

April 25, 1967

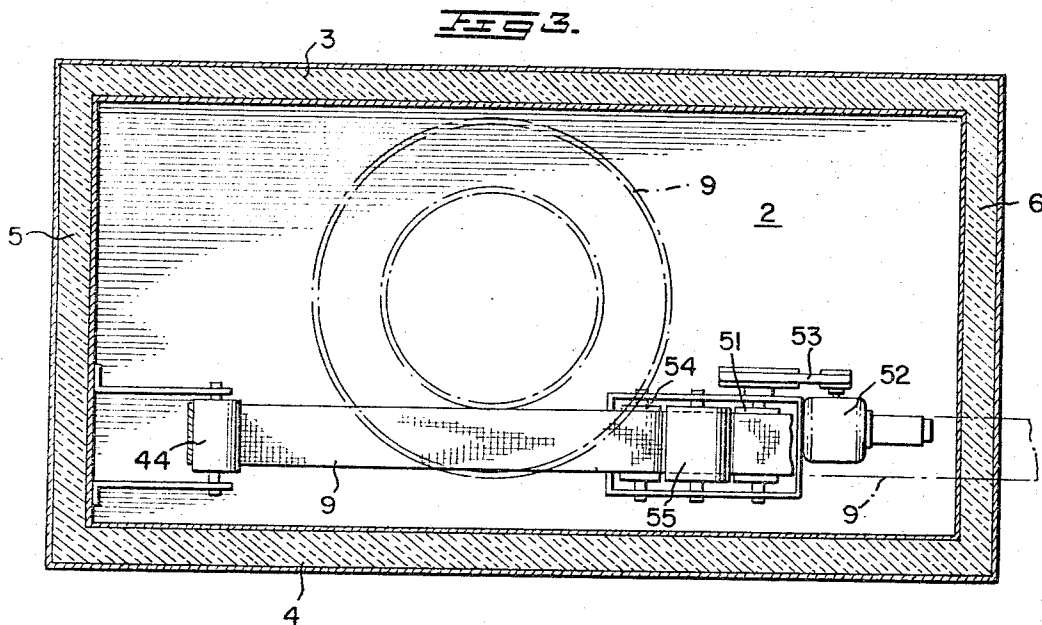
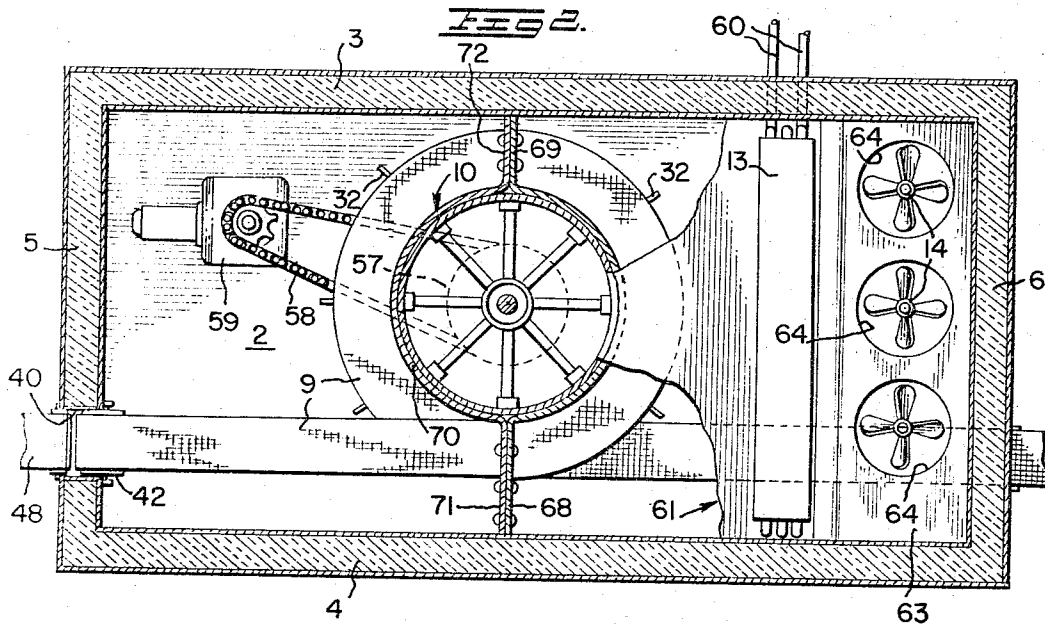
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3,315,492

CONTINUOUS ONCE THROUGH MATERIAL TREATMENT APPARATUS

Filed Feb. 21, 1966

7 Sheets-Sheet 2



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CONTINUOUS ONCE THROUGH MATERIAL TREATMENT APPARATUS

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FIG 4.

