Feb. 27, 1940. W. J. MILLER 2,191,857

METHOD AND APPARATUS FOR MANUFACTURING POTTERY WARE

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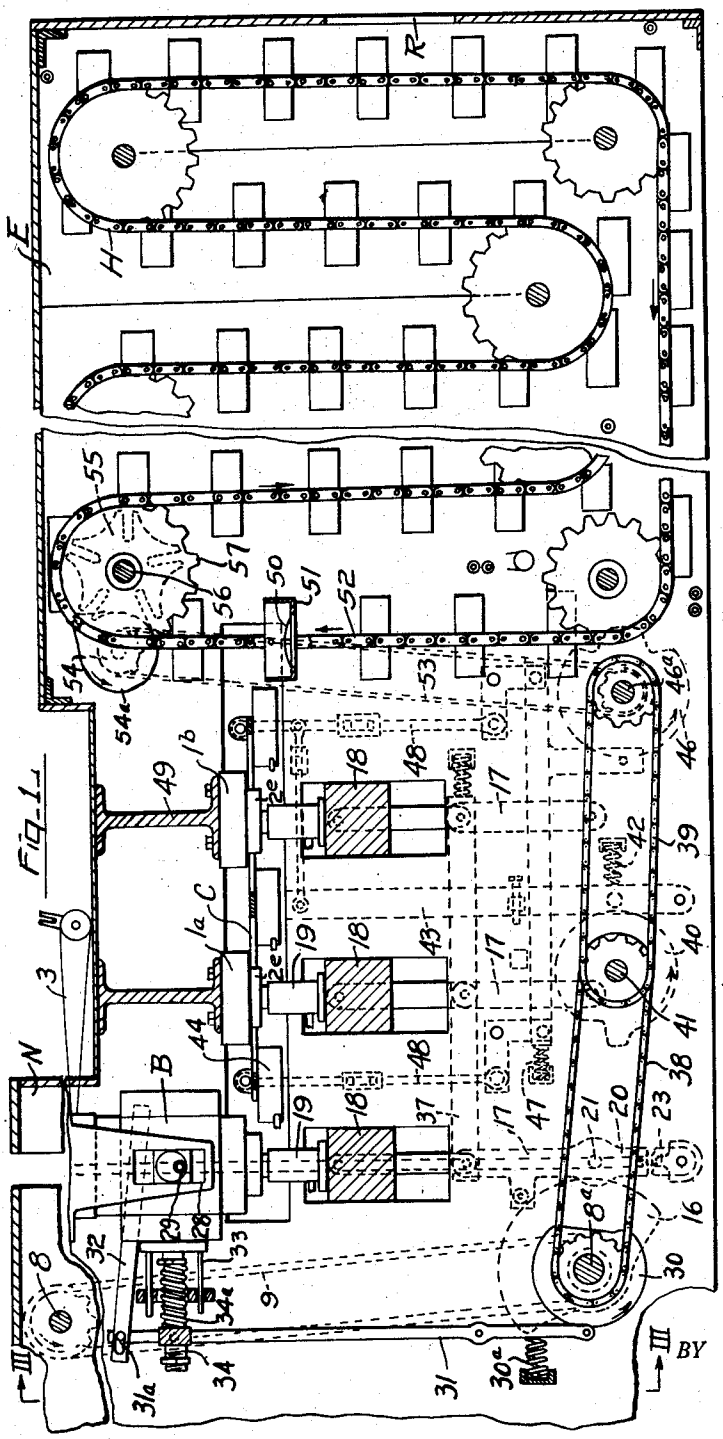


