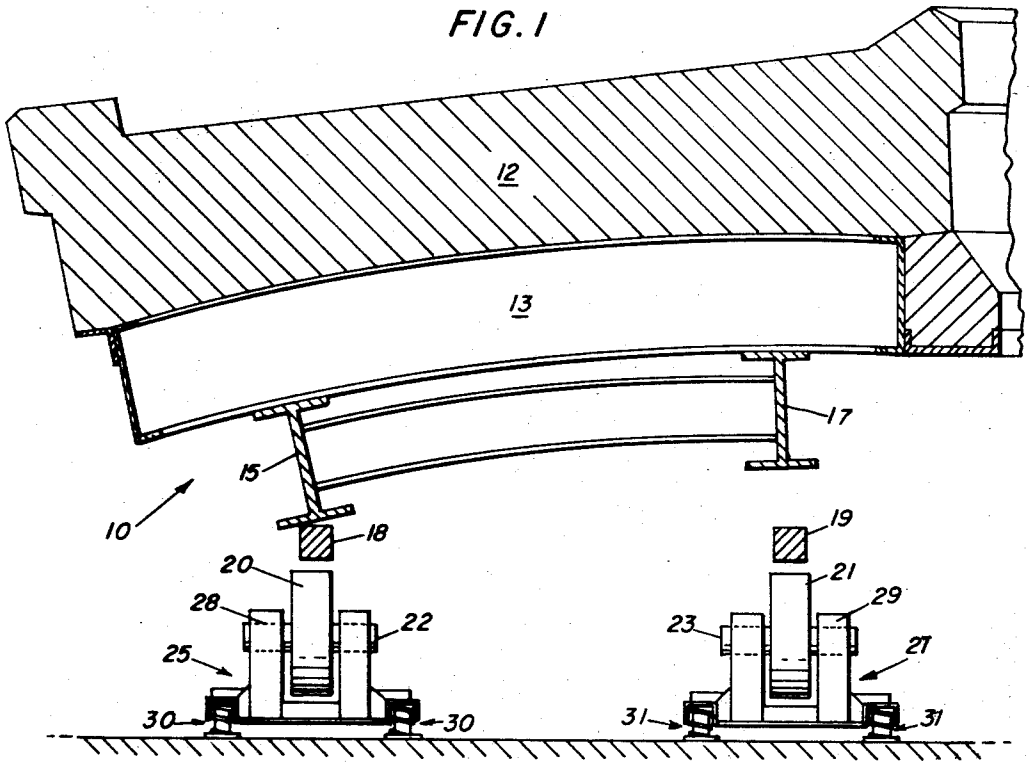
Dec. 24, 1968 H. CUNNINGHAM 3,417,976

SPRING BOX SUPPORT FOR ROTARY HEARTH FURNACE AND THE LIKE

Filed Sept. 27, 1966 3 Sheets-Sheet 1

FIG. 1



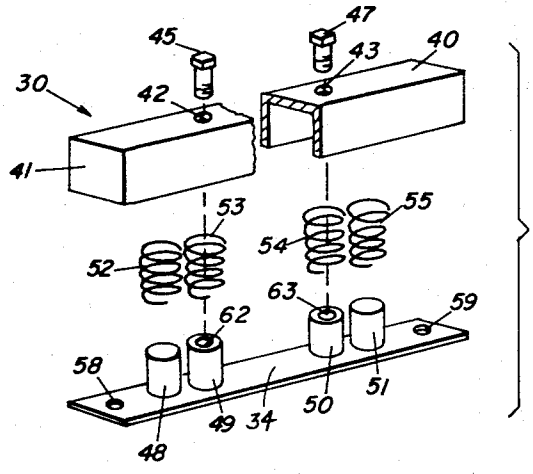


FIG. 2

INVENTOR
HUGH CUNNINGHAM

BY Chisholm and Spencer
ATTORNEYS

Dec. 24, 1968 H. CUNNINGHAM 3,417,976

SPRING BOX SUPPORT FOR ROTARY HEARTH FURNACE AND THE LIKE

Filed Sept. 27, 1966 3 Sheets-Sheet 2

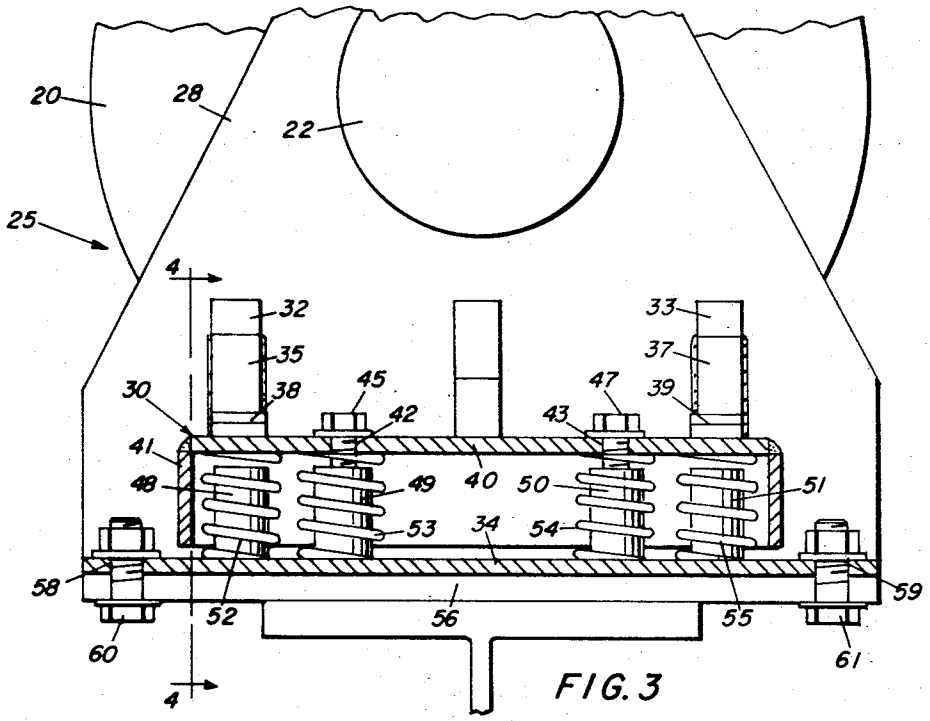


FIG. 3

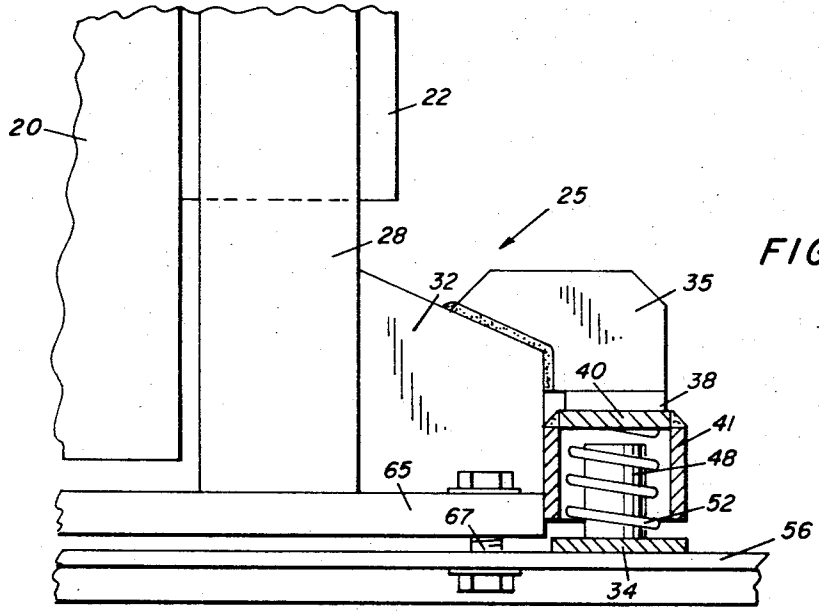


FIG. 4

INVENTOR
HUGH CUNNINGHAM

BY Christholm and Spencer
ATTORNEYS

Dec. 24, 1968 H. CUNNINGHAM 3,417,976

SPRING BOX SUPPORT FOR ROTARY HEARTH FURNACE AND THE LIKE

Filed Sept. 27, 1966 3 Sheets-Sheet 3

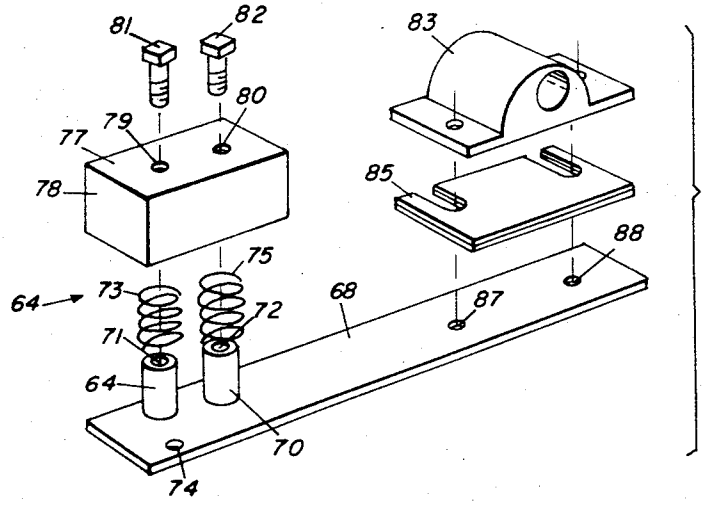


