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Applicant : **IMP- PAK PACKAGING CORPORATION**
1140 West Pender Street, Suite 1750
Vancouver, B.C. V6E 4G1 (CA)

Inventor : **Spratt, Gordon William**
6145 Collingwood Street
Vancouver, B.C. V6N 1T5 (CA)
Inventor : **Birmingham, Brian Donald**
975 Montroyal Boulevard
North Vancouver, B.C. V7R 4G9 (CA)

Inventor : **Wong, John**
1753 Amblegreene Drive
White Rock, B.C. V4A 6H3R 4G9 (CA)

Inventor : **Cunningham, Clarke**
3545 Wellington Crescent
North Vancouver, B.C. V7R 3B3 (CA)

Inventor : **Rimniceanu, Elizabeth**
51 South Warwick Avenue
Burnaby, B.C. V5B 3Y2 (CA)

Inventor : **Zepka, David**
502 Lymination Court
Louisville, Kentucky 40243 (US)

Inventor : **Bush, Nicholas**
607 East Main Street
New Albany, Indiana 47150 (US)

Inventor : **Wolfe, Norman**
202 Cheryl Drivereet
New Albany, Indiana 47150 (US)

Representative : **Andersen, Henrik Rastrup et al**
c/o Plougmann & Vingtoft Sankt Annae Plads
11 P.O. Box 3007
DK-1021 Copenhagen K (DK)

Coating composition containing cement for paper products.

A coating composition comprised of a cement, at least one of a clay and a sulphate, an aqueous emulsion polymer, and preferably an organic acid and a wax, which is degradable in a moisture active environment such as a landfill and which can be applied to degradable substrates to render the substrates water resistant is disclosed herein. Also disclosed is a method for applying the coating to a degradable substrate to prepare a stock product.

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TECHNICAL FIELD

This invention relates to coating compositions and processes for using the coating compositions. More particularly, this invention relates to cement-containing coating compositions which can be applied to paper products, and to processes for preparing and coating these products.

BACKGROUND ART

In recent years, increasing concerns have been expressed about the use of plastic containers, such as styrofoam containers, in the food industry. Plastic containers, such as those used in grocery stores and fast food restaurants to package food, are not degradable and, as a result, are contributing to the fill-up of landfills. In addition, when some plastic containers are manufactured or burned, harmful compounds are released into the atmosphere which cause pollution or which damage the ozone layer. For example, styrofoam is usually foamed by using chlorofluorocarbon blowing agents such as Freon 11 and Freon 12, which can damage the ozone layer. Thus, during the manufacturing of styrofoam, chlorofluorocarbons are usually released into the atmosphere. In addition, when styrofoam is formed using certain chlorofluorocarbons, such chlorofluorocarbon blowing agents will leak out of the styrofoam product during the life of the product. Due to these environmental concerns, there has been an increased interest in recent years in finding substitutes for food packaging plastic containers which are degradable and which do not result in the release of harmful substances when being manufactured or burned.

Although paper containers are degradable, a drawback to using paper containers instead of plastic containers for food is that paper absorbs moisture and grease leading to premature degradation of the container. Thus, in order for paper containers to be adequate substitutes for plastic containers in, for example, the food packaging art, it is necessary to treat the surface of the paper containers to render them substantially moisture-resistant.

It is known that paper products and containers can be rendered moisture-resistant by coating them with various polymers. For example, United States patent No. 3,573,125 discloses that coatings comprised of ethylene-vinyl acetate and wax have been used for years in the packaging field to coat various substrates, including paper. United States patent No. 3,704,157 discloses that paper sheets adapted for packaging can be coated with a copolymer of ethylene and vinyl acetate to impart high moisture barrier properties. United States patent No. 3,298,855 discloses a moisture-resistant wrapping paper prepared by coating paper with blends of polyethylene latex and vinyl acetate copolymer latex. United States pa-

tent No. 3,305,383 discloses that the moisture permeability resistance of paper board substrates used to prepare cartons can be enhanced by employing coating compositions containing wax and a copolymer of ethylene and vinyl acetate.

