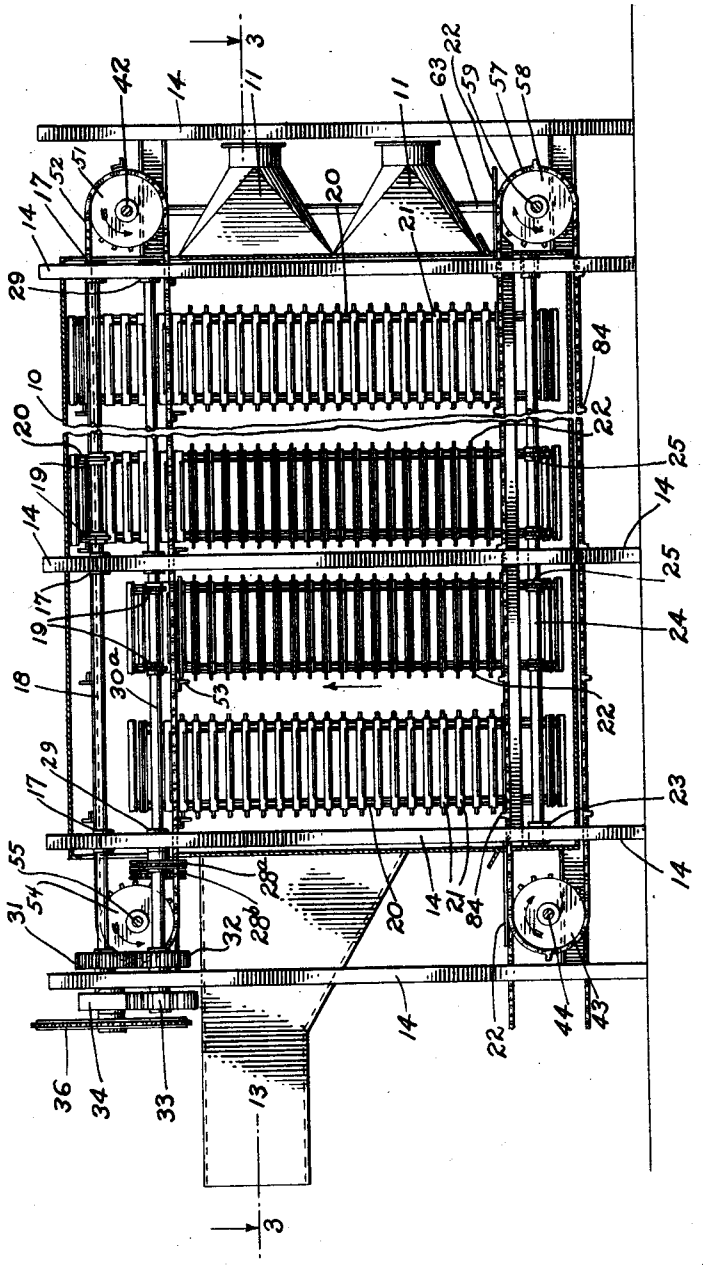
June 26, 1928. 1,675,260

L. L. EDMUNDS

CONTINUOUS CUBE DRYING MACHINE

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Fig. 1.



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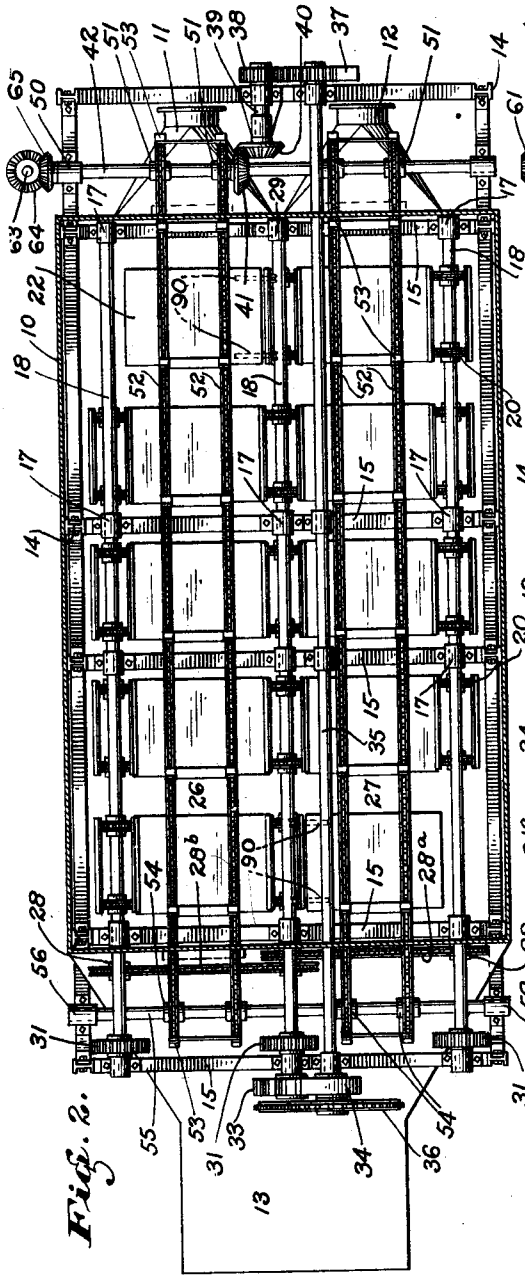


