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(54) **Device and procedure for adjusting the diameter profile of a calender roller**

(57) The present invention concerns a device for adjusting the diameter profile of a roller (3) of a calender (1), comprising:

- means (9) for sensing the transverse thickness profile of a film (2) coming out of a calender (1) and for providing a signal corresponding to the thickness of the film (2);
- a pressurised air source (6);
- a number of nozzles (5), communicating with the pressurised air source (6), designed to direct the air

towards the roller (3);

- means (7) for selectively adjusting the temperature of the air coming out of each nozzle (5);
- means (8) for selectively regulating the flow rate of the air coming out of each nozzle (5);
- means (10) for operating said means (7) and (8) for selectively adjusting the temperature and air flow rate of each nozzle according to the signal corresponding to the thickness of the film coming out of the calender.

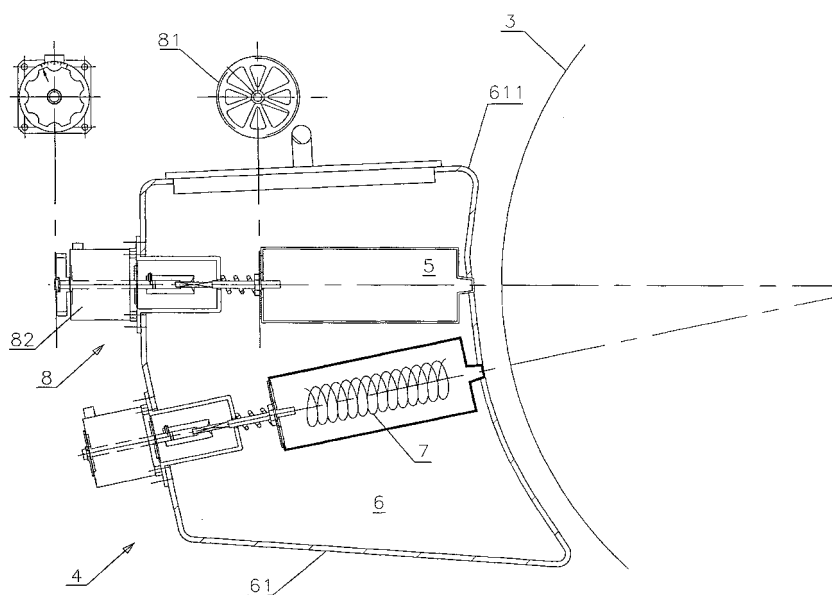


Fig. 3

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Description

[0001] The technical sector to which the invention refers to, is that of devices for adjusting the diameter profile of a calender roller, better known as "calijet".

[0002] It is known that the physical characteristics of material in film - thickness, density, surface roughness etc. - can be appropriately modified by means of a calendering process.

[0003] In fact, systems for the production of material in film normally comprise a calendering station.

[0004] Materials in film that have been calendered, the thickness profile crosswise to the direction of movement of the film is ideally constant but in reality tends to be irregular due to, in particular, mechanical deformations of the calender rollers as a result of the stress as to which they are subjected and to the working tolerances of the rollers.

[0005] To remedy this problem, the diameter profile of at least one of the calender rollers is locally adjusted by means of thermal expansion.

[0006] The most widespread solution involves the selective heating and cooling of a calender roller via jets of hot and/or cold air directed at local areas of the roller to cause local expansion or shrinkage.

[0007] Local adjustment of the roller diameter permits adjustment of the local pressure between the coupled rollers and, therefore, local correction of the transverse thickness profile of the film.

[0008] In practice, a feedback circuit continuously measures the transverse thickness profile of the film and cools the parts of the roller where the film thickness is below the set value and, vice versa, heats the parts of the roller where the film thickness is above the set value.

[0009] The roller which is thermally expanded is usually made of steel, a material that has a thermal expansion coefficient of approximately 12 parts per million and is subject to a thermal range that can reach approximately 300°C.

[0010] In view of the fact that a calender roller can have a diameter of 400-700 mm, can mean that it is possible to obtain local adjustment of the roller diameter in terms of several dozens of µm.

