Feb. 17, 1953

H. M. OSTERTAG

2,628,433

YANKEE DRIER

Filed May 25, 1950

2 SHEETS—SHEET 1

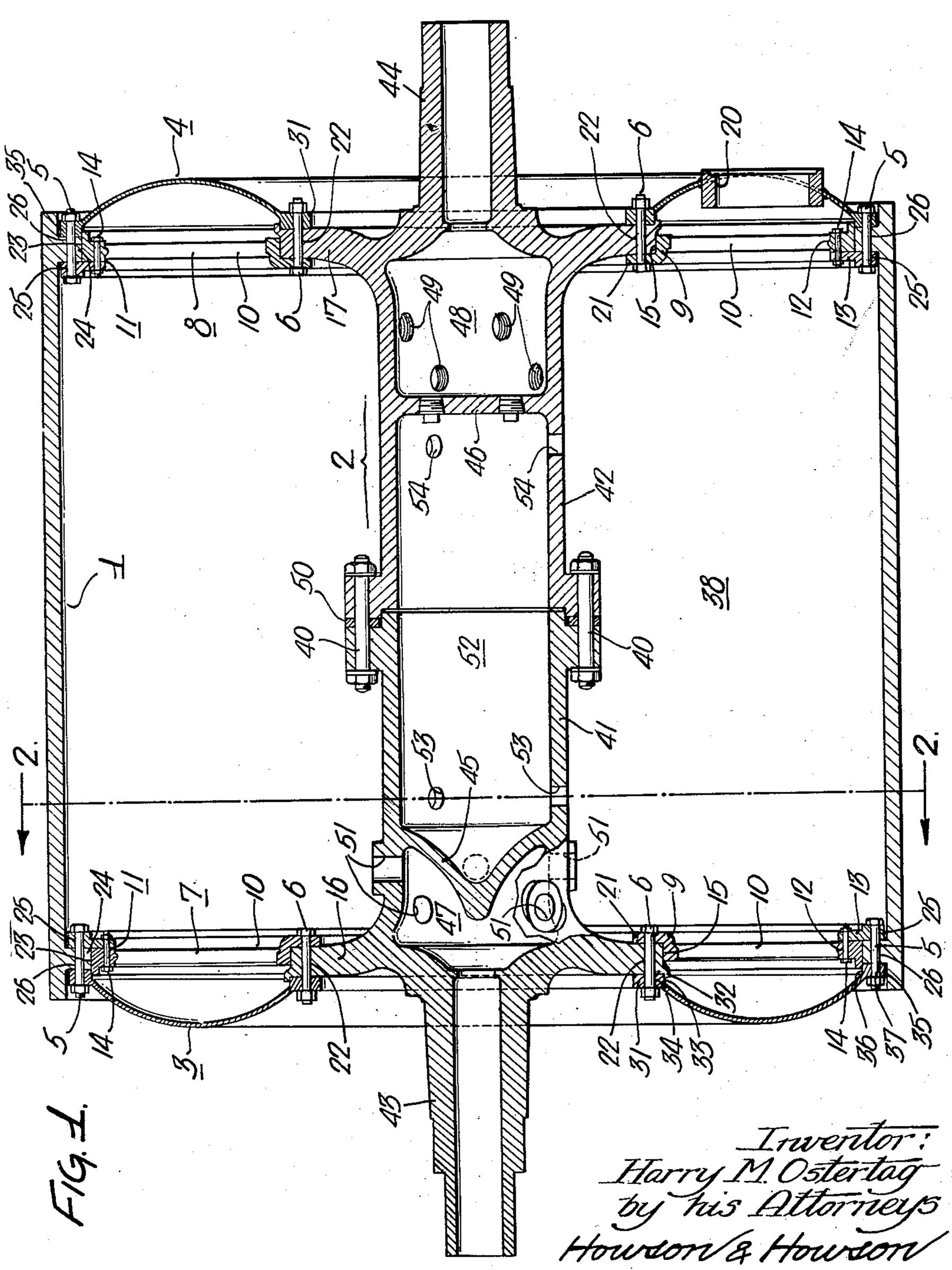

FIG. 1.

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FIG. 4.

