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[54] **SUPPORT ARRANGEMENT FOR A VESSEL USED IN HIGH TEMPERATURE OPERATIONS**

[72] Inventors: **Karl Heinrich Mähringer,** Duisburg-Hamborn; **Karlheinz Langlitz,** Mulheim/Ruhr, both of Germany

[73] Assignee: **Demag Aktiengesellschaft,** Duisburg, Germany

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[51] **Int. Cl.**..**C21c 5/42**
[58] **Field of Search**..........................266/35, 36 P, 39

[56] **References Cited**

UNITED STATES PATENTS

3,391,919	7/1968	Eberhart	266/36 P
3,502,314	3/1970	Puhringer	266/36 P

Primary Examiner—Gerald A. Dost
Attorney—McGlew and Toren

[57] **ABSTRACT**

In an arrangement for supporting a vessel, which is used in high temperature operations, the vessel is supported from a support ring spaced from the vessel. A reinforcing ring is positioned about the vessel and tensile stress elements extend from the reinforcing ring to the support ring which is pivotally mounted. The tensile stress elements are formed of a plurality of individual wires and can be adjustably prestressed. Additionally, bolt-like members secured to the support ring and articulated to the reinforcing ring also provide support for the vessel so that it can be properly sustained in its normal upright position and also when it is tilted from its upright position.

10 Claims, 5 Drawing Figures

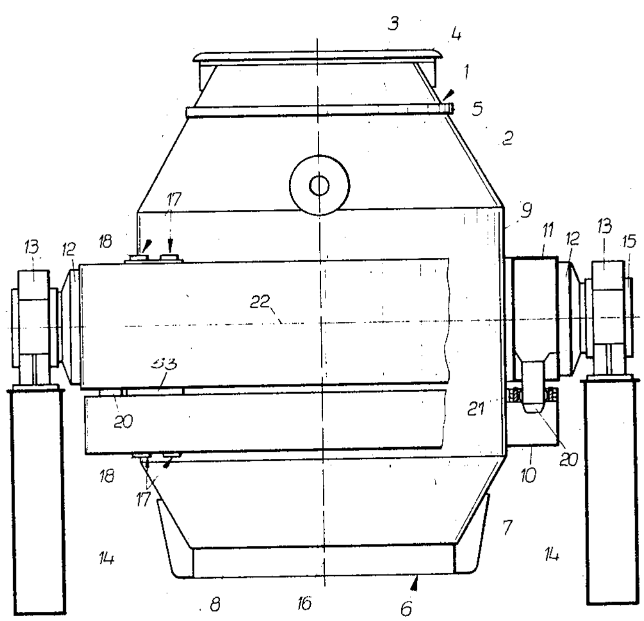
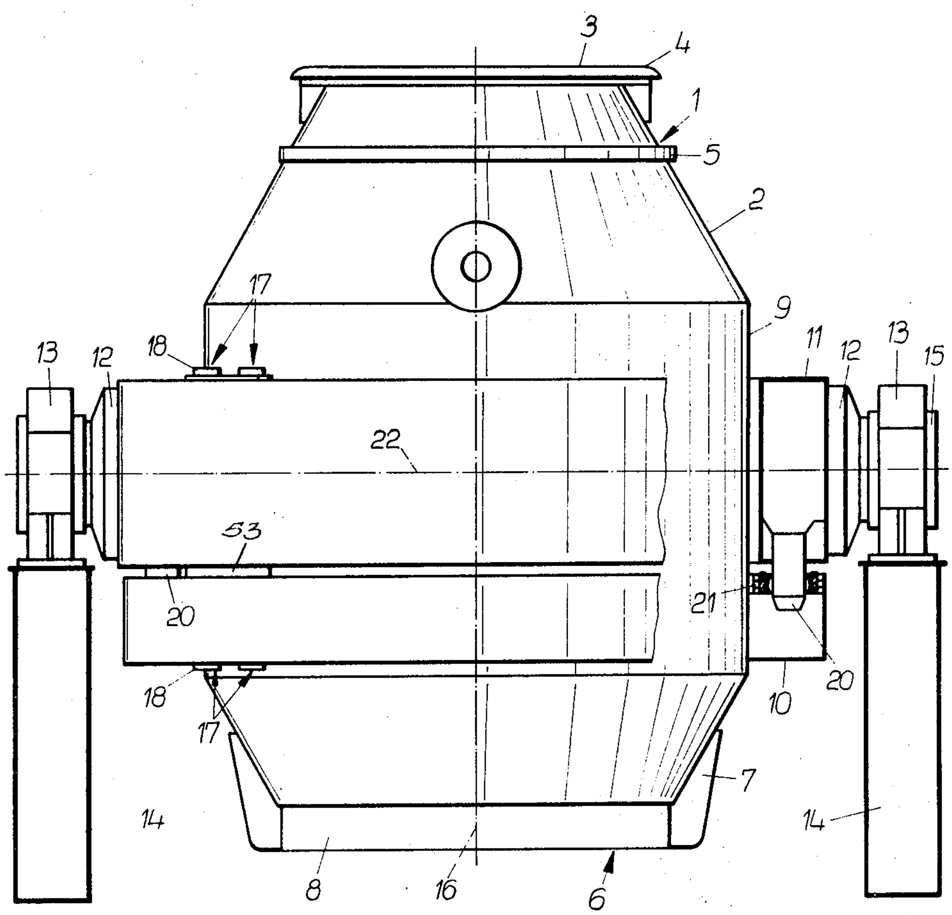