Fig. 2.

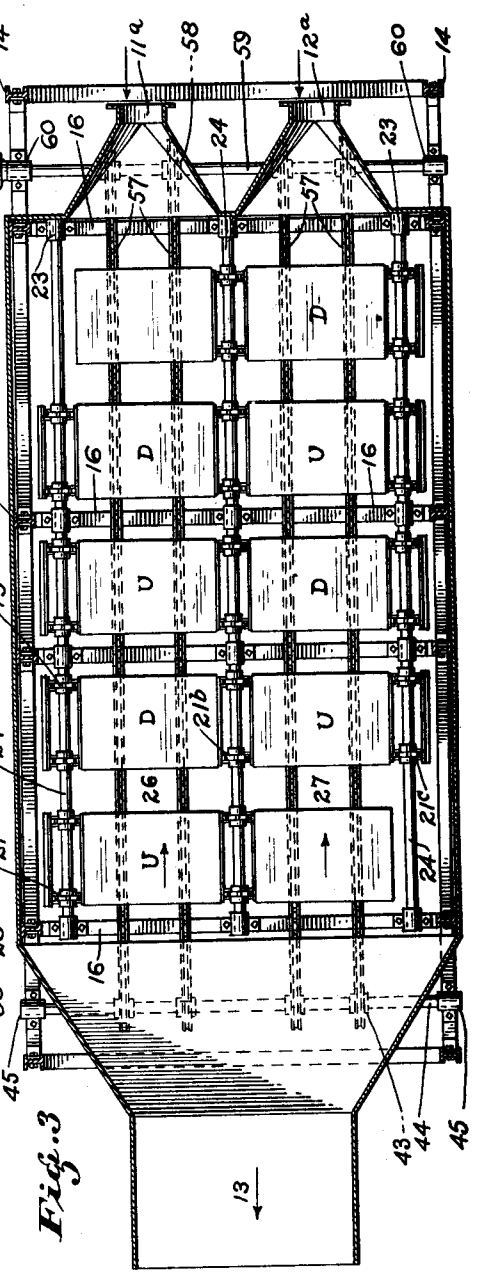


Fig. 3.

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Fig. 4.

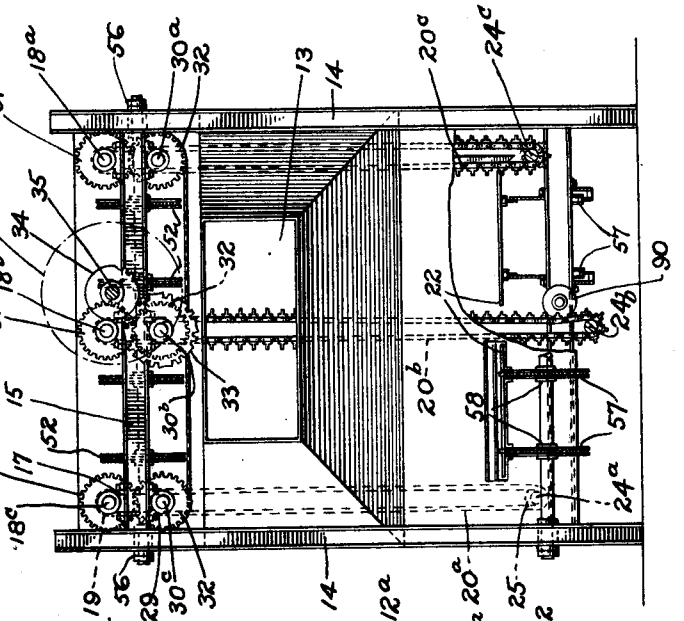
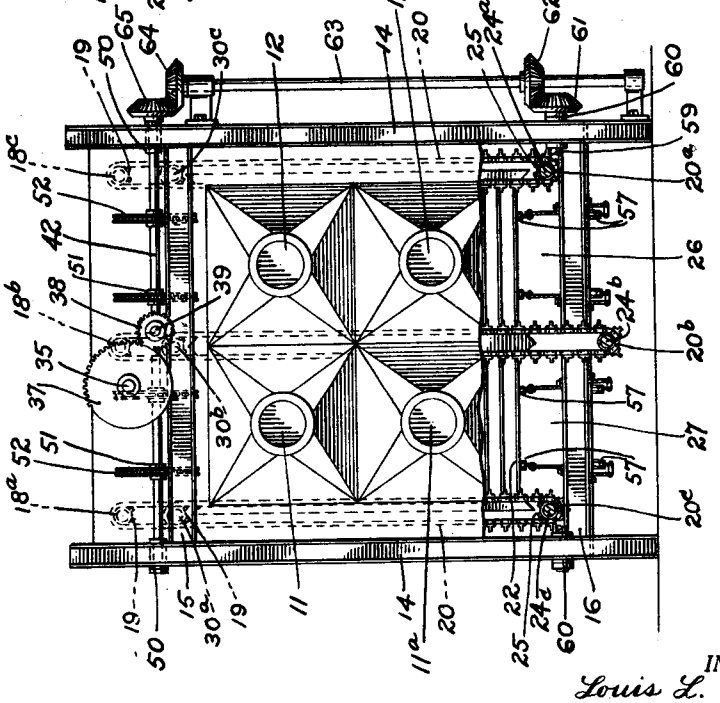


