Nov. 29, 1955 R. E. WHITE ET AL 2,724,909

DRUM DRIER

Filed March 27, 1953

Fig 1.

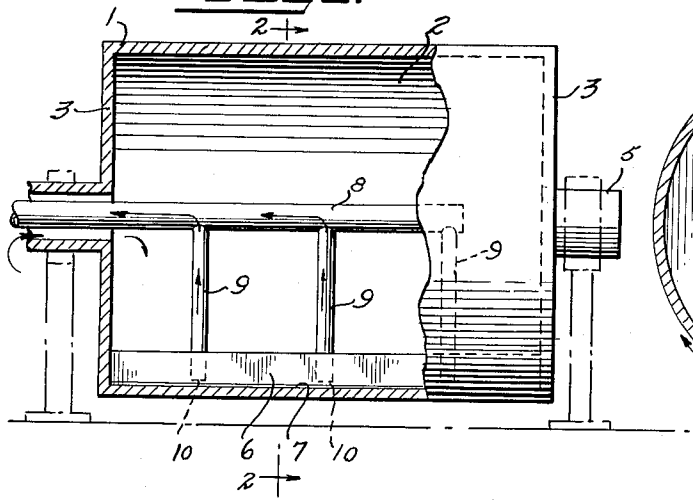


Fig 2.

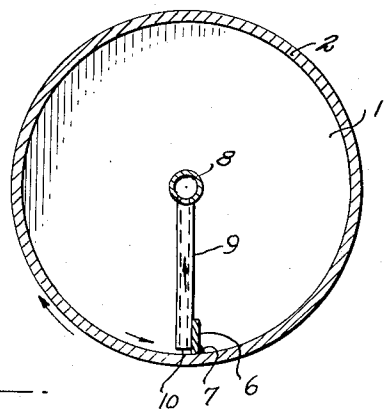


Fig 3.

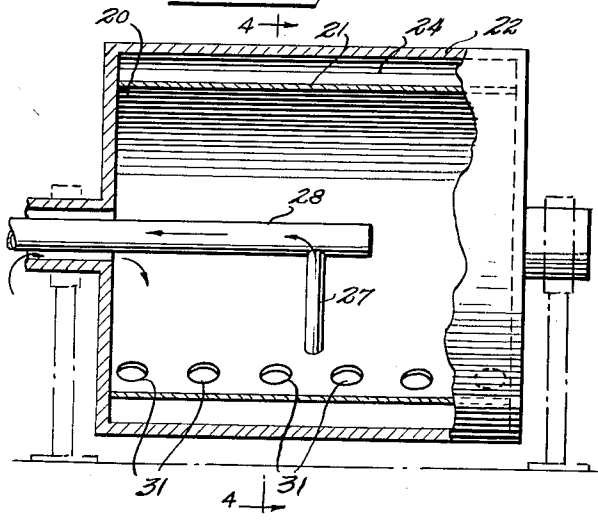
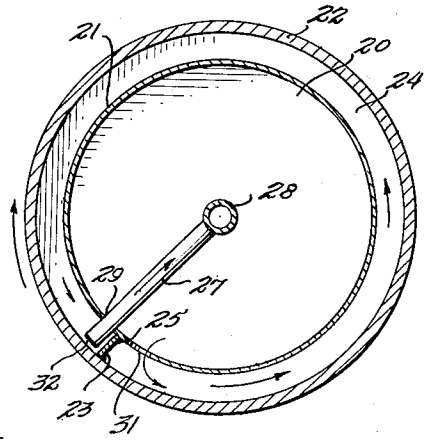


Fig 4.



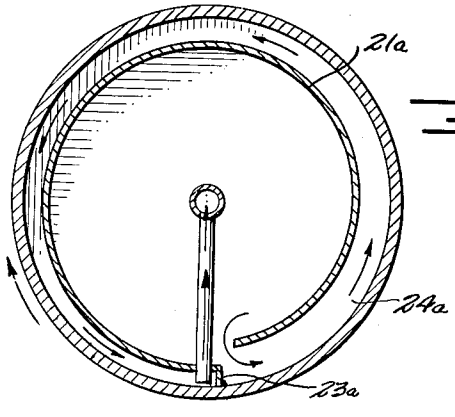


Fig 5.

