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APPARATUS FOR RESISTING ROLL DEFLECTION

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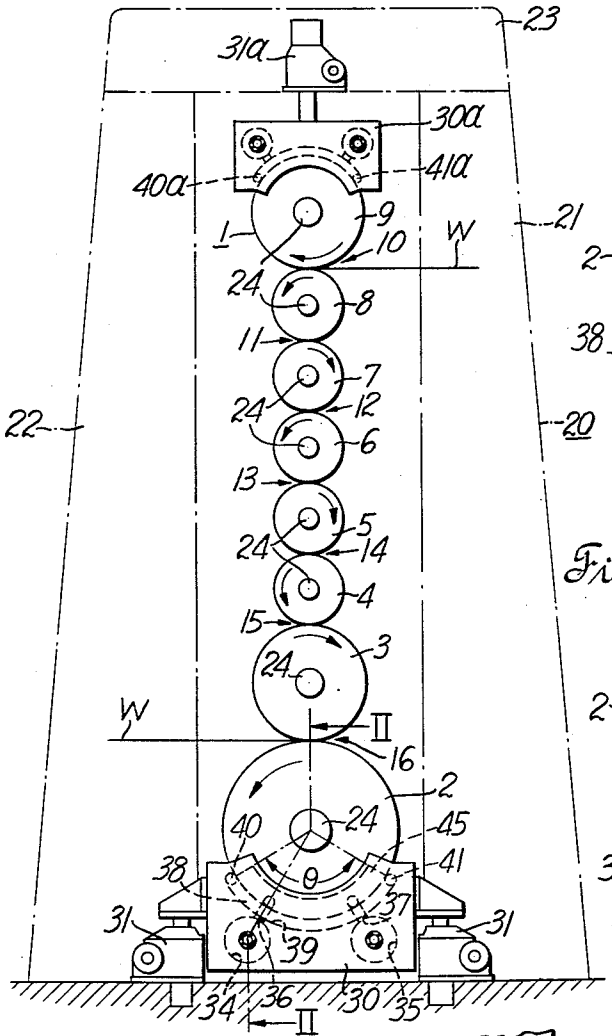


Fig. 1

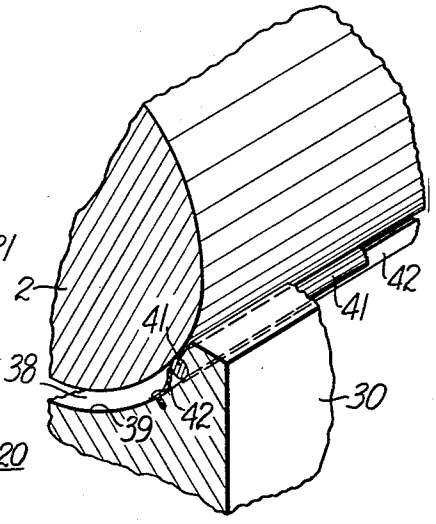


Fig. 3

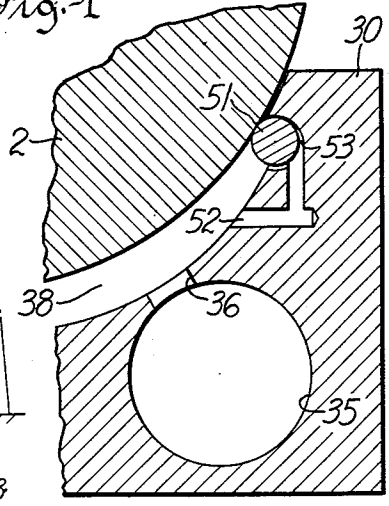


Fig. 4

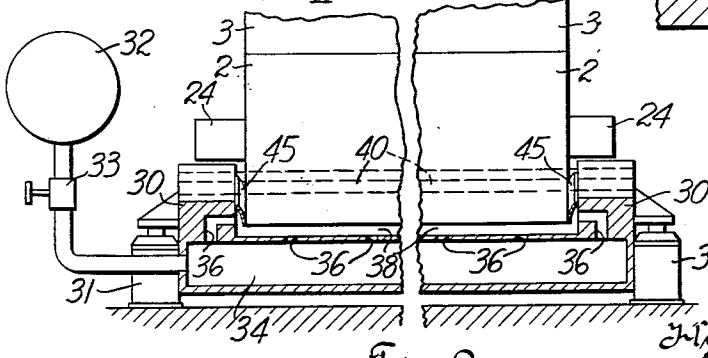


Fig. 2

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APPARATUS FOR RESISTING ROLL DEFLECTION

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This invention relates to an assembly of rolls for pressure treatment of materials passing therebetween, such as for example, a calender section of paper making or converting machine, and in particular to improved control of the nip between such rolls.

