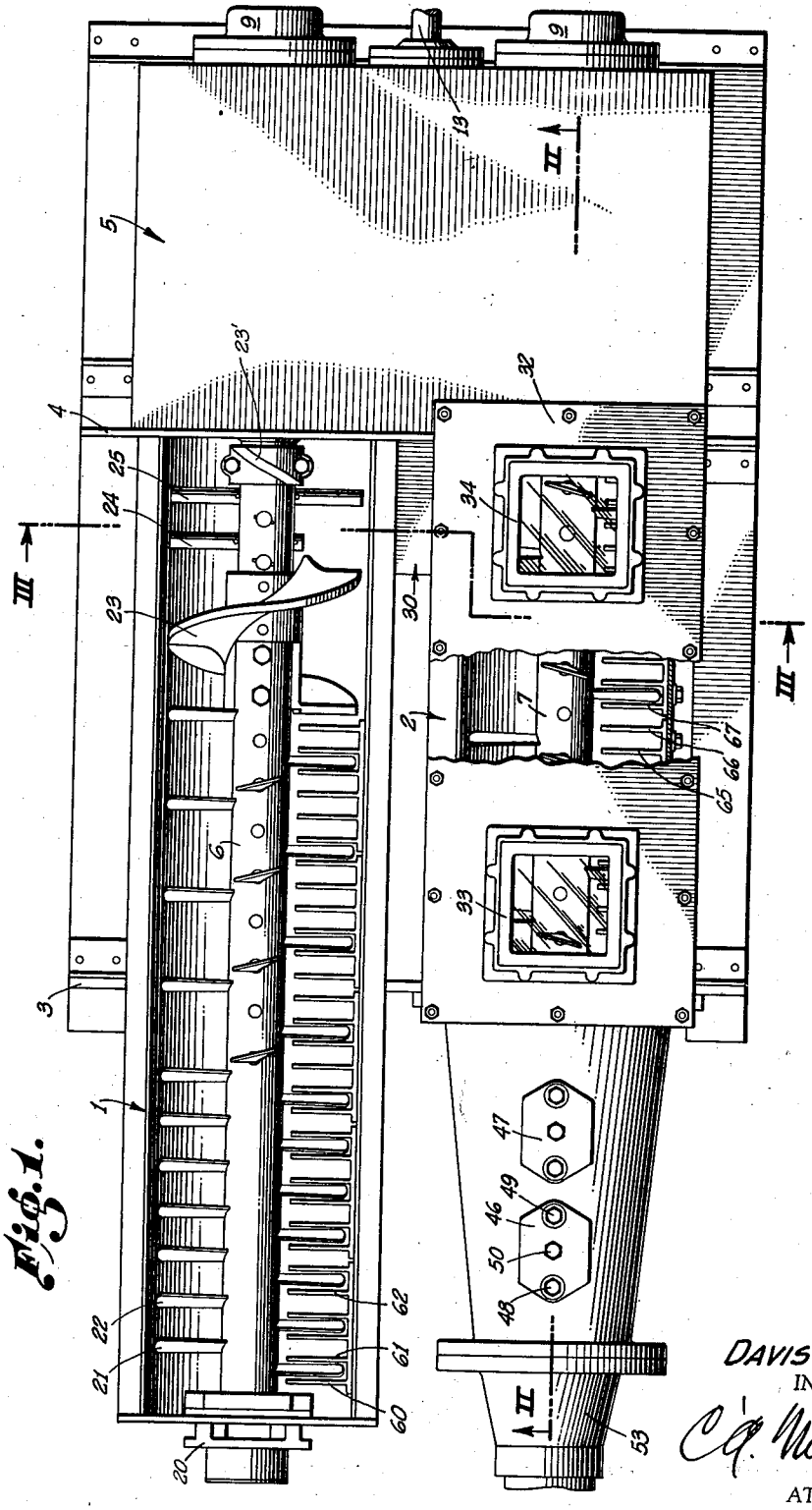


Fig. 1.

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Filed Oct. 24, 1939 4 Sheets-Sheet 2