INVENTOR
Robert E White
Anthony T. Cirrito

BY Daniel E. Ogo

ATTORNEY

United States Patent Office 2,724,909 Patented Nov. 29, 1955

2,724,909

DRUM DRIER

Robert E. White, Havertown, and Anthony J. Cirrito, Honey Brook, Pa., assignors to Lukens Steel Company, Coatesville, Pa., a corporation of Pennsylvania

Application March 27, 1953, Serial No. 345,104

4 Claims. (Cl. 34—124)

This invention relates to drum driers including the single shell and double shell type and particularly to rotating drum driers wherein steam is employed as the heat exchange medium.

Single and double shell drum driers including steam inlet means and condensate removal means are common and have been in commercial existence for some time. Generally, the drier shell or shells are substantially cylindrical in shape, rotatably supported, and closed at their ends except for steam or fluid inlet means and condensate removal means. The means for removing condensate usually includes one or more syphon tubes connected with a condensate pipe. The difficulty over the years in drum driers of this type has been in the means for removing condensate and eliminating within the drier, residual ponds and a liquid film that is of a thickness that interferes with obtaining maximum heat transfer characteristics.

It is the principal object of this invention to provide a drum drier of the single shell or double shell type having means for removing condensate and non-condensable gases from the drier that will overcome the difficulties heretofore mentioned.

Another object of this invention is to provide a drum drier preferably of the type employing steam as the heat exchange medium and wherein there is provided an improved means for removing liquid condensate.

Yet another object of this invention is to provide a drum drier employing steam as the heat exchange medium having means to reduce the rimming condensate film and/or residual condensate ponds to a minimum.

A still further object of this invention is to provide a drum drier of the single shell or double shell type having improved heat transfer characteristics.

Other and further objects of this invention will become apparent from the following description of the annexed sheet of drawings which discloses preferred embodiments of the invention and wherein:

Figure 1 is a sectional view along the longitudinal length of one embodiment of the drum drier of this invention;

Figure 2 is a sectional view taken along the lines 2—2 of Figure 1;

Figure 3 is a longitudinal sectional view of another embodiment of this invention;

Figure 4 is a sectional view along the lines 4—4 of Figure 3, and

Figure 5 is a sectional view of a drum drier similar to the views of Figures 2 and 4, but showing a third embodiment of this invention.

Referring to the drawings in detail and particularly to Figures 1 and 2, the reference numeral 1 represents a drum drier of the single shell type. Drum 1 is provided

with a shell 2 of cylindrical shape and closed at its ends by end plates 3, the drum being supported for rotation in the direction indicated by any suitable means, such as journals and stuffing boxes, etc., represented generally by numeral 5.

Within drum 1 and extending the longitudinal width thereof is a blade 6, and the blade 6 is mounted to the interior of the shell 2 by means of a weld 7. It is essential that the blade 6 be substantially thin compared to the thickness of the shell 2 in order to avoid uneven heat transfer to the outer surface of the shell 2 and for this same reason, the weld 7 or other suitable sealing medium should be of minimum size. It is important that the joints between the blade 6 and the shell 2 and the blade and the end plates 3 be absolutely sealed so that no condensate will be able to flow between the blade and shell, and because of this, it is preferable that the weld extend throughout the area that the blade contacts the shell 2 and end plates 3. Mounted for rotation with the shell 2 is a condensate pipe 8, the specific manner of rotatably supporting this pipe not being shown, as any conventional means may be employed. The condensate pipe may extend any suitable distance within the drum 1 and preferably extends within the shell 2 a considerable part of its longitudinal length and at least half-way therein. Secured to the condensate pipe and communicating therewith is at least one syphon 9. The tip or end portion 10 of each syphon 9 employed should be in very close proximity to or in substantial contact with the blade 6 on its leading side with respect to the normal direction of rotation of the shell 2. The end of the tip 10 of the syphon should also be as close to the interior of the shell 2 as is practical, and preferably no more than ⅛ of an inch should separate the syphon 9 and the shell 2. Suffice it to say that the end portion of each syphon 9 must be, for proper operation, immediately adjacent or in juxtaposed position with respect to the blade 6 and the shell 2. It is important that any clearance allowed between the syphon 9 and blade 6 be maintained as small as possible, because any liquid accumulation between the blade and syphon end portion 10 is deleterious to heat transfer.