One problem in using polymer coatings to render paper articles moisture resistant is that the polymer coatings serve as a barrier to moisture once the articles are buried in a landfill and thereby inhibit the natural and, at this point, desirable degradation of the paper article. However, once the polymer coating breaks down, the paper article can degrade more readily. Thus, there is a need for a polymer coating which can be applied to paper substrates to render them moisture resistant and which will readily degrade so as to permit the degradation of the substrate. Ideally, such a coating would confer to the substrate the advantageous properties of polymer coating while the paper article is in use but would allow for degradation of the paper article after use.

Various compositions containing cement are disclosed in the prior art. For example, United States patent No. 3,063,851 discloses a cement-based paint comprised primarily of Portland cement admixed with a non-aqueous vehicle made up of a small amount of resin dissolved in an organic solvent. The cement-based paint is used to waterproof masonry walls. United States patent No. 2,600,018 discloses a Portland cement-based paint that can be used to coat porous fibre-board material. The Portland cement-based paint contains methyl cellulose.

Several patents disclose the use of an ethylene-vinyl acetate copolymer in conjunction with cement. For example, United States patent No. 4,434,257 discloses a cement composition which is comprised of a mixture of a conventional cement composition with an ethylene-vinyl acetate copolymer emulsion which contains a polyvinyl alcohol and a fatty acid ester of a polyvalent alcohol. The cement composition can be applied to buildings to improve water resistance.

United States patent No. 4,441,944 discloses a cementitious composition comprising a Portland cement, a polymeric emulsion and flyash. The composition can be foamed and applied to the surface of a sheet-like insulating board which can be made of fibrous cellulose.

United States patent No. 4,395,159 discloses a coating composition applied to a metal substrate to protect the substrate from deterioration. The coating composition comprises a cementitious material (such as Portland cement), a filler, a polymeric material (such as vinyl acetate polymers and copolymers) and chopped fibres.

United States patent No. 4,844,964 discloses that Portland cement can be mixed with water and an aqueous emulsion of polymers, such as ethylene vinyl acetate copolymers, and then used to prepare a signboard.

The prior art also discloses that vinous acids may be employed to retard the setting time for cement. For example, United States patent No. 4,892,586 discloses vinous organic acids or salts thereof which may be used as retarders for the setting or solidification of cements. United States patent No. 2,470,505 discloses that maleic acid can be added to a cement slurry to act as a retardant to lengthen the stiffening time. United States patent No. 4,054,461 discloses that hydroxypolycarboxylic acid may be used as a retarder in a cement composition, and United States patent No. 3,188,221 discloses that some organic acids may be used as retarding agents for retarding the setting time of cement. Canadian patent No. 638,274 discloses a cement product containing Portland cement and fatty acids.

However, none of the above-mentioned patents discloses a coating composition which can be applied to a degradable substrate such as paper to render the substrate moisture resistant during the substrate's useful life but which will readily degrade once the substrate is discarded, such as in a landfill, so that the substrate can then degrade and disintegrate.

DISCLOSURE OF THE INVENTION

It is an object of this invention to provide a novel cement coating composition which can be applied to degradable substrates such as paper and certain plastics.

Accordingly, in one of its aspects, the present invention provides a coating composition comprised of a cement, at least one of a clay and a sulphate (i.e. a sulphate salt), an aqueous emulsion polymer which is substantially stable in the presence of the other components of the coating composition, and preferably, at least one of an organic acid and a wax. In use, the coating composition is applied to a degradable substrate to render the substrate substantially water-repellant. Once the coated degradable substrate is discarded in a moisture active environment, such as a landfill, the coating composition will begin to break down, thereby allowing the substrate to degrade.

In another of its aspects, the present invention provides a process for manufacturing a coated product, preferably including a degradable substrate such as paper. The process comprises the use of a first coating composition including a cement, at least one of a clay and a sulphate, an aqueous emulsion polymer which is substantially stable in the presence of the other components of the coating composition, and preferably, at least one of an organic acid and a wax. This coating composition is applied to a first surface of the degradable substrate and then subjected to curing/drying. The coated article comprises the first coating composition coated on the first surface of the degradable substrate and a second coating composition coated on a second surface of the de-

gradable substrate. The second coating composition comprises from about 15 to about 60 percent by weight of a cement, from 0 to about 20 percent by weight of a clay or from 0 to about 10 percent by weight of a sulphate, wherein at least one of the sulphate or the clay is present, and from about 40 to about 75 percent by solids weight of an aqueous emulsion polymer which is stable in the presence of the other components of the second coating composition, wherein said percentages are based on the total solids amount of the cement, sulphate, clay and aqueous emulsion.

