United States Patent

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[72] Inventor Gordon R. Voll
Beloit, Wis.

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[73] Assignee Beloit Corporation
Beloit, Wis.

[54] DRYER DRUM ASSEMBLY
10 Claims, 2 Drawing Figs.

[52] U.S. Cl. 165/89, 34/124
[51] Int. Cl. F26d 11/02, F26f 5/02
[50] Field of Search 34/119, 124, 125; 165/89, 90

[56] References Cited
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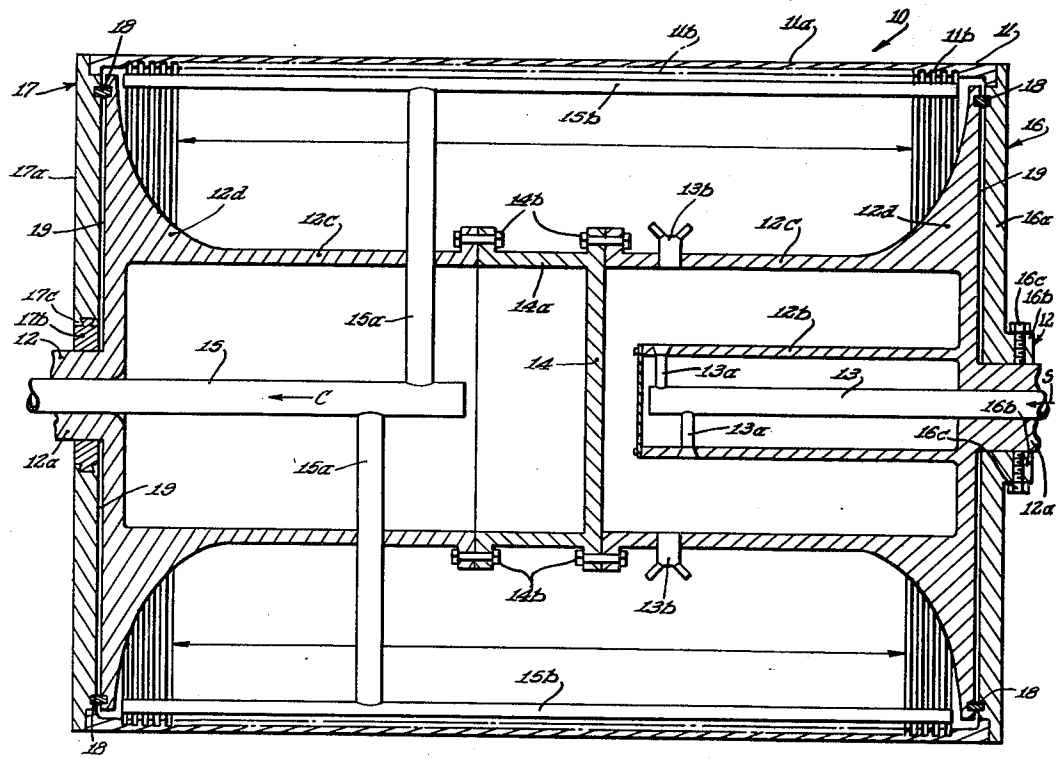
1,672,036 6/1928 Oltman 165/89
3,022,047 2/1962 Swaney 165/89

Primary Examiner—Carroll B. Dority, Jr.
Attorney—Hill, Sherman, Meroni, Gross & Simpson

ABSTRACT: An end head assembly for a steam-heated dryer drum wherein an outer portion of the end head assembly provides radial support for the drum shell on the drum journal while being free to move in an axial direction and take up any radial pressure on the shell and an inner portion is rigidly attached to the journals free of contact with the outer portion and the shell and being arranged to take up any axial pressure on the drum. Flexible seals are provided between the inner and outer portion to maintain the steam within the shell and accommodate relative movements between the inner and outer portions when the shell is subjected to various operating pressures.