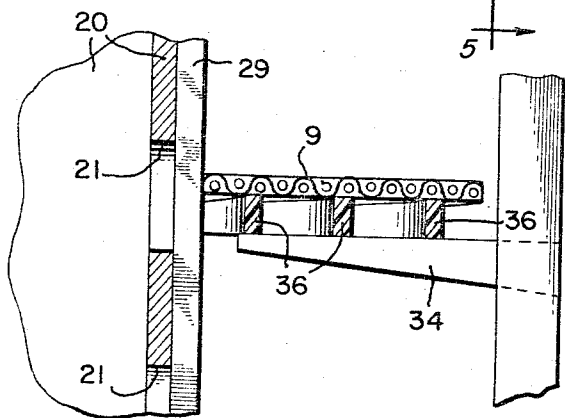
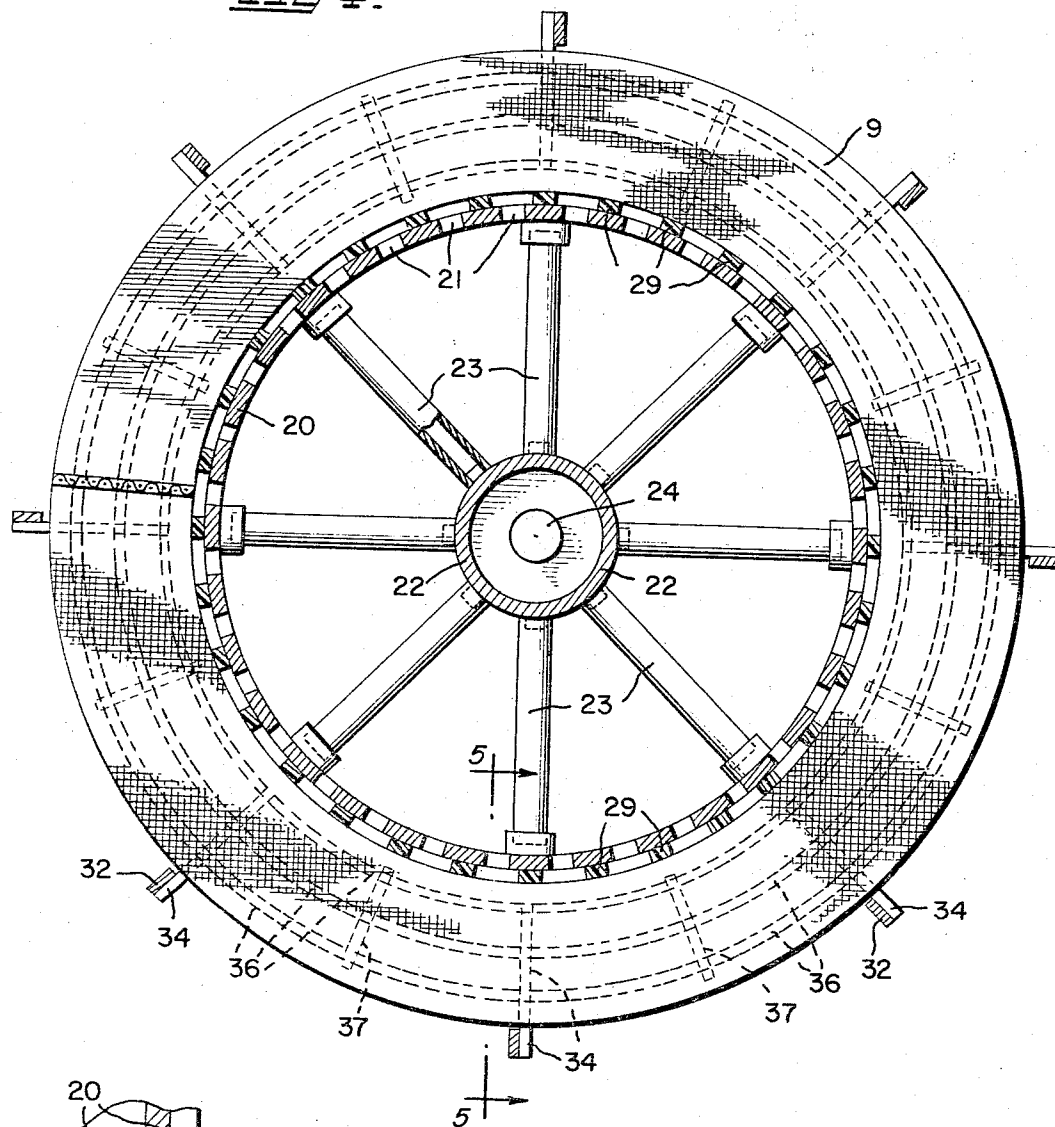


FIG 5.

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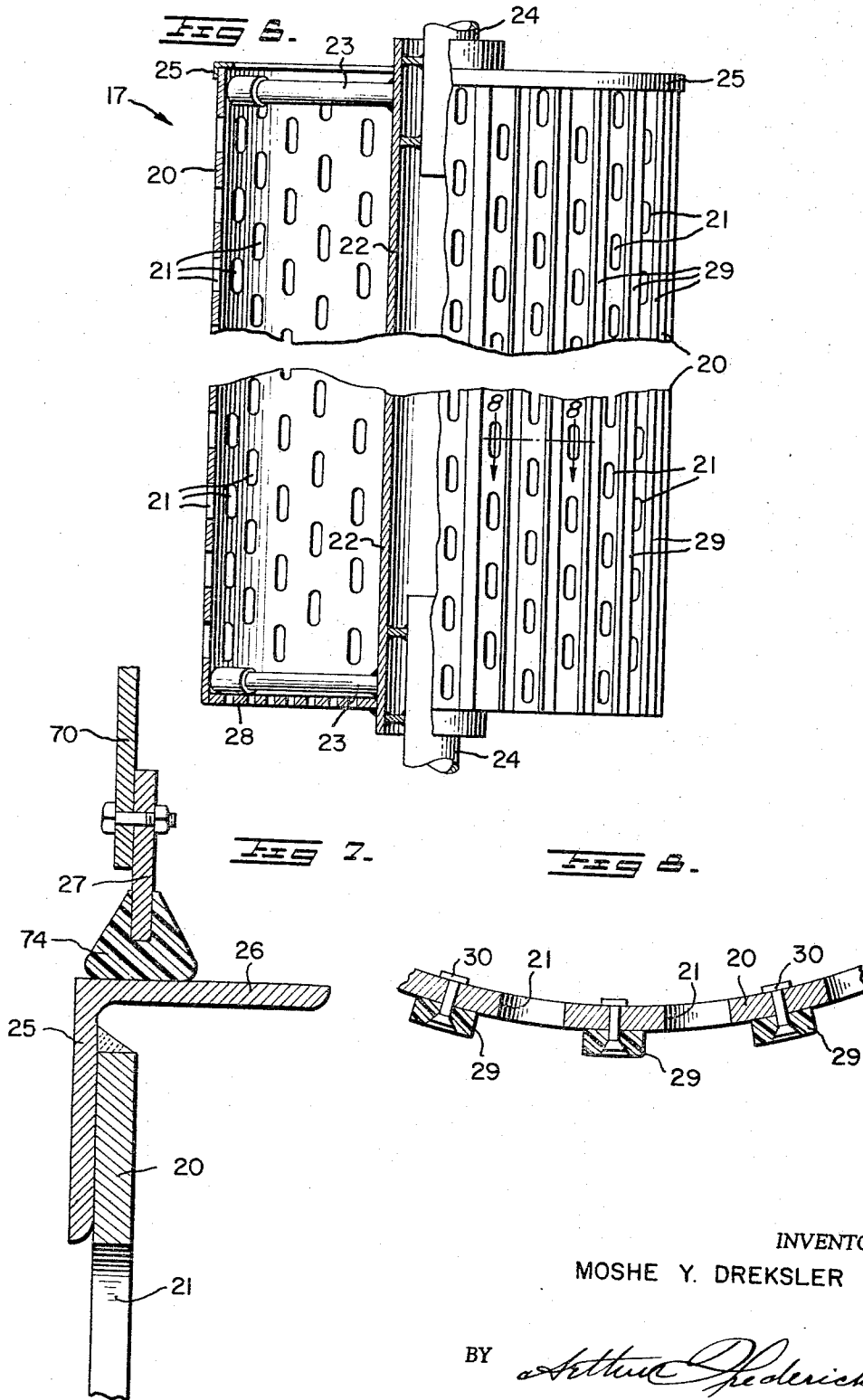
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7 Sheets-Sheet 4