FIG.5

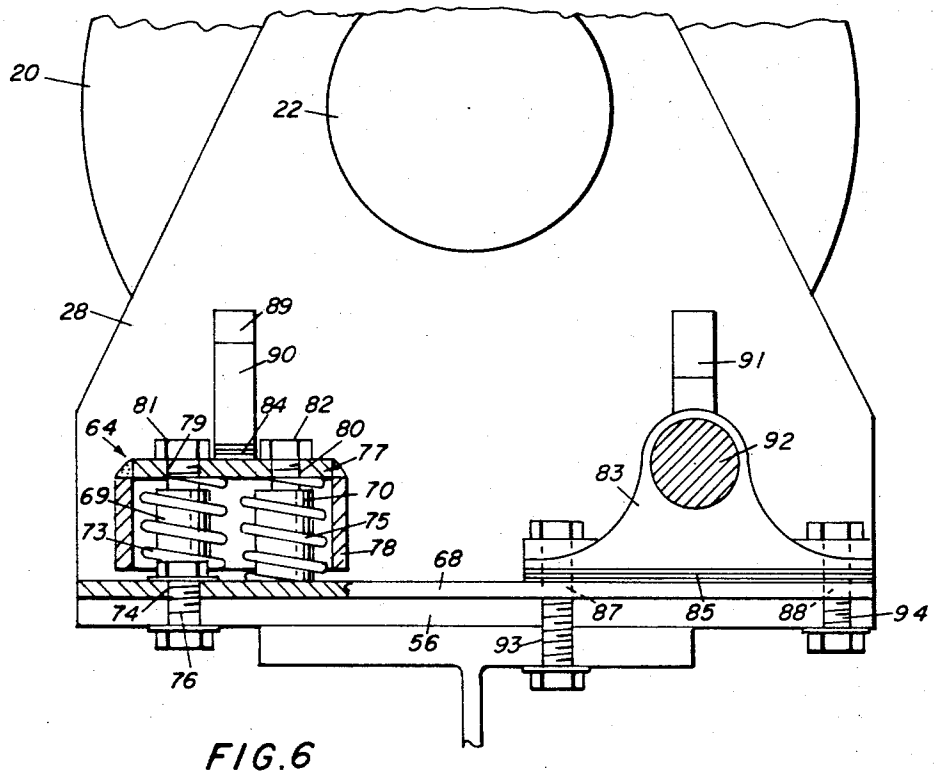


FIG.6

INVENTOR
HUGH CUNNINGHAM

BY Christensen and Spencer
ATTORNEYS

United States Patent Office 3,417,976
Patented Dec. 24, 1968

3,417,976

SPRING BOX SUPPORT FOR ROTARY HEARTH FURNACE AND THE LIKE

Hugh Cunningham, Corpus Christi, Tex., assignor to PPG Industries, Inc., a corporation of Pennsylvania

Filed Sept. 27, 1966, Ser. No. 582,294
10 Claims. (Cl. 263—7)

The present invention relates generally to improvements in rotary hearth furnaces.

It relates, in particular, to the provision of new and effective means for supporting the hearth table during all phases of furnace operation. More specifically, the invention pertains to resilient mounting means which serve to absorb and dampen the diverse loads transmitted by the hearth table to its underlying supports during rotation of the table.

In the usual rotary hearth furnace installation, the hearth table is annular in configuration and is supported throughout its length by continuous circumferential or annular beams; one beam typically being positioned near the inner circumference and the other near the outer circumference of the annular hearth table. These beams in turn are supported, either directly or through intermediate rails, by a plurality of individually mounted, and freely rotating, trunnion rollers. The trunnion rollers are normally journaled in trunnion blocks, one for each roller, each block then being carried by mounting mechanisms of the general nature of the present invention.

