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[11] **3,842,471**

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[54] COMPOSITE ROLL

[75] Inventors: **Karl Olof Polhall; Lennart Nordstrom; Rolf Persson,** all of Smedjebacken, Sweden

[73] Assignee: **Morgardshammar Aktiebolag,** Smedjebacken, Sweden

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July 7, 1972 Sweden 9009/72

[52] **U.S. Cl.** **29/125,** 29/132

[51] **Int. Cl.** **B21b 31/08**

[58] **Field of Search** 29/125, 132, 129, 129.5, 29/123

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Primary Examiner—Alfred R. Guest

[57] **ABSTRACT**

The composite roll comprises an inner member. At least one material engaging rolling ring member of a specially hard wear-resistant material encircles the inner member. The inner member has a pair of supporting walls on either side of the rolling ring member. At least one of the supporting walls is pressed against the rolling ring member thereby placing the rolling ring member in compression. The one wall is secured to the inner member by means of a force-fit or shrinkage-fit so that the rolling ring member is pressed between the two walls on the inner member with a force that is sufficient to cause the rolling ring member to be clamped on the inner member and to rotate with the inner member.

15 Claims, 7 Drawing Figures

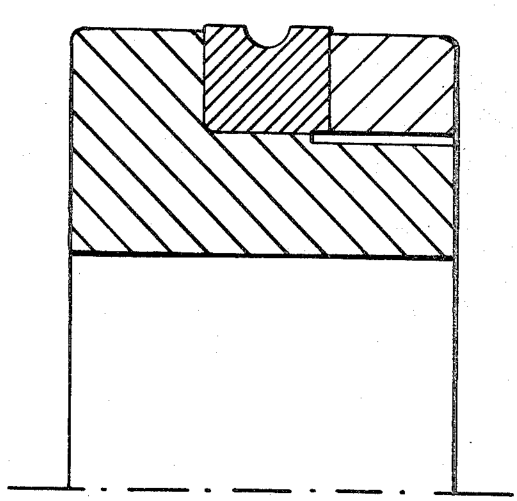


FIG. 1

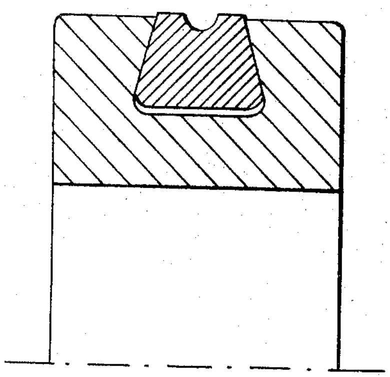


FIG. 2

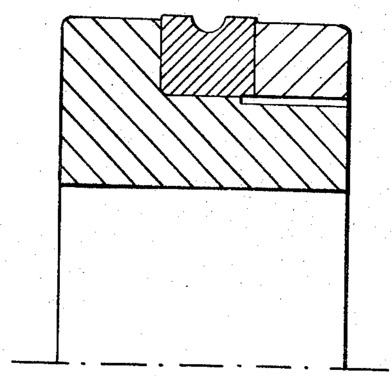


FIG. 3

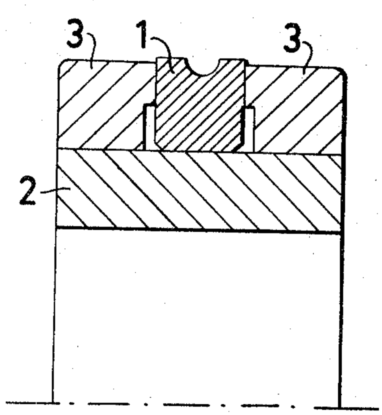


FIG. 4

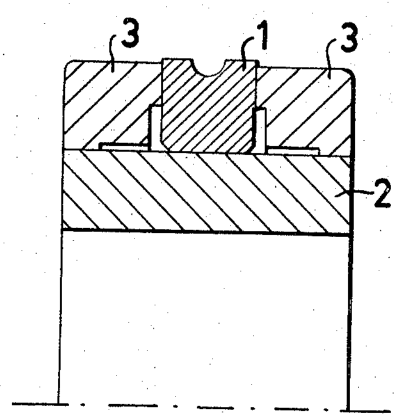


FIG. 5

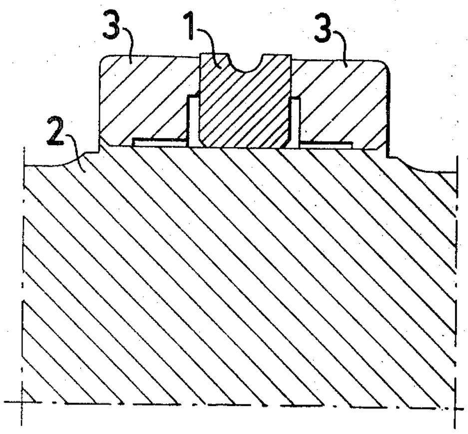


FIG. 6

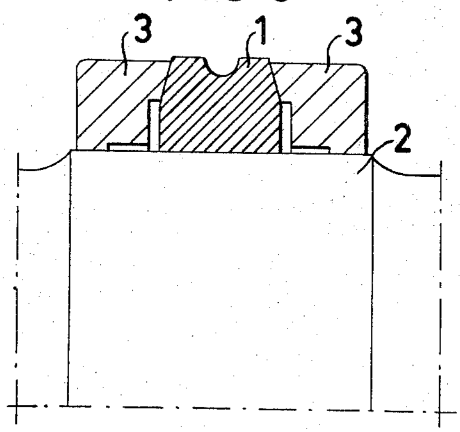
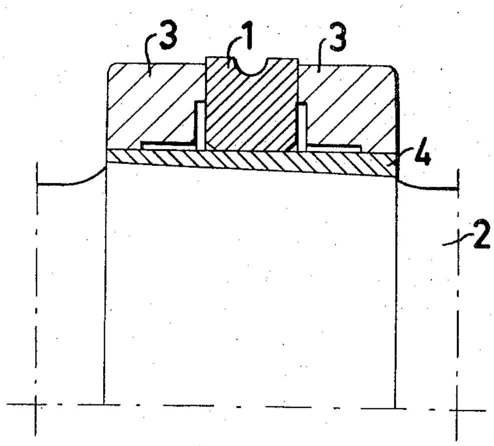


FIG. 7



COMPOSITE ROLL

BACKGROUND OF THE PRESENT INVENTION

The present invention relates to a composite roll and to a method of making same. The rolls to which the present invention applies preferably are used for the forming of material such as in a rolling mill, and in general the rolls include a grooved portion which is adapted to engage and shape the material as the material advances through the rolling mill.

