May 18, 1943. H. C. FRENCH ET AL 2,319,674

ROTARY DRIER

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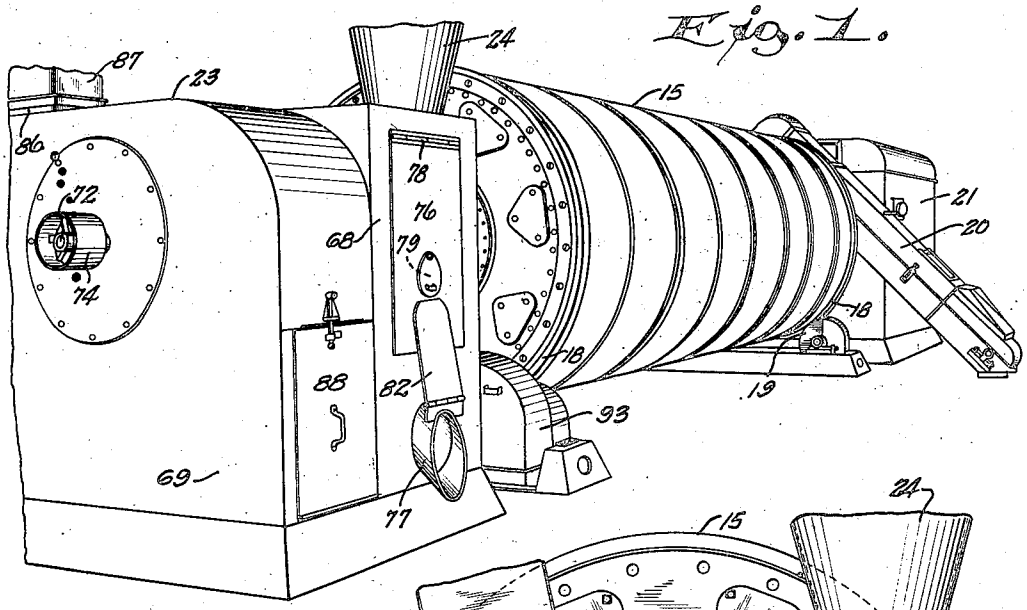
Fig. 1.



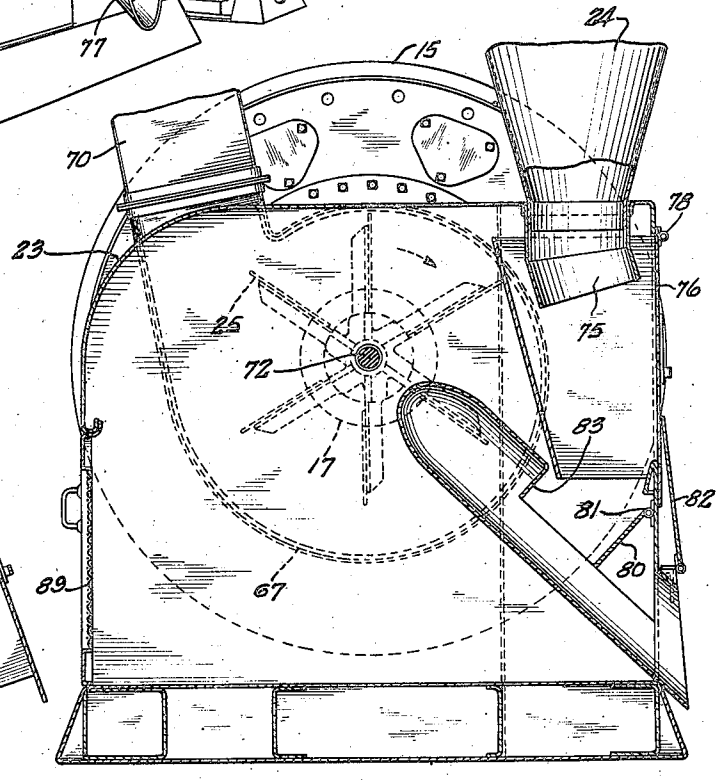


Fig. 2.