Operating conditions peculiar to open hearth furnaces often result in nonuniform loads being imparted to the several trunnion rollers supporting the hearth table. Under the influence of dissimilar thermal gradients and radial thrust forces, the circumferential beams, and particularly the inner beam, often arch out of the horizontal plane in which they normally lie. Thermal gradients are set up in the beams due to the uneven distribution of heat throughout the furnace, and because the top flanges of the beams are in closer proximity to the heat source than are the lower flanges. Unequal rotational expansion of the beams is thus produced, resulting in the distortion previously referred to of the hearth table, and its supporting beams causes radial deformation of the beams as well. Thus, it occurs that the beams transmit diverse loads, both in magnitude and kind, to the trunnion rollers. Sometimes the inner circumferential beam rises entirely off of its trunnions while on occasions it seems to rise off its trunnions only in certain locations.

It not infrequently happens that the inner circumferential beam will rise from load bearing contact with the trunnion rollers at certain points along its length. When this occurs, both those rollers remaining in contact with the beam and the beam itself are subject to severe stress in that the whole weight of the hearth assembly must be borne by only a portion of the supports. Sufficient intensification of these stresses may cause distortion of the hearth table to the point when it may be seriously damaged. And, excessive wear may be produced in the trunnion rollers and journals. Either condition is highly undesirable. Accordingly, ways have been sought to moderate these stresses to within tolerable limits.

One proposed solution has been to provide vertically adjustable mounting mechanisms under the trunnion rollers. Such a mechanism is disclosed in a patent to Trinks, U.S. No. 1,452,856, issued Apr. 24, 1923. However, the Trinks mounts are not resilient as he uses wedges and, consequently, cannot provide an automatic adjustment of the trunnion roller height so as to maintain load bearing contact with the circumferential beams, nor can they effect a dampening of high intensity loads transmitted to those rollers remaining in contact with the beams. Moreover, great practical difficulties would be encountered in attempting to manually adjust these wedges during operation of the furnace.

Another approach is suggested in U.S. Patent No. 1,362,296 to Hagan et al., issued Dec. 14, 1920. Hagan discloses the idea of mounting the individual trunnion roller blocks on compression springs, thereby providing a resilient support. But beyond a broad teaching of this idea, there is no disclosure of the means whereby this mounting is to be accomplished. It is important that, though resilient mounting mechanisms for the trunnion blocks are highly effective, these mechanisms cannot be so flexible, either laterally or vertically, as to impair the stability of the hearth table support complex. Accordingly, sufficient rigidity must be incorporated into the mechanisms so that resilient dampening of load intensities and firm support of the trunnion blocks may be provided simultaneously.

Of further significance here, is the facility with which installation, adjustment and/or replacement of the trunnion rollers, their bearings, or the mounting mechanisms may themselves be effected. Significant savings in labor and shutdown time costs could be realized by the provision of means which increased this facility. Thus, it is of substantial importance that the mounting mechanisms be readily accessible at all times and further, that they be adapted to allow the rapid performance of these functions.

One of the principal objects of this invention, therefore, is to overcome the difficulties previously encountered in providing continuous, uniform support for rotary hearth tables while at the same time effecting a dampening of the loads transmitted by the tables to the underlying structures.

Another important object of the invention is to provide a resilient mounting mechanism for use with a rotary hearth table which satisfactorily dampens loads imparted to it by the table without impairing the load carrying stability of the supporting structure as a whole.

A further object of the invention is to provide a unitized, resilient mounting mechanism for use with a rotary hearth table assembly which may be quickly and simply installed, adjusted and shimmed while in place, and/or replaced.

An additional object of the invention is to provide a unitized, resilient mounting mechanism for supporting the understructure of a rotary hearth table which is so positioned as to be readily accessible at all times.

It is a further object of the invention to provide a unitized, resilient mounting mechanism which attains its load absorptive qualities by simple means, without any complicating features so that it remains of simple construction, is easily handled and economically produced.

A still further object of the invention is to reduce peak loads in the support mechanism particularly in a rotary hearth furnace and to assure equal loads on the trunnions and rails of the mechanism.

Yet a further object of the invention is to provide in the support mechanism for rotary hearth furnaces and the like a convenient means to installing load cells which will indicate the actual load being supported by the trunnions and to adjust the trunnion supports on a measured load basis.

Another object of the invention is to protect the refractory hearth table from damage by providing adjustable resilient support for the various trunnions so as to alleviate the impact caused by the deformation of the hearth steel work above the trunnions.

