

Nov. 20, 1951

J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 1

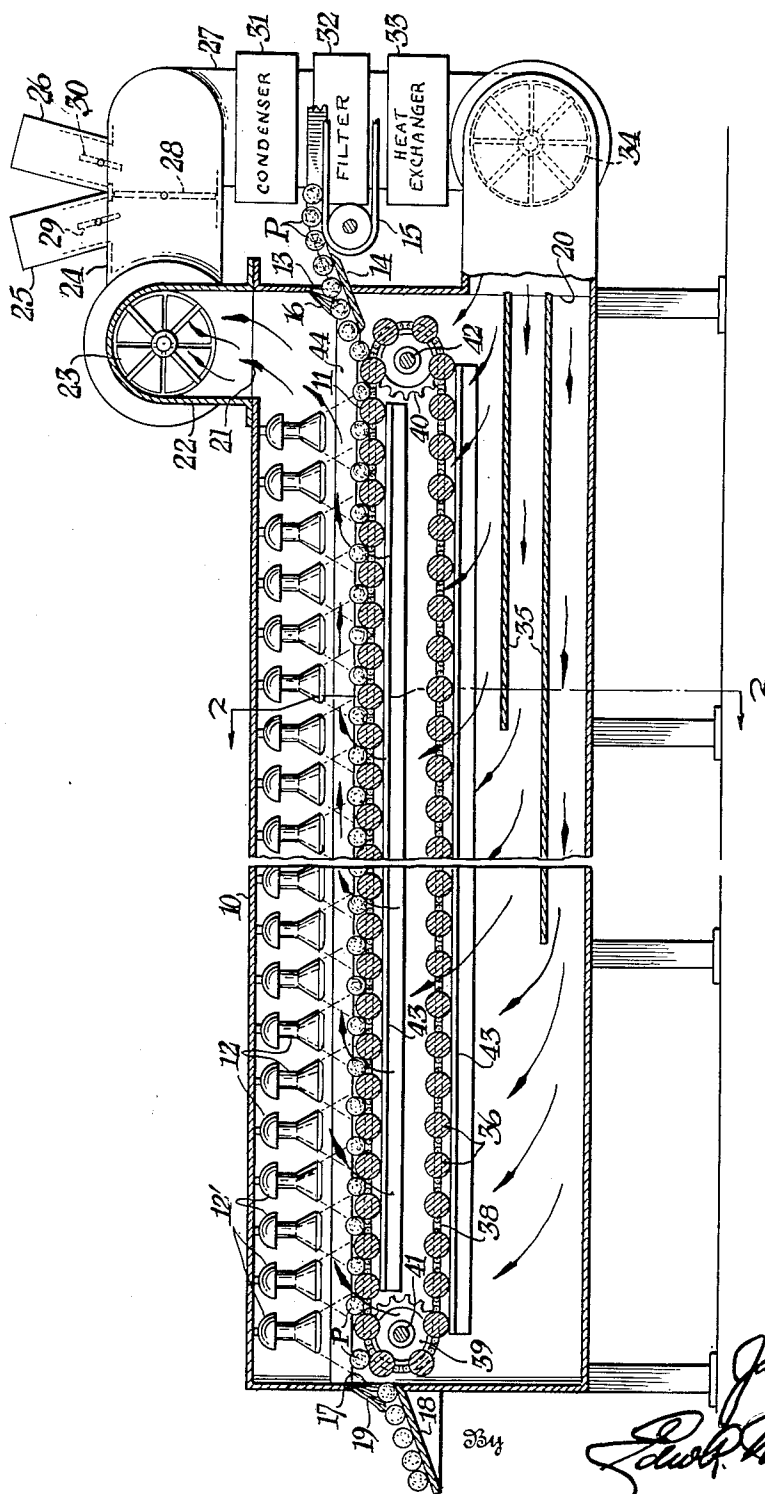


Fig. 1.

Inventor

James L. Parnell

Edw. P. Walcott
Attorney

Nov. 20, 1951

J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 2

Fig. 2.

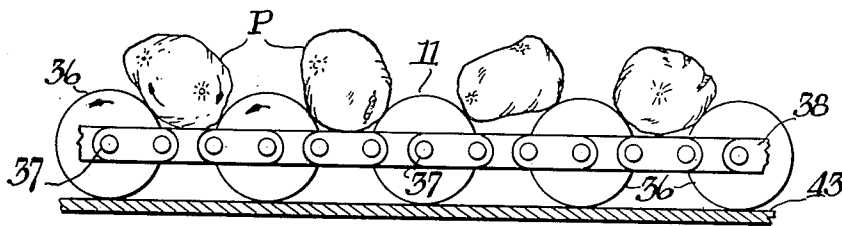
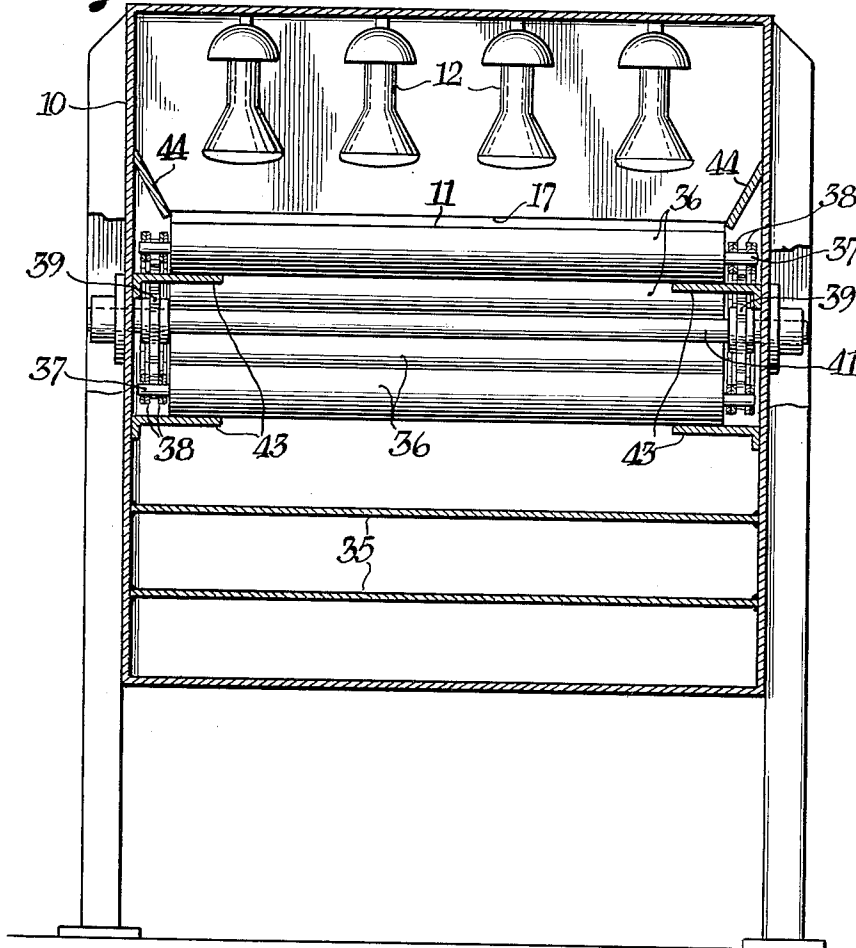


Fig. 3.

Inventor
James L. Parnell
By *Edw. J. Walters*
Attorney

Nov. 20, 1951

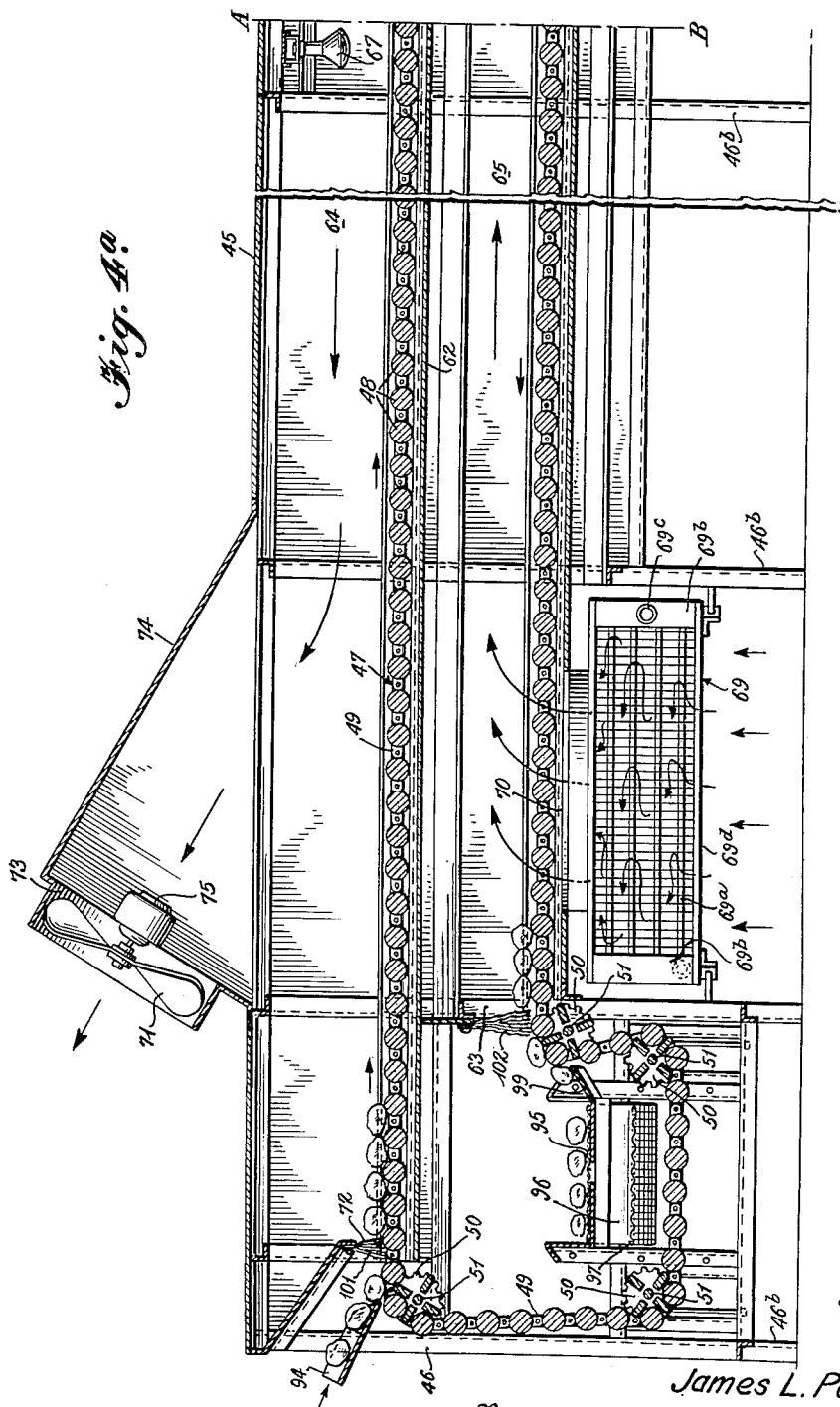
J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 3



