BENDING COMPENSATED ROLL FOR A CALENDER

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References Cited
UNITED STATES PATENTS
242,058 5/1881 Schurmann

2 Claims, 5 Drawing Figures

ABSTRACT

A roll for a calendar, which roll has compensation for bending forces which in operation will be applied between the ends of the roll by pressure of material in a roll gap between the roll and a further roll, said compensation being provided by forming the roll with a core and a shell with resilient means interposed between the core and the shell, the resilient means preferably comprising pieces of steel tubes all having the same outside diameter but inside diameters which reduce progressively from the ends of the roll towards the middle thereof.
BENDING COMPENSATED ROLL FOR A CALENDER

The invention relates to a roll for rolling out plastics material to form a web of sheeting in a calender or roll mill.

With interacting calender rolls, the rolls bend when material passes between them, so that the gap between the rolls is wider in the middle than at the two ends. If the material has a high resistance to deformation and the diameter of the rolls is small relative to their length, then there is a large amount of bending or vice versa. Some bending, however, always takes place and is a great disadvantage in all working processes.

Compensation for bending of the rolls if of great importance, particularly in the manufacture of plastics sheeting.

The previously proposed barrelling of the rolls has the disadvantage that, once the rolls have been formed with determined barrel shapes, it is only under a specific load that the rolls can produce a sheet which is equally thick across the whole width of the web. Unless additional means are used, it is therefore not possible, given a determined degree of barrelling of the rolls, to manufacture different types of sheet with practical tolerances.

Giving the rolls a variable offset can partly deal with these difficulties; but this involves a large industrial outlay thereby making the calender considerably more expensive.

It has been proposed to apply counter bending forces to the rolls in order to compensate for uneven sheet thicknesses. Thus, one roll, or two rolls as a pair, can be braced by tensioning forces generated by hydraulic cylinders and acting on auxiliary bearings provided on the rolls outside the actual roll bearings. Such bracing is directed towards the gap between the rolls and is equivalent to the amount of bending caused by the pressure of material in the gap. The counter bending of a roll, however, has the disadvantage that the main roll bearings have to withstand the counter bending forces as well as the gap forces resulting from the calendering process and this leads to considerable overloading and hence to far more rapid wear on the bearings.

The invention has among its objects to provide a calendering roll, the surface of which, in the region of a bending load applied by material in the gap between the rolls of a calender, is a straight line from one end of the roll to the other at any bending load.

According to the invention, there is provided a roll for rolling out plastics material to form a web of sheeting in a calender or roll mill, wherein the roll comprises a core, a shell and resilient means interposed between the core and the shell at regular intervals around the core, the resilient means compensating for bending of the roll caused by material being rolled, permitting linear supporting of the shell on the roll core, and having a spring force which increases from the ends towards the middle of the roll commensurately with the bending characteristic of the core.

Preferably the resilient means are pieces of resilient metal tubes arranged at regular intervals between the core and the shell and the spring forces thereof are adapted to compensate for the bending of the core produced by the bending force in the gap between the roll and a cooperating further roll, by means of a progressive reduction in the internal diameters of said pieces of resilient metal tubes from both ends of the roll towards the middle of the roll, and a constant external diameter.

This measure provides an advantageous solution to the problem underlying the invention, since it ensures that, when the core of the roll is bent by the pressure of material in the gap between the rolls, the resilient means between the shell and the core will yield more at the ends of the roll than in the middle of the roll, thereby compensating for the bending of the core, which is less at the ends of the roll than in the middle.

The sheeting will show no variation in thickness, or only extremely slight variation, if the opposed roll also undergoes no appreciable bending. This may be taken to be the case, since the opposed roll of a calender has a stretching load applied to it from two sides.

The spring force of the resilient means between the core and the shell would be in a specific ratio to the bending of the core. The greater the bending of the core towards the middle of the roll, the greater must be the spring force of the resilient means between the core and the shell, towards the middle of the roll.

The compression characteristic (a measure of the stiffness of the spring) is understood as being a value equal to the force acting on the spring, divided by the extent of compression of the spring, i.e., \( C = \frac{F}{S} \), where \( C \) represents the spring force, \( F \) the force acting on the spring and \( S \) the distance by which the spring is compressed.

