Oct. 28, 1958 G. HALLDORSSON 2,857,684

ROTARY COOLER AND DRYER

Filed April 12, 1956 2 Sheets-Sheet 1

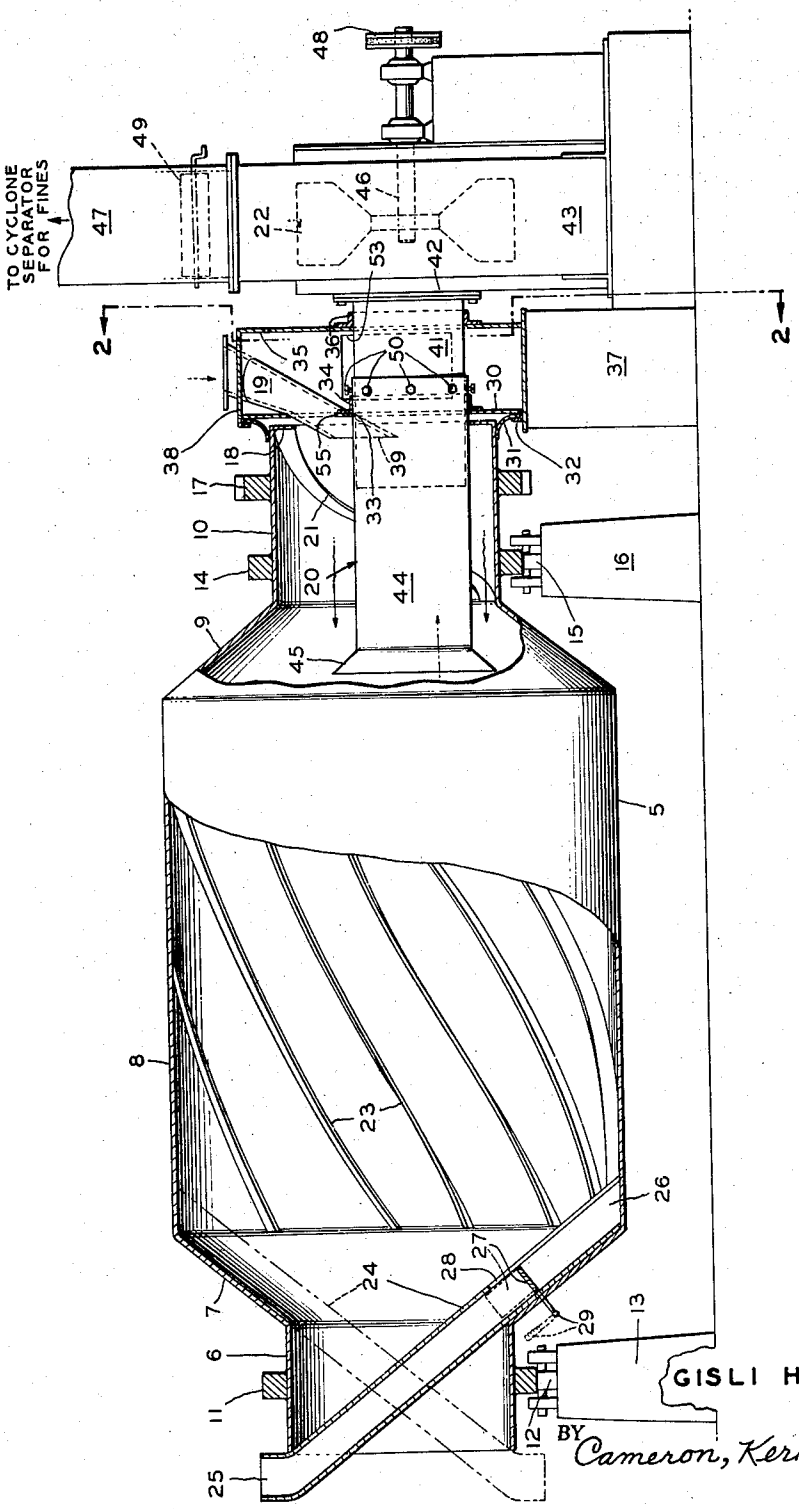


FIG. 1.

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FIG. 2.