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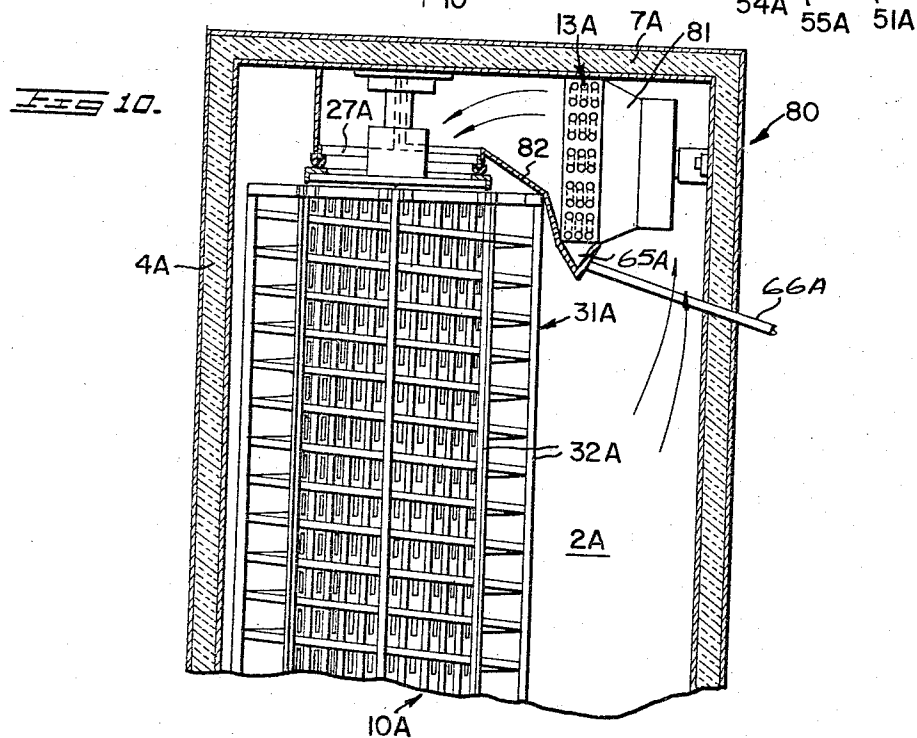
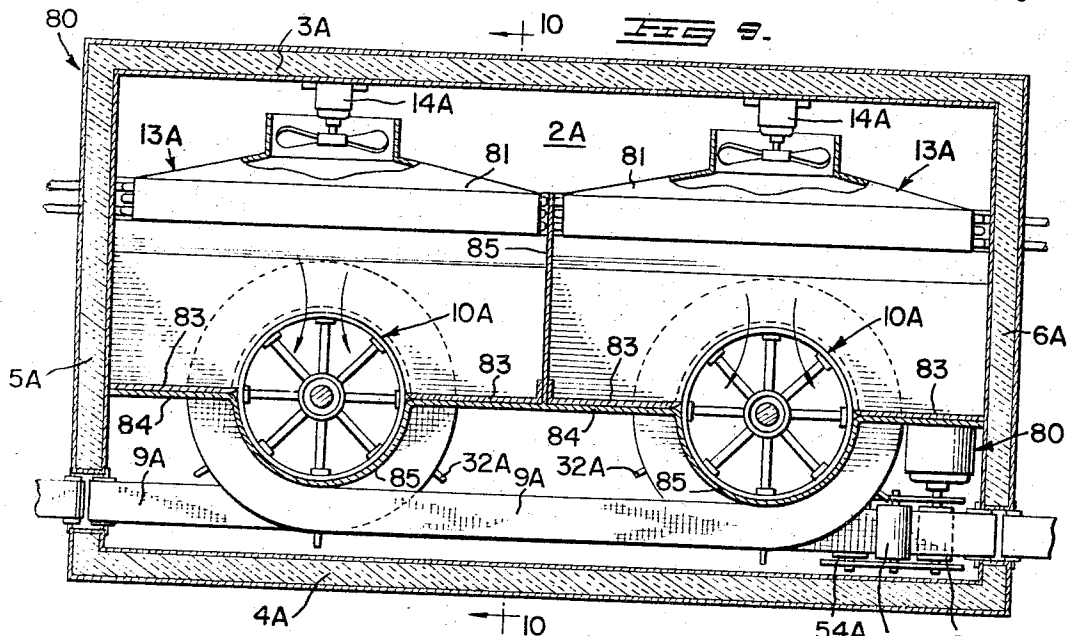
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CONTINUOUS ONCE THROUGH MATERIAL TREATMENT APPARATUS