In this aspect of the invention, it will be understood that the second coating composition may be applied either before or after the first coating composition is applied. Furthermore, it should be understood that the second surface of the degradable surface may include a non-degradable layer on which the second coating composition is applied.

Yet another aspect of the present invention relates to the coated article produced using the present coating composition.

As used throughout the present application, the term "degradable substrate" is meant to encompass any material which has the ability to degrade, decompose or disintegrate. Such degradation may be the result of photodegradable or biodegradable (or both) properties which are present in the substrate. The properties may be inherent such as in many paper substrates or introduced such as in certain degradable plastics. Generally, the choice of substrate to which the present coating composition is applied is not particularly restricted.

The preferred substrate for use with the present coating composition is a degradable substrate. The preferred degradable substrate is paper owing to its relatively low cost. The following detailed discussion of the present invention is provided in the context of paper as the degradable substrate; however, it will be appreciated that the invention is not limited solely for use with degradable substrates, generally, and paper substrates, specifically.

The coating composition of the instant invention comprises a cement, preferably white Portland cement.

The coating composition also comprises a clay. The clay should be of extremely fine particle size and should consist of one or more clay minerals, including hydrosilicates of aluminum, iron or magnesium, and the like. Most preferred among the clays are the kaolin clays which include kaolinite dickite and halloysite-endellite. Clays are well known in the art and the appropriate clay for use in the present coating composition would be apparent to a person skilled in the art.

In addition to the clay, another component of the present composition is a sulphate, preferably, an alkali or alkaline earth metal sulphate, and most preferably, calcium sulphate.

The cements, clays and sulphates suitable for use in the coating composition are readily available commercially.

The coating composition also contains an aqueous emulsion polymer which, preferably, has FDA (or other appropriate governmental) approval, if the finished article is to be used in a food-type application. Any aqueous emulsion polymer which will impart water resistance to a paper substrate may be employed as long as it will not be degraded or otherwise break down at a relatively high pH or in the presence of a cement. Preferably, the polymer is a carboxyl functional emulsion polymer, such as acrylic, polyester, epoxy, vinyl, vinyl acetate, ethylene-vinyl acetate, or epoxy ester polymer or copolymer. Most preferably, the emulsion polymer is an ethylene-vinyl acetate aqueous emulsion copolymer.

The ethylene-vinyl acetate copolymers which are suitable can be prepared by copolymerizing a mixture of ethylene and vinyl acetate in the presence of a free-radical catalyst. Suitable ethylene-vinyl acetate emulsion compositions are readily available commercially. One example of a suitable emulsion copolymer is Airflex™ 100 HS latex, available from Air Products and Chemicals, Inc.

The present coating composition may further comprise a wax, preferably a wax emulsion, to aid in press release, and to retard water and other moisture absorption. The waxes which may be used herein may either be synthetic or naturally occurring. However, in order for the wax to carry out its intended function, it is important that it not degrade in the presence of the other components of the present coating composition. Among the waxes which may be used are included naturally occurring waxes such as esters of long chain fatty alcohols and acids, petroleum and mineral waxes. Among the common waxes which may be used are the vegetable waxes such as camauaba wax, candelilla wax, and hydrogenated candelilla wax. Other waxes include the synthetic waxes such as polyethylene waxes and paraffin waxes, these latter waxes being preferred.

The coating composition may also contain an organic acid, such as maleic, stearic, potassium hydrogen tartrate or oleic acid, or an organic sugar such as corn syrup, which serves to retard the setting time of the coating compositions. Difunctional acids are preferred. The presence of an organic acid in the coating composition helps to prolong the pot life and to make it easier to spray the composition onto a degradable substrate such as paper.

