

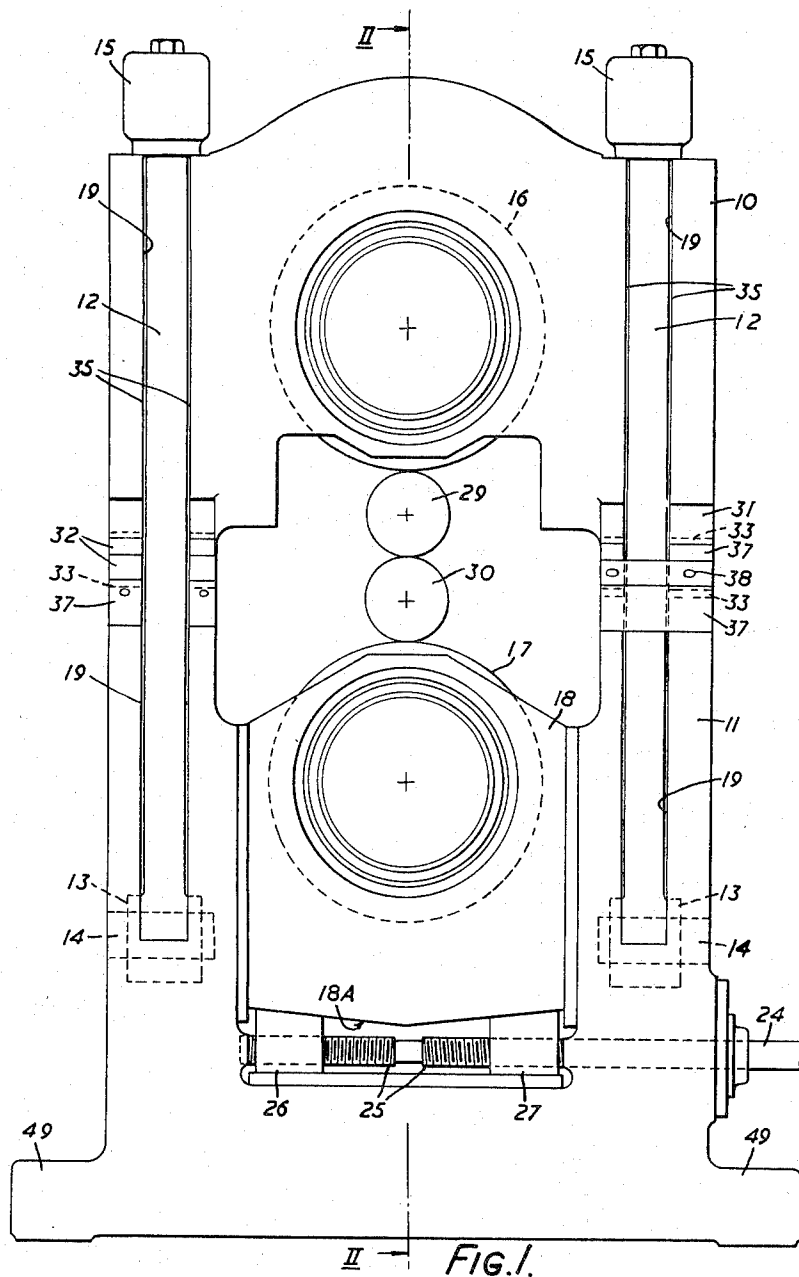
Nov. 16, 1965

D. R. HOWARD
PRESTRESSED ROLLING MILLS

3,217,525

Filed Nov. 6, 1962

6 Sheets-Sheet 1



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