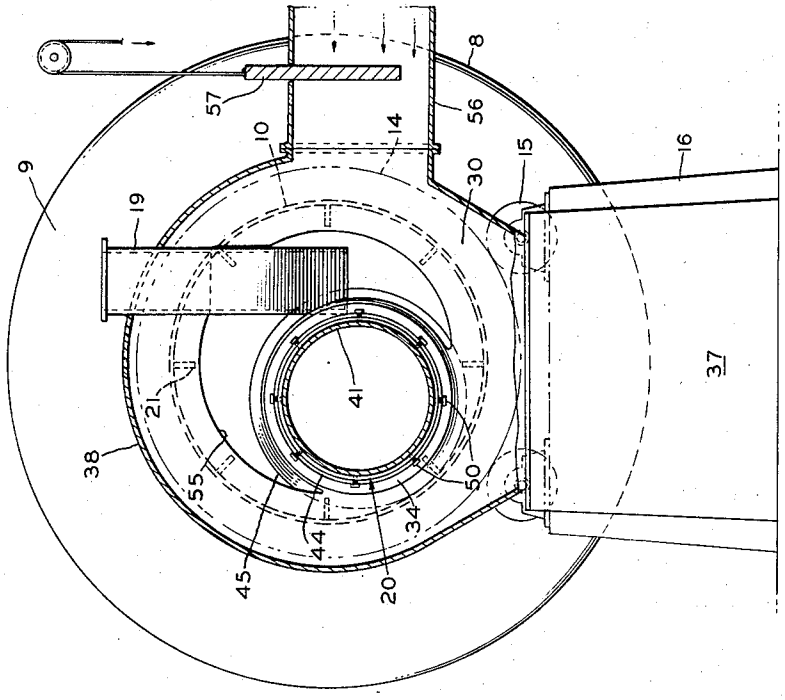
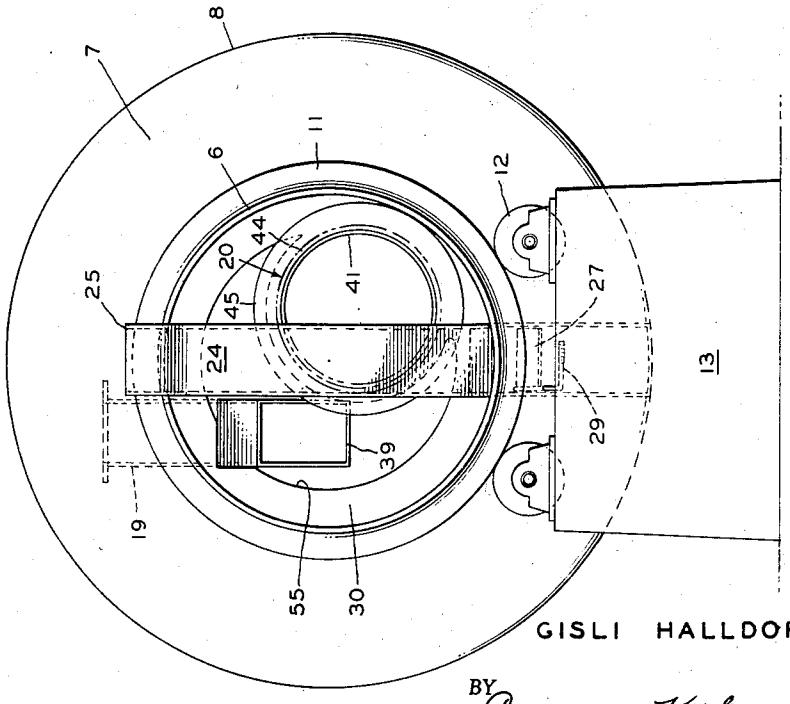


FIG. 3.



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ROTARY COOLER AND DRYER

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Application April 12, 1956, Serial No. 577,845

15 Claims. (Cl. 34—66)

This invention relates to an improved countercurrent rotary cooler and dryer which may also be used as a mixer or reactor for various types of chemical compounds and specifically superphosphate fertilizers.