In addition to the above-described components, the coating composition may comprise one or more of conventional fillers, additives, thickeners, defoamers and pigments. Since the cement coating composition can be readily applied to paper substrates, such as vacuum moulded pulp food trays, and since pigments can be readily added to the coating composition, the

coating composition provides an easy means for colouring the surface of a paper substrate a particular colour.

Preferably, the coating composition is prepared by first combining the clay, the sulphate, the acid and the aqueous emulsion polymer in water. The cement should be added shortly before the coating composition is applied to a paper substrate since the coating composition has a pot life of up to 24 hours once the cement is added,

Generally, the coating composition will comprise: from about 40 to about 90 percent by weight cement, preferably from about 50 to about 75 percent by weight; from 0 to about 20 percent by weight of a clay, preferably from about 2 to about 10 percent by weight; from 0 to about 20 percent by weight of sulphate, preferably from about 1 to about 15 percent by weight; and from about 6 to about 60 percent by solids weight of the aqueous emulsion polymer, preferably from about 10 to about 40 percent by weight; with the proviso that at least one of the clay and the sulphate are actually present in the composition. All weights are based upon the total solids weight of aqueous emulsion polymer, cement, sulphate and clay in the coating composition.

In the event an organic acid or sugar is added, it should be added in an amount in the range of from about 1 to about 20 percent based on the above compositional weight. In the event a wax is added, it should be added in amount in the range of from about 1 to about 25 percent by weight solids level based on the above compositional weight.

Preferably, the coating composition is applied to a degradable substrate such as a paper substrate. More preferably, the paper substrate is prepared from recycled paper fibres. Most preferably, the paper substrate is a vacuum moulded paper article or container prepared from recycled fibres. The preparation of such paper containers and articles by vacuum moulding is known in the art. For example, suitable vacuum moulded articles can be prepared by employing the vacuum moulding machine and the process disclosed in United States patent No. 3,661,707. The coating composition may be applied to a paper substrate by any suitable means and, preferably, is applied by spraying the substrate with the coating. Generally, the coating is applied at a wet film thickness of about 2 to about 10 mils. The coating is then allowed to cure and dry.

In order for the degradable substrate to break down after it is discarded, it is necessary for the coating composition to break down and degrade so that the degradable substrate can degrade. The intact cement in the coating composition serves as a protective coating for the degradable substrate thereby inhibiting premature disintegration of the degradable substrate. Once the cement in the coating composition begins to break down and degrade, the degrad-

able substrate can also begin to degrade.

Disintegration of the coating, and thus of the degradable substrate, will occur when the degradable coating is placed on at least one side of the degradable substrate. Faster disintegration, of course, will occur when both sides of the degradable substrate are coated with the degradable coating. However, it is possible to coat one side with the degradable coating described herein and another side with a more conventional coating or a less degradable coating. In general, with food products a less degradable or non-degradable coating is placed on the side of the degradable substrate which will be exposed to the food product and the reverse side is coated with the composition described herein. The partially degradable compositions which may be used in conjunction with the coating compositions described otherwise herein simply involve the use of higher percentages of the coating composition of the emulsions described herein and lesser amounts of the cement and other components. When the cement and other components are totally removed, of course, the coating composition becomes essentially non-degradable.

A particularly preferred coating composition which still maintains certain degradative properties but which exhibits heightened resistance to liquids generally, and food liquids specifically, involves a coating composition comprising: from about 15 to about 60 percent by weight of a cement; from about 40 to about 75 percent by weight on a solids basis of an aqueous emulsion polymer; from 0 to about 20, preferably from about 1 to about 20, percent by weight of sulphate; and from 0 to about 10, preferably from about 1 to about 10, percent by weight of a clay, all as described above.

The present coating composition may be applied by conventional spraying or airless spraying, with or without electrostatic assist. In addition, electrostatic discs may be used to apply the coating composition.

Although not wishing to be limited to any particular theory or mode of the degradation of the cement in the present coating composition, it is believed that the sulphate (e.g. calcium sulphate) in the coating absorbs water and forms a complex with the kaolin which causes the cement to form a slush and the dried coating to break down. As a result of the presence of the sulphate, kaolin and cement in the coating, the coating will readily degrade and decompose within a few years in a moisture and, preferably, biologically active environment such as a landfill, thereby allowing the degradable substrate also to degrade.