Fig. 1



Inventors

KARL-HEINRICH MÄHRINGER
KARL-HEINZ LANGLITZ

By: McGlew & Toren

ATTORNEYS

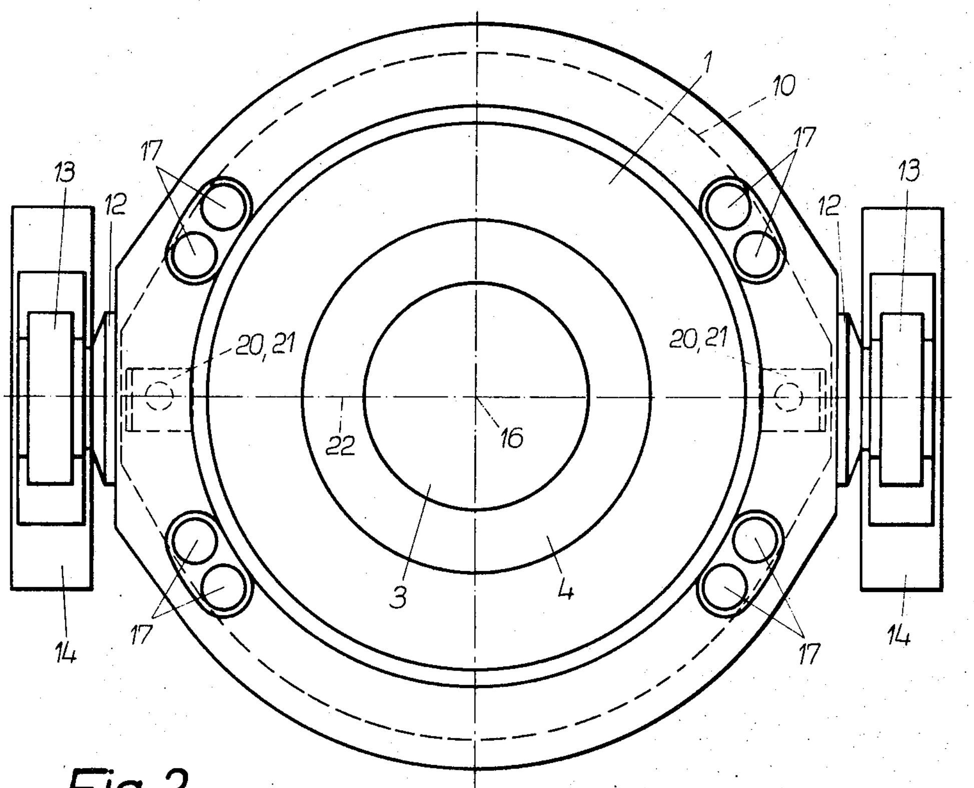


Fig. 2

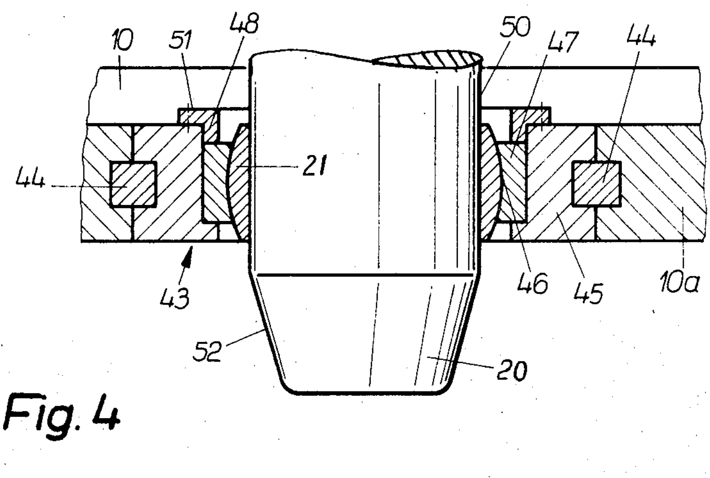