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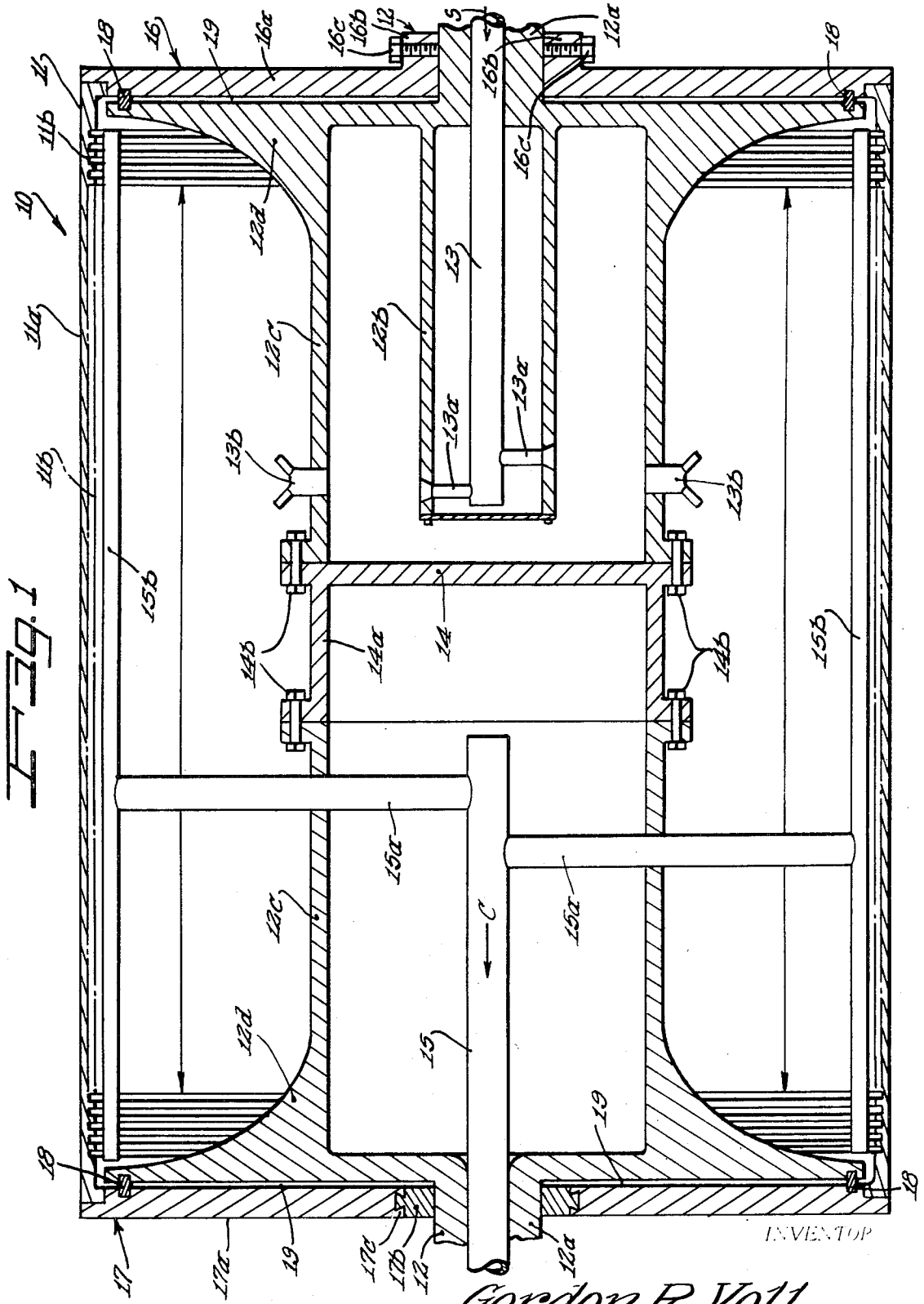