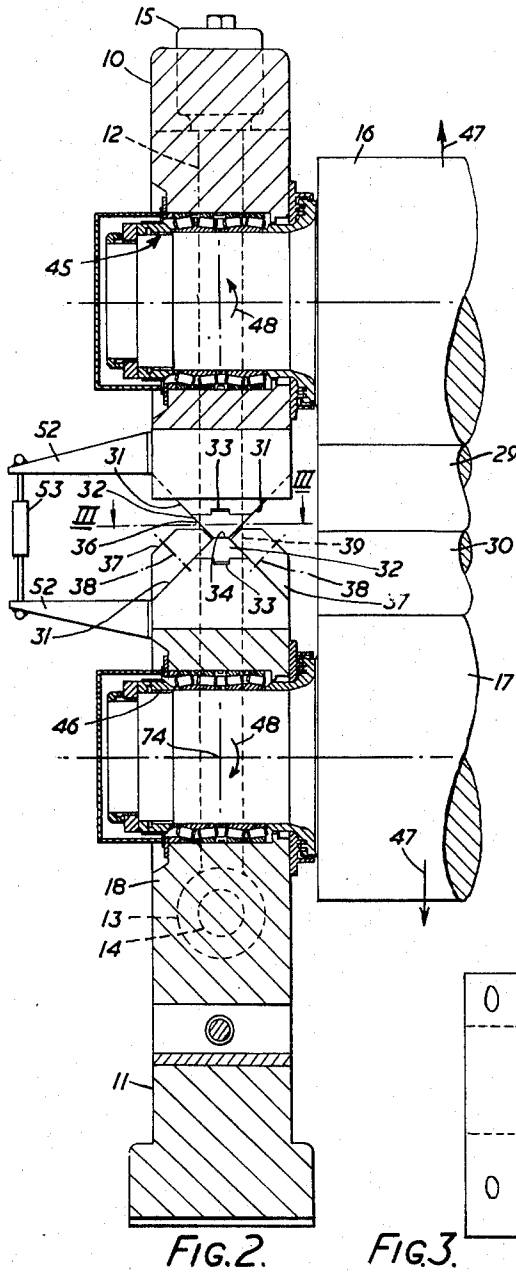
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6 Sheets-Sheet 2



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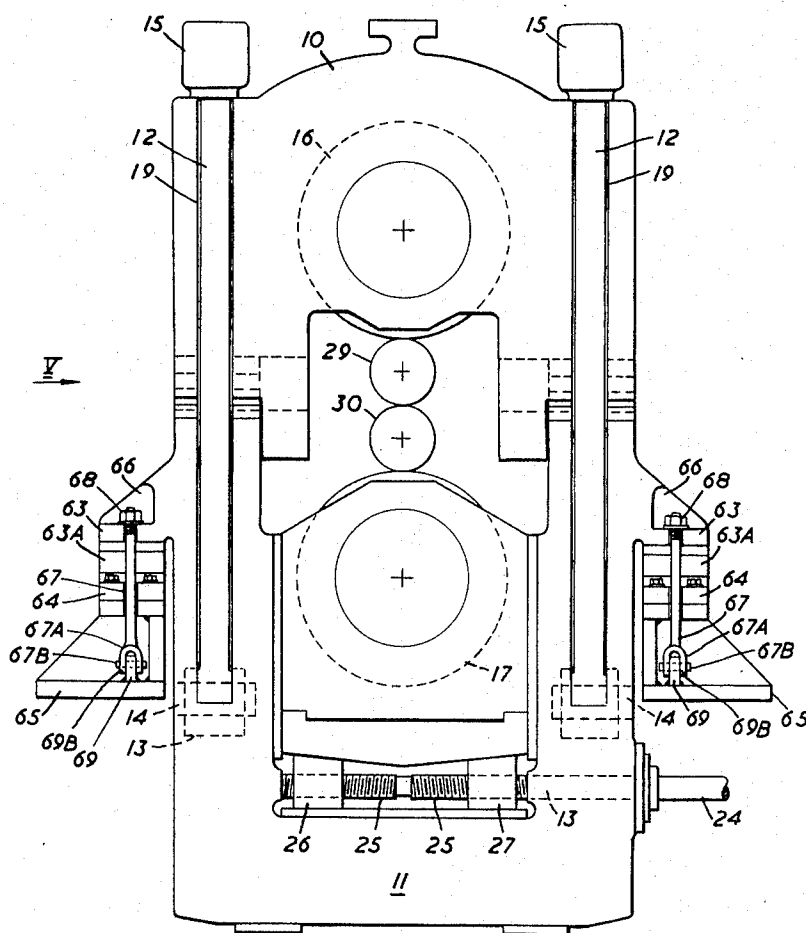


Fig. 4.