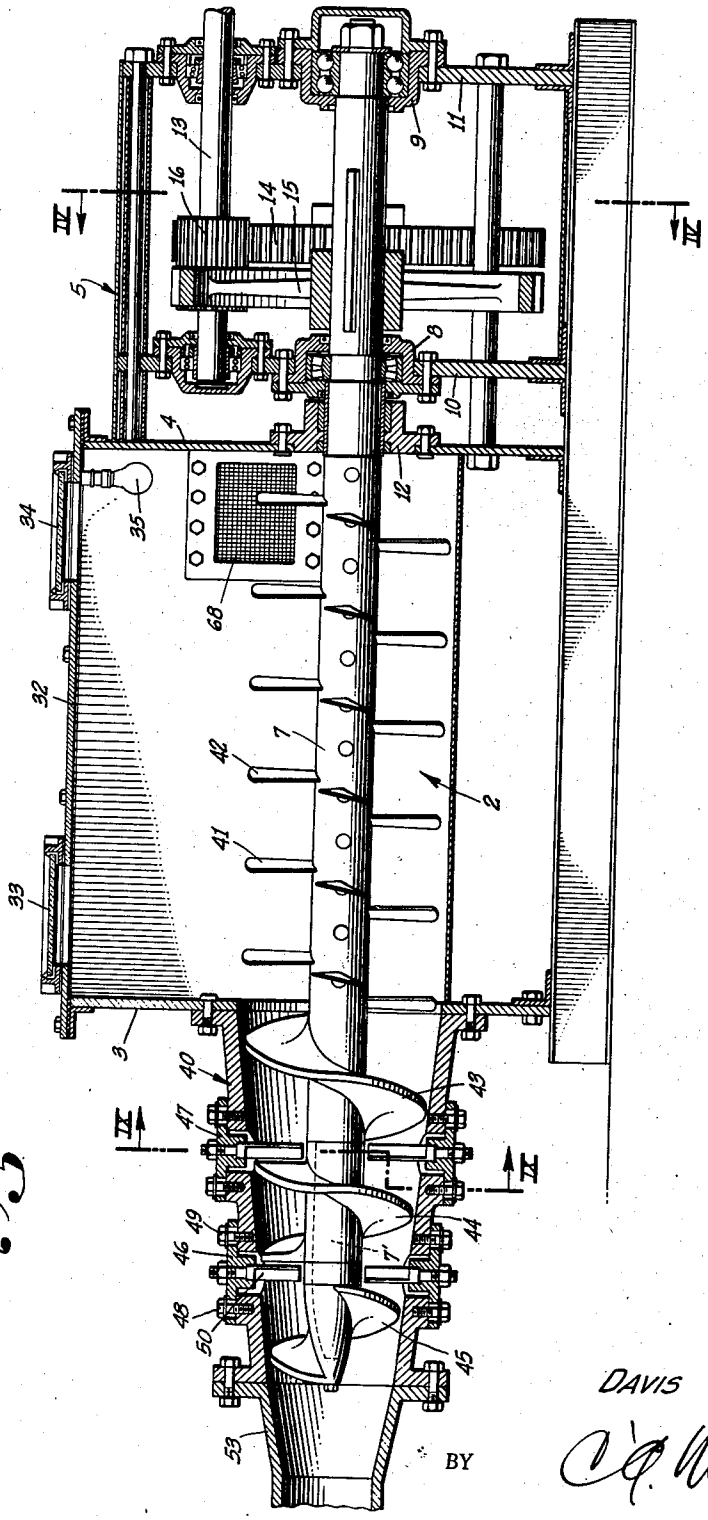


Fig. 2.

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Filed Oct. 24, 1939 4 Sheets-Sheet 3

Fig. 3.

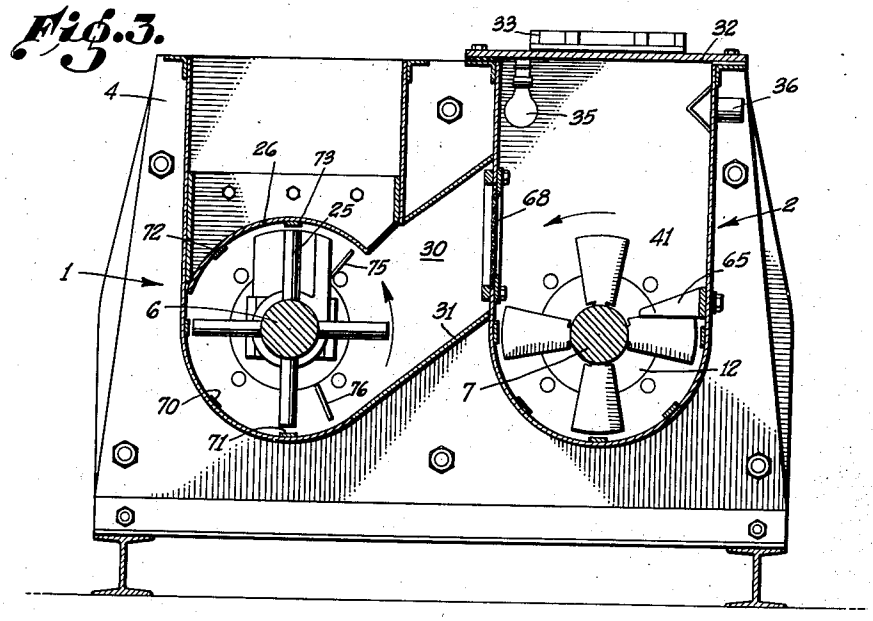
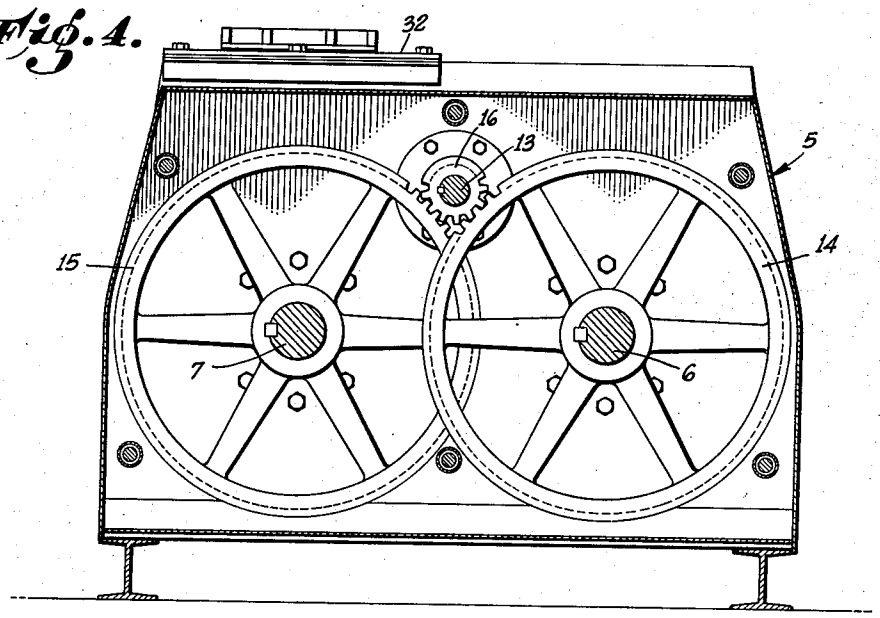