Fig. 1

INVENTOR

Gordon R. Voll

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

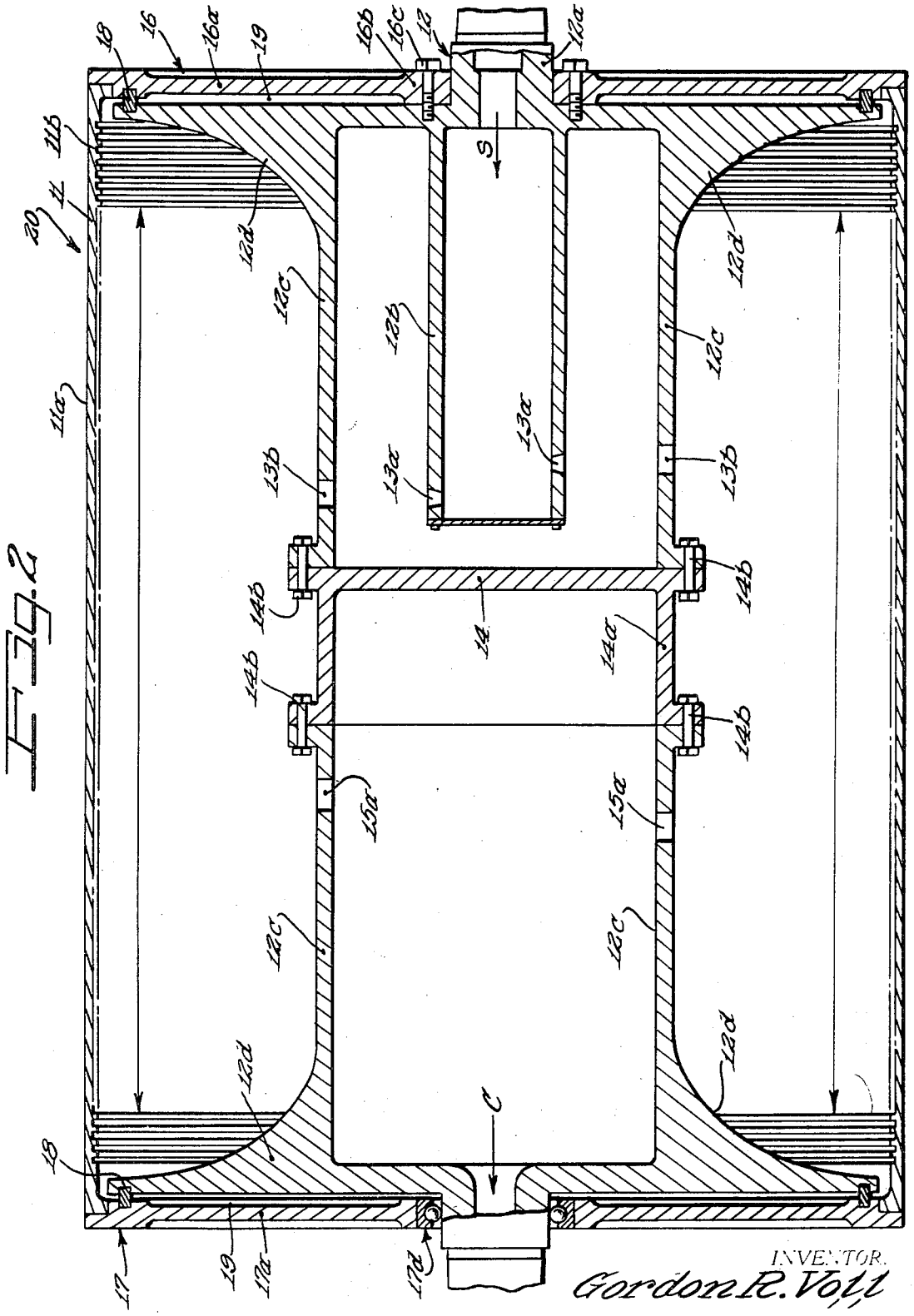

Fig. 2

INVENTOR.
Gordon R. Voll

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

DRYER DRUM ASSEMBLY

BACKGROUND OF THE INVENTION

The present invention relates to drying machinery and more particularly to improvements in steam-heated dryer drum assemblies of the Yankee type.

