

Jan. 27, 1959

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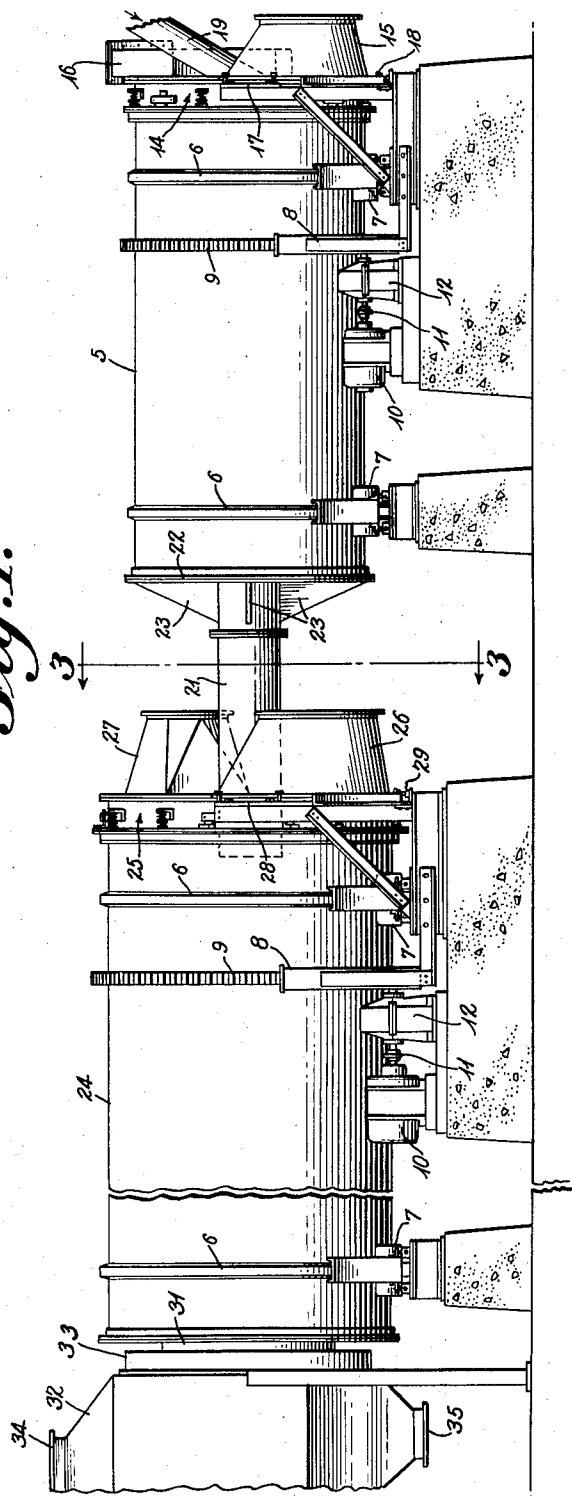
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ROTARY DRYERS AND/OR COOLERS

Filed July 18, 1956

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Fig. 1.