The invention contemplates broadly the provision of a rotary drum dryer provided at its discharge, air intake extremity with a cylindrical neck section of reduced diameter through which extends a valved unloading pipe structure, the neck section extending into an inwardly enlarging conical or hemispherical section extending into an enlarged diameter retention and processing section of extended length, which again reduces into a decreasing conical or hemispherical section and thence to a reduced diameter cylindrical section into which the material feed extends. This reduced diameter feed section is sealed at its extremity and is provided with a telescoping internal exhaust duct which passes through the sealing plate and into closed communication with an enlarged industrial fan which draws the air through the entire structure and forces it upwardly through a conduit to a cyclone separator of conventional form, which is not shown. The fan may be placed on the clean suction side of the cyclone separator. The entire rotating drum structure is mounted at its restricted extremities on suitable rollers for appropriate rotation, motive power for the rotation of the drum being provided through a ring gear applied about the outer periphery of the reduced feed section of the drum.

The primary purpose of the improved cooler and dryer drum structure is to create a unit which will permit a larger hold-up by time and by percentage of unit volume and a greater output capacity per cubic foot of volume and of unit weight than is now possible with similar known units. The unit is designed to be usable as a cooler, dryer or as a combination dryer and cooler and is designed to be capable in certain applications of performing both operations simultaneously. Further, due to its novel design the unit requires less installation space for a desired capacity than was previously required.

The invention also contemplates a unit which is completely free from dust losses, eliminating the loss of fine material at the feed end thereof which creates wear on the seal and a nuisance problem and results in the loss of a considerable percentage of these fine particles.

It is therefore a primary object of this invention to evolve a countercurrent cooler and dryer unit which for a certain capacity requires less space for installation and which is of considerably smaller size than presently known units.

It is a further object of this invention to provide such a unit with improved unloading means at its discharge extremity whereby a certain material level can be maintained in the unit corresponding to the hold-up or processing time desired for a certain feed rate.

Another object of this invention is to provide an improved adjustable internal exhaust duct at the feed extremity of the unit to eliminate dust losses and to control the discharge of fine particles of the material being processed.

It is a further object of this invention to provide improved material feed means at the feed extremity of the unit.

Another object of the invention is to provide improved spirally arranged flights in the retention section of the dryer whereby the material being processed is assisted in moving through the dryer drum counter to the flow of processing air therethrough.

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

Referring to the drawings,

Fig. 1 is a side view, partially broken away and in section, showing the complete cooler and dryer drum unit;

Fig. 2 is a cross sectional view taken on line 2—2 of Fig. 1 taken at the feed extremity of the unit; and

Fig. 3 is an end view of the unit taken at the discharge end thereof.

In the drawings, 5 indicates a rotary dryer drum which comprises a restricted air entry neck 6 of reduced diameter and length which extends into an outwardly diverging conical section 7, extending into retention and processing section 8 of enlarged diameter and length. Retention section 8 extends into converging conical section 9 and thence into feed section 10 of reduced diameter.

Discharge section 6 is provided about its outer central periphery with a tire 11 which seats on paired rollers 12 appropriately supported on a fixed base 13. Feed section 10 is provided about its outer periphery with a tire 14 which rotatably registers with paired rollers 15 appropriately mounted on fixed base 16, this drive band and roller arrangement rotatably mounting the entire cooler and dryer drum structure.

Feed section 10 is also provided about its outer periphery with a ring gear 17 which appropriately registers with a suitable drive gear from a suitable source of power for rotating the entire unit.

Feed section 10 is provided at its outer periphery with a rectangular shoulder 18 which defines a central, circular orifice therein through which are passed the lower extremity of the material feed chute 19 and extensible internal exhaust duct 20, which will be more fully discussed further on in this specification.

Feed section 10 is provided about its inner periphery with a spiral feed flight 21 designed to shower and feed the material entering from material feed chute 19 concurrently with the air into conical section 9 and then into retention section 8 of the drum, counter to the flow of air therethrough as set up by industrial fan 22.

Retention section 8, of enlarged diameter and length is provided about its inner periphery with a series of spirally arranged feeding flights 23 which raise and drop the material therein and urge it rather slowly toward the discharge extremity of the drum countercurrent to the flow of cooling or heating air therethrough from neck 6. Due to the spiral flights in sections 10 and 8 and due to the concurrent flow of the air in section 10 the axial flow of material is faster in section 10 than in retention section 8, where the air flow opposes the axial movement of the material toward the discharge end of the unit.

