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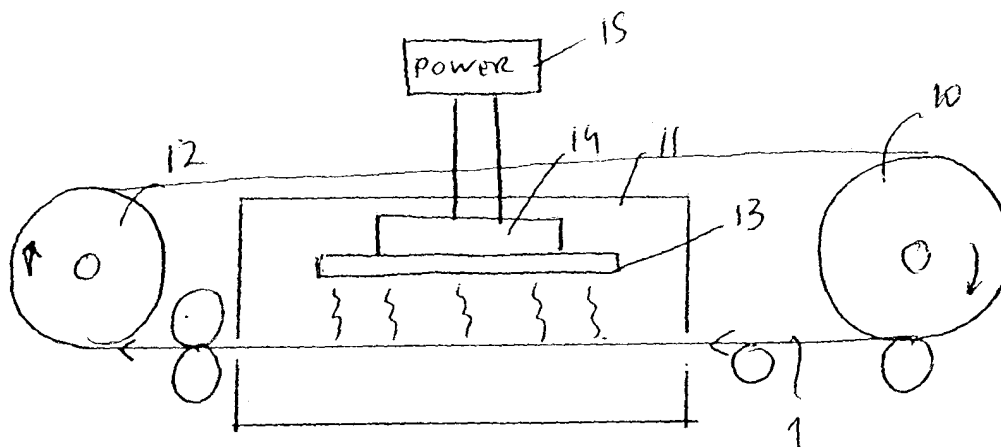
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(54) **Heat setting of fabrics**

(57) A woven or spiral link papermaking fabric (1) is passed through an oven (11) wherein at least one side is subjected to microwave radiation from a microwave radiation emitting device (13) which is powered by a magnetron (14) which is adapted to operate at a fre-

quency of from 100MHz to 300GHz with impedance mismatch and frequency offset between the magnetron (14) and emitting device (13) being controlled to prevent a thermal runaway. The fabric may be of microwave absorbent fibres or yarns or of fibres or yarns including a microwave absorbent additive such as titania.



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Description

[0001] This invention relates to the heat setting of fabrics as woven or spiral-link papermaking fabrics.

[0002] Heat setting is used to lock the woven or non-woven fabric structure to eliminate any possibility of stretching or deformation of the fabric on the machine during use. It comprises essentially of applying heat to the fabric whilst it is under tension and locking the stretched structure into position as it is cooled. The temperature to which the fabric is heated will lie between the glass transition temperature and melting point of the thermoplastic yarn material used in the fabric, so that the yarns are stretched by the tension applied by the heat setting machine. The combination of heat and tension also aligns the molecular chains in the yarns, thus improving tensile properties.

[0003] A typical heat setting installation may comprise two large spaced apart heated rolls around which the fabric, e.g. a press felt basecloth or a dryer fabric is driven at slow speed under tension. Typical examples of such machines are given in US 5,312,523; US 4,504,345 and US 4,495,714.

[0004] Also widely used are heat setting ovens, often 1 to 2 metres in length and heated to 100°C to 250°C, normally 150-220°C for papermachine clothing. The fabric will pass through the oven over a period of about one minute, and then leave the oven and pass through air at room temperature, optionally making a return run through a second similar oven at a slightly higher temperature.

[0005] For certain types of fabric such as carcasses for reinforcing tyres, a single oven split into different heating zones may be used. As the fabric leaves the oven it is cooled, e.g. by simply passing it through air, or over a cooled roll.

[0006] The key problem with heat setting is that it is a highly critical process, in both the heating and more particularly the cooling phases. Minute deviations from set parameters can lead to detrimental flaws in the fabric which may be severe enough to require scrapping of the fabric. The problem of control over cooling of the fabric is not significant for narrow fabrics, e.g. under 3 metres in width, but for very wide fabrics (3-15 metres) used for industrial belting such as papermaking fabrics, filter belts or conveyor belting, insufficient control of cooling due for example to uneven flow of air in the region where the fabric exits the oven, will lead to non-uniform locking of the fabric structure across the width of the fabric. This variation of the fabric structure makes the fabric very difficult to seam and in some cases the fabric will need to be seamed by hand rather than on an automatic or semi-automatic machine, which is a time consuming and highly complicated process. The phenomenon known as edge curl whereby the fabric edges curl up may also occur and this will require time consuming remedial action such as described in US 5,546,643. Poor heat setting also creates the problem of slack edges with

spiral link fabrics.

[0007] So critical is the cooling process that simply opening a window or door in the heat setting machine room can significantly deform the fabric structure.