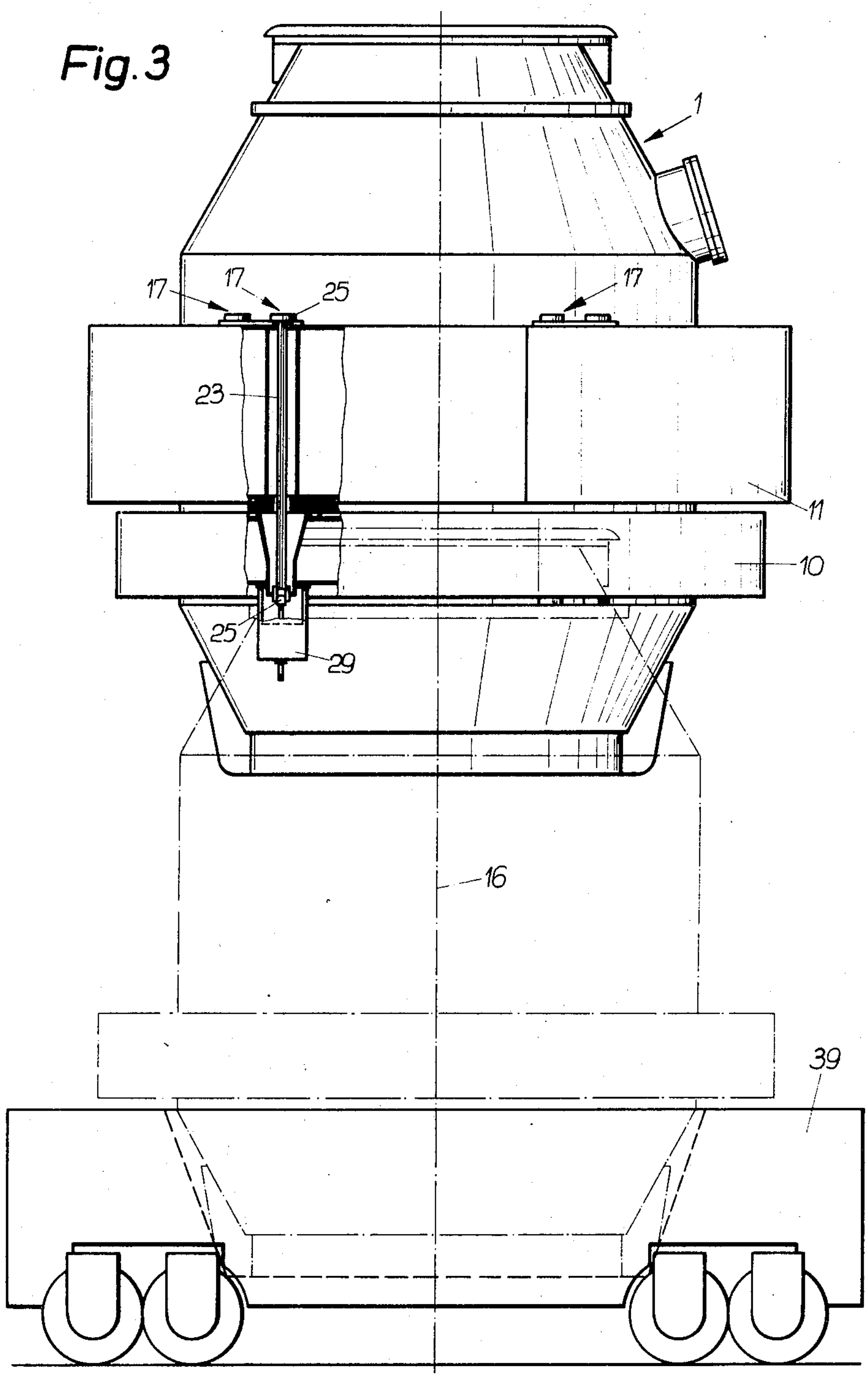


Fig. 4

Inventors
KARL-HEINRICH MÄHRINGER
KARL-HEINZ LANGLITZ

BY McGlew & Toren
ATTORNEYS

Fig. 3



Inventors
KARL-HEINRICH MÄHRINGE
KARL-HEINZ LANGLITZ
By: McGlew & Toren
ATTORNEYS