Unloading pipe structure 24 is shown appropriately affixed at its lower extremity against the wall of conical section 7 and affixed at the outer extremity of retention section 8 of the drum, extending angularly through neck 6 of the drum and appropriately affixed outwardly thereof by means of a suitable bracket, its open discharge extremity 25 being disposed outwardly of neck 6 for the delivery of processed material. Unloading pipe 24 is shown as rectangular but may be of any desired cross-

sectional configuration and is appropriately bisected or opened at its lower extremity to provide a "scoop" or trough section **26**, the opening of which may be varied, to receive processed material fed to it through retention section **8** against the flow of processing air. Unloading pipe **24** is preferably provided with a valve means **27** pivotally mounted in the upper extremity of the "scoop" section **26** thereof and provided with a control lever **29** which is freely accessible to the operator to adjust the position of valve **27** in "scoop" section **26** to regulate the overflow level and amount of processed material discharged through unloading pipe **24**. Valve **27** is shown as rectangular but may be of any desired shape and configuration to conform to the shape of unloading pipe **24** and may be mounted upon a shaft or may be hingedly mounted within "scoop" section **26** of unloading pipe **24**. It will be seen that when valve **27** is in closed postion a small overflow section **28** of the "scoop" section **26** will remain open, above the valve. Thus, when the valve is closed only the overflow section **28** of the scoop **26**, located above the valve, is effective and will maintain the material level at valve height.

Unloading pipe **24** is so designed as to control the unloading of processed material from section **8** of the cooler-dryer and the scoop portion **26** thereof scoops up and delivers a measured portion of the material for each rotation of the drum. The speed of rotation of the cooler-dryer unit controls the rate of feed of material to the discharge extremity of the unit and also governs the rate of discharge through unloading pipe **24**. Delivery of material through the unloading pipe can thus be regulated by varying the R. P. M. of the drum and by valve **27**, which can be positioned to maintain a desired level of material in section **8** of the drum. Valve **27** may take a variety of forms. Its position in pipe **24** tends to determine the natural material level in section **8**, when closing off the lower section of the open scoop.

Referring to the feed extremity or breeching of the dryer and cooler, an appropriate sealing plate or sealing ring **30** is provided adjacent the orificed extremity of feed section **10** of the unit and is provided with a peripherally disposed flexible seal **31** bearing out its inner extremities against the outer periphery of feed section **10** thereof to provide an airtight seal about feed section **10** to prevent the leakage of air into the feed breeching and feed section **10**. Seal member **31** is preferably in the form of a circular seal clamped at its outer peripheral extremities in a peripheral clamp **32** provided about the outer periphery of sealing plate **30**. Sealing plate **30** is preferably provided with an off-center circular orifice **33** of slightly larger diameter than exhaust duct **20**, which extends therethrough and through section **10** into conical section **9** of the dryer drum. Circular orifice **33** is preferably provided about its periphery with an angle ring **34** which is appropriately clamped thereabout and serves to slidably support extremity **44** of exhaust duct **20** in the desired horizontal position within section **10**. A further plate and bracket support **35** is provided outwardly of the support bracket and is also appropriately orificed for the passage of exhaust duct **20**, circular angle member **36** being provided about the periphery of said orifice to further support exhaust duct **20** adjacent its outer extremity.

Sealing plate **30** and plate **35** are appropriately mounted on a fixed base **37** and are connected by a circumferential plate **38** joining their edges forming a feed breeching. Closure plate **38** is appropriately orificed for the reception and support of material feed chute **19**, which extends downwardly therethrough, its open lower extremity **39** being so disposed laterally of exhaust duct **20** as to feed the material to be processed into section **10** of the drum to the side of exhaust duct **20** where it will be picked up and moved inwardly by spiral flight **21** of feed section **10**. As shown, material feed chute **19** is angled at its lower extremity inwardly, its lower extremity extending through orifice **55** in sealing plate **30** to feed the material into the outer extremity of section **10** of the dryer. Material may be fed into feed chute **19** from any suitable source and by any suitable means.

Internal exhaust duct **20**, as shown, is preferably composed of a fixedly mounted cylindrical section **41** which is appropriately mounted on and communicates through the outer wall **42** of fan housing or duct **43** adjacent fan **22**. Closely and slidably fitted over fixed section **41** of exhaust duct **20** is slidable section **44** thereof provided at its outer extremity with a belled throat portion **45** in such fashion that slidable section **44** may be slid inwardly or outwardly over fixed section **41** of exhaust duct **20** to regulate the length of exhaust duct **20** and the position of its outer belled throat **45** within conical section **9** of the drum or within feed section **10** thereof for a purpose hereinafter to be discussed in more detail.

