May 3, 1966 G. KRIKORIAN 3,248,803

ROTARY DRUM HEAT EXCHANGER

Filed April 5, 1963 3 Sheets-Sheet 1

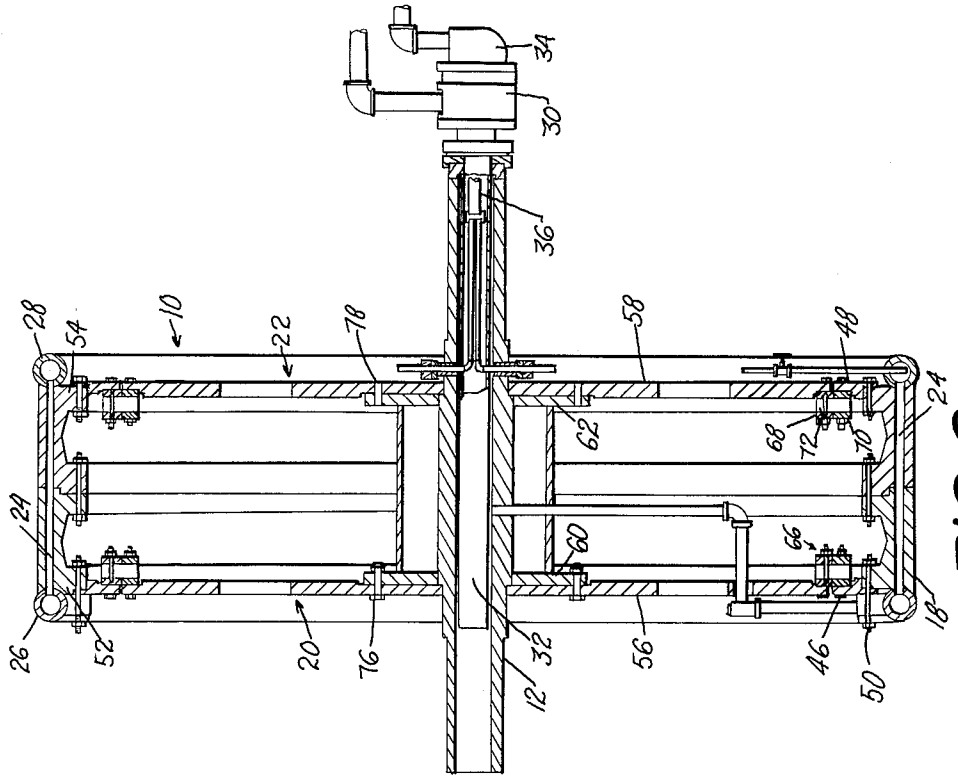


FIG. 2

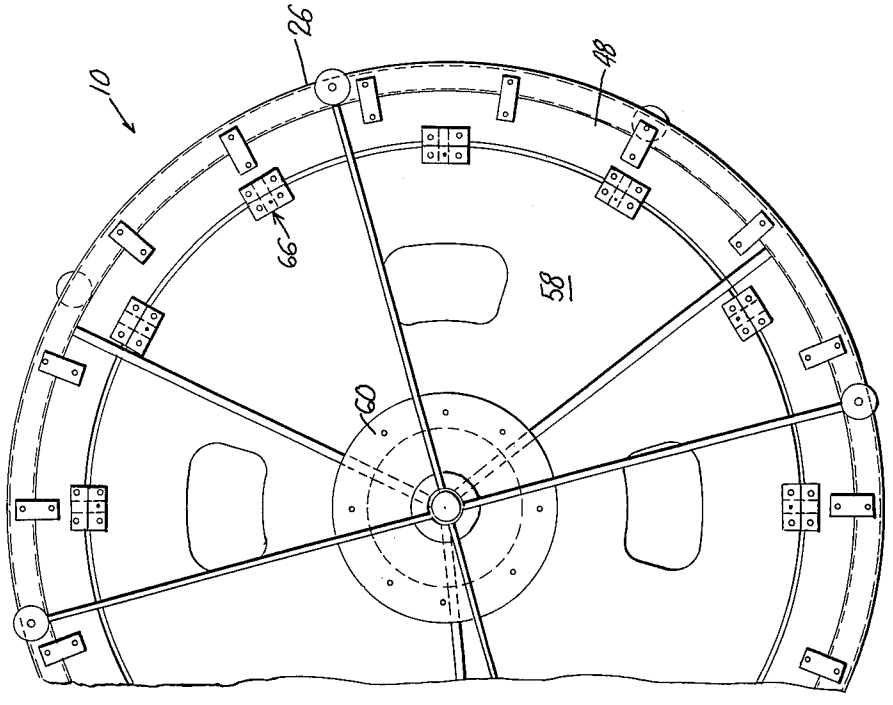


FIG. 1

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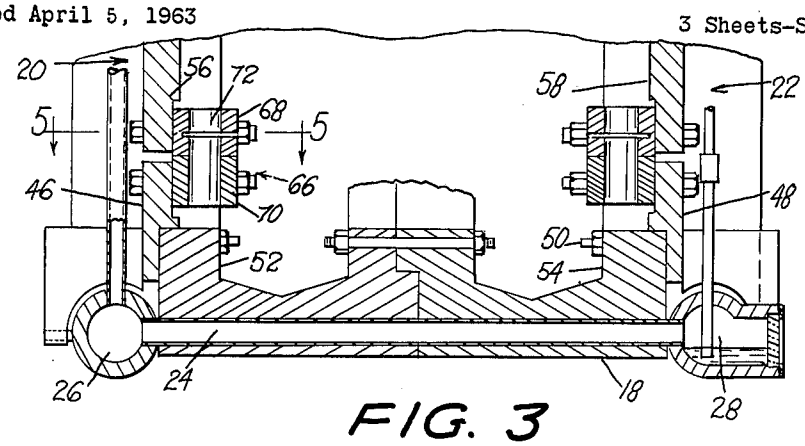