This measure virtually ensures that, on any bending of the core, the shell will form a straight line in the region of a bending load, in the gap between the rolls, since with such relatively slight bending there will be a proportional relationship between the bending of the core and the spring force. It should be emphasised particularly that the invention permits linear supporting of the shell on the core; this contributes much towards forming the straight line described by the shell from one end of the roll to the other in the region of the bending load, i.e. in the gap between the rolls of the calender.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is a cross-section through a roll according to the invention;

FIG. 2 is a plan view of part of the roll of FIG. 1 but without its shell;

FIG. 3 is a section taken on line III—III of FIG. 1;

FIG. 4 is a diagrammatic representation of the bending of the core and of the shell of the roll of FIG. 1; and

FIG. 5 is again a diagrammatic representation of the bending of the roll of FIG. 1, but under a greater stretching load.

Referring to FIG. 1, a roll has an outer shell 1 and a core 2. The shell 1 is spaced from the core 2 and supported over its whole length on the core 2 by pieces of tubing 3, 3a and 3b and pieces of steel rod 4. The pieces of tubing 3, 3a and 3b have different wall thicknesses, the pieces 3b with thinnest walls being provided at the ends of the roll, the pieces 3a with thicker walls nearer the middle and the pieces 3 with thickest walls nearest the middle. Right in the middle are the pieces of steel rod 4. The pieces of tubing 3, 3a and 3b and the pieces of rod 4 all have the same external diameter. The pieces of rod 4 and tubing 3, 3a and 3b are put together
or soldered in such a way that the walls of the tubing 3b become successively thinner and thinner towards the ends. The resultant tubes 3 are sealed at the ends by hemispherical caps 5a.

FIG. 3 shows how the pieces of tubing 3 lie on the core 2 in shallow grooves 3c, equally spaced over the whole periphery.

References 9 to 15 indicate the circuit of a heating medium, which circulates in the direction indicated by arrows. Thus, the heating medium enters at 9 through a tubular member positioned in the bore of the core 2, passes through bore section 10, radial openings 11, through the gaps between the tubing pieces, through radial openings 13 to the annulus 14, exiting from the roll through line 15.

The sealing of the roll to prevent the heating medium from leaking out is provided by seals 5, metal bellows 6 and stops 7, which allow relative axial movement of the core 2 and the shell 1 and only slightly inhibit radial movement between them. The shell 1 is secured against relative rotation with respect to the core 2 by means of adjusting springs 8, which also allow axial movement between the core 2 and the shell 1.

FIG. 4 shows how the resilient pieces of tubing 3, 3a and 3b represented as coil springs are compressed when loaded, causing them to act as springs. The thinner the walls of the tubing 3, the lower is the spring force thereof. Thus, relatively weak springs 3b are provided at the ends, progressively stronger springs 3a are provided towards the middle and strongest springs 3 are provided immediately adjacent the middle. The pieces of rod 4 are presented by a non-resilient block 4.

A datum line 19 is plotted at the points of maximum bending at the middle of the roll, and from this line the differences in bending are measured.

When a bending load 17a is applied to the roll, the core 2 is flexed along a bending line 16. The spring forces selected for the individual pieces of tubing must enable them to be compressed just enough to cause the shell 1 in the region of the bending load to lie at every point no higher and no lower than in the centre. This means that at the place where there is a bending difference 21 the extent 22 of compression of the spring must be equal to the deflection 21 of the core 2.

At the location of a deflection 23 of the core 2 the extent 24 of compression of the springs must be equal to that deflection.

FIG. 5 shows that both the deflections 26 and 28 under a bending load 17b and the extent 25 and 27 of spring compression are proportionately greater than with the bending load 17a in FIG. 4. This means that the extent 25 of spring compression is again equal to the deflection 26 of the core 2, and the extent 27 of spring compression is equal to the deflection 28 of the core 2.

FIGS. 4 and 5 thus indicate diagrammatically that the shell 1 undergoes no bending in the region of the bending load, independently of the size of the load 17a and 17b and of the bending of the core 2. It will particularly be noted from these Figures that the compression characteristics of the springs of the resilient means between the core and the shell must be kept in a specific ratio to the bending of the core.

What is claimed is:

1. A roll for rolling out plastics material to form a web of sheeting in a calender, said roll comprising a core, an outer shell surrounding said core and spaced relative thereto, and resilient means interposed between said core and said shell at regular intervals around said core, said resilient means comprising pieces of resilient metal tubes longitudinally arranged and abutting in rows at regular intervals around said core, the internal diameter of the tubes in each row decreasing from the ends of said rolls toward the center of said roll, said metal tubes having a constant external diameter so as to provide linear support of said shell on said core, said rows of tubes thereby providing a spring force which increases from the ends toward the middle of said roll commensurately with the bending characteristics of said core.

2. The roll of claim 1 wherein said core is formed with longitudinal grooves at spaced intervals around the outer periphery thereof, said tubes being positioned in said longitudinal grooves.

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