By providing this telescoping sectional arrangement of exhaust duct **20** the discharge of fine particles of material from the drum to the conduit **43** and cyclone separator may be controlled and the inlet end of the cooler-dryer is kept free from dust losses to atmosphere. Internal exhaust duct **20** eliminates the dust problem by locating the area of deepest suction pressure which is lower than atmospheric pressure inside the inlet end of the cooler-dryer whereby the fine dust is sucked from the cooler-dryer inlet end, into the mouth of the internal exhaust duct **20** and thence blown or sucked to the cyclone collector. The heavier particles are not pulled into the exhaust duct **20** and travel on against the air stream through the length of the cooler-dryer until they are held at the discharge end where the countercurrent incoming air velocity is high.

Slidable section **44** of exhaust duct **20** slidably fits over or into fixed section **41** thereof and is so designed that the over-all length of exhaust duct **20** may be regulated, as desired, by sliding section **44** on section **41** inwardly or outwardly. Thus, section **44** may be slid in an outward direction toward fan **22** to reduce the length of duct **20** or may be moved inwardly toward section **8** of the dryer to increase the length of duct **20**. Various means may be employed to regulate the position of section **44** on section **41** and the length of exhaust duct **20**. As shown, a series of locking bolts **50** may be provided about the outer periphery of section **44**, registering against the outer surface of fixed section **41**, loosening of the bolts permitting the sliding of section **44**, as desired, on section **41** to regulate the length of duct **20**, the bolts being turned down into frictional engagement with the outer surface of section **41** when the desired length is attained. To make this adjustment the cooler-dryer may be entered, or it may be made through the feed breeching.

As an alternative, elongate adjusting screws may be provided extending through wall **35** of the feed breeching structure, registering with nuts provided about the periphery of the outer extremity of section **44** to move section **44** inwardly or outwardly on section **41**, as desired.

Exhaust duct **20** may be made in one piece and of a fixed length where desired and the best position is known. The farther the bell mouth **45** of section **44** extends into conical section **9** of the unit the larger is the portion of the unit which works as a concurrent cooler or dryer and the smaller the size and amount of fines which will be sucked out through exhaust duct **20**.

With slidable extremity **44** moved outwardly to shorten exhaust duct **20** to its minimum length bell mouth **45** thereof is moved into the inner extremity of feed section **10** and thus the fines do not enter section **9** of the cooler-dryer but are pulled through feed section **10** to bell mouth **45** of exhaust duct **20** and are then pulled rapidly through duct **20** and forced up conduit **47** to the cyclone separator. Thus, by regulating the length of exhaust duct **20** the area of deepest suction inside the inlet end of the cooler-dryer may be positioned, as required, and the dust particles of a certain size separated from the rest of the material and discharged from the cyclone. In

conventional countercurrent coolers or dryers, not provided with such an exhaust duct, the fine dust will not travel against the air in the cooler or dryer and tends to collect at the seal. This causes wear on the seal, loss of valuable fine material and a dust laden atmosphere, since the air velocities normally are not high enough to pick up the dust and carry it to the cyclone collector.

Industrial fan **22** is provided adjacent the open terminal extremity of exhaust duct **20**, rotatably mounted on a shaft **46** in the lower extremity of housing **43** of conduit **47** which extends upwardly therefrom to a cyclone collector for the fine particles, which is of conventional form and which is not shown. A damper **49** is preferably provided in duct **47**, between fan **22** and the cyclone separator for fines to assist in the control of air flow through the unit. This damper will be located in the exhaust duct of the cyclone separator when the separator lies between the unit and fan **22**. Fan **22** is driven from an appropriate source of power through a pulley **48** mounted at the extremity of shaft **46** and acts to pull processing air through entry section **6** of the cooler or dryer drum, through retention section **8** thereof and outwardly through the exhaust duct **20**, passing through feed section **10** thereof. Fan **22** forces this processing air upwardly through conduit **47** to the cyclone collector wherein the fine particles of the material are collected. By controlling the speed of rotation of fan **22** or by adjusting damper **49** in duct **47** or in the cyclone exhaust duct the speed of the processing air passing through entry neck **6**, retention section **8** and suction pipe **20** may be controlled as desired and the processing time of the material may be regulated thereby.