Fig. 5.



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Fig. 6.

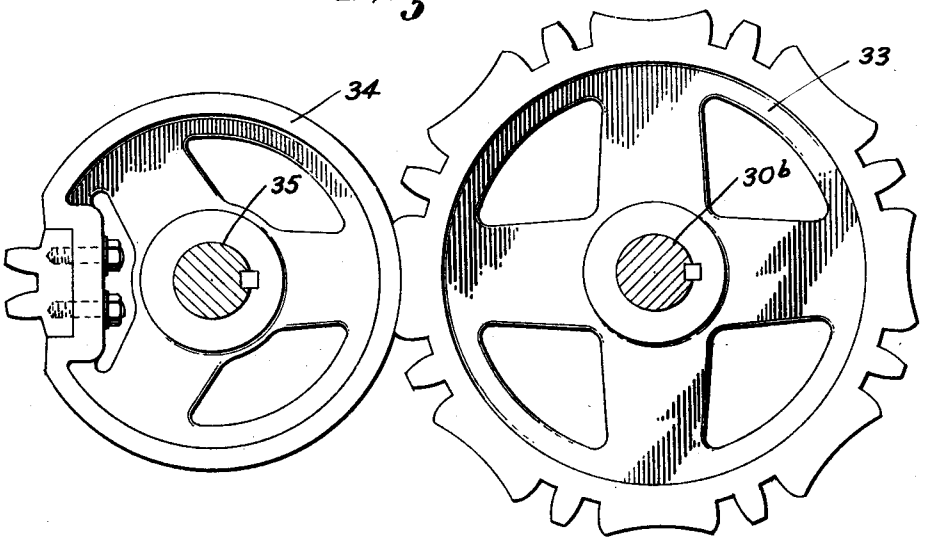
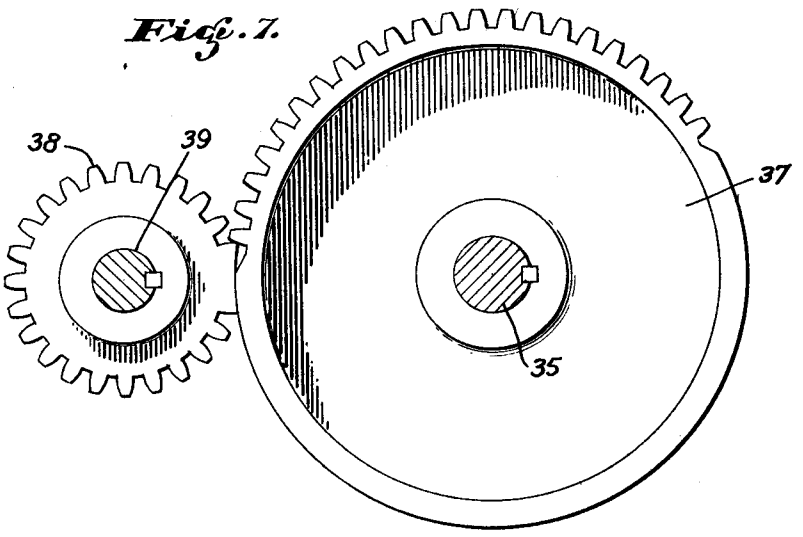


Fig. 7.



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Fig. 8.

