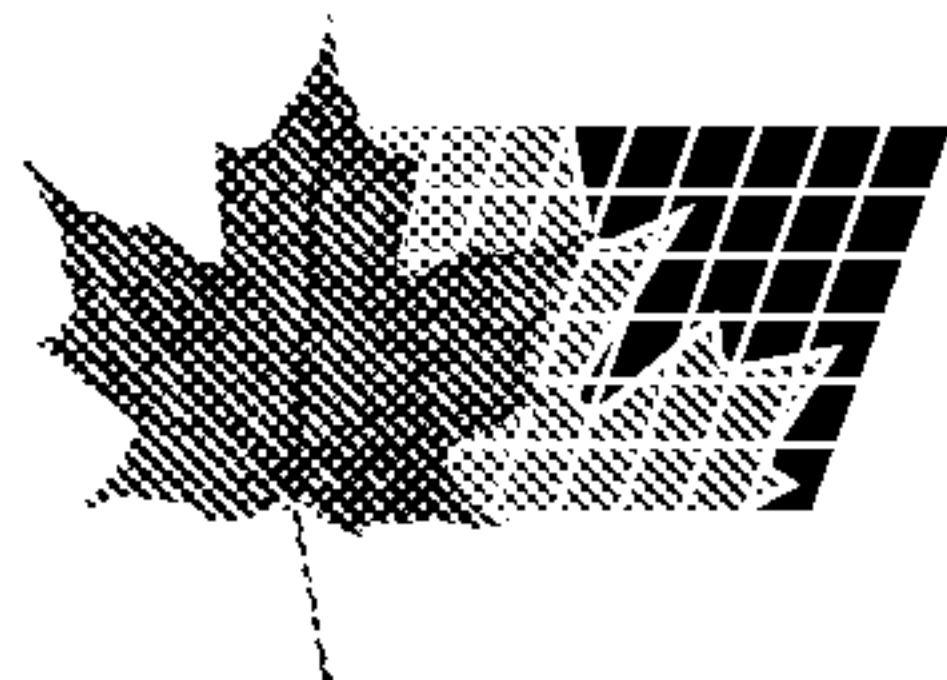




(22) 1992/07/07

(43) 1993/02/16

(45) 2001/04/10

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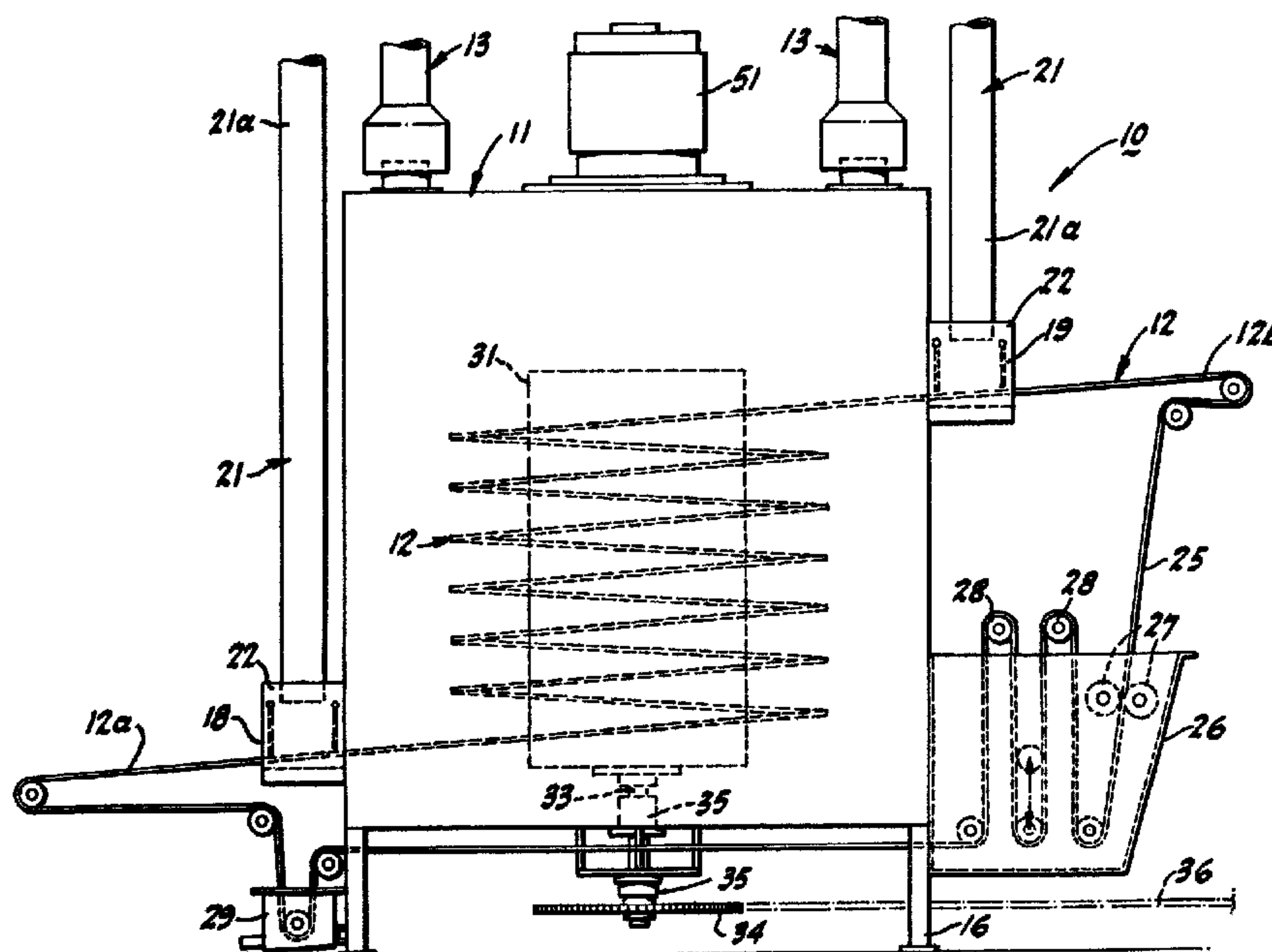
(51) Int.Cl.⁵ A47J 37/04

(30) 1991/08/15 (745,437) US

(30) 1992/04/24 (873,379) US

(54) **FOUR COMPACT DE GRANDE CAPACITE**

(54) **COMPACT, HIGH-CAPACITY OVEN**



(57) An oven with a box-like housing for efficient use of plant floor space encases a spiral food product carrying conveyor. A process vapor is circulated within the housing by "plug fans" with the inlet drawing vapor from the central axial zone of the spiral conveyor and exhausting into plenums along the periphery of the conveyor. The plenums have nozzles oriented to project the process vapor laterally towards the conveyor.

ABSTRACT

An oven with a box-like housing for efficient use of plant floor space encases a spiral food product carrying conveyor. A process vapor is circulated within the housing by "plug fans" with the inlet drawing vapor from the central axial zone of the spiral conveyor and exhausting into plenums along the periphery of the conveyor. The plenums have nozzles oriented to project the process vapor laterally towards the conveyor.

COMPACT, HIGH-CAPACITY OVEN

REFERENCE TO PRIOR APPLICATION

This is a continuation-in-part of our application serial number 07/745,437 filed August 15, 1991, now abandoned.

5 FIELD OF THE INVENTION

The present invention pertains to the treatment of food in a controlled atmosphere and particularly concerns an oven which is compact in its occupied floor area in relation to its cooking capacity and including therein an endless conveyor belt having a generally helical or spiral-form
10 configuration. The oven permits a process vapor flow which maximizes heat transfer to the products with uniformity while minimizing the disturbance to the products carried on the conveyor belt.

BACKGROUND OF THE INVENTION

The continuous preparation of food products such as meat balls, chicken
15 breasts, sausage links and patties and the like have been carried out very successfully within a controlled atmosphere contained within in a linear extending oven. Co-inventors Clark K. Benson and Andrew A. Caridis were named in patents which disclosed novel apparatus and processes for heating and cooking foods in a substantially closed treatment chamber, U.S. Patents
20 Nos. 3,947,241, granted March 30, 1976, 4,167,595, granted September 11,

1979, and 4,949,629, granted August 21, 1990. The treatment chambers disclosed in those patents contain longitudinally extending, endless conveyors which carry the food products through the oven outlets which were displaced a distance from the oven inlets many times by as much as sixty feet thereby
5 requiring on the order of seventy to seventy-five feet of unobstructed floor space in the processing plant where the ovens were installed. In numerous facilities the requisite length of floor space for an elongated oven was difficult to obtain and often plant building extensions were constructed to house the long ovens while in other instances the purchase of a long oven unit was
10 deferred until space could be made available.