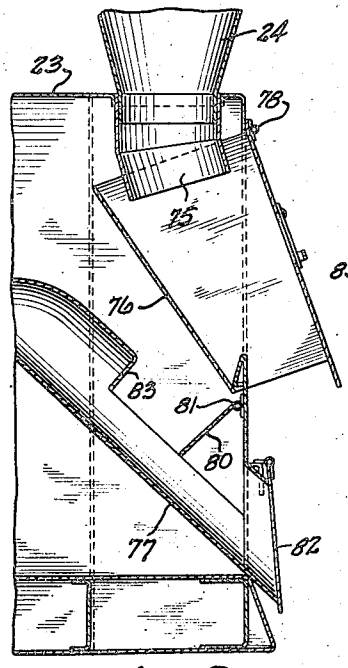


Fig. 3.

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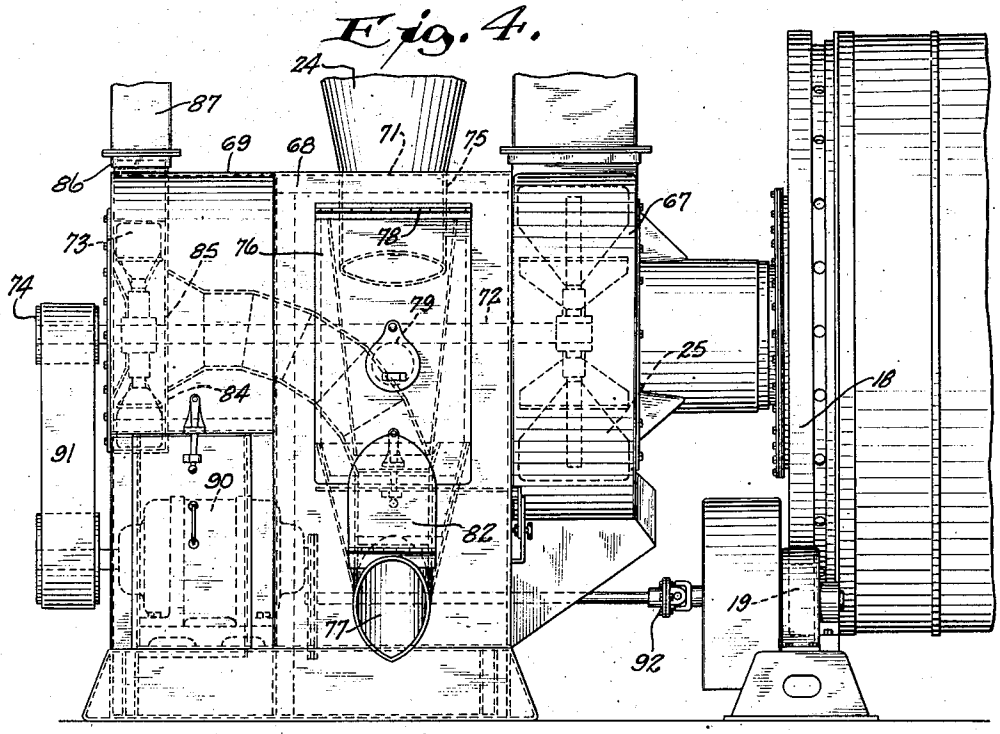
Fig. 4.



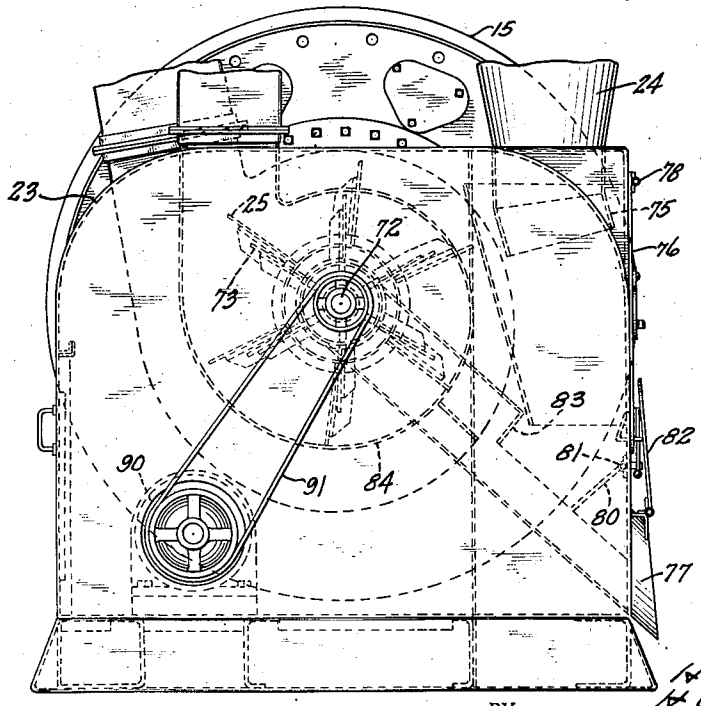


Fig. 5.

