

Oct. 6, 1942.

J. F. SIEGFRIED
MATERIAL REDUCING MILL

2,297,804

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2 Sheets-Sheet 1

Fig. 3.

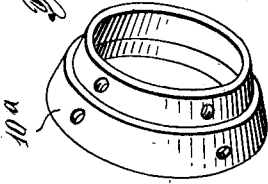


Fig. 2.

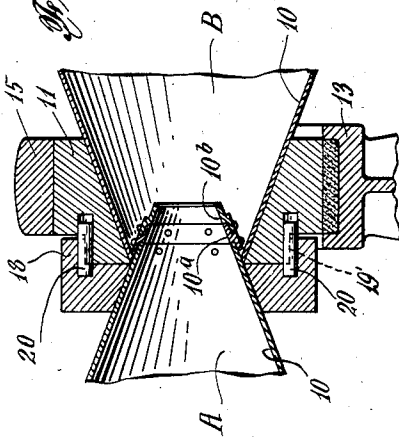


Fig. 1.

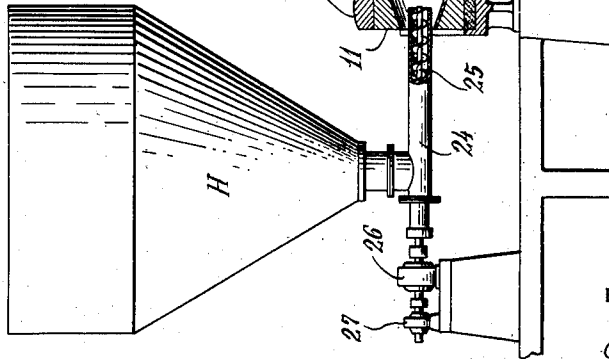
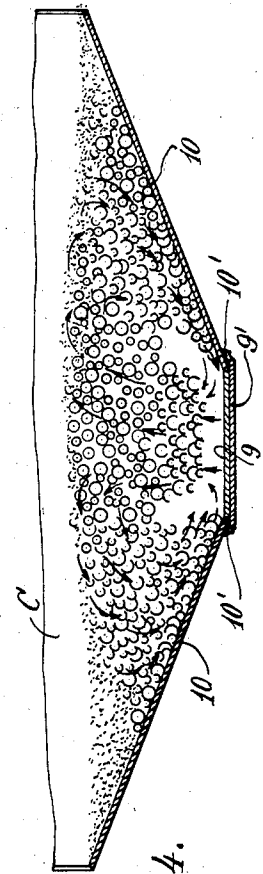


Fig. 4.