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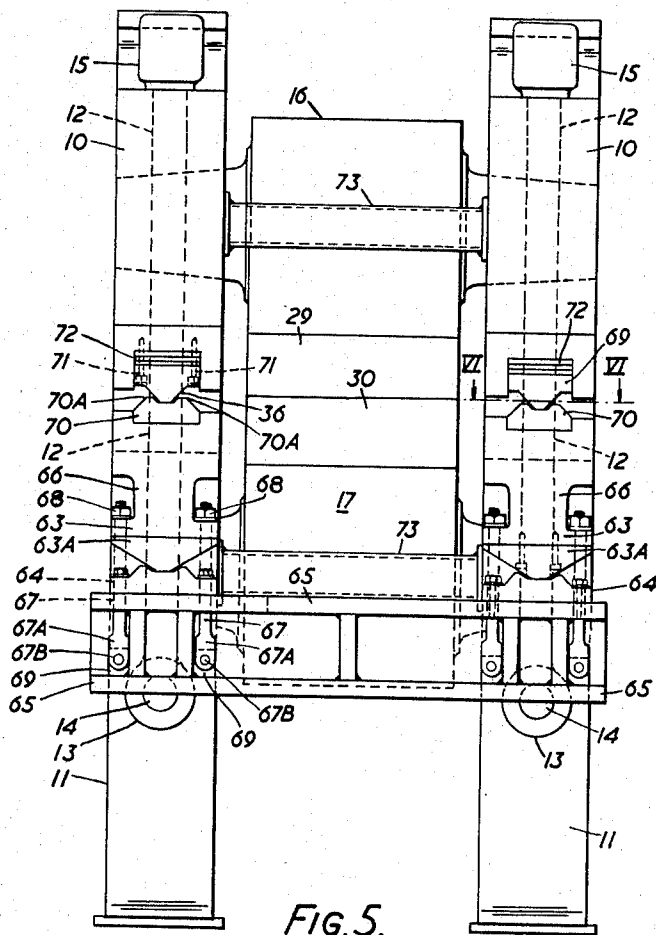


FIG. 5.

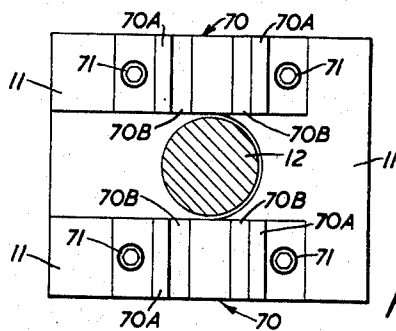


FIG. 6.

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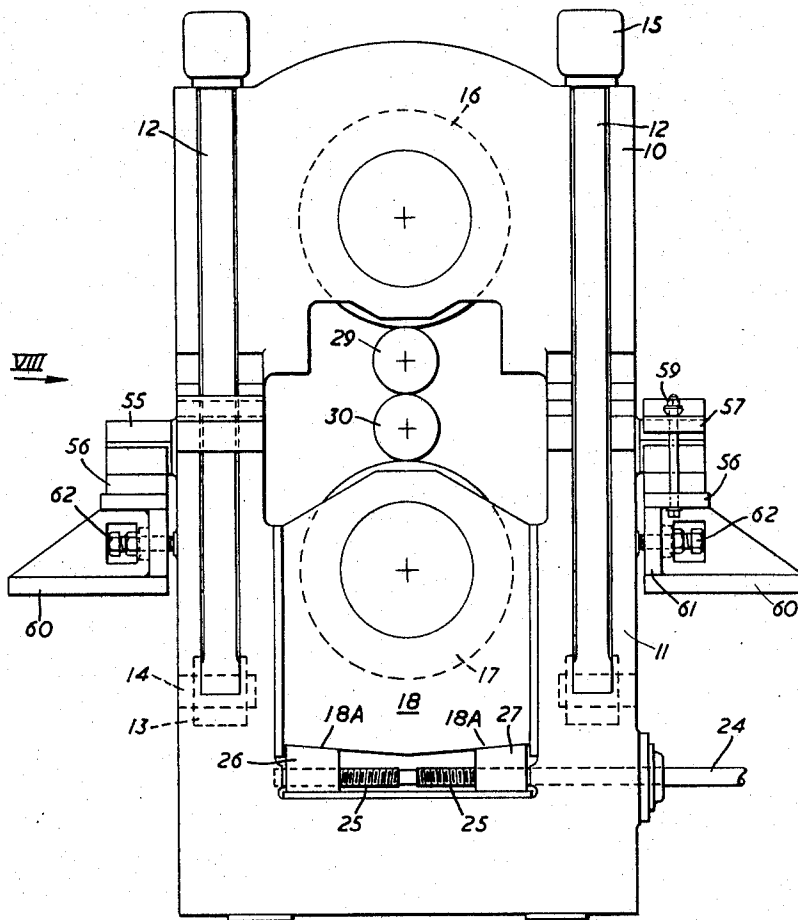


FIG. 7.