It it well understood in paper making and many other arts that if material is fed between cylindrical rolls having absolutely parallel surfaces defining a nip therebetween, the presence of the material and the external load applied to the rolls will tend to cause the rolls to bow apart. This results in pressure being applied unevenly to the material passing between the rolls. According to a practice of the prior art, parallel nip defining surfaces were achieved when material passed between the rolls by making the rolls slightly crowned in the middle. The load applied to the rolls by material passing therebetween then deflected the rolls sufficiently to straighten the nip defining surfaces of the rolls.

While the described practice of the prior art is successful in maintaining uniform spacing of the rolls at the nip with material passing through, there are several disadvantages to this approach. One disadvantage of crowning rolls results from the additional cost and effort involved in making rolls with a proper crown. A second disadvantage results from the fact that crowned midportion of the roll, with its greater diameter, has a greater peripheral speed (in terms of feet per second) than has the end portions of the roll. This can, for example, when such rolls are used to calender paper, result in streaks in the paper. A third disadvantage is that the crown can only be made for one particular external loading. Any deviation from this results in imperfect nips.

The present invention achieves uniform spacing of rolls at the nip without incurring the aforesaid disadvantages. According to the present invention, fluid pressure is applied externally to an uncrowned roll along substantially its entire axial extent and from a direction that opposes the tendency to deflect when material passes between such an uncrowned roll and another roll.

Other features and achievements of the invention will appear from the following more detailed description of the invention with reference to the accompanying drawing, in which:

FIG. 1 is an end view of a calender stack embodying this invention;

FIG. 2 is a view in section taken along line II—II in FIG. 1 and as viewed in the direction indicated by arrows;

FIG. 3 is an enlarged fragmentary view of a portion of the structure shown in FIGS. 1 and 2; and

FIG. 4 is a modification of the structure shown in FIG. 3.

As shown in FIG. 1 a calender stack indicated generally by reference number 1 which comprises a bottom roll 2 and a plurality of superimposed calender rolls 3 through 9, defining a series of nips 10 through 16. A web W passes into nip 10 between rolls 8 and 9, around roll 8 through nip 11, around roll 7, etc., until the web finally passes through nip 16 between rolls 2 and 3. A supporting frame 20 is provided which may be any of the suitable types well known to the trade. The particular type of frame outlined with phantom lines is known to this art as an A-frame, so named because it comprises side portions 21, 22 and a top portion 23 having the general configuration of a letter A. Journals 24 on each end of each roll are fitted in vertical guides (not shown) that permit some free vertical movement of the rolls.

The bottom roll 2, known in the trade as the calender king roll, is cradled beneath its entire length (in an axial direction, as shown in FIG. 2) by a fluid pressure bearing housing 30. Housing 30 is supported relative to a foundation by a jack screw assembly 31 at each of the four corners of the housing. The jack screw assemblies are operative to level housing 30 and the rolls supported thereon.

The housing 30 is constructed to define chambers, a cavity and passages that will now be described.

Housing 30 has internal wall structures 39 that define a pair of plenum chambers 34, 35 which are supplied with a fluid under pressure from a source 32 and under the control of suitable pressure adjusting means 33. Air would be a suitable fluid and the amount of pressure needed will be dictated by operative requirements to be described, but may be expected to be within a range of from 30 to 100 p.s.i. delivered at a rate of from 50 to 200 c.f.m. A plurality of discharge passages 36 from chamber 34 and a plurality of discharge passages 37 from chamber 35, deliver fluid pressure from chambers 34, 35 to a cavity 38. The cavity 38 also is defined by the internal wall structure 39. Cavity 38 has an arcuate configuration subtending an integral angle 0 of about 120 degrees with 60 degrees on each side of a plane defined by the central axes of rolls 2 and 3. Roll 2 is cradled in housing 30 and supported at least in part by fluid pressure within cavity 38. Suitable sealing arrangements must of course be provided between bearing housing 30 and the peripheral and end portions of roll 2, in order that cavity 38 be sealed sufficiently tight to capture fluid pressure therein to act upon the roll 2.