Fig. 1

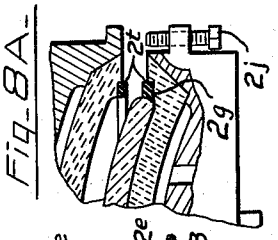


Fig. 8A

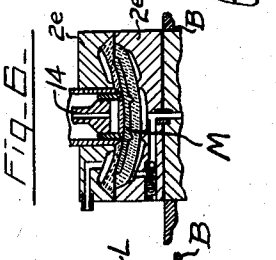


Fig. 6

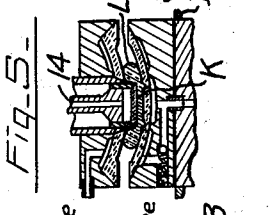


Fig. 5

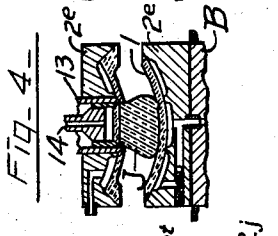


Fig. 4

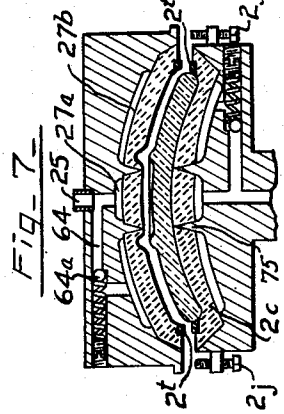


Fig. 7

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METHOD AND APPARATUS FOR MANUFACTURING POTTERY WARE

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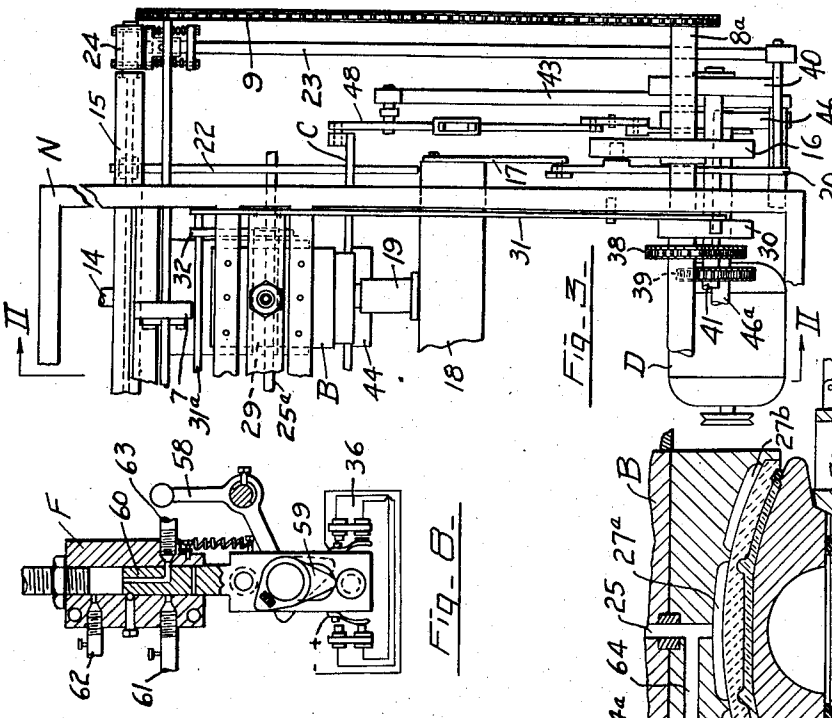


Fig. 3.

Fig. 8.

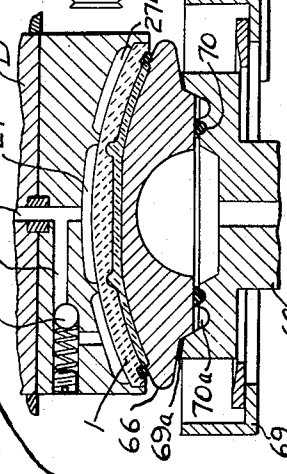


Fig. 9.