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7 Sheets-Sheet 5



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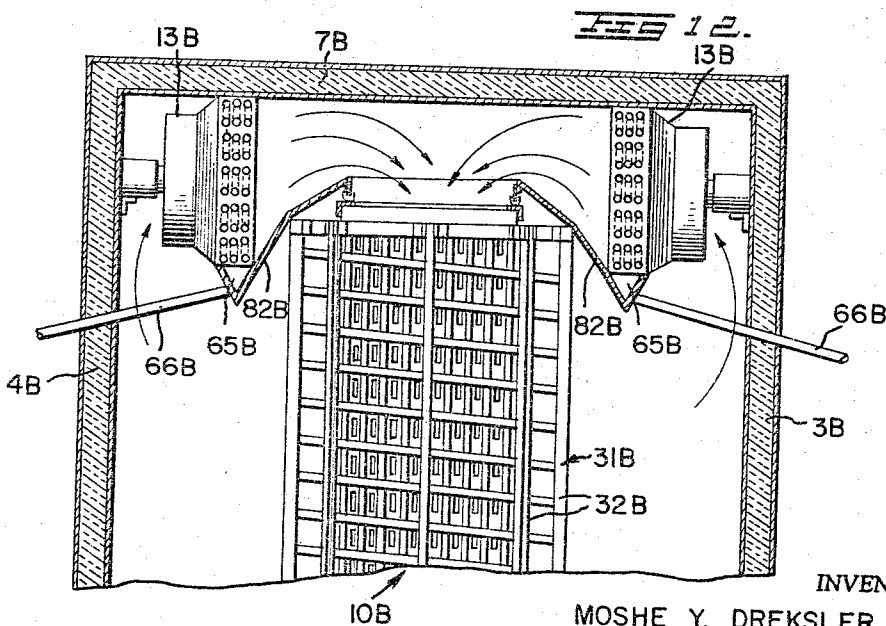
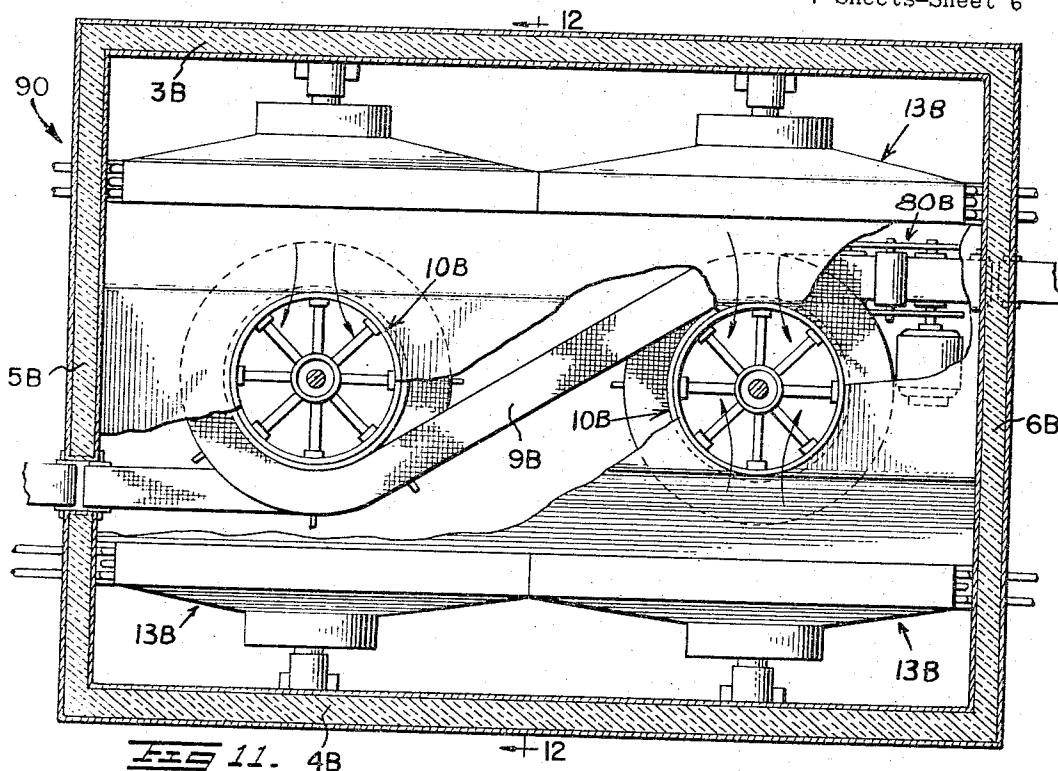
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7 Sheets-Sheet 6