In order that the invention may be more clearly understood, reference will now be made to the accom-

panying drawings which illustrate by way of example preferred embodiments of the invention and in which:

FIG. 1 is a sectional elevation taken along a radius of the annular hearth table passing between two circumferentially adjacent pairs of trunnion roller assemblies;

FIG. 2 is a perspective exploded view of the preferred embodiment of the mounting mechanism;

FIG. 3 is an elevation of the installed, unitized mounting mechanism on an enlarged scale with the front cover removed;

FIG. 4 is an end view of the installed mounting mechanism taken along line 4—4 of FIG. 3;

FIG. 5 is a perspective view of a modified version of the mounting mechanism on a scale approximating that of FIG. 3;

FIG. 6 is an elevation showing the mounting mechanism of FIG. 5 on an enlarged scale in a typical installation.

The preferred and modified versions of the invention are illustrated in connection with a rotary hearth furnace which is subject to the operating conditions described above. It is to be understood, however, that the invention is applicable to other rotary or nonrotary equipment where continuous load support and/or load dampening is an important factor.

In FIG. 1 of the drawings, a section of a rotary hearth table assembly is shown generally at **10**. A hearth table **12** rests directly upon the transverse beam structure **13** which, in turn, is supported by circumferential or annular beams **15, 17**. Beams **15, 17** support the table **12** throughout its length, with beam **15** being located near the outer periphery of the annular table **12** and beam **17** being located near its inner periphery. Directly beneath the outer and inner beams **15** and **17** are rails **18, 19**. These rails **18, 19** are, in turn, supported by trunnion rollers **20, 21**. The continuous rails **18** and **19** will suffer wear due to trunnion loads. These can be repaired or removed and renewed without dismantling the hearth table steel thereabove.

Each of the rollers **20, 21** are freely rotating wheel-like rollers mounted on shafts **22, 23** which are journaled by means of upper and lower bearing units generally indicated at **25** and **27** in trunnion blocks generally indicated at **28, 29**. These trunnion blocks here shown are unitary and U-shaped with legs extending upward from a bight portion. Trunnion blocks **28, 29** are resiliently mounted on the unitized mounting mechanisms of the present invention, shown in simplified form at **30, 31**.

The entire hearth table assembly **10**, including table **12**, beam structure **13**, circumferential beams **15, 17** and rails **18, 19** rotates about a vertical axis extending in a direction normal to the horizontal plane of FIG. 1. Rotation of the table assembly **10** is effected through the provision of trunnion rollers **20, 21** which rotatably engage, in load bearing relationship, the lower surfaces of rails **18, 19**.

FIG. 1 depicts in exaggerated scale the hearth table assembly **10** as it appears after the furnace has been fired and rotation of the table assembly **10** has begun. The beam structure **13** and circumferential beams **15, 17** are shown distorted from the horizontal. Inner circumferential beam **17** is further shown raised out of contact with the supporting rail **19**. It is to be understood, that the extent of this deformation is greatly exaggerated for explanatory purposes and that, under normal operating conditions, the resilient mounting mechanisms **31** would allow trunnion roller **21** and rail **19** to maintain continuous contact with the lower flange of beam **17**.

Notwithstanding the continuous support of roller **21**, some additional load is transferred to roller **20**. Further, increased loads are also carried by the trunnion rollers supporting the inner beam **17** at those points along its circumference where it does not arch from the horizontal. The resilient mounting mechanisms **30, 31** dampen, or "even-out," this nonuniform loading and thus reduce both the stresses produced in the table assembly **10** and the wear caused to the trunnion rollers, their shafts and bearings.

The preferred embodiment of the unitized, resilient mounting mechanism of the present invention is shown in perspective in FIG. 2. The unit **30** is provided with a base plate **34** having permanently attached spring guide pins **48, 49, 50** and **51** extending vertically from its upper surface. Helical compression springs **52, 53, 54** and **55** fit over the guide pins **48, 49, 50** and **51** and abut against the upper surface of plate **34**. It is apparent that lateral movement of the springs **52, 53, 54** and **55** is restrained by the interior guide pins **48, 49, 50** and **51**. Therefore, while lateral resilience is afforded by the unit **30**, there is no danger of lateral collapse of the mounting mechanism.