[0011] US-A-3,770,578 (SPURREL) describes a device provided with a series of nozzles arranged parallel to the roller axis, which can be selectively connected to a source of pressurised hot or cold air.

[0012] The amount of heat or cooling units released is regulated by adjusting the air flow rate of the individual nozzles.

[0013] To prevent air from one nozzle affecting the temperature of the roller corresponding to the adjacent nozzles or to prevent correction of the profile in one part of the film leading to an error in the part where the film thickness profile is correct, SPURREL limits the heating (or cooling) effect of a nozzle by providing the simultaneous outflow of an adequate amount of cold (or hot) air from the adjacent nozzles.

[0014] As the jets of cold air are always accompanied by adjacent jets of hot air - in order to limit the effect of local cooling - the said device must obviously be able to deliver considerable amounts of thermal energy.

[0015] In addition, the said device requires adequate thermal insulation for the hot air tank and is complex and costly from the construction point of view.

[0016] Furthermore, regulating the flow rate of each nozzle affects the pressure in the pressurised air tank and consequently the flow rate of the remaining nozzles, making the regulation of the air flow rate for each individual nozzle inaccurate.

[0017] For this and other reasons the adjustment device described by US-A-3,770,578 is not satisfactory.

[0018] EP-B1-0 194 010 describes an adjustment device comprising a series of nozzles arranged parallel to the roller axis, connected to a single pressurised air source.

[0019] Suitable electrical resistances, positioned at the nozzle inlets or inside the nozzles, can selectively adjust the temperature of the air jet coming out of each nozzle, while the air flow rate is reliably constant.

[0020] The air temperature varies between the ambient temperature and a maximum temperature of approximately 300°C.

[0021] To restrict the diameter, the air is emitted without being heated.

[0022] In this device the nozzles also deliver air to the areas of the cylinder where the film thickness profile is within the pre-set tolerances, and which therefore do not require any adjustment.

[0023] To maintain the local diameter of the cylinder areas where the thickness is within the pre-set tolerances, adequately heated air must be supplied, since ambient temperature air would cause local cooling of the cylinder.

[0024] The said adjustment devices consequently use considerable energy consumption.

[0025] The aim of this invention is therefore to find a solution to the above mentioned problems.

[0026] The said problems are solved by means of a device which can adjust the diameter profile of a roller in accordance with the wording of claim 1 and by means of a procedure for adjusting the diameter profile of a roller in accordance with the wording of claim 5.

[0027] Particular forms of embodiment of the device can be produced in accordance with the wording of claims 2 - 4.

[0028] A possible form of embodiment of the device, in accordance with the patent claims, will now be described purely as a non-restrictive example, with reference to the attached drawings.

- Figure 1 is a schematic view of a calendering system provided with a device for adjusting the diameter profile of a roller according to the invention;
- figure 2 shows the transverse thickness profile measured on a calendered film and the difference

with respect to the set profile;

- figure 3 is a schematic axonometric drawing of the adjustment device in accordance with the invention;
- figure 4 is a schematic

[0029] With reference to the above figures, number 1 indicates, overall, a calender with an inverted L arrangement, into which a film 2 is fed.

[0030] Roller 3 of the calender 1 is designed to expand and contract radially due to thermal action.

[0031] Device 4 is provided to adjust the diameter profile of the roller 3 according to the transverse thickness profile of the film 2 coming out of the calender 1.

[0032] The said device 4 is provided with a number of nozzles 5, communicating with a pressurised air source 6, which direct jets of air onto the roller 3.

[0033] The nozzles 5 are arranged so that the air jets are directed onto adjacent sectors 31 of the roller 3 throughout its length; several nozzles can be directed at the same sector of the roller 3, in particular at the ends of the roller where natural cooling is quicker.

[0034] Means 7 are provided to selectively regulate the temperature of the air coming out of each nozzle and means 8 are provided to selectively regulate the air flow rate of each nozzle 5.

[0035] Means 9 provide an electrical signal, corresponding to the transverse thickness profile of the film 2 coming out of the calender 1, which, via a regulation and control system 10, controls the means 7 for selectively adjusting the temperature of the air coming out of each nozzle and the means 8 for selectively adjusting the air flow rate of each nozzle.