A dryer drum must be capable of efficiently transmitting heat to its surface and be able to withstand operating pressures for safe and efficient operation. These requirements are in diametric conflict with each other since efficient heat transfer requires minimum shell thickness while stress or pressure resistance requires a means capable of withstanding such a pressure or compensating therefore. Some prior art structures have attempted to meet these conflicting requirements by providing dryer shells having relatively thick dryer shell end portions and end head assemblies whereby the shell-head junctures are relatively massive so as to withstand any operating pressures. However, these structures are incapable of uniformly reacting to thermally induced dimensional changes and subject the dryer shells to a bending moment about the end thereof causing a deformation of the shell and/or separation between the end head assemblies and the shell. Other prior art structures have provided a relatively thin shell sealed by end head assemblies having flexible portions which compensate for any pressure induced on the shell. However, such flexible portions do not have sufficient operating life and can not withstand the high-steam pressures necessary for high-temperature drying operations. Further, head assemblies having flexible portions are complicated to assemble and are economically unattractive. The instant invention provides a relatively simple and economical dryer drum assembly overcoming to a large extent the aforesaid deficiencies.

BRIEF SUMMARY OF THE INVENTION

The invention features a dryer drum assembly wherein one end of the dryer shell is rigidly connected to an end of the drum journal by an outer head member that carries no axial pressure load. The other end of the shell is supported by an opposed outer head member on the other end of the drum journal which is free to axially move along the journal. These two outer head members carry any radial load on the drum shell directly to the journal. The drum journal has flange portions spaced from the outer head members and from the shell so that any thermally induced dimensional changes have minimal effect on the head-shell juncture and produce only minor stresses on the shell while accommodating relative movement between the head members and the drum journal.

Accordingly, it is an important object of the invention to provide an improved dryer drum assembly capable of efficient heat transfer and utilization of high-operative pressures and temperatures while avoiding detrimental stresses on the drum.

It is another object of the invention to provide a highly efficient, safe and economical dryer drum assembly wherein bending moments and axial stresses on the drum shell are minimized.

It is yet a further object of the invention to provide a novel dryer drum assembly wherein end head assemblies are provided to radially support the drum shell without being subjected to detrimental axial pressure loads.

Still another object of the invention is to provide a dryer drum assembly wherein thermally induced dimensional changes produce minimal stresses in the drum shell.

Other objects, features and advantages of the invention will become more readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope and novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, with some parts shown schematically, of an embodiment of the dryer drum assembly constructed in accordance with the principles of the invention, and

FIG. 2 is a view somewhat similar to FIG. 1, but with some parts omitted of another embodiment of the dryer drum assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The features and advantages of the invention are most clearly seen in the embodiments thereof as shown in the accompanying figures wherein like reference numerals refer to like parts.

Referring to FIG. 1, wherein an embodiment **10** of a dryer drum assembly is shown having a cylindrical shell **11** of a suitable material, such as iron, steel, etc. The shell **11** has a smooth outer surface **11***a* for contact with the material being dried, i.e., a moist paper web, and a heat-transmitting inner surface **11***b*, Preferably, the inner surface **11***b* is provided with a plurality of alternating circumferentially spaced grooves and ridges over its operative length so as to expose the greatest amount of shell surface to the heating fluid without sacrificing strength characteristics necessary for the shell walls. Additional and more explicit details of such a preferred internally grooved dryer drum construction may be obtained from U.S. Pat. Nos. 3,241,251 or 3,258,851 (both owned by the instant assignee and incorporated herein by reference).

The dryer shell **11** is concentrically mounted on a hollow drum journal **12**. The journal **12** is suitably supported on bearings (not shown) or the like at its respective ends **12***a* allowing the drum assembly to rotate about the journals in a well-known manner. As indicated, the journal **12** is hollow, having a steam inlet means **13** admitting pressurized steam (or some other heat transmitting fluid) from an appropriate source (not shown) to the interior of the journal **12**. The steam inlet means **13***a* acts as a manifold to distribute the steam substantially uniformly throughout the shell interior and is provided with inner-communicating fluid distributing means **13***a* and **13***b* that direct the pressurized steam in a uniform manner throughout the shell. The journal **12** is formed, for the sake of assembly and manufacturing convenience, from a plurality of separate joinable portions. Thus, as shown, the steam inlet end of the journal **12** may be formed to have an interiorly extending shaft stub **12***b* for positioning the steam inlet means **13** and an exteriorly extending shaft stub **12***a* for mounting of bearings (not shown) and to provide support surfaces for a radially extending end head assembly **16**. The interior shaft stub **12***b* (which may, if desired, be dispensed with) is radially spaced from and surrounded by an end body portion **12***c*. It will be noted that the shaft stub **12***b* and end portion **12***c* are connected along their outer ends and, if desired, may be integrally formed with one another, or may be suitably attached to one another, and by welding or bolting. The end portion **12***c* terminates at its inner end beyond the inner end of the stub **12***b* and is separated from the remainder of the journal **12** by a spacing member **14** (forming the mediate body portion of journal **12**) which is attached thereto by appropriate bolt means **14***b*. The end body portion **12***c* has an outer flange portion **12***d* extending radially outwardly therefrom and into close proximity with the inner wall **11***b* of the dryer shell **11**. It will be noted that the flange portion **12***d* does not contact the shell **11** and is interior of the shell ends. The flange portion, **12***d*, is here shown as being integrally formed with end body portion **12***c*, however, it may be separately formed and be suitably attached, as by welding or bolting, if desired.