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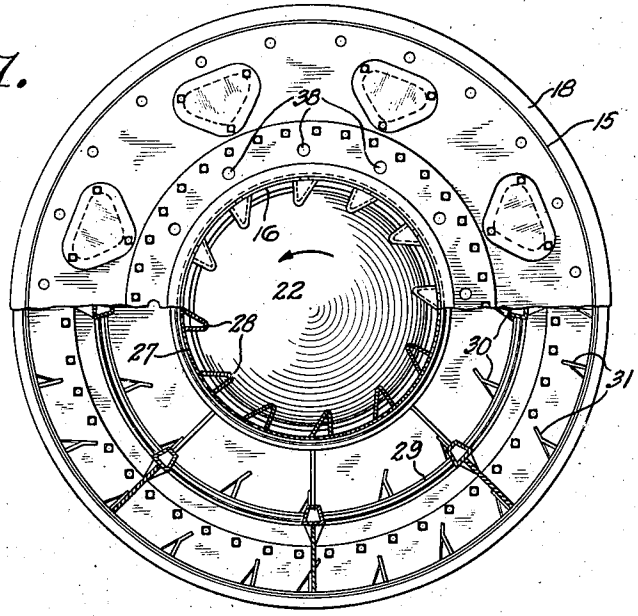
Fig. 7.



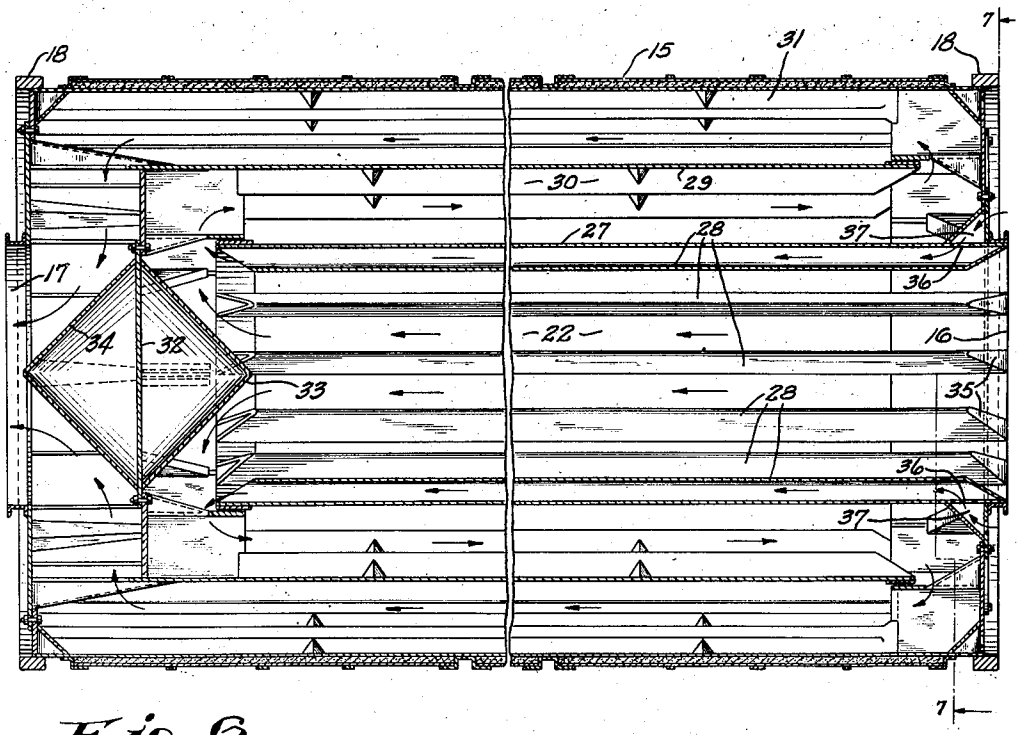


Fig. 6.