If desired, the cyclone separator may be located on the "clean" side of fan **22**, in conduit **47**, between exhaust duct **20** and fan **22**, thus eliminating the handling of dust or "fines" by fan **22**, through fan housing **43**. This is standard practice when handling fertilizers and many other materials.

In view of the novel configuration and arrangement of the cooler or dryer drum and the spiral flights in sections **10** and **8** thereof the material being processed is picked up and showered from the flights and is moved toward the discharge extremity **6** of the drum countercurrent to the flow of processing air pulled therethrough by the fan **22**. The spirally arranged flights have an inclination designed to feed the material and move it countercurrent to the air flow thus allowing more air to be used and increasing the efficiency of the processing of the material and giving a greater capacity for size.

The time of retention of the processed material in section **8** of the drum may be accurately controlled through the valve **27** of the unloading pipe **24**, the open scoop section **26** of which is disposed adjacent the terminal extremity of retention section **8** of the drum. It may also be controlled by regulating the R. P. M. of the drum or by regulating the rate of air flow.

If it is desired to use the structure as a countercurrent heater and dryer an appropriate source of heat may be provided adjacent the neck **6** of the dryer to heat the processing air to the desired temperature as it is pulled into neck **6** by fan **22**. Conversely, if it is desired to cool the processing air appropriate cooling means may be provided.

Feed section **10** may be supplied with hot, dry air through an orifice **53** in casing **38** and orifice **55** in plate **30**, thus furnishing the concurrent air to the feed section **10** in the form of dry, hot air, the cooling air still entering through section **6** and flowing countercurrently. The breeching, consisting of the seal plate **30**, plate **35**, and casing **38**, in such case may be insulated with refractories or other insulating material.

As shown in Fig. 2, orifice **55** in seal plate **30** is preferably disposed therein about the exhaust duct **20** and is curved in configuration in roughly a "half moon" shape, about duct **20**. It is preferably of a width at its widest point equal to approximately one-fourth of the diameter of feed section **10** and tapers to its extremities. The lower extremity of feed chute **19** extends downwardly through the widest section of orifice **55**, into feed section **10**.

The amount of drying air relative to the amount of cooling air may be regulated by a damper **57** in the hot air duct **56** supplying hot air to orifice **53** in plate **38** of the breeching, or by a damper controlling the air inlet to the hot air furnace supplying duct **56**. The main exhaust fan **22** together with the main exhaust damper **49** will still determine the total amount of air being handled and balance it to requirements.

Such a unit will act as a combination dryer-cooler and when wet material enters through feed chute **19** and drops into feed section **10** it will be immediately engulfed in the concurrent flow of hot air flowing through duct **56**, orifice **53** and curved orifice **55** in plate **30**. The surface moisture is thus quickly evaporated and while the material moves concurrently with the air flow through section **10** toward decreasing temperatures it is gradually heated while the gases cool down. The hot gases and vapors are then sucked off through exhaust duct **20** before they can enter retention section **8**. The material, however, moves countercurrently against the increasingly cooler air flowing against it, while being cooled both by the cool air and by evaporation. Finally the material is discharged dry and cool through unloading pipe **24**.

When operated in this manner the unit performs both the concurrent drying and heating operation, which normally is performed in a separate concurent dryer, and also the countercurrent cooling operation, normally performed in a separate countercurrent cooler. Since for temperature sensitive materials concurrent drying usually yields the greatest capacity for a given size dryer and since a countercurrent cooler yields the greatest capacity for a given cooler size, this combination of a concurrent dryer plus a countercurrent cooler provides in one unit the ideal and most compact solution to many drying and cooling problems. Where both operations can be satisfactorily performed in one single unit it is obvious that great savings in cost and space requirement, as well as in maintenance can be expected.

