

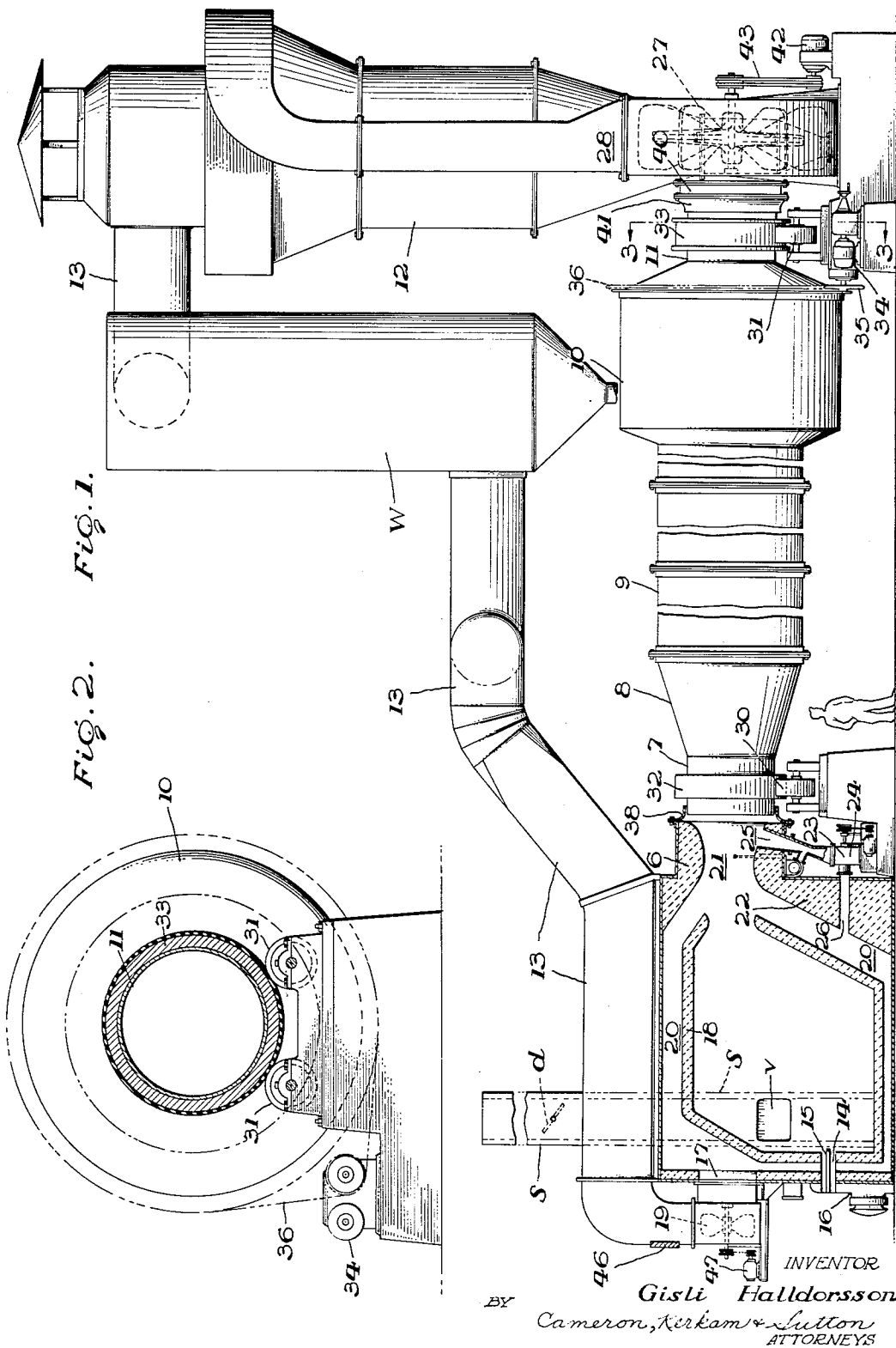
Aug. 16, 1955

G. HALLDORSSON  
ROTARY DRYERS

2,715,283

Filed March 20, 1953

4 Sheets-Sheet 1



**Aug. 16, 1955**

G. HALLDORSSON

**2,715,283**

## ROTARY DRYERS .

Filed March 20, 1953

4 Sheets-Sheet 2

Fig. 3.

FIG. 4.