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2,319,674

ROTARY DRIER

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Original application July 3, 1939, Serial No. 282,592. Divided and this application October 11, 1941, Serial No. 414,582

10 Claims. (Cl. 263—32)

Our invention relates in general to improvements in the art of dehydrating bulk materials, and relates more particularly to various improvements in the construction and operation of rotary driers of the type wherein solid particles such as hay mixed with heated gases such as air, are constantly urged through a revolving drum, the dried material being separated from the heating medium at the discharge end of the assemblage. The present application is a division of application Serial No. 282,592, filed July 3, 1939.

Generally defined, an object of our invention is to provide various improvements in the construction of rotary driers, whereby the cost of construction and operation thereof is reduced to a minimum while the efficiency is enhanced to a maximum.

Some of the more important specific objects of the present invention are as follows:

To provide a drier wherein the material being treated is mixed with the drying medium and the mixture is drawn through the drying zone in a continuous stream, and in which fresh material may be introduced into the advancing stream of mixture without admitting excessive quantities of cold air to the drying zone.

To provide improved instrumentalities for protecting the various elements of a drying unit, against deterioration due to exposure to the weather and excessive heat.

To provide a self-contained complete rotary drier installation which is neat and compact in appearance, which is readily transportable and installable, and which may be operated with minimum power consumption.

To provide an improved automatic cooling system for the material agitating flights of a revolving drum drier or the like, whereby the life of the drum may be materially prolonged.

These and other objects and advantages of the present invention will be apparent from the following detailed description.

A clear conception of the several features constituting the present improvement, and of the mode of constructing and of operating rotary drier installations embodying the invention, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a perspective view of a rotary drier installation embodying the invention;

Fig. 2 is an enlarged transverse vertical section through the material discharge and fan housing, showing the improved product purifier in action;

Fig. 3 is a fragmentary section similar to that of Fig. 2, but showing the purifier inactive, and the parts adjusted for direct delivery of the product;

Fig. 4 is a side elevation of the delivery end of the improved drier installation, showing the parts in a position correspoinding to Fig. 2;

Fig. 5 is an end view of the drier installation looking toward the delivery end thereof;

Fig. 6 is a further enlarged longitudinal central vertical section through fragments of the drier drum, showing details of the air cooling system; and

Fig. 7 is a part sectional end view of the inlet end of the drum of Fig. 6, the section being taken along the line 7—7.

While our invention has been shown and described herein as being specifically applied to a rotary drier wherein material such as green hay is adapted to be drawn by suction along a circuitous path through the revolving drum, it is not the intent to thereby unnecessarily restrict the scope of utility of the improvement.

Referring to the drawings, the improved dryer installation illustrated therein comprises in general a horizontally elongated externally insulated rotary drying drum 15 having an inlet 16 at one end and an outlet 17 at its opposite end, the drum being provided with end tires 18 cooperable with rollers 19 to rotatably support the same; a feeder 20 and a furnace 21 associated with the inlet end of the drum 15 and cooperating with the drier inlet 16 to constantly introduce a mixture of raw material and heated gas into the drying zone 22; a dry material discharge housing 23 and a gas separator 24 associated with the discharge end of the drum 15 and having therein a main fan 25 cooperating with the outlet 17 to constantly withdraw the mixture of treated material and spent heating medium from within the drum 15; and mechanism including a motor 90 enclosed within the housing 23, for rotating the fans, revolving the drum 15, and actuating the feeder 20.

The improved rotary drying drum in which the circuitous drying passage or zone 22 is confined, has therein an inner central cylindrical shell 27 communicating with the inlet 16 and provided with internal longitudinal hollow flights 28, and also has an intermediate shell 29 mounted therein between the shell 27 and the outer drum 15, see Figs. 6 and 7. The intermediate shell 29 and the drum 15 are also provided with internal

longitudinal flights 30, 31 respectively; and the discharge end of the inner shell 27 is spaced from a partition 32 mounted within the shell 29 in spaced relation to the outlet 17, while the discharge end of the intermediate shell is spaced from the inlet end head of the drier drum, thereby providing the circuitous passage. The partition 32 is provided with a cone 33 on one side thereof for deflecting the stream of mixed solids and gases from the inner shell 27 into the intermediate shell 29, and has a cone 34 on its opposite side for deflecting the departing mixture through the outlet 17. The overhanging ends of the shells 27, 29 are mounted for free expansion longitudinally of the drum 15; and the hollow flights 28 within the shell 27 have their ends adjacent the cone 33 open while their opposite ends 35 are closed, but communicate through ports 36 with an annular chamber 37 which in turn is in open communication with the ambient atmosphere through ports 38. This construction of the flights 28 causes a constant circulation of relatively small quantities of cooling air therethrough during normal operation of the drier and protects these flights 28 against rapid deterioration due to exposure thereof to the hot gases entering the drying zone 22.

