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MOVEMENT-COMPENSATING LOAD-SUPPORTING STRUCTURE
FOR CONVERTERS AND THE LIKE

3,333,801

Filed April 29, 1966

2 Sheets-Sheet 1

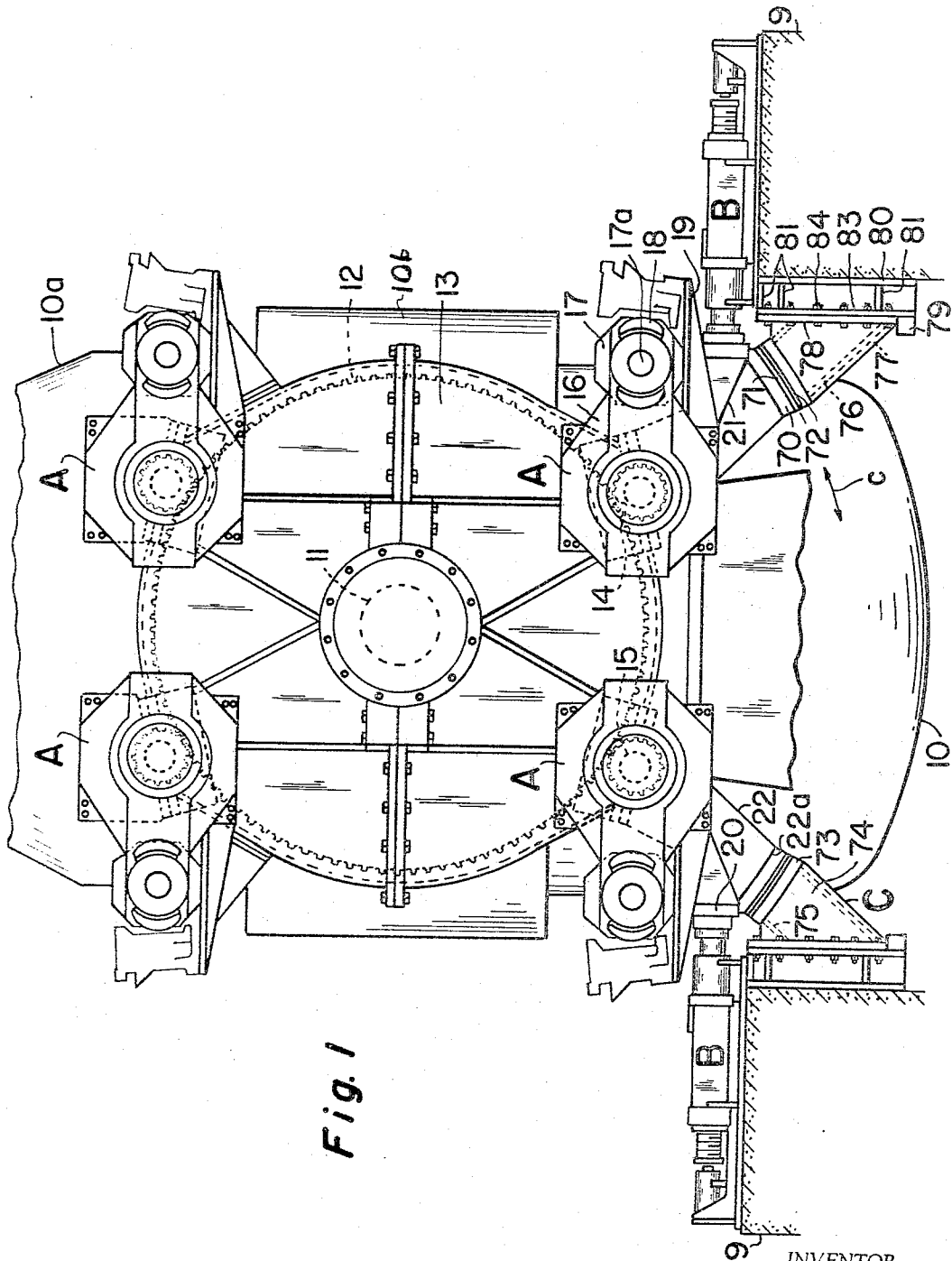


Fig. 1

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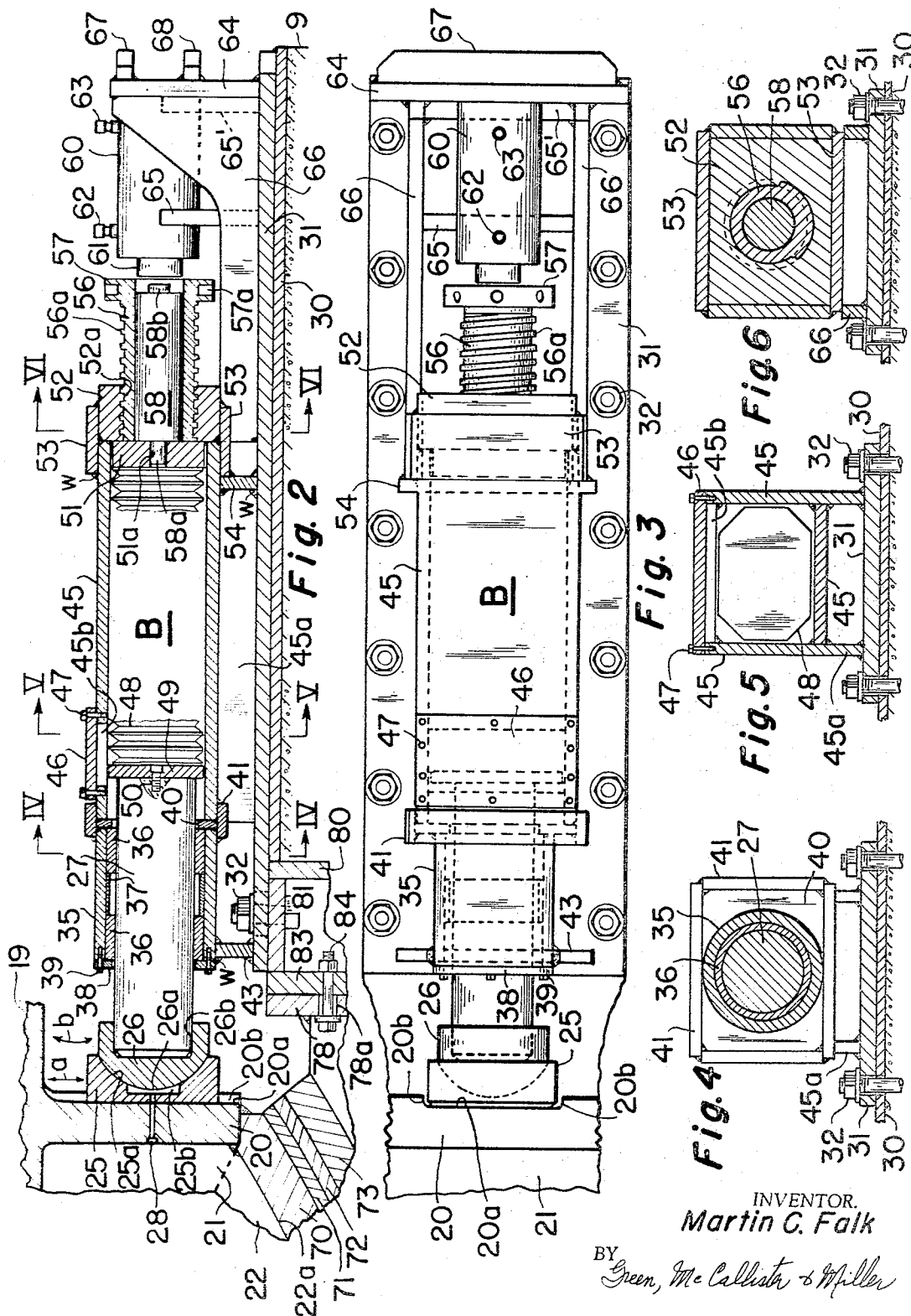
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This invention relates to supporting or housing structure for driving means employed for rotating or turning a heavy device, such as a furnace vessel. The invention particularly pertains to improved load-supporting and force-containing means for a suspended housing or the like for driving or actuating means of a furnace vessel, such as an oxygen converter that is employed for melting and refining a metal such as steel.