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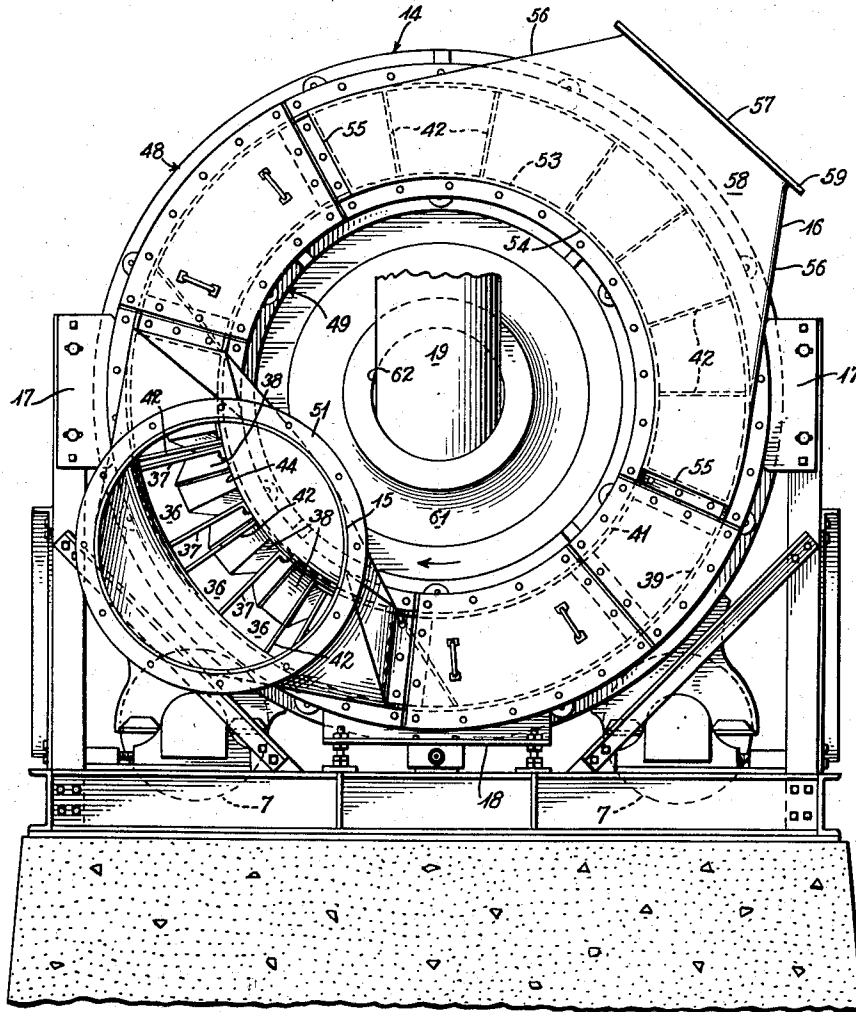
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Fig. 2.



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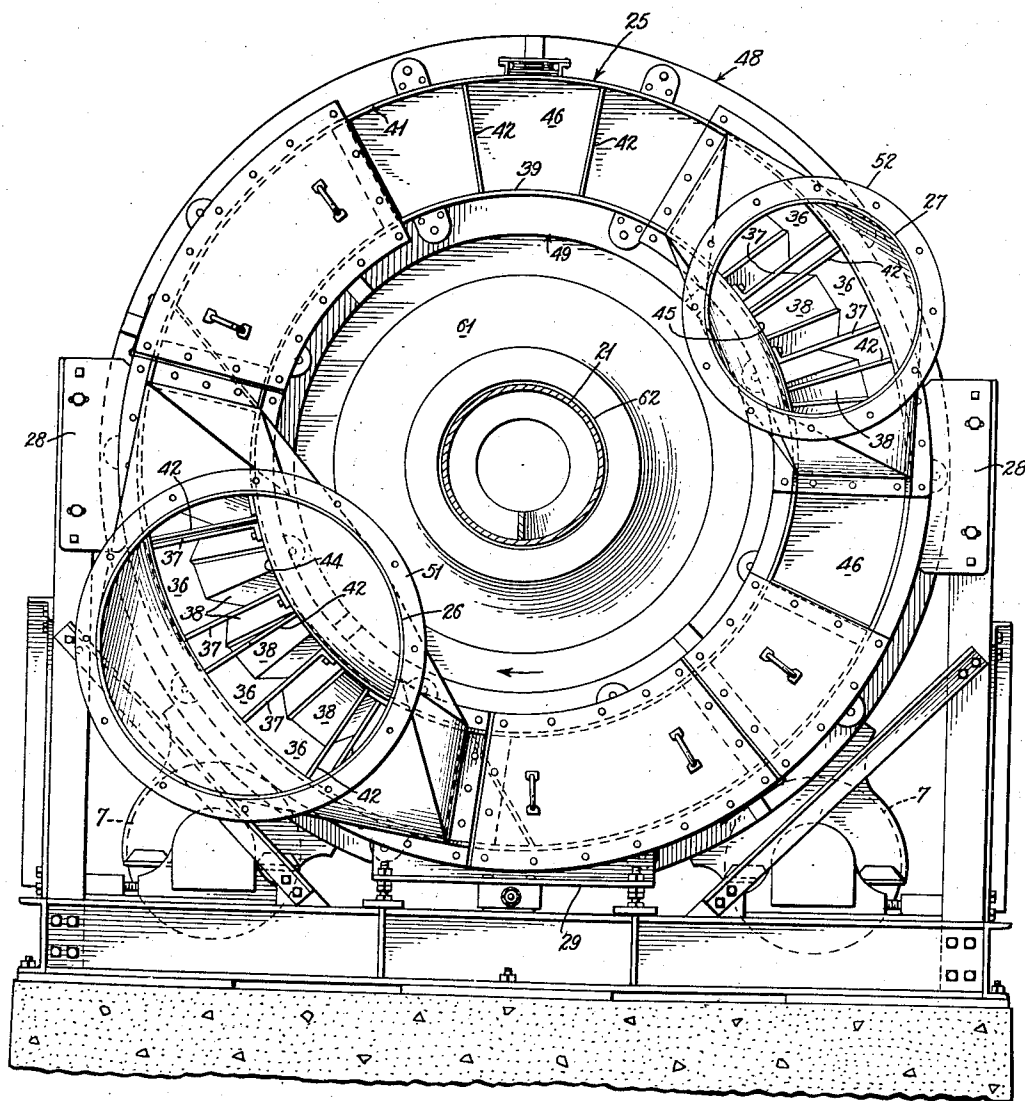
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Fig. 3.