Fig. 4.



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Filed Oct. 24, 1939 4 Sheets-Sheet 4

Fig. 5.

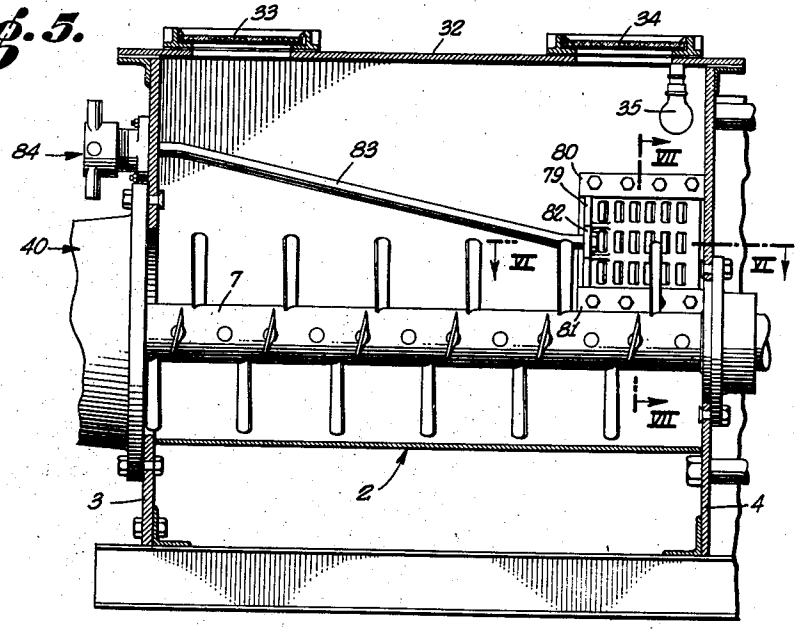


Fig. 6.

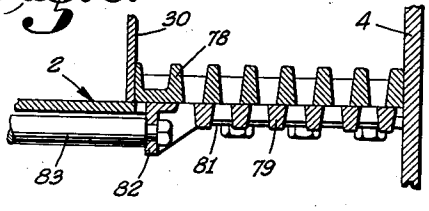


Fig. 7.

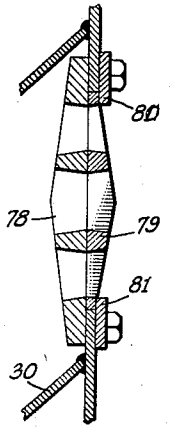


Fig. 8.

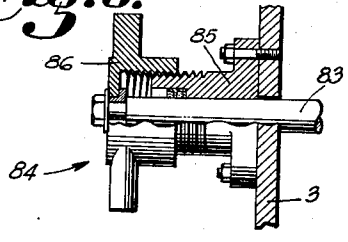
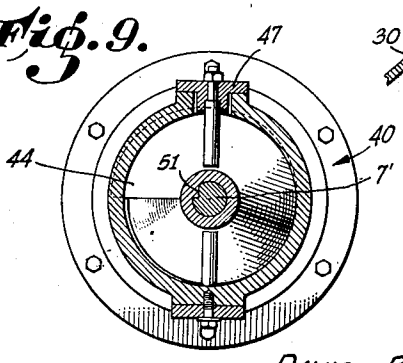


Fig. 9.