The power wheel and drive for heavy rotative furnace vessels that are adapted to, for example, process 50 to 300 tons or more of molten metal are subjected to various forces that have to be taken into consideration, and means provided for containing, resisting or controlling them. Thus, an important phase of my invention deals with movement-compensating load-supporting structure for a drive-carrying shaft-mounted housing that is turnably or rotatably positioned on or suspended from a shaft portion of a heavy device such as a furnace vessel or converter that is subjected to misalignment force during its use and has shaft portions turnably or rotatably mounted with respect to or on stationary support means, such as a pier or foundation structure. Another phase of the invention deals with snubbing means which will cooperate with a rotatably or turnably-mounted housing to, in an improved manner provide for, resist, contain, and control its movement.

It has been an object of my invention to provide effective and efficient snubbing and load supporting means for heavy shaft-mounted equipment that is constructed for turning movement on and for coaxial movement with the shaft;

Another object of my invention has been to provide structure for supporting the total load of a housing and of driving mechanism carried thereby that is employed with rotatively-mounted heavy equipment and to, at the same time, permit limited movement of the structure with respect to a fixed mounting or support structure;

A further object of my invention has been to provide load-carrying structure suitable for a so-called hang-over type of housing or support that is employed for carrying driving or actuating means in a substantially constant efficient and effective driving or meshing relation with a power wheel or driven gear that is secured on the shaft of a heavy device, in the nature of a furnace vessel, for turning or rotating the device;

A further object of my invention has been to provide movement-compensating and load-carrying structure for driving means of a heavy device or furnace vessel that will act in a balanced opposed manner to control relative movement between the structure and fixed or stationary support means;

These and other objects of my invention will appear to those skilled in the art from the illustrated embodiment and the claims.

In the drawings;

FIGURE 1 is a side view in elevation showing structure or apparatus of my invention as employed with a driven trunnion shaft of a furnace vessel;

FIGURE 2 is a greatly enlarged side fragment in sectional elevation showing details of the construction and mounting of a snubber unit constructed in accordance

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with my invention and shown as applied in FIGURE 1; FIGURE 3 is a top plan view of and on the same scale as the unit of FIGURE 2; and

FIGURES 4, 5, and 6 are transverse sections in elevation on the scale of and respectively taken along the lines IV—IV, V—V, and VI—VI of FIGURE 2.

The Lakin et al. Patent No. 3,207,002 sets forth the difficulties that have been encountered in the use of heavy equipment of the type here involved, particularly from the standpoint of driving means therefor. With the present-day trend of increasing the size and capacity of oxygen blow furnaces, the load has increased to such an extent that the snubbing equipment is subjected to increased wear and tear. I have also found that there is an important need for load carrying or supporting means that will at least lessen the load on the trunnion shaft which carries the drive wheel or bull gear, as well as on the housing or supporting structure for drive means, such as gears and motors, that are, in turn, carried on the housing. There has, however, been a problem involved in this connection from the standpoint of the provision of a load supporting means that will not adversely affect the operation of the snubbing means, and that will permit desired limited movement of the supported apparatus to accommodate it to expansion and turning forces. I have been able to devise and provide load supporting means that complements the operation of the snubbing means and enables it to be better designed for its particular functioning and that, at the same time, materially reduces the stress and strain on a driven trunnion shaft or portion.

Referring particularly to FIGURE 1 of the drawings, I have shown a furnace vessel 10 that is in the form of a converter vessel such as used in the oxygen-blow refining of steel. The vessel 10 has an open mouth portion 10a to receive metal to be processed when in its substantially upright position and to pour refined molten metal when in its downwardly-tilted position. The vessel is adapted to rotate about a horizontal axis, represented by a pair of opposed trunnion shaft portions extending in axial alignment from opposite sides of its trunnion ring 10b. FIGURE 1 shows a drive side of the furnace and its driven trunnion shaft portion 11; the other side will customarily have a trunnion shaft portion carried by bearings in a stationary stand. The latter shaft portion, if desired, may also be driven and provided with means illustrated as applied to the shaft portion 11.