During recent years many attempts have been made to produce rolls where the life of the portions of the rolls which contain the material engaging grooves may be prolonged by utilizing modern hard wear-resistant materials, for example, carbide. Such materials are characterized by their extraordinary hardness and great compressive strength but they do have a moderate tensile strength and do have a negligible tensile ultimate strength. Since these materials are also very expensive, it is desirable to make the rolls as composite rolls so that the part which is of the wear-resistant material is given the smallest possible volume. Accordingly, rolls have been constructed of an inner member or roll body of one material and a rolling ring of another material.

The fact that these materials have a negligible or moderate tensile strength has created problems in the formation of the rolls, especially for the hot-rolling of steel. When such rolls are utilized in the hot-rolling of steel, the temperature on the surface of the groove increases, particularly in the area where the surface contacts the material being rolled. This heat causes tensile stresses to be established in the surrounding cool roll material and after a fatigue fatigur cracks appear in the bottom of the groove.

It is known that if the rolling ring member is secured on the inner member by means of a force-fit, tensile stresses are caused in the ring which results in fatigue cracks appearing fairly early and such greatly shortens the life of the roll. It has been discovered that by mounting the rolling ring member in such a way that the ring has compressive stresses established therein when it is mounted on the roll body or inner member, the tensile stresses caused by the heat are substantially reduced and the appearance of fatigue cracks is delayed and the life of the rolling member is substantially increased.

