June 25, 1929. E. L. YOUNGER 1,718,845

DEHYDRATOR

Filed March 10, 1928 5 Sheets-Sheet 1

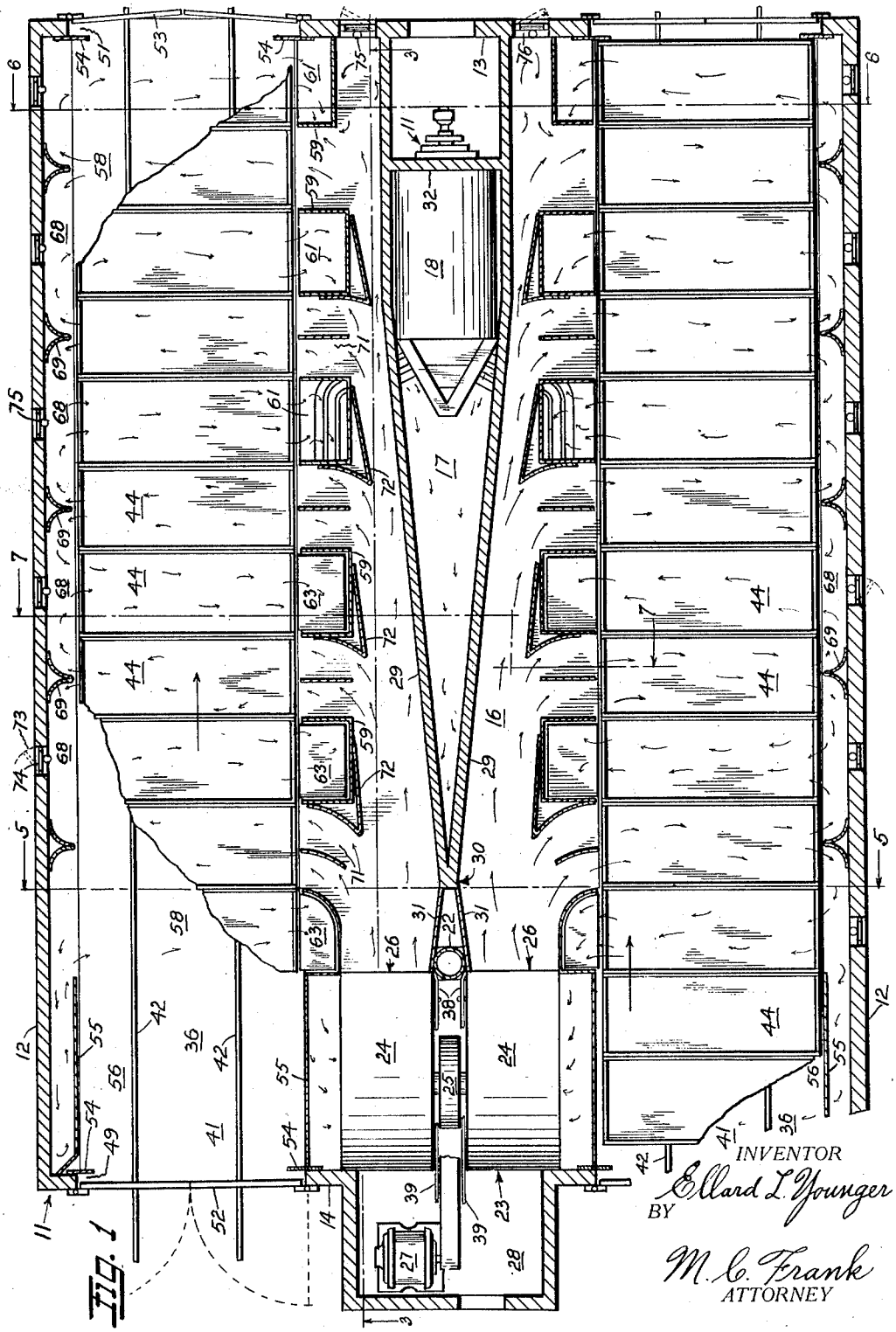


Fig. 1

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DEHYDRATOR

Filed March 10, 1928 5 Sheets-Sheet 2

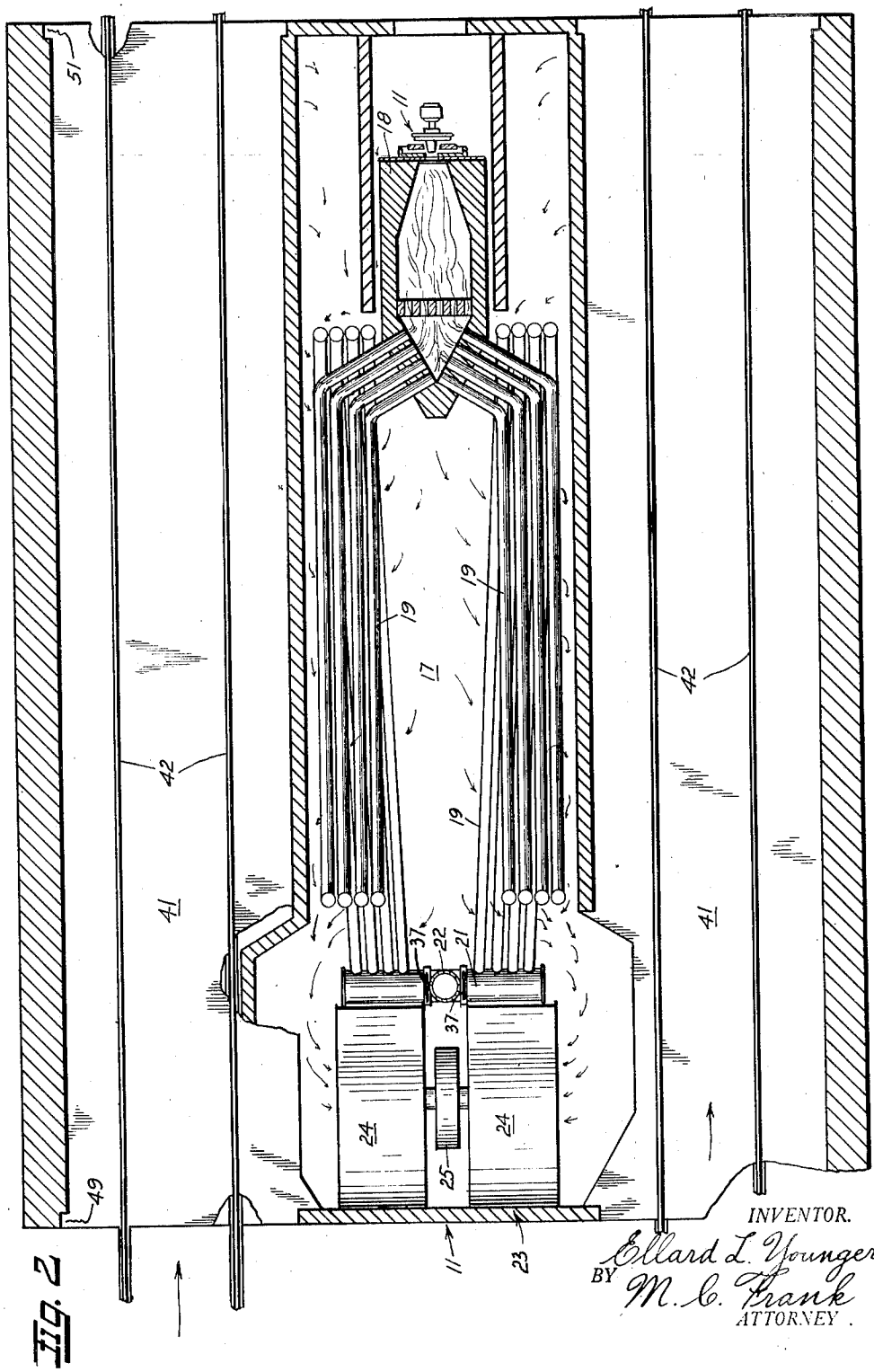


Fig. 2

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DEHYDRATOR

