ABSTRACT

A rolling mill laying head comprises a quill rotatable about a central axis. A guide pipe carried by the quill and is configured and arranged to form a longitudinally moving product into a continuous series of rings. Axially spaced bearings support the quill on a stationary support structure for rotation about its axis. At least one of the bearings comprises a hydrostatic oil film bearing.
FIG. 3
(PRIOR ART)
ROLLING MILL LAYING HEAD

BACKGROUND DISCUSSION

[0001] 1. Field of the Invention
[0002] This invention relates to laying heads of the type employed in rolling mills to form a hot rolled product into a helical formation of rings.

[0003] 2. Description of the Prior Art
[0004] In a conventional laying head, a stationary support structure contains a hollow quill rotatably supported between axially spaced bearings. The quill carries a curved guide pipe having an entry end aligned with the rotational axis of the quill, and a curved intermediate section projecting in a cantilever fashion from the quill to an exit end spaced radially from the quill axis. The quill is rotatably driven by known means, with the guide pipe being configured to receive a product at its entry end and to form the product into a continuous formation of rings emerging from its exit end.

[0005] Roller bearings are typically employed to rotatably support the quill. Under high speed operating conditions, e.g., when handling products traveling at speeds exceeding 100 m/sec, experience has shown that the roller bearings are prone to producing vibrations that disturb operation of the laying head.

[0006] Various schemes have been devised in an attempt at eliminating or at least suppressing such vibrations. For example, as described in U.S. Pat. No. 5,590,848, the cantilevered portion of the guide pipe has been shortened in order to increase the overall stiffness of the laying head. Also, as described in U.S. Pat. No. 7,086,783, the roller bearings have been preloaded to eliminate operating clearances. Although such design modifications have been proven to be beneficial, they have not adequately addressed the vibration problems which continue to plague the laying heads as they are operated at the ever increasing speeds of modern day rolling mills.

[0007] As described in WO2005/084842 A1, it also has been proposed to employ hydrodynamic bearings in place of roller bearings. In a typical hydrodynamic bearing, as schematically illustrated in FIG. 3, a rotating member 10 is surrounded by a bushing 12. The rotating member is subjected to an applied load “L”, and low pressure oil 16 is introduced between the rotating member and bushing via a recess 17 in the interior bushing surface.

[0008] The rotating member forms a single pressure field “P” as a result of a combination of parameters, including the rotational speed of the rotating member, the applied load, the diametrical clearance between the rotating member and bushing, and the viscosity of the oil. The force integrated from the pressure field exactly balances out the applied load, with the centerline 18 of the rotating member 10 being offset from the centerline 20 of the bushing 12, resulting in an eccentricity “E” that is a function of the aforesaid parameters.

[0009] Under lightly loaded high speed operating conditions, as is the case with rolling mill laying head, hydrodynamic bearings are known to experience a vibration effect commonly referred to as “whirl”, where the rotating member orbits inside the bushing in a highly undesirable mode. The radius of the orbit is essentially equal to the eccentricity of the bearing under the specific operating conditions.

[0010] Also, all hydrodynamic bearings require a higher starting torque to overcome the static friction of the rotating member sitting stationary on the bushing. Once rotation commences, the torque requirement drops dramatically. However, the laying head motors and drive trains must be sized to deliver the higher starting torques, and this in turn increases costs.

[0011] The objective of the present invention is to provide a rolling mill laying equipped with a novel and improved bearing that overcomes or at least substantially mitigates the problems associated with mechanical roller bearings and hydrodynamic oil film bearings.

SUMMARY OF THE INVENTION

[0012] In accordance with the present invention, the quill of a laying head is rotatably supported by multiple bearings, with at least one bearing being a hydrostatic oil film bearing. Instead of a single pressure field formed passively in response to rotation of the quill, a plurality of discrete pressure fields are formed by high pressure oil being actively pumped into angularly spaced recesses in the bushing. The recesses are arranged in a manner such that their associated pressure fields urge the quill into concentric alignment with the bushing where it is held during continued operation of the laying head, thus minimizing and ideally eliminating vibration due to eccentricity. The multiple pressure fields also serve to separate the quill from the bushing surface prior to the start of quill rotation, which makes it unnecessary to provide a drive train with a higher starting torque.