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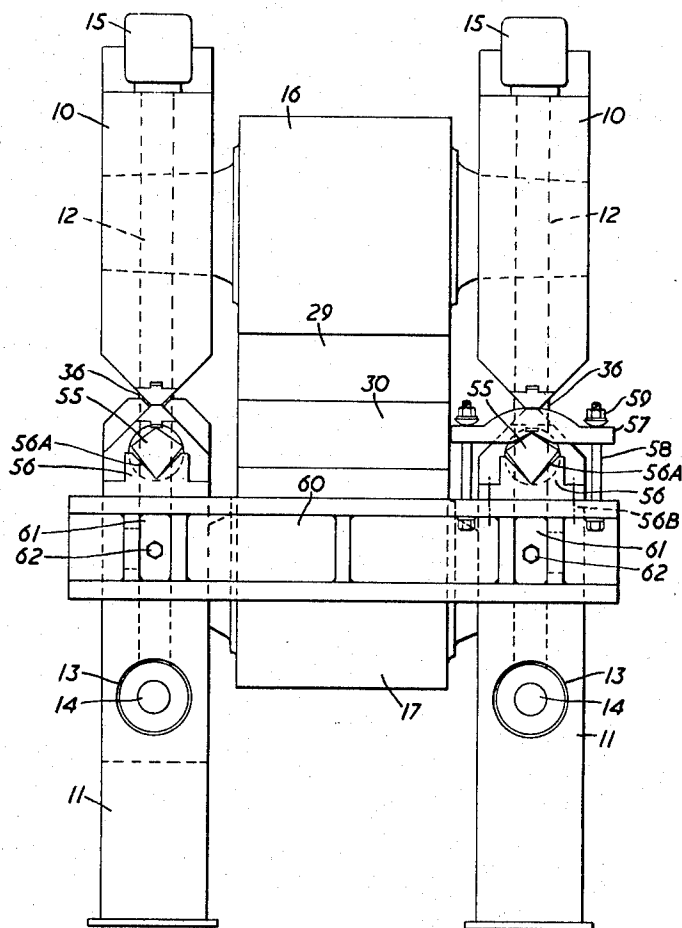
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6 Sheets-Sheet 6



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PRESTRESSED ROLLING MILLS

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15 Claims. (Cl. 72-237)

This invention relates to rolling mills and in particular to means for allowing self-alignment of the roll-neck bearing assemblies which are supported by the housing of a rolling mill.

Consider a rolling mill having at least two parallel rolls. Certain of these rolls, which are for convenience herein referred to as "load-transferring rolls," are designed to transfer the rolling load to which the mill rolls are subjected when the mill is in use, to the housing structures of the mill. In the case of a 2-high mill, each of the two rolls acts as a load-transferring roll; in the case of a rolling mill with more than two parallel rolls, the outermost rolls are commonly arranged to act as load-transferring rolls.

Each load-transferring roll is commonly provided with a pair of roll-neck bearing assemblies, by which is meant the necks of each such rolls together with their associated radial-type bearing assemblies. The roll-neck bearing assemblies are mounted within the housing of the rolling mill, and it is through these roll-neck bearing assemblies that the rolling load is transferred from the rolls of the mill to the housing.

When a rolling mill is in use, the rolling load tends to cause the load-transferring rolls to bow. Unless provision is made for the roll-neck bearing assemblies of the load-transferring rolls to self-align, that is to undergo suitable rotational movement in accordance with the bowing of the load-transferring rolls, bending moments are set up in the roll-neck bearing assemblies and the housing. Such bending moments produce a load distribution on the roll-neck bearing assemblies which is non-uniform in an axial direction and which will tend to lead to premature failure of the bearing assemblies. In extreme cases they might also produce fracture of the roll-necks of the load-transferring rolls.

According to the present invention, in a rolling mill having a housing arranged to support a number of roll-neck bearing assemblies the housing is provided with portions which have a relatively low resistance to bending compared with the rest of the housing carrying the rolling load, whereby, when the rolls are subjected to a rolling load relative movement of different parts of the housing is permitted to take place about the said portions of relatively low resistance to bending so as to permit a degree of self-alignment to at least one of the roll-neck bearing assemblies.

The portions of the housing having a relatively low resistance to bending may be of reduced cross-sectional area relative to the remainder of the housing carrying the rolling load.

The housing may comprise two members prestressed together in which case mutually contacting areas of the two members may be located on the portions having a relatively low resistance to bending.

Stop means may be secured to the portions of the housing between which relative movement takes place so that after a predetermined degree of relative movement, the stop means contact each other, thus offering a greater degree of resistance to bending and preventing overloading of the said portions.

A rolling mill according to the invention may be at

least partially supported by means extending from the housing members in a region of low deflection due to the rolling load, and the said means may be secured to foundation structure in a manner permitting a degree of movement of the said means relative to the said foundation structure. In this case the said means may comprise two members prestressed together, the mutually contacting areas of the said members being of reduced area relative to the cross-sectional area of the remainder of the said means carrying the weight of the mill, or part thereof.