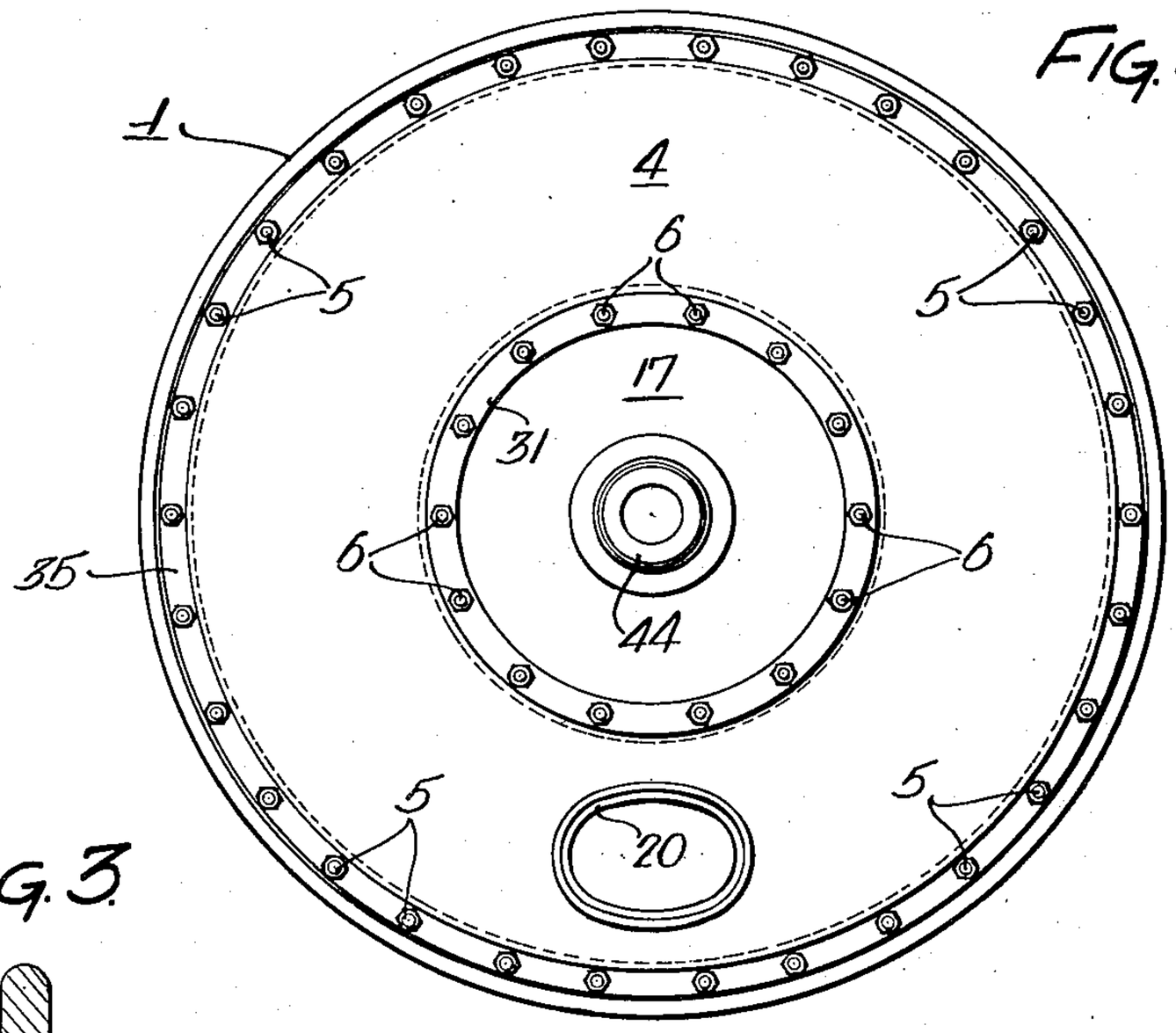


FIG. 3.