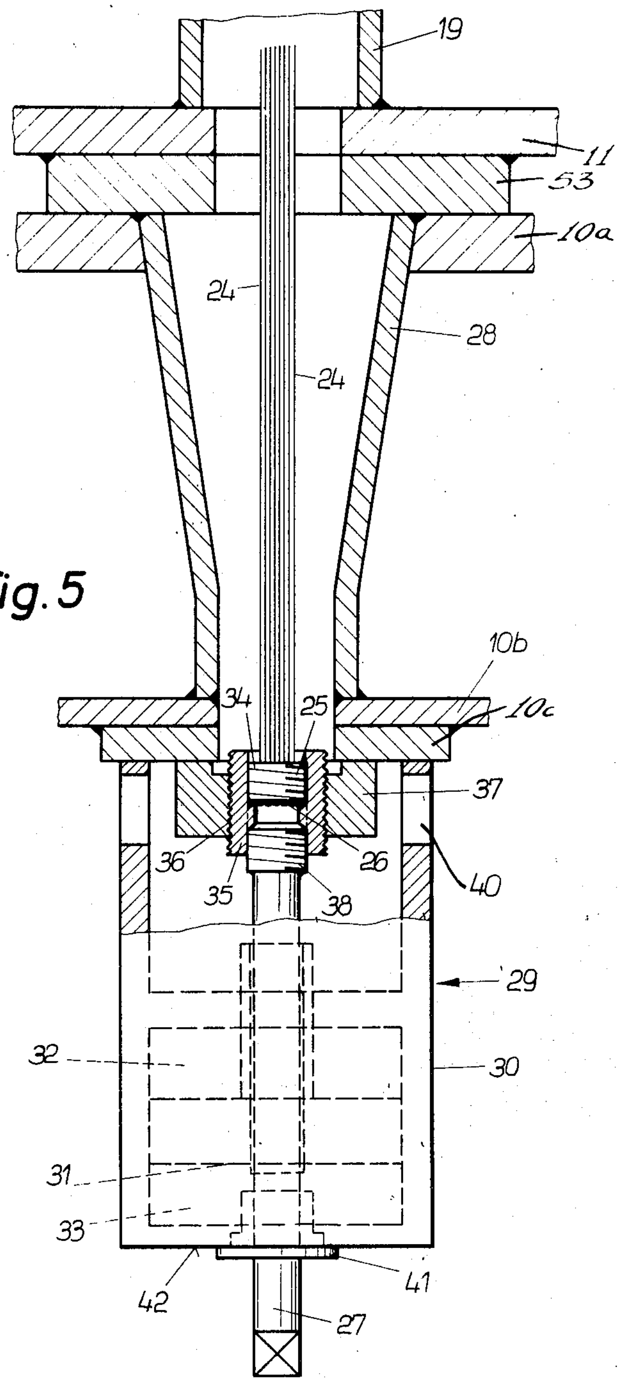


Fig. 5

Inventors
KARL-HEINRICH MÄHRINGER
KARL-HEINZ LANGLITZ
By: McGlew & Toren
ATTORNEYS

SUPPORT ARRANGEMENT FOR A VESSEL USED IN HIGH TEMPERATURE OPERATIONS

SUMMARY OF THE INVENTION

The invention is directed to a support arrangement for vessels which are used under high temperature conditions, such as in a steel converter mill, and, more particularly, it is concerned with a separately arranged support ring to which the vessel is connected by means of tensile stress elements.

In vessels operating under high temperature conditions both in metallurgy and in reactor engineering, such as nuclear reactor vessels, considerable difficulties are experienced due to thermal stresses which can increase up to a point where damage may result to the vessel unless thermal expansion of the vessel is allowed to take place without any restriction. In the interest of a possibly economical construction, thin-walled vessels have advantages. However, it has been found that an adequate increase of the wall thickness does not lead to the desired result because the resulting static stress conditions cannot be proved.

In the past, particularly in steel plant converters, damages have developed which have made it necessary to take special measures for heat expansion, and the problems experienced have been aggravated if the vessels are tiltable. In the course of a tilting movement of the vessel between 0° and 360°, the vessel is subjected to an alternating stress which attains a maximum in a certain position. Independent of these stresses, thermal stresses are produced which depend on the type of support for the vessel. The vessel shell forms a complicated structure and requires a distribution of the tensile-compressive and shearing stresses. Based on the high temperatures within the vessel, locally such temperatures can be as high as 2,000° C, and with the temperature decreasing outwardly due to the lining of the vessel, very high thermal stresses are superposed on the force stresses within the vessel. The stresses which result under such conditions within the vessel appear in larger regions at the flow limit and are responsible for a slowly progressing plastic deformation of the vessel.

The invention is based on the known principle of separating the connecting members between the vessel and its supporting structure which absorbs the loads under the different loading conditions. Accordingly, it is known under certain loaded conditions of the vessel to utilize vertically arranged tensile stress elements which permit transverse movement of the attachment points for the tensile stress elements obliquely to the axis of the tensile stress. In the "belly" position of the vessel (when the longitudinal or central axis of the vessel is in the horizontal position) there is the condition that the thermal stresses can be absorbed in the radial direction and at the same time in the longitudinal direction of the vessel.

In spite of the known support arrangements, the problem of providing an expedient rapid assembly and disassembly of the vessel in its supported position is still unsolved. In placing the vessel in its supported position, it is not only necessary to transmit the complete weight of the vessel (about 1,000 tons) and its contents for continuous operation, but also to introduce the necessary prestressing forces into the supporting elements before the support of the vessel can be considered as completely transferred to its support structure without the need for additional outside support.

Accordingly, it is a primary object of the invention, to provide a support arrangement which permits rapid assembly and disassembly of the vessel in its supported position and also permits in this support arrangement the replacement of vessels without any loss of the advantages of favorable absorption of stresses with additional thermal expandability of the tensile stress elements.

Therefore, in accordance with the present invention, the problems mentioned above are solved by the combination of tensile stress elements, which are secured at their opposite ends to a support ring and a reinforcing ring connected to the vessel, and additional support means formed of bolt connections between the support ring and the reinforcing ring for the "belly" position of the vessel, where the bolts are arranged in the direction of the longitudinal or central axis of the vessel in its upright and tilted positions. Naturally, the thermal expansion of the vessel is greatest when the generation of heat attains its maximum during the converter process while the vessel is in the vertical or upright position. In this position thermal expansion takes place over the tensile stress elements without any introduction of forces acting on the vessel, that is, the vessel is only subjected to minor thermal stresses. The torsional stress in the vessel shell when the vessel is in the "belly" position is absorbed, to a great extent, by the reinforcing ring which is also capable of absorbing major forces limited to smaller surface areas. Accordingly, a pair of bolt connections between the support ring and the reinforcing ring is sufficient under certain circumstances for providing the requisite support. However, several bolt connection arrangements can be provided about the circumference of the support ring and the reinforcing ring. The essential effect of the bolt connections consists in avoiding thermal expansion obstacles, at least in the axial direction of the vessel. Accordingly, the basic concept of the invention combines a high load absorbing capacity of the support arrangement with a high thermal expandability at times of maximum heat production and at the same time a simple assembly and disassembly arrangement so that the vessels can be easily replaced as each new lining of brickwork is required.