The advantages of increasing cooking conveyor length within a housing by including multiple conveyors within an oven are well understood. In some instances conveyors have been arranged in multiple passes with one conveyor flight stacked atop another. Further, the space-saving advantage of arranging
15 the conveyor in a spiral configuration so as to obtain a long cook length in a volume more compact than that in a linear oven is well recognized. Among the problems that arise when configuring the food treatment conveyor in a spiral within a closed box-like housing is how best to promote the even flow of the process vapor with respect to the products carried upon the spiral
20 conveyor belt. Certain workers in the field proposed creating a steady-state, static atmosphere within the oven enclosure while others proposed moving a cooking atmosphere vertically through the open rods or wire mesh in the spiral conveyor stack. Neither of these arrangements satisfies the need for minimizing the pockets of stagnant, slow-moving cooking vapor around the
25 product. Where efficient use is made of the cooking vapor, virtually all of the products on a conveyor belt receive virtually the same heat load and exposure to the cooking vapor, which results in more predictable and uniform products. This is especially true where breaded chicken, meatloaf, shrimp and similar products are treated in a moving cooking atmosphere.

The hot cooking atmosphere applied to a food product may contain, in the case of a direct gas fired oven, the products of combustion including nitrous oxide [NOX] which is believed to cause "pinking" of the inner meat in some poultry products. While the human health risk of pink meat in poultry products is still an open question, food processors have taken the position that such color is to be avoided in cooked chicken parts. Indirect firing or electric heating of the cooking atmosphere in an oven for cooking poultry has been shown to eliminate or to reduce substantially the tendency to produce pink colored but cooked meat. An oven of a design which permits indirect heating by gas firing, electric or thermal fluid heating is very desirable.

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SUMMARY OF THE INVENTION

In one embodiment of the invention an oven is provided with an insulated housing having a product inlet, a product outlet and a spiral conveyor apparatus arranged within the housing including outside extending portions for conveying products through the oven inlet and outlet. The spiral conveyor may include a conveyor belt having a fabric-like array of bent-wire sections wherein individual sections are wrapped around pairs of transverse rods so as to create an extended, food product-supporting surface. A plurality of plenums are disposed along the outer periphery of the spiral conveyor at circumferentially spaced apart locations and nozzle means are arrayed on said plenums in positions serving to project a process vapor circulated therefrom laterally across the tiers of the spiral conveyor. In one embodiment, the nozzle means are arrayed in groups so that alternate groups project the process vapor generally countercurrent to the direction of conveyor movement while other groups direct the process vapor generally concurrent to the direction of conveyor movement. Fan means are arranged into the housing to circulate a cooking process vapor into the plenums through the nozzle means, across the conveyor flights which carry the food products and into a central axial zone of the conveyor for return to the fan inlet. Heating means are arranged in the plenums in the path of the process vapor circulated therethrough to reheat the process vapor.

The invention may be summarized according to one aspect, as in an oven for treating food products with a process vapor, the combination comprising: means defining a housing and including an inlet for food products to be treated therein and

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an outlet for food products issuing from the housing; spiral conveyor means arranged within the housing and including portions for conveying products through the oven inlet and outlet; the spiral conveyor having a central axial zone and
5 being of process vapor pervious construction and arranged in a plurality of stacked, vertically spaced apart tiers affording a substantial cooking area within the oven housing; vertically extending baffle means serving to define a plurality of plenum disposed along the outer periphery of the spiral conveyor at
10 circumferentially spaced apart locations; nozzle means arrayed on said plenums in positions serving to project the process vapor substantially laterally towards the perimeter of the spiral conveyor; the nozzle means being arrayed in groups such that alternate groups project the process vapor generally
15 countercurrent to the direction of conveyor movement and groups project the process vapor generally concurrent to the direction of conveyor movement; the nozzle means being arranged in the plenums to project the process vapor intermediate the tiers of the conveyor; fan means arranged in the housing serving to
20 circulate the process vapor into the plenums, through the nozzle means, across the conveyor and into the central axial zone of the conveyor; heating means arranged in the plenums in the path of the process vapor circulated therethrough serving to reheat the process vapor; and means for supplying water
25 vapor into the oven.

According to another aspect, the invention provides in an oven for treating food products with a process vapor, the combination comprising: means defining a housing and including an inlet for food products to be treated therein and an outlet
30 for food products issuing from the housing; spiral conveyor means arranged within the housing and including portions for conveying food products through the oven inlet and outlet; the spiral conveyor having a central axial zone and including a

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conveyor belt of process vapor pervious construction arranged in a plurality of stacked, vertically spaced apart tiers affording a substantial cooking area within the oven housing; conveyor drive means operative for advancing the conveyor belt in the oven; means serving to define a plurality of plenums in the housing; a first array of nozzle means mounted on said plenums in a position serving to project process vapor in a direction substantially towards the perimeter of the spiral conveyor in a non-radial direction; a second array of nozzle means mounted on said plenums in a position serving to project process vapor in a direction substantially towards the perimeter of the conveyor in a non-radial direction but generally opposite with respect to the direction of conveyor movement from that of said first nozzle array such that the nozzle arrays project the process vapor both generally countercurrent to the direction of conveyor movement and concurrent to the direction of conveyor movement; the nozzle means being arranged in the plenums to project the process vapor generally in a horizontal direction into the space between the tiers of the conveyor; fan means arranged on the housing serving to circulate the process vapor into the plenums, through the nozzle means, across the conveyor and into the central axial zone of the conveyor; heating means arranged in the plenums in the path of the process vapor circulated therethrough serving to reheat the process vapor.

According to yet another aspect, the invention provides a continuous process for treating food product including these steps: providing an oven enclosure having a product inlet and product outlet and a spiral conveyor operative to move products within the oven; placing the food products upon the conveyor and carrying the products up the spiral incline towards the oven outlet while subjecting the products to a rapidly moving process vapor moving generally

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horizontally towards the products in a substantially lateral direction with respect to the spiral conveyor; and removing the treated food products from the oven.

According to still another aspect, the invention
5 provides a continuous process for treating food products including these steps: providing an oven enclosure having a product inlet and product outlet and a spiral conveyor operative to move products within the oven; placing the food products upon the conveyor and carrying the products up the
10 spiral incline towards the oven outlet; generating a process vapor within the oven and circulating the vapor from a zone spaced from the outer perimeter of the spiral conveyor in a general tangential direction towards the food products of the spiral conveyor; and removing the treated food products from
15 the oven.

An object of the present invention is to provide for cooking food products in an improved oven which occupies a compact area of plant floor space where the products may be cooked with predictable uniformity at high efficiency per unit
20 of heat input in the absence of NOX.

Another object of the invention is to provide an improved oven of the type described wherein the cooking process vapor is distributed from an indirect

heat source over the food products arranged along a helical cooking surface wherein the heat supplied to the product is substantially uniform as measured transversely across the cooking surface.

Another object of the invention is to provide a cooking process which is
5 highly energy-efficient for both cooking and browning food products on an inclined, helically-arranged cooking surface having a high-energy transfer to the food product engendered by turbulent vapor flow over the food product.

Another object of the invention is to provide a high capacity oven of compact
10 design which is readily allied with a spiral freezer unit such that products cooked in the oven are easily transferred to the freezer over a minimum of conveyor length.

Further objects and advantages of the invention will become apparent from the accompanying drawings taken in combination with a detailed description
15 of the preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an elevation view of a compact, high-capacity oven having a spiral conveyor system and including the process vapor heating and distribution system of the present invention;

20 Figure 2 is a plan view of the oven in Figure 1;

Figure 3 is a cross-sectional view taken in the direction of the arrows 3-3 in Figure 2;

Figure 4 is a sectional view taken in the direction of the arrows 4-4 of Figure 3;

25 Figure 5 is a sectional view taken from the direction of the arrows 5-5 of Figure 4;

Figure 6 is a view like Figure 1, but showing another embodiment of the invention; and

Figure 7 is a plan view of the oven shown in Figure 6.