[0036] The device operates as follows:

- where the roller diameter profile does not require adjustment, the air flow rate is interrupted;
- where the roller diameter profile has to be reduced, the air is not heated and the air flow rate is regulated according to the difference between the thickness measured and the thickness set, and
- where the roller diameter profile has to be increased, the air flow rate is set at a maximum and the air is heated according to the difference between the thickness measured and the thickness set.

[0037] The advantages of this solution will be immediately evident to the skilled person, in particular the significant energy saving with respect to the previously known solutions.

[0038] According to the embodiment illustrated, the pressurised air source 6 comprises a stainless steel seal manifold 61, fed by a fan (not shown).

[0039] The manifold 61 is arranged parallel to the roller 3 and the nozzles 5 are provided on one face 611 with a half-bearing shape.

[0040] The length and radius of curvature of which depend on the length and diameter of the roller, which

forms an air space that channels the air coming out of the nozzles, increasing the contact time and, therefore, the efficiency of the convective exchange.

[0041] The depth of the air space is preferably 25-30 mm.

[0042] Several nozzles 5 can be provided on the same sector 51, in particular at the ends of the roller 3 where natural cooling of the roller occurs more rapidly.

[0043] The nozzles 5 are suitably arranged so that they are directed at the sectors of the roller with a width of 75 mm; assuming that the roller is 1800 mm long, then there will be at least 24 nozzles.

[0044] The working pressure inside the manifold 61 is substantially constant and is preferably between 15 and 20 mbars.

[0045] To maintain the pressure inside the manifold at substantially constant values, a drain valve can be provided (not shown).

[0046] The air inside manifold 61 is at a substantially constant temperature, preferably at ambient value.

[0047] Operating at a pressure of 15 mbars, the maximum flow rate of each nozzle is preferably 0.4 m³/min.

[0048] According to the embodiment illustrated, the nozzles 5 are tubular-shaped and the devices 7 for selectively adjusting the air temperature consist of electrical resistances 7 arranged inside the nozzles 5.

[0049] The minimum temperature of the air jet is to that of the manifold supply temperature, while the maximum temperature that can be reached is approximately 270°C, and the electrical power of the resistance of each nozzle can reach 1600 Watts.

[0050] According to the preferred embodiment, the nozzles 5 are arranged inside the manifold 61 and are provided with adequate thermal insulation to prevent the resistance affecting the temperature inside the manifold.

[0051] The devices 8, for adjusting the air jet flow rate of the nozzles 5, consist of shutters 81, controlled by a stepper motor 82, which regulate the inlet section of each nozzle 5.

Claims

1. Device for adjusting the diameter profile of a roller (3) of a calender (1), comprising:

- means (9) for sensing the transverse thickness profile of a film (2) coming out of a calender (1) and for providing a signal corresponding to the thickness of the film (2);
- a pressurised air source (6);
- a number of nozzles (5), communicating with the pressurised air source (6), designed to direct the air towards the roller (3);
- means (7) for selectively adjusting the temperature of the air coming out of each nozzle (5);
- means (8) for selectively regulating the flow

- rate of the air coming out of each nozzle (5);
 - means (10) for operating said means (7) and (8) for selectively adjusting the temperature and air flow rate of each nozzle according to the signal corresponding to the thickness of the film coming out of the calender. 5
2. Device, according to claim 1, in which means (63) are provided to maintain the pressure of the pressurised air source (6) constant as the air flow rate varies. 10
3. Device, according to claim 1 or 2, in which said means (7) for selectively adjusting the temperature of the air coming out of each nozzle (5), consist of electrical resistances positioned inside each nozzle and/or before the inlet of each nozzle (5). 15
4. Device, according to claim 1 or 2 or 3 in which said means (8) for selectively regulating the air flow rate of each nozzle (5) consist of shutters (81) controlled by a stepper motor (82). 20
5. Procedure for adjusting the diameter profile of a calender roller, comprising the following steps: 25
- sensing the transverse thickness profile of the film (2) coming out of the calender (1) and provide a signal corresponding to the film thickness; 30
 - provide a number of air jets directed towards the roller (3), selectively adjusting the temperature and air flow rate of each jet so that:
 - a) where the diameter profile of the roller does not require adjustment the air flow rate is interrupted; 35
 - b) where the diameter profile of the roller has to be reduced, the air is not heated and the flow rate is regulated according to the difference between the thickness measured and the thickness set, 40
 - c) where the diameter profile of the roller has to be increased, the air flow rate is at maximum and the air is heated according to the difference between the thickness measured and the thickness set. 45