Based on the above described support arrangement for vessels operating under high temperature conditions which affords a solution to the problems of "load absorption," "thermal expandability without any increase in the thermal stresses," and "vessel replaceability" another important feature of the invention is the disposition of the tensile stress elements in pairs spaced from the plane extending through the longitudinal or central axis of the vessel and through its pivot axis while the elements are in parallel relationship with the longitudinal axis and with the bolt connections located within the plane containing the central axis and pivot axis of the vessel. With such an arrangement it is possible to provide the necessary support for the vessel with a single pair of the bolt connections. Additionally, if the reinforcing ring is positioned below the support ring when the vessel is in its vertical position, the thermal stress in the reinforcing ring is lower, that is, the reinforcing ring can be fastened directly to the lower portion of the vessel shell without any great difficulties. Preferably, the tensile stress elements are comprised of bundles of single or individual wires which are secured at their ends within anchor heads and which can be prestressed by means of mechanical members cooperating with the bundles of wires. The maximum admissible prestressing forces with an average number of individual wires, for example, having a diameter of 7 cm, is already known to be on the order of 500 tons or more. For the wire tension itself, preferably an initial stress of up to 112 kp/mm² is used.

Another feature of the invention is the disposition of the bolt connections exteriorly of the vessel extending between the support ring and the reinforcing ring. With such an arrangement the various parts of the support arrangement are located in lower temperature regions relative to the temperature conditions within the vessel and can be protected from damage or from fouling by dirt and similar material.

If radial thermal expansion occurs in the reinforcing ring any problem that might be developed in the support arrangement is remedied by providing an articulated engagement for the bolt connection within the reinforcing ring.

To obtain the optimum utilization of the tensile stress elements in accordance with the present invention, it is necessary that the elements be protected. Accordingly, the tensile stress elements extend through the support ring and the reinforcing ring with a turnbuckle or similar means for prestressing the elements preferably disposed within a protective housing so that the tensile stress elements and the means for prestressing the elements are completely protected. While the enclosure of the tensile stress elements protects them from slag splashes and the like, it also has a particular advantage in protecting the elements from radiant heat. Moreover, the placement of the elements within the support and reinforcing rings permits the maintenance of a minimum distance from the central longitudinal axis of the vessel and accordingly any load moments are kept correspondingly low.

When the vessel is being positioned within or removed from its support arrangement, it is important to provide for convenient handling of the vessel. If it is necessary to effect the engagement of the vessel at a considerable height, there is always a risk to the operating personnel. Furthermore, if the work has to be conducted at considerable heights, the cost of performing the work is correspondingly high. In accordance with the present invention, one of the two anchor heads of each tensile stress element is arranged on the underside of the lower one of the support ring and the reinforcing ring, and a special adjusting device is provided for preliminary adjustment of the turnbuckle. The preliminary adjustment permits the detachment of the tensile stress elements without the necessity of readjusting the initial stress for reassembly.

Various adjusting devices can be utilized for effecting the preliminary adjustment. However, a particularly advantageous adjusting device consists of a sleeve in which the adjustable turnbuckle is positioned and which can be preliminary adjusted by mechanical and/or hydraulic lifting means.

Hydraulic means can be used for effecting the preliminary adjustment by stressing the individual wires hydraulically by means of a piston arrangement, and after the desired stressing action has been achieved, the prestressing action can be transferred to mechanical means, for example, a spindle member screwed into the sleeve, so that when the hydraulic force is removed the prestressing action on the individual wires remains. If, after a considerable period of operation, there is a reduction in the prestressing force, the adjusting device can be readily manipulated to produce the required prestressing force, that is, to effect a readjustment in the prestressing. Where plastic deformations take place, as mentioned above, the adjusting device provided in the present invention has considerable advantages.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference should be had to the accompanying drawing and descriptive matter in which there is illustrated a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawing:

FIG. **1** is an elevational view of a steel mill converter with a portion shown broken away illustrating a support arrangement in accordance with the present invention;

FIG. **2** is a top view of the arrangement shown in FIG. **1**;

FIG. **3** is an elevational view showing a steel mill converter, as illustrated in FIGS. **1** and **2**, showing its assembled and disassembled positions relative to the support arrangement and with a special change car for the vessel in its disassembled position;

FIG. **4** is an enlarged detail view of the engagement of a bolt connection within a reinforcing ring; and

FIG. **5** is a partial longitudinal sectional view, on an enlarged scale, of a tensile stress element as shown in FIG. **3**.