DETAILED DESCRIPTION OF THE INVENTION

There is shown in the drawings an improved compact oven 10 which is made in accordance with and embodying the principles of the present invention. Referring to Figures 1, 2 and 3, the oven 10 includes an insulated box-like housing 11, a conveyor system 12, heating means 13 and cooking atmosphere circulating fan means 14 serving to move a process vapor through the oven along products carried by the conveyor system 12.

The oven housing 11 may be formed in the compact shape of a generally equilateral rectangle as viewed in the plan of Figure 2. This affords a minimum "footprint" on the processing plant floor. The housing has four upstanding insulated sidewalls 11a, b, c, d, a bottom wall 11e, which may be water cooled or air cooled, and an insulated top wall 11f, Figure 3. The housing 11 may be mounted on a support frame 16 at an elevation sufficient to provide clearance for components of the conveyor drive described below.

The housing 11 is equipped with doors 17a, b, c and d (Figure 4) to afford access to the interior for cleaning, maintenance and inspection purposes. Being that the oven 10 is intended for treatment of food products, all metal portions thereof which come into contact with or are proximate to the food products are formed from stainless steel as required to maintain a high hygienic standard. Thus, the interior walls of the housing 11 are formed of stainless steel sheets as is well known in the industry. The exterior of the housing 11 may as well be formed from stainless steel so as to present a clean appearance typical of well-made food processing equipment.

The housing 11 is provided with an inlet 18 wherein food products are received and an outlet 19 where food products are discharged after treatment, Figure 1. The outlet is located at a distance from the plant floor that makes it quite practical to close couple the oven to a spiral freezer [not shown] using a minimum length of transfer conveyor.

Being that the housing is arranged so that food treatment processing therein may occur at a slight positive pressure over ambient, the inlet 18 and outlet 19 are each provided with a vapor control means 21 comprising a conduit or stack 21a coupled to a vent system in the plant (not shown) for
5 maintaining a draft in the conduit 21. The lower ends of the conduits are secured to shroud enclosures 22 arranged at the oven inlet and at the oven outlet and equipped so that the food products carried by the conveyor may pass through the enclosures 22. The vapor control means 21 provides a draft adjacent to the oven inlet and outlet so that atmosphere from the oven as
10 well as from the plant are taken up the stack thereby enabling control of the atmosphere within the oven at predefined levels of temperature and moisture content while substantially excluding air from entrainment into the oven through the product inlet 18 and outlet 19 openings.

As shown in Figures 1 and 2, the conveyor system 12 includes a linear inlet
15 section 12a as well as a linear outlet section 12b each of which has a length disposed outside of the housing 11. The conveyor segment 12b is provided with means for aggressively cleaning the conveyor belt including a liquid-containing housing 26 wherein a plurality of brushes 27 engage the continuous conveyor belt 25 on opposite side thereof, the belt 25 being reeved over
20 support rollers 28. The liquid within the housing 26 has the further function of cooling the belt so that the belt will be at substantially ambient temperature when products are loaded thereon adjacent the oven inlet 18. Another liquid treatment of the belt is had at the container 29 and this may include further cleansing or an anti-sticking dip of the belt as the cooking
25 process dictates.

Between the inlet 12a and outlet 12b linear sections of the conveyor system 12, there is arranged as an integral part thereof a spiral or helical conveyor

section which may have the general configuration shown in U.S. Patents 4,867,301 and 3,940,133 which are incorporated by reference herein.

The spiral or helical segment of the conveyor system 12 includes a vertically extending axially disposed central drive cage 31 made up of a lattice of vertical rods 32 disposed in a circular array, best shown in Figures 3 and 4. The cage is rotatably driven through a drive shaft 33 extending from the lower portion thereof and projecting through the bottom 11e of the housing 11. Suitable bearing supports 35 maintain the cage in the operative position. The lower end of the cage shaft 33 has mounted thereon a sprocket 34 which may be driven from a motor (not shown) via a drive chain 36. The upper end of the cage 31 is maintaining in operative position for concentric rotation by a number of circumferentially arranged roller supports 37 mounted on the interior mounted conveyor support frame 38. As disclosed in the above-mentioned patents, the cage 31 functions to drive the conveyor belt 25 by engagement of the radially inwardly projecting conveyor belt rod ends in sliding contact with the vertical lattice rods or bars 32.

Generally horizontally extending arms 39 project from the interior mounted conveyor frame 38 and serve as conveyor belt supports. The arms are maintained on the four or more vertical members of the inner frame 38 in a vertically spaced relationship to define the spiral or helical path the conveyor will follow through the oven 10. As may be seen best from Figure 3, the arms 39 serve to establish the conveyor in a series of vertically arranged tiers or decks, one above the other, thereby affording a long expanse of conveyor belt within the oven 10 for establishing a long cooking path between the oven inlet and outlet.

From the above it will be understood that through powered rotation of the drive shaft 33, by the drive chain 36 and sprocket 34, the cage 31 turns about

its vertical axis which serves to urge the conveyor belt 25 along its path on both the linear sections 12a and 12b as well as helical or spiral portions which are wholly contained within the oven housing.

The heating means 13 of the indirect type and the vapor circulating fan means 14 co-act within the housing 11 in a novel manner which creates an excellent cooking environment for distributing the hot process vapor along the food products 41 (see Figure 4) arranged on the conveyor belt. Referring specifically now to Figures 4 and 5, it will be seen that at the upper portion of the housing interior there is provided a generally horizontally extending baffle plate 46 supported from the upper housing wall 11f by a plurality of support rods 47. The top baffle has a central opening 48 which forms the throat to an inlet of a plug fan 49. The fan 49 is preferably a centrifugal fan having an impeller within the housing and is driven by a motor 51 mounted outside the housing 11 on the top wall 11f. As indicated in Figure 3, in operation, the vapor circulating fan 49 draws process vapor from the central portion of the conveyor, generally the zone of the cage 31, and dispels the process vapor radially outwardly in the space between the baffle 46 and the top wall 11f as symbolized by the arrows 50. Often called a "plug fan," the unit 49 may operate to deliver on the order of 18,500 cubic feet per minute of cooking vapor when driven by a 10 horsepower motor 51.

A plurality of vertically arranged baffles 52 are disposed within the housing 11 to define plenums 53. One convenient arrangement has been found to dispose four baffles vertically between the lower housing wall 11e and the top baffle 46 spanning across the corners of the housing 11, best shown in Figure 4. Here it will be understood that the upper baffle 46 is configured for substantially air tight connection with the vertical panels 52 such that the discharge from the plug fan 14 will pressurize each of the four plenums 53.

Cooking vapor distribution nozzles 54 are arranged among the plenums 53 to project therefrom at intervals that generally track the rise of the spiral conveyor. Desirably the nozzles are oriented such that they discharge into the space between consecutive tiers of the conveyor. More specifically, referring to Figures 4 and 5, it will be seen that the nozzles project outwardly from the vertical baffles 52 to distribute the cooking vapor in the direction of the arrows 56. In certain instances the flow as indicated by the arrows is in the direction concurrent to the movement of the conveyor as indicated by the arrows 57 and in other instances the flow from the nozzles is concurrent to the movement of the conveyor as indicated by the arrows 57. This is one of a number of desirable flow patterns.

The nozzles may have various shapes, but generally have a cross-section area on the order of thirty-five square inches. For certain applications, the nozzle may project or discharge the process vapor generally tangentially to the circumference of the helical conveyor section. This orientation causes much less of a "shadow" upon the inner product or the belt which may receive somewhat less heat than the product closer to the nozzles. The nozzle may be mounted in such a way on the vertical baffle 52 so different orientations may be selected for projecting the cooking vapor laterally of the belt.

The table below gives typical air velocity at locations designated in Figure 4 as A, B, C and D, A being proximate to the discharge of the nozzle 54, location B being just at about the mid-point of the conveyor, C being somewhat farther away from the nozzle and on the conveyor belt, and location D being just inside the cage for return to the fan inlet.