Inventor

James L. Parnell

334

Edw. P. Walcott

Attorney

Nov. 20, 1951

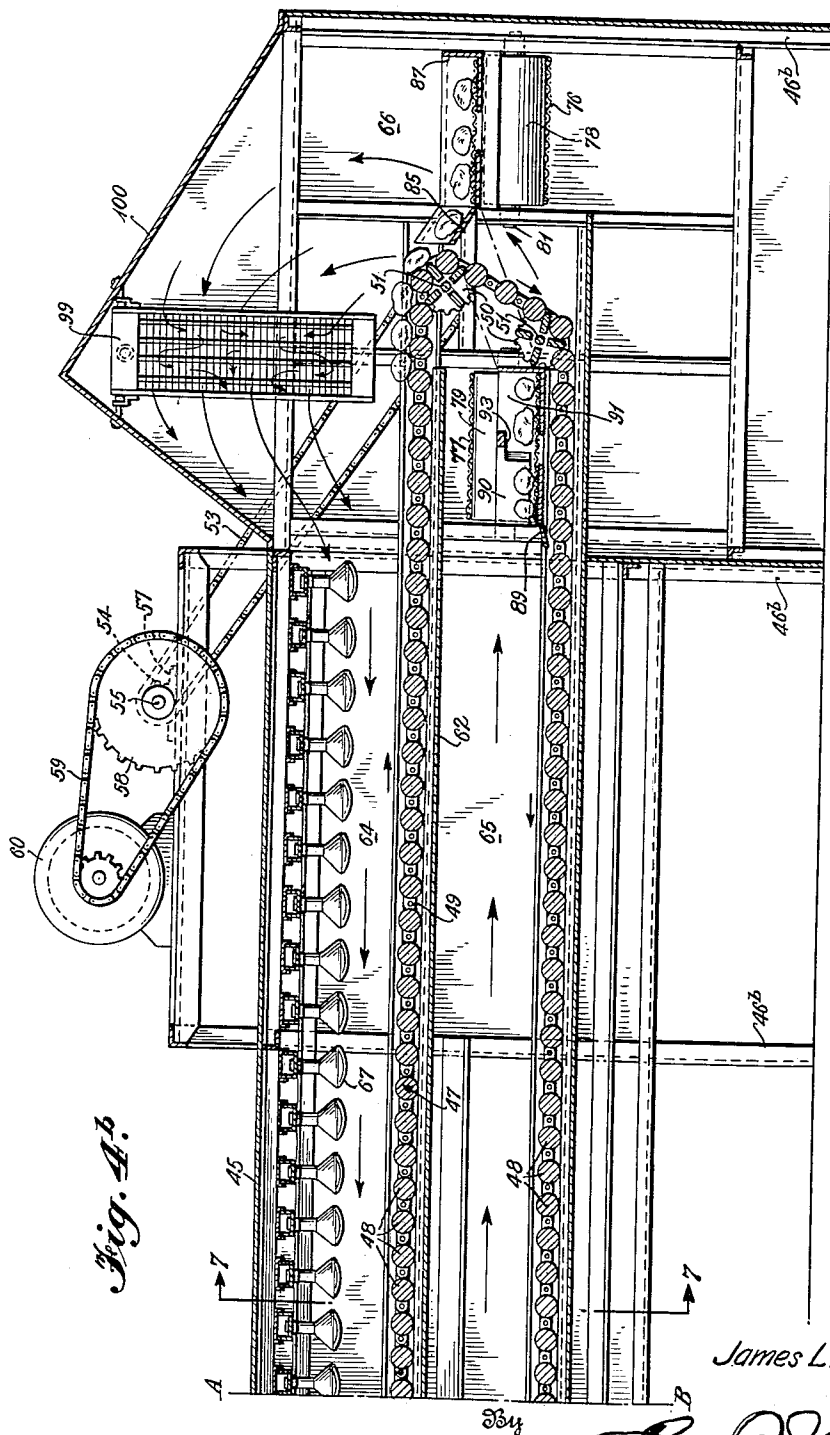
J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 4



Inventor

James L. Parnell

Lawrence P. Walton
Attorney

Attorneys

Nov. 20, 1951

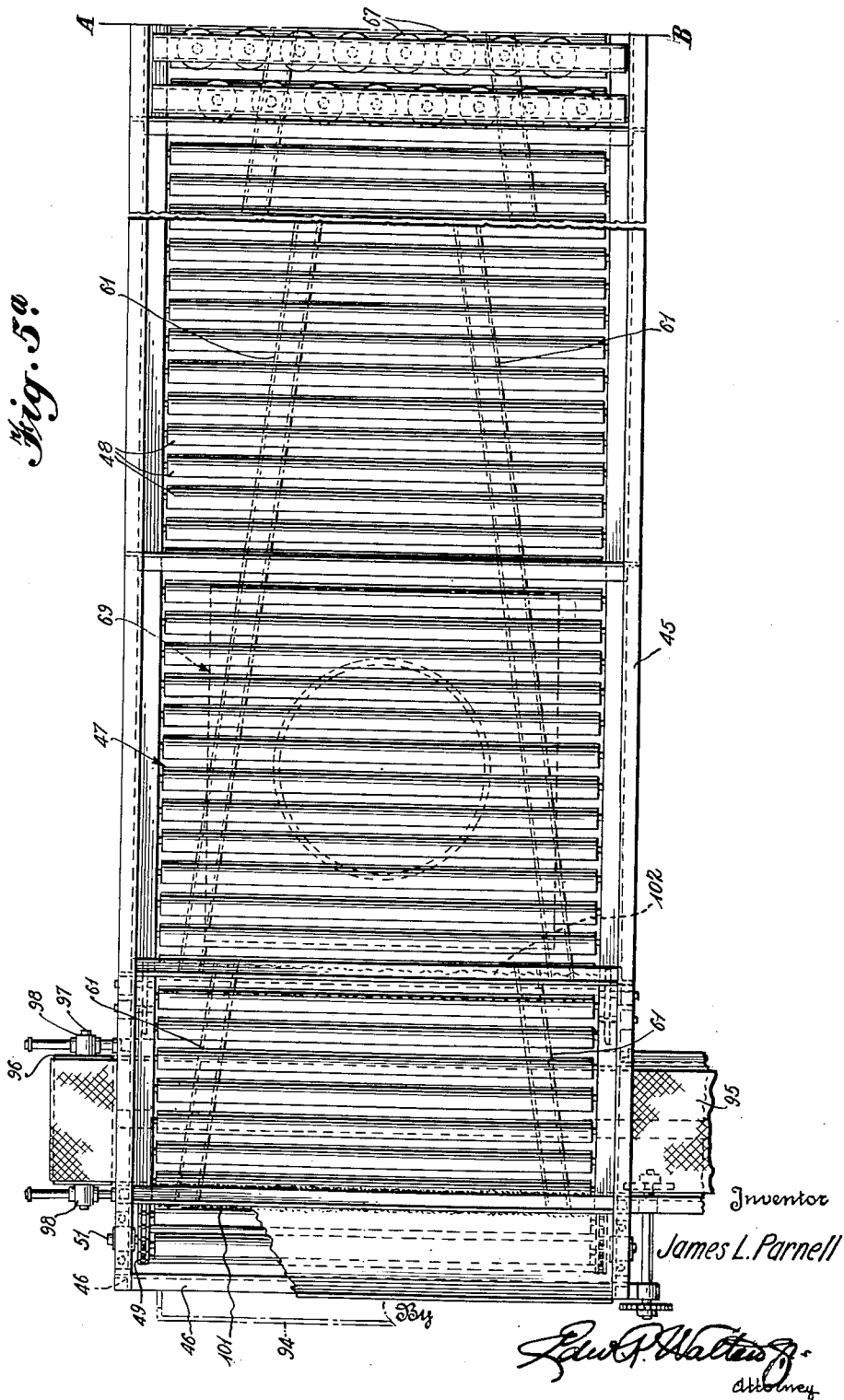
J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 5