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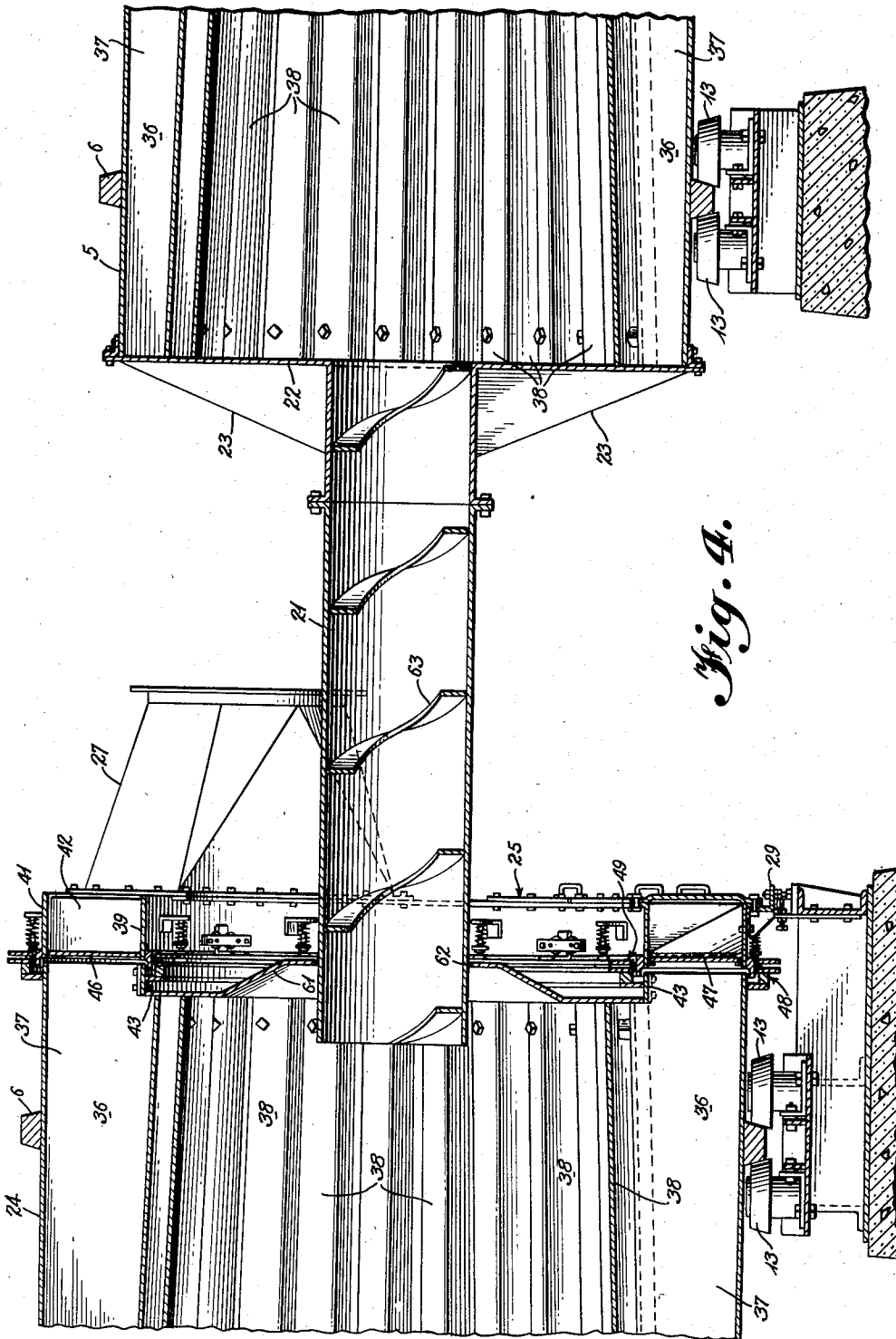