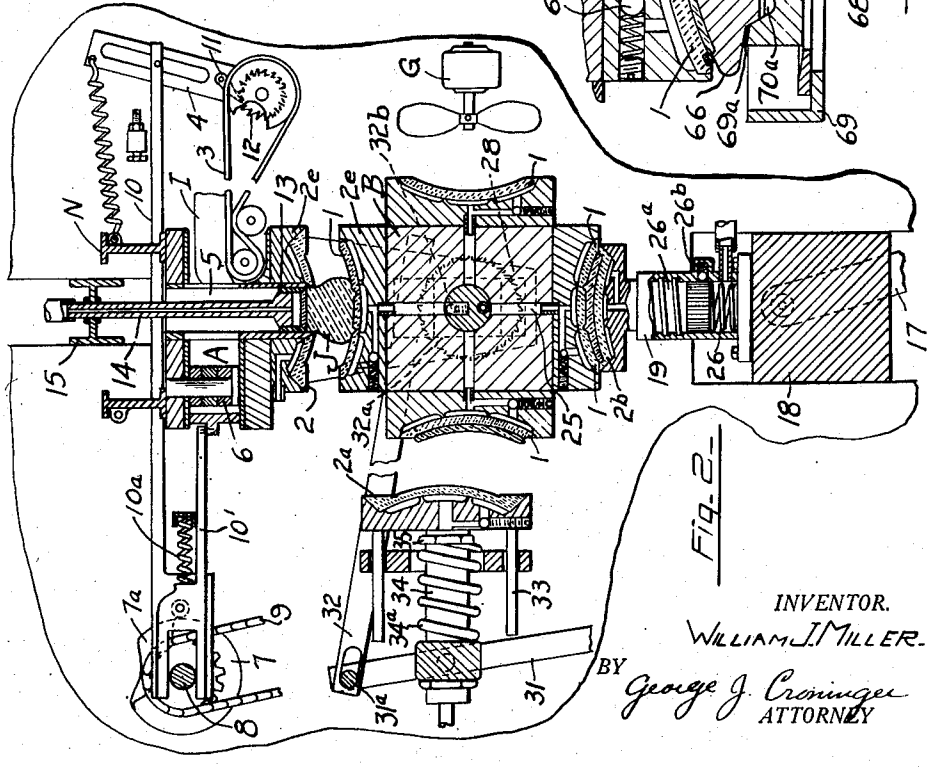


Fig. 2.

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METHOD AND APPARATUS FOR MANUFACTURING POTTERY WARE

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Application May 2, 1935, Serial No. 19,478

25 Claims. (Cl. 25—22)

This invention relates to methods and apparatus for manufacturing pottery ware particularly plates, cups and saucers, etc.; known as jiggered dinnerware and heretofore fabricated by manual jiggering processes from plastic clay. It has to do with automatic ware production from clay mass to dried ware with coincidental shaping and dewatering of the clay by pressure, prior to final drying; the procedural apparatus including a ware fabricating mechanism, dryer, and dryer conveyor preferably operating in timed relation for the progressive stepwise manufacture of ware of this class.

Heretofore, owing to the differences in drying shrinkage of clay, due to variations in moisture content or character, and the extensive shrinkage normally occurring on drying it has been extremely difficult to obtain size and shape uniformity in the dried ware.

The objects are: to eliminate drying shrinkage and its problems from the automatic line production of ware thereby enabling the manufacture of ware of uniform predetermined size and shape from any suitable clay regardless of normal differences in clay, moisture content and consequent drying shrinkage co-efficient; produce ware of better quality and denser bisque; to accelerate production by reducing the forming and particularly the drying time required; in the initial formation of the blank to relieve the forming surfaces of excess pressures and/or breaking strains; to eliminate batting out, profiling (except for finishing), sponging, the use of absorbent molds and all of the equipment required therefor; to expedite straight line automatic production and to reduce clay wastage, percentage of ware loss and substantially eliminate manual intervention.

The procedure embraces the steps of delivering successive plastic clay charges of predetermined bulk, shape and minimum practical moisture content to the forming surfaces of a pair of cooperable permeable dies, forming the charge first into a rimmed disc with predetermined thin regular center section and then progressively spreading and flattening the rim to coincide with the center section to form a soft, unstable, rough blank having predetermined shape and size closely approaching final ware form but of excess thickness; repelling the blank from one of the dies by forcing air under pressure through the permeable walls thereof, advancing the blank to a second permeable die and repressing to eliminate defects from the exposed surface whilst maintaining or reforming the established shape and size; repelling the reformed blank from the die and stepwise advancing it to and through a series of co-operating permeable dewatering dies by establishing a temporary adhering relationship between the clay and a transfer head having a clay receiving surface of predetermined shape retaining contour; subjecting the blank to a sequence of squeezes of predetermined dewatering intensity each squeeze extending over the major portion of a transfer and squeeze cycle, releasing the clay from the dies by forcing a dry preferably heated gaseous fluid at superatmospheric pressure through the die centers at a high pressure and adjacent die peripheries at a reduced pressure; establishing a high velocity flow to purge water from the capillary passages of the die, wipe the ware and die forming surfaces of free water and thermally dry the passage walls and die surfaces of residual film water; repeating the dewatering cycles as aforesaid until the blank has been gradually and progressively dewatered and compacted beyond the stage of major shrinkage down to substantially its dry bulk, density, stability and thin regular ware section, without substantial variation in the established size and shape, and without the production of drying cracks or shrinkage strains; transferring the blank to embellishing dies or a profile to finally enhance and define the surface thereof, depositing the ware in successive order and in predetermined spaced relation on a dryer conveyor; advancing the conveyor in synchronism with the preceding operations and transporting the ware through a drying atmosphere to remove the remaining water preparatory to firing.