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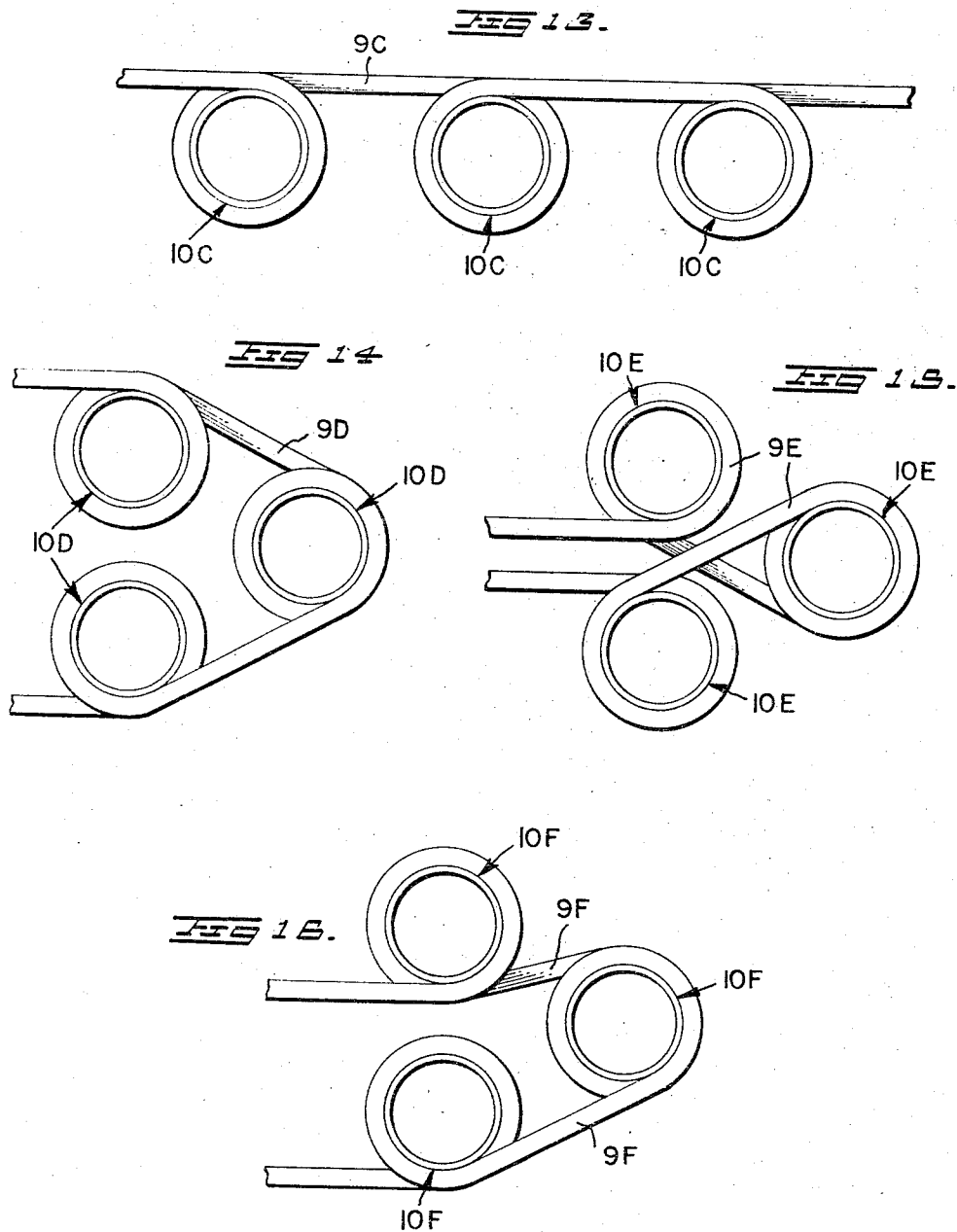
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CONTINUOUS ONCE THROUGH MATERIAL TREATMENT APPARATUS

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7 Sheets-Sheet 7



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3,315,492

CONTINUOUS ONCE THROUGH MATERIAL TREATMENT APPARATUS

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This invention relates to material treating chambers and more particularly to a freezing chamber for continuously conducting material to be frozen through an atmosphere held at subfreezing temperatures.

Many continuous treating, freezing apparatuses of the tunnel freezer type have been devised to freeze material, such as comestibles. Some of the freezing apparatuses previously designed are disclosed in the patents to Buhr, No. 1,865,168; Sterling, No. 2,223,972; Cleveland, No. 2,254,420; Sharpe, No. 2,402,921; Berch et al., No. 2,685,176; Martin, No. 3,173,276; and Wakatsuki, No. 3,226,947. In all of these freezing apparatuses, some of the inherent design problems are to provide sufficient exposure of the material to the low temperatures to achieve thorough freezing and at a rate of movement of material so that the unit has a commercially acceptable capacity. In many designs these two factors are achieved but only by an apparatus of rather large size and complexity.

Accordingly, it is one of the objects of this invention to provide a freezing apparatus of compact construction which provides a high output with sufficient exposure of individual material being treated to insure thorough freezing of such material.

Another object of this invention is to provide a freezing apparatus capable of continuously freezing material to be treated, which apparatus requires substantially less floor space than presently known continuous treating, freezing apparatuses.

A feature of this invention is an endless conveyor belt, a portion of which travels in a helical path in combination with refrigerating equipment and baffling to insure efficient freezing of the material carried by the conveyor belt.

In view of the foregoing it is contemplated by the present invention to provide a novel freezing apparatus comprising a chamber, at least one perforated, open ended drum vertically supported for rotation about its longitudinal axis within the chamber and an endless, flat, foraminous conveyor belt supported exteriorly of said drum and in a helical path of travel around the drum. A drive means is provided for rectilinearly moving said conveyor belt. A drive means may also be connected to the drum to rotate the latter in the same direction as movement of the conveyor belt. The apparatus also has a means for loading and unloading material to be treated onto and from the conveyor belt. An air conditioning means is provided for modifying the temperature of the atmosphere in the chamber. The apparatus has baffle means constructed and arranged in relation to the drum for directing air circulation within the chamber into one end of the drum and out through the perforations in the drum and into contact with the material carried on the conveyor belt.

In other embodiments of this invention, it is contemplated that the freezing apparatuses comprise two or more spaced vertically arranged, perforated drums around each of which an endless flat, foraminous, conveyor belt is supported for movement in a helical path. In these embodiments, a relatively long travel time is provided for the material to be treated in the chamber or the same travel time as in a single drum construction but with smaller drums so that the apparatus may be suitable for low headroom applications.