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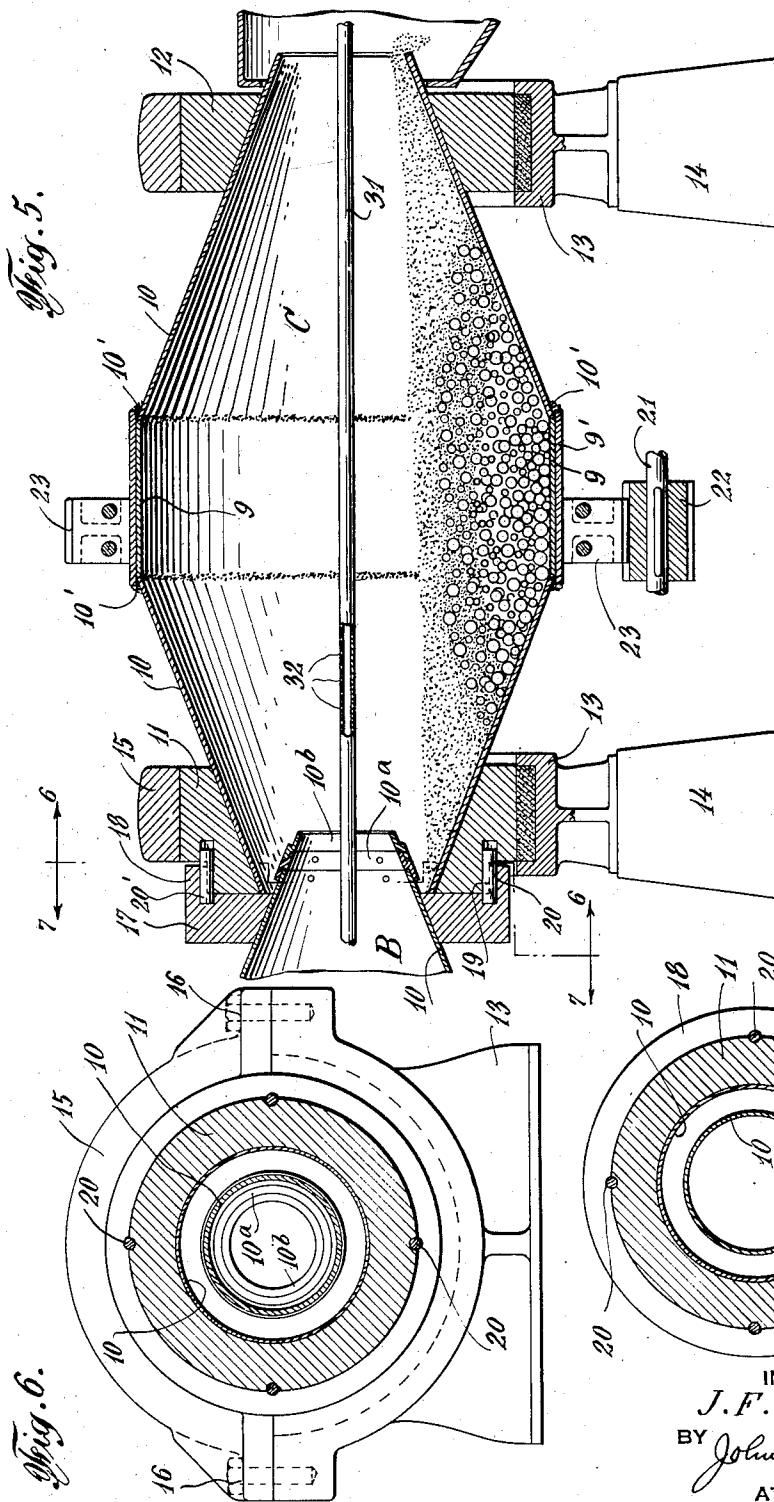
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MATERIAL REDUCING MILL

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9 Claims. (Cl. 83-9)

This invention relates to material reducing means, commonly termed tube mills, and while the invention is applicable for grinding, grading, blending and pulverizing material, it is particularly adapted for grinding and pulverizing clinker in making cement. In grinding and pulverizing cement clinker there is effected reduction of the material preliminary to delivering the material into the mill to pulverize the material, and means, such as a fan, is provided for delivering the reduced material from the mill, the fan drawing air into, through and from the mill, and delivering the material from the mill suspended in an air stream to a collecting chamber or place of storage. In so delivering the material from the mill particles of the material that have not been pulverized are drawn from the mill and means are provided to separate said unpulverized particles of material from the pulverized material by delivering the material by the fan to a separator and returning the separated material to the mill. However, it is impossible to separate flaky material or spitzer from the pulverized material and as the material is delivered through the valve controlled conduits to a place of use, or to apparatus for bagging the cement, the spitzer in the pulverized material acts to cut the conduits and valves and the valve seats, rendering the same useless within a very short time and requiring frequent renewal of the parts.

It is the primary object of the invention to provide an improved construction and arrangement of material reducing mills operative without a preliminary reduction of the material to effect a primary reduction of the material and a final reduction of the material to an impalpable powder or flour and floating off the pulverized material in said condition from the mill free of spitzer, flaky and coarse particles.

It is another object of the invention to provide an improved material reducing and pulverizing mill including endwise arranged rotatable reducing chambers of progressively increased capacity connected together in a unitary structure in axial communication with each other, said reducing chambers having freely moving grinding elements therein and arranged to prevent cascading of the grinding elements and cause the load in the chambers to move to the center thereof and effect reduction of the material by the attrition action of the grinding elements on the material and requiring a minimum amount of power to rotate the same.