Fig. 4.

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ROTARY DRYERS AND/OR COOLERS

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6 Claims. (Cl. 34—129)

This invention relates to new and useful improvements in apparatus for cooling or drying flowable solid materials and deals more particularly with apparatus of the above type which is especially adapted for the treatment of very high temperature materials and for combined drying and cooling operations.

in cooling operations where the temperature of the material to be treated is very high, considerable difficulty has been encountered in the past due to the effect of the heat of the material on the cooler unit. As a result, such cooler units have been constructed of special, heat resistant materials which are expensive and which are sometimes difficult to machine or fabricate.

A similar problem has also been presented in drying operations where the nature of the material to be treated is such that it is advantageous to use a drying medium having a very high temperature. Of course, material subjected to a high temperature drying medium will have its temperature increased sharply as soon as the moisture is removed therefrom. In order to prevent damage to such material, it is essential that it be removed from the dryer as soon as, or prior to, the time that complete drying has been accomplished. In other words, the retention time in such operations has been very critical and close control has been required. Further, the material leaving the dryer after having been subjected to a high temperature drying medium has often been too hot for subsequent operations and has required an additional cooling treatment.

In both such operations where very hot material is subjected to a low temperature cooling medium, and where a very wet material is subjected to a high temperature drying medium, there has been in the past a substantial loss of energy and a corresponding reduction in the efficiency of the operation due to the dissipation and loss of heat in the drying or cooling medium that is discharged from the unit. For example, the heated drying or cooling medium, which could have been used for other processing operations such as preheating the combustion air for kilns, dryers and the like, has been conventionally discharged to the atmosphere because no inexpensive and efficient heat recovery system has been available for use in such operations.

A difficulty encountered in connection with the use of horizontally mounted drum-type dryers, employing internal treatment chambers that gradually increase in diameter, from the feed end to the discharge end, to effect the axial advancement of the material, has been caused by the practical limitations that must be imposed on the outside diameters of said dryers, and the dryer lengths that can be employed because of said diameter limitations. In other words, because the diameter of the discharge end of the gradually increasing internal treatment chamber cannot exceed the permissible maximum diameter of the dryer drum, the overall length of the dryer and the retention period for the material that is provided by such overall length, are both restricted by the practical limitations that must be imposed on the diameter of the dryer.

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It is the primary object of this invention to provide apparatus for drying or cooling material which will operate efficiently and with a minimum of maintenance and repair even though the temperature of the material or drying medium is very high.

A further important object of the invention is to provide cooling or drying apparatus which will permit the efficient recovery of heat from the drying or cooling medium.

Still another object of the invention is to provide drying apparatus which will permit the use of a very high temperature drying medium and which employs a minimum amount of special heat resistant materials in its construction.

A further object of the invention is to provide apparatus for cooling very hot material in such a manner that the heat of the material will not damage the apparatus and only a minimum amount of heat resistant material need be employed in the construction of the apparatus.