[0013] These and other features and their attendant advantages will now be described in greater detail with reference to the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a diagrammatic view, partially broken away, of a laying head equipped with a hydrostatic oil film bearing in accordance with the present invention;

[0015] FIG. 2 is a diagrammatic sectional view taken through the hydrostatic oil film bearing on line 2-2 of FIG. 1; and

[0016] FIG. 3 is a diagrammatic cross sectional view of a hydrodynamic oil film bearing.

[0017] The clearances between the rotating members and bushings in FIGS. 2 and 3 have been exaggerated for illustrative purposes.

DETAILED DESCRIPTION

[0018] With reference initially to FIG. 1, a laying head 22 comprises a quill 24 rotatable about a central axis “X”. A guide pipe 26 is carried by the quill. The guide pipe has an entry end 26a aligned with axis X, and a curved intermediate section 26b leading to an exit end 26c spaced radially from axis X. The quill is contained within a stationary support structure 28 and is supported for rotation about axis X by axially spaced bearings 30, 32. Bearing 30 is a conventional roller thrust bearing, and bearing 32 is a hydrostatic oil film bearing in accordance with the present invention. The quill is rotatable driven by a conventional drive train including meshed bevel gears 34, 36 powered by a gear box and motor (not shown).

[0019] As can be seen by further reference to FIG. 2, the hydrostatic oil film bearing comprises a bushing 38 surrounding the journal surface of the quill 24. A plurality of angularly separated recesses 40 are provided in the interior surface of the bushing. The recesses 40 are connected via supply conduits 42 to a distribution header 44, which in turn is connected to a high pressure oil supply 46. The high pressure oil sup-
plied to the recesses 40 creates discrete pressure fields 48 acting to urge the quill into concentric alignment with the bushing, where it is held, irrespective of the speed at which the quill is driven, during continued operation of the laying head. Eccentricity is thus eliminated, or at least minimized to tolerable levels. The discrete pressure fields 48 also serve, during start up, to lift the journal surface of the quill from the bushing surface, thus reducing friction and eliminating the need for increased starting torque.

[0020] Preferably, at least three recesses 40 are provided in the bushing 38. Preferably, the recesses are equally spaced around the bushing circumference.

[0021] In light of the foregoing, it will now be appreciated by those skilled in the art that by employing a hydrostatic oil film bearing in accordance with the present invention, the quill can be maintained in substantially constant concentric alignment with the bushing, and this can be achieved independently of the speed at which the laying head is being operated. Thus, vibration problems due to whirl in hydrodynamic bearings and clearances in mechanical roller bearings are eliminated or at the very least, significantly minimized to an extent that they no longer impede high speed operation of the laying head. This is achieved with the added benefit of relatively low starting friction.

[0022] The foregoing description has been set forth to illustrate the invention and is not intended to be limiting. Since further modifications of the described embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the scope of invention should be limited solely with reference to the appended claims and equivalents thereof.

What is claimed is:

1. A rolling mill laying head comprising:
   a quill rotatable about a central axis;
   a guide pipe carried by said quill and configured and arranged to form a longitudinally moving product into a continuous series of rings;
   a stationary support structure; and
   axially spaced bearings supporting said quill for rotation about said axis, at least one of said bearings comprising a hydrostatic oil film bearing.

2. The laying head of claim 1 wherein said hydrostatic oil film bearing comprises a bushing surrounding a journal surface of said quill, a plurality of angularly separated recesses in said bushing, and means for supplying an oil under pressure to said recesses to thereby create discrete pressure fields acting on said journal surface to urge said quill into concentric alignment with said bushing.

3. The laying head of claim 2 wherein at least three of said recesses and associated pressure fields are provided in said bushing.

4. The laying head of claim 3 wherein said recesses are equally spaced around the circumference of said bushing.

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