It is a further object of the invention to provide an improved material reducing and pulveriz-

ing mill including endwise arranged tubular bodies having grinding elements therein, each body being in the form of a drum having an intermediate portion of uniform diameter and the intermediate portion of successive bodies arranged of increased diameter and length relative to the intermediate portion of a preceding drum, and the ends of the drums tapering from said intermediate portions toward the axes of the bodies at the same angle and at an acute angle to the axes of the bodies and having inlet and outlet openings at the opposite ends, and said openings of a preceding drum being of reduced diameter relative to the diameter of said openings of the next successive drum with the outlet of a preceding drum opening to the inlet opening of the next successive drum, and the drum having the intermediate portion of largest diameter arranged for the connection of power means to rotate the mill.

In mills for reducing clinker in cement making, the reducing chamber becomes heated due to the frictional movement of the material reducing media and the material which causes any moisture content of the material to vaporize with the result that the pulverized material absorbs said vapors and causes the same to adhere to the wall of the chamber.

It is another object of the invention to provide means to admit air into the reducing chamber or chambers at a slightly higher pressure than atmosphere to cool the mill and expel any vapors from the mill.

In the drawings accompanying and forming a part of this application, Figure 1 is a side elevation showing an embodiment of the invention, and partly in section to show the rotatable mounting of one end of a material reducing chamber and a screw conveyor for feeding material to be pulverized into the mill.

Figure 2 is a sectional view, on an enlarged scale, showing the mounting of the primary reducing drum at the outlet end from the inlet end of the next succeeding drum and the manner of rotatably supporting said latter drum at the inlet end.

Figure 3 is a perspective view of a removable end portion at the outlet end of the reducing chambers.

Figure 4 is a longitudinal sectional fragmentary view of a reducing chamber and showing in a diagrammatic manner the movements of the material reducing elements and material in the reducing chambers to triturate the material as the mill is rotated.

Figure 5 is a longitudinal sectional view, on an enlarged scale, of the drum at the right of Figure 1 to show the manner of rotatably supporting the drum at the outlet and inlet ends and the supporting of the preceding drum at the outlet end.

Figure 6 is a sectional view taken on the line and looking in the direction of the arrows 6-6 in Figure 5; and

Figure 7 is a sectional view taken on the line and looking in the direction of the arrows 7-7 in Figure 5.

In carrying out the embodiment of the invention illustrated in the drawings the mill comprises a series of endwise arranged axial drums, shown as three in number, A, B and C, and arranging the mill with primary, secondary and final material reducing chambers. Each of the chambers comprises a tubular body in the form of a drum having an intermediate portion 9 of uniform diameter and end walls 10 connected to the ends of the intermediate portion, as by butt welding, and tapering from said intermediate portion toward the axis of the body and open axially at the opposite ends, one opening constituting an inlet and the other an outlet. The intermediate portion 9 is reinforced by an annular member 9' disposed about the exterior and of greater width than the length of the intermediate portion 9 of the bodies and secured to the end walls 10 at the juncture thereof with the intermediate portion 9 by welding, as at 10'. The tubular bodies are provided with removable liners of wear resisting material, as is usual in tube mills. The end walls taper or decline from the intermediate wall portion at the same angle and at an acute angle of less than 30 degrees to the axis of the body, practice having shown that the mill will operate at its highest efficiency when the end walls are arranged at an angle of 21 degrees. The intermediate wall portion 9 of the body B is of increased diameter and length relative to the intermediate wall portion of the body A, and the intermediate wall portion of the body C is of increased diameter and length relative to the intermediate wall portion of the body B, thereby increasing the capacity of a successive body relative to a preceding body, and the increase in the capacity of the body C over body B being in direct proportion to the increase in the capacity of the body B over the body A.

The bodies are rotatably mounted in axial alignment with the outlet of a preceding body in communication with the inlet of the next successive body and connected together in a unitary structure to rotate in unison and whereby one body is rotated from the rotation of another body. For this purpose a bearing member 11 is mounted on the inlet end of the end walls 10 of each of the bodies with the end of the bearing member flush with the end of said end wall portion, as shown in Figures 1, 2 and 5, and secured to said end wall as by welding or otherwise. A bearing member 12 is also mounted on the end wall 13 at the outlet end of the body C and secured thereto, as by welding or otherwise, and said bearing member arranged with the end wall extending therefrom, as shown in Figure 5. The bearing members 11 and 12 rotatably engage bearing supports 13 mounted in alignment on suitable foundations 14, the bearing members being retained in the supports 13 by caps 15 secured to the bearing supports 13 by bolts or screws, as shown at 16. The bodies A and B are supported at the outlet ends from and operatively connected to the bearing members 11 by