Filed March 10, 1928 5 Sheets-Sheet 3

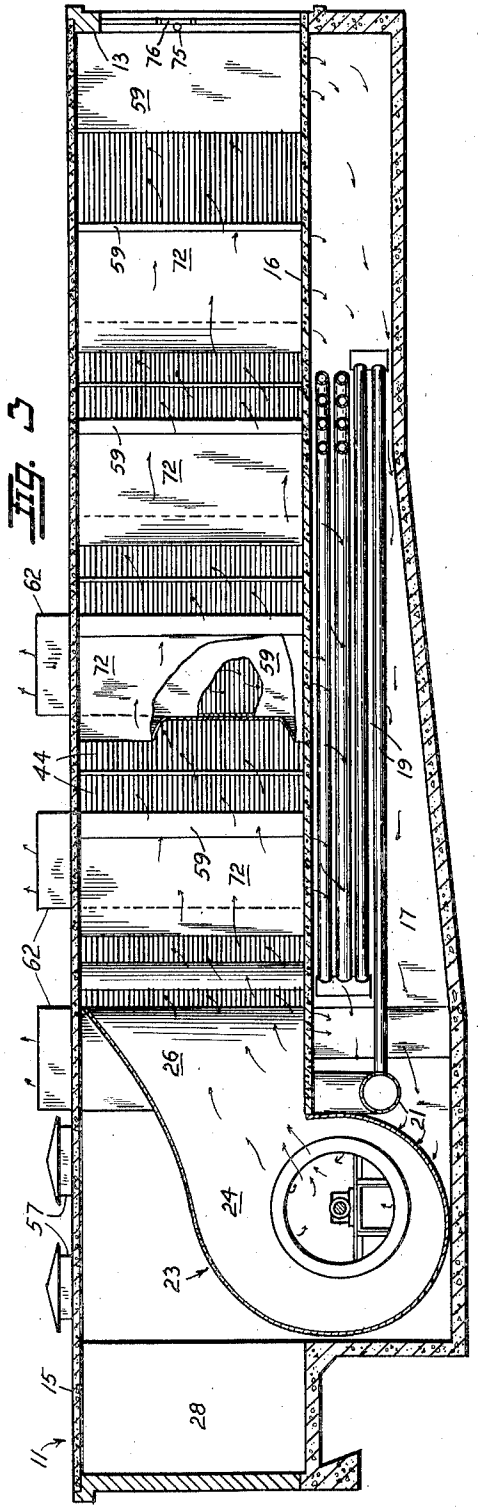


Fig. 3

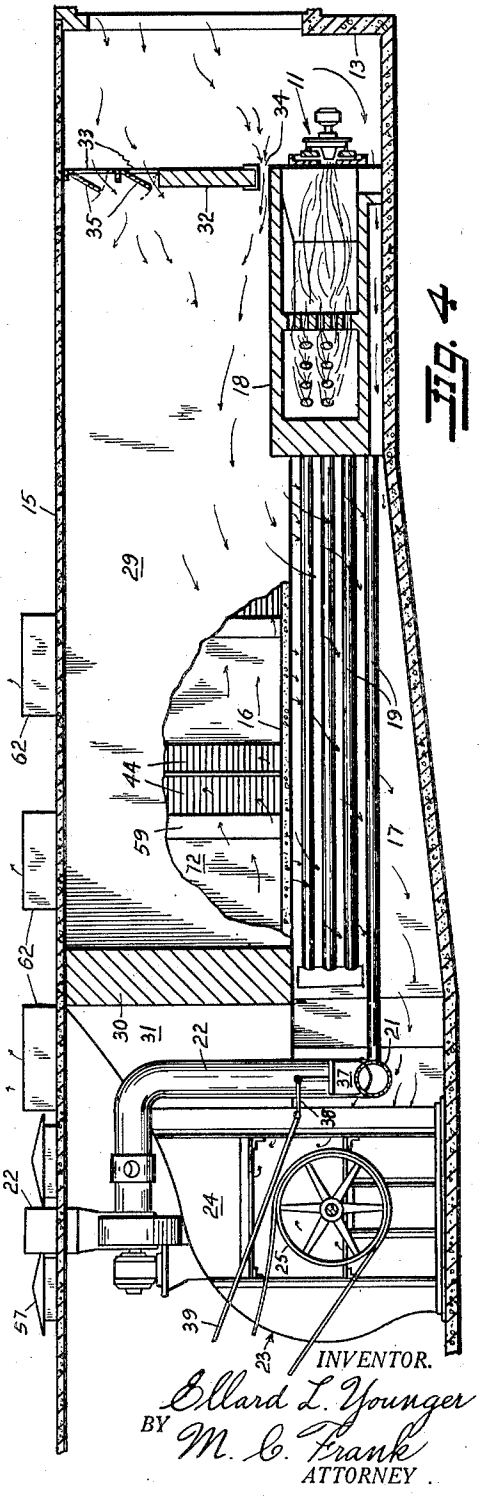


Fig. 4

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DEHYDRATOR

Filed March 10, 1928 5 Sheets-Sheet 4

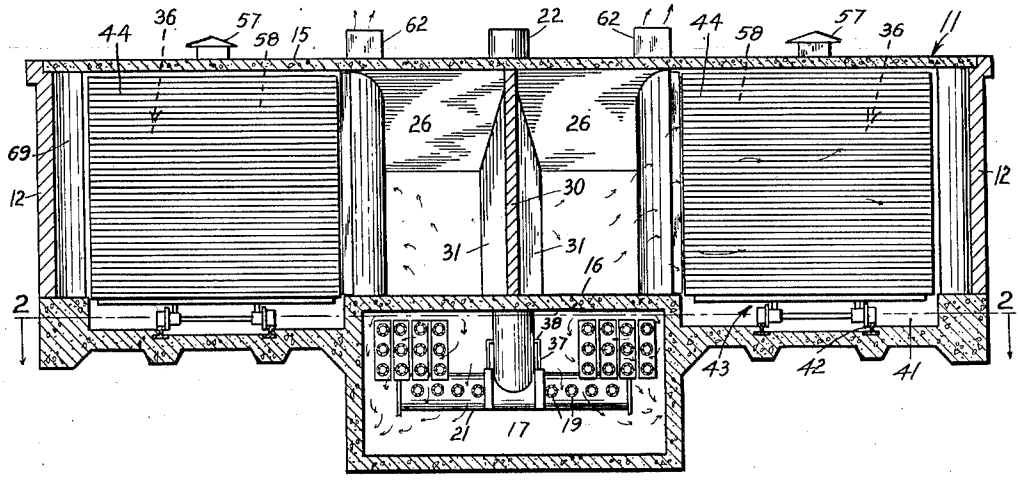


Fig. 5

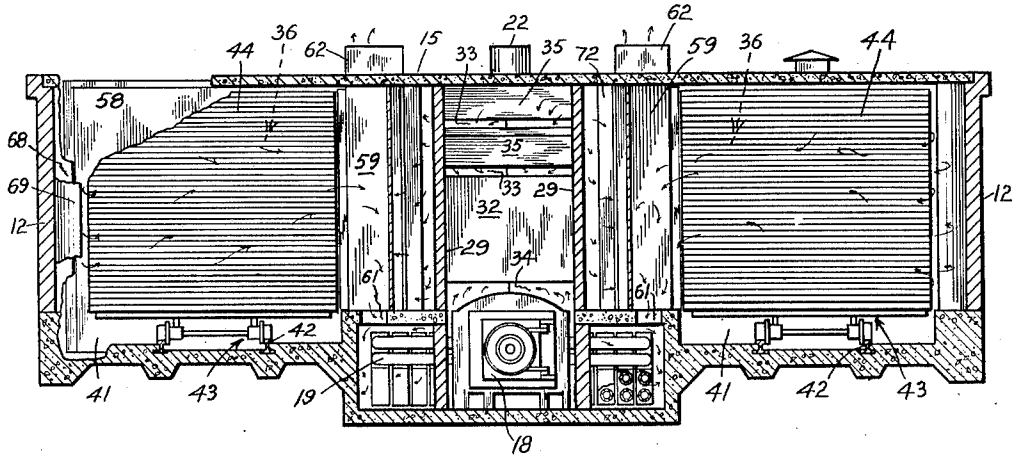


Fig. 6