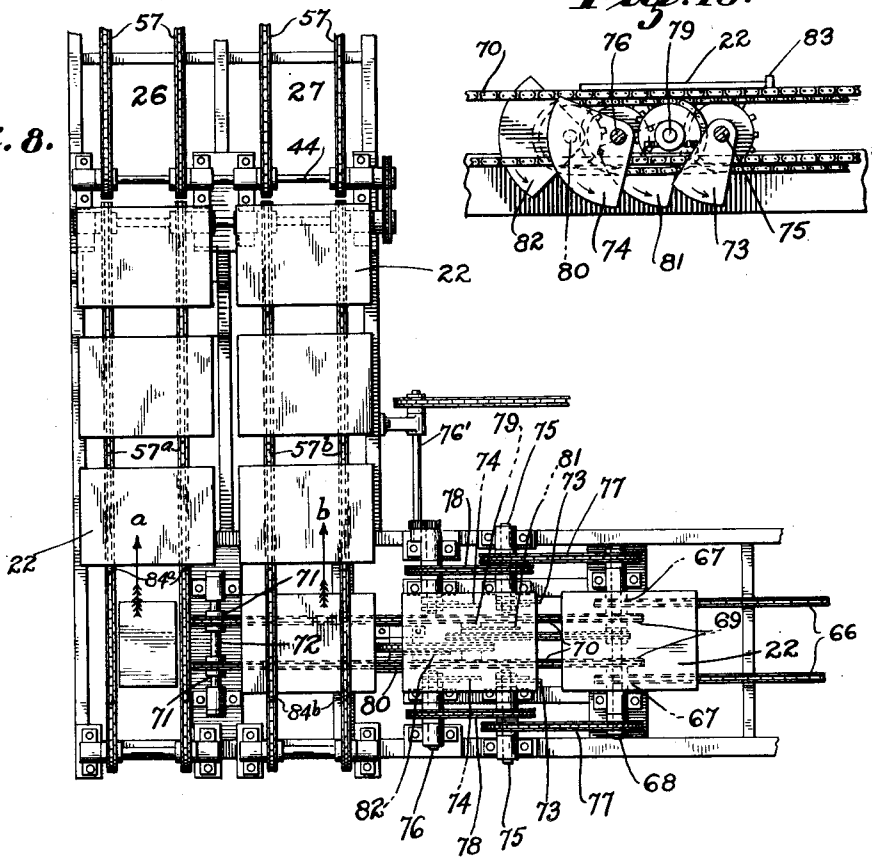
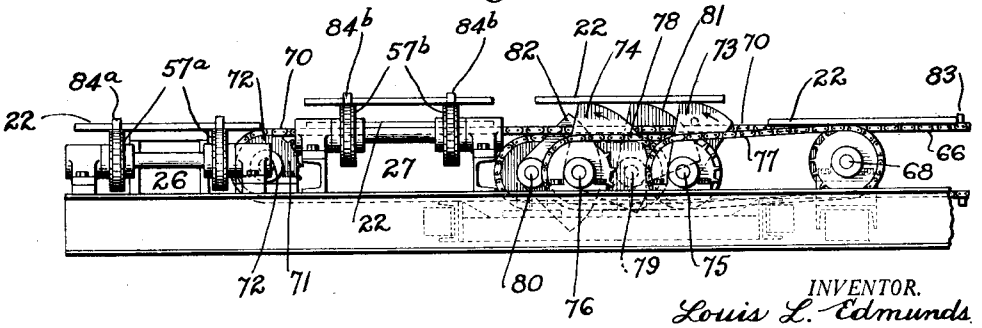


Fig. 10.

Fig. 9.



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UNITED STATES PATENT OFFICE.

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CONTINUOUS CUBE-DRYING MACHINE.

Application filed August 22, 1927. Serial No. 214,550.

This invention relates to a drying apparatus, and particularly pertains to means for drying cube sugar.

At the present time it is common practice in the manufacture of cube sugar for the wet or undried sugar to which has been added a small quantity of white liquor to be fed into a cube forming machine where the sugar is formed and packed into cubes. It is thereafter necessary to dry the cubes so that they will maintain their solid form. Great care must be taken, however, in handling the freshly formed sugar cubes so that they are not disintegrated or otherwise spoiled before they have become dried to a suitable hardness. It is therefore desirable to provide a drying mechanism which will carefully handle the cubes, and which will also insure that the cubes will be dried in a minimum length of time and within an apparatus which requires a minimum amount of floor space. It is the object of the present invention, therefore, to provide a compact drying apparatus through which trays of sugar cubes may be carried, and within which they may be rapidly and thoroughly dried.