means of an annular bearing member 17 mounted on the outlet end wall portions of said bodies A and B with said end walls extended through and from said bearing member, as shown in Figures 2 and 5, said bearing members being secured to the end wall portions as by welding or otherwise. The bearing members 17 each are arranged with an annular peripheral flange 18 projecting from the outer end of said members which is adapted to be engaged upon a portion of reduced diameter 19 projecting from the outer end of the bearing members 11 mounted on the bodies B and C. To transmit the rotary movement of one body to another and rotate the bodies in unison about a generally horizontal axis keys in the form of pins 20 are engaged in aligned sockets in and spaced about the opposed faces of the bearing members 11 and 17, as shown in Figures 2 and 5. By this arrangement the outlet end of the body A extends into the inlet end of the body C so that the outlet of the body A when the bodies are connected constitutes the inlet to the body B and the outlet of the body B the inlet to the body C. The outlet of body A is of increased diameter relative to the inlet to said body, and the outlets of the successive bodies B and C are of progressively increased diameter, the diameter of the outlet of the body C being increased proportional to the increase in the diameter of the outlet of body B over the diameter of the outlet of body A whereby the material is adapted to be retained at a higher level in the body A before it is floated off through the outlet of said body than in the body B, and the material in the body B is adapted to be retained at a higher level than in the body C. Each of the bodies has freely moving material reducing elements therein, such as steel balls. While it is not absolutely essential to the efficient operation of the mill the balls preferably in the body C are of less size than the balls in the body B, and the balls in the body B are of less size than the balls in the body A, and in the operation of the mill the quantity of the reducing elements in each chamber is less than the material to be reduced and pulverized.

The mill is preferably rotated through the body C and for this purpose the power means to rotate the mill is operatively connected to said body C. As shown in Figure 1, the driving means comprises an electric motor M connected through a speed reducing mechanism S to a drive shaft 21 having a pinion 22 fixed thereon meshing with an annular gear 23 disposed about and connected to the intermediate portion of the body C. Means are provided to feed the material to be reduced and pulverized into the mill at a predetermined constant rate proportional to the capacity of the mill to pulverize and deliver the pulverized material from the mill, and is shown as a screw conveyor consisting of a tubular housing 24 supported co-axially of and with the outlet end in communication with the inlet to the primary reducing chamber A with an outlet of a hopper H for the material connected to the housing through the side wall adjacent the opposite end to cause the material to flow by gravity from the hopper into the housing. The material is delivered through the housing by a screw 25 rotatable in the housing and operatively connected through a speed reducing device 26 to a motor 27.

To convey the pulverized material delivered from the mill to a place remote from the mill the body C discharges into a casing 28 having a chute 29 connected thereto leading to a screw

conveyer, as shown in a conventional manner at 30.

By the construction and arrangement of the respective material reducing chambers the load therein consisting of the reducing elements and the material moves to the center of gravity of the chambers, that is, toward the intermediate wall portion 9 below the axes of the chambers. As the mill is rotated the load is moved from the center of gravity in the mill in the direction of rotation of the mill, the material and reducing elements disposed relative to the opposite side of the center of gravity and relative to the end walls 10 moving to the center of gravity in the chambers, and the balls and material moved by the rotation of the mill moving laterally toward the end walls 10 and thence to the center of gravity of the chambers, the material and balls moving in directions substantially as indicated diagrammatically by the arrows in Figure 4. By this movement of the load through the rotation of the mill coarse material and the balls at all times tend to move to the center of gravity of the bodies effecting a separation of the coarse material from the fine material and the fine material rising to the top of the material in the reducing chambers and floating off through the outlet of the reducing chambers and at the same time the material is subjected to the attrition action of the balls. By the rotation of the mill there is a continuous movement of the balls and material away from the center of gravity and then again to the center of gravity of the reducing chambers without any cascading of the balls, as is the case in the present commercial types of material reducing tube mills, and resulting in a quick and more effective reducing of the material. In practice it has been found that the mill may be rotated at three times the speed of the present commercial types of tube mills without slippage of the load relative to the reducing chambers and without cascading of the balls in the respective chambers. Furthermore, practice has shown that by connecting the respective bodies of the mill and rotating the bodies in unison by applying the power to rotate the mill to the body of larger size that the force of carrying over and the momentum of the load in the body of larger size exerts a force on the bodies of smaller size to rotate the same with the result that the power required to rotate the mill is approximately one half the power required to rotate the present commercial types of tube mills of the same capacity. Also, the mill may be rotated at different speeds without any increase in power to rotate the mill and the mill will function with equal efficiency at high and low speeds.