Another important object of the invention is to provide a horizontally mounted drum-type drying or cooling apparatus which will retain the material therein for an extended treatment period while the material is moving continuously through the apparatus.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like reference characters are employed to designate like parts throughout the same,

Figure 1 is a side elevational view of a dryer or cooler embodying the invention,

Figure 2 is an end elevational view of the device illustrated in Fig. 1,

Figure 3 is a transverse sectional view taken on line 3—3 of Fig. 1, and

Figure 4 is a fragmentary, longitudinal sectional view of the center portion of the device illustrated in Fig. 1.

In the drawings, wherein for the purpose of illustration is shown the preferred embodiment of the invention, and first particularly referring to Fig. 1, reference character 5 designates a horizontally arranged cylindrical shell of a dryer or cooler that is supported for rotation by conventional tires 6 and trunnions 7 and is rotated by a pinion, not shown, mounted within the housing 8 and engaging a ring gear 9. The pinion is driven by a motor 10 through a flexible coupling 11 and gear reduction unit 12. The shell 5 is held against longitudinal movement on the trunnions 7 by thrust rollers 13, see Fig. 4, which are arranged to engage the sides of one or both of the tires 6.

At the feed end of the shell 5, see Figs. 1 and 2, there is provided an annular manifold or distributing ring assembly 14 through which a treatment gas, generally air, is introduced into the shell as will be later described. The manifold 14 is provided with an inlet air connector 15 for communication with a suitable source of supply of treatment gas, not shown, and an exhaust air connector 16 for communication with an exhaust duct system, not shown. The entire manifold 14 is mounted in a stationary position on supports 17 at its opposite sides and support 18 at the bottom of the assembly. A suitable feed chute 19 is provided for introducing the material to be treated to the interior of the shell 5 through the center portion of the manifold 14.

At the opposite end of the shell 5 there is provided a cylindrical discharge spout 21 which is rigidly mounted on the end wall 22 of the shell 5 and projects axially outwardly. Stiffening webs 23 extend between and connect the spout 21 and end plate 22 to rigidly maintain their axial alignment.

A second, larger diametered cylindrical shell 24 is

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mounted in spaced, axial alignment with the shell 5 and has the spout 21 projecting into its feed end. The elements for supporting and rotating the shell 24 are identical to those employed in connection with the shell 5 and have been given corresponding reference characters so that a detail description of these elements need not be repeated at this time.

At the feed end of the shell 24, see Figs. 1 and 3, there is provided a manifold 25 which is arranged in surrounding relationship with the end portion of the spout 21 that projects into the shell. The manifold 25 is provided with an inlet air connector 26 for communication with a suitable source of supply of treatment gas such as air, not shown, which is introduced into the shell through the manifold as will be later described. The manifold 25 is also provided with an exhaust air connector 27 for communication with a suitable exhaust duct system, not shown, for removing a portion of the treatment gas from within the shell 24, as will be later described. The entire manifold 25 is mounted in a stationary position on supports 28 at its opposite sides and a support 29 at the bottom of the assembly.

At the opposite end of the shell 24 there is provided a discharge nozzle 31. A discharge hood 32 is mounted to encase the outer end of the discharge nozzle which projects through an opening in one side of the hood. A seal assembly 33 is provided to prevent the escape of gases from the hood 32 around the discharge nozzle 31. At the top of the discharge hood 32 there is provided an outlet connection 34 for communication with an exhaust duct system for the removal of treatment gases from the hood. A discharge spout 35 is provided at the bottom of the hood for releasing fully treated material therefrom.

Referring now to Figs. 2, 3 and 4 for a brief description of the internal construction of the two shells 5 and 24, it will be noted that each has formed therein an annular series of axially extending treatment gas passages 36 adjacent its inner surface which open radially inwardly. These passages are separated by the axially extending, radial louvres 37 that are secured along their outer longitudinal edges to their associated shells in any suitable manner. As illustrated in Fig. 4, the radial louvres 37 are longitudinally tapered to gradually decrease the radial dimension of each passage 36 from the feed end to the discharge end of the associated shell 5 or 24.

Mounted on the inner longitudinal edge portion of each radial louvre 37 is a longitudinally extending tangential louvre 38. Each of the tangential louvres 38 has its leading edge portion connected to its associated radial louvre 37 and its trailing edge portion overlapping the leading edge portion of the next successive tangential louvre in inwardly spaced relationship therewith to provide an outlet opening for each of the treatment gas passages 36. The cross-sectional configurations of the tangential louvres 38 are such that the treatment gas outlets provided by their overlapped edge portions open rearwardly relative to the direction of rotation of their shell 5 or 24 so that material resting on the louvres cannot fall into the treatment gas passages 36.