INVENTOR

*Gisli Halldorsson*

*Cameron, Kerkam & Sutton*  
ATTORNEYS

ATTORNEYS

Aug. 16, 1955

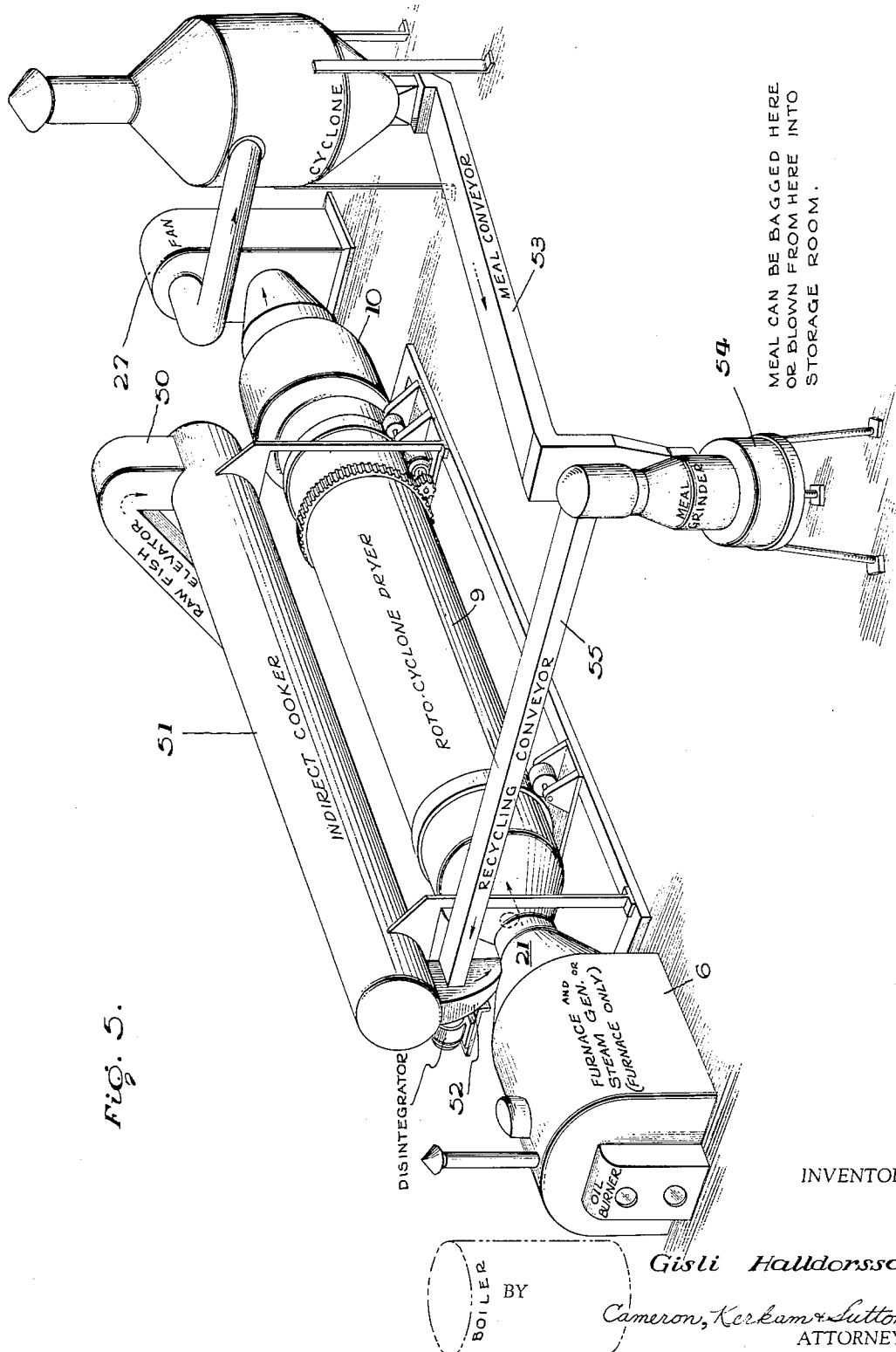
G. HALLDORSSON

2,715,283

ROTARY DRYERS

Filed March 20, 1953

4 Sheets-Sheet 3



Aug. 16, 1955

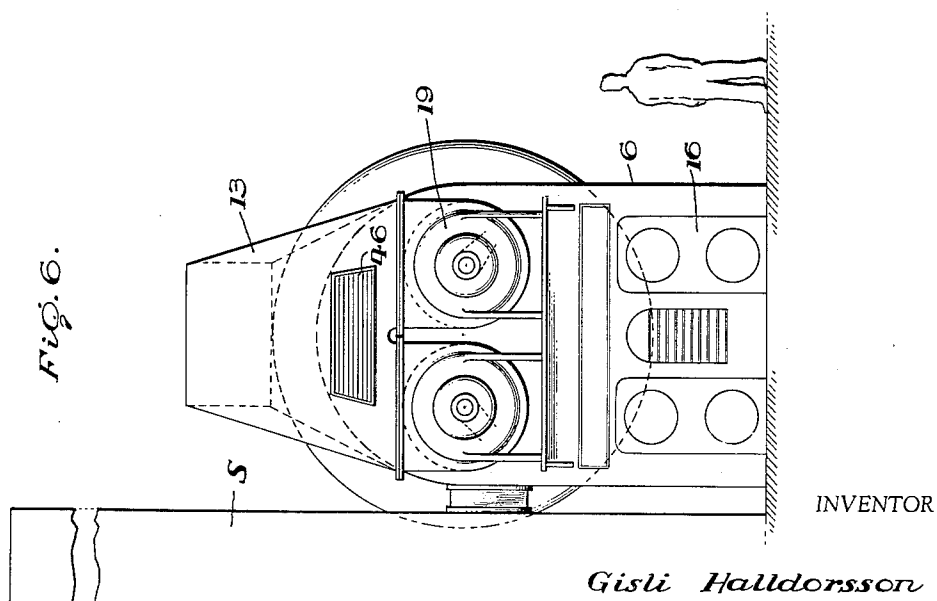
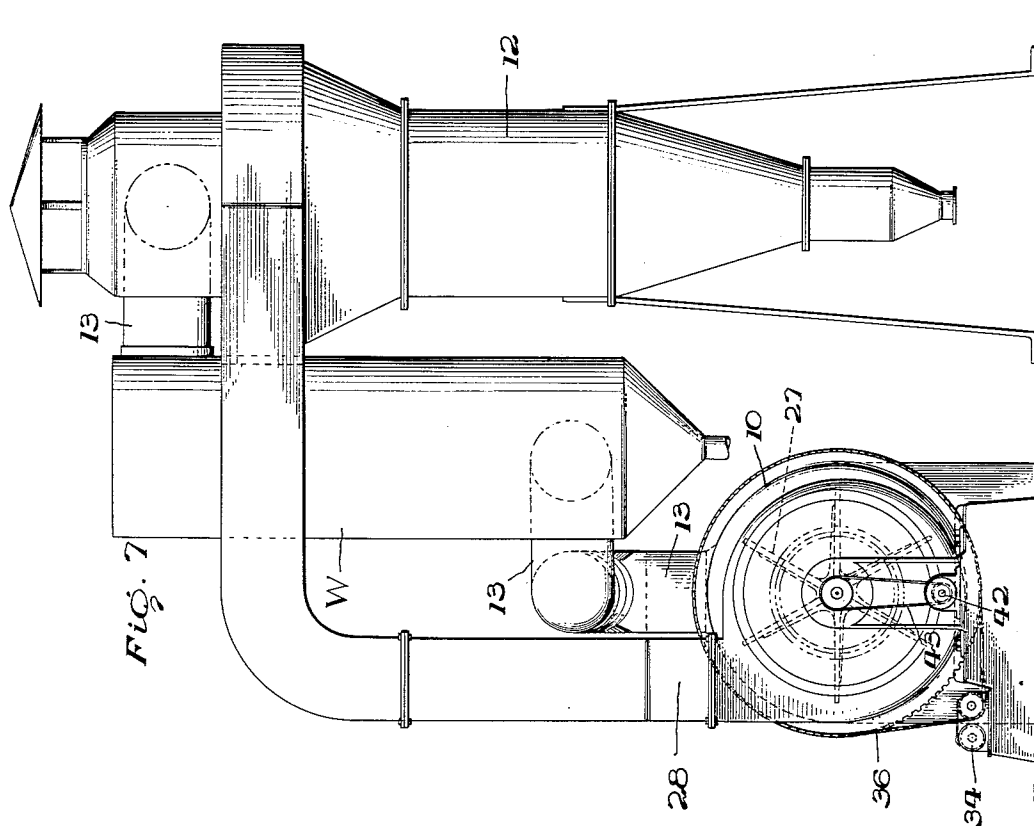
G. HALLDORSSON

2,715,283

ROTARY DRYERS

Filed March 20, 1953

4 Sheets-Sheet 4



BY

Cameron, Kerkam & Sutton  
ATTORNEYS

1

2,715,283

## ROTARY DRYERS

Gisli Halldorsson, Baltimore, Md., assignor to Edw. Renneburg & Sons Co., Baltimore, Md., a corporation of Delaware

Application March 20, 1953, Serial No. 343,539

5 Claims. (Cl. 34—79)

This invention pertains to improvements in rotary dryers for fish meal and analogous material in which the material is passed through the rotating dryer in contact with a stream of heated air in such manner that it is commercially dried at the outlet end of the dryer.

Dryers of this type generally comprise continuous elongate cylinders of constant diameter through which is forced a draft of heated air, the material to be dried being introduced at the inlet end of the rotating cylinder and carried therethrough in contact with the heated air draft. In constant diameter cylinders of this type the speed of the drying air is constant throughout the length of the cylinder except for variation of gas volume due to temperature and humidity changes. The temperature of the air stream gradually decreases from inlet to exhaust end, whereas the relative humidity increases. The velocity usually remains high and it is necessary to provide a drying cylinder of extreme length in order to assure a satisfactory drying time for the material during its comparatively rapid passage through the drying cylinder. The cost and space requirements of such elongate cylinders are high and the product resulting is frequently improperly dried and unsatisfactory. Further, scorching or burning of the material frequently occurs at the inlet end.