Nov. 20, 1951

J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 6

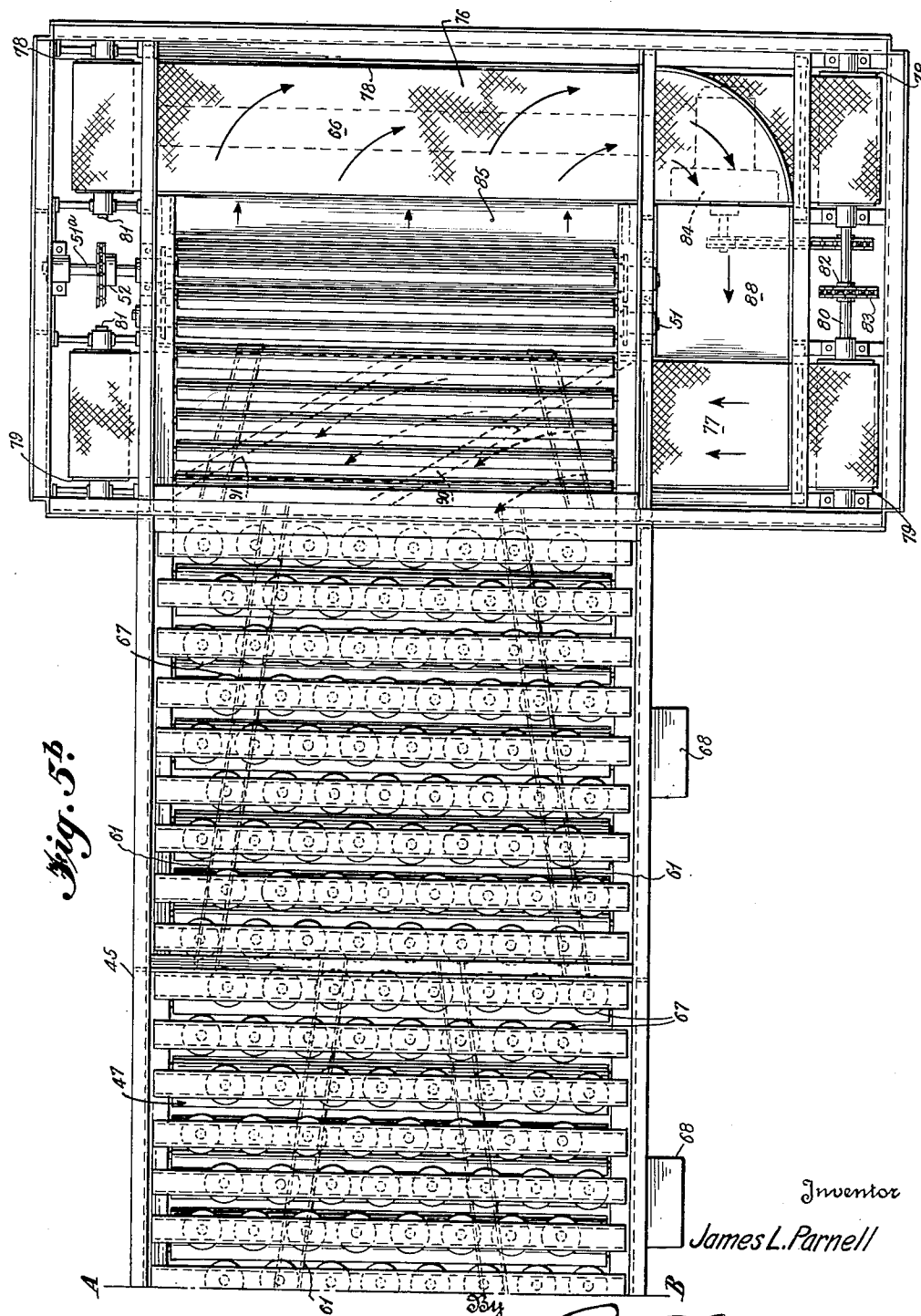


Fig. 5b

Inventor

James L. Parnell

Edw. P. Walters
Attorney

Nov. 20, 1951

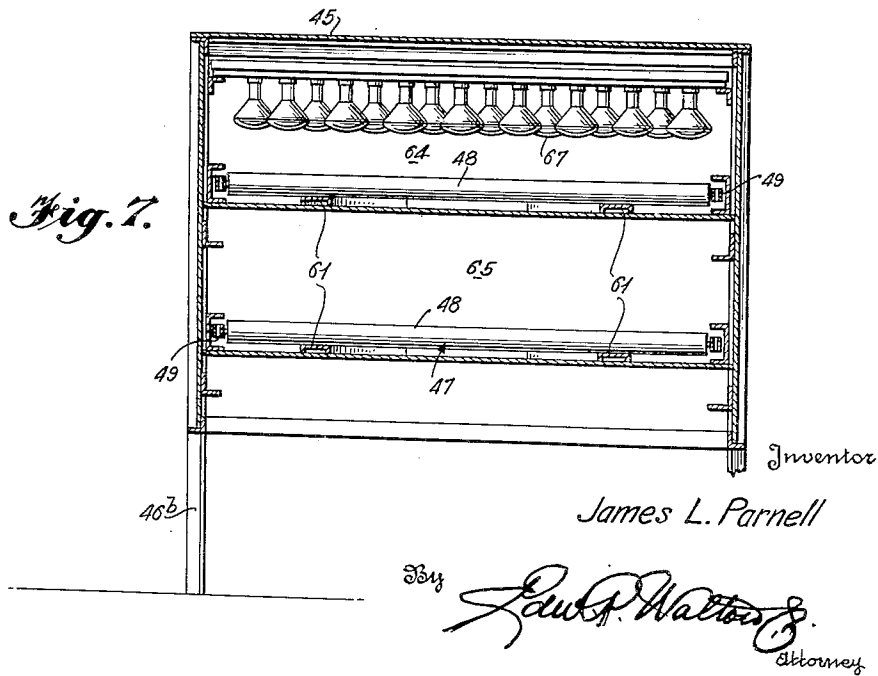
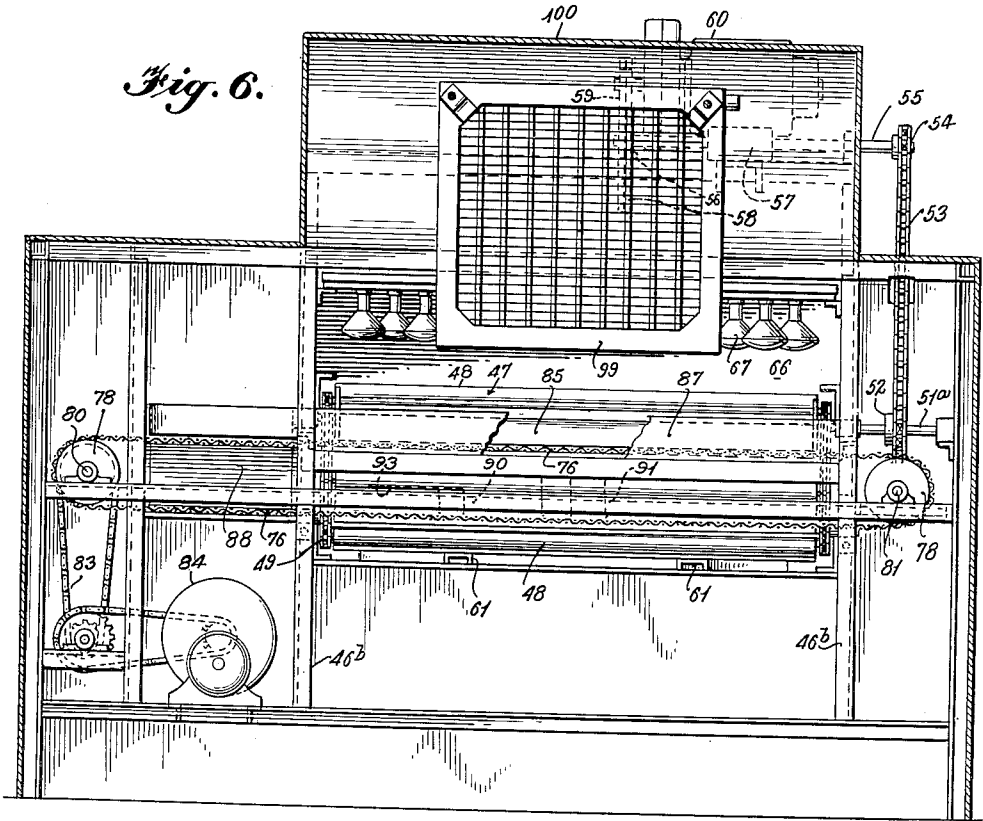
J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 7



Nov. 20, 1951

J. L. PARNELL

2,575,426

METHOD OF AND APPARATUS FOR TREATING EDIBLE PRODUCE

Filed Dec. 22, 1947

8 Sheets-Sheet 8

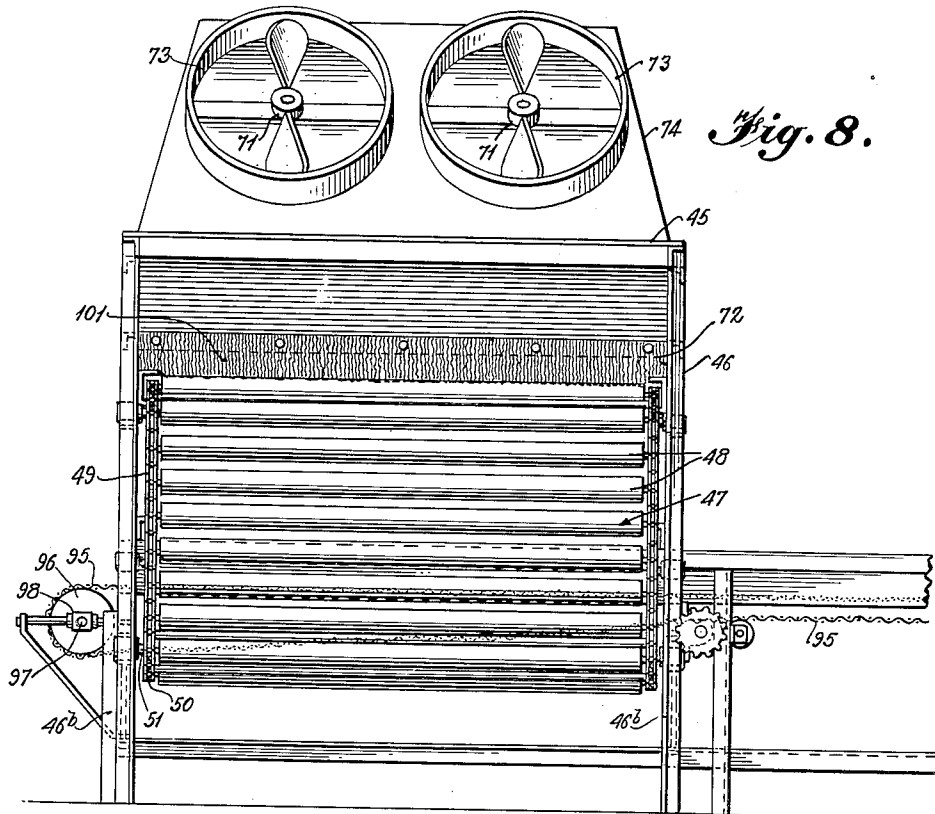


Fig. 8.

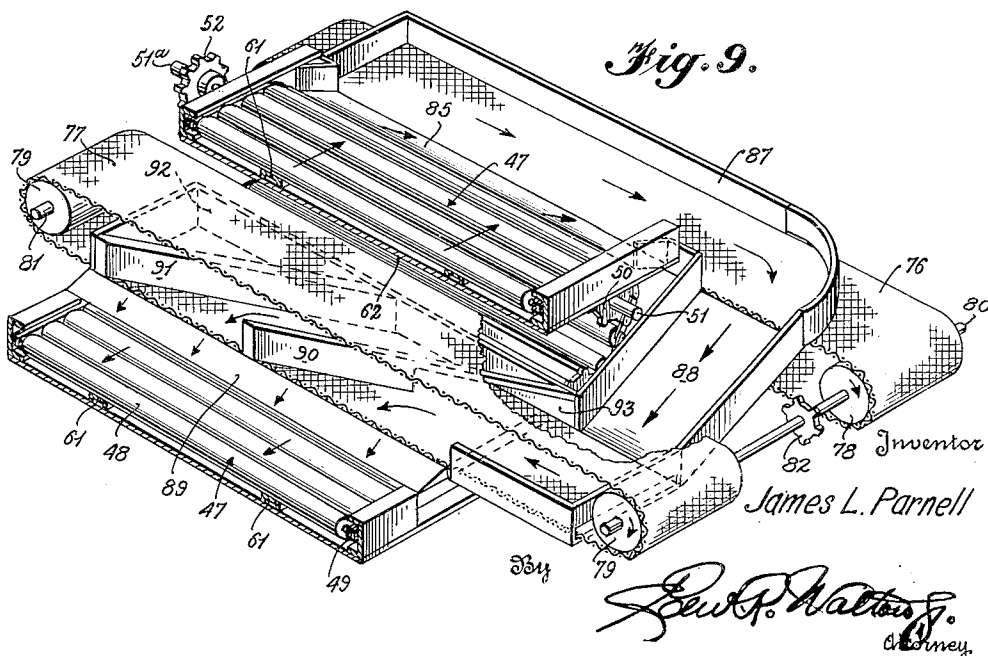


Fig. 9.