A driven wheel or bull gear 12 is secured or feathered on the trunnion shaft 11 for actuating it and is adapted to be positively driven or rotated by peripherally-located and spaced-apart motor drive units A that are shown positioned as upper and lower spaced-apart pairs on a main or primary support housing 13, with one drive unit A of one pair being in vertically-opposed alignment with a corresponding drive unit A of the other pair. Each drive unit A is positioned in a peripheral relation with respect to the bull gear 12, with its drive pinion meshing with the gear 12. The housing 13, as for example illustrated in the Lakin et al. Patent No. 3,207,002, is mounted or journaled on the shaft 11 for turning or rotative movement with respect thereto. The suspended housing 13, in addition to enclosing the bull gear 12, serves as a carrying means or mounting support for the drive units A, including their mounting platforms 19, their housings 16, reversible electric motors 17, speed reducing units, operating connections such as gears, pinions and shafts, and brake equipment 18.

Each drive unit A is provided with what may be termed a secondary, transversely-split, two-part housing 16 that is bolted together and which is, in turn, bolt-secured to a mounting platform 19. This, for example, enables each unit A of the lower pair to be dropped by separating the

lower half of its housing 16 from the upper half thereof to facilitate repair and maintenance.

In the illustrated embodiment of FIGURE 1, each unit A has a reversible electric motor 17 whose shaft 17a carries a brake drum that is adapted to be engaged by a conventional brake mechanism 18 to facilitate positive stopping of the unit A after its power has been shut-off, and to prevent rotative movement during a charging operation of the furnace or a shifting of the metal load, etc. The motor shaft 17a is connected, as customary, through a speed reduction unit, shafting and gearing to actuate a pinion 14 that meshes with the gear wheel 12. It will be noted that each mounting platform 19 is secured to project outwardly from the main housing 13 and has a projecting frame to which the secondary housing 16 of each unit A is bolted. In FIGURE 1, I have shown a pair of spaced-apart platforms mounted adjacent opposite bottom ends of the housing 13. It is thus apparent that the full drive system or apparatus for the driven trunnion shaft 11 is supported or carried on the primary or main housing 13. The same principle of support may be used for example, if the drive motors are not carried by the housing, but are connected thereto by flexibly-coupled shafting. In the latter situation, the drive pinions, their shafts and mounting will be carried by the main housing, and the motors may be mounted on a fixed or stationary plant support means, foundation or pier 9. See also FIGURE 1 of Lakin et al. Patent No. 3,197,187.

As will be appreciated from a study of the construction of FIGURE 1, a so-called overhang type of support structure, principally represented by the housing 13 and the drive mechanism and structure carried thereby, will involve a considerable suspended load for the trunnion shaft 11. I have provided means C, shown as two, under-positioned, horizontally spaced-apart units, that are symmetrical about a center line of the trunnion shaft and particularly, with respect to a vertical projection of the shaft, which units serve to carry the load. The units C make feasible a complete or full support of the load (static and dynamic) represented by the positioned relation of the housing 13 on the shaft 11 and, at the same time, permit relative movement of the housing with respect to fixed or stationary support means, stands or foundation piers 9. The nature and construction of the load supporting or carrying means C of my invention is such that wear and tear on snubber or torque buffer units B (see FIGURE 1) is minimized in that they, in themselves, do not have to function as partial load supports. It also makes it possible to utilize the snubber units B in a cooperating as well as more efficient and effective manner from the standpoint of their desired functioning, adjustment, control and operation.