It may be desirable to effect a less reduction of the material and quicker delivery of the material from the chamber A to the chamber B and from the latter chamber to the chamber C. To produce this result means are provided to increase the size of the outlets of said chambers A and B whereby a less quantity of material is retained in said chambers and comprising sections, shown as two in number, 10a and 10b, adapted to be removably connected to and constitute extensions of the end walls 10, the one section 10a having an end offset laterally and adapted to be engaged in overlapped relation to the end of the wall 10 and secured thereto by suitable means, such as machine screws, and the other section 10b also having an end offset laterally to overlap the section 10a and secured thereto as by machine screws, as shown in Figures 2 and 5. By this arrangement said sections form continuations of

the end wall 10 extending in the plane of the wall thereof. It will be obvious that by removing sections 10b the size of the outlets of the bodies A and B will be increased and that by removing the sections 10a there will be a further increase in the area of the outlets of said bodies which will cause the material to flow at a lower level from the drums than when said sections are connected to the outlet end of the drums.

By the attrition action of the material reducing elements on the material and friction between the reducing elements and bodies the mill and material become heated and a consequent vaporizing of any moisture content of the material, which is absorbed by the pulverized material and causes the same to adhere to the wall of the reducing chambers. To cool the mill and eject vapor in the reducing chambers means is provided for admitting air into respective chambers of the mill at a somewhat higher pressure than atmosphere. For this purpose a pipe 31 is extended through the respective reducing chambers, the pipe having perforations 32 in the wall thereof, as shown in Figure 5, and the pipe positioned so that said perforations open to the reducing chambers above the axis thereof to direct air issuing from the perforations or ports into the reducing chambers above the material therein. The pipe is connected to means, such as a pump (not shown), for delivering air thereto. The air issuing from the pipe ports into the reducing chambers not only cools the mill but causes a sufficient flow of the air to eject any vapors from the mill.

It will be obvious that various modifications may be made in the construction and arrangement of the parts without departing from the scope of the invention.

Having described my invention, I claim:

1. In a mill, primary and secondary reducing chambers having freely moving reducing elements therein, each chamber comprising a horizontal axis drum having an intermediate portion of uniform diameter and end wall portions tapering from the opposite ends of the intermediate portion toward the axis at an angle less than 30 degrees relative to said axis and having axial inlet and outlet openings at the opposite ends, said openings of the secondary drum having a larger diameter than the corresponding openings of the primary drum, and the intermediate portion of the primary drum being of less diameter and length than the corresponding portion of the secondary drum, bearing members mounted on the opposite ends of the secondary drum for rotatably supporting said drum, means connected to said secondary drum adapted for the application of power means to rotate said drum, a bearing member mounted on the inlet end of the primary drum for rotatably supporting said drum at the inlet end, a bearing member mounted on the outlet end of the primary drum supported on the bearing member mounted on the inlet end of the secondary drum with the outlet end of the primary drum extending through the inlet end of and into the secondary drum and retaining material in the primary drum at a higher level than in the secondary drum, and means to connect said latter bearing members to rotate the primary drum from and in unison with the secondary drum.

2. A mill comprising primary and secondary reducing chambers mounted for rotation as a unit about a generally horizontal axis, each chamber comprising a drum having an intermediate por-

tion of uniform diameter and end portions tapering from the opposite ends of the intermediate portion toward the axis, and each drum having axial inlet and outlet openings at the opposite ends, the intermediate portion of the primary drum being of less diameter and length than the corresponding portion of the secondary drum, a bearing member mounted at each end of the secondary drum for support thereof, the inlet end bearing member having a portion of reduced diameter driving means for said mill disposed about the intermediate portion of said secondary drum, a second set of bearings, one at each end of said primary drum for support thereof, the primary drum outlet end bearing member being supported by and in driving engagement with the reduced diameter portion of said secondary drum inlet end bearing member, said primary outlet end extending into said secondary drum inlet end.