FIG. 3

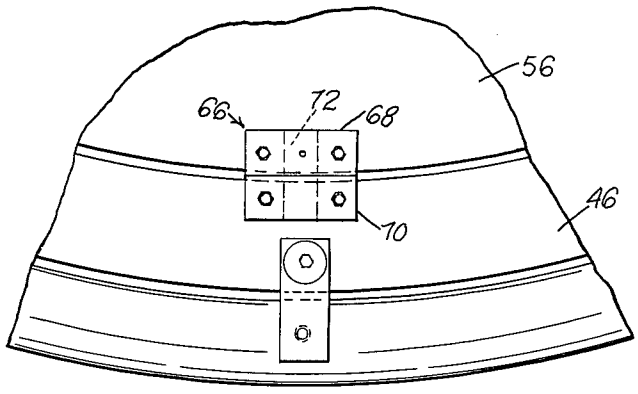


FIG. 4

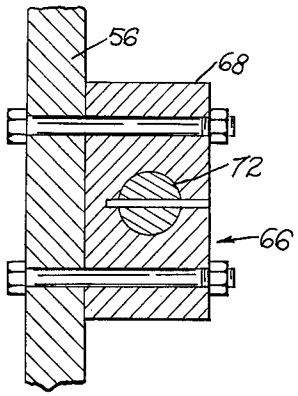


FIG. 5

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ROTARY DRUM HEAT EXCHANGER

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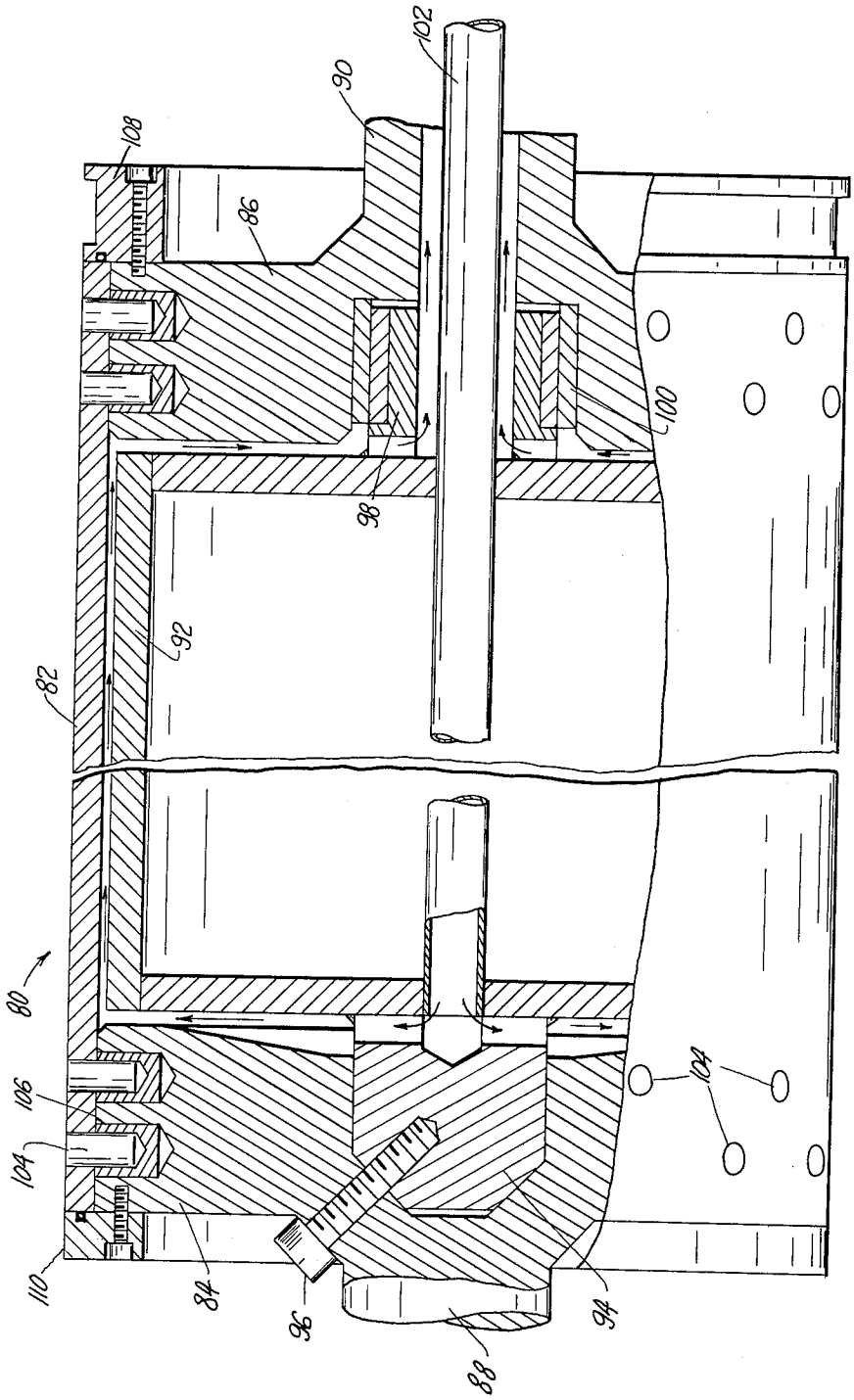


FIG. 6

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3,248,803

ROTARY DRUM HEAT EXCHANGER

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4 Claims. (Cl. 34—110)

The present invention relates to improvements in rotary drum heat exchangers.

The invention is shown in two alternative forms, in one form as embodied in a drum-type dryer having a heated outer shell, and in an alternative form as embodied in a cooling roll having a cool outer shell.

In a preferred form of the invention, a rotary drum dryer is disclosed having a drum of large diameter which comprises a shell, a supporting rotary hub rotating on a fixed axis, and supporting disc or spoke elements which project outwardly from the hub and provide support for the drum. The drum is fitted with a heating system which may comprise a network of pipes through which a heating medium, preferably steam, is circulated about an area adjacent the shell surface to maintain a desired temperature of the external surface of the shell. Dryers of the type referred to are built to operate at high speeds and with a drying surface heated to increasingly high temperatures with the result that difficulty has been experienced in providing a strong drum structure which will provide adequately for the expansion and contraction of the heated shell portion of the drum and will, at the same time, insure that the rapidly rotating shell is at all times adequately supported and held in a coaxially aligned position with relation to the hub axis.

In an alternative embodiment of the invention, a cooling roll is disclosed which comprises two solidly formed end discs, an outer shell which is secured at each end to said discs to rotate on a fixed axis, and an inner shell which cooperates with the outer shell for the circulation of the cooling medium such as water between said shells. In a structure of this type also, the difference in the amount of expansion and contraction experienced in the end discs and in the relatively colder outer shell has presented problems.

It is an object of the invention to provide a novel and improved drum structure including a series of expansion joints in said structure so constructed and arranged that they will permit the shell, heated or cooled as the case may be, to expand and to contract freely with relation to the relatively constant temperature hub and radial supporting parts of the drum and which will, at the same time, maintain the shell securely in an exactly centered and longitudinally determined position with relation to the hub axis.