DETAILED DESCRIPTION OF THE INVENTION

In FIGS. **1** and **3**, a steel plant converter **1** is formed of a vessel shell **2** composed of a number of individual sections welded together. In FIGS. **1** and **3** the vessel is shown in its normal upright position and its vessel mouth **3** at its upper end is reinforced by a mouth ring **4** and additional reinforcing rings **5**, such as the one spaced immediately below the mouth ring **4**, can be arranged about the circumference of the vessel. On the bottom **6** of the converter vessel, ribs **7** are provided for reinforcement and attaching, if necessary, a detachable bottom cover **8**. The central portion **9** of the vessel is cylindrical in shape. Closely spaced above the ribs **7** and in rigid engagement with the central portion **9** of the vessel is a reinforcing ring **10**. As can be noted in FIGS. **1** and **5**, the reinforcing ring **10** has a box-like cross sectional profile and is made up of individual parts welded together. Immediately above the reinforcing ring **10** and extending about the central portion **9** of the vessel **1** is a supporting ring **11** which is spaced outwardly from the vessel. The support ring can be cast or individual sections can be welded together. Further, several cast segments can be secured together to form a full ring.

On diametrically opposed sides of the support ring **11**, note FIGS. **1** and **2**, pivot pins **12** extend outwardly from the support ring and are secured in pivot bearings

13 which, in turn, rest on foundations 14. As indicated by the reference numeral 15 in FIG. 1, a drive element is positioned for pivoting the pins 12 within their bearings 13. Preferably, the drive element 15 is designed so that sagging effects of the support ring 11 and of the pivot pins 12, respectively, or the temperatures reached within the converter, can produce no influence that would affect the torque transmission means.

As mentioned above, in FIG. 1 the converter vessel 1 is arranged in its vertically axial position, that is, its normal upright position with its central or longitudinal axis designated by the reference numeral 16. In this position tensile stress elements 17 are provided which alone carry the weight of the vessel. In FIG. 1 the tensile stress elements are indicated only by their end connections or mechanical attachments 18, since they extend through the support ring 11 and the reinforcing ring 10 and in the open space between the two rings the elements are closed in a housing 19 which is described below in greater detail with respect to the illustration in FIG. 5. For tilting the converter from its normally upright position shown in FIG. 1 in which its central axis 16 is arranged vertically to the "belly" position in which the central axis is disposed horizontally, bolts 20 are provided inside the support ring and extend downwardly into the reinforcing ring 10 where they are secured by means of bolt receivers for transmitting the pivotal action from the support ring through the reinforcing ring to the vessel. A pair of the bolts 20 are provided, each on a diametrically opposed side of the vessel, and the bolts extend in a plane which includes both the central axis 16 of the vessel and the pivot pin axis 22 of the support arrangement. The bolts 20 are rigidly mounted in the support ring. However, they are articulated within the reinforcing ring in a ball and socket-like joint for permitting relative movement between the support ring and the reinforcing ring toward the central axis 16 of the vessel. In FIG. 2 the tensile stress elements 17 are shown disposed in pairs in angularly spaced positions about the reinforcing ring 10 and the support ring 11. The pairs of tensile stress elements 17 are arranged symmetrically to the pivot axis 22 and to the central axis of the vessel 16. While the tensile stress elements 17 are spaced from the plane which includes the pivot axis 22 and the central axis 16 of the vessel, the bolt connections 20, 21 are disposed in the plane of the pivot axis 22 and the central axis 16. The bolt connections 20, 21 are positioned in the range of the pivot pins within the supporting ring 11.

FIGS. 3 and 5 show the essential features of the tensile stress elements 17. Each of the elements 17 consists of a bundle 23 of single or individual wires 24, as illustrated in FIG. 5. Each of the individual wires 24 extends through a corresponding bore in an anchor head 25 and the wires are provided with upset heads which prevent them from being displaced from the anchor heads 25. Each bundle 23 has an anchor head at each of its opposite ends, one cooperating with the support ring 11 and the other with the reinforcing ring 10.

The adjustment of the stress for the wire bundles is effected by an auxiliary removable adjusting device 29 shown in FIG. 5. The necessary supporting forces can be transmitted through housings 28 which are disposed between the upper plate 10*a* and the lower plate 10*b* of the reinforcing ring. Therefore, the housings 28 act not only as reinforcements for the reinforcing ring 10 as it receives the supporting forces, but also form envelopes or enclosures for the bundles 23 of individual wires 24 so that the wires are protected.

Extending downwardly from the underside of the reinforcing ring 10, the adjustment device 29 comprises a housing 30 within which a threaded adjusting spindle 27 is positioned. In addition, the housing 30 serves as a hydraulic chamber for a piston 31 threadedly mounted on the spindle 27 with the housing 30 cooperating with the piston 31 to form a pair of pressure chambers 32 and 33 for containing pressurized hydraulic fluid. The anchor head 25 cooperating with the reinforcing ring 10 is positioned closely below a reinforcing or support plate 10*c* welded or otherwise secured to the undersurface of the bottom plate 10*b* of ring 10. Head 25 has an external or male thread 34 onto which a sleeve 35, having an internal thread, is screwed. Sleeve 35 also has an external thread 36 by means of which the sleeve is threaded within a block 37 engaging the support plate 10*c*.