3. In a mill, primary, secondary and final reducing chambers mounted for rotation about a generally horizontal axis, each chamber comprising a drum having an intermediate portion of uniform diameter and end portions tapering from the opposite ends of the intermediate portion toward the axis, and each drum having axial inlet and outlet openings at the opposite ends, means mounted at the opposite ends of the drums for rotatably supporting and connecting the drums to rotate as a unit with the outlet end of a preceding drum extending through the inlet opening of and into the next successive drum, means connected to the final drum adapted for the application of power to said final drum and rotary the secondary and primary drums from and in unison with said final drum, and each drum having freely moving grinding elements therein operative by the rotation of the drums to triturate material in the drums without cascading movement of the material and said triturating elements, and the inlet and outlet openings of a successive drum being of increased diameter relative to the diameter of the inlet and outlet openings of the preceding drum adapting the drums to retain the material at successive lower levels in the successive drums and cause the triturated material to float off from the drums through the outlet openings, and means to feed material at a uniform rate into the primary drum through the inlet opening thereof.

4. A mill comprising a series of tubular bodies each body having an intermediate portion of uniform diameter and the end portions tapering from the opposite ends of the intermediate portion toward the axis at an angle of not more than 30 degrees and having axial inlet and outlet openings at the opposite ends, a bearing member mounted on each end of the bodies for rotatably supporting and connecting the bodies for rotation as a unit about a generally horizontal axis with the outlet end of a preceding body extending through the inlet opening of and into the next successive body, the intermediate portion of a preceding body being of smaller diameter and less length than the corresponding portion of the next successive body and the openings of a preceding body being of less diameter than the diameter of the next successive body whereby to retain material at a higher level in a preceding body than in a successive body and float off material from a preceding body into a

successive body, freely moving elements in each body operative by the rotation of the bodies to triturate material therein, means to feed material at a predetermined constant rate into the primary body through the inlet opening thereof, and means disposed about the intermediate portion of the final body adapted for the application of power to rotate the bodies in unison.

5. A mill as claimed in claim 1, wherein the means to feed material at a constant predetermined rate into the primary drum comprises a screw conveyer including a housing of less diameter than and opening to the inlet opening of the primary drum and adapted at one end for connection to a source of material, and a rotatable conveying screw in said housing.

6. In a mill as claimed in claim 1, means to admit air at a pressure slightly higher than atmospheric pressure into the drums to cool and expel vapors from the drums.

7. In material reducing means, a series of rotatable drums to contain material to be reduced and freely moving material reducing elements in quantity less than the material, each drum having an intermediate portion of uniform diameter and tapering from said intermediate portion toward the axis at an angle of not more than 30 degrees and having inlet and outlet openings axially at the opposite ends, the inlet and outlet openings of a preceding drum being of less diameter than said openings of the next successive drum, means to support the drums at the opposite ends and connect a preceding drum at the outlet end to the inlet end of the successive drum for rotation of the drums in unison about a generally horizontal axis, and the outlet end of a preceding drum being extended into the inlet opening of a successive drum whereby to retain material at a higher level in a preceding drum than in a successive drum and cause the material to float from a preceding drum into a successive drum to above the level of the material in the latter drum, means disposed about the intermediate portion of uniform diameter of the last drum of the series adapted for the application of power to rotate the drums in unison, said drums adapted by the rotation thereof to move the material and reducing elements from the center of gravity of the portions of the drums of uniform diameter of the drums upwardly in the direction of rotation of the drums and cause the same to move to the tapering ends of the drums without cascading movement thereof and cause the material and reducing elements to move along the tapering ends toward and displace the material and reducing elements moved from the center of gravity of the portion of uniform diameter of the drums.

8. In a mill as claimed in claim 1, conical members adapted for removable connection endwise to the outlet end of drums opening to the inlet end of successive drums to vary the quantity and level of material retained in said drums.

9. In a material reducing mill as claimed in claim 1, a pipe extended longitudinally through the drums having ports in the side wall opening to the drums above the axis thereof adapted for connection to a source of and admission of air into the drums at a pressure slightly higher than atmospheric pressure to cool the drums and expel vapors therefrom.

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