Each lower platform 19, as shown particularly in FIGURES 1, 2 and 3, has an outwardly-extending snubber flange or projecting abutment member 20 that is adapted to be operatively-engaged by or connected to an associated snubber unit B. Each snubber flange 20, on its outer side or face, has an inset, vertical slot or guide portion 20a, as defined by a pair of spaced-apart, vertical, guide edge portions 20b, to slidably-receive an abutment slide block or element 25. The slide block 25 is positioned for sliding movement in a plane parallel to the longitudinal axis of the trunnion shaft 11, or vertically in the illustrated embodiment, as indicated by the arrows a of FIGURE 2, and in cooperation with a conical or spherical socket part 26 that is loosely-slidably positioned on the outer end of an operating plunger 27, in such a manner as to avoid an end tilting (lifting or lowering force) on the plunger. This provides a sliding universal type of connection between each flange 20 and the associated snubber unit B. Each snubber member or flange 20 is reinforced by a wing portion 21 extending from its associated platform 19. A load-carrying leg or arm 22 projects radially-downwardly or in an inclined plane outwardly with respect to the shaft 11 from the reinforcing wing portion 21 and is weld-secured

to the lower end of the abutment flange 20 (see FIGURE 2) as an integral part of each lower platform 19 and thus, of the main housing 13. Each load-carrying leg 22 is provided with a somewhat planar abutment face or plate portion 22a that is sloped along a line or curved area of revolution about the housing 13. The face is shown slightly curved to conform to the line of revolution and thus, to correspond to the direction of rotative thrust, indicated by the arrows c of FIGURE 1 of the drawings.

The slide block or element 25 has a spherical, conical or rounded open outer bore face 25a that terminates centrally thereof in an inwardly-offset grease bore or recess portion 25b. Lubricating grease or the like may be introduced into the recess portion 25b through a grease port or passageway 28 extending through the snubber or abutment flange 20 and through the block 25. A pivot element, cup-shaped or socket element 26 is adapted to somewhat loosely-slidably fit on a forward end of the plunger 27 to carry it within a substantially cylindrical open end bore 26b thereof. The pivot, socket or cup-shaped element 26 has a front conical, rounded or spherical end face 26a that corresponds in curvature with the rounded portion 25a of the slide block 25, in order to define a spherical (ball and socket) mounting therewith for self-alignment purposes. The positioning and mounting of the slide block 25 and the element 26 between the abutment flange 20 and the forward end of the plunger 27, minimizes any tilting force on the end of the plunger and, at the same time, maintains it in operating alignment with the flange 20 under conditions of both slight outward thrust or vertical movement (as represented by the arrows a), and under conditions of circular thrust or turning movement (as represented by the arrows c). The operating connection between the end of the plunger 27 and the abutment flange 20 thus may be termed a ball and socket, guided-slide type of connection.

As shown particularly in FIGURES 2 to 6, inclusive, each snubber unit B has a base mounting plate 30 positioned on the foundation or pier 9 of a plant. A top mounting plate 31 is shown positioned on the lower plate 30 and secured thereto and to the fixed structure 9 by bolt and nut assemblies 32 whose bolts are securely-embedded at their lower ends within the pier structure 9 and whose upper ends are threaded to removably-receive nuts and washers thereon. Each unit B is shown provided with a cylindrical front housing 35 which encloses the plunger 27 and which carries a pair of front and back spaced-apart bearing sleeves 36. As shown particularly in FIGURE 2 the bearing sleeves 36 are maintained in an operating relation by a spacer sleeve 37 to abut against front and back end closure rings 38 and 40. The front ring 38 is removably-secured to the housing 35 by threaded bolts 39 and the back ring 40 may be fixedly-secured in position between the back end of the housing 35 and the front end of an intermediate housing 45 that is shown of rectangular shape. A closure piece or ring 41 is secured, as by weld metal, between the housings 45 and 35 and to the back end ring 40.

The intermediate housing 45 serves to position a shock-absorbing, resilient, cushioning unit or assembly 48 which may be of bellows-like shape and made-up of integrally-connected rubber sleeve sections reinforced by wire ring inserts. The assembly 48 will normally be under a preset compression force between the back end of the operating plunger 27 and a front face of a slidable end abutment plate or member 51. To facilitate the replacement and maintenance of the shock-absorbing unit or assembly, the housing 45 is provided with an open top portion 45b over which a top closure piece or plate member 46 is removably-secured by threaded bolts 47. The unit or assembly 48 operates axially or endwise within the housing 45 and, at its front end, abuts against a front abutment disc or plate 49 that is shown removably-secured to the end of the plunger 27 by a threaded bolt 50 for movement therewith. At its back end, the unit 48 rests against rectangular,

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back abutment plate or member 51 that is slidably-positioned in the housing 45, and that has a central bore 51a therethrough to receive a pin end extension 58a of a pressure-setting or adjustment control plunger 58 which, like the front plunger 27, is shown of solid cylindrical construction.