The endless conveyor type of feeder 20 which is cooperable with the drier to insure uniform admission of an uninterrupted supply of raw material to the drying zone 22, is shown in detail in our co-pending application and communicates directly with the drier inlet 16.

The furnace 21 for supplying heated gases to the drying zone 22 through the inlet 16, may be either oil or gas fired, and is adapted to deliver the heating medium in swirling condition toward the inlet 16 and beneath the feeder delivery passage. The gravitating solids are thus spread and intimately mixed with the gaseous heating medium, and the temperature of this mixture may be modified by admitting regulated quantities of tempering air in any desired manner. The furnace 21 may be readily detached from the drum 15 and feeder 20, and the feeder 20 may likewise be readily detached from the drum 15, so that the heating, feeding and drying units of the installation may be conveniently handled for shipment and installation.

The improved dry material discharge housing 23 which also serves to support the separator 24 and to enclose the power plant and auxiliaries, is shown in detail in Figs. 1 to 5 inclusive, and comprises three adjoining compartments 67, 68, 69 all forming part of the housing 23. The inner compartment 67 provides an enclosure for the main suction fan 25, and has a side inlet communicating directly with the drum outlet 17, and also has a tangential peripheral discharge passage 70 which is in open communication with the upper end of the cyclone separator 24. This separator 24 is of the well known type wherein the heavier particles are separated from the gases by centrifugal force created by swirling the mixture about a central upper gas outlet, and in which the separated heavy solids or particles gravitate toward a lower outlet opening 71. The main fan 25 is mounted upon one end of a shaft 72 which passes entirely through the housing 23 axially of the drum 15, and the opposite end of this shaft has an auxiliary fan 73 mounted thereon and is also provided with a driving pulley 74, see Figs. 4 and 5.

The intermediate compartment 68 of the housing 23, has a downwardly directed fixed spout 75 therein which communicates directly with the separator outlet opening 71, and below this spout 75 is located an adjustable by-pass chute 76 and a heavy particle separator and final cooling conduit 77, see Figs. 2 and 3. The chute 76 is rectangular in transverse cross-section and is slightly longitudinally tapered, and is moreover swingably adjustably suspended by a hinge 78 so that the chute will normally tend to assume a position as indicated in Fig. 2, in vertical alinement with the spout 75. The chute 76 may be provided with a latch or other means for positively holding it in vertical position, although the suction normally existing therein will tend to maintain this chute in such position. The front of the chute 76 is provided with a normally closed sight opening 79, and may be swung about its suspension hinge 78 into the position shown in Fig. 3 whereupon material passing through the chute 76 may be discharged at the front of the compartment 68 directly from the separator 24. The medial portion of the inclined separator and cooling conduit 77 is upwardly open and is normally disposed in direct vertical alinement with the open lower end of the chute 76, and an adjustable baffle plate 80 attached to the front wall of the housing 23 extends toward the conduit axis and may be readily adjusted to various angular positions about a pivot 81 in order to vary the velocity of the flow. The lower end of the conduit 77 has an opening which may be closed by a cover 82, but the cover 82 may be disposed in open position as in Fig. 2 when the chute 76 is in vertical position. Above the medial upper opening in the inclined conduit 77, is a fixed downwardly extending baffle wall 83, and the upper end of this conduit 77 is curved laterally and extends into the outer compartment 69 axially of the shaft 72.

The outer compartment 69 of the housing 23 forms an enclosure for the auxiliary fan housing 84 within which the fan 73 is confined, and the axial inlet opening 85 of the fan 73 communicates directly with the separator conduit 77 while the peripheral tangential outlet 86 thereof communicates with a final delivery pipe 87 which may lead to any desred storage space or bagging zone. The housing compartment 69 may also be provided with front and rear inspection doors 88, 89, respectively, and besides enclosing the auxiliary fan, this compartment 69 also houses an electric motor 90 which is operatively connected to the fan driving pulley 74 by a belt 91. The motor 90 may also be drivingly connected in any suitable manner, with a universal driving connection 92 associated with one of the drum supporting rollers 19 through suitable reduction gearing located within an auxiliary housing 93, so that operation of the single motor 90 will produce simultaneous operation of the fans 25, 73, drum 15, and feeder 20. The rear door 89 is exposed to both compartments 68, 69, and is provided with a screen as shown in Fig. 2, for permitting passage of atmospheric air to the fan 73. The separator 24 may be readily detached from the housing 23, and the housing 23 with its contents may be readily detached from the drum 15, for shipment, and the entire assemblage may therefore be conveniently handled in the form of segregated units for transportation, but may also be quickly assembled into a complete installation.