In the drawings:

Fig. 1 is a sectional elevation of the preferred form of apparatus.

Fig. 2 is a detail in section of the clay feeding and blank forming apparatus.

Fig. 3 is a fragmentary end elevation of Fig. 1 disclosing various drive mechanisms.

Figs. 4, 5, 6 and 7 are details in section of a pair of dies representing the various stages in the transition of a clay charge into a blank.

Fig. 8 is a detail partly in section of a cam operated control valve.

Fig. 8a is a fragmentary section of a pair of dies with co-operating brim sealing members and an approach adjustment.

Fig. 9 is an elev tion disclosing a method and apparatus for practicing the system with travelling absorbent molds.

Generally, the fabricating apparatus of Figs. 1, 2 and 3 comprises a frame N which supports

a charge forming and feeding apparatus A, a turret B having a plurality of demountable shaping and/or dewatering dies 1 mounted thereon, a ware transfer C, having transfer heads 44, lower dewatering die assembly 2b and upper and lower dewatering die assemblies 1a and 2c respectively, finishing die assemblies 2d and 1b together with driving and synchronizing mechanism operated by motor D, these several apparatuses forming one line of a contemplated multiple of parallel lines of production including a drier E and a ware conveying apparatus H common to one or more lines of production. The fabricating machine operates in repeated cycles and completes one piece of ware in a line at the termination of each machine cycle, the other pieces of ware yet in the machine being advanced one step toward completion.

A conditioned and preferably heated clay billet I, Fig. 2, is placed manually on belt 3 and advanced by spring actuated adjustable stroke rod 4 into a compacting chamber 5 formed by pivoted jaws 6, thereafter closed as linkage 10^1 is shifted to left, through spring 10a, Fig. 2, cam 7 on shaft 8 driven from main shaft 8a, Fig. 1, by chain 9. The jaws segregate and compact a measured charge of clay J, and, incident to jaw closing, the belt actuated pawl 11 is reset on ratchet 12 by cam 7a through linkage 10 for the next succeeding advance of billet I.

The charge J is then progressed through bushing 13 in open center male die holder 2e by pourous faced plunger 14 adjustably secured to cross head 15, and onto the contoured face of a rising female die 1, on elevatable turret B, Figs. 1 and 2 elevated by cam 16, Fig. 1, through toggle 17, cross head 18, pressing unit 19 and cooperating dewatering dies 1 and 2b; plunger 14 recesses the center portion of the charge J, Fig. 5, and presses it against the die to establish a predetermined relatively thin center section K, the remaining material forming a thick section ring L around the plunger, Fig. 5. Upon continued elevation of die 1, the ring L is uniformly distributed in a radial direction to relatively thin regular section and the clay compacted against, defined and supported by the chamber wall, Fig. 6, thus forming a soft, highly plastic blank M.

The center thickness of the blank is maintained by elevating the plunger in unison with die 1, through cross head 18, Fig. 3, and rods 22 adjustably secured in cross head 15. As cross head 18 rises, cross head 15 is moved downwardly by one of the interconnected toggles 17 through links 23 connected to an extension 20 below a fixed pivot 21, Fig. 3 and to cross head 15 through a resilient terminal assembly 24 and as rods 22 engage cross head 18, the plunger and cross head 15 are elevated in unison therewith due to the lost motion in terminal assemblies 24.

Radial spreading and/or expansion of the charge J is thus divided into two pressure stages, each of a lower value than the high pressure normally required to completely spread a charge in one continuous operation from mold center to brim. This relieves the relatively fragile dies of excess pressures and breaking strains. The charge is normally shaped between the dies on all surfaces into a rough blank M of predetermined size and shape closely approximating that of the finished ware except for plunger marks, excess thickness and plasticity and at a moderate pressure of slight dewatering intensity.

The ware and/or blank brim is defined and compacted by a ring of resilient material 2t, such as rubber, preferably mounted on or in each die of a pair, in grooves 2g at the brim of the matrices, Fig. 8a. Its resiliency permits variable approach of a pair of dies for determining blank and/or ware thickness and on separation of the dies, progressively parts from the blank and/or ware brim to avoid deformation thereof. The closest approach of the dies at any station may also be limited by a pair of opposed adjustment screws 2j, Figs. 7 and 8a.