Prior art efforts establishing the compressive stresses in the rolling ring member have involved basically two different types of constructions, one is by the casting of the rolling ring member into a roll body or the like. In this manner, great compressive stresses are established in the rolling ring member, since the rolling ring has a considerably lower coefficient of linear expansion than the material in which it is cast, namely, the material of the roll body. As a result, during the rolling of the rolling ring material after casting, the rolling ring is compressed by various surfaces of the roll body. Such a method, however, is difficult to carry out, particularly when there are special requirements regarding hardness, strength, toughness, etc., of the material in the roll body. It is also necessary to have the materials of the roll body and rolling ring with a proper difference in the coefficient of expansion.

In addition, rolls have been constructed where the inner member or roll body has a fixed flange and

against which the roller ring is compressed by a flange threaded on the roll body. In this manner, compressive stresses are achieved in the roller body and, this has affected the hardness of the material of which the roller body may be constructed. Besides, it is difficult to draw the threaded flange in such a way that great compressive forces are achieved.

SUMMARY OF THE PRESENT INVENTION

The present invention is directed to the provision of a composite roll which is not subject to the problems outlined above with respect to the prior art.

The roll of the present invention is one in which a rolling ring member is supported on a roll body or inner member in a manner to establish compressive stresses therein as in the prior art. The compressive stresses are established by a pair of wall or ring members which are supported on the inner member. At least one of the walls or ring members is secured to the inner member by means of a tight force-fit or shrink-fit. The pair of rings or walls on the inner member are forced against the side surface of the rolling ring with a substantial force during the assembly of the parts on the inner member. As a result, the rolling ring member is clamped between the walls on the inner member with a substantial force and compressive stresses are established in the rolling ring member. The force between the walls on the inner member and the rolling ring member is sufficient so that the frictional drag is such that the rolling ring member will rotate along with the inner member in order to properly perform its function on the material engaged, i.e., in the case of a rolling mill to properly shape the material during the rolling operation.

The present invention obviously therefore does not require that the rolling ring material have a lower coefficient of linear expansion than the roll body or inner member as is necessary in the casting technique of the prior art. In fact, in the present invention the rolling ring material may be any wear-resistant material and it may have a lower, identical or greater coefficient of linear expansion than that of the roll body. In addition, in view of the fact that no threads are necessary on the roll body or inner member, it is possible to use any material whatever for the roll body without consideration given to the cutting of threads or the like on the roll body.

DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the present invention will be apparent to those skilled in the art to which it relates from the following detailed description of the preferred embodiments thereof made with reference to the accompanying drawings in which:

FIG. 1 is a sectional view of a composite roll of the prior art in which a rolling ring is cast into a roller body;

FIG. 2 is a sectional view of a composite roll also of the prior art in which a rolling ring is compressed by a threaded flange on the roller body; and

FIGS. 3–7 are cross-sectional views of a composite roll embodying the present invention.

As noted hereinabove, the present invention is directed to a composite roll and a method of forming same. Specifically, the composite roll of the present invention includes a roll body or inner member **2** which may comprise either a solid shaft or a sleeve which is intended to be mounted on a rolling drive shaft of a rolling mill or the like. A rolling ring 1 is loosely on inner member 2. The rolling ring 1 may be made of a hard wear-resistant material, such as carbide or ceramic material. The rolling ring 1, of course, has a groove therein which is adapted to receive the hot metal material and shape the hot metal material as it is advanced through the rolling mill.

As noted hereinabove, as the hot metal material is advanced through the rolling mill, there is a tendency for tensile stresses to be established in the rolling ring 1, and in order to control those tensile stresses and minimize and establishment of such tensile stresses, the rolling ring 1 is placed under axial compression by a pair of rings 3 which engage the opposite sides of the roll 1 and apply a substantial axial compressive force to the ring 1 in order to place the rolling ring 1 under compressive stresses. Thus, the tensile stresses which are caused by the heat are reduced or minimized and the tendency for fatigue cracks to be established is minimized and the life of the rolling ring 1 is greatly lengthened.