The invention will be more fully understood from the

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following detailed description thereof when considered in connection with the accompanying drawings wherein several embodiments of the invention are illustrated by way of example and in which:

FIG. 1 is a vertical sectional view of a freezing apparatus according to one embodiment of this invention;

FIG. 2 is a view in section taken substantially along line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 1;

FIG. 4 is a view in section taken substantially along line 4—4 of FIG. 1, somewhat enlarged;

FIG. 5 is a fragmentary sectional view taken substantially along line 5—5 of FIG. 4, somewhat enlarged;

FIG. 6 is a view of the drum according to this invention with a portion thereof broken away for the sake of illustration;

FIG. 7 is a fragmentary view on an enlarged scale of the baffle sealing means according to the present invention;

FIG. 8 is a fragmentary sectional view taken substantially along line 8—8 of FIG. 6, somewhat enlarged;

FIG. 9 is a sectional view of a freezing apparatus according to another embodiment of this invention;

FIG. 10 is a fragmentary view, in section, taken substantially along line 10—10 of FIG. 9;

FIG. 11 is a view, in section, of a freezing apparatus according to a further embodiment of the present invention;

FIG. 12 is a fragmentary sectional view taken substantially along line 12—12 of FIG. 11; and

FIGS. 13, 14, 15 and 16 are schematic illustrations of various three drum embodiments of this invention.

Now referring to the drawings and more particularly to FIGS. 1 to 8, inclusive, the reference number 1 generally designates a freezing apparatus according to one embodiment of the present invention. The freezing apparatus 1 has, as best shown in FIGS. 1 to 3, a chamber 2, defined by side walls 3 and 4, end walls 5 and 6, a roof 7 and a floor 8, the walls and roof being suitably heat insulated. Within chamber 1 is disposed an endless conveyor belt 9, a portion of which is supported to travel in a helical path about a guide and anti-friction drum 10. The drum 10 is supported for rotation about a vertical axis by bearing assemblies 11 and 12. A suitable refrigerating system, well known to those skilled in the refrigeration art and which includes an evaporator coil 13 connected to receive liquid refrigerant, is provided to condition the air in chamber 2. With the exception of evaporator coil 13, the refrigeration system components, such as the compressor and condenser (not shown), are preferably disposed outside chamber 2. A plurality of fans 14 are disposed within chamber 2 to effect circulation of the conditioned air in the chamber and through evaporator coil 13.

As best shown in FIG. 6, drum 10 comprises an elongated, annular, open-ended shell 20, which has a plurality of spaced perforations or apertures 21 therein. The shell 20 is connected at opposite ends to a tubular axle 22 by means of circumferentially spaced, radially extending spokes 23. To each end of axle 22 is secured a stub shaft 24 which projects from each end of axle 22, the stub shafts being journaled in bearings 11 and 12. A sealing ring 25 is welded or otherwise suitably secured to the upper periphery of shell 20 to provide a sealing surface 26 (see FIG. 7) which coats with a baffle seal ring 27 to provide a sliding seal as will be more fully explained hereinafter. The lower open end of shell 20 is closed by a perforated plate 28 which restricts flow of air from drum 10 and thereby causes air to flow laterally from the drum through apertures 21 in shell 20. It is also within the scope and spirit of the present invention to close the lower end of drum 10 with an imperforate plate

and provide air distribution baffles within the drum. A plurality of circumferentially spaced wear strips 29 are secured, as by rivets 30, to the outer peripheral surface of shell 20. Strips 29 are preferably constructed of material having a high resistance to wear and self-lubricating characteristics, such as fluorocarbon resins commercially known by the trademarks "nylon," "Nylatron" and "Teflon." As best shown in FIGS. 4 and 5, strips 29 are constructed and arranged to engage the inner surface of conveyor belt 9. To support conveyor belt 9 around drum 10, a support frame 31 is positioned adjacent drum 10.

The frame 31 comprises a plurality of circumferentially spaced, vertical columns 32 which are secured to floor 8 and interconnected at the top by braces 33. As best illustrated in FIGS. 4 and 5, columns 32 are spaced from the surface of shell 20 and each column supports a plurality of vertically spaced, horizontally extending arms 34. Each of the arms 34 of a column 32 is horizontally offset from the arms of the next adjacent column 32 so that the arms 34 form a spiral or helix around drum 10. On arms 34 are secured spaced, parallel rails 36, each of which follow a helical path around drum 10. Each rail 36 is preferably constructed of plastic material having a high resistance to wear and self lubricating characteristics, such as Nylatron, nylon or Teflon. To maintain rails 36 in parallelism between arms 34, spacer members 37 are secured to rails 36. As shown in FIG. 5, rails 36 support conveyor belt 9 in a flat position and in a helical path about drum 10.

The conveyor belt 9 is a foramous flexible belt which may be of the construction shown in U.S. Patent No. 3,225,896 sold under the trademark "Omni-flex" or any other similarly constructed belt which has lateral flexibility permitting the outer edge to extend and the inner edge contract so that the belt remains substantially flat as it travels in a curved path.

As best illustrated in FIG. 1, a conveyor belt loading port 40 is provided in end wall 5 at substantially the same level as the top of drum 10, while an unloading port 41 is provided in end wall 6 at a level substantially that of the lower end of drum 10. Conveyor belt 9 is suitably supported adjacent loading port 40 and unloading port 41 by rollers 42 and 43, respectively. To support and effect change in direction of conveyor belt 9, rollers 44 and 45 are supported on brackets 46 and 47 mounted on end wall 5. Adjacent loading port 40 and unloading port 41 there may be disposed loading and unloading conveyors 48 and 49, respectively, to deliver material to be treated on to conveyor belt 9 and to receive treated material discharging from the conveyor belt. Loading port 40 and unloading port 41 are sealed from ambient atmosphere by air screen assemblies 50 acting alone or in conjunction with conventional mechanical sealing means, as for example, spaced, flexible flaps, not shown.

The conveyor belt 9 is driven in any suitable manner by a direct or frictional drive means 51. As shown, the conveyor belt 9 may be frictionally driven by a roller 51 which is rotatively driven by a motor 52. The motor 52 is connected to drive roller 51 by a chain and sprocket assembly 53.

Cooperating with drive roller 51 and another roller 54 is a tensioning roller 55 which is supported for rotation about its axis and vertical movement in a roller support frame 56. The tensioning roller 55 functions to apply a desired predetermined tensional force on conveyor belt 9 and also to allow for the change in length of the belt upon start-up, change in loading and/or thermal expansion and contraction of the conveyor belt.