Coincident with an initial separation of dies 1 and 2, the blank is repelled from the upper die by forcing a dry, gaseous and preferably heated fluid under control of valve F, Fig. 8, through the permeable matrix. The plunger is dropped in unison with the lower die approximately ⅛ of an inch thereby mechanically forcing the blank off the upper die surface before it is repelled from the arrested plunger. The turret then continues in its descent and comes to rest at the bottom of guides 28, Fig. 1, on trunnions 29 and is then rotated counter-clockwise a quarter turn by cam 30 on shaft 8 through spring 30a lever 31, lost motion connection 31a, pawl 32 and ratchet wheel 32a. The lost motion connection permits a die 2a to be withdrawn by lever 31 prior to rotation of a turret. A spring pressed detent 32b locates and holds the turret stationary after each turn.

Upon the succeeding elevation of the turret, the closed center die 2a mounted in a passaged base 2e on passaged stem 34 pivotally connected to lever 31 and having guide bars 33 is advanced by lever 31 into co-operation with the blank to press and remove the plunger marks, complete the expansion of the blank (if such has not been entirely completed theretofore), and redefine its shape and contour, the pressure applied being preferably of slight dewatering intensity. The degree of pressure is adjustable through spring 34a encompassing rod 34 and nut 35.

After die 2a is withdrawn and the blank repelled, the turret is then lowered and rotated counter-clockwise one division to locate the blank in inverted position over die 2b on elevatable left end pressing unit 19, simultaneously registering conduit 25 leading to die chamber 27a with a closed high pressure line 25a under control of valve F. When die 2b rises, a pressure load of dewatering value is imposed on the blank by the weight of the turret to commence the dewatering and compacting thereof as the turret is elevated, the maximum load on the blank occurring incident to the closing of dies 1 and 2 and the pressing of a charge J. Any excess pressures are dissipated by spring 26, adjustable for tension by threaded stem 26a with detent 26b for locking although the possibility of the occurrence of such is minimized by the stepwise application of pressure in the spreading of the charge. The blank is preferably squeezed at a moderate pressure to remove shrinkage water but at an increase over that occurring during the previous stages, but not to a major extent, the clay being compacted to a degree of stabilization enabling subsequent pick-up, transfer and redeposit by a form retaining head without harmful shape deformation.

The shrinkage water expelled at this or any prior forming station or subsequent dewatering station is free to move and enter the capillary passages of the permeable dies at or below atmospheric pressure and is subsequently purged

therefrom incident to repelling of the blank. In the discharge of expelled water it is preferred to slightly separate the dies, Fig. 7, and repell the clay from one of the forming surfaces, for instance die 1, the fluid being forced through the center at a high pressure to avoid center stagnation and through the concentric peripheral zone at a lower pressure. This establishes a radial flow in the narrow gap between blank and matrix toward the brim and besides repelling the blank, purges the capillary passages of the die of any held water and wipes the ware and die forming surfaces of freewater whilst thermally drying the passage walls and die surface of residual film water, subsequently subjected to fan G.

Accordingly, when the turret is lowered, the blank is repelled from die 1 and deposited on die 2b, the die 1 purged and then dies 1 and 2b are fully separated. A transfer frame C is then shifted to the left by cam 40 on shaft 41 through spring 42 and adjustable jointed linkage 43 to center a transfer head 44 over the blank. The frame is then lowered by cam 46 on shaft 46a through spring 47 and jointed linkage 48 and the semi-stabilized blank secured to the contoured surface of the head by suction. The transfer is then elevated coincidently with purging of die 2b, then completely elevated and shifted to right, lowered and the blank deposited on die 2c as suction is discontinued. The transfer is then returned to intermediate position, Fig. 1, and the blank elevated into engagement with die 1a and finally dewatered down to substantially its dry bulk, density and thickness, the degree of pressure being substantially higher due to the increased density of the blank and being held preferably for a period representing the major portion of a transfer and squeeze cycle.