It is therefore a primary object of the present invention to provide an improved rotary dryer of varied diameters wherein the speed of the air stream and particles is controlled in the various sections of the dryer to provide a high velocity for the particles at the feed or inlet end of the dryer, a considerably lower velocity for the particles passing through the central portion thereof and a very much lower velocity toward the discharge end of the dryer, to assure a completely dried and unscorched product at the discharge end of the dryer, where the temperature is lowest and the material may remain for a prolonged period without being damaged from heat.

It is a further object of this invention to provide an improved dryer in which danger of burning or scorching of the particles at the hot feed end thereof is eliminated and a complete drying of the larger particles is accomplished.

It is a further object of this invention to evolve a rotary dryer of improved internal configuration and shorter length than conventional dryers of similar capacity.

It is another object of this invention to provide improved means for recirculating the drying air to the inlet end of the dryer, usually after washing and removal of moisture by condensation, for reuse in the drying operation.

It is a further object of this invention to provide means for deodorizing the recycled gases by passing a portion of the recycled gases through the hottest part of the furnace where they are incinerated and then discharging these incinerated gases through a stack to the atmosphere.

It is a further object of this invention to provide an improved, enlarged chamber at the discharge end of the dryer, wherein larger particles of material will be re-

2

tained and dried internally before final delivery to the collector.

It is another object of this invention to provide improved and easily removable conveyor flights with changeable pitch within the rotary dryer.

Other and further objects of this invention will become apparent as this specification proceeds.