NOZZLE-VELOCITY
Feet Per Minute

	<u>Location</u>	<u>Low</u>	<u>Mean</u>	<u>High</u>
5	A	1676	2165	2653
	B	1261	1588	1915
	C	984	1238	1493
	D	490	634	777

The capacity of the plug fan is on the order of 18,500 cubic feet per minute with the fan being driven by a ten horsepower motor, as mentioned above.

- 10 The process vapor heating and reheating means is of a noncontaminating design and shields the cooking atmosphere entirely from the products of combustion thereby preventing the introduction of NOX (nitrous oxides) which can have a color-affecting result on certain meat products. Further, the heating means may include electrically heated resistance elements or
- 15 liquid heat exchanger radiation tubes. Shown in Figure 5 of the drawings is a gas burner heating system including a gas/air burner 61 firing at the bottom of a tube array 62, which, in this instance, is a triple-pass array. The heating tubes exit the housing 11 through the top wall 11f into a stack assembly 63, Figure 5. Fuel for the burner 61 and air are received as
- 20 indicated by the arrow 66. The operation of the heating means is such that products of combustion are propelled through the tube array 62 giving off heat, into the stack system 63 thereby supplying heat in the plenum 53 wherein the tube array is located.

The circulation of the process vapor via the plug fan 49 passes the process

25 vapor into the plenum 53 heated by the tube array heater means, the process vapor being discharged through the nozzles 54 towards the food product 41 carried upon the conveyor belt 25. The process vapor flows as indicated by the arrows 50 radially inward to the cage central zone of the conveyor

to be drawn upwardly through the throat 48 of the plug fan through the opening in the top baffle 46.

EXAMPLES

From our prior experience with ovens of various types and from calculation
 5 made with regard to the oven 10 we predict that products will be cooked to a good commercial standard at the times and temperatures set forth below. The three typical products selected are widely distributed from the food processing industry and will demonstrate the advantages of the present invention.

10 Whole Roasted Chicken

	Size:	3.1 lbs. (average weight of broiler chicken)
	Cook Time:	40 minutes
	Dry Bulb:	325 F
15	Wet Bulb:	185 F
	Fan Speed:	75%
	Yield:	72 to 80% depending on use of marinade
	Cooking Area:	710 sq. ft.
20	Belt Loading:	4.7 lbs./sq. ft.
	Rate:	5000 lb/hr

Institutional Meatloaf

	Size:	6 lbs.
	Cook Time:	45 minutes
25	* Dry Bulb:	300 F
	Wet Bulb:	185 F
	Fan Speed:	60%
	Yield:	90%
	Cooking Area:	250 sq. ft.
30	Belt Loading:	9 lbs./sq. ft.
	Rate:	3000 lb/hr

* Undo high temperatures to be avoided so as to minimize a splitting open of the meatloaf product.

Skinless, Boneless Chicken Breast and Thighs

	Size:	3-4 ounce
	Cook Time:	6 minutes
5	Dry Bulb:	275 F
	Wet Bulb:	190 F
	Fan Speed:	80%
	Yield:	84%
	Cooking Area:	411 sq. ft.
	Belt Loading:	1.7 lbs./sq. ft.
10	Rate:	7,000 lb/hr

The product is a salad meat which is neutral in color.

The reference above to wet bulb and dry bulb temperature is an indication of the moisture content in the oven through the release of live, superheated steam into the oven 10 through the steam sparger 55, as shown in Figure 3. The introduction and regulation of steam into a moving cooking atmosphere was disclosed in our prior U.S.patents 3,947,241 and 4,167, 595 wherein the moisture control apparatus regulates the moisture content by reference to the wet bulb and dry bulb temperatures for establishing the dew point or moisture content within the cooking chamber.

FURTHER EXAMPLES

Baked Potatoes

	Size:	5-6 ounces
	Cook Time:	25 minutes
25	Dry Bulb:	325 F
	Wet Bulb:	175 F
	Fan Speed:	85%
	Yield:	84%
	Cooking Area:	552 sq. ft.
30	Belt Loading:	5.5 lbs./sq. ft.
	Rate:	6,800 lb/hr

Strip Steaks

	Size:	3" x 7" x .75" thickness
	Cook Time:	8.5 minutes
	Dry Bulb:	350 F
5	Wet Bulb:	190 F
	Fan Speed:	85%
	Yield:	90%
	Cooking Area:	95 sq. ft.
	Belt Loading:	2.5 lbs./sq. ft.
10	Rate:	356 lb/hr

Chicken - Split Wings

	Size:	* 10 grams (post marinade 11.4 grams)
	Cook Time:	12 minutes
15	Dry Bulb:	350 F
	Wet Bulb:	190 F
	Fan Speed:	95%
	Yield:	78%
	Cooking Area:	95 sq. ft.
20	Belt Loading:	2.5 lbs./sq. ft.
	Rate:	1,187 lb/hr

Fruit Pies

	Size:	* 110-125 grams .75" thick x 5" diameter
25	Cook Time:	12.5 minutes
	Dry Bulb:	325 F
	Wet Bulb:	185 F
	Fan Speed:	98%
	Cooking Area:	95 sq. ft.
30	Belt Loading:	1.9 lbs./sq. ft.
	Rate:	866 lb/hr

* Yield ignored for this product.

Pork Ribs

	Size:	* 1385.9 grams
	Cook Time:	25 minutes
5	Dry Bulb:	240 F
	Wet Bulb:	190 F
	Fan Speed:	60%
	Yield:	74%
	Cooking Area:	95 sq. ft.
	Belt Loading:	2.2 lbs./sq. ft.
10	Rate:	279 lb/hr

Meat Pies (Parochki)

	Size:	2.25" wide x 5" long (5 ounces)
	Cook Time:	8 minutes
15	Dry Bulb:	350 F
	Wet Bulb:	180 F
	Fan Speed:	100%
	Cooking Area:	95 sq. ft.
	Belt Loading:	2.7 lbs./sq. ft.
20	Rate:	1,923 lb/hr

* The yield was a good color with even cooking throughout.

Bread and Batter Chicken - Bone In

	Size:	* 1,164 grams
	Cook Time:	Fry time - 2 minutes Oven time - 20 minutes
25	Dry Bulb:	350 F
	Wet Bulb:	185 F
	Fan Speed:	95%
	Yield:	105%
30	Cooking Area:	95 sq. ft.
	Belt Loading:	3 lbs./sq. ft.
	Rate:	855 lb/hr

* These were mixed chicken parts, including drumsticks, breasts, wings.
The yield reflects the weight increase by the breading.

SECOND EMBODIMENT OF THE INVENTION

Referring to Figures 6 and 7, another embodiment of the invention 110 is illustrated there and includes the insulated housing 111, a conveyor system 112, radiant tube burner indirect heating means 113 and the vapor circulating
5 fan means 114.

As was the case with the improved compact oven 10, the oven 110 includes a support frame 116 and other components in common with the oven 10 including portions not shown, doors, oven inlet, oven outlet and conveyor belt portions which extend through the inlet and outlet as well as the spiral
10 conveyor 125. The inlets and outlets of the oven 110 are equipped with vapor control means constructed and arranged as described above as in the compact oven 10.

The housing 111 is provided with a generally horizontally extending top baffle 146 having four openings 148 to serve as throats or inlet openings for plug-
15 type centrifugal fans 149. The four fans 149 are disposed in the central zone of the oven 110 in generally superimposed relationship to the drive cage 131 arranged therein. Vertical panels or baffles 152 are arranged in a generally twelve-side array viewed in plan spaced radially outwardly from the outer periphery of the helically arranged conveyor 125. At their lower margin the
20 panels 152 are secured in a substantially airtight relationship with the bottom or floor of the housing 111 and along their upper margins are arranged in a substantially air tight relationship with the upper or top baffle 146, thereby to define a plenum system surrounding the spiral conveyor within the housing 111. Nozzles 154 project from the baffles 152 towards the spiral conveyor
25 belt 125. Preferably, the nozzles may be disposed in a vertical array so that the nozzles issue the process vapor into the space between the superimposed tiers of the spiral conveyor, as illustrated in Figure 6. In alternate vertical rows, the nozzles 154 may extent counter-current to the direction of conveyor

movement as indicated by the arrow 157 so that the nozzles project the process vapor in the direction of arrows 156 as shown in Figure 7. A supply of steam may be introduced into the oven through the conduit 155, Figs. 6 and 7.