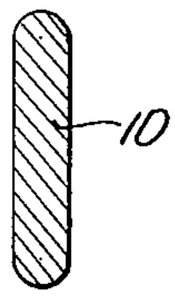
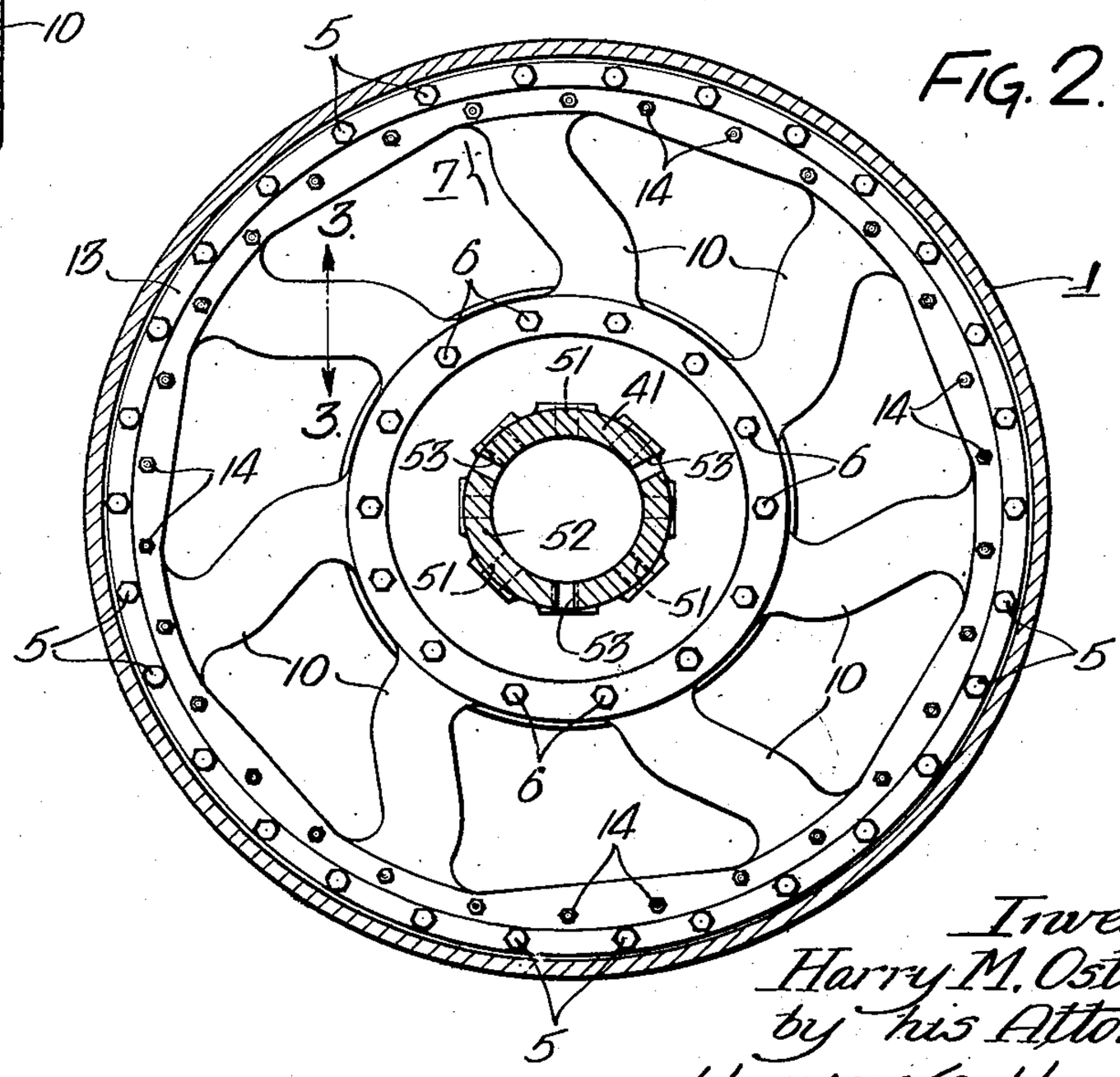


FIG. 2.



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UNITED STATES PATENT OFFICE

2,628,433

YANKEE DRIER

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10 Claims. (Cl. 34—124)

1

This invention relates primarily to paper-making machines, and a principal object of the invention is to provide a "Yankee Dryer" of generally improved structural and functional characteristics.

A more specific object is to provide a Yankee dryer capable of safe operation under relatively high internal steam pressures, and which may be operated safely at relatively high speeds so as to utilize for increasing production the relatively high temperatures obtainable from the aforesaid high steam pressures.