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Patented Sept. 3, 1940

2,213,381

UNITED STATES PATENT OFFICE

2,213,381

EQUIPMENT FOR PLASTICIZING

Davis Brown, Los Angeles, Calif.

Application October 24, 1939, Serial No. 300,996

12 Claims. (Cl. 259—6)

The present invention pertains to equipment particularly well adapted in blending, mixing and plasticizing compositions capable of being formed into objects or shapes of a desired size and contour by the application of pressure to the material. Machines embodying the present invention are particularly well adapted for use in mixing and blending clays, clay-like compositions and ceramic mixes and in extruding such mixes in a continuous manner. Although the description given hereinafter will specifically refer to the use of the machine in the ceramic field, it will be understood that the machine may also be employed effectively in the preparation of other compositions such as, for example, those including resins or polymerized compounds with oils, fillers, fibrous material, etc.

Heretofore the ceramic industry has employed mixing devices known as pug mills. All clays and other ceramic materials supplied to such pug mills had to be ground before being added to the pug mill. Water is generally added to the material in the pug mill and the resultant mass is then transferred to an extruding machine which forces the clay mass through a desired die. Augers are generally employed if the extrusion is to be substantially continuous. The augers cause the formation of lines of clevage in the extruded objects, such lines of clevage or slip weakening the objects thereunder. Such prior independent units generally had to be driven independently and occupied a very large amount of floor space. Such units were generally positioned at different levels so as to permit gravity feed from the pug mill to the extrusion machine.

The pug mills are not ordinarily provided with any means whereby coarser lumps of material may be reduced in size and such coarser lumps often cause imperfections in the objects extruded by the subsequent extrusion machine. The beating action of the pug mill very often causes air to be entrapped in the relatively plastic mass and again the entrapped air bubbles not only weaken the ware but very often cause cracks or complete destruction of the ware.

One of the objects of the present invention is to provide a compact unit which will not only mix and plasticize the ingredients or materials being employed but will in addition assure the elimination of all coarse lumps therein. In accordance with the present invention, the mixing section (which takes the place of an ordinary pug mill) not only mixes the ingredients but also subjects them to a certain amount of attrition or rubbing. Furthermore the arrangement of elements within the mixing section permits a much more effective application of power to the material so that a large through-put is obtained in addition to the improved quality thereof. The mixing sections of the machines of this invention are in adjacent relation to a treating section which completes the mixing operation and at the same time assures the removal of any entrapped air or gas from the material and then forces the material through a die. Material is transferred from the mixing section to the treating section by the action of pusher elements in the mixing section and by the action of a vacuum in the treating section. The extrusion means provided in the treating section are discontinuous and means are provided for preventing the formation of slip planes or lines of cleavage in the extruded objects.

An object of the present invention, therefore, is to provide improved types of mixing, plasticizing and treating machinery adapted to handle ceramic materials.

Other objects, advantages, uses and modifications will become apparent to those skilled in the art from the following description of an exemplary form which may be assumed by a machine constructed in accordance with this invention.

In order to facilitate explanation, reference will be had to the appended drawings, in which:

Fig. 1 is a plan view of a machine.

Fig. 2 is a longitudinal vertical section taken along the plane II—II of Fig. 1.

Fig. 3 is a transverse section taken along the plane III—III of Fig. 1.

Fig. 4 is an end view of the machine.

Fig. 5 is a vertical section taken through a modified form of treating unit.

Fig. 6 is a horizontal fragmentary section along the plane VI—VI of Fig. 5.

Fig. 7 is an enlarged vertical section taken along the plane VII—VII of Fig. 5.

Fig. 8 is an enlarged side elevation of a grid adjustment device.

Fig. 9 is a transverse section taken along the plane IX—IX of Fig. 2.

As shown in the drawings, the machine comprises a mixing section, generally indicated at 1, and a treating section, generally indicated at 2. Both the treating section and the mixing section are preferably round-bottomed and of substantially U-shape in cross section. The mixing section 1 is preferably longer than the treating section 2. Ordinarily, the length (or volumetric capacity) of the treating section 2 should be not less than about one-half the length of volumetric

capacity of the mixing section 1. These two sections are maintained in parallel adjacent relation and in substantially the same horizontal plane or level by means of frame members, such as, for example, frame members 3 and 4 extending transversely of the longitudinal axes of the sections. The frame member 4 may constitute the end wall of these two sections 1 and 2 and may also form a transverse wall separating the mixing and treating sections 1 and 2 from an enclosed housing, generally indicated at 5. Longitudinally extending, axially positioned shafts 6 and 7 are rotatably held within the mixing and treating sections 1 and 2. These shafts 6 and 7 extend into the housing 5 and are there suitably supported as in bearings 8 and 9 held in supports 10 and 11. A suitable packing gland 12 may be provided in the frame 4 so as to prevent any of the materials being treated from finding their way into the bearings which support the shafts. It is to be noted that the bearings 8 and 9 are spaced from one another an appreciable distance so as to adequately support and position the shafts 6 and 7.