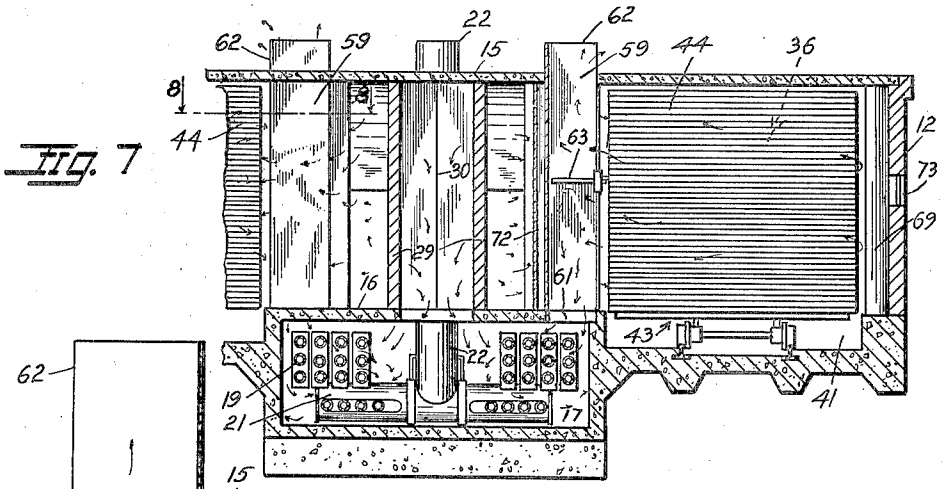
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June 25, 1929. E. L. YOUNGER 1,718,845

DEHYDRATOR

Filed March 10, 1928 5 Sheets-Sheet 5

Fig. 7



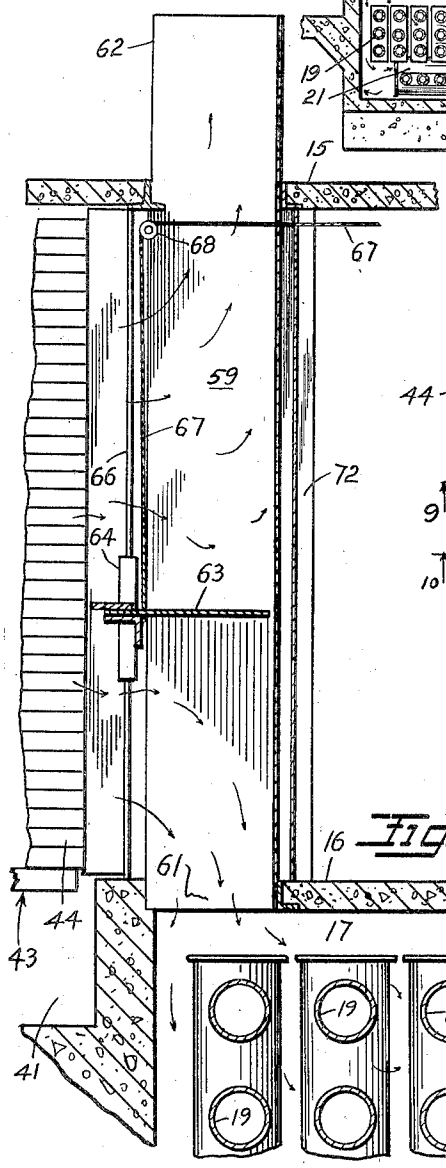


Fig. 9

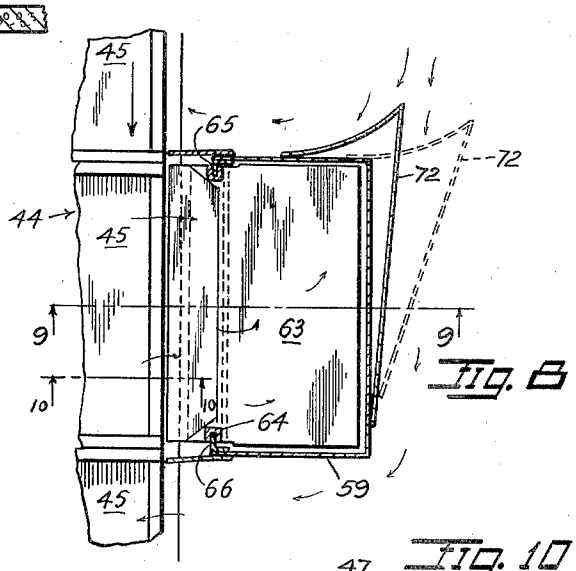
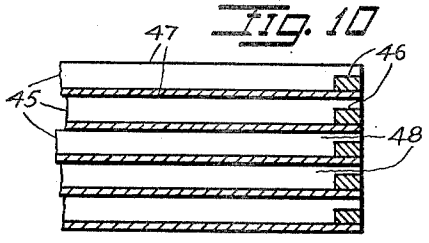


Fig. 8

Fig. 10



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Patented June 25, 1929. 1,718,845

UNITED STATES PATENT OFFICE.

ELLARD L. YOUNGER, OF WOODLAND, CALIFORNIA, ASSIGNOR TO YOUNGER DEHYDRATOR COMPANY, OF WOODLAND, CALIFORNIA, A COPARTNERSHIP COMPOSED OF E. L. YOUNGER, ELLARD L. YOUNGER, AND M. A YOUNGER.

DEHYDRATOR.

Application filed March 10, 1928. Serial No. 260,739.