A top cover plate **40** having a depending circumferential skirt **41** engages the upper ends of springs **52, 53, 54** and **55** and forms a close fitting box-like container around the spring members; as can be best seen in FIG. 3. Undue lateral movement, by either translation or rotation of the top cover plate **40** is prevented by the proximity of skirt **41** to the spring members **52, 53, 54** and **55**. Sufficient lateral movement will cause the skirt **41** to abut against the springs which, in turn, will abut against the interior guide pins **48, 49, 50** and **51**, thus stopping any further movement in that direction. It can be seen that this restraining feature will operate whether the lateral motion is directed longitudinally or transversely of the unit **30**.

Openings **42, 43** are provided in cover plate **40** to allow passage therethrough of adjusting cap screws **45, 47**. These cap screws are threadedly received in openings **62, 63** in spring guide pins **49, 50**. By tightening or loosening screws **45, 47** the overall height of the unit **30** may be varied as desired. Openings **58, 59** in base plate **34** permit rigid attachment of the unit **30** to an underlying support.

From the foregoing, it can be seen that the mounting mechanism of the present invention provides a resilient, load dampening mount of unitized construction which may be expeditiously used and handled with little effort and which affords a maximum of resiliency without sacrifice of support stability.

A typical installation of the unit **30** just described is shown in FIGS. 3 and 4. A trunnion roller **20** is journaled at **25** in trunnion block **28**. The block **28** is carried by the resilient mounting mechanism **30**.

As can be seen from FIG. 1, two such units **30** and **31** are ordinarily used to support each trunnion block but in that the installation of each is identical only one will be described in detail.

Projecting from the side of trunnion block **28** are two gusset plates **32, 33**. Permanently secured to the plates **32, 33** are load bearing lugs **35, 37**. The horizontal lower surfaces of lugs **35, 37** bear against removable shims **38, 39** which, in turn, rest on the upper surface of top cover plate **40** of the mounting unit **30**. The unit **30** itself is fixedly attached to base member **56** by means of fasteners **60, 61**. Additional restraining means may be used to moveably secure the trunnion block base member **65** to the base member **56**. Loosely tightened bolts **67** are illustrated for this purpose in FIG. 4, however, any suitable means may be employed.

Installation of the mounting unit **30** is accomplished by first raising the trunnion block **28** off the supporting member **56** as by jacking, etc., and thereby positioning the unit **30** under the load bearings lugs **35, 37**. As a preliminary step to inserting the unit **30**, the adjusting screws **45, 47** are tightened, thus making the unit of as little vertical height as possible. Fasteners **60, 61** are then put in place and the unit **30** fixedly secured to the base member **56**. Prior to loosening the adjusting screws **45, 47**, the

shims 38, 39 are installed. Any desired shim thickness may be used and the overall height of the trunnion roller 20 thereby controlled. The jacks may then be moved and the adjusting screws 45 and 47 loosened from the guide pins 49 and 50 to permit the springs 52, 53, 54 and 55 to be released and engage cover plate 40 in lead bearing relationship with the unit 30. It should be apparent that a second unit 30 is to be installed at this time on the opposite side of trunnion block 28; as can be seen in FIG. 1. Thus, upon release of the springs and removal of the jacks, etc. used to raise the block 28, the two resilient mounting mechanisms 30 will carry the block 28 in its entirety.

During operation of the furnace, the hearth table assembly 10 as a result of its rotation, imparts oblique loads to the trunnion rollers 20 so that load components are created in directions both lateral and vertical to the plane of roller rotation. These loads are transmitted successively through trunnion roller 20, shaft 22, trunnion block 28, gusset plates 32, lugs 35, 37 and shims 38, 39 to the mounting mechanism 30. Lateral movement of the load bearing springs 52, 53, 54 and 55 in response to the lateral load components occurs within the limits allowed by interior guide pins 48, 49, 50 and 51. As can be seen in FIGS. 3 and 4, lateral movement of these springs can take place either longitudinally or transversely of the unit 30. Thus, the unit 30 may respond to forward rotation loads as well as radial thrust forces delivered to the trunnion roller 20. Of course, the unit 30 is adapted to absorb substantial vertical loads. Direct compression of the helical springs 52, 53, 54 and 55 results upon transmittal of the vertical load component incident upon roller 20 to the cover plate 40 of unit 30.

It is further apparent from FIGS. 3 and 4 that the springs 52, 53, 54 and 55 may extend when under light loads in order to maintain load bearing engagement and between the roller 20 and the overlying circumferential beams 15, 17 when these beams are subjected to the distortion forces previously described. The range of such extention is limited however, and, normally, the thickness of shims 38, 39 is increased in order to permit the trunnion roller 20, 21 to follow the circumferential or annular beams 15, 17.