Each of the two shells 5 and 24 and the structure mounted therein is identical to that which is fully illustrated and described in the application for United States Patent, Serial Number 546,092, filed by Norman L. Francis, on November 10, 1955 for Apparatus For Drying and Cooling.

Referring now to Figs. 2 and 3, it will be noted that the annular manifolds 14 and 25 associated with the shells 5 and 24, respectively, are identical in every respect except that the construction of the exhaust air connector 27 associated with the manifold 25 differs from that of the exhaust air connector 16. It will be noted that the connector 27 spans a smaller exhaust opening through its associated manifold 25 than is

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spanned by the connector 16, as will be later described. For the remaining structure of the two manifolds 14 and 25, corresponding reference characters will be applied to the corresponding parts of each and the following description of the manifold 25 is equally applicable to the manifold 14.

Referring now to Figs. 3 and 4, it will be noted that the manifold 25 includes concentrically arranged, radially spaced inner and outer rings 39 and 41, respectively, which are supported in their concentric relationship by radial webs 42 extending therebetween. The rings 39 and 41 are supported in axially aligned relationship with the ring 43 carried by the inner edges of the radial louvres 37 at the feed end of the shell 24 and with the shell 24, respectively, by the supports 28 and 29. Extending between and mounted on the inner edges of the two rings 39 and 41, to close the spaces formed by the rings and the adjacent ends of the inlet and exhaust openings 44 and 45, respectively, are a pair of back plates 46. The inlet and exhaust openings 44 and 45 are centered at substantially diametrically opposed points on the manifold 25, and it will be noted that the circumferential dimension of the exhaust opening 45 is less than that of the inlet opening for a purpose that will be described in connection with the operation of the device.

An outer seal assembly 48 is provided to close the gap between the outer ring 41 and the shell 24 and a similar inner seal assembly 49 is provided to close the gap between adjacent edges of the inner ring 39 and the ring 43 to prevent the escape of treatment gas from between the rotating shell 24 and the stationary manifold 25.

The inlet air connector 26 is mounted on the outer edges of the inner and outer rings 39 and 41 in alignment with the inlet opening 44 and provides an annular connecting flange 51 at its outer end for connection with the duct system of a treatment gas supply system, not shown. The exhaust air connector 27 associated with the manifold 25 is similar in construction to the inlet air connector 26 but is smaller and is mounted on the outer edges of the inner and outer rings 39 and 41, respectively, in alignment with the exhaust opening 45. An annular flange 52 is provided at the outer end of the exhaust air connector 27 for joining the connector to the duct work of an exhaust system, not shown.

The exhaust opening 53 of the manifold 14 spans an arc which is of substantially greater length than that of the inlet opening 44 and is centered at a substantially diametrically opposed point on the manifold from said inlet opening. The exhaust air connector 16 has an arcuately formed inner side wall 54 which is aligned with and connected to the inner ring 39; a pair of end plates 55 which are aligned with and connected to the radial webs 42 at the two ends of the exhaust opening 53; and outer side walls 56 which converge tangentially to the radially outwardly directed outlet opening 57. The front, or outer face, of the exhaust air connector 16 is covered by a plate 58. A similar plate, not shown, covers the rear, or inner face of the connector 16. A flange 59 surrounds the opening 57 for joining the exhaust air connector to the duct work of an exhaust system, not shown.

By reference to Figs. 2, 3 and 4, it will be seen that the two shells 5 and 24 are each provided with a feed end plate 61 which is mounted inside the ring 43 and is provided with a central opening 62. The feed chute 19 extends through the opening 62 of the plate 61 associated with the shell 5 and the discharge spout 21 extends through the opening 62 of the plate 61 associated with the shell 24. Mounted on and extending along the length of the inner surface of the rotating spout 21 is a screw conveyor flight 63 by means of which material entering the discharge spout is advanced into the shell 24.