To seal the peripheral surface of roll 2 to housing 30, a pair of round rods 40, 41 are journaled in housing 30. The rods 40, 41 may be made of, coated with or encompassed with a sleeve of, a suitable nonlubricant requiring rubberlike bearing material. One example of a suitable material is a material known in the trade as Teflon. As shown in FIG. 3, rod 41 makes rolling contact with roll 2 to provide support for roll 2 with relatively fluid tight contact therebetween. A flexible doctor 42, shown in FIG. 3, made of such flexible bearing material as described with reference to rod 41, may have a portion secured to wall structure 39 and another portion engaging the rod 41. Fluid pressure within cavity 38 will hold doctor 42 against rod 41 to seal the small clearance space required between the rotatable rod 41 and housing structure 30. As shown in FIG. 4, a rod 51 makes rolling contact with roll 2 and is air loaded to maintain sealing contact therebetween by air from cavity 38 through passage 52 to cavity 53. A small and inconsequential amount of leakage is permitted through a clearance between rod 51 and adjacent portions of housing 30 that define cavity 53. Such clearance may suitably be about 0.001 inch.

A seal between the housing 30 and the end portion of roll 2 may be provided by a flexible member 45 (see FIG. 2) which may be made of the same or similar material as the doctor 42. The member 45 is secured to housing 30 and will be held against the rotating roll 2 by fluid pressure in cavity 38, as fluid pressure in cavity 38 holds doctor 42 against rotating rod 41.

A bearing housing 30*a*, constructed similarly to bearing housing 30, may be suspended by jack screw assemblies 31*a* from the top portion 23 of the frame 20. The jack screws 31*a* will be adjusted to maintain desired sealing contact between rods 40*a*, 41*a* and the periphery of roll 9.

In the operation of the calender shown in the drawing, passing the web W into nip **10** between the pair of rolls **8**, **9** tends to cause roll **9** to bow upwardly and roll **8** to bow downwardly. The web next passes into nip **11** between rolls **7** and **8** where there is a tendency to bow roll **8** upwardly and roll **7** downwardly. Roll **8** therefore is exposed to substantially equal forces tending to bow it both upwardly and downwardly and therefore a roll **8** remains substantially unbowed. However, top roll **9** and bottom roll **2** (the "king" roll) have the web passing only beneath the former and over the latter so such tendencies are not canceled out. The manner in which the present invention operates to resist such tendencies to bow the top and bottom rolls in the stack is substantially the same and therefore the operation will be described in detail with respect to but one of these rolls, the king roll **2**.

By way of example, the king roll **2** in a calender, such as shown in the drawing, may have a diameter of 30 inches and a working surface width of 100 inches. The cavity **38** may face 120 degrees of roll surface, which for a 30 inch diameter roll would be subtended by a chord of approximately 26 inches. Then sufficient compressed air may be delivered to the plenum chambers **34**, **35** for discharge through passages **36**, to provide within cavity **38** enclosed by roll **2**, about 150 cubic feet per minute at about 30 pounds per square inch. This upward force of 30 p.s.i. multiplied by the product of the chord of cavity **38** (26 inches) times the effective roll width (100 inches) will provide an upward force of 78,000 pounds to resist the tendency of roll **2** to bow downwardly. A similarly appropriate rate and pressure fluid may be delivered in like manner to bearing housing **30***a* over roll **9** to resist the tendency of roll **9** to bow upwardly. The pressures and rates of flow of fluid to both bearing housings **30**, **30***a* may be adjusted to achieve desired uniform spacing of adjacent roll surfaces that act to define a nip therebetween. Devices and procedures for achieving variation in the delivered pressure and flow rate for suitable fluids, such as air, are well known to this and many other arts.

With the structure and operation thereof, both described, the present invention achieves the desired result of eliminating the need for crowned rolls and the disadvantages attendant therewith. Other achievements and advantages will perhaps occur to those skilled in this art. Likewise, variations in the manner such achievements and advantages are achieved will, perhaps, occur to those skilled in this art without departing from the spirit of the present invention and it is therefore intended that the scope of the invention be limited only by the scope of the claim appended hereto.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

In an assembly including a first roll and a second roll arranged in axially parallel alignment to define a nip therebetween for pressure treating material passing through the nip, a bearing housing having internal wall structure defining a cavity enclosed by a portion of the periphery of the first of the rolls, the cavity being disposed on a side of this first roll opposite the nip, fluid pressure delivery means associated with the housing to deliver fluid pressure to said cavity to direct force of the fluid pressure upon the portion of the roll enclosing said cavity, a seal between the wall structure defining the bearing cavity and the surface of the roll enclosing the cavity, which includes a rod parallel to the roll with rolling contact between the outer convex surface of the rod and the outer convex surface of the roll, with the diameter of the rod being at least equal to the radial dimension of said cavity radially outward of the roll surface, and said housing defining a passage from the cavity to the side of the rod opposite the roll and the cavity to direct pressure from the cavity to maintain the aforesaid contact.

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