The invention relates to dehydrator apparatus of the continuously operative type which is particularly arranged for the dehydration of foods carried in stacks of trays.

A general object of the invention is to provide a dehydrator of the class described in which the temperature and humidity conditions to which the food is subjected during the dehydration process are arranged to be constant whereby a particularly uniform product of superior quality results.

A more specific object of the invention is to provide in the apparatus means for raising the food to a dehydration temperature prior to effecting the dehydration thereof.

Another object of the invention is to provide a dehydrator of the character described in which the food is passed through a succession of independently operable drying zones arranged to have like temperature and humidity conditions uniformly maintained in each, whereby a uniform treatment of the food is arranged to be effected during its passage through the apparatus.

Yet another object of the invention is to provide independently operable control means for the different ones of the aforesaid drying zones.

A further object of the invention is to provide apparatus of the character described so arranged that the food being treated in each drying zone therein may be sampled at any time and the drying conditions in such zone may also be readily determined.

A still further object of the invention is to provide a dehydrator so designed and constructed as to operate with particularly high thermal and mechanical efficiencies.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following specification and in the accompanying drawings, in which:

Figure 1 is a plan sectional view taken above the main floor line of a dehydrator structure embodying the present invention.

Figure 2 is a plan sectional view of the structure taken just beneath the main floor thereof, as indicated by the line 2—2 in Figure 5.

Figure 3 is a longitudinal sectional view of the structure taken on the line 3—3 in Figure 1.

Figure 4 is a longitudinal mid-section view of the structure.

Figures 5 and 6 are transverse sectional views taken respectively on the lines 5—5 and 6—6 in Figure 1.

Figure 7 is a fragmentary sectional view taken on the line 7—7 in Figure 1.

Figure 8 is an enlarged fragmentary plan taken on the line 8—8 in Figure 7.

Figure 9 is a fragmentary vertical section taken on the line 9—9 in Figure 8.

Figure 10 is a fragmentary vertical section through a stack of trays for carrying the food through the apparatus, the section being taken generally at the line 10—10 in Figure 8.

As herewith particularly illustrated, the apparatus of the dehydrator is disposed in a generally rectangular housing structure 11 including side walls 12, a rear wall 13, a front wall 14, and a roof 15. The housing 11 is provided with a main floor 16 beneath which is defined a pit 17 extending longitudinally and centrally of the structure. A furnace 18 is provided in the pit 17 adjacent its rear end, such furnace being of a usual type and having a burner 11 for a fluid fuel such as crude oil at its rearward end. The heated air and products of combustion are arranged to escape from the furnace through a plurality of fire-tubes 19 disposed in the pit 17 forwardly of the furnace and arranged to serve as a radiator for the heat generated in the furnace as it is carried therethrough. The tubes 19 terminate in a manifold 21 disposed transversely across the pit at the forward end of the tubes 21 and communicating with a flue 22 extending centrally upwardly therefrom to discharge through the roof 15.

A blower fan 23 is also mounted in the pit 17, such fan having duplicate sections 24 at opposite sides of a pulley 25 mounted on the fan shaft and lying in the axial line of the pit forwardly of and adjacent the manifold 21. Each of the fan sections 24 is arranged to receive air from the pit 17 and to deliver such air upwardly and rearwardly into the space above the floor 16 through discharge funnels 26. The fan 23 is arranged to be operated through a belted connection of the pul-

ley 25 with a suitable source of power; as here shown, an electric motor 27 is belted to the pulley 25 for this purpose. In the present embodiment, the motor 27 is disposed above the level of the floor 16 and forwardly of the front wall 14 in a special compartment 28 provided therefor.

Extending vertically between the floor 16 and roof 15 are partition walls 29, said partitions extending rearwardly in diverging relation from a common intersection at a point 30 in the axial line of the structure and adjacent the outlets of the funnels 26 to the rear wall 13. Forward extensions 31 of the walls 29 extend from the point 30 to terminate at the rearward edges of the inner side walls of the fan funnels 26, said partition portions preferably enclosing the flue 22 between them, as shown. A cross-partition 32 extends upwardly from a point adjacent the rear end of the furnace and between the walls 29, said partition providing fresh air inlet openings 33 adjacent the roof 15 and another air inlet opening 34 between its lower edge and the top of the furnace 18. Dampers 35 are provided in the openings 33, such dampers being hingedly supported at their upper edges and being arranged to be drawn inwardly against the resistance of their weight in accordance with the inward draft thereagainst. The floor 16, it will now be noted, is omitted between the two partitions 29, so that when the fan 23 is operated, air may be drawn generally downwardly from the openings 33 and 34 around the furnace and along the tubes 19 whereby it may be heated before it is drawn into the fan, it being noted that the pit 17 is thus arranged to serve as a common source of heated air for the two fan sections and that the partitions 29 and 31 cooperate to divide the space above the floor 16 into two separate food treating chambers 36 extending the full length of the housing.