When the drier installation has been properly constructed and assembled, and the motor 90 is placed in operation, the fans 25, 73 are rotating, the drum 15 is revolving, and the feed conveyor

20 may be placed in operation and any material deposited within the feed conveyor hopper will naturally be carried upwardly and deposited into the conduit leading from the furnace 21. During normal operation of the furnace 21, hot gases of combustion mixed with heated air are being delivered with a swirling motion through the drier inlet 16, and the bulk material which is being fed in a constant stream by the feed conveyor will be mixed with the swirling hot gases, and the mixture will advance through the drier due to the suction created by the main fan 25 adjacent the drier outlet 17. During its passage through the drier drum 15, the solid particles of the mixture will be constantly showered across the interior of the shell 27 by the revolving flights 26, and the particles are ultimately drawn past the cone 33 into the intermediate shell 29 where the solid particles are further showered across the stream of hot gases. From the end of the shell 29, the mixture passes into the outer annular space where the revolving flights 31 further shower the solid particles and agitate the mixture, and the finally treated material is ultimately discharged through the outlet 17 along the cone 34. The fan 25 then propels the mixture of solids and gas through the main separator 24 wherein the spent gases of combustion and heated air are separated from the dry material, and the latter is discharged through the spout 75.

If the chute 76 is disposed as shown in Fig. 3, the dried material is by-passed to the exterior of the housing 23. If, however, the chute 76 is disposed as shown in Fig. 2, the dried material is drawn through the inclined conduit 77 and upwardly through the fan 73 where it is cooled and eventually delivered through the pipe 87. During passage of the solids into the conduit 77, the abnormally heavy particles such as stones and metallic particles, are separated by gravity and flow downwardly and out of the lower end of the conduit 77. The lighter dried product passes upwardly past the baffle 83 and through the fan 73, and is thoroughly cooled during this passage.

From the foregoing detailed description it will be apparent that the present invention provides an improved drier installation which is extremely simple and compact in construction, and which is moreover highly efficient in operation. The formation of the inner flights 28 of the revolving drum, with air passages therethrough prolongs the life of the drier and also offers an opportunity for increased production. Due to the circulation of air through the flights 28, these flights do not become overheated and thus tend to eliminate scorching of material. The cooling of these flights also permits the use of higher inlet temperatures so that more material can be fed into the machine in order to absorb the additional heat.

The improved housing 23 provides an enclosure for both fans, for the driving motor, and for accessory apparatus such as oil pumps, compressors, and expansion tanks. This housing also encloses the auxiliary separator and cooler, and serves as a support for the main separator 24. The housing 23 with the apparatus confined therein may be readily handled as a unit and thereby facilitates assembly of the installation. The adjustable chute 76 which permits direct by-passing of the treated product, is of considerable advantage in many instances, and the adjustable baffle 80 permits variation in the velocity of flow of the material through the conduit 77 so as to insure most efficient cooling and separation of abnormal particles.

The present improvement has proven highly advantageous in actual use, and it has been found that by providing detachable units such as earlier described, the installation can be readily assembled and dismantled in the shortest possible time. The drier drum 15 is preferably externally insulated so as to prevent undesirable loss of heat, and the furnace 21 should be likewise insulated. All mechanism of the installation is effectively protected against damage and from the weather, and the interior of the drying drum is also protected against deterioration due to overheating and is devoid of objectionable corners wherein material might accumulate.

It should be understood that it is not desired to limit this invention to the exact details of construction or to the precise mode of use, herein shown and described, for various modifications within the scope of the claims may occur to persons skilled in the art.

We claim:

1. In a drier, a rotary drum having a central tubular drying zone open for the admission of material to be treated at one end and terminating axially of a deflecting cone at its opposite end, a series of elongated hollow material agitating flights extending along said zone and being sealed therefrom at the material admission end but being open adjacent said cone, conduit means connecting the sealed ends of said vanes with atmosphere, and means for reducing the pressure in said zone below atmospheric.