Referring to the drawings, Fig. 1 is a perspective view, partially in section, taken from one side of the rotary dryer, showing the improved furnace and dryer structure and the drying air recirculating system;

Fig. 2 is a cross sectional view taken at the discharge end of the dryer on line 3—3 of Fig. 1;

Fig. 3 is a cross sectional view of the improved dryer, taken on its longitudinal axis, illustrating schematically the arrangement of the "flights" about the interior periphery of each section thereof;

Fig. 4 is cross-sectional view of the flights, showing the preferred shape of each;

Fig. 5 is a plan view of a special type of complete installation utilizing the improved rotary dryer;

Fig. 6 is a partial end view taken from the furnace end of the dryer and Fig. 7 is a partial end view taken from the discharge end of the dryer and showing the an, duct, collector and condenser and wash tower structure.

In the drawings, Fig. 1, 6 indicates the furnace or air heating chamber, 7 indicates the narrow entry neck of the rotary dryer, 8 indicates the outwardly expanded section of the dryer, 9 indicates the elongate, constant diameter section thereof, 10 indicates the enlarged retention and terminal drying section of the dryer, 11 indicates the narrowed exit neck of the dryer, 12 indicates the vortical flow meal collector and 13 indicates the air recirculating or recycling duct extending from the upper extremity of the flow meal collector to the condensing and wash tower W and thence to the recycling fans located at the face of the furnace structure. As there are novel aspects to each of the elements of the entire dryer structure each element will be considered in detail, from the furnace through the recycling and condensing and wash tower structure.

Referring to furnace 6, it is preferably of substantially rectangular cross-section and is appropriately lined with fire-brick or other heat-resistant material. Furnace 6 is provided at its outer face with a port 14 in which are disposed the burners or nozzles 15 of appropriate oil burner equipment 16 which is preferably disposed outwardly of the lower face of the furnace. Let into the outer furnace wall, above port 14, is an appropriate air duct or vent 17 through which recycled air from conduit 13 is delivered into the peripheral portion of furnace 6 outwardly of internal baffles 18 by recycling fan or fans 19 which are disposed adjacent the outer, upper wall of furnace 6 outwardly of vent 17 and at the extremity of recycle conduit 13. As shown, internal baffle 18 generally conforms to the internal configuration of furnace 6 in such fashion as to provide an outer passage 20 for recycled air, leading to the neck 21 thereof. A portion of the recycled air and gases, will be led into duct 14, adjacent burners 15, and thence into the main combustion chamber of the furnace where these gases are incinerated at the hottest point in the furnace. An outlet vent v is provided in the furnace wall adjacent this incinerating area for discharging these incinerated and deodorized gases into a stack S, through which the incinerated and deodorized gases pass to the atmosphere. Stack S, as shown, is provided adjacent its upper extremity with a damper d, which may be adjusted to open or close stack S to the atmosphere.

Fire bridge 22 is provided extending upwardly at an obtuse angle at the interior end of furnace 6 to provide

a shield for the material to be treated and to prevent burning or scorching thereof in neck 21.

The feed mechanism for the fish meal or other material to be treated is shown at 23 and broadly comprises a motor driven screw feed and disintegrator 24 which directs the material into an attenuated angular passage 25 whence it is delivered into neck 21 of furnace 6 for its initial drying and transmission into the restricted neck portion 7 of the rotary dryer structure. Air passage 26 is shown communicating between passage 20 and feeder 24. Comparatively high velocity air passes through passage 26 and assists in blowing the disintegrated material through passage 25 into neck 21. A conventional overfeed arrangement extending into the dryer throat may be used.

Extremely high temperatures, i. e. on the order of 3000 to 3500° F., are generated in a limited space in front of the burner 15 in the combustion chamber of furnace 6 where incineration of part of the recycled gases takes place and whence incinerated and deodorized gases pass up the stack S. It is an important object of this invention to eliminate scorching or burning of the material in the neck 21 of furnace 6 and in constricted neck portion 7 of the dryer, where operating temperatures are much lower.

The functioning of the furnace structure will be discussed at more length later in this specification.

Furnace 6 provides the necessary heat for heating the drying air before its passage through the rotary dryer. It also acts to incinerate a portion of the recycled gases, as will be discussed further. The drying air is pulled through the rotary dryer by means of a centrifugal fan 27 rotatably mounted at the discharge end of the dryer adjacent the restricted exit neck 11 thereof in the base of vertical duct 28 which directs the heated air stream and entrained material to the upper extremity of vortical flow meal collector 12, as will be discussed in more detail.

Referring to the rotary dryer structure per se, it will be noted that the rotary dryer comprises broadly a narrow entering neck 7, which is preferably of cylindrical shape and of relatively small diameter, an outwardly enlarging conical section 8, an elongate medial portion 9 of constant diameter, extending into an enlarged retention cylindrical drying chamber 10 of comparatively short length, a short conical section and a small diameter cylindrical exit neck 11. In cases where it is not desirable to remove the material by air, the retention chamber 10 may serve as the extreme outlet end of the dryer, opening into a backbox and discharging the material directly into a screw conveyor by gravity.

The rotary dryer is preferably rotatably mounted on pairs of rollers 30 at its inlet end and on rollers 31 at its exhaust end. Running bands or tires 32 and 33 are provided about the terminal extremities 7 and 11, respectively, of the rotary dryer and provide bearing surfaces for rotation thereof on paired rollers 30 and 31.

Rotative force is applied to the dryer by means of an appropriate motor and reducer 34, driving a sprocket 35 which registers with a chain drive 36 provided about the outer periphery of retention section 10 of the dryer. The drive may be of the gear type or of the friction type, if desired, using heat resistant rubber as the driving surface for the rollers, where low surface temperatures of the running bands may make this feasible.