Means are preferably provided for so controlling the heating of the air in the pit by the tubes 19 that the temperatures of the air discharged from the different fan sections may be varied at will. Accordingly, and as shown, damper gates 37 are provided in the flue manifold 21 at opposite sides of the flue 22, said gates being adjustably controlled as by lever rods 38 having ends 39 thereof extending into the motor compartment 28 whereby their actuation for setting the gates 37 is facilitated. Preferably, the heating tubes 19 are divided into two sets disposed generally along opposite sides of the pit 17 and discharging into the manifold 21 at corresponding sides of the damper gates 37. The independent adjustment of the latter gates, coupled with the adjustment of the fuel supply to the furnace is arranged to provide for an absolute control of the temperatures of the air streams delivered into the different chambers 36. When the gates 37 are similarly set, the temperatures of the two air streams will be alike, but if the gates 37 are differently set, the air in that side of the pit which corresponds to the gate which is open the most will receive the most heat and the air stream delivered therefrom will therefore be warmer. In this manner, the temperatures in the two chambers 36 may be different, whereby different products requiring different dehydration temperatures may be simultaneously treated in the dehydrator.

Each of the chambers 36 is provided with a depressed floor portion 41 of uniform width extending longitudinally of the chamber in spaced parallel relation to its side walls 12 and also spaced from the longitudinal partitions 29 and 31. Tracks 42 are provided on the floor portion 41, such tracks extending longitudinally of said floor portion and being arranged to carry suitable tray-carrying trucks 43. Stacks 44 of rectangular trays 45 are arranged to be mounted on the trucks 43, and the trays 45 are provided with opposed edges 46 of less height than their other edges 47 whereby they may be stacked on the trucks to provide passages 48 between them which extend transversely of the trucks. Preferably, and as shown, the stacks of successive trucks are arranged to abut and to extend close to the roof 15 which provides a horizontal ceiling over the stacks, whereby lines of the stacks provide, in effect, partitions through the chambers 36. As shown, the amount of depression of the floor portion 41 is preferably such that the floors of the trucks are flush with the undepressed portions of the floor 16 and the width of the depression provided is preferably no greater than that of a tray 45. In this manner, the only path provided for air circulation between opposite sides of a line of abutting stacks is the aforesaid passages 48 between the trays, it being noted that a whole number of abutting stacks 44 is preferably arranged to closely fit between the end walls 13 and 14. The walls 14 and 13 are provided with inlet and outlet openings 49 and 51 respectively to permit the passage of the loaded trucks therethrough, suitable doors 52 and 53 being provided at said openings and the tracks 42 being extended therethrough and therefrom to suitable loading and unloading stations (not shown).

It will now be clear that the apparatus is arranged to be used with lines of abutting stacks in the chambers 36 and that the introduction of one or more fresh stacks through an inlet opening 49 involves a rearward shifting of the corresponding line of stacks whereby a like number of stacks will be moved from the chamber through the outlet opening. To prevent a loss of heat through the door openings as a stack of trays is introduced or removed therethrough, the door openings are no larger than necessary for the passage of a stack and flaps 54 are prefer-

ably provided to extend into the openings from the inner sides of the casings thereat for rubbing engagement with the trays of the stack whereby a seal is provided at the end of a line of stacks within the structure independently of the doors In practice, it has been found that ordinary belting may be advantageously used to form the sealing flaps 54. In this manner, it will now be obvious that the dehydrator is arranged for continuous operation and that each stack of trays is arranged to be progressively disposed in a plurality of positions as it passes through the device.

Since food to be introduced for dehydration would usually be at a much lower temperature than the desired dehydration temperature therefor, means are provided for giving the food to be treated an initial warming treatment before subjecting it to the dehydration process proper. Accordingly, and as shown, the portions of the chamber 36 nearest the inlet openings 49 and opposite the funnels 26 are utilized for this purpose. Extending inwardly from the sides of the openings 49 in close parallel relation to the opposed stack ends of one or more stacks nearest said openings, are metallic plates 55. The plates 55 extend from the floor 16 to the roof 15 and because of their close proximity to the stacks, prevent a circulation therethrough of the air controlled by the blower 23. Such air however striking the plates 55 gives up its heat thereto, whereby the latter are heated and so radiate heat within the space between the plates. As here shown, the plates 55 extend along two stacks, such having been found most satisfactory for units of the size herewith particularly disclosed. The space 56 thus defined between the plates 55 is vented through the roof 15 by means of suitable open vent pipes 57 whereby a relatively slow circulation of air therethrough entirely by convection is permitted. Since a stack will remain for some time in the space 56, the temperature of the food will be raised to a temperature approximating that of the air circulated by the fan 23, and this heating, accompanied by a slight sweating effect, will operate to so condition the food surfaces or skins as to prevent "bleeding" or "juicing" of foods having a high moisture content. Since the air circulation through the space 56 is relatively slow, the air therein will quickly become saturated with moisture, so that practically no dehydration effect occurs in such space. It will thus be clear that the major function of the chamber portions which comprise the spaces 56 is to condition or temper the food for the dehydration process to follow, and such spaces will accordingly be hereinafter referred to as tempering chambers, while the remaining portions 58 of the chambers 36 will be known as drying chambers.

Means are provided for effecting a directed circulation of the air in the drying chambers 58 whereby such air may be forced through the stacks and may thereafter be allowed to escape from the apparatus or be returned to the pit 17 for recirculation. Accordingly and as shown, a series of ducts 59 is provided, said ducts being of channel section and being vertically disposed inwardly of the stacks with their open sides disposed thereagainst. Preferably, and as shown, each duct is arranged to lie with its open side in exact registration with the tray ends 46 defining the side of a stack and the ducts are provided opposite alternate stacks, beginning with the first stack rearwardly of the tempering chamber 56. All of the ducts extend between the floor 16 and the roof 15 and register at their lower ends with passages 61 communicating with the pit 17; in the present embodiment, the floor 16 is arranged to overlie said pit at the bases of the ducts whereby the passages 61 are simply provided as openings through the floor.