The present invention contemplates the provision of a housing through which a circulation of heated air may take place, and within which housing a conveying mechanism is provided which makes it possible for substantially the entire cubical area of the housing to at all times be filled with cube laden trays moving in a counter-direction to the heated air and being dried thereby.

The invention is illustrated by way of example in the accompanying drawings, of which

Fig. 1 is a view in side elevation showing the drying apparatus with parts broken away for the sake of convenience.

Fig. 2 is a view in plan showing the complete machine.

Fig. 3 is a view in plan similar to Fig. 2, and is viewed on the line 3—3 of Fig. 1. This view has parts broken away for the sake of convenience.

Fig. 4 is an end view of the machine showing the entry end.

Fig. 5 is a view showing the discharge end of the machine.

Fig. 6 is an enlarged view in elevation showing the gears by which intermittent driving motion is imparted to the vertical conveyors.

Fig. 7 is a view of the gears used to give intermittent driving motion to the tray transfer means whereby the trays are horizontally shifted.

Fig. 8 is a fragmentary view in plan showing the means by which the trays are delivered to the entry end of the machine.

Fig. 9 is a fragmentary view in elevation showing the tray delivery means and the manner in which trays are alternately delivered to two entry openings of the machine.

Fig. 10 is a fragmentary view in elevation showing the tray lift cams in their lowermost position.

Referring more particularly to the drawings, 10 indicates an outer shell or housing adapted to enclose the mechanism with which the present invention is concerned, and through which shell or housing air is circulated from air inlets 11, 11^a, 12 and 12^a to air outlet 13. It is intended that the circulation of air lengthwise of the housing shall be in counter-direction to the movement of trays of material to be dried through the housing, and it may be desirable to cause the air to pursue a sinuous path of travel through the housing either in a horizontal or a vertical plane. The housing is formed with a plurality of upright frame members 14 which support the walls of the housing and at the same time provide suitable supports for horizontal frame members 15 and 16 disposed near the top and the bottom of the housing. These frame members extend horizontally across the housing at intervals, and provide supports for bearings. The upper frame member carries bearings 17 for upper sprocket shafts 18^a, 18^b and 18^c, upon which are sprocket wheels 19. These wheels receive vertically moving conveying chains 20^a, 20^b and 20^c respectively, which are equipped with flights 21 upon which trays 22 may be disposed. The bearings 23, carried by the lower transverse frame members 16, receive lower sprocket shafts 24 carrying sprocket wheels 25 around which the chains are led.

Disposed at the bottom of the frame structure and in equal spaced relation to each

other in a horizontal plane with the top frame structure are three shafts 24^a, 24^b and 24^c. The shafts extend substantially throughout the length of the machine and carry a plurality of sprocket wheels 19 and 25. By reference to Figs. 2 and 5 of the drawings it will be seen that the sets of sprocket chains as viewed in any vertical transverse section of the machine, cooperate to form two vertical and parallel lanes 26 and 27 along which the trays 22 may be moved by the chain in an upwardly or downwardly direction, as the case may be. The sprocket chains may therefore be conveniently designated as 20^a, 20^b and 20^c. It will therefore be evident that the two runs of the intermediate chain 20^b will be travelling in opposite directions, and that the right-hand run of the chain 20^b, as seen in Fig. 2, will be travelling in the same direction as the left-hand run of the chain 20^a, while the left-hand run of the intermediate chain 20^b will be travelling in the same direction as the right-hand run of the chain 20^c. Thus the flights on the adjacent runs of the chains will be travelling in the same direction and will act to elevate a sugar tray along one of the vertical lanes, while lowering a tray along the other vertical lane in the same vertical plane.

By reference to Fig. 4 it will be seen that the transverse frame members 15 carry bearings 29 which receive shafts 30^a, 30^b and 30^c respectively. These shafts are disposed in the same vertical plane with the shafts 18^a, 18^b and 18^c previously described. A set of sprockets 19 are also caried on these shafts, but attention is directed to the arrangement of the sprockets as shown in Figs. 2 and 4, where it will be seen that pairs of sprocket wheels 19 are alternately disposed upon the various shafts 18^a, 18^b and 18^c and 30^a, 30^b and 30^c in order to insure that the adjacent sets of conveying chains 20^a, 20^b and 20^c, as considered lengthwise of the machine, will convey trays in opposite vertical directions. Thus the first set of conveying chains will elevate a tray of material to be dried, and when this tray reaches the top of its path of travel it will be shifted horizontally and longitudinally of the machine onto a second set of conveyor chains, which are travelling downwardly. This alternate movement of the sets of chains is arranged throughout the length of both of the vertical lanes 26 and 27, and is brought about due to the fact that the shafts 18^a, 18^b, and 18^c, and 30^a, 30^b and 30^c rotate in opposite directions, as indicated particularly by the arrows in Fig. 1 of the drawings.