Preferably, a plurality of syphons 9 are employed, and when such is the case, the syphons are spaced at suitable distances within the drier, as indicated in Figure 1, and preferably with each tip 10 drawing from the midpoint of equal length spans of the blade 6 and of the drier. In the event only one syphon 9 is employed, to assist in removing condensate and directing same toward the entrance 10 of the syphon, the blade may be of helical arrangement with the syphon at the leading side of the trailing extremity thereof, or of V-shape with the syphon at the base of the V. In other words, unless a plurality of syphons are employed, the blade preferably should be of special construction to assist in directing liquid toward the single syphon, and for this reason, it is preferable to merely employ a straight blade as shown in Figures 1 and 2, and a plurality of syphons. Where drum driers of large diameter are used, two or more blade and syphon arrangements uniformly spaced around the shell may be employed.

It was previously mentioned that the tip 11 of each syphon 9 should be as close to the interior of shell 2 as practical. This is principally so in order to maintain the small pool existing immediately in front of the blade to a minimum. The residual film on the interior of the drying drum is considerably reduced with this arrangement, due to the fact that a velocity gradient always exists

within the film such that that portion of the film next adjacent the shell has the same velocity as the shell and the blade, while the remaining laminations of film have velocities less than that of the blade 6 and thus the blade overtakes the slower laminations.

The operation of the structure shown in Figures 1 and 2 is believed clear, but, briefly, in use the drum drier is rotated in the direction indicated at a predetermined speed, and steam is supplied to the interior of the shell 2. Some of the steam, the heat transfer medium, condenses to liquid, and it is essential that this liquid does not form a residual pond and that any liquid films formed are reduced to a minimum. The blades 6 and syphons 9, as well as the condensate tube 8, rotate with the shell 2, and in view of this and the fact that no liquid can flow between the blade 6 and the shell 2, liquid condensate and non-condensable gases are syphoned through a substantial part of each revolution of the drum and liquid ponds are substantially eliminated, and residual films are considerably reduced, thus providing substantial improved heat transfer characteristics.

Referring to Figures 3 and 4, there is shown a drum 20 having an inner shell 21 and an outer shell 22, the direction of normal rotation of the drum being indicated by the arrows in Figure 4. A blade 23 similar to blade 6 is permanently affixed between the shells 21 and 22 and in the annular space 24 created by the difference in diameter of the cylindrical shells 21 and 22. The blade 23 is preferably sealed to the outer shell 22 in the same manner as blade 6, and in addition, the blade 23 is welded, or sealed by other suitable means, at 25 to the inner shell 21, and preferably this weld, to provide a complete seal, extends throughout the area of contact of blade 23 with the inner shell 21. One or more syphons 27 communicate with a condensate tube 28 and extend by means of a tight seal fit through openings 29 in the inner shell 21. Aside from passing through openings 29, the syphons 27 are positioned in the same manner as syphons 9 with respect to blade 23 and outer shell 22.

Numeral 31 represents a plurality or a series of orifices in shell 21, the center of these orifices extending in a line parallel to the blade 23, and on the side of the blade opposite syphons 27. Instead of a plurality of apertures 31, there may merely be one continuous elongated slot extending the longitudinal length of the inner shell 21. By having holes 31 positioned in a line directly behind blade 23 with respect to the normal path of rotation of the drier or on the trailing side of the blade, the steam that enters the space 24 follows a path, indicated in the drawing, of approximately 360° in length within the space 24. Condensation takes place during travel and thus the steam velocity decreases along the path from ingress to egress. The liquid condensate is removed in the same manner as indicated in connection with Figures 1 and 2 during operation or rotation of the drier drum and supply of heat transfer fluid therein. As is the case in connection with Figures 1 and 2, the blade 23 and the relationship of the syphon or syphons therewith functions within the annular rim 24 to eliminate ponds and to reduce residual films, but in this instance, further improvement of heat transfer characteristics are obtained. Because of the relationship of slots 31 with respect to the blade 23 and the path of the vapor, non-condensable gases are swept to the outlet or inlet 32 of each syphon 29, uniform heat transfer is promoted across the complete face of exterior shell 22, and the steam acts to sweep the condensed film toward the blade 23 and thus further reduce the condensate film.