An appropriate conical seal 38 is provided about the entry end of neck 7 of the dryer and is affixed about the outer periphery of neck 21 of furnace 6. Entry neck 7 is of restricted diameter to provide high initial velocity to the highly heated air and entrained material at the entry end of the rotary dryer. From entry neck 7 the shell of the dryer is gradually widened in conical section 3 to gradually increase the diameter of the dryer and to decrease the speed of the hot air and material, prior to its entry into elongate cylindrical section 9 of the dryer.

Enlarged retention chamber 10 is provided at the terminal extremity of the dryer. As a result of its enlarged diameter air entering retention chamber 10 from section 9 drops considerably in velocity whereby section 10 acts as a "trap" or holding station for large, internally moist particles of the material. The particles trapped within section 10 are maintained in this section of the dryer until they are sufficiently internally dried, at which time their weight is reduced to a point where they are light enough to be carried off by the air stream into attenuated neck portion 11 at the terminal end of the dryer, wherein air velocity rapidly increases. This high velocity air draws the enlarged dry particles upwardly into duct 28 for delivery into the upper section of vortical flow meal collector 12.

The interior of each of the sections of the rotary dryer is preferably provided with "flights" 37 peripherally disposed about their interiors, as shown in Fig. 3. This arrangement of the "flights," as shown in Fig. 3, is designed to provide a heavy showering of the material in the initial end of the dryer where the "flights" are higher than in the medial and terminal portions thereof. In the latter portion of the dryer care must be taken to shower the material more thinly to prevent its being blown away too rapidly and to insure its retention within the dryer for the required length of time to insure satisfactory drying.

The flights 37, as shown, are preferably spaced equidistant from each other about the inner peripheries of the various sections of the dryer, as shown in Fig. 3. In section 1a of the dryer, spiral cast iron flights, preferably of greater height than the balance of the flights, are provided, to produce a heavy showering of the material in this section.

A cross-sectional view of the various individual flights is shown in Fig. 4 of the drawings. This view illustrates the respective angularities of each of flights A, B and C. It will thus be seen that flight A comprises an elongate flight with its extremity inclined at an acute angle to its rectilinear section, flight B comprises a short rectilinear flight, lacking the angular extremity of flight A, and flight C comprises a flight similar to flight A, but with its extremity inclined at a right angle to its rectilinear portion.

Referring to Fig. 3, section 2a of the dryer is preferably provided with flights A, B and C of less height than the spiral flights in section 1a, i. e. where, for example, the height of the spiral flights in section 1a is 8", the height of the rectilinear portions of flights A, B and C in section 2a will be 6". The order of the flights in section 2a is preferably A—B—A—C—A—B—A—C.

In section 3a of the dryer, the height of the flights is preferably one half the height of the flights in section 2a, i. e. 3", and the order of the flights is: B—C—B—A—B—C.

In section 4a flights of the same height as in section 3a are utilized, the order being preferably A—B—A—C—A.

Section 5a carries flights of the same height as section 4a, preferably arranged B—C—B—A—B.

Section 6a carries flights of the same height as section 5a, preferably arranged A—B—A—C—A.

Sections 7a—12a, inclusive, also carry flights of the same height as in section 6a, preferably arranged B—A—B—C—B—A.

Each flight section is preferably offset 3" with respect to the preceding section, as shown, and the flight profiles are matched to insure even showering of the material.

The arrangement of the flights as shown in Fig. 4 provides for a heavy showering of material in sections 1a and 2a, where the flights are higher, and a lighter showering thereof in sections 3a—12a, inclusive, to insure that the material not be blown away too quickly, but be retained within these latter sections for a time sufficient to insure proper drying therein.

Each flight is preferably bolted in each section by two bolts, directly to the dryer shell, to permit easy

removal and change of the flights depending upon conditions. Each flight may be supplied with a third or extra bolt hole, as shown, to permit arrangement in spiral, where desired.

The normal position of the flights in sections 2a-12a, inclusive, as shown, is parallel to the longitudinal axis of the dryer. This arrangement may be varied as required by local conditions and depending upon the speed with which it is desired to pass the material. To increase retention time, some or all of the flights in any of the sections may be removed.

The heights of the flights given is by way of illustration only and may be varied as required, depending upon conditions. The respective heights of the flights should, however, be maintained.

As shown in Figs. 1 and 6, the base of duct 28 is appropriately enlarged to contain centrifugal fan 27. Fan 27 is preferably of the material handling industrial type and is aligned with cylindrical extension 40 at the lower extremity of duct 28. The outer periphery of extension 40 extends into conical section 41 affixed about the outer periphery of terminal section 11 of the dryer. Fan 27 is preferably sealed and maintains the furnace under a negative pressure whereby air will be pulled into the furnace through all openings connecting it with the atmosphere at furnace level. This fan must overcome the resistance in the furnace and dryer on the suction side to provide the air and gases with sufficient velocity to discharge them through the dryer. Fan 27 is preferably driven from a motor 42 through a suitable belt drive 43. For a dryer of the size here described, this motor is preferably of approximately 75 horsepower and the fan should handle up to approximately 75,000 C. F. M. of air at 200° F. and must be able to operate under from 300 to 400° F. temperature.