The driving arrangement for the shafts 18^a, 18^b and 18^c, 24^a, 24^b and 24^c, and 30^a, 30^b and 30^c, is as follows: The shafts 18^a, 18^b and 18^c are each fitted with a gear 31, which gears are in constant mesh with gears 32 carried by the complementary parallel shafts 30^a, 30^b and 30^c, and means for driving the shafts 30^a and 30^c is accomplished through the chains 28^a and 28^b, shaft 30^b being the driving member. Mounted on each shafts 30^a, 30^b and 30^c, are sprocket wheels 28 around which chains 28^a and 28^b are led, so that all of said shafts will rotate in unison. The shafts 24^a, 24^b and 24^c will, of course, be driven through the sprocket chains 20^a, 20^b and 20^c. The shaft 30^b extends through the bearing 29 and receives an intermittent driven gear 33 which is in constant mesh with a driving pinion 34. These gears are more particularly shown in Fig. 6 of the drawings, where it will be seen that the pinion 34 will rotate the gear 33 a fraction of a full rotation thereof for each complete rotation on the pinion. The pinion is mounted upon a driving shaft 35 driven from a source of supply through a suitable transmission mechanism, such as the sprocket chain arrangement 36. The driving shaft 35 exends parallel to the shafts 18^b and 30^b, and extends throughout the length of the machine. At the opposite end of the drive shaft 35 a gear 37 is secured. This is a mutilated gear of the general design shown in Fig. 7 of the drawing. It is in mesh with a complementary mutilated pinion 38, so that a partial rotation of the gear 37 will act to produce a substantially complete rotation of the pinion 38 and the shaft 39 upon which it is mounted. The shaft 39 carries a mitre gear 40 in mesh with a mitre gear 41 mounted upon a shaft 42. The shaft 42 is mounted in suitable bearings 50 secured to the frame structure of the machine. A plurality of sprockets 51 are secured upon the shaft and receive longitudinally extending transfer chains 52. These chains extend throughout the length of the machine over the lanes 26 and 27, and are intended to carry operating fingers 53 which will engage the uppermost trays in the upwardly moving stacks and will cause the trays to be shifted onto the uppermost flights of the chain in the next succeeding downwardly moving stack. The chain 52 is led around sprockets 54 at the opposite end of the machine. These sprockets are carried upon a jack-shaft 55, rotatably secured in bearings 56, as clearly shown in Fig. 2 of the drawings.

It is also necessary to shift the lowermost tray in the downwardly moving stack onto the flights of the chain in the next succeeding upwardly moving tray stack, and for this purpose a set of sprocket chains 57, similar to the set 52, are disposed in parallel relation thereto and beneath the tray stacks, as shown in Figs. 4 and 5 of the drawings. These sprocket chains 57 are led around sprockets 58 mounted upon a shaft 59 at the discharge end of the machine, and are rotatably mounted in bearings 60 mounted on the

frame work. The chain 57 is led around sprockets 43 at the opposite end of the machine and are secured to shaft 44 rotatably mounted in bearings 45 secured to the frame structure. A bevel gear 61 engages a bevel gear 62, and is driven thereby. The gear 62 is secured at the lower end of a vertical shaft 63. The upper end of this shaft carries a bevel gear 64 in mesh with a bevel gear 65. The gear 65 is mounted upon the shaft 42. It will thus be seen that by this arrangement the sets of transfer chains 52 and 57 will be simultaneously driven in synchronism and in opposite directions at the top and bottom of the tray stacks.

