(51) International Patent Classification: F16C 13/00.

(21) International Application Number: PCT/FR02/00325

(22) International Filing Date: 18 April 2002 (18.04.2002)

(55) Invention Title: APPARATUS FOR CONTROLLING VIBRATION OF ROTATING ROLLS

(57) Abstract: An apparatus to observe the vibration of rolling rolls (3), (4) and to control the vibration, during operation, the apparatus comprising a frame (1), into which the bearing housings (7) of both rolling rolls are fixed, a rotary system of the rolls and a system to move and support the bearing housings of the rolls and to produce nip forces and supports between different rolls. The bearing housings of first roll (4) are by means of first upper arm (5) supported in frame, which arm being from its one end fixed to the frame by a joint and the other end of said upper arm fixed to the frame by means of a load cell (10), and further, the apparatus has a separate locking unit (8) loading said end against said load cell and the bearing housings of the second roll (3) are supported in frame by means of the second lower arm (2), which arm is from its one end fixed to the frame by a joint, and further, to support said lower arm with respect to frame the apparatus has a knee-joint linkage (9) affecting the magnitude of nip force and supporting the second arm, the knee-joint of which linkage is affected by a force required in order to increase or decrease the angle of the knee-joint.
Published: with international search report

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APPARATUS FOR CONTROLLING VIBRATION OF ROTATING ROLLS

The invention relates to an apparatus for controlling the vibration of rolls rotating in contact with each other during operation, whereby the apparatus comprises a frame, to which the bearing blocks of both rotating rolls are attached, an arrangement to rotate the rolls and an arrangement to move and support the bearing housings of the rolls in order to produce nip forces between different rolls and supports for the rolls.

Previously known are, among others, from the Finnish patent specification FI-101322, a framework for calenders, where the calender rolls are pressed against each other by a hydraulic cylinder affecting the bearing housings of the rolls. The bearing housings of the uppermost roll, among the bearing housings of the rolls, are firmly fixed to vertical pillars and the attachment of the lowest roll is by means of sliding guides carried out in vertical pillars so that in controlling the push force of the cylinder the nip force can be controlled that presses the rolls against each other and is direction the bearing housings of the lower roll.

By means of such a solution nip forces of different magnitudes can be produced in adjusting the hydraulic pressure. However, by means of the solution the stiffness of the system, for instance to avoid vibration, cannot be controlled. Supports or mutual flexibilities between bearing housings and frame cannot be adjusted.

Although wanted, with load cylinders the lower roll cannot be supported, e.g. flexibly or rigidly, since the cylinder has only a bearing power controlled each time by means of hydraulic pressure.

To be able to observe and control the vibration of rolls, to change the flexibility and stiffness of the system and to change the suspension of the bearing housings, one has arrived at a new solution regarding the suspension of bearing housings, which solution is characterized in that the bearing housing of the first roll is by means of the first arm supported in the frame, which arm is from its other end fixed to the frame by a joint and the first end supported in the frame by means of a load cell and, further, the apparatus has a locking unit loading said end against said load cell, and the bearing housing of the second
roll is supported in the frame by means of another arm, which arm is from its other end fixed to the frame by a joint, and to support the second arm in the frame there is in the apparatus a knee-joint linkage affecting the magnitude of nip load and supporting the second arm, the knee-joint of which linkage is affected by a power required to increase or decrease the angle of the knee-joint.

Other embodiments of the invention are presented in the dependent claims.

The advantage of the apparatus as per this invention is that both by normal operation of the apparatus and by dynamic tests of the apparatus the stiffness properties of the system can be modified. The same loading device can support the roll either stiffness or flexibly, while keeping the nip load unchanged. On the other hand, the nip load is fully adjustable and, similarly, different support stiffnesses of roll can be freely chosen for each chosen nip load. The apparatus is suitable for dynamic examination of calenders and for continuous use in a production plant, whereby the system stiffness can be easily changed, while the rotation speeds of rolls are changing, on changing the nip load or, when for instance, as a result of wear due to long term operation, the stiffness of system must be changed to avoid vibrations.

In the following the invention is disclosed with reference to the enclosed drawing, where Fig. 1 is the apparatus viewed from one end.

Fig. 2 is the apparatus and rotary system diagonally viewed from the side.

Figure 1 shows a calender with two rolls viewed from the end, whereby the first roll, i.e. the upper roll 4, has a bearing housing 7, by means of which roll 4 is fixed to first arm 5. Arm 5 is from its other end by means of a joint fixed to frame post 1. The other end of the first arm rests by means of load cell 10 on a support shelf in the post. By means of hydraulic cylinder 8 the first arm 5 can be loaded in pulling it against load cell 10.

The second roll 3, i.e. the lower roll, is by means of bearing housing 7 fixed to second arm 2. The second arm 2 is from its one end fixed to post 1. The other end of the second arm can move freely between the two supporting shelves of the right side post without touching
the support shelves during normal operation. The second arm 2 is supported by means of knee joint linkage 9. The joint linkage 9 is kept in a wanted angle $\theta$. The angle must be greater than zero.