The rings 3 may be made of a material similar to that of the body of the inner member 2, and the rings 3 are secured to the inner member 2 by means of a force-fit or a shrink-fit. The assembly technique is such that axial compressive forces are applied to the rings 3 and thereby to the rolling ring member 1 while the shrink-fit or force-fit is being effected. As a result, once the rings 3 are secured to the inner member 2, the rings 3 then apply an axial force to the rolling ring member 1 which results in substantial compressive axial stresses being formed in the ring member 1.

The force which is applied by the ring members to the rolling ring member 1 is sufficient to cause the rolling ring member 1 and the supporting ring members 3 to rotate as a unit along with the inner member 2 to effect rolling of material and shaping of the material by the groove in the rolling ring member 1. Moreover, the force is sufficient so that the rolling ring member 1 is retained in its proper position and no relative movement occurs between any of the members 1, 2, and 3.

In view of the fact that the rolling member 1 is provided with substantial compressive stresses during the formation thereof the tendency of harmful tensile stresses being established in the ring member 1 are minimized as in the prior art. In addition, in view of the fact that there is no casting of the rolling ring member in the body of the roller, as in the prior art as shown in FIG. 1, the wear-resistant material of the rolling ring member may have a lower, identical or greater coefficient of linear expansion than that of the roller body. Moreover, since the rolling ring member is not axially compressed by a threaded flanged portion on the roller body, as is shown in FIG. 2, there is no problem of the type of material which is used for the roller body in view of the fact that it is not necessary to provide threads thereon.

FIGS. 4–7 show different modifications of composite rolls which embody the present invention. In FIG. 4, the compressive effect on rolling ring 1 is provided, even though there is an inner partial clearance between the member 2 and the rings 3. Of course, the force per unit of area between the inner peripheral portions of the rings 3 and the outer peripheral surface of the inner member 2 is increased so that the axial frictional force applied in a compressive or axial direction to the ring 1 remains, in effect, substantially the same as that shown in FIG. 3.

FIG. 5 shows a further modification in which the axial force applied to the rolling ring member 1 can be increased. In FIG. 5, a boss is formed on the inner member 2 and which cooperates with a tapered surface on the inner periphery of the members 3 to increase the axial compressive force which is supplied by the rings to the ring member 1.

In the embodiment of FIG. 6, the ring 1 is shaped with an outwardly tapering cross section, and as a result as the rings 3 are forced axially toward the ring 1, a radial component force is applied to the rolling ring member 1 which increases the compressive stresses in the ring 1.

In the embodiment of FIG. 7, an inwardly conical intermediate sleeve 4 is provided which is disposed between the rings 1 and 3 on the one hand, the inner member 2, on the other hand. During the assembly of the embodiment of FIG. 7, the inner member 2 is forced into the sleeve 4 and due to the conical or tapered surfaces of the members 2 and 4, the member 4 is pressed radially outwardly and into a tight force fit engagement with the peripheral surfaces of the rings 3. As a result, the rings 1 and 3 are tightly engaged or press fit on the member 4. Of course, this operation is provided simultaneously with the forcing or axial loading of the rings 3 in order to provide the axial compressive forces in the ring 1.

In the embodiments of the invention disclosed in FIGS. 3–6, the rings 3 are heated prior to their mounting on the member 2. Once heated, the rings are slipped on the member 2. Then axial compressive forces are applied to the rings 3 in order to set up the axial or compressive stresses in the ring 1. Such can be applied by any suitable external means. As the rings 3 cool, they shrink down onto the inner member 2, and as a result they are force-fit or shrunk-fit into engagement with the member 2. After cooling has been effected, the axial forces applied to the rings 3 by the external means may be removed. As a result, the composite ring embodying the present invention is provided. Of course, rather than the rings 3 being shrunk-fit onto the inner member 2 to provide the force-fit the rings 3 may be press-fit onto the inner member 2 and during the press-fitting effecting the axial compression of the rolling ring 1.

As a result of the method, the rolling ring 1 was loosely positioned on the inner member 2 is caused to rotate as a unit with the inner member 2 due to the frictional forces between the periphery of the rings 3 and the rolling ring 1. In addition, the frictional force-fit of the rings 3 on the inner member 2 maintains the compressive stresses in the rolling ring 2.