Alternatively, a rolling mill according to the invention may be at least partially supported by means extending from the housing members in a region of low resistance to bending, and may comprise means forming upper and lower knife edges engaging with V-shaped slots in a clamp member securing the said means to foundation structure.

Difficulty is often experienced in obtaining a signal which is a measure of the rolling load to which a rolling mill is subjected. However, such a signal may be easily obtained in the case of a rolling mill according to the invention, which may include measuring means responsive to the said relative movement of different parts of the housing structure under the effect of the rolling load, the measuring means being arranged to supply a measure of the magnitude of the rolling load, and comprising an extensometer or the like.

The invention, which may be carried into practice in a number of ways, will now be described with reference to the accompanying drawings of which:

FIGURE 1 is an end elevation of a 4-high prestressed rolling mill with the drive arrangements omitted;

FIGURE 2 is a part cross-sectional front elevation, taken along the line II-II of FIGURE 1;

FIGURE 3 is an enlarged view, taken along the line III-III of FIGURE 2, with the top housing removed;

FIGURE 4 is a view similar to that of FIGURE 1, but showing a modified form of the invention and alternative means for supporting the housing structure;

FIGURE 5 is a view in the direction of the arrow V in FIGURE 4;

FIGURE 6 is an enlarged view along the line VI-VI in FIGURE 5 with the top housing removed;

FIGURE 7 is a view similar to that shown in FIGURES 1 and 4, showing a still further means of supporting the housing structure, and

FIGURE 8 is a view in the direction of the arrow VIII in FIGURE 7.

Referring to FIGURES 1 and 2: the rolling mill has, at each end, a housing structure formed in two principle parts, an upper housing member 10 and a substantially U-shaped lower housing member 11. The members 10 and 11 are prestressed together by means of a pair of prestressing bolts 12 which extend through open-sided slots 19 formed in the outer faces of the housing members 10 and 11. Each of the bolts 12 is provided at its upper end with a hydraulic nut 15, and at its lower end with an eye 13 by which each bolt is pivotally anchored within the lower housing member 11 by a co-operating pin 14. The arrangement is such that when it is required to remove the upper housing member 10, the nuts 15 are loosened, whereafter the bolts 12 may be swung out of the slots 19 by pivotal movement about the pins 14.

The upper housing member 10 acts as a chock for an upper backing roll 16, whereas the lower housing members 11 is provided with a separate chock 18 to house a lower backing roll 17, the chock 18 being capable of vertical movement within the lower housing member 11.

The roll gap of the rolling mill can be adjusted by causing the chock 18 to move vertically within the lower housing member 11, by rotation of a shaft 24, having

oppositely threaded portions 25, upon which are engaged a pair of threaded wedges 26 and 27 which are arranged to engage with the lower surfaces 18A of the chock 18.

The work rolls of the mill are indicated at 29 and 30, details of the chocks provided for these work rolls being omitted.

Each of the side limbs of the housing members 10 and 11 is provided at its end with a tapered portion 31. Each tapered portion 31 terminates in a tapered contact member 32, which is secured to the tapered portion 31 by means of screws 32A, FIGURE 3. The members 32 are provided with ribs 33 which engage in corresponding slots formed in the relevant tapered portion 31. The contact members 32 are formed for example, of material such as suitably hardened steel which is capable of withstanding large stresses without permanent deformation. The upper housing member 10 and the lower housing member 11 thus have two limited areas 34 of mutual contact.

As described above, the housing members 10 and 11 are prestressed together by the bolts 12. However, clearance 35 (FIGURE 1) is provided between the bolts and the slots in which they are located to permit relative movement between the housing members 10 and 11 and the bolts 12, as will be described below.

In the region of the tapered portions 31 of the limbs of the housing members 10 and 11, the bolts 12 project out of the slots in which they are located, as indicated at 36 in FIGURE 2. In this region, the tapered portions 31 of each of the limbs of the lower housing member 11 are provided, at opposite sides, with stop members 37 which are bolted to these limbs by means of bolts, the axes of which are indicated at 38. The stop members 37 are provided with cavities 39 through which the portions 36 of the bolts 12 extend, suitable clearances being provided between the walls of the cavities 39 and the bolts 12, for the purpose to be described hereinafter.

The roll-neck bearing assemblies for the upper and the lower backing rolls 16 and 17 are indicated respectively at 45 and 46, and are preferably so arranged that axial movement of the roll-necks of the backing rolls 16 and 17 can take place, relative to the upper housing member 10 and the chock 18 respectively.