A common drive shaft 13 is also positioned within the housing 5, this shaft 13 being driven from any suitable source of power, such as an electric motor or the like. Gears 14 and 15 are mounted upon the shafts 6 and 7 and engage with a pinion gear 16 mounted upon the drive shaft 13. In this manner, shafts 6 and 7 are driven simultaneously in the same direction.

The outer end of shaft 6 may be journaled in a suitable bearing 20. The shaft 6 is provided with a plurality of mixing blades, such as the blades 21, 22, etc. and is also provided with a material-advancing element such as the auger section 23 spaced from the inner end of the mixing section 1. Between the auger means 23 and the end of the mixing section 1 pusher elements, such as the paddles or rods 24, 25, are mounted on the shaft 6.

The greater portion of the length of the mixing section 1 is open so as to permit material to be treated to be discharged into this section, preferably near the outer end indicated at the left hand side of Fig. 1. A relatively short domed cover 26 is applied to this mixer 1 adjacent the other end thereof and above the auger 23 and pusher elements 24 and 25.

A passageway or chute, generally indicated at 30 (Fig. 3) connects the mixing section 1 with the treating section 2 adjacent the frame 4 and housing 5. This chute 30 includes a bottom portion 31 which extends from the bottom of the mixing section 1 (beneath the domed cover 26) upwardly to the adjacent treating section 2 and preferably the bottom 31 extends to a point of the side wall of the treating section 2 at a level of the shaft 7 therein. In other words, the chute 30 is upwardly inclined from near the bottom of the mixing section 1 to the treating section 2. The direction of rotation of the mixer shaft 6 is such that the passageway elements 24 and 25 move material from the bottom of the mixer section 1 upwardly into the chute 30. The direction of rotation of the shafts is indicated by arrows in Fig. 3.

The top of the treating section 2 is provided with a cover 32 which is substantially gas-tight, suitable gaskets being used in bolting down the closure member 32. Windows 33 and 34 may be provided in this cover to permit inspection of the material within the treating section. A source of illumination, indicated at 35, may be included to facilitate such examination. A suction line 36 may communicate with the upper part of the treating section 2, such suction line leading to a suitable exhauster or vacuum pump whereby a subatmospheric pressure may be maintained within the treating section 2 at all times.

The shaft 7 extending into the treating section 2 is not supported at its outer end, such outer end of the shaft 7 being indicated at 7' where it is shown extending into a conical die-receiving head 40 attached to the outer end of the treating section 2 as, for example, at the frame 3. The shaft 7 is provided with mixing blades 41, 42, etc. extending through the treating section 2. Spaced auger elements 43, 44 and 45 are carried by the shaft 7 within the conical head 40. It is to be noted that the auger sections 43, 44 and 45 are spaced from each other and thereby interrupted. The conical head 40 is provided with ports covered by covers 46, 47, etc., these covers being removable and adjustably held in position as, for example, by means of the machine screws 48, 49, passing through slots formed in the covers 46, etc. Each of the covers, such as the cover 46, carries an adjustably positionable blade or pin 50, the socket of such pin being removably and attachably held by the cover 46. The angular position of the pin or blade 50 within the cover can be changed and the longitudinal position of such pin may also be adjustably varied by means of the machine screws 48, 49. The pins, such as the pin 50, extend into the conical head 40 towards the shaft 7 and into positions between the spaced auger sections, such as the auger sections 44 and 45.

As shown in more detail in Fig. 9, the shaft 7 may have a keyway 51 cut along one side of the shaft, the collar 52 of the auger section 44 being provided with an integral key, permitting such auger section to be slipped onto the shaft. The end auger element 45 may be applied in a similar manner and then retained in position by means of a transverse pin.

The clearance between the pins or blades 50 and the edges of the adjacent auger sections can be readily adjusted by either adjusting the angular position of the pins or blades 50 or the adjustable holding plates 46, 47, etc.

It is to be understood that at the end of the conical die-receiving head 40 a suitable die, such as the die 53, is attached, the precise contours of the opening in such die depending upon the object it is desired to make from the material being treated.

In order to more effectively mix material supplied to the mixer section 1 and in order to cause a certain amount of rubbing or attrition so as to break up agglomerates or larger particles, the mixer section is provided with a comb attached to the inner side of the mixing section 1. Stationary comb elements are indicated at 60, 61 and 62 and extend horizontally inwardly from that side of the mixing section 1 which faces the adjacent treating section 2. These comb elements are approximately at the level of the shaft 6 or slightly thereabove. The specific position of these comb elements referred to is employed whenever the shaft 6 revolves in the direction of the arrow indicated in Fig. 3 since in this manner the mixing blades 21 and 22 force the material around the lower portion of the mixer section 1 and against the stationary comb-like elements 60, 61, etc., preventing the material from revolving with the shaft and instead producing a cutting and rubbing action on the material which hastens the mixing.