The spacing member **14** has extending leg portions **14***a* which are of a predetermined length for spacing the opposed end portions **12***d* of the journal **12** to accommodate various dryer shell lengths. The spacing member **14** also provides strength characteristics to the journal and a means of joining, as by bolt means **14***b*, the opposite ends of the journal into a unitary structure.

The other journal end **12***d*, i.e., the condensate outlet end, is somewhat similarly formed as the steam inlet end but does not have interiorly extending shaft stubs, although if desired, one could be provided. The outwardly extending shaft stub **12***a* is suitably mountable on bearings (not shown) and is hollow to

accommodate a condensate removal means **15** composed of a syphon means **15***a* extending in opposite directions into dipper tubes **15***b* or the like in close proximity with the inner shell wall **11***b* for removal of spent steam and/or condensate in a well understood matter. Such condensate removal systems are disclosed in more detail in U.S. Pat. Nos. 3,258,851; 3,241,251 or 2,993,282 (all owned by the instant assignee and incorporated herein by reference) wherein condensate removal means particularly adapted for operation with an interiorly grooved dryer drum are disclosed. The end body portion **12***c* and the radially extending flanges **12***d* are similarly arranged as explained in conjunction with the steam inlet end. It will again be noted that the flanges **12***d* extend radially upwardly from the journal stub into close proximity with the inner wall **11***b* of shell **11**, but out of contact therewith and within the peripheral end boundaries of the dryer shell ends.

As will be appreciated, journal **12** is composed of a suitable metallic material to provide necessary strength characteristics to support the dryer assembly **10**. Necessarily, such metallic materials undergo thermally induced dimensional changes in accordance with its particular coefficient of thermal expansion. Of course, such dimensional changes occur in all directions but are most noticeable in the direction of greatest extent, i.e., along the length of the journal in the axial direction thereof, and the amount of such dimensional changes is readily calculated. In accordance with the invention, the journal is free from axial contact with the dryer drum for at least such a precalculated distance so that during its dimensional changes no detrimental axial loading of the drum takes place. In this manner, the journal (and all of its various portions) can undergo thermally induced dimensional changes without producing undue bending moments about the shell end or other detrimental stresses in the dryer shell.

As shown, the dryer shell **11** is radially supported on the opposite journal stubs **12***a* by means of opposite end head assemblies **16** and **17**. It will be noted that the end head assemblies **16** and **17** are composed of outer head members **16***a* and **17***a* respectively and spaced inner members **12***d*. The outer head members **16***a* and **17***a* are spaced axially outwardly from the flanges or inner members **12***d* a distance **19** which is at least equal to the thermally induced dimensional changes occurring in the journal. As will be appreciated, the distance **19** is at least equal to the thermally induced linear changes occurring in the journal, however, as indicated hereinbefore, such changes are of the greatest extent or moment and therefore the distance between the outer and inner members of the end head assemblies is at least equal to the greatest amount of dimensional change. In other words, the dimensional changes that occur within the journal **12** by reason of thermal expansion or contraction fail to induce any detrimental stresses on the drum shell, but the drum shell is sufficiently radially supported on the journal stubs for operation.