- 5 Disposed within the plenums 153 are the heating tubes 113 which are of the gas-fired radiant tube burner type. Alternatively, the heating units 113 may be electrical resistance units or transfer fluid heating units as are well known in the industry.

10 The structures described above function whereby products are introduced on the conveyor belt 125 and carried through the inlet (not shown) of the oven 110. The conveyor belt is driven through the drive cage 131 so that the products are carried along a spiral path through the oven 110 wherein they receive treatment from a circulating process vapor. The process vapor is generated within the housing by first introducing steam at a controlled
15 rate so as to achieve a predeterminate rate of humidity within the housing while supplying to the housing with the radiant tube heat means 113. The process vapor is caused to circulate within the housing by the four plug fans 149 in a path wherein the process vapor is withdrawn from the central zone of the housing as defined more or less by the drive cage 131 and then
20 propelled substantially horizontally by the fan discharge toward the plenums 153. The plenums thus pressurized serve as a reservoir of circulating process vapor which is discharged therefrom through the nozzles 154 in the direction of arrows 156.

25 The area of the discharge nozzle is selected in relation to the movement of the process vapors so as to cause a large measure of stimulated turbulence in the region of the nozzles. This is in contrast to high velocity, direct impingement of process vapor upon the product which is not the intention

of the inventors. The stimulated turbulence causes flow of the process vapor along the product carried on the belt uniformly throughout the lower, mid and higher tiers of the conveyor system and promotes even heat transfer to the food products. This has the effect of promoting a uniform appearing
5 and uniformly cooked food product from ovens constructed in accordance with the principles of this invention.

It will thus be seen that the objects set forth above may readily and efficiently be attained and certain changes may be made in the above construction and differing embodiments of the invention made without departing from the
10 scope hereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

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CLAIMS:

1. In an oven for treating food products with a process vapor, the combination comprising:

means defining a housing and including an inlet for
5 food products to be treated therein and an outlet for food products issuing from the housing;

spiral conveyor means arranged within the housing and including portions for conveying products through the oven inlet and outlet;

10 the spiral conveyor having a central axial zone and being of process vapor pervious construction and arranged in a plurality of stacked, vertically spaced apart tiers affording a substantial cooking area within the oven housing;

vertically extending baffle means serving to define a
15 plurality of plenum disposed along the outer periphery of the spiral conveyor at circumferentially spaced apart locations;

nozzle means arrayed on said plenums in positions serving to project the process vapor substantially laterally towards the perimeter of the spiral conveyor;

20 the nozzle means being arrayed in groups such that alternate groups project the process vapor generally counter-current to the direction of conveyor movement and groups project the process vapor generally concurrent to the direction of conveyor movement;

25 the nozzle means being arranged in the plenums to project the process vapor intermediate the tiers of the conveyor;

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fan means arranged in the housing serving to circulate the process vapor into the plenums, through the nozzle means, across the conveyor and into the central axial zone of the conveyor;

5 heating means arranged in the plenums in the path of the process vapor circulated therethrough serving to reheat the process vapor; and

means for supplying water vapor into the oven.

2. The oven of claim 1 wherein the heating means
10 comprises radiant heating tubes in an array of at least three passes.

3. The oven of claim 2 wherein the radiant heating tubes passes are generally vertically arranged and wherein heat is supplied by gas fired burner means disposed at the lower end
15 portion of the heating tubes.

4. The oven of claim 2 wherein the radiant heating tubes are supplied heat from a remotely located heat source such as a fluid heat transfer exchanger, or through an electric resistance heating system.

20 5. In an oven for treating food products with a process vapor, the combination comprising:

means defining a housing and including an inlet for food products to be treated therein and an outlet for food products issuing from the housing;

25 spiral conveyor means arranged within the housing and including portions for conveying food products through the oven inlet and outlet;

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the spiral conveyor having a central axial zone and including a conveyor belt of process vapor pervious construction arranged in a plurality of stacked, vertically spaced apart tiers affording a substantial cooking area within
5 the oven housing;

conveyor drive means operative for advancing the conveyor belt in the oven;

means serving to define a plurality of plenums in the housing;

10 a first array of nozzle means mounted on said plenums in a position serving to project process vapor in a direction substantially towards the perimeter of the spiral conveyor in a non-radial direction;

a second array of nozzle means mounted on said
15 plenums in a position serving to project process vapor in a direction substantially towards the perimeter of the conveyor in a non-radial direction but generally opposite with respect to the direction of conveyor movement from that of said first nozzle array such that the nozzle arrays project the process
20 vapor both generally countercurrent to the direction of conveyor movement and concurrent to the direction of conveyor movement;

the nozzle means being arranged in the plenums to project the process vapor generally in a horizontal direction
25 into the space between the tiers of the conveyor;

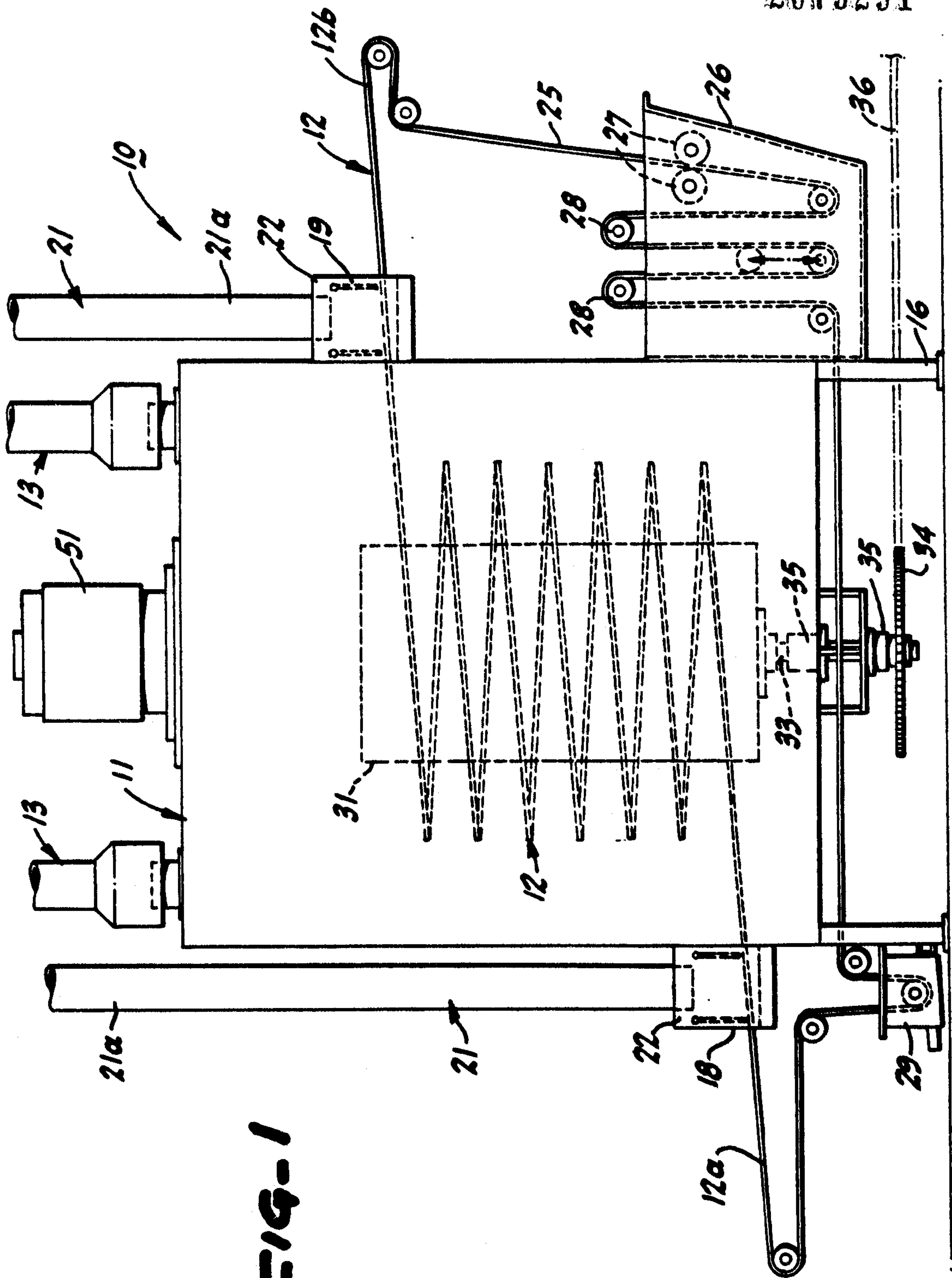
fan means arranged on the housing serving to circulate the process vapor into the plenums, through the nozzle means, across the conveyor and into the central axial zone of the conveyor;