Figure 5 illustrates a further embodiment of this invention, and the structure shown is substantially identical with that shown in Figure 2, with the exception of the fact that the inner shell 21*a* is of spiral formation, and it is to be noted that the annular space 24*a* decreases from the trailing side of the blade 23*a* to the leading side thereof. In using the double shell drier of Figure 3, the advantages previously enumerated are present and, in addition, the steam velocity within the annular space 24*a* is maintained substantially constant and at a high level, in view of the decrease in cross sectional area of the rim. A constant vapor velocity results in a uniform transfer of heat around the shell, and non-condensables and condensate film are further reduced in the improved sweeping action.

Referring to the embodiments shown in Figures 3, 4, and 5, namely drums of the double shell type having an annular space therebetween, it is to be understood that heat exchange medium such as steam may be supplied to and removed from the space by passage through hollow spokes which constitute the end portions of the drier.

While the device as shown and described herein is admirably adapted to fulfill the objects and features of advantage previously enumerated as desirable, it is to be understood that the invention is not to be limited to these specific features, but that the means and construction herein disclosed are susceptible of modification in form, proportion, and arrangement of parts without departing from the principle involved or sacrificing any of its advantages; and the invention is, therefore, claimed in embodiments of various forms, all coming within the scope of the claims which follow.

We claim:

1. A drum drier comprising inner and outer shells having peripheries of different radii and thereby providing a cylindrical space therebetween, said shells being substantially closed, a fluid removal blade in said space permanently affixed to said shells to provide a seal against the passage of fluid, said blade extending the longitudinal length of said outer shell, said inner shell being provided with at least one opening communicating with the space, steam inlet means communicating with said opening, a condensate pipe mounted for rotation with said shells, and at least one syphon connected with said condensate pipe and having its tip extending in said space in close proximity to the interior of said outer shell, said opening being substantially immediately adjacent said blade on one side thereof and the syphon being substantially immediately adjacent said blade on the other side thereof, the other side being the leading side with respect to the normal direction of rotation of the drier.

2. A drum drier comprising inner and outer substantially cylindrical shells having peripheries of different radii and thereby providing a cylindrical space therebetween, means for supplying steam to said space, a fluid removal blade in said space permanently affixed to said shells to provide a seal against the passage of fluid, said blade extending the longitudinal length of said space, a condensate pipe mounted for rotation with said shells, and at least one syphon connected with said pipe and having its tip extending in said space in close proximity to and immediately adjacent the interior of said outer shell and substantially abutting said blade on the leading side thereof with respect to the normal direction of rotation of the shells, said supply means including at least one opening in said inner shell, said opening being on the trailing side of said blade and in close proximity thereto.

3. A drum drier comprising inner and outer substantially cylindrical shells having peripheries of different radii and thereby providing a cylindrical space therebetween, means for supplying steam to said space, a fluid removal blade in said space permanently affixed to said shells to provide a seal against the passage of fluid, said blade extending the longitudinal length of said space, a condensate pipe mounted for rotation with said shells, and at least one syphon connected with said pipe and having its tip extending in said space in close proximity to the interior of said outer shell and substantially abutting said blade on the leading side thereof with respect to the normal direction of rotation of the shells, said inner shell

being of spiral formation whereby the space decreases in area from substantially adjacent the trailing side of said blade to substantially adjacent the leading side thereof, and steam enters said space at the opening formed in said inner shell by the spiral configuration thereof.

4. The combination defined in claim 1 wherein said inner shell is of spiral configuration.

References Cited in the file of this patent

UNITED STATES PATENTS

784,821	White	Mar. 14, 1905
1,483,343	Gladin	Feb. 12, 1924
2,150,132	Sandwell	Mar. 7, 1939
2,521,371	Hornbostel et al.	Sept. 5, 1950
2,545,917	Cowie	Mar. 20, 1951

FOREIGN PATENTS

10,210	Great Britain	1886
350,718	France	Apr. 18, 1905