The end head assemblies **16** and **17** enclose the interior of the drum shell so as to form a chamber therewith, which is appropriately sealed to maintain pressurized stem therein, as will be explained hereinafter. Each of the end head assemblies **16** and **17** are comprised of inner or flange members **12***d* and outer or headplate members **16***a* and **17***a* respectively. The outer members **16***a* and **17***a* are of metallic composition and may be in a disclike configuration or a spokelike configuration. Further, these outer members may be of sufficient thickness to be rigid under all operating load conditions or may be formed to be somewhat bendable, at least at the upper regions thereof, to absorb a substantial portion of any axial load. Each of the outer head members **16***a* and **17***a* are formed to have a central opening of sufficient size to accommodate the journal stubs **12***a* and have sidewalls extending from this central opening in a radial direction. The upper end or outer end face surface of each of the outer head members **16***a* and **17***a* contact opposite ends of the drum shell **11** are rigidly attached thereto as shown. It will be noted that the sidewalls of the respective head members **16***a* and **17***a* are spaced a distance **19** from the inner or flange members **12***d*. The distance **19** is at least equal to the thermally induced dimensional changes occuring in the journal **12** when it is exposed to operating conditions. In this regard, it will be appreciated that the distance **19** is more accurately defined by the amount of linear dimensional change occurring in the journal, but that since this change is greater than the other dimensional changes, it is more convenient to refer to merely dimensional changes.

The inner end face surfaces of the respective head members **16***a* and **17***a* actually define the central opening mentioned hereinbefore and are movably supported on the journal ends **12***a* whereby any radial pressure, such as produced by contact with moist web, a nip roll, etc., is transmitted radially only to the journal ends **12***a* and not to the flange members **12***d*. More specifically, it will be noted that one of the outer members, i.e., **16***a* has its inner end face surface rigidly attached to the journal stub **12***a* as by bolt means **16***c*, but that this outer member **16***a* does not carry any axial pressure load since the opposed outer member **17***a* has its inner face surface in a supported and movable relation on the opposite journal stub **12***a* whereby outer head member **17***a* (consequently the rigid attached shell **11** and opposed head member **16***a*) is free (relatively speaking) to move in an axial direction on the journal. The inner end face surface of outer member **17***a* is provided with a means **17***b* accommodating relative movement between the journal surface and the head member **17***a*. As shown in FIG. **1**, this means **17***b* comprises a low-friction solid sealing means composed of, for example, carbon or some other relatively rigid friction-free material accommodating relative movement between metallic surfaces and having sufficient strength characteristics to withstand the radial load.

The space **19** between the outer members **16***a* and **17***a* respectively and the inner or flange members **12***d* may be exposed to atmospheric pressures so that the side surfaces of the outer members **16***a* and **17***a* are not subjected to the steam pressure within the dryer drum. IN this regard, it will be noted that means **18** is positioned between the respective flanges **12***d*, **12***d* and outer members **16***a*, **17***a* in the vicinity of the shell **11** so as to seal the interior of the shell **11** from atmosphere and to define a pressure chamber within the shell. As shown, sealing means **18** may be positioned between the inner side surfaces of the respective outer members **16***a* and **17***a* and the respective outer side surfaces of the flange members **12***d*, **12***d* by pressure fitting into appropriately sized grooves in such side surfaces. Sealing means **18** is preferably composed of thermally expandable flexibly resilient pressure means capable of withstanding operating stream pressures within dryer drums while being sufficiently resilient to absorb a substantial portion of the expansion pressure and thereby avoid transmitting undue axial pressure to the outer members. Such heat seal means are well known in the art and need not be described further.

Referring now to FIG. **2** wherein a further embodiment **20** of a dryer drum assembly constructed according to the principles of the invention is illustrated. The embodiment **20** is substantially similar to the embodiment shown at FIG. **1**, except that the steam inlet means **13** is omitted and steam is merely shown as entering through the hollow journal end **12***a* for distribution by the inner shaft stub **12***b* throughout the interior of the drum as explained hereinbefore. Similarly the condensate removal system **15** as illustrated in FIG. **1** is omitted since intermittent vacuum may be applied for removal of the condensate. Further, the heating fluid may comprise dry heated air wherein no condensate would be present and the inlet pressure be sufficient to drive spent heating fluid out of the shell. The journal **12** of the dryer drum **20** is essentially identical in the construction and assembly of its flanges **12***d*, end and mediate body portions **12***c* and **14** as described in conjunction with dryer drum **10**. Likewise, the shell **11** has a smooth outer surface **11***a* and an interiorly grooved surface **11***b* such as explained in conjunction with reference to the other embodiment. However, as will be appreciated other dryer shells and journals may be utilized with the end head assemblies of the invention.