In operation, the rolls are subjected to the rolling load and consequently the backing rolls 16 and 17 tend to bow in the direction of the arrows 47, FIGURE 2. The roll-neck bearing assemblies 45 and 46 transmit the rolling load to the upper housing member 10 and the chock 18 respectively and, because of the bowing of the backing rolls 16 and 17, the roll-neck bearing assemblies will tend to undergo pivotal movement in the direction of the arrows 48.

Because of the means provided between the chock 18 and the wedges 26 and 27, the lower roll-neck bearing assembly 46 and its associated chock 18 are allowed to undergo pivotal movement to allow the roll-neck bearing assembly 46 to self-align.

Furthermore, because of the reduced cross-section of the limbs of the housing members 10 and 11 in the region of the areas 34 of mutual contact, the housing structure has a relatively low resistance to bending in these regions. Consequently, the upper housing member 10 is permitted to undergo pivotal movement in the direction of arrow 48, relative to the lower housing member 11, the regions of the limbs which are of reduced cross-section acting as hinges, the bending of the housing structure therefore, being concentrated in these regions. This relative movement permits a degree of self-alignment to the upper roll-neck bearing assembly 45.

The areas 34 of mutual contact are made large enough to avoid buckling of the housing structure under the combined effects of the rolling load and of the prestressing forces exerted by the bolts 12. The areas 34 are also chosen, in relation to the magnitude of the prestressing force exerted by the bolts 12, that when movement of

the upper housing member 10 relative to the lower housing member 11 takes place under the action of a rolling load, the areas 34 remain fully in contact.

As mentioned above, suitably large clearances 35 are provided between the bolts 12 and the walls of the slots 19 through which the bolts 12 extend. Accordingly, the bolts are normally not in contact with the housing members 10 and 11, except through the medium of the hydraulic nuts 15 bearing upon the housing member 10 and where they are anchored to the lower housing member 11 by means of the pins 14.

For this reason, the resistance of the bolts 12 to movement of the housing member 10 relative to the housing member 11 is relatively small, in fact, when the housing members 10 and 11 move under the action of a rolling load, the bolts 12 will tend to protrude from the slots 19 through which they extend. However, if under the action of a rolling load the bolts 12 were permitted to protrude excessively from their slots, buckling of the housing structure might take place when large rolling loads are applied. It is for this reason that the stop members 37 are provided, the clearances between the bolts 12 and the walls of the cavities 39 of the stop members 37, permitting the bolts 12 to protrude only a limited distance out of the slots 19. If the rolling load becomes larger than a value corresponding to this amount of relative movement of the bolts 12 and the housing structure, the portions 36 of bolts 12 come into contact with the stop members 37 so that effectively the bolts 12 and the housing structure are brought into contact. The bolts 12 and the housing structure would therefore tend to move in unison as the rolling load is increased, so reducing the tendency to buckling of the housing structure.

As previously mentioned, in the case of prestressed rolling mills, it is difficult to obtain a signal which is a measure of the magnitude of the rolling load, to which the rolling mill is subjected. However, such a signal may be obtained by securing an extensometer 53 or the like, between extension arms 52 which extend outwardly from the housing members 10 and 11. When relative movement of the housing members 10 and 11, takes place under the action of a rolling load, the change in the separation of the arms 52 will be a measure of the magnitude of the rolling load. Consequently, an output signal which is a measure of the magnitude of the rolling load can be obtained from the extensometer 53.

A preferred means of partially supporting a rolling mill (having a housing structure according to the invention) in a region of low deflection due to the rolling load, together with a modified form of the contact members 32, is shown in FIGURES 4 to 6. Parts of the rolling mill which are common to all the drawings have the same reference numerals, and will not be further described.

In FIGURES 4 to 6 the side limbs of the housing members do not have the tapered portions 31 of the FIGURES 1 to 3 embodiment, but the end faces of the limbs contain slots to receive upper and lower contacting members 69 and 70 respectively, which are secured in the slots by bolts, two only of which are shown at 71 in FIGURE 5. The upper contacting members 69 are provided with packing pieces 72 for the purpose of adjustment during assembly and to accommodate changes in roll diameter. The lower contacting members 70 have upwardly extending ridges 70A which are provided for the purposes of location during assembly. In this embodiment the stop means for providing additional resistance to bending, after a predetermined relative movement has taken place, may comprise packing pieces (not shown) inserted between the horizontal faces of the side limbs of the housing members.

The embodiment shown in FIGURES 4 to 6 also includes tie bars 73 at the front and the rear of each load-transferring roll. The longitudinal axes of the tie bars extend parallel with the longitudinal axes of the load-transferring rolls 16 and 17. The longitudinal axes of

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each pair of tie bars are in a common plane with the longitudinal axis of their associated load-transferring roll, and this plane is normal to the plane of the axes of the load transferring rolls.