Certain of the ducts 59 are arranged to be utilized in carrying off the necessary amount of more humid air whereby the regulation of the relative humidity of the air in the drying chambers may be held at a desired value. Accordingly, and as shown, some of the ducts are vented through the roof 15 by means of vent pipes 62 and such ducts are also provided with horizontal partitions 63 which divide them at a point between the floor and roof whereby air entering these ducts above the partitions 63 may escape through the vent pipes 62, while that entering these ducts below the partitions 63 may escape only into the pit 17 for re-circulation. In the present embodiment, only the three ducts in each drying chamber 36 which are nearest the temper chamber 56 are provided with the vent pipes 62 and partitions 63, while the remaining three ducts open only into the pit 17.

Preferably, and as shown, the duct partitions 63 are arranged for vertical adjustment in their ducts. As herewith particularly shown, the partitions are each slightly smaller than the passages provided by their ducts and are provided at opposite sides with guide blocks 64 having longitudinal slots 65 slidably engaged with vertical tracks 66 provided at opposite sides of the ducts. The partitions are each arranged to be supported by and from a cord 67 passing therefrom over a pulley 68 to some convenient point outside the chambers 36, whereby their positions may be independently adjusted when and as desired without interfering with the continuous operation of the apparatus. It will be noted that any required number of the ducts 59 may be provided with the vents 62 and partitions 63, it benig further noted that the air coming from the stacks nearest the tempering chamber will tend to be moistest, whereby

the present disposal of the ducts having the vents and partitions will be a usual and desirable one.

Though such is not shown, it will be clear that all of the ducts might be provided with the vents 62 and partitions 63, since raising a partition to the ceiling line of the drying chamber will render the vent thereof inoperative. The exact number and arrangement of ducts 59 from which part of the air flowing thereto is arranged to be vented may, it is noted, be varied under different temperature and humidity and other operating conditions, and a limitation to the present arrangement is therefore not intended.

As hereinbefore noted, the tray sides opposite each outer side wall 12 are spaced therefrom, thus defining an air space between each line of tray stacks and the opposed wall 12. The spaces thus defined are divided into sections 68 by means of vertical partitions 69 extending between the walls 12 and the side line of the stacks and from the floor 16 to the roof 15. The partitions 69 are arranged to lie opposite its mid-points of the trays of certain alternate stacks. With the present arrangement, the most forward one thereof lies at the middle of the second stack from the tempering chamber 56. It will now be noted that the relation of the ducts 59 and partitions 69 to the stacks is such that they lie opposite different stacks. In this manner, a stream of air entering a stack between a pair of the ducts 59 will flow through the stack to the other side and there be divided between two adjacent spaces 68 by reason of the partitions 69. From the spaces 68, the air is arranged to flow back to the blower side of the stacks through those stacks which register with ducts 59, whence the air is arranged to be directed in the manner previously indicated. In this manner, those stacks opposite all but the extreme end ducts are arranged to receive air from both sides thereof at their ends nearest the walls 12 whereby a full flow of air along the tray edges 47 is assured, the division of the streams passing toward the walls 12 having a corresponding effect in the trays of the other stacks as well. As particularly disclosed in Figure 1, the end stacks receive air but from one air stream through one adjacent stack whereby the air flow therethrough is less rapid than is that through the other stacks. Preferably, and as shown, the passages 71 between adjacent ducts 59 are partitioned, and certain of the ducts are provided with deflectors 72 directed generally toward the fan end of each chamber 36 for assisting in an even distribution of the air delivered by and from a fan section 24 to the different stacks. It will be noted that the amount of fresh air received through the dampers 35 and other air inlets adjacent the furnace will vary in accordance with the amount of air which is allowed to escape above the duct partitions 63, it being further noted that the gravitational resistance to the opening of said dampers will tend to prevent abrupt changes in the pressure conditions in the pit 17 and drying chambers 58.

Assuming that the fan and furnace are in operation, heated air from the pit 17 will be delivered under pressure to the chambers 58 at the portions thereof between the lines of stacks and the partitions 29. A substantially even distribution of air is then effected from such chamber portions to the passages 71 and thence through the stack thereat and back through another or other stacks to the ducts 59. The present arrangement by which the air streams through the different stacks are divided either upon their entrance to or exit from the stacks, it is noted, prevents dead air spaces along the tray edges 47 and so insures an even treatment of the tray contents. Furthermore, in no case is air permitted to pass more than twice across the line of trays before being exhausted or redelivered to the heating pit, whereby the effecting of the same treatment for all the stacks is assured in the drying chamber 58, it being noted that the trays of a line thereof are thus arranged to be successively disposed in plurality of dehydrating zones, rather than in a single zone as has heretofore been the practice. The advancing of the trays one tray space at a time, will of course effect a reversed circulation of air therethrough, whereby even drying is further assured.

It will now be noted that the disposal of the air heating means centrally of the structure in the axial line thereof results in a marked conservation of the heat generated in the furnace, since the circulated air is exposed to outside walls to a minimum amount. This arrangement has a further advantage in that the disposal of the lines of stacks along the side walls 12 permits a provision in such walls of openings 73 provided with doors 74 for permitting access to the stacks. The openings 73 are relatively small and are preferably provided between the partitions 69 and opposite alternate stacks. Hygrometers 75 are preferably disposed at the openings 73 in each of the chamber portions 68 and the food in the opposed stacks is also arranged to be sampled through the openings 73. In this manner, an operator may be fully advised of the drying conditions and results in the different drying zones and thus be guided in effecting a regulation of the action of the apparatus through use of the flue dampers 37 and movable duct partitions 63. Hygrometers 75 are also preferably provided at openings 76 provided in the rear wall 13 between the rearmost ducts 59 and the longitudinal partitions 29.