After final dewatering, the shaped blank is transferred to die 2d and pressed against a finishing die 1b demountably attached to lintel 49 and having a contoured and polished surface for embellishing the exposed surface of the blank. A profile may be substituted if desired such as that shown in my co-pending application, now matured into Patent No. 2,046,525, together with instrumentalities for spraying fluid for moistening the blank surface prior to or during profiling and driving the chuck spindle intermittently through a motor controlled by adjustable cam operated switch 36, Fig. 8. It is understood that the dies 2b and 2d are elevated in unison by virtue of a cross link 37 connected across the knees of toggles 17.

The completed ware is transferred after embellishment to and deposited on a form retaining support 50 of one of a plurality of spaced trays 51 pivotally suspended from the chains 52 of a short length drier conveyor operating in drier E and in synchronism with the transfer C and fabricating mechanisms from driven shaft 46a (driven in unison with shafts 41 and 8a by chains 38 and 39, Fig. 1,) chain 53 sprocket 54, motion plate 54a and Geneva 55 on shaft 56 carrying drive chain sprockets 57.

The low percentage of residual moisture in the ware precludes shrinkage strains and distortion during drying and insures uniform predetermined diameter and ware shape. Since the critical shrinkage period is avoided, the drying time required is considerably reduced by the immediate application of high temperature, low humidity air. After traversing the drier, the ware is removed preferably at R and may be then further processed or transferred directly to the kiln.

The dies disclosed herein, the clay contacting face of the plunger and the clay engaging faces of the transfer heads are preferably made of permeable material. The dies are mounted in bases 2e and sealed therewith around the brims and forming a hollow central chamber 27a and a concentric peripheral chamber 27b separated by an upstanding ring of material 75. Both the plunger and the transfer heads are chambered behind the permeable faces and such chambers as well as chambers 27a and 27b are in communication with a source of sub and/or super atmospheric pressure controlled by one or more valves, Fig. 8, to control clay adhesion to and/or repulsion from the surfaces in question. The valve is substantially the same as that shown and described in my Patent 2,046,525, having a phase changing control 58 and cams 59 and intermittently reciprocating a passage slide valve 60 between suction inlet 61, super atmospheric pressure inlet 62 and an outlet 63. The chambers 27a and 27b in the dewatering die assemblies are interconnected by passage 64 having an adjustable reducing valve 64a therein.

I have shown in Fig. 9 that the system may be practiced on travelling absorbent molds 66, a conveyor 67 advancing the molds cyclically on one or more lines to and through a dryer and back to temporary halted position first under the turret for the application of a formed blank thereto, then under the succeeding dewatering and finishing dies, the molds being elevated at each station by chucks 68 through the open bottoms of trays 69. The resiliency of rectangular section brim seating ring 69a and circular section center ring 70 on chucks 68 insures mold stabilization, proper seating thereof and equal distribution of pressures thereon incident to the pressing operations, the mold having chip collecting grooves 70a to prevent interference thereof with mold seating. This subject matter is more fully disclosed and claimed in a co-pending application, now matured into Patent 2,046,525.

It is entirely within the spirit and scope of this invention to operate the fabricating device and dryer separately with manual transfer of the ware therebetween. Any number of these fabricating instrumentalities may also be arranged in side by side relation for the operation of a plurality of parallel lines of production either with or without a synchronized conveyor.

I claim:

1. In apparatus for the manufacture of dinnerware the combination which comprises a plurality of pairs of cooperable means for dewatering clay bodies each pair forming therebetween a clay receiving and dinnerware shaping cavity, means for transferring clay between one pair of dewatering means and another, a dryer having a conveyor therein and means for operating said conveyor in timed relation with said transfer means.

2. In apparatus for the manufacture of potteryware, the combination which comprises a continuous chain conveyor and a fabricating apparatus, means for operating said fabricating apparatus and said conveyor in timed relation, a transfer operating between said fabricating apparatus and conveyor for transporting fabricated articles from one apparatus to the other, said fabricating apparatus including a plurality of means for pressing clay bodies, means for varying the degree of pressure applied whereby said clay

bodies may be progressively shaped, gradually dewatered, and then finished before transfer to the conveyor.

3. In the manufacture of din[illegible] ware, the method of forming clay blanks which comprises, progressively pressing a clay body and forming in successive order the foot of the blank, the faces and thereafter the brim and thereafter repressing the blank to remove surface irregularities.