By reason of the various stationary comb elements a larger number of mixing blades can be employed and their effectiveness is greatly increased since the revolving mixing blades approach the combs from the lower side and a relatively small proportion of material is forced up between the blades and the combs, the remainder of the material being positively advanced longitudinally of the mixing section 1 and towards the passageway or chute 30. The space immediately above the shaft 6 (in the open portion of the mixing section 1) is thus maintained relatively free from material, thereby facilitating continuous feeding of new material to the machine. For the reasons stated, the capacity of the machine is greatly increased and production efficiency improved.

Similar stationary comb-like elements may be carried by the inner surface of the treating section 2 and such comb-like elements are shown at 65, 66 and 67. These stationary elements are removably attached to the side wall in any suitable manner. Such stationary comb-like elements also cooperate with the various mixing blades 41, 42, etc., carried by the shaft 7. In the treating section 2, not only is the material more positively advanced through the treating section but in addition when a high degree of vacuum exists in such treating section a larger area of material is subjected to the action of vacuum due to the relatively thin films of material which are extruded between mixing blades and stationary comb-like elements. The deaeration or degasification of the material is thereby accomplished very readily.

Positioned within the passageway or chute 30 and preferably at the near outlet from such passageway into the treating section 2 a screen 68 is positioned as shown in Fig. 3. This screen subdivides the material which is forced out of the mixing section 1 through the passageway 30 into the treating section 2 and the subdivided material is then carried down by the rotation of the blades on the shaft 7. In actual operation it is to be understood that the auger element 23 forces the material against the closed end of the mixing section 1 from which position the material is pushed by pusher means 24, 25 into the passageway. The screen 68 causes the material to compact in the passageway so that a seal is established, preventing the escape of vacuum from the treating section 2 by way of the passageway 30. The movement of the material through the passageway is facilitated somewhat by the vacuum existing in the treating section 2 so that the conjoint action of the pusher elements 24, 25, etc. and the subatmospheric pressure existing in the treating section 2 assures movement of the material through the passageway. It is also to be remembered that the compacted material being extruded through the die by the auger elements 43, 44, 45 forms another gas-tight seal so that the subatmospheric pressure maintained in the treating section is utilized in properly degasifying and deairing the material therein.

Reference has been made heretofore to the fact that comb-like elements prevent the material from simply churning around with the mixing paddle. In order to prevent the material being treated from exerting undue wear upon the interior surfaces of the mixing and treating chambers, longitudinally disposed bars or ridges, such as the bars 70 and 71, may be formed on the interior surfaces of the mixing chamber, particularly along the bottom thereof. Additional ribs 72, 73, may be formed in the dome cover 26. These ribs 70 to 73 cause a small film of material to be retained on the surfaces, this material then acting as a buffer or film which protects the surfaces of the equipment from the abrasive and rubbing action of the material while it is being advanced by the mixing blades. The end of the mixing section 1 (such as the end formed by the frame 4) may also be provided with a plurality of radial ribs 75, 76, etc., these inwardly extending radial ribs preventing the material being mixed or treated from being forced against the end of the mixing section 1 by the auger elements 23 and from unduly wearing or abraiding the end of the unit. A small amount of material seems to be retained between the ribs at all times, such small amount of material then acting as a buffer which protects the end of the machine from further abrasion. Attention is also called to the fact that an auger section 23' of reverse pitch to that of auger 23 is shown positioned between the end of section 1 and the pusher elements 24, 25, thereby preventing the material being treated from unduly compacting in the end zone of this mixer section.

In many instances it is desired to vary the size of the openings in the screen 68 which admit material into the treating section 2. In order to facilitate such adjustment, a construction such as is shown in Figs. 5, 6 and 7 may be employed. It will be noted that in this modification a stationary grid 78 is positioned at the outlet end of the passageway 30. A movable screen or grid 79 having openings of the same size as the openings in the grid 78 is slidably mounted in adjacent relation to the grid 78. The movable grid 79 is shown facing the interior of the treating section 2 and is horizontally movable by reason of retaining guides 80 and 81. The movable grid 79 is provided with a lug 82 attached to a bar 83, such bar 83 then extending upwardly to a point exteriorly of the treating section 2. Horizontal movement of the end of the bar 83 will obviously cause a horizontal sliding movement of the grid member 79 so that the size of the openings through which material may be extruded from the passageway 30 may be adjustably varied. Fig. 9 shows certain details of construction of an adjustment head generally indicated at 84 in Fig. 5.

The frame 3 may be provided with a boss 85 as most clearly shown in Fig. 8, and the arm or rod 83 may slidably extend therethrough. A hand wheel 86 may be threadedly mounted on said boss 85, said hand wheel being rotatable on the rod 83. Rotation of the hand wheel 86 causes the hand wheel to travel on the external threads of the boss 85 and the rotatable connection between the hand wheel and the rod 83 imparts a longitudinal or axial motion to the rod 83, thereby increasing or diminishing the size of the apertures in the grid.