A further object is to provide a Yankee dryer of the type including a central shaft, and a cylindrical shell supported on the shaft, wherein by reason of novel construction hereinafter described, expansion during warm-up periods will occur with substantial uniformity throughout the several structural members of the dryer.

More specifically, the invention contemplates a Yankee dryer of the stated type wherein the structural members which support the cylindrical shell on the central shaft are divorced from the function of containing the internal steam pressure within the shell and occupy positions within the pressure area so that, like the central shaft, the said members are surrounded by the heating medium.

A still further object of the invention is to provide a Yankee dryer of the aforesaid type wherein the structural members which support the shell on the shaft operate under direct compression between the shell and the shaft in transferring to the latter the loads imposed upon the shell by the pressure roll, as hereinafter more specifically described.

Another object of the invention is to provide a Yankee dryer in accordance with the preceding paragraph wherein the said shell supporting members are capable of compensating for variations in the relative axial lengths of the shell and shaft without impairment of their capacity for supporting the said pressure-roll load and the weight of the shell.

Still another object is to provide a Yankee dryer having a central shaft of improved structural and functional characteristics.

The invention resides also in certain novel structural features hereinafter described and illustrated in the attached drawings, wherein:

Fig. 1 is a longitudinal sectional view of a Yankee dryer made in accordance with the invention;

Fig. 2 is a sectional view on the line 2—2, Fig. 1;

Fig. 3 is a sectional view on the line 3—3, Fig. 2; and

2

Fig. 4 is an end elevational view of the dryer.

With reference to the drawings, the embodiment of my invention therein illustrated comprises a cylindrical shell 1, the outer face of which constitutes the working surface of the dryer; an axial shaft 2 within the shell; head members 3 and 4 at opposite ends respectively of the shell, said members being attached to the shell and to the shaft by means, in the present instance, of bolts 5 and 6 so as to form with said shaft and shell and within the latter an enclosed chamber; and a member in each end of the chamber designated respectively by the reference numerals 7 and 8 which constitute the means for supporting the shell coaxially on the shaft.

In the present instance the members 7 and 8, which are identical in form but are mounted in reverse positions, consist individually of a spoke structure comprising an inner flanged ring 9 and an outer composite ring 11, the latter ring being composed of an annular rim element 12, formed integrally with the spokes 10, and a flat annular element 13 which is secured to one side of the rim 12 and forms a radially projecting flange at one side of the latter. The elements 12 and 13 are secured together by means of bolts 14. In the dryer assembly the inner rings 9 of the spoke structures seat against the peripheral faces 15 of the integral radial flanges, 16 and 17, respectively, of the shaft 2, with the radial flange portions 21 of the rings 9 in face-to-face engagement with the confronting sides of the said flanges 16 and 17. The flange portions 21 are apertured in registration with holes 22 in the rim portions of the flanges 16 and 17 for reception of the securing bolts 6. The outer surfaces of the elements 12 of the rings 11 seat respectively against the inner peripheral faces 23 of a pair of flanges 24 which project inwardly from the inner cylindrical surface of the shell 1 at positions adjoining the ends of the latter. The flange elements 13 of the rings 11 seat against the inner faces of the flanges 24 and are secured against said faces by the bolts 5 which extend through apertures 25 in the flange elements 13 and registering holes 26 in the flanges 24.

The spokes 10 of the members 7 and 8 are formed integrally with the rings 9 and 11 and are preferably shaped as illustrated in Figs. 2 and 3. The cross sectional form of the spokes is illustrated in Fig. 3. The spokes 10 transfer radial pressures imposed upon the outer surface of the shell 1 directly to the shaft 2 under radial compression. It will be noted also that the spokes being of relatively great width and lesser thick-

ness, are capable of the small lateral deflections axially of the dryer required to compensate for changes in the relative effective lengths of the shall 1 and shaft 2 that might arise from unbalanced thermal conditions in the dryer structure without, however, adversely affecting the primary function of the spokes to support the shell and to transfer loads imposed upon the shell to the shaft. It is to be noted that the spoke structures 7 and 8 constitute the sole means of support for the shell 1 upon the shaft.