Inventor

James L. Parnell

Lew P. Walter
Attorney

UNITED STATES PATENT OFFICE

2,575,426

METHOD OF AND APPARATUS FOR
TREATING EDIBLE PRODUCEJames L. Parnell, Orlando, Fla., assignor to
American Machinery Corporation, Orlando,
Fla., a corporation of Florida

Application December 22, 1947, Serial No. 793,214

23 Claims. (Cl. 99—154)

1

This application is a continuation-in-part of my prior application Serial No. 683,659, filed July 15, 1946, now abandoned.

This invention relates to a method of and apparatus for the treatment of produce such as vegetables and fruits, to prepare them for packing and shipping and, more particularly, to the treatment of produce in such a manner as to completely dry the surfaces of the produce and to kill bacteria or other organisms which can be killed without injury to the produce and these including those which are most commonly the cause of spoilage during the shipment and storage stage between the producer and the consumer.

The produce packers absorb considerable loss of their products during the transportation and storage thereof due to the development of bacterial soft rot in potatoes which is caused by the organism *Bacillus carotovorus*, whereas citrus fruits are primarily damaged by blue mold, while the loss in peaches is principally due to brown rot. Various attempts have been made to overcome these losses by treating the produce to remove the surface moisture therefrom. It is well recognized that surface moisture on produce promotes the development of these organisms, particularly within surface depressions such as potato eyes, cuts, bruises or the like. Therefore, it has been the practice to pass the produce through a drying machine where it is subject to heat and air currents to remove this surface moisture.

In all of the prior art methods and apparatus, the heating has been effected by currents of air that have been heated by steam radiators to temperatures ranging up to 145° F. It has been the theory that the hot air would evaporate the moisture on the surface of the produce but would not affect the produce as long as the temperature was not raised above the neighborhood of this specified point. This treatment has not been completely effective, however, due to the fact that the surfaces of the produce were not always dried and invariably there was always a certain amount of moisture left within in any depressions in the surfaces, due to the poor air circulation within these depressions. Consequently, these prior art methods and apparatus have basically failed in their purpose.

Having in mind the defects of the prior art methods and apparatus, it is an object of this invention to provide a process, and means for effecting the process, by which the surfaces of the produce are raised to a temperature that is sufficient to not only evaporate all moisture

2

therefrom, but is also sufficient to kill any bacteria or other organisms which can be killed without injury to the produce and that are present on the surfaces, and particularly within any depressions within the surfaces. A sufficient volume of air current should be passed over the produce to take up all evaporation and thereby expedite the drying operation. It is contemplated and a commercial necessity that this treatment should be effected within short periods of time so that large volumes of produce may be processed within normal operating periods and that the surface temperature may be elevated without obtaining excessive temperatures in the underlying tissues of the produce. The apparatus for performing the process should also incorporate simplicity of design and economy of operation.

The foregoing and other objects ancillary thereto are preferably accomplished, according to a preferred embodiment of the invention, by subjecting the produce to infra-red irradiation. Specifically, the produce is fed onto an endless conveyor that is disposed within an elongated drying chamber with infra-red lamps positioned above the conveyor. Air is supplied at different points along the length of the chamber so as to pass around, between and over the produce to take up the moisture evaporated therefrom. The moisture laden air is expelled from the chamber at the end at which the undried produce is fed into the chamber so that it does not contact the dried produce. If desired, this air may be dehumidified and it may be preheated so as to increase its moisture absorption capacity and to assist in the drying operation. In addition, the conveyor may be in the form of a heat absorbing grid composed of a plurality of metal rollers that will be heated by the action of the infra-red irradiation and will thereby assist with the drying operation and will heat the air passing therearound to increase its moisture absorption capacity.

The infra-red lamps are preferably disposed about six inches above the bed of the conveyor so that they will lie about four inches above the tops of the produce on the conveyor and the conveyor is driven, preferably, at a speed that will transport the produce through the machine within a period of time to obtain maximum results on the organisms that it is desired to control. It has been found that by treating produce with infra-red irradiation the temperature of the produce surfaces, and the moisture film thereon, is raised very rapidly to a degree that is not only

above the point of evaporation, but is also above the death point of such bacteria and other organisms that are present on the surfaces. Furthermore, the infra-red irradiation penetrates the areas of all cracks and depressions in the surfaces and increases the surface temperature within these areas just as efficiently as it does the smooth, exposed areas. This heating action is a unique property of infra-red irradiation in that it generates heat at the surface against which it impinges rather than dispersing heat through the intermediate air.

The conveyor is composed of rollers which are rotated as they are moved so that they cause the produce thereon to roll as it passes beneath the lamps. Consequently, all of the surfaces of the produce are exposed to the infra-red irradiation. In view of the fact that the heating per se is effected by the infra red irradiation, it is necessary to circulate through the machine and around the produce only enough air to take up the evaporated moisture, which is but a small part or fraction, approximately one-seventh, of the volume of air that is required to evaporate the surface moisture by the heat content of the circulated air. Furthermore, by preheating the air, its moisture absorbent capacity is increased so that it may more efficiently remove the moisture and may even assist in the evaporation thereof. If desired, a bank of ultra-violet lamps may be mounted above the conveyor so as to subject the produce to their germicidal action.

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout, and in which:

Figure 1 is a cross sectional view taken longitudinally through a preferred form of produce treating apparatus;

Figure 2 is a cross sectional view taken on line 2-2 of Fig. 1;

Figure 3 is an end view in elevation of a segment of an endless conveyor comprising rollers;

Figure 4a is a longitudinal vertical section of the supply-discharge end half of the final commercial embodiment of the invention;

Figure 4b is a similar view of the diversion end half of the same;

Figure 5a is a longitudinal horizontal section on line 5-5 of Fig. 4a;

Figure 5b is a similar view on line 5-5 of Fig. 4b;

Figure 6 is a transverse vertical section on line 6-6 of Figure 4b;

Figure 7 is a transverse vertical section on line 7-7 of Figure 4b;

Figure 8 is a front elevation of the supply-discharge end of the machine; and

Figure 9 is a fragmentary prospective view of the transverse mechanism at the diversion end of the machine.

A method of and apparatus for drying and treating produce, to overcome the defects hereinbefore enumerated, should have the totally distinct characteristics of raising the surface temperature of the produce, including any depressions therein, not only above the evaporation point but also to or above the death point of the bacteria and other organisms that may be pres-

ent (i. e., may be killed without injury to the produce), and of creating this temperature very rapidly and efficiently. Accordingly, one embodiment of the invention, referring to Figs. 1 and 2 of the drawings is constituted by a machine composed of an elongated housing 10 forming a drying chamber or passage and having an endless conveyor 11 positioned longitudinally therein and a plurality of infra-red lamps 12 and ultra-violet lamps 12' in the top thereof for directing irradiation down upon the bed formed by the upper run of the conveyor 11.

A supply opening 13 is located at one end of the housing 10 just above the bed of the conveyor 11 and a chute 14 is mounted therein to receive produce P from the conveyor 15 of an adjacent machine, such as a washer. A curtain 16, of any desired type is suspended over the opening 13 to prevent the free passage of air therethrough. A discharge opening 17 is located at the other end of the housing 10 immediately adjacent the end of the bed of the conveyor 11 with a chute 18 positioned therein to receive the produce P as it rolls from the conveyor 11. A curtain 19 is suspended over the opening 17 to inhibit air passage therethrough. The housing 10 has two openings at its supply end, one opening 20 in the bottom thereof through which air is supplied to the chamber, and the other opening 21 being located in the top of the housing 10 for the discharging of air therefrom.

A conduit 22 is in communication with the discharge opening 21 and is connected with an air pump 23 which evacuates the air from the chamber 10 and discharges it through a conduit 24. The conduit 23 is in communication with two pipes 25 and 26 and also with a branch conduit 27. A damper 28 is mounted within the conduit 24 and dampers 29 and 30 are positioned in the mouths of the pipes 25 and 26 respectively so that the air evacuated from the chamber 10 by the pump may be recirculated through the branch conduit 27, or it may be discharged through the pipe 25 and fresh air drawn to the branch conduit 27 through the pipe 26. When the dampers 28, 29 and 30 are in the positions shown in Fig. 1, the latter action takes place. The air that is fed into the branch conduit 27 may be passed through a condenser 31 or dehumidifier to remove the moisture therein, from which it may be passed to a filter 32 for the removal of any foreign matter or additional moisture, after which it may be passed to a heat exchanger 33 for either cooling or heating the air before it is then fed through the supply opening 20 and into the housing 10.

If desired, a pump 34 may be positioned to force the air through the supply opening 20. On the other hand, this pump can be dispensed with, the suction of the pump 23 being relied upon to draw the necessary quantity of fresh air into the chamber. The use of the pump 34 is desirable, however, when dehumidified or preheated air is employed as it supplies sufficient air to maintain the pressure within the housing 10 above the surrounding atmospheric pressure and thereby eliminates the seepage of untreated air into the housing 10 through the openings 13 and 17. A plurality of baffles 35 are mounted in front of the supply opening 20 to distribute the air throughout the length of the chamber 10 so that a substantially even volume passes up through the conveyor 11 and around the produce P supported thereon.