The adjustment plunger 58 is operatively-positioned for sliding movement within a hollow, adjustment screw cylinder or sleeve 56 that has relatively flat wear-resisting outer threads 56a along the outer periphery of its axial length. The threads 56a are adapted to adjustably-operate within an internally-threaded collar or socket 52 that is shown weld-secured to the back end of the housing 45, as reinforced by an overlapping closure or banding member 53. The socket 52 and screw sleeve 56 constitute a mechanical screw jack. It will be noted that the front housing 35 has a leg or stand 43 projecting therefrom that is weld-secured (see w) to the platform member 31, and that the housing 45 also has a similar leg or stand 54 that is weld-secured to the same platform member.

The hollow adjustment screw 56 is provided at its back end with a projecting flange 57 having peripherally spaced-apart radially-open socket portions 57a therein to receive a rod-like pin or tool. It is thus apparent that a rod-like tool may be inserted within one of the sockets 57a to turn the screw 56 within the collar 52 and advance or retract the screw 56. Since the front end of the screw 56 is adapted to abut with the back end of the slide member 51, an adjustment of compression force exerted on the shock-absorbing assembly 48 may be accomplished to provide it with a desired setting.

As also particularly illustrated in FIGURES 2 and 3, the adjustment plunger 58 has a back end abutment boss 58b that is adapted to engage the forward end of a piston rod 61 of a fluid-operated or hydraulic jack 60. It will be noted that the resilient assembly 48 is provided with a preset compression force, axially or endwise, by opposed force exerted by the back end of the operating plunger 27 and exerted by the front face of the slide member 51 that engages the back end of the assembly 48. It is apparent that the compression force exerting position of the slide part 51 may be adjusted more or less minutely to give a finely adjusted relation by the screw 56 and may be adjusted in larger increments by the fluid jack 60. That is, the fluid jack 60 may be employed for rougher adjustments while the mechanical screw 56 may be used for finer or micrometer adjustments.

The fluid jack 60 has, as shown, a cylindrical housing within which piston rod 61 and its piston operate in the usual manner of a fluid motor and, as controlled by front and back positioned fluid ports 62 and 63 which alternatively become fluid inlet and outlet ports, depending upon the desired direction of movement of the piston and thus of the piston rod 61. The jack 60 is shown secured on the platform member 31 by a pair of spaced-apart front and back mounting brackets 65 and 65'. The platform 31 is also provided with a pair of longitudinally-extending transversely spaced-apart side frame members 66 that are secured to the fluid jack 60, to the closure or banding member 53, and to an upright back end plate 64. The back end plate 64 is shown provided with a pair of backwardly-extending vertically spaced-apart reinforcing shelf portions 67 and 68.

In FIGURES 1 and 2, each load support projection or leg 22 is shown as extending in an inclined, radial manner, downwardly-outwardly from an associated platform 19 and the main housing 13, in a balanced, offset manner with respect to the other load support leg 22. The abutment face portion 22a of each load supporting leg 22 has a reinforcing face plate 70 secured thereto that (as shown in FIGURE 2), on its outer face, is provided with a bearing portion or pad 71 secured thereon. Each bearing pad 71 cooperates with a complementary bearing pad 72 that is secured to the forward face of a reinforcing face plate 73 of an upwardly-inwardly projecting abutment post 74

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that also extends radially with respect to the trunnion shaft 11. The bearing pads 71 and 72 have curved, complementary, opposed, abutment faces that correspond in slope and curvature to a common line or area of revolution about the housing 13 or substantially to the rotative thrust movement imparted to the housing 13, as represented by the arrows c of FIGURE 1. Each post 74 extends endwise in alignment with an associated leg 22 to provide opposed diagonal supports adjacent opposite bottom end portions of the housing 13.