The apparatus described above operates in the same manner to cool very high temperature materials or to dry wet materials with a very high temperature treatment

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gas. The following description of the apparatus, therefore, will be specifically directed to an operation involving the cooling of a high temperature material.

The hot material is introduced into the shell 5 through the feed chute 19 while the shell is rotating in a clockwise direction as viewed in Fig. 2. This material, after entering the shell 5, will form a bed which extends longitudinally of the shell and is displaced circumferentially from the bottom of the shell in the direction of rotation to a position at which the treatment passages 36 which are aligned with the inlet opening 44 lie radially outwardly of the material.

A cooling gas, such as air, at a relatively low temperature is introduced into the inlet connector 15 for flow into the aligned treatment gas passages 36 and through the outlets between the tangential louvres 38 into contact with the bottom of the bed of hot material throughout the length of the shell 5. The cooling treatment gas flowing through the material bed in the shell 5 will reduce the temperature of the material by the transfer of heat to the gas so that the temperature of the fluid that has passed radially through the material to the central portion of the shell 5 is increased to a relatively high value. The heated treatment gas within the central portion of the shell 5 is thereafter removed from such portion through the treatment passages 36 that are located with their outlet openings arranged in the upper portion of the shell and is withdrawn from the treatment passages through the exhaust connector 16 at the feed end of the shell. Any conventional duct system which is connected to an exhaust fan, or the like, may be connected to the exhaust connector 16 for transferring the heated treatment gas from the dryer to a point of use or discharge to the atmosphere.

As the depth of the bed of material in the shell 5 increases, it will reach a value at which some of the partially cooled material will spill into the discharge spout 21 and will be moved therealong by the screw conveyor flight 63 and introduced into the shell 24. This axial movement of the material through the shell 5 and the discharge spout 21 is continuous and results from the longitudinal inclined arrangement of the tangential louvres 38 within the shell.

The partially cooled material introduced into the shell 24 is again subjected to the cooling action of a treatment gas which is introduced through the inlet connector 26 and which flows through the material into the centrally located space within the interior of the shell. Since the temperature of the material entering the shell 24 may still be relatively high, a portion of the cooling gas adjacent the feed end of the shell 24 will be increased in temperature by its passage through the material bed. A substantial portion of the heated treatment gas may be removed through the outlets of the treatment gas passages 36 aligned with the exhaust connector 27 and from such passages into an exhaust duct system which is employed to conduct the heated gas to any suitable point of use.

At the discharge end of the shell 24, however, the temperature of the treatment gas which has passed through the material bed will remain at a relatively low value and this portion of the treatment gas is removed through the discharge spout 31 of the shell 24 and through the hood 32 and its outlet connection 34 for release in any suitable manner. Since the exhaust connector 27 is aligned with an exhaust opening 45 that spans a relatively small number of treatment gas passages 36, the proportion of the treatment gas withdrawn from the shell 24 through the exhaust connector 27 is limited to a sufficient extent to prevent the withdrawal of all of the treatment gas within the shell 24.

It will be noted that the use of two separate shells 5 and 24 through which the material continuously passes permits the shell 5, which is subjected to the hottest material, to be smaller in all dimensions than the shell 24 so that special, heat resistant materials which are relatively

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expensive may be employed in the construction of only the shell 5 and thereby effect a substantial saving in the total cost of the complete installation. Further, it will be seen that substantially all of the gas that has been highly heated in the shell 5, by passing through the hottest material, as well as a large portion of the gas that has been heated in the shell 24, by passing through its still incompletely cooled material, are almost immediately withdrawn, from possible further contact with the material, through the treatment passages located in the upper portions of the shell, instead of being compelled to move concurrently with the material to the discharge end of the shell according to common practice. This prompt removal of the heated treatment gas, as soon as it has performed its portion of the material cooling operation, prevents the partially cooled material at any given location throughout the lengths of the shells from absorbing additional heat due to its coming in contact with higher temperature gas.

The operating conditions described above are similar to those which result from the drying of a wet material with a very high temperature treatment gas except that the temperature of the gas is somewhat lowered by its passage through the bed of wet material. The treatment gas, however, will retain sufficient heat to make desirable the recovery and subsequent use thereof by the withdrawal of the gas through the exhaust connectors 16 and 27. Also, the wet material will be partially dried during its passage through the shell 5 so that a lower temperature treatment gas may be employed in the shell 24 to eliminate the possibility of damaging the structure of the latter shell.