Referring to the end head assemblies **16** and **17** respectively, it will be noted that an outer head member **16***a* is secured to the journal **12** near its inner end **16***b* by means of a bolt **16***c*, but otherwise it is identical to the end head assembly **16** described in conjunction with embodiment **10**. The opposite movably supported outer head member **17***a* is supported on the journal stub **12***a* by means of a ball bearing means **17***d*. As will be appreciated, such bearing means contain races and bearing balls of conventional construction. Expandable heat seal means **18** are provided between the respective outer head members **16***a* and **17***a* and the inner flange members **12***d*, **12***d* in the manner explained hereinbefore. As indicated before, outer member **17***a* may be deliberately designed to be sufficiently flexible or bendable to absorb a substantial portion of the pressure created by the axial expansion of the journal.

Thus, when a heating fluid (such as steam) is introduced into the interior of the drums, the journal, along with its rigidly attached flanges begins to expand (most notably in the linear direction) and the outer flanges of the journal move toward the outer head members respectively into the space between such members and journal ends and somewhat compress the seal means therebetween thereby dissipating the expansion pressure. The dimensional change of the journal does not induce any detrimental stresses on the outer shell of cause any undue bending moment about the shell ends, such as would occur if the journal was rigidly attached to the outer shell.

In summation, it will be **1** that the invention provides a dryer drum assembly comprising a cylindrical shell, a central shaft or journal coaxial with the shell and a pair of opposed end head assemblies interconnecting the shell with the shaft. The shaft has a pair of opposed end flanges extending radially upwardly into the vicinity of the shell and spaced therefrom free of any radial pressure from the shell. A pair of opposed outer members are concentrically mounted on the shaft, axially outwardly from the flanges, and extend radially upwardly into supporting contact with the shell free from any axial pressure on the shaft. A means is positioned between the respective head members and flanges to define a pressure chamber interior of the shell and accommodate relative movement between the flanges and the head members whereby dimensional changes in the shaft fail to induce detrimental bending moments to the shell. The means between the flanges and outer head members comprise flexibly resilient heat seal means, such as pressure gaskets, mounted in the vicinity of the shell. One of the outer head members is rigidly attached to the shaft while the opposite head member is free to move along such shaft. In this manner, the outer head members carry minimal axial pressure, and dimensional changes in the shaft produce no detrimental stresses in the shell.

In this regard, it will be appreciated that while the flexibly resilient seal means between the outer head members and the flanges are to some extent pressure absorption devices, they also transmit some small nondetrimental amounts of pressure to the outer head members. Nevertheless, such resilient means very significantly reduce the axial and bending stresses on the dryer shell and thereby provide greater safety in the operation of dryers constructed in accordance with the principles of the invention and allow utilization of higher dryer temperatures.

I claim:

1. An end head assembly for a dryer drum having a drum shell and a drum journal comprising; a headplate member having extending radial side surfaces, said side surfaces having an inner end surface movably supported on the drum journal and an outer end surface rigidly attached to the drum shell whereby any radial pressure on the shell is transmitted only to the drum journal, a flange member having extended radial side surfaces spaced out of contact with said headplate member side surfaces, said flange member side surfaces having an inner end surface rigidly attached to the drum journal and an outer end surface in the vicinity of the drum shell out of contact therewith whereby any axial pressure is transmitted only to the drum journal, and means positioned between said headplate member and said flange side surfaces accommodating relative movement between said members while providing a thermal seal between said members and the drum shell, said means including a pair of spaced expandable heat seal means, one of said pair being positioned in the vicinity of the drum shell between an outer side surface of said flange member and an inner side surface of said headplate member and the other of said pair being positioned in the vicinity of the drum axis between an outer surface of the drum journal and an inner end surface of the headplate member.