The arrangement shown and described herein results in a machine having a surprisingly high efficiency. Power consumption per ton of material treated is exceptionally low, this being due, apparently, to the fact that all important bearings are maintained away from the material treated and are enclosed in the housing 5, and to the fact that the material is not permitted to cling to and rotate with the shafts but instead is positively advanced longitudinally at all times. By positioning the combs 60, 61, 62, 65, 66, 67 above the shaft axis and on the up-turning side

of the shafts and blades, a large amount of material is retained in the bottoms of the mixing and treating sections and prevented from rotating. Since the material is thus retained in the lower section of the mixer 1, the blades 21 and 22 more effectively advance the material longitudinally of the mixer.

Positive movement of the material from the mixer section 1 to the treating section 2 is assured by reason of the auger elements 23 and 23'.

The remarkable efficiency of the machine is also influenced by the construction of the outlet from the treating chamber 2. It is to be noted that the conical die-receiving head 40 is of gradually tapering section and is provided with a mouth or opening into the treating section 2, which is of substantially the same diameter as the diameter of the shaft 7 and its associated blades 41, 42, etc. As a result, the material being moved from the treating section 2 into a die 53 is not pressed against or forced through a small constriction or opening in a flat wall but instead is gradually directed into the die 53 by reason of the conical head 40. Power is not unnecessarily expended in forcing the material into the die.

Material extruded through a die such as the die 53, will be found to be of increased strength and free from laminations or planes of weakness. The superior quality of the product is apparently due to the thorough deaeration to which the material is subjected in the treating section 2 and also due to the fact that the auger elements 43, 44 and 45 are spaced and cooperate with the stationary elements, such as the element 50.

In ordinary extrusion or molding machines, the air present in the material being extruded acts as a lubricant between strata formed by unequal rates of flow of material at different points of cross section in the mass. These strata or thin layers of air result in laminations and in an imperfect bonding of the material. The deaeration to which the material is subjected in treating section 2 prevents such laminations from forming. The stationary elements 50 further eliminate the possibility of forming slippage planes or laminations. In addition, the stationary elements 50 prevent the material from rotating with the auger sections 43, etc., without longitudinal motion. The stationary elements 50 insure a positive and continuous forward feeding of the material into the die 53.

The arrangement of mixing and treating sections which has been described results in an apparatus which occupies very little floor space and which is particularly well adapted for use with but a single source of power. It is to be noted that a single motor or drive shaft effectively and simply drives both sections. Moreover, the specific arrangement referred to hereinabove obviates the necessity of elevating the material to be treated to any appreciable distance above the working level. It has been found that in actual practice mixing is accomplished much more readily and quickly, the quality of the resulting product is improved and the equipment is capable of handling a very large tonnage of material with a very small power consumption. In comparison with previous machines, the apparatus of this invention is approximately one-half in length and in height. A product of improved character and quality is obtained even though the production per horsepower hour is three times that of machines previously employed. By reason of this small size, a saving in labor is obtained.

Those skilled in the art will appreciate that numerous changes and modifications may be made in the machine without departing from the teachings hereof. All changes and modifications coming within the scope of the appended claims are embraced thereby.

I claim:

1. In a device for use in mixing and treating ceramic materials, the combination of: a mixer of substantially U section and provided with a dome cover adjacent one end thereof, an opening in the side of said mixer beneath said dome cover, a longitudinally extending shaft in said mixer, mixing blades carried by the shaft, an auger element carried by the shaft under said dome cover, pusher elements carried by the shaft between said auger and the end of said mixer, said pusher elements being adapted to discharge material through said opening; a single series of horizontally and inwardly extending stationary comb elements carried by the inner surface of said mixer on the side of said opening, said elements resisting upward movement of material in said mixer when the shaft is rotated.

2. In a machine of the character described, the combination of: a mixer of substantially U section provided with a dome cover adjacent one end thereof, an opening in the bottom portion of the side of said mixer beneath said dome cover, a longitudinally extending shaft in said mixer, mixing blades carried by the shaft, said blades being adapted to mix and move material toward the covered end of the mixer; an auger element carried by the shaft under said dome cover, an auger element of reverse pitch carried by the shaft adjacent the end of the mixer, pusher elements carried by the shaft between said opposing auger elements, said pusher elements being adapted to discharge material through said opening; and means for rotating the shaft to move material by said pusher elements through said side opening.

3. In a machine of the character described, the combination of: a mixer of substantially U section provided with a dome cover adjacent one end thereof, an opening in the bottom portion of the side of said mixer beneath said dome cover, a longitudinally extending shaft in said mixer, mixing blades carried by the shaft, said blades being adapted to mix and move material toward the covered end of the mixer; an auger element carried by the shaft under said dome cover, an auger element of reverse pitch carried by the shaft adjacent the end of the mixer, pusher elements carried by the shaft between said opposing auger elements, said pusher elements being adapted to discharge material through said opening; means for rotating the shaft to move material by said pusher elements through said side opening; and a single series of horizontally and inwardly extending comb elements attached to the side of said mixer above the axis of said shaft and adapted to cooperate with mixing blades to resist upward movement of material by said blades.