Referring back to the rotary dryer, as has been previously stated the "flights" in each cross section of the dryer should be arranged to "shower" the material in each cross section as evenly as possible. There are several types of flight profile in each section of the dryer. The flights should be so arranged in each section as to keep the material evenly distributed, over each section, leaving no passage through which the drying air may short circuit. The flights are generally arranged to serve this purpose of equal distribution of the material in each section. They are arranged so that the material will not "shower" until it nears the upper section of the dryer. The flights in some sections may be inclined axially to throw the material rearwardly, depending upon the speed at which it is desired to pass the material through that section.

The normal speed of rotation of the dryer is from 3-8 R. P. M., which speed may be varied depending upon the nature of the material being treated and the specific drying problem involved.

The drive for the dryer may be by means of a band gear driven by a pinion on the motor reducer 34, or it may be by sprocket gear and chain drive from the motor reducer or by a friction drive using heat resistant rubber or neoprene rubber as surfaces for the driving rollers.

As has been stated previously, the air velocity in the dryer is at its lowest in the enlarged retention chamber 10 thereof in which large, partially moist particles are trapped and circulated for a considerable period of time until they are properly dried internally, at which time their weight is sufficiently reduced to allow them to be pulled out of section 10 by the comparatively high velocity air in restricted neck section 11 of the dryer. From neck section 11 they pass up through duct 28 into the top section of vortical collector 12. The properly dried material falls by gravity into the lower section of collector 12 and is appropriately sacked or blown to the storage room therefrom.

The temperatures in the dryer decrease rather rapidly from their highest point at throat 21 of the furnace where the air enters narrow neck 7 of the dryer at tem-

peratures on the order of 600° F. The flash evaporation of free surface moisture drops the temperatures to approximately 400° F. in conical section 8 of the dryer and the air temperature is further reduced in cylindrical section 9 thereof to approximately 250 to 300° F. at the inlet to enlarged retention section 10 thereof. In retention section 10, the air temperature drops further to 200 to 150° F., the temperature of the material therein being somewhat lower.

The air velocities in the dryer vary. The conveying velocity in dryer throat 7 is approximately 2400 F. P. M., which drops to 1500 F. P. M. in conical section 8 and to about 1300 F. P. M. in elongate cylindrical section 9. It is about 1200 F. P. M. at the end of section 9, where it enters "Roto Cyclone" section 10. The air velocity in section 10, which has almost twice the cross-sectional area of cylindrical section 9, drops to less than half of the velocity in sections 8 and 9 to about 500 to 700 F. P. M., resulting in retention in enlarged section 10 of large, partially dried particles of the material. These large particles remain in section 10 until sufficiently dry and light to be carried off through neck 11 of the dryer, where velocities again rise to approximately 2400 F. P. M.

Normally, the drying air is recycled, as shown in Fig. 1, recycle duct 13 being provided communicating between the upper extremity of vortical flow meal collector 12, condensing and wash tower W and recycling fans 19, at the face of the furnace.

Condensing and wash tower W has a dual function in recycling duct 13. It is provided about its interior with water sprays through which the recycled air is passed and which dissolve water soluble gases and impurities in the recycled air. Further, the sprays condense the moisture contained in the recycled air and this moisture runs down the walls of the tower and is entrapped in a water trap at the base of the tower. Thus, the recycled gases are both dried and partially purified in the condensing and wash tower and are conditioned for repassage through the furnace and dryer.

Duct 13 is provided at its lower, outer extremity with a damper or vent 46 which may be opened, as desired, to regulate the amount of atmospheric air pulled into the furnace chamber by recycling fans 19. This fresh air can also be admitted through feed 24 and passage 25. Recycling fans 19 may be of the axial-flow or of the centrifugal type and are driven from a motor 47 provided for that purpose. Fans 19 draw the heated air through duct 13 and condensing and wash tower W, assisting fan 27 in its action of exhausting or "pulling" the air through the furnace and dryer and discharging it through the collector.

Referring to Fig. 5 of the drawing, one special embodiment of a complete installation utilizing the improved dryer structure of the present invention is illustrated. In this installation for non-oily raw fish, where no press is used, the raw fish is first elevated into the indirect cooking chamber by an elevator 50. After cooking in cooker 51 the cooked fish is delivered to a disintegrator 52 whence it is delivered to throat 21 of furnace 6, whence it is delivered into the rotary dryer structure. The heated air and entrained material are pulled through the rotary dryer by means of the fan 27 and thence into the cyclone collector. From the collector the dried material is delivered by meal conveyor 53 to grinder 54 where the bulk of it is bagged or blown into the storage room. A recycling conveyor 55 is provided to recycle part of the meal back to the disintegrator 52 where it is used to condition the wet material by making it more suitable for drying. This is merely one illustration of a complete installation designed to utilize the improved rotary dryer. In this particular type of installation meal recovery is increased 20 to 25% over that in conventional installations using presses. Many other modified installations have been developed utilizing the improved rotary dryer.

The feed mechanism for the dryer may be varied in many respects depending upon the nature of the material being dried and the problem involved. A screw conveyor may be utilized, combined with a disintegrating mill to refine the particles before entering the dryer throat. The material may be fed to the dryer by an underfeed or an overfeed screw and introduced by paddles into the dryer throat, where the air stream of highly heated air will carry it into the dryer. As an alternative, a combined disintegrator-blower may be utilized, or a steam-heated, hollow screw conveyor under pressure may be used to blow the material into the dryer throat. The release in pressure in an installation of this type assists in exploding the material from within and shortens the drying time.