The head member 3 is of annular form having at its inner periphery a rim 31 which in assembly seats against the outer face of the flange 16, it being noted that the latter flange has an axially projecting bead 32 which engages the outer periphery 33 of said rim. The rim 31 is provided with apertures 34 which register with the holes 22 of the flange 16 and which receive the outer ends of the bolts 6, so that in addition to securing the spoke structure 7 to the flange 16, these bolts also secure in place the inner peripheral portion of the head member 3. A corresponding rim 35 is formed at the outer periphery of the head 3 for seating engagement with the outer face of the flange 24 of the shell 1, it being noted in this case that the rim element 12 of the spoke structure 7 is extended in the axial direction so as to overlap the inner peripheral surface 36 of the rim 35. The rim 35 is apertured, as indicated at 37, and these apertures register with the holes 26 of the flange 24 for reception of the bolts 5 which thereby secure the outer peripheral portion of the head 3 to the shell.

The head member 4, and the manner in which it is secured between the shaft and shell, are identical with the member 3 with the exception that it is provided with a manhole 20 of suitable form which, when removed, affords access to the interior of the dryer.

It will be noted that in assembly the heads 3 and 4 close the space between the ends of the shell 1 and the shaft 2 and thereby form between these members a chamber 38 which receives the steam or other heating medium as hereinafter more fully set forth. The walls of the heads 3 and 4 are bowed outwardly and have flexibility for self-adjustment to any changes in the radial distance between the shell 1 and the shaft 2 that might arise from thermal causes. The sole function of the heads 3 and 4 is to contain the steam or other medium within the chamber 38, the heads being divorced from the function of supporting the shell on the shaft. Conversely the function of supporting the shell on the shaft, residing in the spoke members 7 and 8, is divorced from the other function of containing the steam pressure.

The central shaft 2 is composed in the present instance of two axial sections designated respectively by the reference numerals 41 and 42. Both sections are hollow and each terminates at its outer end in a trunnion extension, 43 and 44 respectively. These trunnions also are hollow to afford communication from outside the dryer with the interior of the shaft. The trunnions 43 and 44 constitute the means for rotatably supporting the cylindrical drum or dryer. The inner end of the shaft section 41 is bolted to the inner end of the section 42 by means of bolts 40, a suitable spacer ring 50 being provided between the confronting faces of the sections. Each of the sections 41 and 42 is provided with a partition, 45 and 46 respectively, each located toward the outer or trunnion end of the section so as to form within the latter a relatively small chamber, 47 and 48 respectively, adjoining the inner end of the trunnion. The chamber 48 is the steam admission chamber to which steam is conducted from an external source through the trunnion 44 and from which the steam passes through ports 49 to the drum chamber 38. The chamber 47 is the condensate exhaust chamber to which the condensate is conducted from the chamber 38 through ports 51 and from which the condensate is discharged through the trunnion 43, the cone-like shape of the partition 45 aiding in the deflection of the condensate to the trunnion passage. Access for steam from the chamber 38 to the interior chamber 52 of the shaft between between the partitions 45 and 46 is afforded by ports 53 and 54 in the walls of the sections 41 and 42. The condensate removal devices form no part of the present invention and are not illustrated.

By reason of the construction described above, the Yankee dryer assembly of this invention exhibits certain highly desirable structural and functional characteristics. Steam admitted to the dryer at the beginning of a warm up period will initially contact only that end of the shaft 2 which includes the trunnion 44 and the chamber 48 so that axial expansion in the shaft will be small until after the steam will have had an opportunity to contact both the shell 1 and the remaining major portion of the shaft. Expansion of shaft and shell will thus occur simultaneously and substantially uniformly. The spoke structures 7 and 8 which, as previously described, are divorced from the function of containing the steam within the chamber 38, are themselves contained within that chamber in such manner that they are substantially entirely surrounded by the steam. The spoke structures will thus expand as a whole and uniformly with the other structural portions of the dryer including the shell 1 and the shaft 2 which are directly exposed to the action of the steam. The stress effects of the widely differing temperatures upon the purely structural elements of the dryer, are thus effectively minimized. By divorcing the members 7 and 8 from the function of containing the pressure steam within the chamber 38, and by thereby relieving the said members from unbalanced steam pressures, the complicated and multiple stresses experienced in prior structures wherein functions of structural support and pressure containment have been combined in the same member, and which have precluded the use of the higher steam pressures and temperatures, have been largely avoided, and the herein described dryer is capable of operating under materially higher steam pressures than heretofore has been considered generally practicable. As a result of the use of relatively high pressure steam, on the order for example of 160 p. s. i., the effective temperatures of the dryer have been materially increased so that it is possible to operate the dryer efficiently at relatively high speeds and to thereby materially improve the production characteristics. In this phase also the separation of the structural support members 7 and 8 from the function of steam pressure containment has an important effect, since it substantially eliminates the complicated stress problems which arise in dryer structures of the type wherein the head members of the drum which confine the steam pressure also function to support the shell on the shaft, and makes possible a theoretically and actually simplified construction affording in full