The conveyor 11 is composed of a plurality of rollers 36 that, as best shown in Fig. 2, have trun-

nions 37 mounted on each end and these trunnions 37 are journaled in, and form the pivots for, adjacent links of an endless sprocket chain 38, as best shown in Fig. 3. By this arrangement, the rollers 36 are joined together to form the equivalent of an endless belt, but due to their pivotal mountings in the chain 38, are capable of individual rotation. The chains 38 are mounted on sets of sprockets 39 and 40 which are positioned at opposite ends of the housing 10, one set of sprockets 39 being mounted on an idler shaft 41, whereas the other set of sprocket 40 is mounted on a driven shaft 42 which drives the conveyor 11. Supporting ledges 43 are mounted on the side walls of the housing 10 and in line with the runs of the conveyor 11 so that the rollers 36 may be supported in a plane and rotated by contact therewith as the conveyor 11 is driven. The bed of the conveyor is supported in a fixed plane so that the produce P will be evenly spaced from the lamps 12 and 12' and the rollers 36 are rotated in order to roll the produce P supported thereon so that all of their surfaces will be exposed to the infra-red irradiation produced by the lamps 12, and the ultra-violet irradiation produced by the lamps 12'. Guard plates 44 are mounted on the sides of the housing 10 and just above the bed of the conveyor 11 in order to prevent the produce P from rolling laterally from the conveyor.

To review the operation of the machine, it will be understood that the produce P is fed from the conveyor 15 of the preceding machine onto the chute 14 so that it will roll through the supply opening 13, brushing aside the curtain 16, and onto the bed of the conveyor 11. The preceding machine is usually a washer or the like so that the produce P is usually damp, if not covered with a film of moisture. The conveyor 11 being driven, through the medium of the shaft 41, is moved along to transport the produce P through the length of the housing 10 beneath the lamps 12 and 12', the rollers 36 rotating on the ledges 42 and thereby turning the produce P to expose all of its surfaces to the irradiation. At the end of the conveyor run, the produce P drops through the discharge opening 17 to the chute 18 from which it may be fed to a grading, boxing or bagging station.

As the produce is transported through the housing 10 the irradiation from the lamps 12 evaporates the moisture from the surfaces of the produce P and the air being supplied through the opening 20 and distributed by the baffles 35 passes up between the rollers 36 and the produce P, taking up the evaporated moisture before it is discharged through the opening 21 by the pump 23. The discharge opening 31 is immediately above the produce supply opening 13 so that the moisture-laden air passes over only the wet or untreated produce rather than contacting the dried and treated produce. A sufficient volume of air is passed through the machine to take up all of the moisture as it is evaporated from the produce, and, preferably, although not necessarily, the air is preheated before contacting the produce in order to increase its moisture absorption capacity.

The preheating of the air may be effected by the heater 33, or by a novel arrangement which comprises heat absorbing metal rollers 36 that generate and absorb heat from the infra-red irradiation of the lamps 12, and discharge or radiate this heat through the freshly supplied air as the air passes up between them. The rollers 36

become heated, primarily, while passing along the upper run of the conveyor 11, whereas they radiate their heat, primarily, while passing through the lower run of the conveyor 11. In the prior art machines it has been the practice to form the conveyors of non-heat absorbing materials on the theory that a hot conveyor would be injurious to the produce supported thereon. It has been discovered, however, that in the processing of certain types of produce, such as potatoes, the heated grid, formed by the conveyor 11, does not injure the produce but is actually beneficial because it assists in raising the surface temperatures of the produce, as well as preheating the air as described above. The use of a heat absorbing conveyor is not necessarily desirable in treating all types of produce, and therefore the invention is not necessarily restricted to the inclusion of this feature.

In the prior art apparatus, the drying action has been performed by the circulation of hot air around the produce and by passing the produce directly over or within the vicinity of heaters, such as hot-air heater or steam radiators. By these arrangements, all of the drying action is performed by the contact of hot air with the surfaces of the produce. All of these arrangements required the generation of high temperatures and the pumping of large volumes of air through the drying chamber because, due to the relatively poor heat transfer from the air to the surfaces of the produce, a much greater amount of air, by volume, is required to evaporate surface moisture as is required to absorb and carry off the evaporated moisture. These characteristics necessarily required the use of larger machines, covering considerable floor space, which were limited in their capacity due to the time required to effect the necessary heat transfer. Furthermore, the drying of the surfaces of the produce has been incomplete and the moisture has not been completely removed, particularly from depressions such as cuts or eyes. Instead, the moisture film has been heated short of total evaporation but to a degree that promotes multiplication of the bacteria and other organisms in the produce.

It has now been discovered that all of the moisture can be completely evaporated from all portions of the surfaces of the produce and within a relatively short time, by subjecting the produce to infra-red irradiation which has the inherent phenomena of not radiating or dispersing heat through the air, but of generating heat only by contacting a surface that is relatively non-pervious to this type of radiation. In other words, the infra-red irradiation produced by the lamps 12, does not heat the chamber within the housing 10 per se, but upon impinging against the surfaces of the produce this irradiation is immediately transformed into heat at the point of contact. Consequently, the heat is created directly at the point at which it is desired, namely, the surfaces of the produce. Furthermore, the irradiation passes into all the depressions equally as efficiently as upon more exposed surfaces.

The irradiation necessarily strikes the exposed surfaces of the conveyor rollers 36, so that it will generate heat on these surfaces if they comprise a material which is impervious to the radiation, such as steel and other metal and materials. On the other hand, if a heated conveyor is not desirable, it may comprise materials that are pervious to infra-red irradiation so that rela-

tively little heat is generated. Thus, without the necessity of a complicated structure, the conveyor 11 may be arranged to become a grid for transferring heat directly to the surfaces of the produce P and for assisting in the maintenance of the surface temperature for the desired period of time. It is particularly useful in maintaining the temperature of the under surfaces of the produce P which, at the moment are not exposed to the infra-red irradiation. Where this feature is deemed not to be injurious to the produce P, its inclusion expedites the treatment of the produce P so as to materially increase the volume of produce P that may be processed within any given time.

Whereas the drying ability of infra-red irradiation is of primary importance, it has a greater and even more important distinction in its ability to sterilize the surfaces of the produce by killing these bacteria or other organisms thereon which can be killed under conditions inherent in the operation of the apparatus and method, herein disclosed, without deleterious effect on the produce and inhibiting the action of such bacteria-produced enzymes. This action is actually more in the nature of flash pasteurization, rather than sterilization, as it resides in the quick elevation of the temperature of the moisture on the surface of the produce and the surface temperature of the produce to a degree well above the death point of these organisms for a short period of time. Flash pasteurization refers to a heat treatment of 180° F. for one minute, whereas in the present process a heat treatment of about 180° F. is applied for an average of two to two and one-half minutes to the moving surfaces of rolling produce. To be on the safe side, the rolling potatoes may be exposed for three minutes or more. Of course, if the produce was stationary so that the radiation was concentrated on one surface, then the time of exposure could be reduced to about one minute, so that the treatment would approximate flash pasteurization in this case.

Employing potatoes as an example, their treatment is directed primarily to the elimination of bacterial soft rot which is caused by the organism *Bacillus carotovorus*, whose thermal death-point is about 124° F. for ten minutes. It has now been found that by substantially increasing the temperature, however, the deathpoint is reached much more rapidly. It should be borne in mind that the required temperature is that of the water film and the surface of the potato and not just the temperature to which the potato is exposed. In other words, even though the potato is exposed only to currents of air heated to 145° F., its surface temperature might barely reach 124° F. after prolonged exposure due to the slowness of heat conduction from heated air and cooling effect from the evaporation of water.

In contrast with the prior art methods, the present process, employing infra-red irradiation, rapidly creates very high surface temperatures. This is due to the fact that the heat is generated by the irradiation upon contact with the surfaces so that the heat originates right at the point at which it is desired. Furthermore, since the coefficient of heat absorption by radiation of water is 4.10 or an average of 95% of perfect absorption, the temperature of the water film on the potato is elevated very rapidly to substantially the degree of heat generated. On the other hand, the coefficient of heat conductivity of air is only

.163, so that when air is the method of heat transmission, the rate is very low.

In actual practice, it has been found that by positioning standard commercial infra-red lamps about six inches above the bed of the conveyor, the upper surfaces of the average potato will then lie about four inches from the lamps, and the over-all average irradiation temperature at this distance, and with two minutes exposure, will range in the vicinity of 190° F. The coefficient of heat absorption from irradiation of the moisture film on the potato being 95%, the temperature of this film will be elevated to about 180° F. This temperature for this period of exposure has been determined as sufficient to inhibit the decaying action of the soft rot organisms. By raising the temperature of the organism to 180° F., its thermal deathpoint is effected much more rapidly and the enzymes produced by the organisms is inhibited entirely. It is the enzyme that actually produces the decaying action by dissolving the middle cell walls which results in the breakdown of the tissue. This enzyme is entirely inhibited at a temperature of about 145.4° F. Furthermore, the elevated temperature tends to speed the formation of wound-cork in surface injuries, and this cork will protect the potato from attack by later activity of a *Bacillus carotovorus* organism.

In view of these findings, the infra-red lamps 12 are mounted in the housing 10 about six inches above the bed of the conveyor 11 and the conveyor 11 is driven at a speed that will transport the produce P, when treating potatoes, through the housing 10 in about two to six minutes depending upon the constancy of the surface exposed to said irradiation. In order to further sterilize the produce P, a bank of ultra-violet lamps 12' may be positioned within the housing 10 and above the conveyor 11. The germicidal action of ultra-violet irradiation is well-known and, although it does not appear to materially attack the organism *Bacillus carotovorus*, its effect is beneficial in eliminating or inhibiting other organisms that may be present on the surface of the produce.

Of course, it will be understood that, in the above specification, treatment of potatoes has been emphasized. However, peaches, citrus fruit and other like produce may be treated, in which event, particularly in the case of thin-skinned fruits such as peaches and plums, the distance of the lamps from the bed may be varied—as, for instance, raised to 8 or 10 inches above the bed and the time of exposure to the infra-red light may be shortened or prolonged according to the nature of the product being treated. Also, it may be found desirable, in some cases, such as in the case of relatively soft, thin-skinned produce, to employ rollers or a conveying bed of some other less heat absorbing and radiating material than metal. In practice wood has been found to be quite satisfactory in such cases.

Subsequent to the above findings and practice, I have found that the principles thereof may be efficaciously carried out, for general commercial usages, by the method and apparatus hereinafter to be described as a continuation of the foregoing invention and which apparatus is, at present, a standard commercial machine.

Referring to Figures 4a and 4b of the drawings, it will be observed that the most outstanding change has been (1) the provision of means for transferring the potatoes, or other articles, being processed, from the top flight of the live roller conveyor to the bottom flight at the end of the

structure (where they were formerly discharged from the machine for grading and packing); (2) the provision of an impervious horizontal partition between the upper and lower conveyor flights to divide the housing into two closed passages communicating at one of their adjacent ends, thus forming a duct or channel having two open ends; and (3) the upper and bottom flights of the conveyor traveling through said passages, respectively, and the drying-air flowing from one end of said duct or channel to the other in reverse direction to the travel of the said conveyor.