[0008] It has been proposed to carry out heat setting of such fabrics by passing the fabric through a bath of heated liquid, and molten eutectic alloys on the one hand, and glycerol on the other have been proposed as suitable liquids.

[0009] The liquid is maintained at a temperature suitable for heat setting of the material, such as a woven or nonwoven fabric of yarns of polyester or polyolefin or polyamide synthetic materials.

[0010] The liquid immersion method has been found to be relatively slow, involving substantial dwell times of the fabric in the liquid bath, and also expensive in energy required to maintain the liquid in the bath at the required temperature.

[0011] It is an object of the invention to provide a method and apparatus for heat setting of fabrics, especially fabrics for use as papermachine clothing which will enable the heat setting to be carried out more quickly, with correspondingly shorter dwell times of the fabric in the heat setting apparatus, and an improvement in energy efficiency.

[0012] According to the invention a method of heat setting a fabric includes the step of subjecting the fabric to microwave energy in order to heat the material of the yarns in fabric to increase the temperature thereof and thus heat set the yarns.

[0013] The invention also includes apparatus for heat setting a fabric including microwave emission means for subjecting a fabric to microwave energy.

[0014] The microwave energy may be emitted with a frequency of 100MHz to 300GHz and the fabric during subjection to the microwave energy may be subjected to an air pressure of atmospheric, or just below atmospheric pressure.

[0015] The microwave emission may comprise a magnetron adapted to emit microwave energy at a frequency on the range 100MHz to 300GHz, and this is preferably housed in a shielded structure to prevent leakage of unwanted or hazardous microwave energy, through which the fabric is passed.

[0016] One or both faces of the fabric may be subjected to the microwave energy, simultaneously, or using a suitable fabric guidance system, in turn, or simply by using two separate microwave energy emitters.

[0017] It has been found that the use of microwave energy applied directly to the fabric achieves a much quicker heat setting effect than for example using the same energy to heat up and maintain a liquid bath at the required temperature. It has also been found surprisingly that yarn abrasion resistance is improved by heat setting under microwaves, which is of great benefit for papermaking fabrics as in particular it extends their useful life.

[0018] Any yarn material containing carbonyl or car-

boxyl groups such as a polyester or polyamide, or a blend containing them can be directly heat set by subsection to microwave energy. Where yarns which do not contain such resonant groups are used, such as polyolefins, microwave absorbing additives may be incorporated into the microwave-transparent polymers to render these materials capable of absorbing microwave energy, and thereby being heat set with their use. Examples of such absorbent materials include carbon black, ferrite, iron and titania. The proportion of absorbent filler may be from 0.1-40wt%, but preferably in the range 0.1-5wt%. The preferred range helps to reduce yarn embrittlement, and also reduces the colouring effect of the absorbent materials where such colouring would be undesirable.

[0019] Titania is a preferred material for use as a microwave absorbent, as it is widely used as a pigment for polyester or polyamide monofilament yarns used in papermaking fabrics, and thus will frequently not require to be added specifically for the purpose heat setting the yarns.

[0020] Heating of the yarns in the fabric is preferably regulated by control of a magnetron used to power the microwave heater. The characteristics of the magnetron which may be controlled include its loading behaviour, and the possibility of preselecting impedance mismatch and frequency offset between the magnetron and a resonant cavity applicator in the heater. This can prevent a so-called thermal runaway, when the polymer temperature approaches melting point. Such heating control can give better yarn cross-sectional heat treatment uniformity, so that the yarn is not for example softened on the outside with the core remaining solid.

[0021] An embodiment of heat setting method and apparatus will now be described by way of example with reference to the accompanying drawing, which is a diagrammatic side view of the apparatus.

[0022] In the method and apparatus of the preferred embodiment of the invention, an endless fabric 1 for heat setting is guided by end rolls 10, 12 and fed through a microwave radiation-proof enclosure or oven 11. The fabric may be cycled more than once through the oven 11.

[0023] Within the oven 11, the fabric 1 is exposed to microwave radiation emitting device 13 which incorporates resonant cavity applicator means, and is powered by a magnetron 14, which is in turn supplied with electrical energy from a power source 15.

[0024] The microwave energy is emitted at a frequency of from 100MHz to 300GHz, and the impedance mismatch and frequency offset between the magnetron 14 and emitting device 13 is controlled to prevent any thermal-runaway.