The tie bars are provided to maintain the centers 74 (FIGURE 2) of the roll-neck bearings at the desired distance apart, and also to further the requirement ideal that movement of the housing members due to the rolling load takes place as pivotal movement about the centers 74 of the roll-neck bearing assemblies, as indicated by the arrows 48.

The rolling mill support means above referred to comprise arms 63 integral with the lower housing member 11. The arms 63 are provided, at their lower ends with a removable tapered portion 63A which bears on a cradle member 64 secured to a platform structure 65. The arms 63 are also provided with webs 66, at each side of which are located bolts 67 which extend downwardly through open-sided slots formed in the tapered portion 63A and the cradle member 64. The bolts 67 are provided at their upper ends with nuts 68 and at their lower ends with eyes 67A which engage pins 67B extending through eyes 69B in lugs 69 secured to the platform 65.

The arrangement is such that when the lower housing member 11 is required to be removed, the upper housing member 10 is first removed by releasing the nuts 15 on the prestressing bolts 12, swinging the bolts 12 outwardly, that is away from the housing members, by pivotal movement about the pins 14. The nuts 68 upon the upper ends of the bolts 67 are then released and the bolts 67 are swung outwardly, away from the lower housing member 11, by pivotal movement about the pins 67B.

Referring now to FIGURES 7 and 8 which illustrate a second construction for supporting the housing structure, in which the mill is shown partially supported in the region of the portions of the housing structure which have a relatively low resistance to bending. This support means comprises knife-edge structures 55, which are of substantially diamond-shaped cross-section, and which form part of and protrude outwardly from, the lower housing member 11. The knife-edge structures 55 are supported in cradles 56 which have formed in their upper surfaces, V-shaped slots 56A which are arranged to receive corresponding lower V-shaped portions of the knife-edge structures 55. The cradles 56 are secured to a platform structure 60 by bolts, the axes of which are indicated at 56B. Clamp members 57, of which one only is shown in each of the figures, and which have in their lower surfaces inverted V-shaped slots, are arranged to receive the upper V-shaped surfaces of the knife-edge structures 55. The platform structure 60 is secured to suitable foundations, not shown.

Guide means, in the form of set-screws 62 which extend through upright member 61 of the platform 60, are provided to assist in accurately locating the lower housing member 11 when it is being lowered into the position as shown in the drawing.

The above-described means of part-supporting the rolling mill, permits a degree of self-alignment to both the upper and lower roll-neck bearing assemblies 45 and 46. It will be appreciated therefore, that with the embodiments shown in FIGURES 4 to 8, when used in conjunction with the embodiment shown in FIGURES 1 to 3, affords the lower roll neck bearing assembly 46 a degree of self-alignment is not required.

It will be appreciated that when a rolling mill according to the invention includes a housing which is not prestressed, a degree of local prestressing in the region having a relatively low resistance to bending is desirable.

It will be further appreciated, that in a rolling mill according to the invention and having a two-part housing, the two parts of which are prestressed together, the portion or portions of the housing having a relatively low resistance to bending may comprise plates of suitably

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dimensioned material held in compression between the portions of the housing. In a further embodiment rollers may be held in compression between arcuate faces on the limbs of the housing members, thus permitting the housing members some pivotal movement about the rollers. In this case the rollers, in co-operation with the arcuate faces, provide restraint against lateral movement of the housing members relative to each other, the lateral restraint in the other embodiments described being provided by virtue of the friction between the mutually contacting faces of the contacting members.

In a further embodiment the stop means may comprise "O" rings of suitably elastic material located around the bolts 12 so that upon sufficient relative movement due to the rolling load taking place between the bolts and the housing members, the "O" rings are compressed between the bolts and the housing members, thereby providing an increased degree of resistance to relative movement of the bolts and the housing members.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

What I claim is:

1. A rolling mill stand comprising a pair of housings, upper and lower load-transferring horizontal rolls mounted between the housings, upper and lower roll neck bearing assemblies supported in each housing, each housing being formed in two parts, means for forcing the upper and lower part of each housing towards one another, and means arranged between the upper and lower part of each housing, said latter means having a relatively low resistance to bending compared with the housings, carrying the rolling load, so as to permit a degree of self alignment of the roll neck bearing assemblies of one of the rolls.