A preferred embodiment of the invention comprises a rotary drum heat exchanger having a shell with an external heat exchanging surface, a rotary hub, and a plurality of disc headers mounted on the hub for supporting the shell, said heat exchanger being provided with a series of expansion joints connected between each said disc header and said shell around the periphery of said disc header, each said expansion joint comprising a pin and sleeve connection interconnected between said disc header and shell permitting relative movement of the interconnected portions of said disc header and shell only along a line radially of said drum axis. The arrangement is such that the portion of the shell at the location of each said expansion joint is freely adjustable only in a radial direction with relation to said hub, while at the same time that portion of the shell is fixedly secured tangentially with relation to said disc header. The tangential support provided at each of a plurality of such locations combines

to maintain said shell in a fixed position coaxially with said hub.

In order to provide for expansion and contraction of the shell relatively to the rotary hub longitudinally, only one of the disc headers is rigidly secured to the rotary hub. Any other said disc header is connected to the rotary hub by means of a series of axial expansion joints connected between the said disc header and said rotary hub, each said axial expansion joint comprising a sleeve and pin connection interconnected between said disc header and said rotary hub permitting relative movement of the disc header and said rotary hub only along a line parallel to said hub axis.

In the alternative embodiment of the invention shown, the outer shell of the cooling drum is supported coaxially with relation to the end supporting discs by means of radial pins which are secured at their outer ends directly into the outer shell and are fitted into sleeve sockets formed in the peripheral surface of the end discs.

With the above and other objects in view as may hereinafter appear, the several features of the invention consist in the devices, combinations and arrangement of parts hereinafter described and claimed which together with the advantages to be obtained thereby will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a view in end elevation of a rotary drum dryer, but with the adjacent disc header removed, illustrating the several features of the invention;

FIG. 2 is a view in side elevation of the rotary drum dryer shown in FIG. 1;

FIG. 3 is a detail view on a large scale and in section of the lower portion of the drum shown in FIG. 2;

FIG. 4 is a fragmentary view of the drum in end elevation illustrating one of the fastening devices for securing the drum to the disc header;

FIG. 5 is a detail sectional view taken on a line 5—5 of FIG. 3 illustrating one of the expansion joints; and

FIG. 6 is a view partly in section of a modified form of the invention as shown in a cooling roll.

Referring to the drawings, the invention is herein disclosed in a preferred form in a rotary drum dryer of the general type having a rotary drum **10** of substantial diameter consisting of a sleeve hub **12** supported in sleeve bearings, not shown, and a shell **18** which is supported with relation to the hub by means of two perforated disc headers **20, 22**. The shell has formed therein adjacent the outside peripheral surface a series of parallel longitudinally extending conduits **24**. At the ends of the shell there are provided manifolds **26, 28** in the form of steel pipes which are bent into a circular form having the same diameter as the shell, and abut the two ends of the shell. The manifolds extend entirely around the drum. Each conduit **24** is tapped at its two ends into the respective manifolds.

Steam is passed through the manifolds **26, 28** and conduits **24** by means of a steam supply system which comprises a steam inlet junction **30** and a large diameter pipe **32** fitted within the sleeve hub **12** through which steam is introduced into the drum and a condensate outlet junction **34** and a small diameter condensate outlet pipe **36** fitted within the inlet pipe **32** through which condensate is withdrawn from the drum. The steam inlet pipe **32** and condensate outlet pipe **36** are connected with the manifolds **26, 28** through connecting pipes which form no part of the present invention and are therefore not here further referred to.

In accordance with the invention, the supporting structure for the drum shell **18** including the disc headers **20, 22** is constructed and arranged to provide a drum struc-