Insertion of additional shims 38, 39 for this purpose is easily accomplished due to the unitized construction of unit 30 and because of its accessibility to workmen. When it is desired to increase the overall height of the trunnion rollers 20, 21, the adjusting screws 45, 47 are tightened by hand to compress the springs 52, 53, 54 and 55, the support bocks 28, 29 jacked up slightly and extra thickness needed to increase the load height is added. Screws 45, 47 may then be loosened to allow cover plate 40 to again bear against the lower surface of shims 38, 39. Finally, the blocks or jacks may be removed from beneath trunnion blocks 28, 29. Upon completion of this relatively simple operation, a resilient support will once again be provided by the rollers 20, 21 to the table assembly 10.

In that the mounting mechanisms 30 are mounted on the external sides of trunnion block 28, they are always readily accessible for the performance of such vertical adjustments. Installation or removal of the units 30 likewise may be easily carried out.

From the foregoing discussion, it is apparent that the unitized, resilient mounting mechanisms 30 of the present invention effect a moderation of the loads carried by the individual trunnion rollers 20, 21 and also avoid the concentration of excessive stresses in the table assembly structure 10. In this way, an "evening" in distribution and dampening of nonuniform loading patterns associated with rotary hearth furnace tables is achieved.

A variation of the invention is shown in FIGS. 5 and 6. This embodiment is intended to provide lateral resiliency in the direction of hearth table rotation but not in a direction transverse thereto. Referring now to FIG. 5, it can be seen that the resilient mounting mechanisms, shown generally at 64, is basically the same as that of the preferred embodiment. A base plate 68 is provided with permanently attached spring guide pins 69, 70. Helical compression springs 73, 75 fit over these pins, the lower ends abutting against plate 68 and the upper ends against cover plate 77. A depending circumferential skirt 78 is provided on cover plate 77 and performs the same functions as in the first embodiment. Adjustment cap screws 81, 82 pass through openings 79, 80 in cover plate 77 to be threadedly received in openings 71, 72 in the guide pins 69, 70. Base plate 68 is provided with an opening 74 located opposite of guide pin 69. Fastener 76 is inserted in opening 74 in order to fixedly secure the plate 68 to base member 56.

Mounted on the end of plate 68 opposite to unit 64 is a conventional journal support 83. Openings 87, 88 are provided in plate 68 so that both the plate 68 and the support 83 may be secured to base member 56. Shims 85 are interposed between support 83 and plate 68. Changes in the shim thickness may be made in the usual way in order to vary the height of support 83 above plate 68.

FIG. 6 shows the modified mounting mechanism 64 installed under a trunnion block 28 on which is carried a trunnion shaft 22 and roller 20. Installation of resilient unit 64, including plate 68, is carried out in the same manner as described previously for the preferred embodiment. As before, gusset plate 89 carries a permanently attached lug 90 which engages through shims 84 the upper surface of cover plate 77. After plate 68 is positioned on top of base member 56, the shims 85 and journal support 83 may be installed. A journal stub-like shaft 92 is permanently mounted on gusset plate 91 to cooperate with journal support 83. Fasteners 93, 94 may be used to fixedly secure journal support 83, shims 85 and plate 68 to the base member 56.

As can be seen from FIG. 6, rotation of table assembly 10 will cause the trunnion roller 20 to rotate in the direction indicated by the arrow. Loads imparted to roller 20 in the direction of this rotation will be transmitted to unit 64 and produce a compression of springs 73, 75. Journal support 83 will allow block 28 to pivot about shaft 92 while restraining lateral movement of the block 28 in a direction transverse to plate 68. Limited movement of springs 73, 75 in a direction longitudinal of plate 68 occurs as block 28 pivots about shaft 92. Thus a dampening of longitudinally directed load components as well as purely vertical load components is achieved. Adjustment of the thickness of shims 84 is accomplished here as in the preferred embodiment in order to allow trunnion roller 20 to follow the beams 15, 17 if the latter becomes distorted. This version of the mounting mechanism is as freely accessible as the first and thus may be quickly installed, adjusted and/or replaced. Accordingly, it is clear from the preceding discussion that this embodiment of the invention provides a support which possesses both load dampening resilience and excellent lateral stability.

This completes the description of the present invention. It will be apparent that the embodiments thereof may be easily and economically produced from commercially available materials and may be used with existing equipment with but little, if any, modification of the equipment being required. For example, the preferred embodiment of the invention may be used in many installations without more than the addition of lugs 35, 37 to the equipment to be supported. Further, the mounting mechanisms may be constructed in various sizes and shapes as desired.