2. In a drier, a rotary drum having an inlet opening at one end and having a drying zone therein, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, each of said flights being hollow and having an opening communicating with the drying zone, there being an annular chamber adjacent the inlet opening of the drum communicating with the hollow interiors of all of the flights, means positioned circumferentially outwardly of the inlet opening of the drum for admitting fresh air to said annular chamber, and means for causing said fresh air to be drawn through said flights.

3. In a drier, a rotary drum having an inlet opening at one end and having a drying zone therein, means for admitting hot gases of combustion to said inlet opening, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, each of said flights being hollow and having an opening communicating with the drying zone, means including a duct circumferentially outwardly of the inlet opening of the drum for connecting portions of said flights adjacent the inlet end of the drum with the atmosphere, and means for causing air to be drawn through said flights.

4. In a drier, a rotary drum having an inlet opening at one end and having a drying zone therein, means for admitting hot gases of combustion to said inlet opening, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, each of said flights being hollow and having an opening communication with the drying zone, an annular chamber surrounding the inlet opening of the drum and connecting portions of said flights adjacent the inlet end of the drum with the atmosphere, and means for causing air to be drawn into said flights.

5. In a drier, a rotary drum having an inlet opening at one end and having a drying zone therein, means for admitting hot gases of combustion to said inlet opening, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, each of said flights being hollow and having an opening communicating with the drying zone, means including a duct circumferentially outwardly of the inlet opening of the drum for connecting portions of said flights adjacent the inlet end of the drum with the atmosphere, means for causing air to be drawn through said flights, and means adjacent the inlet opening of the drum for sealing the hollow interiors of the flights from the hot gases of combustion admitted through said inlet opening.

6. In a drier, a rotary drum including spaced inner and outer cylinders, said inner cylinder having an inlet opening at one end and having a drying zone therein, means for admitting hot gases of combustion to said inlet opening, a series of material agitating flights extending longitudinally from said inlet end of the inner cylinder toward the opposite end, each of said flights being hollow and having an opening communicating with the drying zone, means forming an annular chamber surrounding the inner cylinder adjacent the inlet end thereof, means for admitting fresh air to said annular chamber, there being perforations in the wall of the inner cylinder affording communication between said annular chamber and the hollow interiors of the flights, and means for causing air to be drawn into said annular chamber and through the flights.

7. In a drier, a rotary drum having a material inlet opening at one end, means adjacent said end for supplying heated gases to the drier, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, said flights being hollow and having outlet openings inside of the drum spaced toward the opposite end of the drum from the place of admission of heated gases to the drum, means for connecting portions of said flights adjacent the inlet end of the drum with the atmosphere, and means for causing air to travel through said flights and be discharged into the drum to act on the material after the material has first been acted upon by the hot gases.

8. In a drier, a rotary drum having a material inlet opening, means for supplying heated gases to the drier, a series of material agitating flights extending longitudinally within the drum, said flights being hollow and having outlet openings inside of the drum, means for connecting portions of said flights with the atmosphere, and means for causing air to travel through said flights and be discharged into the drum, the outlet openings of the flights being so positioned with respect to the place of admission of the hot gases to the drum that air is discharged from the flights into the drum after the material to be dried has first been acted upon by the hot gases.

9. In a drier, a rotary drum having a material inlet opening at one end, means adjacent said end for supplying heated gases to the drier, a series of material agitating flights extending longitudinally from said inlet end of the drum toward the opposite end, said flights being hollow and having outlet openings inside of the drum spaced toward the opposite end of the drum from the place of admission of heated gases to the drum, means for connecting portions of said flights adjacent the inlet end of the drum with the atmosphere, and a suction fan for causing the material to be dried to travel through the drum, said same means also causing air to travel through said flights.

10. In a drier, a plurality of spaced and communicating concentric drums rotatable together, the innermost drum having an inlet opening at one end and having its opposite end in communication with the next adjacent drum, means adjacent the inlet end of the inner drum for supplying heated gases to the drier, a series of material agitating flights extending longitudinally from the inlet end of the innermost drum toward the opposite end, said flights being hollow and having outlet openings inside of the drum spaced toward the opposite end of the drum from the place of admission of heated gases to the drum and near the place of communication between the innermost drum and the next adjacent drum, means for connecting portions of said flights with the atmosphere, and means for causing air to travel through said flights and be discharged into the drum to act on the material when the material is about to enter the next adjacent drum.

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