The reinforcing plate 73 is secured to the upper face of each post to carry its bearing pad 72. As shown particularly in FIGURE 1, each post 74 is reinforced by structural members 75, 76, and 77, and, at its back end, carries a vertical mounting plate 78 that is fixedly-secured in abutment with and to a vertical mounting plate 83 by bolt and nut assemblies 84. The mounting plate 83 is carried by a reinforced frame structure consisting of members 80 and 81 in a fixed relation on the foundation or pier 9. A shear block 79 is carried by the abutment plate 83 in such a manner that the lower end portion of the abutment plate 78 rests thereon. It will be apparent from the construction that the full weight or load of the housing 13 and the structure and apparatus supported or carried thereby may be carried by the fixed posts 74, and that relative movement, such as in the direction of the thrust arrows c of FIGURE 1, is enabled by the support legs 22 with respect to the posts 74 between the opposed abutting faces of the pads 71 and 72.

It will be apparent that the sliding abutment of bearing portions 71 and 72 enables the load, including its weight, the weight of the apparatus carried thereby and loading imparted by movement or jarring of the vessel 10, to be fully supported on fixed or stationary support means of the plant in a relative movement-permitting relation with respect thereto. The bearing portions 71 and 72 permit both resisted and contained turning movement of the housing 13 on the shaft portion 11 and controlled coincidental axial movement of the housing as primarily resisted, contained and controlled by the snubber units B. The units C thus relieve the units B of the housing load and, at the same time, cooperate with or supplement the units B in their functioning. The use of common integral projecting portions 21 and 22 for the units B and C in their peripherally spaced-apart and opposed relation at the lower portion of the housing 13 provides optimum results.

Although I have illustrated a particular embodiment of my invention as applied to a furnace vessel, it will be apparent to those skilled in the art that various modifications and changes may be made therein without departing from its spirit and scope and also that it may be applied to other heavy devices where a similar problem may arise.

I claim:

1. In a movement-compensating load-supporting structure for a drive-carrying housing that is turnably-suspended from one shaft portion of a heavy device such as a furnace vessel that is subjected to misalignment force during its use and has shaft portions turnably-mounted with respect to stationary support means, housing support means projecting from a lower portion of the housing, post means projecting from the stationary support means substantially endwise towards and in alignment with said housing support means, complementary bearing portions on outer ends of said housing support and post means and having opposed faces in sliding abutment with each other that are sloped along a common line of revolution about the housing, whereby the load of the housing will be supported in a relative movement-permitting relation on said post means by said housing support means.

2. In a movement-compensating load-supporting structure as defined in claim 1 wherein, said housing support means has portions projecting in generally opposite directions from the housing, said post means has portions

projecting generally in opposite directions from the stationary support means to cooperate with an associated portion of said housing support means, and each portion of said housing support means and of said post means has complementary bearings on its outer end that is in an opposed slide-abutting relation with an associated portion of the other means, and said complementary bearing portions are sloped along the common line of revolution about the housing, whereby the load of the housing will be supported on the portions of said post means to resist turning movement of the housing in either direction about the one shaft portion.

3. In a movement-compensating load-supporting structure as defined in claim 1 wherein, side-positioned means positioned on the stationary support means cooperates with the housing and said post means for resisting and containing turning movement of the housing and to provide for and control coincidental axial movement of the housing with a preset application of force.

4. In a movement-compensating load-supporting structure as defined in claim 1 wherein, said post means has a pair of posts securely fixed to the stationary support means, said pair of posts are in an opposed spaced-apart relation with each other and project radially-inwardly towards the axis of the one shaft portion, and said housing support means has a pair of legs projecting from the housing radially-outwardly of the one shaft portion to cooperatively-engage an associated post of said post means to resist turning movement of the housing.

5. In a movement-compensating load-supporting structure as defined in claim 1 wherein, said support means is in the form of leg means, said complementary bearing portions are in the form of bearing pads secured on the outer ends of said leg and post means in sliding abutment with each other, and said bearing pads have opposed complementary curvilinear faces sloped along the common line of revolution about the housing.