4. In an apparatus of the character described, the combination of: a treating section including a semi-circular bottom, a removable air-tight top, and end portions; a shaft extending axially through said section, bearing and driving means for said shaft externally of said section adjacent one end thereof, a conical die-receiving head con-

centric with the shaft and extending from the other end of said section, mixing blades carried by said shaft, said mixing blades being adapted to move material toward said conical die-receiving head, a port communicating said conical die-receiving head with said treating section, said port and the large diameter of said conical head being substantially equivalent to the diameter of the blades on said shaft; a plurality of spaced auger elements carried by the shaft in said conical head, and a plurality of inwardly extending adjustably held blades in said conical head between said spaced auger elements.

5. In an apparatus of the character described, the combination of: a treating section including a semi-circular bottom, a removable air-tight top and end portions; a shaft extending axially through said section, bearing and driving means for said shaft externally of said section adjacent one end thereof, a conical die-receiving head concentric with the shaft and extending from the other end of said section, mixing blades carried by said shaft, said mixing blades being adapted to move material toward said conical die-receiving head, a port communicating said conical die-receiving head with said treating section, said port and the large diameter of said conical head being substantially equivalent to the diameter of the blades on said shaft; a plurality of spaced auger elements carried by the shaft in said conical head, a plurality of inwardly extending adjustably held blades in said conical head between said spaced auger elements; and horizontally and inwardly extending comb elements attached to the side of said section above the axis of the shaft therein, said comb elements cooperating with mixing blades to resist upward movement of material by said blades.

6. In a machine for mixing, plasticizing, deaerating and extruding clay-like materials, the combination of: a mixer and a substantially air-tight deaerating device in parallel horizontal relation to the mixer; a chute connecting the lower side portion of the mixer with an upper side portion of the deaerating device, means within the mixer for moving clay into said chute, a driven shaft in said deaerating device, blades on said shaft, a conical die-receiving head concentric with said shaft and extending from said deaerating device, and auger elements on said shaft within said conical head.

7. In a machine of the character described, the combination of: a gas-tight treating section including a semi-circular bottom, a removable top, and end portions; a chute having a bottom extending upwardly to the wall of said treating section at one end thereof; a grid in said chute near the wall of said treating section; a shaft in said treating section having bearing and driving means exterior of said treating section at one end thereof; a conical die receiving head concentric with said shaft and extending from the other end of said section; a plurality of mixing blades on said shaft adapted to move material toward said die receiving head; a plurality of spaced auger elements carried by the shaft within said conical die receiving head; and a plurality of inwardly extending adjustably held blades in said conical head between said spaced auger elements.

8. In a machine of the character described, the combination of: a gas-tight treating section including a semi-circular bottom, a removable top, and end portions; a chute having a bottom extending upwardly to the wall of said treating section at one end thereof; a grid in said chute near the wall of said treating section; means for adjusting the effective area of said chute including a movable grid in sliding contact with the stationary grid; a shaft in said treating section having bearing and driving means exterior of said treating section at one end thereof; a conical die receiving head concentric with said shaft and extending from the other end of said section; a plurality of mixing blades on said shaft adapted to move material toward said die receiving head; a plurality of spaced auger elements carried by the shaft within said die receiving head; and a plurality of inwardly extending adjustably held blades in said die receiving head between said spacer auger elements.

9. In a machine of the character described, the combination of: a mixing section; a treating section substantially parallel to said mixing section and in the same horizontal plane; a chute leading from said mixing section to said treating section, said chute having a bottom extending upwardly from the bottom of said mixing section to the wall of said treating section; a grid in said chute near said treating section; and means for maintaining a suction in said treating section.

10. In a machine of the character described, the combination of: a mixing section, a treating section substantially parallel to said mixing section and in the same horizontal plane; a chute leading from the mixing section to said treating section, said chute having a bottom extending upwardly from the bottom of said mixing section to the wall of said treating section; a grid in said chute near said treating section; means for adjustably regulating the effective area of said grid, said means including a movable grid in sliding contact with the stationary grid, and means for adjustably moving said movable grid; and means for maintaining a suction in said treating section.

11. In a machine of the character described, the combination of: a treating section; an upwardly inclined chute for delivering material to one end of said treating section; a shaft in said treating section; a conical die receiving head on one end of said treating section concentric with said shaft; spaced auger means on said shaft within said die receiving head; a plurality of inwardly extending adjustably held blades in said conical head between said spaced auger elements; and a grid in said chute.

12. In a machine of the character described, the combination of: a treating section; an upwardly inclined chute for delivering material to one end of said treating section; a shaft in said treating section; a conical die receiving head on one end of said treating section concentric with said shaft; spaced auger means on said shaft within said die receiving head; a plurality of inwardly extending adjustably held blades in said conical head between said spaced auger elements; and a grid in said chute, said chute having means for varying the effective opening of its openings.

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