4. In apparatus for the manufacture of pottery ware the combination which comprises, automatic clay feeding means, means for forming clay charges, a rotatable turret having a plurality of dies associated therewith for receiving clay charges, means co-operable with said dies for shaping said clay, a plurality of pairs of dies arranged in sequence adjacent said turret, means for transferring shaped clay to and between said last named pairs of dies, a conveyor and means for operating said conveyor and said transfer means in timed relation.

5. Apparatus for the manufacture of pottery ware which comprises, in combination, an automatic clay feeding apparatus, a turret having a plurality of dies thereon, means for rotating said turret to successively present said dies to said feeding means, a plurality of independently movable dies arranged adjacent said turret and co-operable with the dies thereof, means for applying sub and/or super atmospheric pressure to said dies, and a plurality of pressing means arranged in sequence and adjacent said turret and transfer mechanism operating between said turret and said pressing means.

6. In apparatus for the manufacture of pottery ware the combination which comprises, an automatic pottery ware fabricating machine, a dryer and a conveyor operating in said dryer, means operating in timed relation with said conveyor for removing ware from said machine and depositing the same on said conveyor, said means including a plurality of suction cups adapted to transport ware in different stages of fabrication from one position on the machine to another incident to transferring ware to the conveyor.

7. Apparatus for the manufacture of potteryware which comprises, in combination, an automatic clay feeding apparatus, a turret having a plurality of female dies associated therewith, a male die adjacent said turret, means for rotating said turret to present said female dies first to said automatic clay feeding apparatus and then to said die; means for moving said male die into and out of co-operation with said female dies; means for releasing said male die from said clay; a crosshead, a chuck carried thereby, a die supported by said chuck and adapted to co-operate with the female dies of said turret and to elevate said turret and a transfer for removing clay from said last named die.

8. Apparatus for the manufacture of potteryware which comprises, in combination, a rotatable turret having a plurality of dies associated therewith, means for feeding clay into said dies and means for removing clay after shaping from said turret, a plurality of co-operable die bodies, means for transferring shaped clay thereto, means for elevating one of said dies to squeeze clay between it and its companion die and means for controlling the degree of pressure applied to said clay.

9. Apparatus for the manufacture of potteryware which comprises, in combination, a rotatable turret having a plurality of dies mounted therein, means for feeding clay into said dies, means for forming said clay into undewatered blanks, means for removing said blanks from said turret and means for squeezing said blanks to expel water therefrom, said means comprising a pair of permeable matrices, means for moving one of said matrices relative to the other and means for varying the degree of pressure applied to said blanks.

10. Apparatus for the manufacture of potteryware which comprises, in combination, a rotatable turret having a plurality of dies mounted therein, means for feeding clay into said dies, means for forming said clay into undewatered blanks, means for removing said blanks from said turret and means for squeezing said blanks to expel water therefrom, said means comprising a pair of permeable matrices, means for moving one of said matrices relative to the other and means for varying the closest approach of said matrices.

11. Apparatus for the manufacture of potteryware which comprises, in combination, a rotatable turret having a plurality of dies mounted therein, means for feeding clay into said dies, means for forming said clay into undewatered blanks, means for removing said blanks from said turret and a plurality of means for squeezing said blanks to progressively remove water therefrom, said means comprising pairs of permeable matrices and means for limiting the closest approach of the matrices of a pair and adjustable means for regulating the degree of pressure applied to said blanks.

12. An apparatus for the manufacture of potteryware which comprises, in combination, a clay shaping mechanism, means for dewatering clay, a clay transfer and a dryer, mechanism for operating said clay shaper, means for operating said dewatering mechanism and means for operating said transfer in timed relation with said clay shaping and said dewatering means.

13. Apparatus for the manufacture of potteryware such as plates, cups, saucers and the like from plastic clay comprising, in combination, means for shaping clay bodies out of plastic clay by pressing comprising permeable die surfaces, means for dewatering shaped clay by pressing comprising permeable die surfaces and means for varying the pressure applied to the clay incident to shaping and dewatering.

14. Apparatus for the manufacture of potteryware comprising, in combination, means for shaping clay bodies, means for dewatering previously shaped clay bodies comprising a plurality of dies having permeable clay engaging faces and means for applying sub and super atmospheric pressure through the faces of said dies to draw the liquid constituents of the clay squeezed from said clay incident to dewatering into the dies and to purge the dies thereof through their faces, respectively.