By means of hydraulic cylinder 6 linkage 9 is pushed with the knee joint making the angle smaller in order to support second arm 2 and at the same time to produce nip load between the rolls. Stiffness i.e. flexibility of linkage 9 can be gained adjusting the knee joint angle $\theta$. When roll 3 and 4 dimensions remain constant and the attachment of first arm 5 unchanged, the knee joint angle $\theta$ is adjusted by increasing or decreasing the thickness of adjusting plate 15 underneath the lower knee joint bracket. The thickness of adjusting plate 15 is so chosen that it produces the angle $\theta$ wanted. If the aim is to retain same nip load, the hydraulic pressure of cylinder 6 must also be changed. The stiffness of the system grows, when the angle $\theta$ decreases, and flexibility grows, when the angle $\theta$ increases.

So that cylinder 6 would remain horizontal, the position of cylinder 6 is in regard to frame 1 adjustable in the vertical direction by means of set screws 16. Also between cylinder 6 bracket and frame 1 adjusting plates must be used if one wants to keep the cylinder piston position in cylinder, i.e. the distance of the cylinder bracket constant. Then also the hydraulic stiffness of cylinder remains constant, while knee joint angle $\theta$ is changing.

By choice of the cylinder 6 hydraulic pressure the nip force wanted can be produced. Cylinder 8 is the locking cylinder of upper arm 5 and the tractive force by which it pulls the upper arm 5 end against load cell 10 is chosen substantially greater than the nip force.

For instance, cylinder 8 can be replaced by a spring, as a cup spring set, weights or similar, which cause required pretension against load cell 10.

The nip force produced by cylinder 6 tends to lighten the load of load cell 10. The nip force can be counted from the load difference between cylinder 8 and load cell 10. Due to the solution first arm 5 and the bearing housing 7 of first arm 4 are tensioned, while rolls are rotating and first arm 5 having great stiffness.
To locking cylinder 8 a pressure accumulator can be added that allows cylinder 8 to yield if for some reason or other overloading occurs in the first roll. An overload situation occurs, when first arm 5 does not any more press load cell 10. Almost in this situation, at the latest, the locking cylinder 8 should be adjusted to yield against the pressure accumulator. By normal working situation arm 5 presses the load cell by substantial force. Detection of proper rigidity for the system is done after the assembly in choosing the angle $\theta$ and the pressures of cylinders 6 and 8.

Figure 2 shows an apparatus including rotary arrangements. Both rolls 3 and 4 are rotated by means of an own motor 14, a gearing 13 and an articulated shaft 11,12. The motor operations and the rolls form a torsional vibration system that receives impulses from tooth contact situations of the gearings, from torque formation of electric motors and from variations of the reeling resistance of roll covers. In order to control and observe torsional vibrations, between gearing 13 and the articulated shaft a coupling 17 has been installed, the flexing and damping qualities of which can be varied within limits wanted.

Control of nip force and retain of set value is adjusted, for instance in transmitting the signal out of load cell 10 to the proportional valve that controls the pressure of the pushing side (+) of cylinder 6. In the chamber of cylinder 6 secondary side (-) a certain pressure is maintained, if one wants to use said chamber to damp passive vibration.

The invention is not restricted to the enclosed embodiment but many modifications are possible within the inventional concept presented in the claims.
CLAIMS

1. An apparatus to control, during operation, the vibration of rolls (3),(4) rolling in contact between each other, the apparatus comprising a frame (1), into which the bearing housings (7) of both rolling rolls are fixed, a rotary system to rotate the rolls and a system to move and support the bearing housings (7) of the rolls and to produce nip forces and supports between different rolls, characterized in that bearing housing (7) of first roll (4) is by means of first arm (5) supported in frame 1, which arm being from its one end fixed to the frame by a joint and the other end of said arm fixed to the frame (1) by means of a load cell (10), and further, the apparatus has a separate locking unit (8) loading said end against said load cell and the bearing housing of the second roll (3) is supported in frame (1) by means of the second arm (2), which arm is from its one end fixed to the frame by a joint, and further, to support said arm (2) with respect to frame (1), the apparatus has a knee-joint linkage (9) affecting the magnitude of nip force and supporting the second arm, the knee-joint of which linkage is affected by a force required in order to increase or decrease the knee-joint angle $\theta$.

2. An apparatus according to claim 1 characterized in that the knee-joint linkage is adjustable into joint angles $\theta$ of different size for the time of support in order to produce different supporting stiffnesses.

3. An apparatus according to claim 1 characterized in that the nip force can be counted from the loading difference between locking unit (8) and load cell (10).

4. An apparatus according to any above claim 1 - 3 characterized in that the knee-joint linkage (9) supporting the second arm (2) is in the vertical line and the knee joint affected by the horizontal actuator (6).

5. An apparatus according to any above claim 1 - 4 characterized in that cylinder (8) is furnished with a pressure accumulator.

6. An apparatus according to any above claim 1 - 5 characterized in that cylinder (6) is double-acting and to both of its pressure chambers controlled pressure has been led.
7. An apparatus according to any above claim 1 - 6 characterized in that the control of the valve adjusting the pressure of cylinder (6) is arranged on basis of the signal received from load cell (10).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16C 13/00, D21G 1/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16C, D21G, F16F, B21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[ ] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents
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Date of the actual completion of the international search: 2 July 2002

Date of mailing of the international search report: 11-07-2002

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