[0025] The fabric 1 may be a woven or nonwoven fabric, or a spiral link fabric, of a microwave absorbent polymer such as polyamide or polyester (or any other containing resonant groups such as carbonyl or carboxyl), or it may be composed of yarns or fibres of a microwave

transparent polymer such as a polyolefine, containing an absorbent filter in the range 0.1-5wt%. This filter may be titania which is often included in formulations as a white pigment and thus need not in most cases be specially included to act as a microwave absorbent.

[0026] Other materials which may be used as a microwave absorbent include carbon black frequently used as a black or grey pigment, ferrite, or iron.

[0027] The irradiation with microwaves can effect rapid heating to the required temperature for heat setting which is quicker than that effective by use of a bath of heated liquid.

[0028] Only one side of the fabric may be directly subjected to microwave radiation, but especially for multiply fabrics both surfaces may be irradiated, eg by using two, or successive microwave radiators.

Claims

1. A method of heat setting a fabric including the step of subjecting the fabric to microwave energy in order to heat the material of the yarns or fibres of the fabric to increase the temperature thereof and thus heat set the yarns.
2. A method according to claim 1 wherein the microwave energy is emitted in a frequency range of 100MHz to 300GHz.
3. A method according to claim 1 or 2 wherein the fabric is subjected to an air pressure equal to or below atmospheric pressure, during subsections to the microwave energy.
4. A method according to any preceding claim wherein one or both faces of the fabric are subjected simultaneously or in turn to the microwave energy.
5. A method according to any preceding claim wherein the yarn of fibre material contains carbonyl or carboxyl groups.
6. A method according to any one of claims 1 to 5 wherein microwave absorbing or resonant additives are added to microwave transparent polymers in the yarn or fibre material.
7. A method according to claim 6 wherein said microwave absorbing material is any one of carbon black, ferrite, iron or titania.
8. A method according to claim 7 wherein the microwave absorbing material comprises 0.1-5wt% of the yarn or fibre composition.
9. A method according to any preceding claim wherein a magnetron is used to power the microwave heater

and is controlled by control of its loading behaviour and by preselecting impedance mismatch and frequency offset between the magnetron and a resonant cavity applicator in the heater.

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10. Apparatus for heat setting a fabric comprises means for subjecting the fabric to microwave energy, including microwave emission means, and means for guiding the fabric through a zone wherein it is subjected to the microwave energy. 10
11. Apparatus according to claim 10 wherein the microwave emission means comprises a magnetron adapted to emit microwave energy at a frequency in the range of 100MHz to 300MHz housed in a shielded structure to prevent leakage and through which the fabric is passed. 15
12. Apparatus according to claim 10 wherein the fabric guiding means is disposed to enable each side of the fabric to be exposed in turn to the microwave emission means. 20
13. Apparatus according to claim 11 wherein said magnetron is arranged to be controlled in respect of its loading behaviour and/or preselection of impedance mismatch and frequency offset between the magnetron and a resonant cavity applicator in the heater. 25

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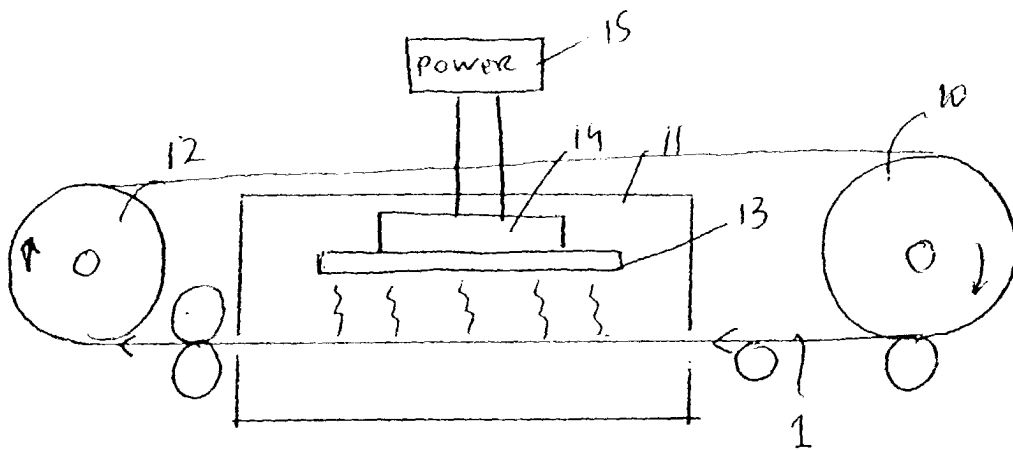
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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 5504

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 October 1999	Examiner Goodall, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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