The shaft 44, as shown in Fig. 8 of the drawings, is disposed beyond the entry end of the machine, and in such position as to permit trays 22 to be deposited thereupon and to be carried in to the lower end of the machine. This arrangement makes it possible for the machine to be manually fed or automatically fed. The automatic feeding means is shown in Figs. 8 and 9, where it will be seen that parallel horizontally extending conveyor chains 66 are disposed at right angles to the chains 57. The chains 66 are led around sprockets 67 on a shaft 68. This shaft also carries a pair of sprockets 69, which are disposed between the sprockets 67 and receive parallel chains 70. The parallel chains 70 extend in longitudinal alignment with the chains 66, and pass around sprockets 71 carried on a shaft 72, which shaft is disposed between adjacent pairs of the lower transfer chains 57^a and 57^b. The upper run of chains 70 passes between runs of the pair of chains 57^a which act to transfer trays in the lane 26 of the machine. This clearance is sufficient to permit filled trays to be carried upon the upper runs of the chains 70 and to be deposited upon the upper runs of chains 57^b, which act to transfer trays in the lane 27. It will therefore be evident that some means must be provided to alternately deposit trays upon the separate pairs of transfer chains serving the lanes 26 and 27. This means comprises a plurality of lifting and shifting cams, as particularly shown in Fig. 9 of the drawing. Cams 73 and 74 are disposed upon the outer sides of the chains 70 and are mounted upon complementary shafts 75 and 76 respectively. The shafts 75 and 76 drive the shaft 68 through sprocket chains 77 and 78. A pair of shafts 79 and 80 are also provided and support cams 81 and 82 at points intermediate the chains 70, the cam 81 being positioned at a point in advance of cams 73 while the cam 82 is in advance of the cams 74. By examination of Fig. 9 of the drawing it will be seen that the cams 73, 74, 81 and 82 have arcuate faces concentric with their axes of rotation, and that the cams represent sectors of circles subtended by chords of different lengths. The cams 73 are provided with relatively short arcuate faces which contact with the under side of a tray at a point near the rear edge thereof. The cams 74 have faces of considerably greater length than those of cams 73, and simultaneously contact with the under face of the tray at a time contact is made by the cams 73. The initial point of contact of cams 74, however, is beneath the advance portion of the tray and the developed arcuate length of each of the cams 74 represents the length of the tray yet to traverse the initial point of contact with the cams 74, so that the tray will be continuously supported by the cams 74 until the rear edge of the tray passes the axis of shaft 76. The cam 81 is disposed upon the shaft 79 at a point substantially midway between shafts 75 and 76, and has a developed arcuate length gearing with the portion of the tray which has not yet passed the axis of the shaft 79. The cam 82 is mounted on shaft 80. The shaft 80 is disposed in advance of shaft 76, and its cam 82 is of sufficient length to insure that the tray will be suitably supported while being transferred from the sprocket chains 70 onto the first pair of transversely extending sprocket chains 57^a. The tray shifting and elevating mechanism is so designed that trays successively delivered on the chain 66 will be alternately placed upon the sets of transfer chains 57 serving lanes 26 and 27 of the driving apparatus.

Operation.

In operation of the machine trays are placed on the chains 66 and may be disposed in accurate spaced relation to each other by spacing lugs 83 carried by the chain. The advancing trays will be shifted from the chain 66 onto the chain 70, and will be carried forwardly over the shafts 65, 66, 79 and 80. It will be assumed that in the initial operation the cams carried by the shafts are in their lowermost positions, as shown in Fig. 10, so that the first tray will continue its travel as supported and conveyed by the chain 70 and will be shifted over to the pair of chains 57^a which serve the lane 26. It is to be understood that all of the conveying chains in the drying mechanism are operating in synchronism, and that chain 57^a will carry the tray into the machine and position it between flights on the adjacent parallel runs of sprocket chains 21^a and 21^b. During this transferring and horizontal shifting movement of the trays the elevating chains 20 are motionless, thus permitting the trays to be moved horizontally and into their desired position within the tray stacks. In order to insure that this operation will be produced properly, lugs 84 are secured to certain of the links of the chains 57 to engage and shift the trays. After the first