2. End head assemblies for a steam heated dryer drum comprising,

a pair of outer members, each having a central opening receiving opposite ends of a drum journal and side surfaces radially extending from said opening to define inner and outer end face surfaces,

said outer-end surfaces being rigidly attached to respective ends of a drum shell,

one of said inner end surfaces being rigidly attached to one of said journal ends and the other of said inner end surface being in axially movable contact with the other of said journal ends in a radial load bearing relation,

a pair of inner members integrally formed with the drum journal along opposite ends thereof, said inner members having side surfaces radially extending from said journal into relatively close proximity and out of contact with the drum shell, each of said inner members being positioned adjacent and axially inwardly a distance from a respective outer member equal to at least any thermally induced dimensional changes occurring in said drum journal,

a first means positioned between respective adjacently opposite side surfaces of said members in the vicinity of the drum shell, and

a second means positioned between said other inner end surface and said other journal end in an axially movable relation thereto, whereby said means maintain stream pressure within the drum shell and permit relative movement between said outer and inner members while avoiding temperature induced stresses to the drum shell.

3. The dryer drum assembly as defined in claim **2** wherein one of said pair of said outer members is rigidly attached to an adjacently opposite inner member in the vicinity of the drum journal.

4. The dryer drum assembly as defined in claim **2** wherein one of said pair of said outer members is rigidly attached to the drum journal and out of contact with an adjacently opposite inner member.

5. The end head assembly as defined in claim **2**, wherein the side surfaces of the outer members are exposed to atmospheric pressure.

6. The end head assembly as defined in claim **2** wherein the first and second means, comprise resiliently expandable pressure gaskets.

7. The end head assembly as defined in claim **2**, wherein the first means comprises a resiliently expandable pressure gasket, and the second means comprises a ball-bearing means.

8. A dryer drum assembly comprising,

a cylindrical shell,

a hollow journal shaft coaxial with said shell,

said shaft having means distributing pressurized stream within said shell and means withdrawing spent steam from said shell,

said shaft having a pair of opposite flanges positioned in the vicinity of the shaft ends and within the shell periphery out of contact therewith,

a pair of opposite head members coaxially mounted on said shaft ends, each outwardly spaced a distance from an adjacently opposite flange equal to at least any thermally induced dimensional changes occuring in said shaft, said head members extending radially outwardly from said shaft into contact with the respective shell ends, one of said head members being rigidly attached to said shaft, the other of said head members being axially movable along said shaft, and

means positioned between the respectively adjacently opposite head members and flanges maintaining the pressurized steam within the shell and accommodating relative movement between the flanges and head members whereby thermally induced expansion of the shaft avoids temperature stresses on the shell.

9. The dryer drum assembly as defined in claim 8 wherein the means positioned between the respective adjacently opposite head members and flanges comprise an upper resilient expandable heat seal means positioned in the vicinity of the cylindrical shell between said members and a lower ball bearing means positioned away from said upper seal means in a pressure transmitting relation between the other of the pair of head members and the journal shaft and out of contact with the adjacently opposite flange.

10. An end head assembly for a dryer drum having a drum shell and a drum journal comprising; a head plate member having extended radial side surfaces, said side surfaces having an inner end surface movably supported on the drum journal and an outer end surface rigidly attached to the drum shell whereby any radial pressure on the shell is transmitted only to the drum journal, a flange member having extended radial side surfaces spaced out of contact with said head plate member side surfaces, said flange member side surfaces having an inner end surface rigidly attached to the drum journal and an outer end surface in the vicinity of the drum shell out of contact therewith whereby any axial pressure is transmitted only to the drum journal, and means positioned between said head plate member and said flange side surfaces accommodating relative movement between said members while providing a thermal seal between said members and the drum shell, said means including an expandable heat seal means positioned in the vicinity of the drum shell between an outer side surface of the flange member and an opposed inner side surface of the plate member, and a ball bearing means positioned in the vicinity of the drum axes between an outer surface of the drum journal and the inner end surface of the plate member supporting said plate member on the bearing journal.

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