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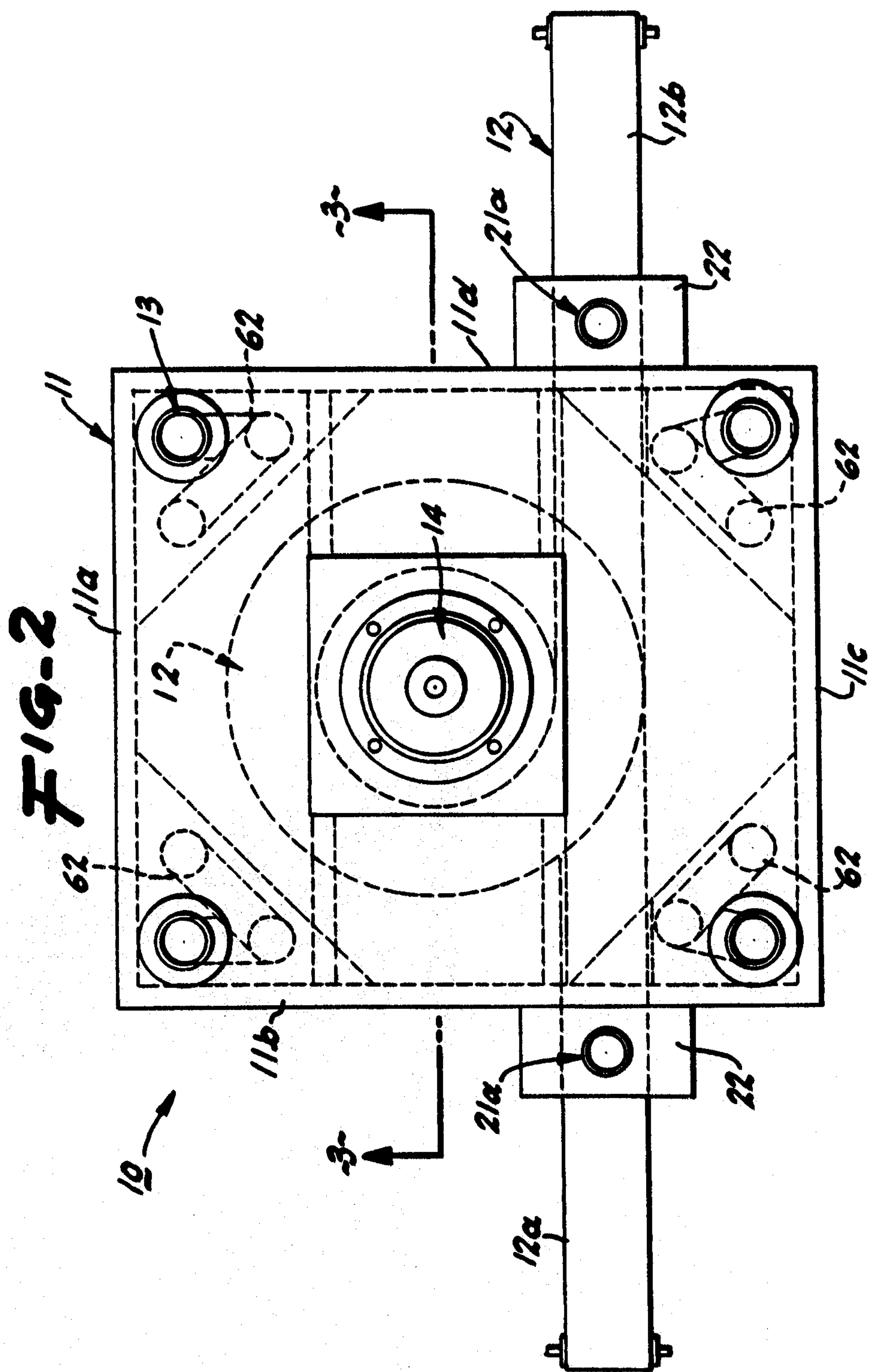
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heating means arranged in the plenums in the path of the process vapor circulated therethrough serving to reheat the process vapor.

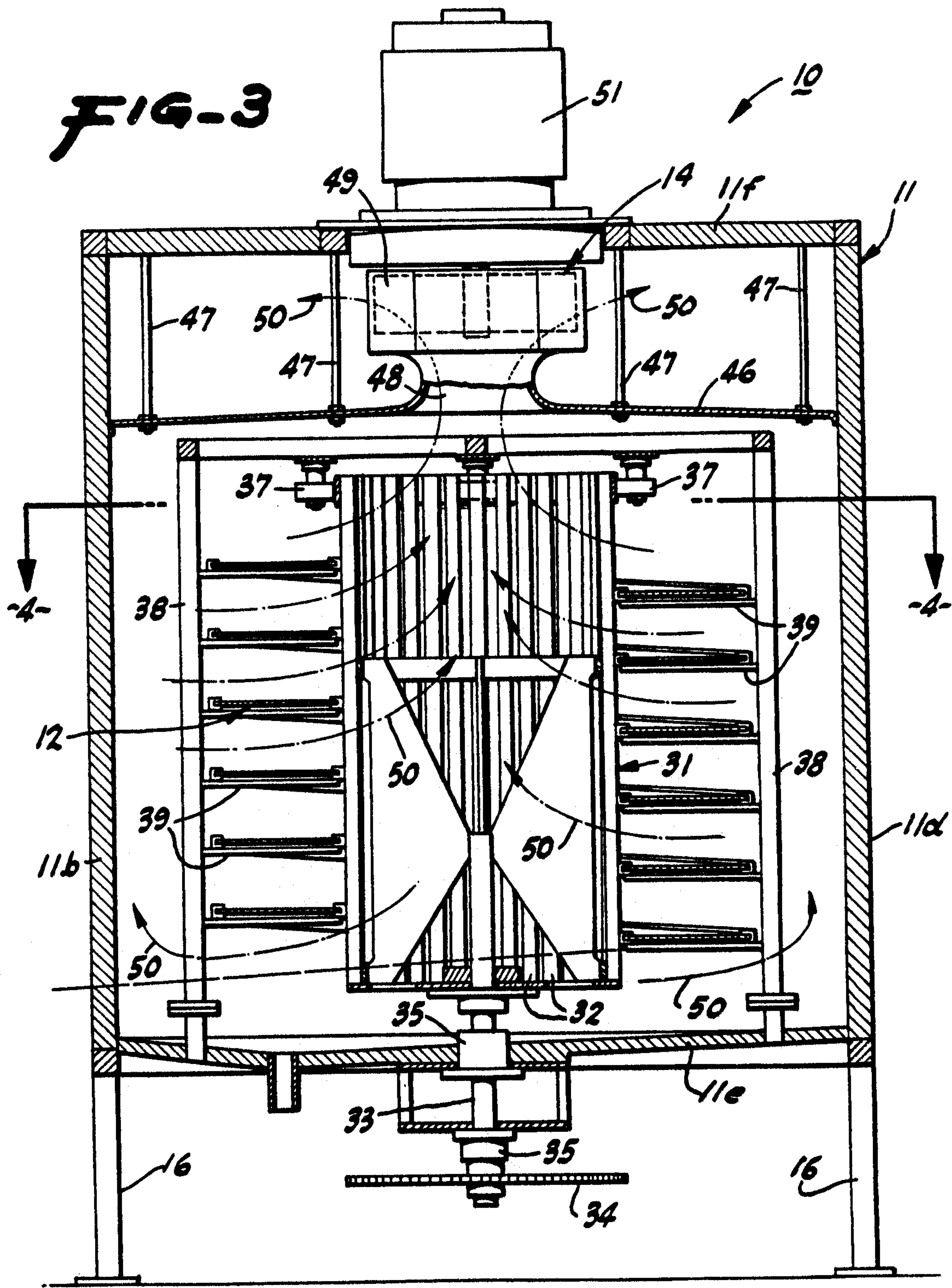
6. The oven according to claim 5 wherein the fan means
5 is arranged on the upper portion of the housing to discharge process vapor into the upper portions of the plenums at a substantial equal rate as among the plenums and the fan inlet is disposed to receive process vapor from the central axial zone of the spiral conveyor.
- 10 7. The oven of claim 6 wherein the fan means comprises a plurality of driven fan impellers mounted with the fan inlets disposed above the spiral conveyor serving to supply process vapor into the plenums.
8. The oven according to claim 6 wherein the conveyor
15 drive means includes a drive cage centrally disposed with respect to said spiral conveyor;
- drive shaft means extending from said drive cage through a lower portion of the oven; and
- motor means disposed outside the oven housing coupled
20 to the drive shaft operative to drive the spiral conveyor.