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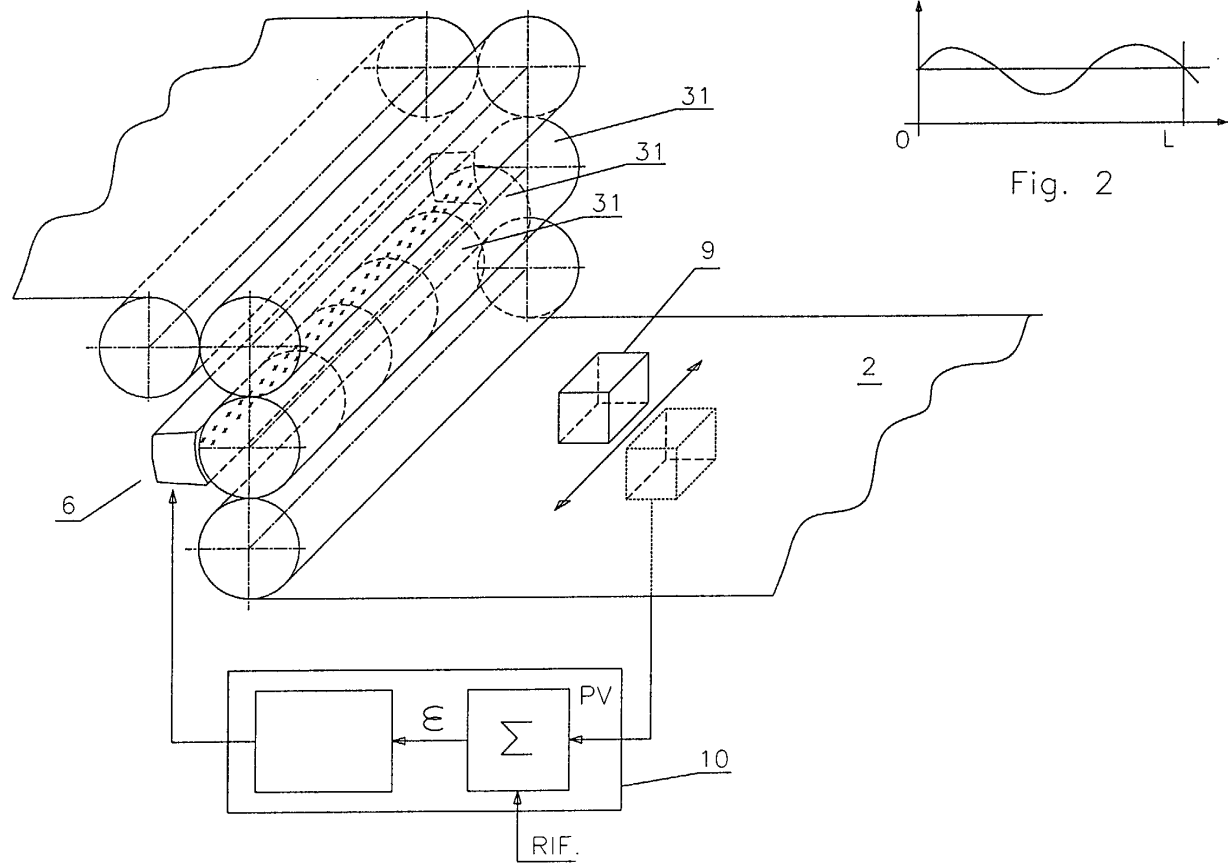