The dimensions of the various sections of the rotary dryer may be varied within a wide range depending upon the nature of the product to be dried, the volume to be handled and upon various other factors. The diameters of the various sections of the dryer are selected in accordance with the air volumes which have to pass through each section to carry heat and moisture and by the air velocity required in the particular section. This air volume is a function of the air weight and temperature and also of the moisture content. The maximum desirable material speed through each section is also not constant but varies with moisture content and temperature. Further, the axial movement of the material, which gradually becomes lighter as it is dried, is a variable function of the air velocity and also of the rotation of the dryer. These constants can be varied in the field to suit conditions.

The dimensions of the dryer illustrated in the drawings are preferably as follows: Neck 7, 7' diameter $\times$ 42" length; conical section 8, 7-9' in diameter $\times$ 48" length; cylindrical section 9, 9' diameter $\times$ 28' length; conical section between sections 9 and 10, 9-12' diameter $\times$ 18" length; enlarged retention section 10, 12' diameter $\times$ 17' length; tapered section between retention section 10 and restricted section 11, 12-7' diameter $\times$ 18" length; neck section 11, 71" diameter $\times$ 54" length. These dimensions are by way of illustration only and may be varied as desired providing the proportionate sizes are maintained.

The furnace unit used with a dryer of these dimensions would be on the order of 24 feet $\times$ 18 feet $\times$ 12 feet with a volume of about 1800 cubic feet and a maximum capacity of 60,000,000 B. t. u. per hour. A furnace of this capacity would handle press cake from 60 to 80 tons of raw fish per hour when using normal high temperature drying of from 1200 to 600° F., depending upon the moisture in the press cake. For low temperature drying of from 600° to 200° F. only about half of this capacity would be utilized and the unit would handle twenty-five to thirty tons per hour.

Dryer neck 7 is preferably 7 feet in diameter and 42" in length. Discharge neck 11 at the delivery end of the dryer is preferably 71" in diameter and 54" in length. These two extremities of the rotary dryer are the high velocity sections thereof, the high velocity being required in throat 7 to prevent scorching or burning of the meal therein. The high velocity at terminal section 11 of the dryer is necessary in order to pull particles of meal from enlarged section 10 of the dryer and force the entrained particles upwardly through conduit 28 into the vortical flow collector 12.

The overall operation of the improved dryer is as follows: the fish meal or press cake in disintegrated condition is delivered of the high velocity, high temperature throat 21 of the furnace structure by means of an appropriate screw feed and air blast 23 whence it is blown by the high velocity stream of heated air into the narrow neck section 7 of the dryer. Velocity of the air stream is high in neck section 7 to pull the material rapidly therethrough and prevent scorching or burning of the meal at this high temperature point in the dryer. Tem-

peratures at this point in the throat of the dryer attain 600° F. If the material were maintained for an appreciable time in the throat 7 at these temperatures it would tend to be scorched or burnt. From section 7 the partially dried material is delivered into conical or enlarging section 8, where air velocity decreases and further drying takes place. From section 8 the material passes into cylindrical or quick drying section 9 where it is subjected to a reduced air velocity and temperature, drying of small particles being substantially completed and internal drying of the larger particles being initiated. From elongated cylindrical section 9 the particles are carried into enlarged retention section 10 of a cross-sectional area substantially twice as large as that of section 9. In enlarged section 10 the larger particles are "trapped" and are maintained under rotation and agitation, subject to comparatively low temperature and velocity drying air, until they are completely internally dried and are light enough to be carried out of section 10 by the high velocity air passing through restricted terminal section 11 at the discharge end of the rotary dryer. After passing through restricted section 11 the large and small particles are forced upwardly through duct 28 into the upper section of vortical flow collector 12 where they are collected for bagging or for blowing into the storage room. As shown in Fig. 1, the drying air may be recycled from the upper extremity of vortical collector 12 back to the recycling fans 19 by means of recycling duct 13, through condensing and wash tower W. This recycling of the drying air is especially necessary where conditions require scrubbing and incineration of gases passing to the atmosphere to eliminate objectionable odors and fumes. On each run the drying air will pick up moisture from the material and discharge it in the condensing and wash tower. A portion of the oxygen of the air will be consumed by combustion and a corresponding amount of atmospheric air required for combustion must be introduced for each drying cycle. A corresponding amount of incinerated gases thus must be discharged from the system for each cycle. Therefore, a large quantity of air may act as drying medium for carrying water vapor at low temperatures, recycling again and again, and only a small portion thereof is discharged to the atmosphere. Recycling maintains the heat of the recycled air to a certain extent, even when the recycled air is washed, and thus is a considerable factor for fuel saving. Recycle ducts 46 may be adjusted automatically by thermostats and humidistats to control the amount of atmospheric air introduced into the system adjacent recycling fans 19.

A portion of the recirculated air which would normally be dispelled to the atmosphere is introduced into the combustion compartment of the furnace adjacent the burners whereby the gases immediately reach a very high temperature and are thus incinerated. The fresh air is introduced peripherally about the combustion chamber of the furnace or at the furnace throat in such fashion that it passes through the normal drying cycle before taking part in the combustion. The incinerated air is conveyed through a vent *v* to the stack S and dispersed to the atmosphere.