To further insure a maximum thermal efficiency for the apparatus, the housing walls and roof are preferably all formed of heat

insulating materials such as concrete or hollow tiles, and the partitions 29 are also preferably formed of similar material.

The process which the present apparatus is arranged to carry out proceeds essentially as follows. Each stack of loaded trays is first disposed in a tempering chamber 56 during the time between the shifts of the stacks of its line. The stack is then, by succeeding shifts, moved progressively through the drying zones, assuming two positions in each zone whereby it receives drying air through it in two directions while in the zone. The latter treatment is repeated until the stack moves through the outlet door at the rear of the apparatus. Preferably, the drying air is arranged to have a relatively high humidity as it primarily enters the different zones whereby its circulation through the food on the trays may not unduly or improperly dry out the same. A food dried with the present apparatus is not as completely dehydrated as would the same food be when sun dried, yet, owing to the preliminary tempering treatment hereinbefore described, the product thereafter keeps as well or better than if prepared by sun drying and is vastly more uniform in quality. From the standpoint of the drier, these facts are important because a given weight of untreated food produces a maximum weight of dried product, and the uniformity and fine condition of the product command the top price therefor. To insure proper humidity for the circulated drying air when starting up, stacks of empty trays are placed ahead of the filled trays and are wet down within the drying chamber, as by use of a hose or sprinkler system (not shown), so that by the time the food in the first loaded stack has been tempered, the air in circulation through the drying chamber has acquired a proper humidity. This treatment of the empty tray stacks also, it will be noted, preserves the trays of such stacks from being dried out, as such trays are usually of wood.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the construction and method of operation will be readily understood by those skilled in the art to which the invention appertains, and while I have described the principle of operation, together with the device which I now consider to be the best embodiment thereof, I desire to have it understood that the device shown is merely illustrative, and that such changes may be made, when desired, as fall within the scope of the appended claims.

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

1. In a food dehydrator, a housing having a longitudinal partition defining food treating chambers at opposite sides thereof, an air heating chamber underlying and coaxial with said partition, a furnace in said heating chamber, a flue for said furnace extending upwardly from said heating chamber in the axial line of said partition and provided with an intake manifold extending therefrom laterally of said axis, sets of fire tubes connecting said furnace with said manifold at opposite sides of said flue, and dampers in said manifold at opposite sides of said flue whereby the flow of gaseous products from said furnace to said flue through said sets of tubes may be adjustably controlled.

2. In a food dehydrator, a housing centrally partitioned to provide a pair of food treating chambers at opposed sides thereof, an air heating chamber, means for effecting a circulation of air from said last chamber through both of said first chambers, and means for independently varying the temperatures of the air delivered to said first chambers from said last chamber.

3. In a food dehydrator, a housing centrally partitioned to provide a pair of food treating chambers along different walls thereof, means providing a plurality of independent drying zones in each of said chambers, an air heating chamber, means for effecting a circulation of air to each of said food treating chambers and through said zones thereof from said air heating chamber, means to adjustably and independently control the temperature of the air delivered from said air heating chamber to said treating chambers, and normally closed hand holes in said wall at said different zones to permit simultaneous samplings of the food therein during the operation of the dehydrator.

4. In a food dehydrator, an air heating chamber, a furnace at an end of said chamber, a flue for the furnace at the opposite end of the chamber and centrally of said end, an intake manifold for the flue extending laterally of the longitudinal axis of the chamber, sets of fire tubes connecting said furnace with said manifold at opposite sides of said flue, and dampers in said manifold at opposite sides of said flue whereby the flow of gaseous products from said furnace to said flue through said sets of tubes may be adjustably varied.

5. In a food dehydrator, a housing partitioned to provide a pair of food treating chambers, an air heating chamber, means for effecting a circulation of air from said last chamber through both of said first chambers, and means for independently varying the temperatures of the air delivered to said first chambers from said last chamber.

6. In a dehydrator of the class described, a drying chamber, a stack of horizontally disposed trays in said chamber through which drying air is arranged to be circulated, an air heating chamber for supplying air to the drying chamber, an upright duct having an

open side registering with the side of the stack from which said air is arranged to leave the stack, said duct communicating with said air heating chamber at its lower end and opening externally of said chambers at its upper end, and a vertically adjustable horizontal partition in said duct arranged for adjusted disposal therein to variably divide the air from said stack with respect to its flow from the duct ends whereby only the air from trays above the partition is permitted to escape upwardly through the duct.

7. In a dehydrator of the class described, a drying chamber, a stack of horizontally disposed trays in said chamber through which drying air is arranged to be circulated, an air heating chamber for supplying air to the drying chamber, an upright duct having an open side registering with the side of the stack from which said air is arranged to leave the stack, said duct communicating with said air heating chamber at its lower end and opening externally of said chambers at its upper end, a vertically adjustable horizontal partition in said duct arranged for adjusted disposal therein to variably divide the air from said stack with respect to its flow from the duct ends whereby only the air from trays above the partition is permitted to escape upwardly through the duct, and means automatically operative to allow fresh air to flow directly into said heating chamber in replacement of said escaped air.

In testimony whereof, I affix my signature.

ELLARD L. YOUNGER.