ture of maximum strength and rigidity while at the same time permitting to the shell **18** complete freedom to expand and contract in accordance with the varying thermal conditions. The disc headers **20**, **22** which, in the embodiment shown are constructed of heavy material, are divided into outwardly disposed rims or ring members **46**, **48** which are rigidly secured by an axially extending bolt **50** to inwardly extending flanges **52**, **54** formed at the respective ends of the shell **18**, and inner core disc members **56**, **58** which are mounted respectively on the hub discs **60**, **62** which are fixedly mounted on the sleeve hub **12** of the drum assembly. In the embodiment shown, the core disc members **56**, **58** are positioned in the same transverse planes respectively with the outwardly disposed rims **46**, **48** and are spaced therefrom a sufficient amount to allow for any relative expansion or contraction thereof. In order to provide a rigid axially centered support for the shell **18** on the core discs **56**, **58**, there are provided at evenly spaced intervals around the periphery of each disc header twelve identical expansion joints, generally designated at **66** comprising sleeve and pin connections interconnecting said rims **46**, **48** and said core disc members **56**, **58**, each said sleeve and pin connection permitting relative movement of the interconnected portions of said rim and core disc members only along a line radially of said drum axis. Said expansion joints have the effect of securing the rim **46** or **48** to the associated inner core disc member **56** or **58** in such a manner that the engaged portion of the rim is permitted to move freely in a radial in and out direction, but is positively secured against transverse movement with relation to the core disc in any direction. Inasmuch as these expansion joints are identical in their construction and mode of operation, only one such joint will be specifically described in connection with FIGS. 3–5, inclusive. As shown in these figures, the expansion joint **66** comprises a metal block **68** formed with a pin receiving bore and bolted to the core disc member **56** adjacent the peripheral edge thereof. A similarly formed block **70** is bolted to the rim **46** radially outwardly from the block **68** and is similarly formed with a radial pin receiving bore providing a pin receiving sleeve element in alignment with the bore formed in the block **68**. A guiding pin **72** extends through both of said bores and is press fitted and pinned into the bore of the block **68** being, however, slidably fitted within the sleeve element provided by the block **70** and bore therethrough. With this arrangement, it will readily be appreciated that the portion of the shell, controlled by each expansion joint including the guiding pin **72**, is free to move radially inwardly and outwardly as the shell contracts or expands, being, however, rigidly secured against any lateral movement by engagement with the respective guiding pin **72**.

In the illustrated construction, provision is made also for expansion and contraction of the shell in an axial direction. Further in accordance with the invention, expansion joints are provided between the sleeve hub **12** of the drum and one of the core header discs on which the shell **18** is carried. As best shown in FIGS. 1 and 2 of the drawings, the header core disc **56** is rigidly secured to the hub disc **60** by bolts **76**. The header core disc **58**, on the other hand, is supported with relation to the hub disc **62** by means of expansion pins **78** which are fitted into aligned axially extending bores in the disc member **58** slidable on the hub disc **62**. The pins **78** will preferably have a press fit with the pin receiving bore in the hub disc **62** and a sliding fit with the bore in the header core disc **58** thus providing an axially expandable pin and sleeve bearing connection between said hub disc **62** and said slidable header core disc **58**. A substantial number of these pins is provided at spaced intervals around the circumference of the hub disc in order to provide a strong support for the header core disc **58**. The arrangement is such that the header core disc **58** is free to move axially as dictated by the expansion or contraction of the shell **18**, but, on the other hand, is very rigidly supported against lateral or turning movement with relation to the sleeve hub **12**.

FIG. 6 of the drawings illustrates another embodiment of the invention in a cooling roll, which comprises a drum **80** having a peripheral surface in the form of a shell **82** which is continuously cooled by the circulation of a cooling medium in contact with the inner periphery of said shell. The drum **80** comprises generally two headers **84**, **86** on which the shell **82** is mounted. The header **84** is formed on the end of a pivot shaft **88** which carries one end of the cooling roll assembly, the header **86** being similarly formed on the end of a hollow shaft **90** which provides pivotal support for the other end of the cooling roll assembly. The cooling roll assembly is also provided with an inner drum **92** having the end portions thereof narrowly spaced from the headers **84**, **86** and the outer periphery thereof narrowly spaced from the inner periphery of the shell **82** so that a space is provided between the inner drum **92** and shell **82** for the circulation of cooling water. The inner drum **92** is secured at its left-hand end to a bearing block **94** rigidly fastened into a bore in the header **84** by screws **96**. At its right-hand end the inner drum **92** is formed with a tubular extension **98** having a sliding fit with a sleeve bearing **100** provided in the header **86**.

Coolant is introduced into the cooling roll through an inlet pipe **102** which extends through the hollow shaft **90** along the rotational axis of the cooling roll being supported at its left-hand end as shown in FIG. 6 in the bearing block **94** for the end of the inner drum **92**. The coolant enters the coolant space provided interiorly of the shell **82** at the left-hand end of the drum assembly, flows to the right-hand end of the drum assembly and is drawn off through a passageway formed between the outside diameter of the pipe **102** and inside diameter of the hollow shaft **90**.