I claim as my invention:

1. In a rotary hearth furnace having an annular, horizontally rotating hearth table, inner and outer circumferential beams supporting said table, a plurality of independently mounted trunnion rollers supporting each of said inner and outer circumferential beams, a trunnion roller block supporting each of said trunnion rollers, and resilient mounting means for each trunnion roller block,

the improvement in which said resilient mounting means comprises a self-contained and compression spring assembly, said assembly being removable positioned in load bearing engagement with each trunnion roller block and having means for adjusting the vertical height of said assembly.

2. A furnace according to claim **1**, in which the improvement in said resilient mounting means comprises an independent, vertically adjustable, compression spring unit, wherein said spring unit has vertical adjustment means whereby said unit may be completely disengaged from load bearing engagement with said trunnion roller block.

3. A furnace as claimed in claim **1**, the improvement in which said resilient mounting means comprises an independent, vertically adjustable, compression spring unit removably positioned in load-bearing relationship with said trunnion roller block, wherein said spring unit comprises a plurality of compression spring members interposed between a base plate member and a cover plate member and wherein means are provided for adjusting the spacing between said base plate member and said cover plate member so that the spring unit may be disengaged from load bearing engagement with said trunnion roller block.

4. In a rotary hearth furnace having an annular, horizontally rotating hearth table, inner and outer circumferential beams supporting said table, a plurality of independently mounted trunnion rollers supporting each of said inner and outer circumferential beams, a trunnion roller block supporting each of said trunnion rollers, and resilient mounting means for each trunnion roller block, the improvement in which said resilient mounting means comprises self-contained spring assembly removably positioned in load-bearing relationship with said trunnion roller blocks, said spring assembly comprises a plurality of helical compression spring members interposed between a base plate member and a cover plate member, said base plate member carrying thereon a plurality of vertical guide members slidable fitting within said spring members and wherein means are provided to adjust the spacing between said base plate member and said cover plate member so that said spring assembly may be removed from load bearing engagement with said trunnion roller blocks.

5. A furnace as claimed in claim **4** wherein said cover plate member includes a depending protective skirt positioned about said helical compression spring members.

6. In a rotary hearth furnace having an annular, horizontally rotating hearth table, inner and outer circumferential beams supporting said table, a plurality of independently mounted trunnion rollers supporting each of said inner and outer beams, a trunnion block supporting each of said trunnion rollers, and mounting means for each said trunnion block, the improvement in which said mounting means comprises a base plate, pivotal mounting means toward one end portion of the base plate pivotally mounting the trunnion block for pivotal movement transverse to the axis of the trunnion roller, resilient mounting means toward the other end portion of the base plate for supporting the trunnion block, said resilient mounting means comprising compression spring means interposed between said base plate and a cover plate member, said cover plate member being in supporting engagement with said trunnion block, and means for adjusting the spacing between said base plate and said cover plate member.

7. A resilient mounting means comprising a self-contained spring assembly having a plurality of helical compression spring members interposed between a base plate member and a cover plate member, said base plate member carrying thereon a plurality of vertical guide members over which said spring members are received and means for adjusting the spacing between said base plate member and said cover plate member against the action of said compression spring members.

8. A resilient mounting means according to claim **7** wherein said means for adjusting the spacing between the base plate member and the cover plate member are cap screws passing through said cover plate member and threadedly received in threaded apertures in said vertical guide members and wherein said cover plate member has a depending skirt extending about said spring members to limit the side sway of said resilient mounting means.

9. A resilient and pivotal mounting assembly comprising a base plate, pivotal mounting means toward one end portion of the base plate for pivotally supporting an object, resilient mounting means toward the other end portion of the base plate for resiliently supporting said pivotally supported object, said resilient mounting means comprising compression spring means interposed between said base plate and a cover plate member, said cover plate member being in supporting engagement with said object, and means for adjusting the spacing between said base plate and said cover plate against the action of said cover plate member.

10. A resilient and pivotal mounting asssembly according to claim **9** wherein said resilient mounting means includes a vertical guide member fixed to and extending upward from said base plate within said compression spring means and said means for adjusting the spacing between said base plate and cover plate are bolts extending between the cover plate and base plate.

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JOHN J. CAMBY, *Acting Primary Examiner.*

U.S. Cl. X.R.

263—28; 266—34