To minimize the frictional forces between conveyor belt 9 and drum 10 and also to insure that the outer edge of the conveyor belt will not tilt upwardly away from rails 36, drum 10 may be rotated in the same direction as the conveyor belt is traveling. The drive of drum 10 may be accomplished by securing a sprocket 57 (FIG. 2)

to one of the stub shafts 24 and rotating the sprocket by means of a chain 58 driven by a motor 59.

As previously stated, the freezing apparatus 1 according to this invention includes a conventional refrigerating system, one of the components of which is evaporator 13. Evaporator 13 is secured to roof 7 transversely of chamber 2 and is dimensioned to extend substantially the entire distance between side walls 3 and 4. Evaporator 13 is provided with pipe connections 60 for receiving and discharging refrigerant fluid.

Air flow in chamber 2 is controlled by a baffling means 61 which is spaced below roof 7 to form a false ceiling and a secondary chamber 62. Baffling means 61 extends between side walls 3 and 4 and from end wall 6 to about a point in alignment with the longitudinal axis of drum 10. As shown in FIG. 1, baffling means 61 has a flat portion 63 with cylindrical openings 64 therein in which fans 14 are mounted. From flat portion 63, the baffling means has a V-shaped configuration in cross section to form a trough 65 beneath evaporator 13. Trough 65 serves as a reservoir to receive water from the evaporator when the latter is defrosted. The collected water is removed from the trough via a drain pipe 66. The baffling adjacent the top of drum 10 is provided with a semi-circular, depending flange 67 and up-standing partition walls 68 and 69 on either side of drum 10. Partition walls 68 and 69 are secured to a vertical end wall which has a semi-circular portion 70 of the same radius as flange 67 and flat end portions 71 and 72 which abut and are co-extensive with partition walls 68 and 69. Flat end wall portions 71 and 72 and partition walls 68 and 69 are secured together in any suitable manner. The semi-circular portion 70 and flange 67 are secured to sealing ring 27 as by bolts 73 (only one of which is shown in FIG. 7). Sealing ring 27 has a diameter substantially the same as drum 10 so that the sliding seal member 74 engages sealing surface 26 of drum 10. Seal member 73 is composed of preferably material having a high resistance to wear and self-lubricating characteristics, such as fluorocarbon resin material commercially known under the trademarks "Nylatron," "nylon" and "Teflon." The baffling means 61 functions to channel the air circulated by fans 14 through the evaporator 13 and, thence, through drum 10, with negligible amounts of air bypassing the drum.

In operation of the described freezing apparatus 1, the refrigeration system is placed into operation so that refrigerant is circulated through evaporator 13 via pipes 60. The fans 14 are operated to effect circulation of air in chamber 2, through evaporator 13, to reduce the temperature of the circulating air. After the air temperature has reached the desired sub-freezing value, conveyor belt 9 is driven and material to be frozen is delivered to conveyor belt 9 through loading port 40. As the material is carried by the conveyor belt 9 in a spiral path downwardly adjacent drum 10, refrigerated air discharges from the drum, through apertures 21, into contact with the material to absorb heat from the latter. After the material has been thoroughly frozen, it is discharged through unloading port 41 on to conveyor 49 which carries the material to a place of packaging, boxing or storage. After the air is warmed by passing around the material to be treated it is caused by fans 14 to pass through evaporator 13 where the heat is removed before it again passes through the drum and into contact with further quantities of material to be treated.

When the heat transfer efficiency of evaporator 13 is reduced by the accumulation of frost on its heat transfer surfaces to a predetermined minimum value, the evaporator is defrosted in any one of a number of conventional methods. The water collected in trough 65 during the defrosting operation is carried off by drain pipe 66. After normal flow of refrigerant through the evaporator 13 is restored, the apparatus is ready to process additional material.

In FIGS. 9 and 10, another embodiment of this inven-

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tion is illustrated. This freezing apparatus 80 according to this embodiment primarily differs from the embodiment shown in FIGS. 1 to 8 in that the conveyor belt follows a spiral path successively around two drums. The components and parts of the embodiment shown in FIGS. 9 and 10, which correspond to components and parts in the embodiment shown in FIGS. 1 to 8, will be designated by the same reference number but with the suffix A added thereto.

The construction of each drum 10A and the support frame 31A adjacent each of the drums is the same as drum 10 and support frame 31 previously described with respect to freezing apparatus 1. One or both of the drums may be positively rotated by a suitable drive means (not shown) such as described with respect to freezing apparatus 1. The conveyor belt 9A is rectilinearly driven by a suitable drive means such as described for freezing apparatus 1. In this freezing apparatus 80, loading and unloading of conveyor belt 9A is accomplished through loading port 40A and unloading port 41A both of which are located in the lower portion of end walls 5A and 6A.

The freezing apparatus 80 has an evaporator 13A for each drum 10A with a fan 14A mounted in a frusto-conical shaped baffle 81 which is directly connected to the evaporator 13A. Each of the evaporators 13A is connected to and forms a part of the same or independent refrigerating system (not shown). The baffling means for freezing apparatus 80 is similar to that of the baffling means described for freezing apparatus 1 in that it forms a false ceiling which prevents circulated air from by-passing drums 13A. A baffle 82 is connected to the housing of each of the evaporators 13A and has a configuration similar to the baffling 61 described for freezing apparatus 1. Similarly to baffling 61, baffle 82 has a semicircular depending flange associated with each drum and which is connected to a sealing ring 27A. Baffle 82 also has four vertically extending portions 83 which engage the roof 7A on either side of each of the drums. A vertical partition plate 84 extends from roof 7A and between end walls 5A and 6A. Partition plate 84 has semi-circular portions 85 disposed adjacent each drum 10A, which portions are connected to sealing rings 27A. Baffle portions 83 are suitably connected to partition plate 84 to thereby cause substantially all recirculated air to pass into the top of drums 10A. To more nearly achieve independent dual circulation of air within chamber 2A, a central partition plate 85 is connected to baffle 82, roof 7A and partition plate 84.