The operation of the countercurrent cooler and dryer is broadly as follows. With fan **22** rotating and with the drum under rotation through ring gear **17**, air flow and speed of rotation being as desired, the material to be processed is fed through material feed chute **19** into feed neck **10** of the drum structure. In feed section **10** the material is raised and dropped and moved forwardly toward retention section **8** by means of spiral flight **21** and the inward air flow through section **10** until the bulk of the material is moved through conical section **9** into enlarged retention section **8**. In section **8** the material is raised and showered and progressively moved toward the discharge end thereof by means of spiral flights **23** against the flow of air therethrough, the processed material finally reaching the scoop extremity **26** of unloading pipe **24**. The time of retention of the material in retention section **8** may be accurately controlled to assure the desired period of treatment. This control may be had by controlling the speed of air flow, the speed of rotation of the drum and by controlling the extent of opening of the valve **27** of unloading pipe **24** at the extremity of section **8** of the drum. If it is desired to retain all of the processed material for an extended period in section **8** of the drum valve **27** may be maintained for an extended period in closed position. (Batch or cyclic operation.)

As neck section **6** and exhaust duct **20** are of reduced diameter air velocity through these two terminal sections is high. Thus processing air enters through section **6** at high velocity. Its velocity is progressively reduced through conical section **7** and air velocity is at its lowest passing through enlarged diameter retention section **8**. Air velocity again progressively increases through de-

creasing conical section 9 into exhaust duct 20 where air velocity is at its highest. Thus, by adjusting the inner telescoping section 44 of exhaust duct 20 over or within the fixed section 41 thereof the bell mouth 45 thereof may be moved inwardly into feed section 10. As the velocity of air passing through duct 20 to fan 22 is preferably 5–6000 F. P. M., which is a conveying velocity, and the air flow through feed section 10 is inward to bell mouth 45, fine material will be picked up in section 10, cooled and/or dried and pulled directly through duct 20 and conduit 47 to the cyclone collector, leaving the coarser material to pass through sections 9 and 8 of the drum for processing therein and discharge therefrom through discharge pipe 24. By virtue of the high velocity of the processing air passing through entry neck 6 of the drum none of the processed material will escape through neck 6, its forward movement induced by spiral flights 23 in retention section 8 of the drum being positively opposed by the high velocity air entering through neck section 6 thereof.

Due to the provision of internal exhaust duct 20, passing through breeching plate 30 into the retention section 8 of the unit the air flow through feed section 10 moves in concurrent flow with the material and thus assists in moving the material into the retention section 8 from feed section 10. The only air passing through feed section 10 is the air sucked or pulled through the feed chute 19 or passing through opening 53, provided in breeching plate 38 from hot air duct 56. Thus even the finest material will have no tendency to escape through the seal as it would thus be in opposition to air movement in section 10.

Where it is particularly important to separate the fine from the coarser material the inner extremity 44 of suction pipe 20 may be retracted on section 41 thereof into feed section 10 of the drum so that it will pick up the fine material in feed section 10 and separate it from the coarser material. Such a separation of the fine material is frequently desirable, for example, in the fertilizer industry where it is important not to overload screening equipment and where the "fines" can be blown by the fan to the cyclone and readily recovered therein.

It will thus be seen that in the present countercurrent cooler and dryer structure a machine of great capacity for unit size has been provided in which the fine material may be readily separated at the feed end from the coarser material and in which the coarser material may be processed in the retention section for the desired period while being fed countercurrent to the processing air stream. By providing the extensive spiral flights 23 in retention section 8 the material is heavily showered therein and is acted upon by the countercurrent flowing air while being steadily moved toward the discharge end of the retention section. The ultimate processing time control in this structure is governed by the amount of air regulated by fan 22 and damper 49, the speed of rotation and by the unloading pipe 24 and valve 27 regulating the time of retention of the material in section 8 and the delivery of processed material therefrom.

This cooler-dryer structure is susceptible to many uses and adaptable to the processing of many different types of material. It can be used as a countercurrent cooler, countercurrent dryer or as a combination concurrent dryer countercurrent cooler or as a mixer or reactor for various types of material. Nothing in this specification is intended to limit the scope of the invention and throughout the substitution of analogous elements may be made without departing from the spirit of this invention.