degree the structural strength required for high speed operation.

The form of the shell-supporting spoke structures 7 and 8 also contributes in an important functional respect. The spoke elements 10, as previously set forth, act under direct compression to transfer to the shaft 2 the loads imposed upon the outer surface of the shell 1, the principal part of this load resulting from the pressure of the pressure roll which in practice bears against the roll in radial direction with a force of say 75,000 pounds. This load when added to the weight of the shell itself produces a total radial load upon the spokes 10 of say of 120,000 pounds. The spokes 10 are well able to support loads of this proportion and at the same time, as previously set forth, to compensate for changes in the relative axial dimensions by lateral deflection. Since the spoke structures are entirely surrounded by the steam within the chamber 38, they are free from any pressure from that source tending to effect axial displacement. The heads 3 and 4 which confine the steam pressure are preferably made of steel, and being entirely independent of the spoke structure may be relatively thin and flexible so as to impose no stress upon the spoke structure.

Condensate is removed from the dryer by pressure differential. When operating at low speeds and low pressures there is a tendency for the condensate to build up in the evacuation chamber creating a considerable pond which must be evacuated before the dryer can be brought up to the relatively high speeds for which it was designed. Such evacuation requires the use of a considerable volume of steam and loss of considerable time. The partition 45 and the small evacuation chamber 47 are designed to reduce to a minimum the losses of steam and time arising from this cause by limiting both the size of the pond and the volume of steam required to effect the evacuation.

I claim:

1. A Yankee dryer comprising in combination a cylindrical shell forming the working surface of the dryer, an axial shaft in said shell, a head member at each end of the shell attached to the shell and to the shaft and forming with said shell and shaft an enclosed chamber for steam under pressure, said shaft and shell constituting the inner and outer walls respectively of said chamber, and the head members forming the end walls of the chamber, and a member at each end of and within said chamber supporting the shell in coaxial relation on the shaft and relieving the head members of shell supporting function.

2. A Yankee dryer according to claim 1 wherein the said support member is in the form of a spoke structure constituting a separate structural unit connected to the shaft and to the shell.

3. A Yankee dryer according to claim 2 wherein the spokes are arranged to operate under

radial compression between the shell and the shaft in transferring to the latter the weight of the shell and loads imposed upon the shell from external source.

4. A Yankee dryer according to claim 3 wherein the spokes of said structure are capable of flexure in axial direction without impairment of their pressure-transferring capacities so as to compensate for relative changes in the effective axial lengths of the shell and shaft.

5. A Yankee dryer according to claim 1 wherein the head members are divorced from the function of supporting the shell on the shaft, said head members being bowed and being flexible in radial direction for self-adjustment in accordance with variations in the radial distance of the shell from the shaft.

6. A Yankee dryer according to claim 5 wherein both the support members and the head members are detachably connected to shell and shaft.

7. A Yankee dryer according to claim 6 wherein a single set of bolts connects the support member and head member at each end of the dryer to the shell and shaft.

8. A Yankee dryer according to claim 1 wherein the shaft is composed of two longitudinal sections secured together at a joint in the interior of the dryer, each said shaft section being hollow and having ports in the walls thereof communicating with the interior chamber of the dryer, the outer ends of each of said shaft section forming a hollow trunnion for mounting the dryer structure in suitable bearings.

9. A Yankee dryer according to claim 8 wherein each of the shaft sections has a partition in the outer end forming a relatively small chamber at the inner end of the trunnion, each said chamber having in the wall thereof a port opening to the interior of the shell.

10. A Yankee dryer according to claim 9 wherein the space within the shaft between the partitions communicates through ports with the interior of the shell.

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