After spindle 27 is threaded into sleeve 35, preferably until its collar or flange 41 bears against the bottom surface 42 of housing 30, hydraulic fluid under pressure is introduced into pressure chamber 32 until a predetermined pressure in this chamber is attained. This forces piston 31 downwardly, carrying along spindle 27, so that wire bundle 23 has imparted thereto a certain initial stress. At the same time, block 37 is displaced downwardly from supporting plate 10*c*, and collar 41 is displaced downwardly from surface 42. By means of a suitable tool, such as a wrench, inserted through openings 40, block 37 can be threaded upwardly manually so that it firmly engages supporting plate 10c. However, it is also possible to initially readjust spindle 27 so that its collar 41 again bears firmly on surface 42. Before threading block 37 upwardly, the hydraulic pressure fluid in chamber 32 can be expanded. As soon as block 37 again bears firmly against plate 10*c*, and the pressure in chamber 32 is released, spindle 27 is screwed out of sleeve 35 so that the adjusting device 29 can be removed and used again for clamping another wire bundle 23.

The assembly of the converter 1 into its pivoting or tilting base construction 13, 14 proceeds as follows:

The converter vessel 1 is moved by means of a vessel change car 39, see FIG. 3, into a position aligned below the support ring 11. The vessel change car 39 is provided with a lifting device, not shown, which may consist, for example, of hydraulic cylinders. Vessel 1 is then lifted from its disassembled position, in which it rests on vessel change car 39 as shown in dotted lines, upwardly into support ring 11 until reinforcing ring 10, on vessel 1, engages all the fitting pieces 53 welded to the undersurface of the support ring. During this lifting operation, the two guide bolts 20 extend into their receivers 21. Tension elements 17 are introduced from the top into and through the enclosures 28, these tension elements having the heads 25 on their lower ends secured in the sleeves 35. The blocks 37 are threaded onto the sleeves 35 until they bear against the associated supporting plates 10c. After this, the prestressing, using the adjusting device 29, is effected by the spindle 27 in cooperation with the piston 31 and the chambers 32 and 33, as already described. With the vessel secured to the support ring the lifting means on the vessel change car can be retracted and the car can be moved out of the assembling position. The vessel is now in its operating position within the support ring **11**.

During the assembly and disassembly of the converter vessel **1**, advantages result not only from the relative displaceability of the bolts **20** due to thermal expansion of the vessel shell, but additional advantages result during the insertion of the bolt **20** into the bolt receiver **21**. As shown in FIG. 4, the reinforcing ring has a ball and socket-like joint **43** which receives the lower end of the bolt **20**, and a description of whose structure follows. Within the upper plate **10**a of the reinforcing ring **10** a ring **45** is removably secured by means of adapters **44** and receives a second ring **47** having a spherically shaped inner surface **46**. The ring **47** is held in place within the ring **45** by means of a cover member **48** which is threaded into engagement with the ring **45**. Another ring **49** forms the bolt connection **21** and has a spherically shaped outer surface which fits within the spherically shaped inner surface **46** of the ring **47** and is firmly pressed onto the cylindrically shaped shaft **50** of the bolt **20** by a shrink fit. The bolt **20** does not perform any movement. However, due to the spherically shaped surfaces of the ring **47** and the ring or bolt connection **21** in engagement with one another, the reinforcing ring can effect movement relative to the bolt.

With this arrangement, it is possible to insert the bolt **20** into the bolt connection **21** and effect the threaded joint **51** by means of the cover **48** for assembling the ring **47** within the ring **45** during the assembly of the vessel **1**. In assembling the bolt **20** within the reinforcing ring **10** a frustoconical end **52** is provided on the bolt to insure proper connection though the axis of the bolt and of the ring **45** are not in alignment. Accordingly, for the operative utilization of the vessel, it is possible, without any great difficulty, to assemble the vessel into the support ring.

We claim:

1. A support arrangement for tiltable vessels using high temperature operations, such as vessels used in steel mill converters, comprising, in combination, a vessel having a central axis disposed in the upright position when said vessel is in its normally upright positions, a support ring laterally surrounding said vessel in spaced relation therewith, said support ring being disposed in a plane transverse to the central axis of said vessel, a reinforcing ring laterally embracing said vessel in supporting contact with said vessel, said reinforcing ring being spaced from said support ring and disposed in a plane transverse to the central axis of said vessel, a plurality of tensile stress elements each extending between said support ring and said reinforcing ring, means securing said tensile elements to said support ring and to said reinforcing ring, said tensile elements constituting the sole means supporting said vessel from said support ring, means for tilting said vessel from its normally upright position about an axis intersecting said central axis and perpendicular thereto, and bolts secured to said support ring in angularly spaced relation and engaged with said reinforcing ring, said bolts transmitting the shearing forces, existing during tilting of said vessel, to said support ring.

2. A support arrangement, as set forth in claim **1**, wherein said tensile stress elements are arranged in pairs in angularly spaced positions about said vessel and said tensile stress elements are spaced from a plane passing through the central axis of said vessel and through the axis about which said vessel tilts.