Due to these changes, the potential drying ability of the air stream is utilized for pre-drying the product and, after subjection to infra-red light irradiation, for a post or final drying of the product instead of depending largely upon the infra-red source of heat for drying effect. The resultant advantage of these changes is a material reduction in the number of the costly infra-red lamps required with their attendant cost of replacement and electricity consumption, and other marked reduction in cost of other equipment and operation, while effecting the complete drying of the product and inhibiting the rot-producing action of the bacteria above mentioned. It will be noted further that the intake blower 34 and the apparatus 31, 32 and 33 (Fig. 1) for dehumidifying, filtering and recirculating air, which had already passed once through the machine, have been eliminated.

After the above modifications were made, including making the duct or chamber (64, 65 and 66) airtight, it was found that with the exhaust fans doing all of the work of creating a stream of drying air through the machine, there was negative pressure throughout the entire air channel below that of the atmosphere. It has become apparent that the drying step in the process is greatly facilitated by rarefaction of the air within the housing and that the effect of this condition is largely responsible for the rapid completion of surface evaporation during the passage of the produce through the post-drying when it is not subjected to infra-red irradiation.

This permits the reduction in the number and the area of the infra-red lamp bank proportionate to the time of exposure sufficient to inhibit the action of the rot producing organisms only. Actually, subsequent experience in the shipment and storage of potatoes which were processed through the machine, shown in Figures 4a to 9, inclusive, has been that practically no rotting or other deterioration of the produce has occurred. The reason for this is not understood fully. However, it is believed that the application of the various increments of heat to the surfaces of the product by infra-red radiation, by the heated air currents traveling in opposition to the movement of the product, by the conduction or absorption of heat by the conveyor, by increasing the air tightness of the housing, by introduction of the partition 62 which divides the housing into two passages, and by rarefaction of the air throughout the entire housing, has resulted in the advantages of the machine shown in Figures 4a to 9.

Referring now to the drawings with particularity, housing 45 of the machine, shown in Figures 4a to 9, inclusive, is approximately forty (40) feet long and approximately six (6) feet wide, with the exception of the widened diversion compartment 66 at the rear end of the machine, and four (4) feet high. The housing 45 is supported by legs 45b in order to give it the desired

elevation above the floor or other supporting surface. Although it is necessary to provide openings for entrance and exit of air and the potatoes or other produce, the housing in other respects is made as nearly airtight as possible. The produce entry and discharge openings 72 and 63, respectively, are provided with curtains 101 and 102 of any type, common in the art, to restrict air ingress to a minimum, these curtains being shown herein as of the mop-type.

The main conveyor 47, which transports the potatoes or other produce to be processed through the machine in a lengthwise direction, is essentially the same as that described in connection with Figures 1, 2 and 3. Its rollers 48 are arranged in customary manner with their ends pivotally connected with endless sprocket chains 49 that are operatively mounted on aligned pairs of direction-change sprockets 50. The sprockets of each pair are supported by transverse shafts 51, of which all are idlers except the upper one at the diversion end of the machine (Figs. 4b, 6 and 9) which has an extended end 51a to which is fixed a driven sprocket 52 connected by sprocket chain 53 with sprocket 54 secured to countershaft 55 journaled in suitable bearings 56 and 57 on top of housing 45. The countershaft has a sprocket 58 fixed thereto which is driven through the medium of sprocket chain 59 by constant-speed electric motor 60. The diameter ratios of the sprockets involved in transmission of power from the motor to the main conveyor are such that the conveyor will move at a speed of approximately twenty (20) feet per minute. The effective length (sum of horizontal flights) being approximately seventy-five (75) feet, the time of passage of the produce through both horizontal flights, or drying time, will be approximately three and one-half (3½) minutes, which has been found to be a sufficient duration for potatoes under favorable condition; however, this time element may be varied according to conditions.

A horizontal partition 62 is provided between the top and bottom flights of the conveyor 47. This partition connects the side walls of the housing 45 and extends lengthwise from the entry and discharge openings 72 and 63 to a point near the diversion, or transfer, end 66 of the housing to divide the latter into parallel upper and lower passages 64 and 65 which communicate with each other at the closed diversion compartment 66.

Improved track rails 61 are provided for supporting the working flights of the conveyor and their load of produce (instead of the ledges 43 shown in Figures 1 to 3 inclusive) and are sustained in position by the partition 62 and by the bottom wall or floor of the housing 45 by securing said rails thereto, although the rails 61 may be otherwise supported. As shown most clearly in Figure 7, each track rail may be in the form of a channel bar disposed in inverted position with the edges of its flanges extending downwardly and with the conveyor rollers bearing upon the cross web for rolling contact therewith. Referring now to Figures 5a and 5b, it will be observed that the entire track for each conveyor flight comprises a plurality of aligned sections, each section being composed of a pair of rails which are in converging relationship lengthwise of the flight with which they are associated and which are equally spaced on opposite sides of the center line of the flight. Due to this arrangement, individual rollers will have properly balanced support, but, as they roll over the rails,

the points of support will vary throughout the length of the rollers. In this way, continual wear at any particular point will be prevented. Also, there will be better support afforded for the central portion of each roller where the lead of produce exerts its vertical strain.

It will be noted further that the rails of each track section converge, but, in the present machine, convergence terminates short of intersection. This is to afford varying points of contact from one end of the section to the other but to avoid any rocking or wobbling of the rollers which might occur if the converging ends of the rails were brought too close together, and thus too near to the center line of the conveyor flight, unless the ends of each track section overlap or extend one beyond the other as may be done.

Whereas in the machine of Figures 1, 2 and 3, the bank of infra-red lamps was co-extensive with the entire top flight of the conveyor, the bank of lamps 67, in the machine in Figures 4a to 9, are disposed throughout approximately the last twenty (20) feet of extent of passage 64 considering the direction of movement of the top flight of the conveyor. This position permits travel of the wet potatoes for about 15 to 18 feet from the supply opening 72 to subject them to pre-drying before reaching the infra-red irradiation area. There are approximately 288 lamps in the bank and they are connected electrically with a suitable source of current through circuit control apparatus which is designated generally by the numeral 68. The specific characteristics of these lamps and the spacing of them from the top flight of the main conveyor are substantially the same as in the original machine illustrated in Figures 1 to 3 inclusive. The time of exposure of each potato or other item of produce to infra-red irradiation has been reduced by the change in extent of the lamp bank to approximately one minute.

Air enters the lower passage 65 of the housing through a unit heater 69 which is positioned in the air intake opening 70. This heater may be a standard steam space heater, now an article of commerce, such as the one shown in the drawings, which is box-like in structure with heating elements 69a of the fin-and-tube type forming its side walls. The tubes of the heating elements are connected with headers 69b at the corners of the structure, which in turn are connected by piping 69c with a source of steam (not shown). An impervious wall 69d closes the bottom of the structure but the upper part of the same is open. Therefore, air drawn into the lower passage of the housing through opening 70 first enters the heater through the heating elements forming the sides thereof and then moves upwardly through the open top thereof as indicated by the arrows in Figure 4a. Although this type of heater, which was currently available, has been chosen, it is to be understood that some other means for heating the incoming air may be substituted without departing from the scope of the present invention. For instance, steam pipes running lengthwise of the lower passage 65 might serve the purpose. Furthermore, I do not desire to be limited to the use of steam as the heating medium. Electricity, for instance, might be used instead.

Air is drawn into the housing through the heater 69 and the intake opening 70 preferably by means of electrically operated air exhausting means 71 mounted on top of the housing 45 at or near the supply opening 72 where the potatoes, or the pro-

duce, are deposited upon the top flight of the main conveyor belt. The exhausting means may be a pair of exhaust fans such as those shown particularly in Figures 4a and 8 which are mounted in outlet openings 73 in hood 74, which is preferably an integral part of housing 45. It has been found that the desired rate of evacuation of air through the outlet openings 73 will be attained by the use of 24-inch fans driven by one-half horsepower motors, such as those indicated at 75, at approximately 1750 R. P. M. Both motors are connected with a suitable source of electric current through control mechanism not shown. While actually using two fans and motive power of the characteristics just mentioned, it is to be understood that I do not intend to be limited to the specific exhausting means disclosed in the present application. It might be found desirable to use one large exhaust fan instead of two smaller ones, or to use a blower of the type disclosed in Figure 1. Regardless of the precise type of air exhaustion means which may be chosen, the fact that air is sucked through the interior of the housing instead of being blown in through the intake opening has been found to have two distinct advantages. First, the air stream has negative pressure and, second, the flow of air is smooth and free from turbulence.

Referring particularly to Figs. 4b, 5b, 6 and 9, construction of the mechanism for transferring or diverting potatoes from the top flight of the main conveyor to the bottom flight thereof should be readily understood. It will be observed that the housing of the machine is widened at this location to accommodate the transfer mechanism. To a maximum reasonable extent this enlarged part of the housing has been made airtight. Two parallel transfer belts 76 and 77 are mounted on supporting pairs of rollers 78 and 79 fixedly attached to horizontal shafts 80 and 81 that are disposed parallel to each other at opposite sides of the main conveyor within the enlarged housing section. These shafts are journaled in suitable bearings and the one at the left side of the machine (Fig. 6) has a sprocket 82 which is connected by sprocket chain 83 with an individual motor 84, which is connected with the source of electric current for the other motors and operates at such constant speed that both transfer belts will move in the direction of the arrows at the same speed as the main conveyor. The location of shafts 80 and 81 and the diameter of rollers 78 and 79 are such that the upper flight of each belt will be slightly lower than the top flight of the main conveyor and the lower flight of each belt will be slightly elevated above the bottom flight of the main conveyor. This permits both flights of transfer belt 77 to extend through the space between flights of the main conveyor.

Transfer belt 76 is disposed adjacent to the upper driven shaft of the main conveyor at the diversion end of the machine. An inclined chute 85 is mounted to bridge the gap between transfer belt 76 and the main conveyor where it changes direction around the sprocket wheels on the driven shaft just mentioned. This chute causes the potatoes, or other produce to be deposited on the upper flight of transfer belt 76 for movement in the direction of the arrows.