6. In a movement-compensating load-supporting structure as defined in claim 5 wherein, said leg means has a pair of legs projecting radially-outwardly in a peripherally spaced-apart relation from and with respect to the housing, and said post means has a pair of posts projecting radially-inwardly from the stationary support means towards and in substantial alignment with an associated one of said legs.

7. In a movement-compensating load-supporting structure as defined in claim 6 wherein, an abutment flange projects from the housing adjacent each of said legs, and snubber means is secured on the stationary support means adjacent each of said abutment flanges to cooperatively engage therewith to provide for and control coincidental coaxial movement of the housing.

8. In a movement-compensating load-supporting structure as defined in claim 6 wherein, abutment flanges project from the housing adjacent said legs, and opposed snubber means secured on the stationary support means cooperates with said abutment flanges and said post means to resist and contain turning movement of the housing on the one shaft portion and provide for and control coincidental axial movement of the housing.

9. In a movement-compensating load-supporting structure as defined in claim 5 wherein, snubber means is secured on the stationary support means, abutment means is carried by the housing, said snubber means engages said abutment means for resisting and containing turning movement of the housing on the one shaft portion, and said snubber means has means to, in cooperation with said leg and post means, provide for and control coincidental axial movement of the housing.

10. In a movement-compensating load-supporting structure as defined in claim 5 wherein, a driven gear is secured on the one shaft portion within the housing, drive pinion means is operatively-carried by the housing in operating engagement with said driven gear, and actuat-

ing means for said drive pinion means is carried by the housing for rotating said driven gear, and said leg means projects from the housing adjacent said actuating means.

11. In a movement-compensating load-supporting structure as defined in claim 1 wherein, a pair of platforms are mounted in a suspended relation adjacent opposite lower end portions of the housing, a driven gear is secured on the one shaft portion, driving means is positioned on each of said platforms for actuating said driven gear, said housing support means has a pair of legs and said post means has a cooperating pair of posts, one leg of said pair projects radially-outwardly and downwardly from one of said platforms and the other leg of said pair projects in the same defined manner from the other of said pair of platforms, and one post of said pair projects radially-inwardly and upwardly-endwise towards one of said legs and the other post of said pair projects in the same defined manner towards the other of said legs.

12. In a movement-compensating load-supporting structure as defined in claim 11 wherein, a snubber flange projects from each of said platforms adjacent to the associated leg, and a pair of snubber units are secured on the support structure with one of said snubber units having a movement resisting and containing connection with one of said snubber flanges and with the other of said snubber units having a movement resisting and containing connection with the other of said snubber flanges.

13. In a movement-compensating load-supporting structure as defined in claim 12 wherein, each of said snubber units has an operating plunger, a resilient compressible force-absorbing assembly, and an adjustment plunger for applying a compression presetting to said assembly; said assembly is operatively-positioned endwise between said operating plunger and said adjustment plunger, and cooperating means is carried by an outer end of said operating plunger and by an associated snubber flange that provides a sliding universal joint connection between said snubber flange and said operating plunger.

14. In a movement-compensating load-supporting structure as defined in claim 13 wherein each of said snubber units also comprises, a slide plate in abutment with a back end of said resilient compressible-force-absorbing assembly, a screw socket, a sleeve-like screw operatively-positioned in said socket to, at its front end, engage said slide plate and effect a compression presetting of said assembly, said adjustment plunger being operatively-positioned for sliding movement within said sleeve-like screw to, at its front end, engage said slide plate, a fluid motor positioned in alignment with said adjustment plunger and having a piston at its front end to engage a back end of said adjustment plunger and advance it to effect a compression presetting of said assembly.

15. In a movement-compensating load-supporting structure as defined in claim 13 wherein said cooperating means comprises, a slide block guidably-carried by the associated snubber flange and having an outwardly-open rounded socket portion, and a cup-shaped element having a rounded end operatively-positioned within said socket portion and having an opposite sleeve-like open end portion slidably-positioned on the outer end of said operating plunger.

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