2. A rolling mill stand comprising a pair of housings, upper and lower load-transferring horizontal rolls mounted between the housings, each housing being formed in two parts, the lower parts slidably supporting chocks carrying roll neck bearing assemblies for the lower roll and the upper parts carrying roll neck bearing assemblies for the upper roll, means for adjusting the height of the chocks relative to the housings, means for forcing the upper and lower parts of each housing towards one another, and means arranged between the upper and lower parts of each housing, said latter means having a relatively low resistance to bending about an axis parallel to the pass line of the stand, compared with the housings carrying the rolling load, so as to permit a degree of self alignment of the upper roll neck bearing assemblies.

3. A rolling mill stand according to claim 2 in which the means having a relatively low resistance to bending are of reduced cross sectional area relative to the housings carrying the rolling load.

4. A rolling mill according to claim 2 in which the means having relatively low resistance to bending are made from material having a higher limit of elasticity than the housings carrying the rolling load.

5. A rolling mill stand according to claim 2 including stop means arranged to contact one another after a predetermined degree of relative movement has taken place between the upper and lower parts of each housing, to offer a greater degree of resistance to bending.

6. A rolling mill stand according to claim 2 in which the means having a relatively low resistance to bending comprise contact members detachable from the housing parts, said contact members being of substantially triangular cross section, an apex of the triangle being truncated and the surface thus formed on each contact member contacting the corresponding surface of its associated contact member.

7. A rolling mill stand according to claim 2 including tie-bars at the front and rear of the upper load-transferring roll, inter-connecting the housings adjacent the roll neck bearings of that roll, the axes of the tie-bars being parallel with, and in horizontal plane through the axis of the upper load-transferring roll.

8. A rolling mill stand according to claim 2 in which the means for forcing the upper and lower parts of each housing together comprise bolts located in slots passing through the housing parts, clearance being left between the bolts and the housings sufficient to allow limited relative movement, and stop means being provided to limit the pivotal movement between the housings and the bolts.

9. A rolling mill stand according to claim 2 including an extensometer connected between the upper and lower parts of one housing, and arranged to give a signal indicating the magnitude of the rolling load.

10. A rolling mill stand comprising a pair of housings, upper and lower load-transferring rolls mounted between the housings, each housing being formed in two parts, bolts for prestressing the housing parts together, a pair of chocks carrying roll neck bearing assemblies for the lower roll, means for adjustably supporting the chocks in the lower housing parts respectively, roll neck bearing assemblies for the upper roll, the upper roll neck bearing assemblies being mounted directly in the upper housing parts in fixed relation relative thereto, bearing means located between the upper and lower parts of each housing so as to allow limited pivotal movement of the upper housing parts relative to the lower housing parts about axes parallel to the pass-line of the stand, and means allowing limited pivotal movement of the lower roll neck bearing assemblies about axes parallel to the pass line of the stand.

11. A rolling mill stand comprising a pair of housings, upper and lower load-transferring rolls mounted between the housings, each housing being formed in two parts, the lower parts slidably supporting chocks carrying roll neck bearing assemblies for the lower roll, and the upper parts having roll neck bearing assemblies for the upper roll mounted therein fixed relation relative thereto, means for forcing the upper and lower parts of each housing towards one another, means for adjusting the height of the chocks relative to the housings, means arranged between the upper and lower parts of each housing, said latter means having a relatively low resistance to bending about an axis parallel to the pass line of the stand com-

pared with the housings carrying the rolling load, so as to permit a degree of self alignment of the upper roll neck bearing assemblies, the lower parts of each housing being supported on a foundation, and further means arranged between the lower part of each housing and the foundation, said further means having a relatively low resistance to bending about an axis parallel to the pass line of the stand, so as to permit a degree of self alignment of the lower roll neck bearing assemblies.

12. A rolling mill stand according to claim 11 in which said further means having a relatively low resistance to bending are located between members extending substantially horizontally from the lower parts of the housings, at the front and rear of the mill, said members extending from the lower housing parts in regions having a low deflection and low resistance to bending due to the rolling load, and including means securing said members to the foundation structure in a manner permitting a degree of pivotal movement of the lower housing parts relative to the foundation structure.

13. A rolling mill stand according to claim 11 including tie-bars at the front and rear of each load-transferring roll, each of the tie-bars inter-connecting the housings adjacent the roll neck bearings of its associated load transferring roll, the axes of the tie-bars being parallel with, and adjacent the horizontal planes through, the axes of their associated load-transferring rolls.

14. A rolling mill stand according to claim 11 including stop means arranged to limit the pivotal movement of the lower housing parts relative to the foundation.

15. A rolling mill stand according to claim 11 in which the further means having relatively low resistance to bending comprise tapered contact members, the contact areas of which have reduced cross-sectional areas relative to the remainder of the means carrying the weight of the mill.

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