tray has been moved in the direction of the arrow *a*, as indicated in Fig. 8 of the drawings, to a position where it will properly register with the first set of sprocket chains 21^a and 21^b, the entire system of horizontal tray conveyors within the dryer including chains 57 is rendered inoperative, at which time the stacks of trays engaged by the several complementary runs of chains will move in alternate directions. The chains 66 and 70 will be continuously driven from shaft 76. In order to clarify the operation, the trays shown in Fig. 3 of the drawings have been alternately marked with the letters U and D to indicate that the stacks of trays in these various positions are at all times moving in an upwardly direction when marked with the letter U, and a downwardly direction when marked with the letter D. When the first tray 22 in the first stack of lane 26 has reached the horizontal plane of the axes of shafts 24 the vertically moving sprocket chains 20 will become inoperative, due to the action of the gears 33 and 34 and all of the shafts 18, 24 and 30 will be locked by the gears 33 and 34 so that the weight of the material carried in the trays will not cause the shafts to rotate and the material to "run down" the stack. At this period of rest the horizontal conveying system within the dryer and the transfer chains 57, will be set in motion through the gears 37 and 38. A second tray 22 will be advanced over the lifting station as defined by the continuously moving cams 73, 74, 81 and 82. At this time the cams will be in the position as shown in Fig. 9, so that the pairs of cams 73 and 74 and the intermediate cam 81 will simultaneously contact with the bottom of the tray at such points as to permit the tray to be lifted without losing its equilibrium. The cams will then rotate in the general direction of travel of the chains 70, and will lift the tray as indicated in Fig. 9 and will shift it onto the pair of chains 57^b which serves the lane 27 of the dryer. When this operation has been completed, lugs 84^b on the chain 57^b will move the tray horizontally in the direction of the arrow *b*, as indicated in Fig. 8, and will position the tray between flights on adjacent runs of chains 21^b and 21^c and in the first "up" stack of the lane 27. Simultaneous with the shifting of a tray into the machine along lanes 26 and 27 and in the directions of the arrows *a* and *b*, as shown in Fig. 8, lugs 84 will shift each of the bottom trays 22 in each stack of trays, and will move them horizontally onto the lowermost tray position in the next succeeding stack towards the discharge end of the machine. It is also to be understood that the conveyor chains 52, which are disposed above the tray stacks, will act in the same manner through their lugs to simultaneously shift the uppermost tray in each tray stack into proper position with relation to the next succeeding set of vertically moving chains 20, and along the particular lane towards the discharge end thereof. By this arrangement the lowermost tray in each of the "down" tray stacks will be shifted horizontally to the lowermost tray position in the next succeeding "up" tray stack, and the uppermost tray in each of the "up" tray stacks will be simultaneously shifted to the uppermost position in the next "down" tray stack. It will thus be seen that the trays will pursue a sinuous path of travel in a vertical plane from the entry to the discharge end of the housing while travelling along parallel lanes and in a counter-direction to the direction of the flow of the heating medium. When the trays reach the last stack in each of the lanes 26 and 27 they will move to the lowermost position in the stacks, due to the fact that the final stacks in each lane are "down" tray stacks, and they will then be engaged by the lugs 84 on the lower chains 57 and will be carried from the housing and the machine to any desired packing apparatus.

In order to prevent the downwardly moving flights of the first pair of chains 20^b in lane 27 and the last pair of upwardly moving chains 20^c in lane 26 from overturning the trays moving in close proximity, idlers 90 are provided to hold the flights away from the tray edge, as shown in Fig. 4.

It will thus be seen that by the arrangement here disclosed a maximum amount of sugar may be continuously subjected to a drying action as it moved from the relatively cool end of a drying compartment within which hot, moisture laden air is present, to a relatively hot end of said compartment within which dry air of higher temperature is present, and which air is moving in a counter-direction of travel to the material being dried, and whereby the material may be dried rapidly and thoroughly.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention, as defined in the appended claims.

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

1. A drying apparatus comprising a housing through which hot air may have an end to end flow horizontally, a plurality of sets of vertically moving endless tray conveyors disposed side by side throughout the length of the housing, adjacent tray conveyors moving in alternate vertical directions, and means for progressively shifting the trays from one set of conveyors to the next adjacent set progressively throughout the length of the housing.

2. A drying apparatus comprising a hous-

ing through which an end to end horizontal flow of hot air may take place, a plurality of sets of vertically moving endless conveyors arranged side by side throughout the length of the housing, said conveyors being equipped with supporting flights for trays and being driven to cause adjacent sets of conveyors to move in alternate directions, and means for shifting a tray from one set of conveyors to the next succeeding set after it has been carried throughout the length thereof, and whereby said tray will pursue a progressively sinuous path of travel throughout the length of the housing.

3. A drying apparatus comprising a horizontal housing through which heated air has an end to end circulation, a plurality of sets of endless conveyors adapted to receive trays and support them horizontally while moving them vertically, means for intermittently driving said conveyors in unison, means disposed above and below the sets of vertically moving conveying mechanisms and adapted to shift a tray which has been moved to its extreme position by a set of vertical conveyors to the next succeeding set of vertical conveyors, and means operating in synchronism with the driving means for the vertical conveyors whereby the tray shifting mechanism will operate during the interval of inactivity of the vertical conveyors, so that the trays will be progressively moved throughout a vertical sinuous path of travel towards the discharge end of the machine and in a counter-direction to the flow of hot air therein.

4. A drying apparatus comprising a horizontal housing through which heated air has an end to end circulation, a plurality of sets of endless conveyors adapted to receive trays and support them horizontally while moving them vertically, means for intermittently driving said conveyors in unison, means disposed above and below the sets of vertically moving conveying mechanisms and adapted to shift a tray which has been moved to its extreme position by a set of vertical conveyors to the next succeeding set of vertical conveyors, means operating in synchronism with the driving means for the vertical conveyors whereby the tray shifting mechanism will operate during the interval of inactivity of the vertical conveyors, so that the trays will be progressively moved throughout a vertical sinuous path of travel towards the discharge end of the machine and in a counter-direction to the flow of hot air therein, duplicate sets of said conveyors arranged parallel, and feed means for alternately feeding the trays to said duplicate sets of conveyors.

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