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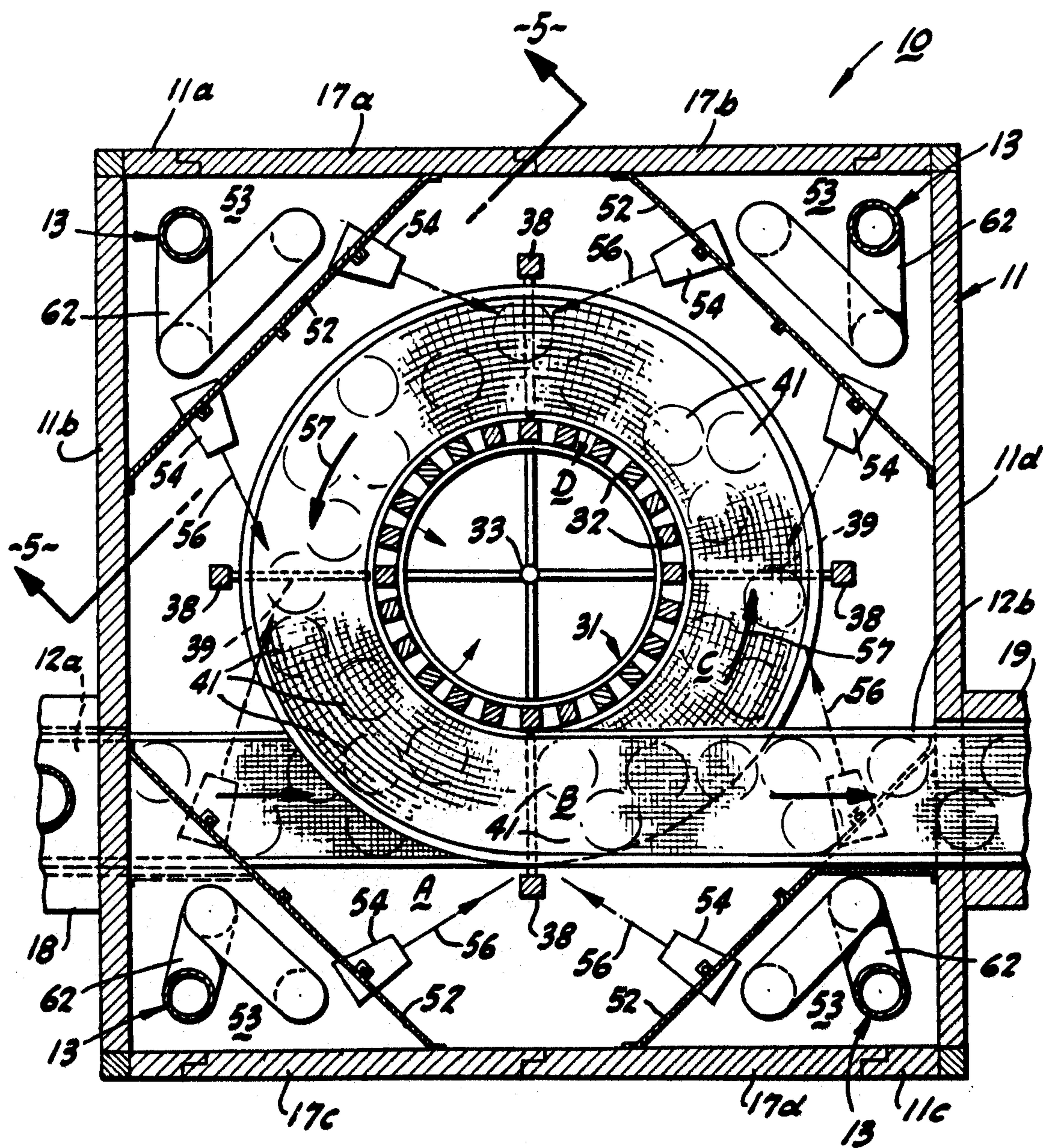


FIG-4

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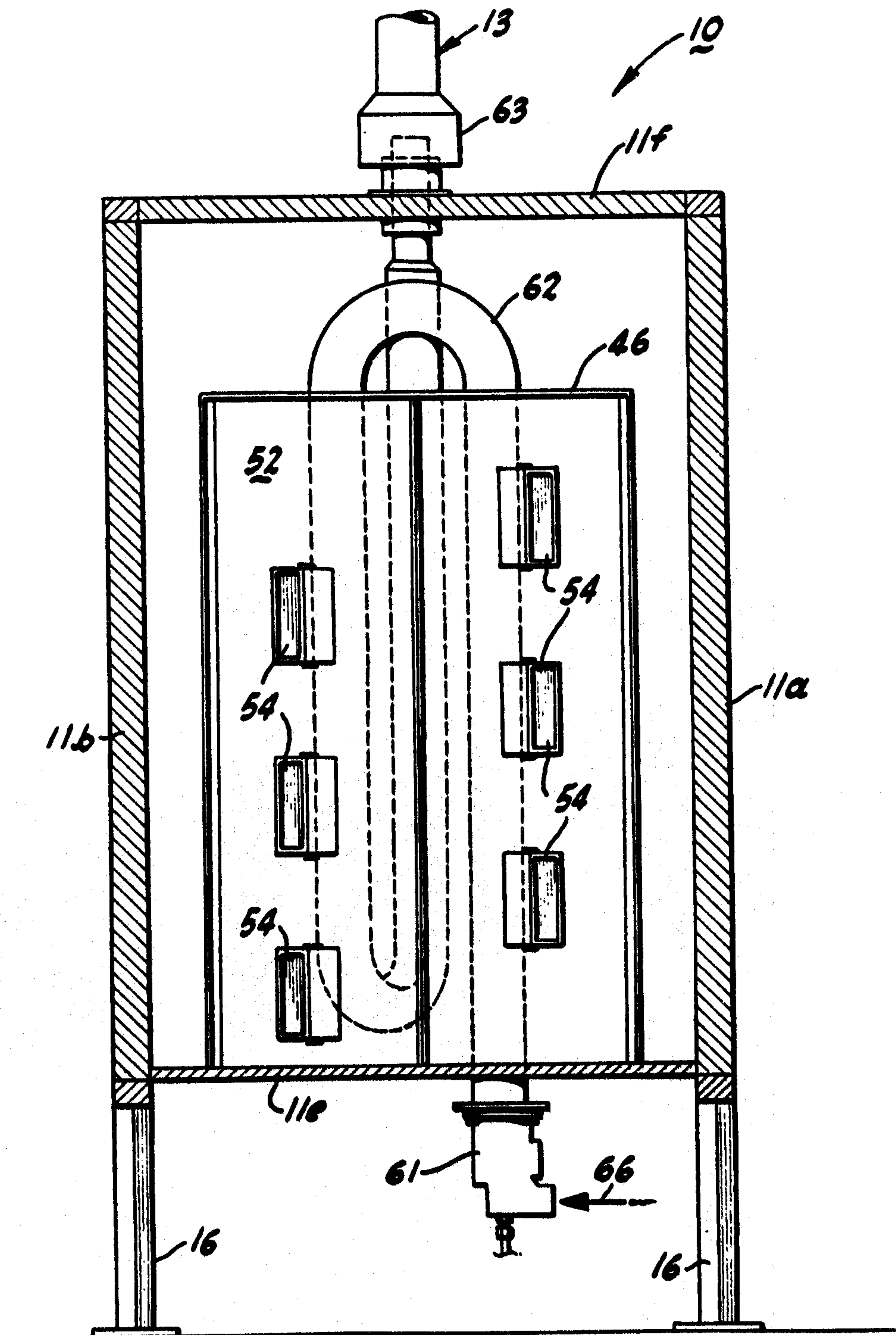