Since the coating composition of this invention is non-toxic, it may be used to coat paper articles for food storage, such as vacuum moulded paper food trays used in the fast food industry. The paper containers coated with the coating composition have a semi-lustrous finish and smooth surface texture and are resistant to food juices and moisture.

Embodiments of the present invention will be described with reference to the following Examples which are provided for illustrative purposes only and should not be used to limit the scope of the invention. In the following Examples, all parts are by weight, unless otherwise specified.

Example 1

Components A and B were prepared as follows:

Component A

24.39 parts water were blended under agitation with 0.41 parts of a Natrosol™ 330 thickener available from Aqualon Co., 0.96 parts of Tamol™ 850 surfactant available from Rohm & Haas Co., 0.30 parts of ammonium hydroxide and 0.54 parts of Drewplus™ L140 defoamer available from Drew Chemical. Also added with agitation were 16.8 parts of Kronos™ 2020 titanium dioxide available from Kronos, Inc., 2.57 parts of Hitox™ titanium dioxide available from Hitox Corporation of America, along with 2.57 parts of burnt umber pigment and 14.98 parts of calcium carbonate. 20.74 parts of water, 127.99 parts of Airflex 100, an EVA emulsion (aqueous emulsion polymer) available from Air Products & Chemicals Company and 90.17 parts of Michemlub™ 368, a wax emulsion available from Michelman Chemical Co. were then added to the mixture.

Component B

17.95 parts of water were blended with 7.11 parts of corn syrup, 3.66 parts of ammonium hydroxide, 9.33 parts of potassium hydrogen tartrate, 9.33 parts of Tamol™ 850, 24.70 parts of Huber™ 35, a kaolin clay (clay), 9.89 parts of calcium sulphate (sulphate), and 1.08 parts of Drewplus™ L140. To this mixture was added a total 156.88 parts of tap water, and 459.88 parts of white Portland cement type I (cement).

Components A and B were then mixed together and exhibited a pot life of two hours. Over this period of time the mixture could readily be applied to reconstituted paper or cardboard flats by spraying as well as by other conventional coating means.

A coating of the Component A and Component B mixture was sprayed to a thickness of 3 mils on reconstituted paper plates using, in one case, a standard spray gun and, in another case, an electrostatic disc. The plates were dried in a 350°F oven. The plates were then placed in a platen press and heated at a temperature of 100° C and under 100 psi for about 1 second. A uniform, smooth coating resulted. The coatings degraded when placed in a moisture active landfill, i. e., a landfill containing sufficient moisture to degrade the coating in question over time.

Example 2

A two-component coating composition was prepared as follows:

Component A

69.12 parts of water were mixed with 1.50 parts of Natrosol™ 330, 2.73 parts of Tamol™ 850, 0.30 parts of ammonium hydroxide, 1.54 parts of Drewplus™ L140 defoamer. Added to this mixture under agitation were 47.62 parts of Kronos™ 2020, 7.30 parts of Hitox™ titanium dioxide, 0.96 parts of burnt umber pigment, 42.46 parts of calcium carbonate, 58.77 parts of water, 362.70 parts of Airflex™ 100 emulsion, and 255.54 parts of wax emulsion.

Component B

3.58 parts of water were mixed with 1.52 parts of corn syrup, 0.79 parts of ammonium hydroxide, 2.0 parts of potassium hydrogen tartrate, 2.0 parts of Tamol™ 850, 5.30 parts of Huber™ 35 clay, 2.13 parts of calcium sulphate, and 0.23 parts of Drewplus™ L140. Added for viscosity control were 33.65 parts of water. Finally 98.64 parts of white Portland cement type I were added to the mixture.

Components A and B were blended and sprayed to a thickness of 5 mil on a reconstituted paper plate stock, dried and cured as in Example 1. The reverse side of the plate was sprayed, dried and cured with the blend described in Example 1.

The coated plates were then brought in contact with meat products. The inside coating using the Example 2 composition showed excellent resistance to the meat product. When the coated plate is exposed to a moisture active landfill, it degraded.