In order to prevent small potatoes from becoming stuck in the valleys between rollers of the main conveyor in such a manner that they otherwise would continue to the lower flight, ejector strips 86 of well-known construction are mounted on the driven conveyor shaft 51a. A combined

retaining and deflecting wall 87 of just the required height extends from the lower end of chute 85 to surround the effective area of the upper flight of transfer belt 76. At the right side of the machine (near side, Fig. 9) a second chute 88 is inclined forwardly and downwardly from the upper flight of belt 76 to the lower flight of belt 77. Continuations of the wall 87 form the sides of this chute. In effect, walls 87 channel the produce from chute 85 to chute 88. Due to the features of construction just described, potatoes or other produce will be ejected from the top flight of the main conveyor through chute 85 onto belt 76 and will be moved to the right of the machine and discharged through chute 88 onto the lower flight of belt 77, which latter flight moves toward the left and will convey the potatoes to the bottom flight of the main conveyor. A third chute 89 leads from the lower flight of transfer belt 77 downwardly and forwardly to the upper surface of the bottom flight of the main conveyor. Two diagonal deflectors 90 and 91 overlie the lower flight of belt 77 and are connected with a retaining wall 92 which extends across the bottom flight of the main conveyor immediately in rear of belt 77. Deflector 90, which is nearer to chute 88 has its right rear half undercut to provide an aperture 93. As the processed articles are deposited upon the lower flight of belt 77 and are moved thereby toward the left side of the machine, approximately half of them will be deflected immediately onto the lower flight of the main conveyor, whereas the other half will move through aperture 93 and will be deflected by deflector 91 onto the main conveyor. This distributing mechanism prevents excessive accumulation of produce on the far side of the main conveyor.

At the front end of the machine there are two laterally extending conveyor belts for transporting the product to and from the machine—one (not shown) depositing the cleaned, wet potatoes, or other processed articles, onto chute 94 which directs them through supply opening 72 onto the top flight of the main conveyor for movement in the direction of the arrows; and the other conveyor belt 95 being partially contained within the open framework 46 of the machine, directly in front of the discharge opening 63 and slightly below the same. One end of the conveyor belt 95 is trained around a roller 96 mounted on a shaft 97 journaled in bearings 98 and located at such height that its upper flight of belt 95 will pass in front of the direction-change sprocket shaft 51 which is disposed directly beneath the discharge opening 63. A discharge chute 99 bridges the gap between the main conveyor at this point and the upper surface of the conveyor belt. The other end of the conveyor belt may extend to a grader or bagging machine, if desired.

Should there be an undesirable temperature drop between the upper and lower passages 64 and 65 of the housing, or the temperature of the air otherwise needs to be raised, a booster heater 99 has been installed in the upper part of the diversion compartment 66 within the air-stream and covered by the hood 100.

The operation of the machine (shown in Figs. 4a to 9) will now be described. When the infra-red lamps 67 are turned on and the exhaust fans 73 and the various conveyors operating, wet potatoes, delivered to chute 94 from the washing machine, will enter supply opening 72 where they will settle into valleys between rollers of the main

conveyor. The entrance of potatoes should be delayed, of course, until the infra-red lamps and the heated air entering through heater 69 have heated the interior of the machine to working temperatures. As the potatoes move from the supply opening 72 toward the bank of lamps 67, they will go through a pre-heating stage which will reduce the surface water to a very thin film, which film is believed to be desirable. Because water is relatively opaque to infra-red light rays, it is thought that the presence of a thin film of water aids the skins of the potatoes in directly absorbing most of the radiated heat at the surface with only a little penetrating to the interior tissues through conduction. Due to the spacing of the infra-red lamps from the top flight of the conveyor, the outer surfaces of the produce will be raised to a temperature in the order of 180° F. Because the potatoes are being continually reversed or rotated in position by the conveyor rollers, approximately one-half of the surface area will be exposed at a time. During the approximately one minute which is required for each potato to pass through the infra-red irradiation area, the surfaces thereof will have been maintained at the bacteria-killing temperature just long enough to accomplish the desired result without cooking or otherwise injuring the rest of the potato. In addition to bacteria-destruction, the heat applied by the infra-red irradiation will aid in the evaporation of moisture from the surfaces of the produce. When the potatoes leave the infra-red irradiation area, they will enter the diversion compartment of the housing. Here they will be deposited by chute 85 on transfer belt 76. When they reach the deflecting portion of wall 87 at the right side of the compartment, they will be deflected through chute 88 onto transfer belt 77, which will reverse their direction of movement. Deflector 90 will send half of the stream of potatoes through chute 89 onto the rear side of the bottom flight of the main conveyor, whereas the other half of the stream will pass through aperture 93 and upon encountering deflector 91 will join the first half of the stream on the far side bottom conveyor flight. Passing through the lower passage 65, the potatoes in damp condition will be completely dried by the steam of comparatively dry heated air which is coming in through intake opening 70.

Considering the drying of the potatoes, or other produce, separately from the bacteria-killing or inhibiting action of the infra-red irradiation for a moment, it should be readily understood that several increments of heat make up the total drying heat applied during movement through both passages. The heated air entering intake opening 70 furnishes one increment. Because of the blackening of the rollers of the main conveyor, another increment of heat will have been absorbed through exposure to infra-red rays which penetrate through the spaces between potatoes on the conveyor. This increment will be applied to the produce through conduction. A still further heat increment will be applied through convection by branch currents of the air stream which infiltrate between rollers of the main conveyor and are deflected by the partition wall 62 back through the spaces between potatoes into the main stream. All of these heat increments will be combined in the upper passage 64. In the lower passage, the potatoes will be heated by the main air stream and by contact with the conveyor rollers, which will have retained some of the absorbed heat, before being discharged in dry

condition through opening. Due to the negative (sub-atmospheric) pressure of the air in the lower passage, and also to its heated comparatively dry condition because of having just entered through the heater, drying of the produce is accelerated and is accomplished completely before the discharge opening is reached.

It should be apparent that the final commercial embodiment of my invention is a machine which is highly efficient in conservation of heat and which consumes a minimum of electric energy for operation of the infra-red lamps. There is further economy in the utilization of space in the building which houses the drying machine together with the cooperating washing and grading apparatus. Utilization of the bottom flight of the main conveyor for the post-drying step of the process has made it unnecessary to carry out this step in a separate housing, which would have to be of substantially the same length as the main housing of the machine, making an overall length of nearly ninety (90) feet.

The following is a table of internal air pressure, velocity and temperature reading recorded during actual operation of the final standard commercial machine illustrated in Figures 4a to 9 of the drawings:

	Top flight center	Bottom flight center	2 ft. forward of intake	6 in. outside exhaust	4 ft. inside exhaust
Air pressure (inches of water below atmos- pheric)-----	.1	.04	-----	-----	.12
Air velocity (ft. per min.) -----	500	250	100	1,500	-----
Temperature, (deg. Fahrenheit)-----	At intake—150				
			140	120	-----

It is to be understood that the foregoing quantitative readings represent conditions of operation which obtained at a certain time and under favorable circumstances. In future operations under different conditions, internal pressure, temperature and velocity of the air flow may be varied to meet the need for satisfactory results. The table is introduced principally to demonstrate that there is a reduction of pressure in the machine as herein described and that there are progressive changes in velocity and temperature at different points in the machine.

Although certain specific embodiments of the invention are shown and described, it is quite obvious that many modifications thereof are possible. The invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

That which is claimed as new is:

1. The method of treating produce, such as whole fruits and vegetables, to kill rot-producing organisms thereon without substantially dehydrating or cooking the produce internally, which method includes rapidly elevating the temperature of the surfaces of the produce from a non-cooking temperature to a temperature of the order of about 180° F., maintaining the surface of the produce at said high temperature for a sufficient period of time to kill said organisms thereon while simultaneously subjecting the surfaces of the produce to a current of dry pre-heated air having a temperature of 100° F. to 150° F., and then immediately lowering the temperature of the surfaces of the produce to a non-cooking temperature to prevent dehydrating and cooking the produce internally.

2. The method of treating produce, such as whole fruits and vegetables having moist sur-

faces, to dry the same and inhibit the rot-producing action of certain organisms which comprises exposing the produce to infra-red irradiation and to a stream of heated air in a confined housing.

3. The method of treating produce, such as whole fruits and vegetables, to kill rot-producing organisms thereon without substantially dehydrating or cooking the produce internally, which method includes rapidly elevating the temperature of the surfaces of the produce from a non-cooking temperature to a temperature of the order of about 180° F. by exposing the produce to infra-red heat rays, maintaining the surface of the produce exposed to said infra-red heat rays and at said high temperature for a sufficient period of time to kill said organisms thereon, while simultaneously subjecting the surfaces of the product to a current of dry pre-heated air and then immediately lowering the temperature of the surfaces of the produce to a non-cooking temperature to prevent dehydrating and cooking the produce internally.

4. The method of treating produce, such as whole fruits and vegetables, to kill rot-producing organisms thereon without substantially dehydrating or cooking the produce internally, which method includes rapidly elevating the temperature of the surfaces of the produce from a non-cooking temperature to a temperature of the order of about 180° F. by exposing the produce to infra-red heat rays, maintaining the surface of the produce exposed to said infra-red heat rays and at said high temperature for a sufficient period of time to kill said organisms thereon, while simultaneously subjecting the surfaces of the product to a current of dry pre-heated air having a temperature of 100° F. to 150° F. and then immediately lowering the temperature of the surfaces of the produce to a non-cooking temperature to prevent dehydrating and cooking the produce internally.

5. The method of treating produce, such as fruits and vegetables, to kill rot-producing bacteria and other organisms on the surface of the produce without substantially dehydrating or cooking the produce internally, said produce having surface moisture, which method includes exposing said produce to infra-red heat rays of sufficient intensity to rapidly elevate the temperature of the surface moisture on said produce to a temperature of the order of about 180° F. or higher, before any substantial evaporation occurs whereby said bacteria and other organisms in contact with said heated moisture are heated to the death temperature of said bacteria and other organisms, and maintaining said surface moisture on the produce at said temperature for a sufficient length of time to effect the killing of said bacteria and other organisms and to evaporate the surface moisture and simultaneously subjecting the surfaces of the produce to a current of dry pre-heated air to carry the evaporated moisture away from the produce as the moisture evaporates.

6. The method of treating produce, such as fruits and vegetables, to kill rot-producing bacteria and other organisms on the surface of the produce without substantially dehydrating or cooking the produce internally, said produce having surface moisture, which method includes exposing said produce to infra-red heat rays of sufficient intensity to rapidly elevate the temperature of the surface moisture on said produce to a temperature of the order of about 180° F. or higher, before any substantial evaporation occurs

17

whereby said bacteria and other organisms in contact with said heated moisture are heated to the death temperature of said bacteria and other organisms, and maintaining said surface moisture on the produce at said temperature for a sufficient length of time to effect the killing of said bacteria and other organisms and to evaporate the surface moisture and simultaneously subjecting the surfaces of the produce to a current of dry pre-heated air having a temperature of 100° F. to 150° F. to carry the evaporated moisture away from the produce as the moisture evaporates.