Fig. 1

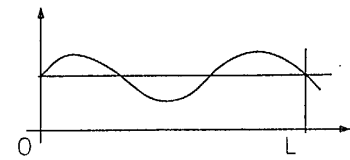


Fig. 2

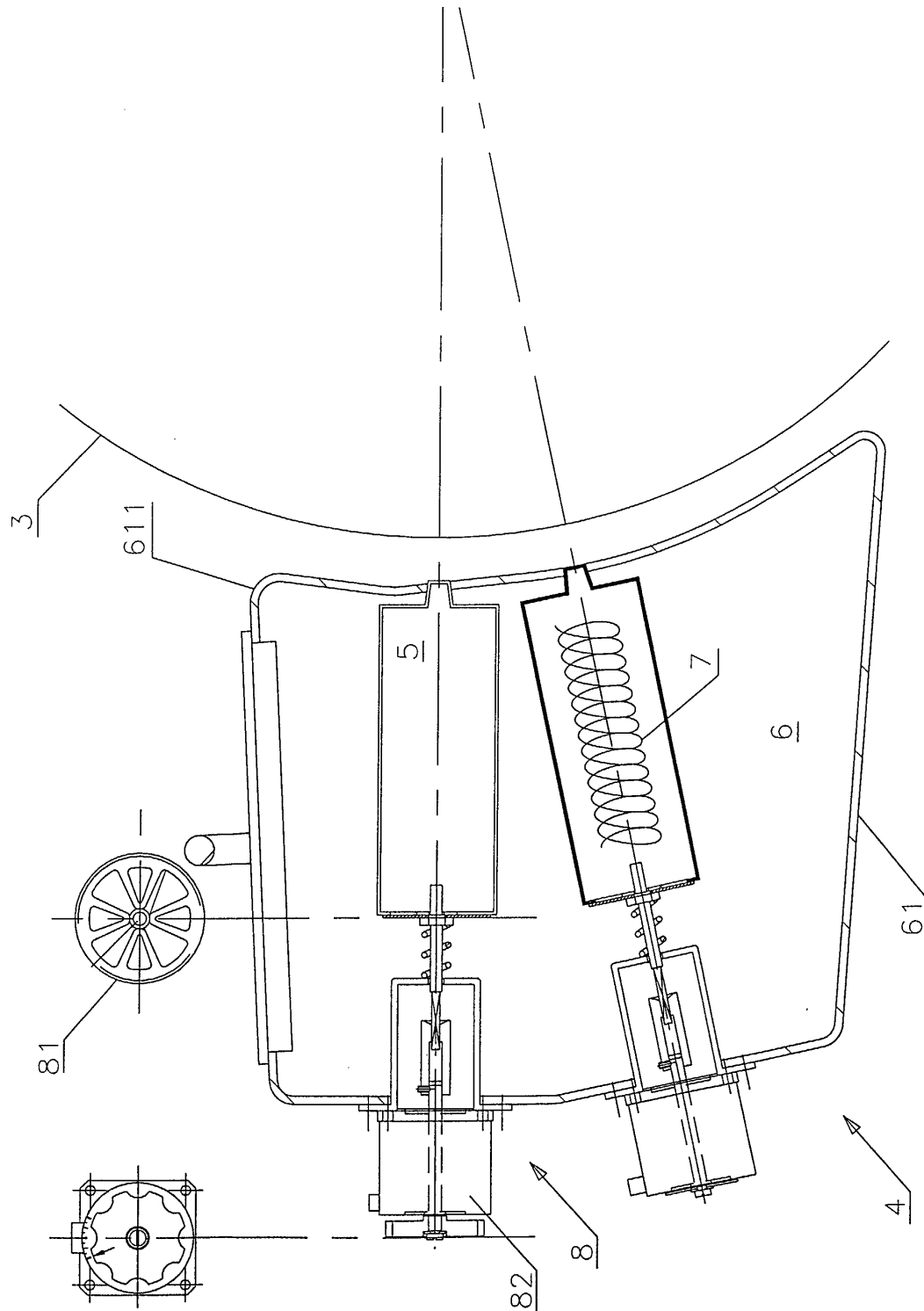


Fig. 3