As can be seen, the Example 2 blend contains a much higher level of emulsion than does Example 1 so as to retard food liquid penetration of the cardboard stock. On the other hand, the material prepared in Example 1 is much more readily degradable because of its high concentration of cement and its relatively low amount of emulsion polymer.

Claims

1. A degradable coating composition comprising:
 - (a) a cement;
 - (b) at least one of a clay and a sulphate; and
 - (c) an aqueous emulsion polymer which is substantially stable in the presence of the other components in said coating composition.
2. The coating composition defined in claim 1, wherein both of said clay and said sulphate are

present.

3. The coating composition defined in claim 1, further comprising at least one of a wax, an organic acid and a sugar.
4. The coating composition defined in claim 1, comprising:
 - (a) from about 40 to about 90 percent by weight of said cement;
 - (b) from 0 to about 20 percent by weight of said clay;
 - (c) from about 0 to about 20 percent by weight of said sulphate; and
 - (d) from about 6 to about 60 percent by weight of said emulsion polymer; all based on the total weight of said cement, said clay, said sulphate and the solids weight of said emulsion polymer.
5. The coating composition defined in claim 4, further comprising from about 1 to about 20 percent by weight of an organic acid and from about 1 to about 25 percent by weight of a wax.
6. The coating composition defined in any of the preceding claims, wherein the clay is based upon aluminum silicate.
7. The coating composition defined in any of the preceding claims, wherein the sulphate is an alkali or alkaline earth metal sulphate.
8. The coating composition defined in any of the preceding claims, wherein the sulphate is calcium sulphate.
9. The coating composition defined in any of the preceding claims, wherein the polymer is an ethylene-vinyl acetate emulsion copolymer.
10. A process for manufacturing a coated article comprising a degradable substrate, the process comprising applying as a first coating composition the coating composition defined in claim 4 to a first surface of said degradable substrate and curing/drying said coating composition, wherein said first surface of the degradable substrate is coated with said first coating composition and a second surface of said degradable substrate is coated with a second coating composition comprising from about 15 to about 60 percent by weight of a cement, from 0 to about 20 percent by weight of a clay or from 0 to about 10 percent by weight of a sulphate, wherein at least one of the sulphate or the clay is present, and from about 40 to about 75 percent by solids weight of an aqueous emulsion polymer which is stable in the

presence of the other components of said second coating composition, wherein said percentages are based on the total solids amount of the cement, sulphate, clay and aqueous emulsion.

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11. The process defined in claim 10, wherein the degradable substrate is paper.

12. A coated article comprising a degradable substrate having a first surface thereof coated with a first coating composition initially comprising:

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(a) from about 40 to about 90 percent by weight of a cement;

(b) from 0 to about 20 percent by weight of a clay;

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(c) from about 0 to about 20 percent by weight of a sulphate; and

(d) from about 6 to about 60 percent by weight of an emulsion polymer which is stable in the presence of the other components of said first coating composition;

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all based on the total weight of said cement, said clay, said sulphate and said emulsion polymer;

wherein at least one of said clay and said sulphate is present.

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13. The article defined in claim 12, wherein said degradable substrate further comprises a second surface thereof coated with a second coating composition initially comprising

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(a) from about 15 to about 60 percent by weight of a cement;

(b) from 0 to about 20 percent by weight of a clay

(c) from 0 to about 10 percent by weight of a sulphate; and

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(d) from about 40 to about 75 percent by weight of an emulsion polymer which is stable in the presence of the other components of said second coating composition;

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all based on the total weight of said cement, said clay, said sulphate and said emulsion polymer which is stable in the presence of the other components of said first coating composition;

wherein at least one of the sulphate or the clay is present.

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European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 92 61 0002

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DATABASE WPIL, n088-164117, Derwent Publications Ltd, London, GB; & JP-A-63101434(NISSHIN SPINNING KK) 06-05-1988*The entire abstract* -----	1	D21H19/64
			TECHNICAL FIELDS SEARCHED (Int. Cl.5) D21H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 DECEMBER 1992	Examiner FOUQUIER J.
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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