The essence of the present invention lies in the novel, varied diameter construction of the rotary dryer, in the novel, adjustable flight arrangements therein and in utilizing one furnace for heating the air and incinerating waste gases, instead of two, as is now customary. By utilizing a rotary dryer constructed in conformity with this disclosure it is possible to obtain an improved drying of fish meal and other materials at lower temperatures and with less space requirements than was possible with previous equipment. By utilizing the novel dryer structure disclosed loss due to scorching and burning of the meal particles is eliminated and a highly improved product results. Further, due to the enlarged retention chamber and the other novel features of the dryer, one of these dryers will

handle the capacities of several conventional units, resulting in lower capital investment and operating costs.

The invention is subject to numerous modifications without departing from the spirit thereof. The dryer may be utilized in many different types of installations to great advantage, the essence of this invention lying in the improved configuration of the rotary dryer structure itself.

Attention is directed to the appended claims for a limitation of the scope of the invention.

What is claimed is:

1. In a rotary dryer, a furnace, a fan disposed at the face of said furnace for introducing air therethrough, a rotary dryer horizontally mounted adjacent the neck of said furnace and comprising a restricted cylindrical section, an enlarged outwardly diverging conical section adjacent said restricted cylindrical section, an extended cylindrical section adjacent said conical section, an enlarged cylindrical retention section adjacent said extended cylindrical section, a converging conical section at the terminal end of said enlarged cylindrical section, said sections being arranged end to end along a common axis, fan means adjacent said neck disposed in the lower extremity of a vertically extending duct, a vertical collector disposed adjacent said duct and receiving the upper extremity thereof and a recycle duct for heated air communicating between the upper extremity of said collector and said recycle fan means at said furnace.

2. A rotary dryer for fish meal and analogous material comprising a furnace, a rotary dryer rotatably mounted adjacent the mouth of said furnace and communicating therewith, comprising a restricted cylindrical neck section, an outwardly widened section communicating with said neck section, an elongated cylindrical section of constant diameter adjacent said outwardly widened section, a retention section of greatly enlarged diameter and short length adjacent said elongated cylindrical section and reducing into a narrow cylindrical neck at the terminal end of the dryer, said sections being arranged end to end along a common axis, an upright duct adjacent the end of said dryer and communicating therewith, a fan rotatably mounted in the lower extremity of said duct adjacent the end of said dryer, a collector stack vertically disposed adjacent said duct and communicating therewith at its upper extremity, a recycle duct extending from the top of said collector to the face of said furnace, fans rotatably mounted in the extremity of said recycle duct adjacent said furnace and communicating therewith to pull air through said duct and into said furnace, an air vent in said recycle duct, whereby material delivered into the neck of said furnace will be blown through said rotary cylinder in stages and delivered into said collector in a completely dry condition.

3. A rotary dryer comprising a restricted cylindrical neck section, an outwardly enlarged conical section adjacent said neck section, an elongated section of constant diameter adjacent said conical section, a retention section of greatly enlarged diameter and comparatively short length adjacent said elongated section and a terminal sec-

tion of greatly reduced diameter adjacent said retention section said sections being arranged end to end along a common axis whereby the velocity of material laden air drawn through said dryer will vary in an inverse ratio to the various diameters of the sections of the dryer.

4. In an improved rotary dryer, a furnace, fans disposed at the face of said furnace for forcing air therethrough, a rotary dryer horizontally mounted adjacent the neck of said furnace and comprising a restricted cylindrical section, an enlarged outwardly diverging conical section adjacent said restricted cylindrical section, an extended cylindrical section adjacent said conical section, an enlarged cylindrical retention section adjacent said extended cylindrical section, a narrow restricted neck at the terminal end of said enlarged cylindrical section, a series of staggered conveyor flights of gradually decreasing height peripherally arranged in each of said sections, fan means adjacent said neck disposed in the lower extremity of a vertically extending duct, a vertical collector disposed adjacent said duct and receiving the upper extremity thereof and a recycle duct for heated air communicating between the upper extremity of said collector and said recycle fan means at said furnace.

5. In an improved rotary dryer, a furnace, fans disposed at the face of said furnace for forcing air therethrough, a rotary dryer horizontally mounted adjacent the neck of said furnace and comprising a restricted cylindrical section, an enlarged outwardly diverging conical section adjacent said restricted cylindrical section, an extended cylindrical section adjacent said conical section, an enlarged cylindrical retention section adjacent said extended cylindrical section, a narrow restricted neck at the terminal end of said enlarged cylindrical section, a series of graduated and staggered flights of decreasing height affixed within each of said sections, fan means adjacent said neck disposed in the lower extremity of a vertically extending duct, a vertical collector disposed adjacent said duct and receiving the upper extremity thereof and a recycle duct for heated air communicating between the upper extremity of said collector and said recycle fan means at said furnace.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |                  |               |
|-----------|------------------|---------------|
| 1,981,235 | Vogel-Jorgensen  | Nov. 20, 1934 |
| 1,988,677 | Arnold           | Jan. 22, 1935 |
| 2,096,049 | Lissauer         | Oct. 19, 1937 |
| 2,132,972 | Schmidt          | Oct. 11, 1938 |
| 2,143,505 | Arnold           | Jan. 10, 1939 |
| 2,341,101 | Howard           | Feb. 8, 1944  |
| 2,388,902 | Callaghan et al. | Nov. 13, 1945 |
| 2,461,134 | Arnold           | Feb. 8, 1949  |
| 2,504,156 | Ronne            | Apr. 18, 1950 |
| 2,506,739 | Raypholtz        | May 9, 1950   |
| 2,609,186 | Anderson         | Sept. 2, 1952 |
| 2,618,865 | Arnold           | Nov. 25, 1952 |