15. Apparatus for the mass production manufacture of potteryware comprising, in combination, a plurality of pairs of permeable pressing dies arranged in sequence and forming a production line, means for feeding the line with individual clay charges, means for transporting the clay in various stages of fabrication along the line, means for opening and closing the dies to first shape the clay charge and then dewater the same as the blanks progress along the production line and a dryer for receiving the clay bodies subsequent to dewatering.

16. Method of manufacturing potteryware such as plates, cups, saucers and the like from plastic clay which consists in first pressing a clay mass

at less than dewatering pressure to shape the same and then immediately repressing the preformed clay mass at pressures of dewatering intensity whilst maintaining the pre-established shape to remove a material portion of the water therefrom.

17. A process for the manufacture of ceramic ware such as plates, cups, saucers and the like which comprises, preparing a plastic mass comprising clay and water, forming the mass to the desired shape and materially reducing the water content by the application of mechanical pressure to the mass while the mass is in contact with a permeable support into which the water passes, releasing the pressure and then expelling the water from the permeable support.

18. A process for the manufacture of ceramic ware such as plates, cups, saucers and the like which comprises, forming a mass of plastic clay having a water content which will promote plastic deformation between permeable supports which permit the passage of water thereinto, applying mechanical pressure to the mass to expel water therefrom into the permeable supports while at the same time shaping the mass and compacting and densifying it, releasing the pressure and separating the clay from the permeable supports and purging the supports of held water.

19. A method of making potteryware which comprises, squeezing a clay mass containing water between permeable shaping members, expelling the water into the shaping members whilst consolidating the clay, releasing the pressure and separating the shaping members and blowing the water removed from the clay back onto the surface of the clay.

20. Apparatus for the manufacture of potteryware such as plates, cups, saucers and the like from plastic clay comprising, in combination, means for shaping clay bodies into final ware form by the application of a sequence of pressures thereto, and means for repressing the formed bodies to progressively remove shrinkage water therefrom, compact the clay and reduce the body to substantially its dry bulk and density and means for actuating said shaping means and said repressing means in timed relation.

21. Apparatus for the manufacture of potteryware comprising, in combination, means for progressively squeezing a plastic clay body into an approximation of ware form wherein the blank has predetermined brim, faces and a deformable body, means for squeezing such blanks whilst maintaining the form previously imparted thereto to remove the shrinkage water therefrom and compact the material without producing shrinkage cracks, means for transferring the plastic deformable body from the first named means to the second named means, the article when pressed having substantially its dry bulk and density and being substantially of a leather hard character and a dryer for the reception of the shaped, dewatered ware.

22. In combination with a mold, apparatus for forming mold bonded clay bodies comprising a pressing instrumentality adapted to co-operate with the central zone of the molding surface of a mold to press upon and reduce that portion of a charge of clay over-lying the central zone to a predetermined thickness, means operable prior to the withdrawal of the pressing instrumentality to distribute the remainder of the charge of clay over the exposed portion of the molding surface and reduce the same to a predetermined thickness thereby dividing the formative process into successive stages and reducing the pressure required to move the clay over the surface of the mold and means for releasing the pressing instrumentality and distributing means from the surface of the clay.

23. A method of forming a mold bonded clay body which comprises, depositing a charge of clay on the center of distribution of the molding surface of a mold and then pressing out the central portion of the body to the thickness desired in this portion of the blank thereby leaving a ring of unpressed clay surrounding the central portion and then applying pressure to said ring of unpressed clay whilst holding the central portion of the blank at the pre-established thickness to thereby cause the previously unpressed clay to be distributed over the exposed portion of the mold in a direction toward the brim thereof thereby completing the formation of the mold bonded clay body.

24. Apparatus for the manufacture of potteryware comprising, in combination, a press for shaping clay bodies including permeable means for squeezing clay bodies therebetween to remove water from the said clay, means for applying air under pressure through the permeable means operable upon separation of said permeable means to purge said permeable means of held water and eject the same in the direction of the clay body.

25. In apparatus for manufacturing potteryware such as plates, cups, saucers and the like from plastic clay, means for applying mechanical pressure to unformed clay bodies to distribute the material over a molding surface and shape the same, said means being adapted to allow free movement of the liquid constituents of the clay body by being constructed of a permeable material together with means for applying mechanical pressure to the clay in said shaped clay bodies at a value which will move the liquid constituents out of the body, said last named means being adapted to allow free movement of the liquid constituents by being constructed of a permeable material.

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