In accordance with the invention the shell **82** is fitted over the peripheral faces of the two headers **84**, **86** loosely to permit expansion and contraction of the rim with respect to the two headers, being connected thereto only by means of radial pins **104** which are arranged in two rows in staggered relation at spaced intervals about the periphery of the shell adjacent each end thereof. Each pin **104** is press fitted through the shell and extends radially inwardly into and has a sliding fit with a socket **106** which is held by a press fit in a radial bore in the periphery of the respective header. In the construction shown, there are twelve pairs of pins **104** mounted at equally spaced intervals about the periphery of the shell **82**. The pins are further arranged in opposed relation at opposite sides of the shell on diameters angularly arranged with relation to one another and passing through the axis of the headers. It will be evident that each opposed pair of pins will provide a fixed support for the shell, including the rotational axis thereof, against movement in a direction transversely of the said diameter on which said pins are located while permitting expansion and contraction of the shell longitudinally of said diameter, so that the rotational axis of the shell is rigidly held at the point of intersection of all of said diameters in a position concentric with the hub axis. The arrangement is such that the shell **82** is at all times supported securely in an exactly centered position with relation to the rotational axis of the pivot shaft **88** and shaft **90** while at the same time it is permitted to expand and to contract freely in a radial direction independently of the headers **84**, **86**. In order to prevent leakage of the cooling medium through the relatively loose connections provided between the shell **82** and the headers **84**, **86**, the header **86** is provided adjacent its outer edge with a ring **108** which overlies the end of the shell **82**. The header **84** is similarly provided with a ring **110** which overlies the opposite end of the shell **82**. O-rings **112**, **114** mounted in the inner faces of the rings **108**, **110**, respectively, prevent the escape of

coolant past the ends of the outer shell **82**. The shell **82** and headers **84**, **86** of the cooling roll illustrated in FIG. 6 may be assembled as follows:

The sockets **106** are press fitted into bores in the peripheries of the two headers **84**, **86** and the shell **82**, similarly drilled to receive the pins **104**, is then slid into position axially over the headers **84**, **86**. Each pin receiving hole in the shell **82** is now lined up with the associated socket **106**, and a pin **104** is driven into position through the shell **82**. Finally the rings **110**, **108** are assembled and screwed to the outer faces of the headers **84**, **86** in the positions shown.

With the construction shown, the outer shell **82** is permitted to expand and to contract radially with relation to the relatively thick-walled headers **84**, **86** by means of the pin and socket connections above described, while at the same time the shell is at all times held firmly in its centered position with relation to the rotational axis of the cooling roll. Expansion and contraction of the outer shell **82** axially with relation to the inner drum **92** is permitted by the sliding fit provided between the bearing **100** formed within the right-hand header **84** and the tubular extension **98** of the drum **92**.

The invention having been described what is claimed is:

1. A rotary drum for use in a rotary drum heat exchanger which comprises a shell having an external heat exchanging surface, a rotary hub, a plurality of disc headers mounted on the hub and spaced from one another along the length of the shell for supporting said shell, a series of expansion joints on which the shell is supported from said disc headers comprising opposed pairs of pin and sleeve bearing connections at opposite sides of each disc header along diameters intersecting the hub axis at a substantial angle to one another, the pins extending radially of the drum axis for movement relatively to said sleeve bearings only along said diameter, each opposed pair of pin and sleeve bearing connections on a said diameter providing a fixed support for said shell including the rotational axis thereof against movement in a direction transversely of said diameter, while permitting expansion and contraction of the shell longitudinally of said diameter, whereby the rotational axis of the shell is rigidly held at the intersection of said diameters concentric with the hub axis.

2. A rotary drum according to claim **1** in which each said expansion joint comprises a guide block having a bore extending radially of the shell axis secured to said shell, a guide block having a bore extending along the same radial line secured to said disc header, a guide pin extending through both of said bores, and means securing said guide pin within one of said bores in position for sliding engagement with the other said bore.

3. A rotary drum according to claim **1** in which a plurality of pin and sleeve bearing expansion joints are provided between each said disc header and said shell evenly spaced from one another about the periphery of said rotary drum and are paired in opposed relation at opposite ends of a plurality of pairs of perpendicularly crossing diameters.

4. A rotary drum according to claim **1** including a said disc header shiftable axially on said hub in accordance with the axial contraction and expansion of said shell, said axially shiftable header comprising a shell supporting disc member having radial pin and sleeve bearing expansion joints with said shell, a hub disc member fixed to said hub in radially overlapping relation to said shell supporting disc member, and a plurality of axially extending pin and sleeve bearing connections between the overlapping portions of said hub disc member and said shell supporting disc member spaced about the axis of said hub on which the said shell supporting disc member is keyed to turn with and is freely shiftable axially with relation to said hub disc member and hub.

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