Having described the invention, what is claimed is:

1. A composite roll comprising an inner member, at least one rolling ring member of a hard wear-resistant material encircling said inner member, said inner member having a supporting wall on either side of the rolling ring member, said supporting walls applying compressive axial forces against the opposite surfaces of said rolling ring member to establish compressive stresses in the rolling ring member, at least one of said supporting walls being secured to said inner member by means of a force-fit, said supporting wall members applying a compressive force to said rolling ring member which is

sufficient to cause the rolling ring member to rotate with the inner member during shaping of material.

2. A composite roll as defined in claim 1 wherein said supporting walls contact said rolling ring member only at the outer periphery thereof.

3. A composite roll as defined in claim 2 wherein the supporting walls are shaped with annular clearance between the inner member and the walls in the area axially adjacent a radial surface of the rolling ring member.

4. A composite roll according to claim 3 wherein the rolling ring member partly at least is tapering towards the periphery.

5. A composite roll according to claim 1 wherein said supporting walls comprise a pair of ring members force-fit on said inner member.

6. A composite roll according to claim 5 wherein said rolling ring member and said pair of ring members are mounted on an inwardly conical intermediate sleeve into which the inner member which is outwardly conical is pressed, said rolling ring member having an inner diameter that is loosely fit on said intermediate sleeve after the inner member has been pressed into the intermediate sleeve.

7. A composite roll according to claim 5 wherein the axial securing of said pair of ring members is increased by a pair of bosses on the inner member which engage said respective pair of ring members.

8. A method of forming a composite roll, said method comprising the steps of providing an inner roll member, loosely encircling the inner roll member with a hard wear-resistant rolling ring, locating supporting walls on the opposite axial sides of said rolling ring, applying axial compressive forces to said rolling ring to thereby set up axial compressive stresses in said rolling ring member, and force fitting at least one of said supporting walls on said inner member while maintaining said axial compressive forces on said rolling ring member whereby said rolling ring is axially compressed between said supporting walls and is rotatable with said inner roll member.

9. A composite roll comprising an inner member, at least one rolling ring member of a hard wear-resistant material encircling said inner member, said inner member having a supporting wall on either side of the rolling ring member, said supporting walls applying compressive axial forces against the opposite surfaces of said rolling ring member to establish compressive stresses in the rolling ring member, the supporting walls being shaped with annular clearance between the inner member and the walls in the area axially adjacent a radial surface of the rolling member whereby said supporting walls contact said rolling ring member only at the outer periphery thereof, cylindrical inner surfaces of at least one of the supporting walls being provided with clearance adjacent the rolling ring member, at least one of said supporting walls being secured to said inner member by means of a force-fit, said supporting wall members applying a compressive force to said rolling ring member which is sufficient to cause the rolling ring member to rotate with the inner member during shaping of material.

10. A composite roll as set forth in claim 9 wherein at least part of the rolling ring member tapers toward the periphery thereof.

11. A composite roll as set forth in claim 10 wherein portions of said supporting walls are tapered to conform with the tapered parts of the rolling ring.

12. A composite roll as set forth in claim 9 wherein said supporting walls comprise a pair of ring members force-fit on said inner member.

13. A composite roll according to claim 12 wherein said rolling ring member and said pair of ring members are mounted on an inwardly conical intermediate sleeve into which the inner member which is outwardly conical is pressed, said rolling ring member having an inner diameter that is loosely fit on said intermediate sleeve after the inner member has been pressed into the intermediate sleeve.

14. A composite roll according to claim 12 wherein the axial securing of said pair of ring members is increased by a pair of bosses on the inner member which engage said respective pair of ring member.

15. A method of forming a composite roll as set forth in claim 8 wherein the step of force fitting at least one of the supporting walls on the inner member while maintaining said axial compressive forces on said rolling ring member includes the steps of heating the supporting wall, placing the supporting wall on the inner roll member, applying axial compressive forces to the supporting walls, and allowing the heated supporting wall to cool.

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