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

What is claimed is:

1. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical air entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a material feed duct extending into said feed section, a hot air duct communicating with said feed section, an exhaust duct of reduced diameter disposed through said feed section and said seal plate and eccentric therewith, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights in said feed and retention sections and an unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

2. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a material feed duct extending into said feed section, a hot air duct communicating with said feed section, a telescoping exhaust duct of small diameter disposed through said feed section and said seal plate and eccentric therewith, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights in said feed and retention sections and an unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

3. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a material feed duct extending into said feed section, a hot air duct communicating with said feed section, a longitudinally extensible exhaust duct extending through said feed section toward said retention section, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights in said feed and retention sections and an unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

4. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a material feed duct open at its upper extremity extending into said feed section, a hot air duct communicating with said feed section, a longitudinally extensible exhaust duct extending through said feed section, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a

cyclone collector for fine material, spiral flights in said feed and retention sections and an unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

5. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, an angular material feed duct extending into said feed section, a hot air duct communicating with said feed section, a longitudinally extensible exhaust duct extending through said feed section into said retention section, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights peripherally disposed in said feed and retention sections and a valved unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

6. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, an open material feed duct extending into said feed section, a hot air duct communicating with said feed section, a longitudinally extensible exhaust duct of reduced diameter extending through said feed section into said retention section, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, high spiral flights arranged within said feed and retention sections and a cylindrical unloading pipe extending from the extremity of said retention section through said entry neck, a scoop at the inner extremity of said unloading pipe whereby processed material will be delivered from said retention section through said unloading pipe.

7. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a vertically disposed, open material feed duct extending into said feed section, a hot air duct communicating with said feed section, an exhaust duct of reduced diameter disposed through said feed section and said seal plate and eccentric therewith, a fan in sealed comunication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, steeply angled spiral flights in said feed section, more gradually angled spiral flights in said retention section and an open-ended unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

8. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of enlarged diameter and

length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, an angular material feed duct extending into said feed section, a hot air duct communicating with said feed section, an exhaust duct of reduced diameter disposed through said feed section and said seal plate, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights in said feed and retention sections and a valved unloading pipe extending from the extremity of said retention section through said entry neck whereby processed material will be delivered from said retention section through said unloading pipe.

9. In a countercurrent cooler and dryer for material, a rotary drum comprising a cylindrical entry neck of small diameter, a divergent conical section adjacent said entry neck, a retention section of substantially twice the diameter and three times the length of said entry neck adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter and length, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, an open material feed duct extending into said feed section, a hot air duct communicating with said feed section, an exhaust duct of reduced diameter disposed through said feed section and said seal plate, a fan in sealed communication with the extremity of said exhaust duct, a duct leading from said fan to a cyclone collector for fine material, spiral flights in said feed and retention sections, an open-ended unloading pipe extending from the extremity of said retention section through said entry neck, a valve in said unloading pipe adjacent its inner extremity whereby processed material will be delivered from said retention section through said unloading pipe.

10. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and said seal plate into said feed section, an orifice in said seal plate, a hot air duct communicating with said feed casing, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

11. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and

said seal plate into said feed section, an enlarged, curved orifice in said seal plate, a hot air duct communicating with said feed casing, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

12. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and said seal plate into said feed section, an orifice in said seal plate curved about said exhaust duct, a hot air duct communicating with said feed casing, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

13. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and said seal plate into said feed section, an orifice of substantial size in said seal plate, a hot air duct communicating with said feed casing, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

14. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and said seal plate into said feed section, an orifice in said seal plate, a hot air duct communicating with said feed casing, a valve in said hot air duct, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

15. In a combination concurrent dryer and countercurrent cooler for material, a rotary drum comprising a cylindrical cool air entry neck of small diameter, a divergent conical section adjacent said cool air entry neck, a retention section of enlarged diameter and length adjacent to and extending from said conical section, a convergent conical section adjacent said retention section extending into a feed section of reduced diameter, said sections being disposed on the same longitudinal axis, a seal plate closing the extremity of said feed section, a feed casing integral with said seal plate, a material feed duct extending into said feed section through said feed casing, an exhaust duct of reduced diameter disposed through said feed casing and said seal plate into said feed section, an orifice in said seal plate disposed about said exhaust duct, a hot air duct communicating with said feed casing, a fan in sealed communication with the extremity of said exhaust duct and communicating with a cyclone separator and an unloading pipe extending from the extremity of said retention section through said entry neck, whereby processed material will be delivered from said retention section through said unloading pipe.

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