FIG-5

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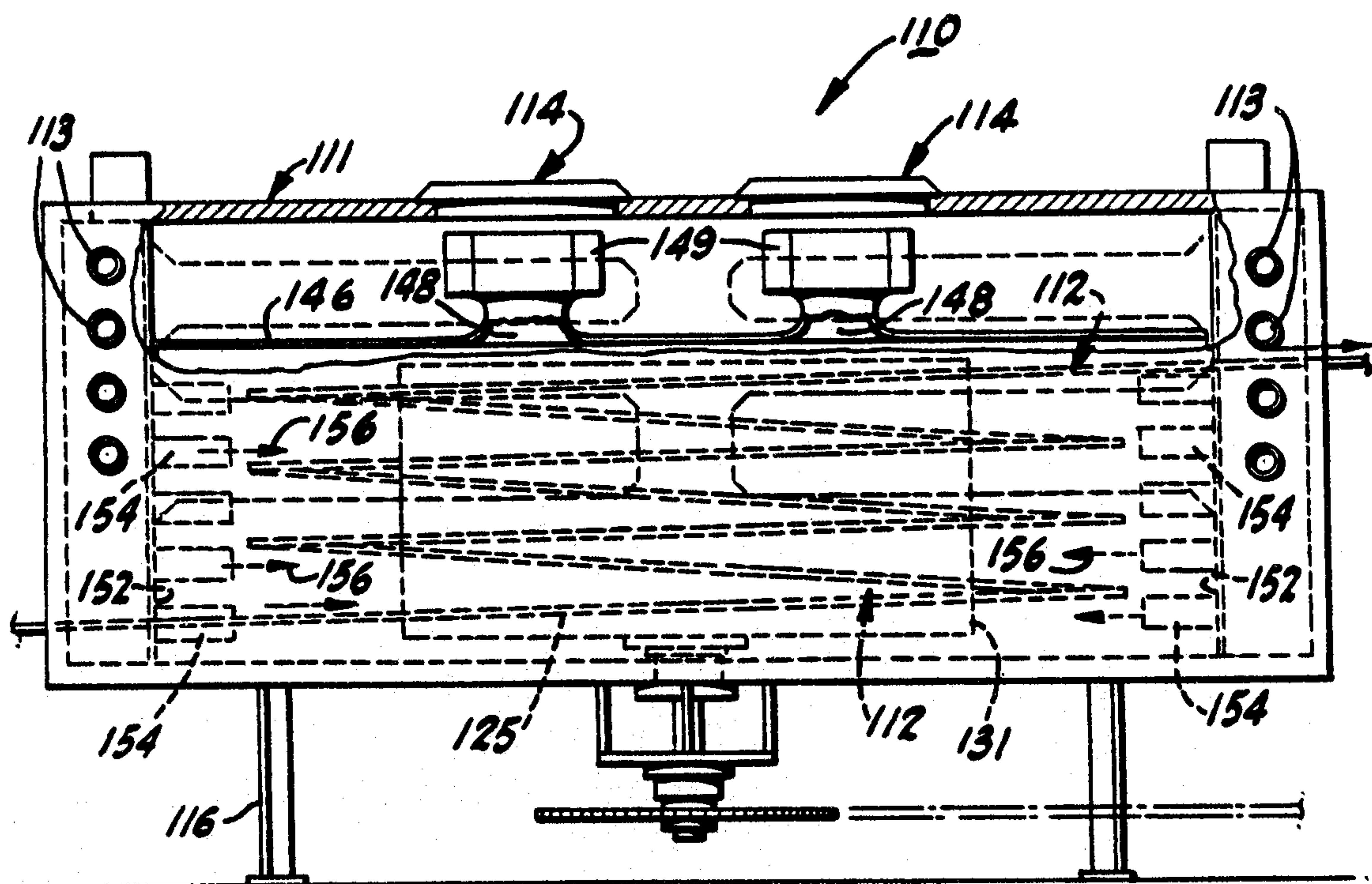


FIG-6

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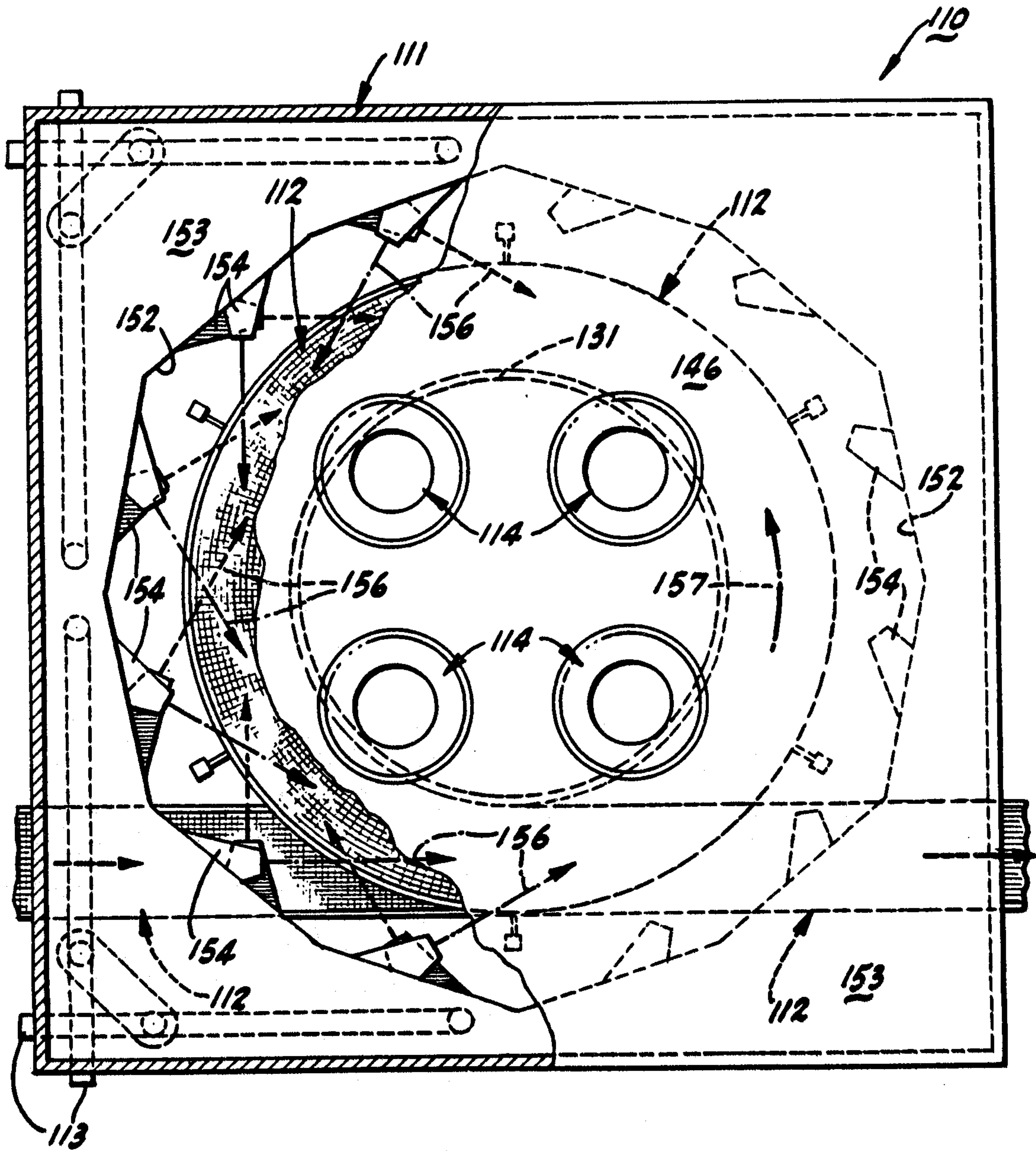


FIG-7

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