7. The process of treating wet edible produce to dry the same and inhibit rot-producing action of certain organisms and which includes placing the produce into a confined area, sucking air therethrough and heated in excess of 100° F., and discharging said air from said area at the entry of said produce, moving said produce through said area in a direction counter to said flow of heated air to first subject the produce to a pre-drying step, and, at a point intermediate said passage of said produce in said area, exposing the produce to infra-red irradiation treating step in the presence of said heated flow of air, and then subjecting said produce to the action of said heated air only for a distance from the infra-red irradiation step to the intake of said heated air into said area.

8. The process of treating wet edible produce to dry its surface and inhibit rot-producing action of certain organisms and which includes placing the produce into a confined area, sucking air therethrough and heated in excess of 100° F. from the produce discharge end to the produce entry end and discharge said air at said entry end, moving said produce through said area in a direction counter to said flow of heated air, and, at a point intermediate said passage of said produce in said area exposing the produce to infra-red irradiation at a surface temperature in the order of 180° F. for a period to flash-pasteurize said surface.

9. The method of treating wet edible produce to dry the same and inhibit rot-producing action of certain organisms which includes moving the produce in a definite course occupying approximately 3½ minutes of time through a confined space containing a stream of air flowing counter to the direction of movement of the produce and which has been heated to a temperature in excess of 100° F., and exposing the produce to infra-red irradiation in the order of 180° F. throughout a period of approximately one minute commencing after partially pre-air-drying of said produce immediately after beginning its movement through said course.

10. The method of treating wet edible produce to dry the same and inhibit rot-producing action of certain organisms which includes moving the produce in a definite course through a confined space containing a stream of air heated to a temperature in excess of 100° F. and has a pressure value below that of the outside atmosphere, and exposing the produce to infra-red irradiation at an intermediate point in its course of movement.

11. The method of treating edible produce to dry the same and inhibit rot-producing action of certain organisms which includes imparting translatory movement to the produce in the definite course through a confined space containing a stream of air which has been heated to a temperature in excess of 100° F. and has a pressure

18

value below that of the outside atmosphere, exposing the produce to infra-red irradiation at an intermediate point in its course of movement, and turning the produce while passing through its course.

12. In a process of treating wet edible produce to dry the same and inhibit rot-producing action of certain organisms and which includes placing the produce into a confined area having a pressure therein reduced from normal atmospheric air pressure by drawing air therethrough and heated in excess of 100° F. moving said produce through said area in a direction counter to said flow of heated air, and, at a point removed from the entry of said produce into said area, exposing the produce to infra-red irradiation.

13. In a process of treating wet edible produce to dry the same and inhibit rot-producing action of certain organisms and which includes placing the produce into a confined area having a pressure therein reduced from normal atmospheric air pressure by drawing air therethrough and heated in excess of 100° F., moving said produce through said area in a direction counter to said flow of heated air, exposing the produce to infra-red irradiation, and subsequently subjecting the said produce to the action of said heated air only.

14. A machine for drying edible produce and inhibiting rot-producing action of certain organisms, particularly with respect to whole fruits and vegetables having moist surfaces, said machine having a confined duct or passage through which said produce passes from a point of entry to a point of discharge of said produce, an air suction device communicating with said passage and disposed adjacent the point of entry of said produce into said passage and arranged to draw air through said passage from a point at least adjacent to said produce discharge, conveying means for conducting said produce thru said passage from said point of entry to said point of discharge, and heating means for heating the air introduced into said passage.

15. A machine as set forth in claim 14 further characterized by infra-red ray generating means disposed in said passage at points remote from and between the produce entry point and discharge point.

16. A machine for drying whole edible fruits and vegetables and inhibiting rot-producing action of certain organisms, said machine having an elongated substantially horizontal housing forming a confined treating passage through which said produce passes from a point of entry to a point of discharge, an endless air-pervious conveyor supported in a generally horizontal position within said housing and adapted to provide a produce receiving bed, means for driving said conveyor, a source of infra-red heat rays positioned in said housing to direct infra-red heat rays upon the produce supported on said conveyor, an air space in said passage extending along and above and below said conveyor within said passage, a source of heated air, means introducing said heated air into said passage, an air suction device communicating with said passage and arranged to draw said air through said passage and exhaust said air from said passage, said air introduction means and said air suction device being disposed respectively above and below the generally horizontal plane of the conveyor, whereby the heated air is caused to pass along and through portions of said conveyor in its travel in said passage.

17. A machine as set forth in claim 16 wherein said means introducing heated air into said treating passage included a forced air introducing device.

18. An apparatus of the character described for treating produce to dry the surface thereof and to kill bacteria and other organisms thereon without internally dehydrating or cooking the produce, which apparatus includes, in combination, an elongated housing constituting a produce treating chamber, an endless conveyor having an air pervious flight supported horizontally in said chamber and having produce supporting spaced live rollers, the flight of said conveyor being adapted to support produce resting on the live rollers thereof, means for driving the conveyor, means engaging said live rollers for causing said rollers to rotate as the conveyor progresses, whereby produce resting on said rollers is rotated on the conveyor, a source of infra-red heat rays positioned in the chamber above said flight of the conveyor to direct infra-red heat rays downwardly on produce supported on said flight of said conveyor, inlet means at one end of the chamber for directing produce upon one end of said flight of said conveyor, a discharge opening at the opposite end of the chamber through which produce may pass from said conveyor, an air space in the chamber extending along and above and below said flight of said conveyor, means for introducing heated air into one end portion of said air space, air suction means at the produce inlet end of the chamber and in communication with said air space, and baffle means in the air space disposed to direct the heated air to pass through said conveyor, whereby the air flow is through said chamber and along and through said conveyor.

19. An apparatus of the character described for treating produce to dry the surface thereof and to kill bacteria and other organisms thereon without internally dehydrating or cooking the produce, which apparatus includes, in combination, an elongated housing constituting a produce treating chamber, an endless conveyor having upper and lower flights supported horizontally in said chamber and having live produce supporting rollers, the upper flight of said conveyor being adapted to support produce resting on the live rollers thereof, means for driving the conveyor, means engaging said live rollers for causing said rollers to rotate as the conveyor progresses, whereby produce resting on said rollers is rotated on the conveyor, a source of infra-red heat rays positioned in the chamber above the upper flight of the conveyor to direct infra-red heat rays downwardly on produce supported on the upper flight of said conveyor, inlet means at one end of the chamber for directing produce upon one end of said upper flight of said conveyor, a discharge opening at the opposite end of the chamber through which produce may pass from the opposite end of said conveyor, an air space in the chamber extending along and underneath the lower flight of said conveyor, means for introducing heated air into one end of said air space, and air exhaust means above the upper flight of the conveyor at the end of the chamber where said produce inlet means is located, whereby heated air is drawn upwardly from said air space through the lower and upper flights of the conveyor and the rollers of the conveyor are heated.

20. Apparatus as set forth in claim 19 and having baffles in said air space distributing the

heated air beneath said lower conveyor flight to different areas thereof.

21. A machine for drying edible produce and inhibiting rot-producing action of certain organisms, particularly with respect to whole fruits and vegetables, said machine having a duct or enclosed passage comprising two portions substantially co-extensive and communicating at one of their adjacent ends, the other free ends of said passage portions providing entry and discharge points for said produce, air-restricting certain means at said free ends of said passage, said passage having an air inlet at said produce discharge end portion, and air-heater at said air inlet, an air suction device communicating with said produce entry end portion of said passage, a movable conveyor having one reach or flight disposed in one portion of said passage and another reach or flight disposed in the other portion of said passage, and a transfer device at the communicating ends of said portions of said passage for diverting said produce from the upper surface of one flight of said conveyor to the upper surface of said other flight, whereby said produce is moved through said passage from its point of entry to its point of discharge in opposition to the flow of heater air through said passage.

22. A machine for drying potatoes or similar produce and for treating the produce to inhibit the rot-producing action of certain organisms which comprises a housing, an endless conveyor operatively mounted in the housing and arranged to provide top and bottom horizontal flights adapted to convey the produce in one direction on the top flight and in the opposite direction on the bottom flight, means for transferring produce from the top flight to the bottom flight at the descending end of the conveyor, a horizontal partition wall located in the housing between flights of the conveyor to divide the housing into upper and lower passages which intercommunicate at the descending end of the conveyor, a generator of infra-red light rays disposed in the upper passage above the top flight of the conveyor, means for creating a stream of air in the housing and moving through the passages in a direction counter to that of the conveyor and at a rate to create an internal pressure within said passage below atmospheric pressure, and means for heating the air stream.

23. A machine for drying potatoes or similar produce and for treating the produce to inhibit the rot-producing action of certain organisms which comprises a housing, an endless conveyor operatively mounted in the housing and arranged to provide top and bottom horizontal flights adapted to convey the produce in one direction on the top flight and in the opposite direction on the bottom flight, means for transferring produce from the top flight to the bottom flight at the descending end of the conveyor, a horizontal partition wall located in the housing between flights of the conveyor to divide the housing into upper and lower passages which intercommunicate at the descending end of the conveyor, a generator of infra-red light rays disposed in the upper passage above the top flight of the conveyor near the descending end thereof, the housing having an air intake opening in the lower passage near the ascending end of the conveyor and an air outlet opening in the upper passage near the ascending end of the conveyor, means for exhausting air through the outlet opening at a rate to create an internal pressure

21

within said passage below atmospheric, and means for heating the air at the intake opening.

JAMES L. PARNELL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,256,825	Parker	Feb. 19, 1918
1,339,092	Benjamin	May 4, 1920
1,609,849	Wagner	Dec. 7, 1926
1,863,222	Hoermann	June 14, 1932
1,897,431	Jones	Feb. 14, 1933
2,156,845	Gentele	May 2, 1939
2,268,803	Cowl	Jan. 6, 1942

22

Number	Name	Date
2,308,601	Gentele	Jan. 19, 1943
2,326,115	Arthur	Aug. 10, 1943
2,349,300	Olsen	May 23, 1944
2,351,801	Baumann	June 20, 1944
2,359,199	Burnett	Sept. 26, 1944
2,391,195	Ross et al.	Dec. 18, 1945
2,419,875	Birdseye	Apr. 29, 1947
2,450,590	Gullo	Oct. 5, 1948

OTHER REFERENCES

"Electronic Processing," Scientific American, March 1944, pages 106, 107, and 108.
 "Infra-red Radiation," pages 229 and 230 of the magazine "The Chemical Age," March 4, 1944; vol. L, No. 1288.