3. A support arrangement, as set forth in claim **2**, wherein each said tensile stress element comprises a bundle of individual wires extending in the direction of the central axis of said vessel, said means for securing said tensile stress elements to said support ring and to said reinforcing ring comprising an anchor head at each end of said bundle of wires for anchoring the ends of said wires, and means for adjustably prestressing said bundles of wire.

4. A support arrangement, as set forth in claim **3**, wherein each said bundle of wires extends through said support ring and reinforcing ring, said means for adjustably prestressing said bundles of wire comprising a turnbuckle type assembly releasably engageable with the underside of the lower one of said support ring and reinforcing ring in the normally upright position, and a housing enclosing said turnbuckle assembly with the lower end of said turnbuckle assembly extending through and being accessible at the lower end of said housing.

5. A support arrangement, as set forth in claim **4**, wherein said housing is engageable with the underside of the lower one of said support ring and reinforcing ring, a block engageable with the underside of the lower one of said support ring and reinforcing ring, within said housing, a sleeve threaded into said block, the anchor head securing the lower ends of said bundle of wires being threadedly engaged in said sleeve, said type assembly turnbuckle comprising a spindle axially alignable with said bundle of wires and having its upper end threadedly engaged in said sleeve, said spindle extending downwardly from said sleeve with its lower end extending through said housing so that said lower end is accessible for prestressing said bundle of wires, and a collar secured to said spindle and engageable with the bottom surface of said housing.

6. A support arrangement, as set forth in claim **5**, wherein said housing forming a closed space therein, a hydraulic piston disposed within and dividing said space in said housing into two hydraulic chambers, said hydraulic piston being adjustably mounted on said spindle in said housing so that by regulating the hydraulic pressure within said chambers a preliminary prestress can be applied to said bundle of wires and then by adjusting said spindle within said sleeve the prestress is transferred to the mechanical connection of said spindle to said sleeve and said housing.

7. A support arrangement, as set forth in claim **1**, wherein said bolts are rigidly secured to said support ring, and connector means are fixed within said reinforcing ring for receiving each of said bolts so that said reinforcing ring can move relative to said bolts.

8. A support arrangement, as set forth in claim **7**, wherein said connector means comprises a ball and socket joint assembly, said ball and socket joint assembly comprising an inner ring having a cylindrical bore and engaged on said bolt by a shrink fit, the outer peripheral surface of said inner ring having a spherical configuration, an outer ring disposed in contacting en-

gagement with said inner ring and having an inner spherically shaped surface in sliding engagement with the outer spherically shaped surface of said inner ring, and means for securing said inner and outer ring within said reinforcing ring.

9. A support arrangement, as set forth in claim **1**, wherein said means for tilting said vessel comprises a pair of pivot pins diametrically disposed and extending outwardly from the outer surface of said support ring, pivot bearings for said pivot pins positioned outwardly from said support ring, and foundation means for supporting said pivot bearings.

10. A support arrangement for tiltable vessels used in high temperature operations such as vessels used in steel mill converters, comprising a vessel having a central axis disposed in the upright direction when said vessel is in its normally upright position, a support ring disposed laterally about and in spaced relationship with said vessel, said support ring disposed in a plane normal to the central axis of said vessel, a reinforcing ring extending laterally about and in supporting contact with said vessel, said reinforcing ring spaced below and in parallel relationship with said support ring when said vessel is in its normally upright position, means for pivotally supporting said support ring with the pivot axis extending through and at right angles to the central axis of said vessel, a plurality of tensile stress elements disposed in pairs extending between said support ring and said reinforcing ring and said tensile elements being disposed in parallel relationship with the central axis of said vessel, said pairs of tensile elements being spaced symmetrically on opposite sides of said pivot axis and of said central axis, said tensile elements being spaced from the plane containing said pivot axis and said central axis of said vessel, each said tensile stress element comprising a bundle of individual wires, an anchor head at each end of said bundle of wires for anchoring the ends thereof, and a turnbuckle assembly engageable to the underside with said reinforcing ring for prestressing said wires, said turnbuckle assembly comprising a block arranged to contact the underside of said reinforcing ring, a sleeve in threaded engagement with said block, said anchor head securing the lower end of said bundle of wires secured in threaded engagement with said sleeve, a spindle in axial alignment with said bundle of wires having its upper end in threaded engagement within said sleeve and extending downwardly therefrom, a housing enclosing said turnbuckle assembly below said reinforcing ring, said housing having an opening in the lower end thereof and said spindle extending through said opening so that it is accessible for prestressing said bundle of wires, a pair of bolts each disposed on one end of said pivot axis with the upper end of said bolt rigidly secured within said support ring and the lower end of said bolt extending downwardly into said reinforcing ring, an inner ring within said reinforcing ring engaged on the lower end of said bolt with a shrink fit, the outer peripheral surface of said inner ring having a spherical configuration, an outer ring disposed in contacting engagement with said inner ring having an inner spherically shaped surface in sliding engagement with the outer spherically shaped surface of said inner ring, and means for securing said outer ring and said inner ring within said reinforcing ring.

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