It is to be understood that the form of this invention herewith shown and described is to be taken as a preferred example of the same, and various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, I claim:

1. A device of the type defined, comprising first and second horizontally arranged cylindrical shells rotatably supported in spaced axial alignment and each having a feed end and a discharge end, said first shell having its discharge end arranged adjacent the feed end of the second shell, a plurality of axially extending louvre assemblies mounted in each shell to form a circumferentially arranged series of treatment passages with each passage having a rearwardly opening gas outlet throughout its length and to form a support for a bed of material, means for supplying material to the feed end of said first shell, rotating means for receiving material from the discharge end of said first shell and for transferring it to the feed end of said second shell while restricting the flow of treatment gas from said first shell to said second shell, said means being connected to one of said shells so as to be operatively rotated thereby, means for withdrawing material from the discharge end of the said second shell, separate inlet means associated with the feed end of each shell for introducing treatment gas, and separate exhaust means associated with the feed end of each shell for withdrawing spent treatment gas.

2. A device as defined in claim 1 further characterized by said means for receiving material from the discharge end of said first shell and for transferring it to the feed end of said second shell including a first end plate having a central opening associated with the discharge end of said first shell, a second end plate having a central opening associated with the feed end of said second shell, a cylindrical spout extending between said first and second shells, said spout having its one end connected to said first end plate in surrounding relationship with the opening therein and its other end extended through the opening in said second end plate so as to protrude into the interior of said second shell, and means for supporting said spout to relieve said second end plate from the weight thereof.

3. A device as defined in claim 2 further characterized by said cylindrical spout having an internal screw conveyor flight extending along substantially its entire length and rigidly connected thereto so as to partake of the motion of said spout and to push the material therethrough, and said supporting means comprising a plurality of stiffening webs extending between and connected to said spout and to said first end plate so as to rigidly maintain said spout in axial alignment.

4. A device of the type defined, comprising first and second horizontally arranged cylindrical shells rotatably supported in spaced axial alignment and each having a feed end and a discharge end, said first shell having its discharge end arranged adjacent the feed end of the second shell, a plurality of radial louvres mounted in each shell to provide an annular series of axially extending treatment gas passages within the shell, a plurality of axially extending tangential louvres supported on the radial louvres of each shell and having their adjacent edge portions circumferentially overlapped in spaced relationship to provide outlets for said passages, means for introducing material into the feed end of said first shell to form a bed supported on the tangential louvres thereof, a cylindrical discharge spout mounted on the discharge end of said first shell for rotation therewith and extending in axial alignment with said shells into the feed end of said second shell, means mounted in said discharge spout for advancing material therein toward the feed end of said second shell when the spout is rotated and for restricting the flow of treatment gas from the first shell through the spout, a stationary treatment gas manifold mounted in sealing relationship with the feed end of each of said shells and having an inlet opening aligned with the passages positioned radially outwardly of the location of the bed in the shell for the flow of treatment gas through the aligned passages and their outlets through the material

bed, means associated with each of said manifolds for withdrawing gas from the shell through passages that are spaced circumferentially from the location of said bed, and means for withdrawing the fully treated material from the discharge end of said second shell.

5. A device as defined in claim 4 further characterized by each of said manifolds having an exhaust opening aligned with passages that are spaced circumferentially from the location of said bed, the manifold associated with said first shell having an exhaust opening of sufficient size to permit the gas withdrawing means associated therewith to exhaust substantially all of the treatment gas from the first shell, and the manifold associated with said second shell having an exhaust opening which is of such a size that the gas withdrawing means associated therewith is operable to exhaust a portion only of the treatment gas from said second shell.

6. A device as defined in claim 4 further characterized by the radial louvres of each shell being longitudinally tapered to support said tangential louvres in diverging relationship with the axis of the shell from the feed end to the discharge end of the shell, the gravitational effect of said diverging relationship causing the material to move longitudinally in each shell toward the discharge end thereof, and said first shell having a diameter less than that of said second shell.

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