While the air circulated into each of the drums 10A discharges into a common plenum, the use of two evaporators 13A and circulating fans 14A directly associated with each evaporator permits a relatively close control of the freezing process as the material is carried along by conveyor belt 9A.

In FIGS. 11 and 12 a still further embodiment of the present invention is illustrated. The freezing apparatus 90 is similar to freezing apparatus 80 in that two drums are employed. In view of the similarities of freezing apparatus 90 to freezing apparatuses 1 and 80, parts of freezing apparatus 90 corresponding to like parts in freezing apparatus 80 will be designated by the same number but with the suffix B added thereto.

The freezing apparatus 90 shown in FIGS. 11 and 12 is provided with a pair of evaporators 13B associated with each drum 10B, which evaporators are independently controlled so that it is possible to operate the apparatus to provide various temperature regions and, also, operate while one of the evaporators is being defrosted. Suitable baffling 82B is provided to form a false ceiling and prevent but negligible amounts of air from by-passing drums 10B. The conveyor belt 9B extends between drums 10B in a manner different from that shown in FIG. 9 for freezing apparatus 80. By arranging the conveyor belt 9B to bring its opposite side into engagement with the other drum 10B, more even wear and strain in the conveyor belt is achieved than in the freezing apparatus 80.

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In FIG. 13 a three drum arrangement is diagrammatically shown wherein three drums 10C are arranged in a straight line. It is to be noted that the arrangement permits loading and unloading of conveyor belt 9C at different elevations.

In FIG. 14 a three drum arrangement is schematically illustrated wherein three drums 10D are arranged with respect to each other in a triangular pattern. In this arrangement, loading and unloading of conveyor belt 9D can be achieved at different levels.

In FIG. 15 is shown schematically another three drum arrangement in which the conveyor belt 9E is so supported around the drums 10E that loading and unloading of the conveyor belt 9E can be achieved at points closer together than in the embodiment shown in FIG. 4.

In FIG. 16 another three drum arrangement is diagrammatically shown. In this arrangement the conveyor belt 9F is supported around the drums 10F so that both sides of the conveyor belt come into contact with the drums.

It is now readily apparent, from the foregoing description, that a novel continuous treating, freezing apparatus has been provided which utilizes a minimum amount of floor space and at the same time provides the necessary exposure time for thorough freezing of the material. It is a freezing apparatus of a high degree of efficiency since air by-passing the drums is minimal.

Although several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the arrangement of parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed is:

1. In combination with an air conditioning means, an apparatus for treating material comprising

(a) wall means defining a chamber,

(b) a perforated, open ended drum vertically supported for rotation about its longitudinal axis within said chamber,

(c) an endless, flat, foraminous conveyor belt,

(d) a stationary support exteriorly of said drum constructed and arranged to support the conveyor belt substantially flat and in a helical path of travel around said drum,

(e) loading means for delivering material onto said conveyor belt,

(f) unloading means for removing material from said conveyor belt after being treated,

(g) means for rectilinearly moving said conveyor belt,

(h) means for circulating the conditioned air in said chamber, and

(i) baffle means for directing air circulation within said chamber into one end of said drum and out through the perforations in the drum and into contact with the material carried on the conveyor belt.

2. The apparatus of claim 1 wherein said drum is provided with a plurality of wear strips secured to the exterior of the drum so as to engage the inner edge of the conveyor belt.

3. The apparatus of claim 1 wherein said means for moving the conveyor belt is a drive means connected to said drum to rotatively drive the latter.

4. The apparatus of claim 1 wherein said drive means include means to move the conveyor belt and means to rotate said drum in the same direction as linear movement of the conveyor belt adjacent the drum.

5. The combination of claim 1 wherein the air conditioning means includes a heat exchanger coil disposed in said chamber so that the air is circulated therethrough and thereby conditioned.

6. The combination of claim 1 wherein the air conditioning means is a refrigeration system which includes an evaporating coil disposed in a subchamber formed within said chamber by the baffle means, the

baffle means sealingly engaging a portion of one of the open ends of the drum.

7. In combination with an air conditioning means, an apparatus for treating material comprising

- (a) wall means defining a chamber,
- (b) a plurality of spaced, perforated open ended drums disposed within said chamber,
- (c) each of said drums being vertically supported for rotation about their respective longitudinal axis,
- (d) an endless, flat, foraminous conveyor belt,
- (e) a stationary support constructed and arranged exteriorly of the drums to support the conveyor belt substantially flat and in a helical path of travel successively around each of said drums,
- (f) loading means for delivering material onto said conveyor,
- (g) drive means for linearly moving said conveyor belt,
- (h) means for circulating the conditioned air in said chamber, and
- (i) baffle means for directing air circulation within said chamber into one end of said drum and out through the perforations in the drum and into contact with the material carried on the conveyor belt.

8. The combination of claim 7 wherein drive means includes means for moving the conveyor belt and means for rotating at least one of said plurality of drums in the same direction of movement of the conveyor belt associated with that drum.

9. The combination of claim 7 wherein two sets of fans are provided on opposite sides of the drums to effect dual circulation of conditioned air in said chamber.

10. The combination of claim 7 wherein the conveyor belt extends between said drums so that the opposite side

edges of the conveyor belt are adjacent each of the peripheral surfaces of the respective drums.

11. The combination of claim 7 wherein said baffle means slidably and sealingly engages the periphery of the upper end of the drums.

12. The combination of claim 7 wherein said baffle means includes annular sealing means constructed and arranged to slidably engage the periphery of upper end of each of the drums.

13. The combination of claim 7 wherein said plurality of drums are arranged in a straight line so as to provide various temperature regions.

14. The combination of claim 7 wherein said plurality of drums are disposed with the axes thereof lying in a triangular pattern.

15. The apparatus of claim 7 wherein each of the drums is provided with replaceable wear strips disposed in spaced relationship to each other on the exterior surface of the drum.

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