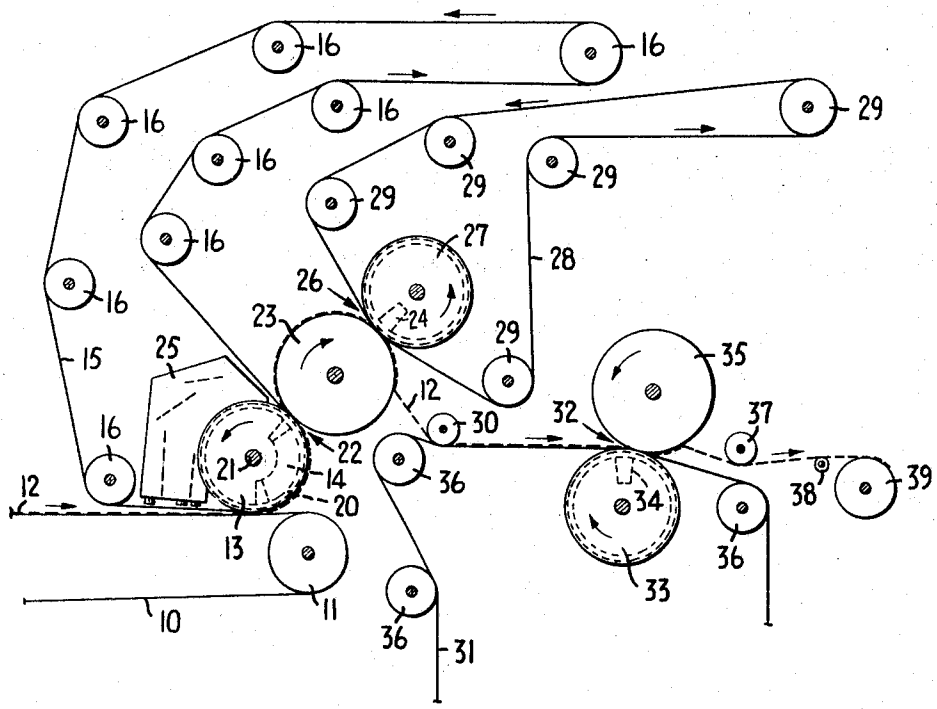
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FELT DRIERS FOR PAPER-MAKING MACHINERY

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FELT DRIERS FOR PAPER-MAKING MACHINERY

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This invention relates to felts for paper-making machinery and, more particularly, to felts treated in a novel and highly effective manner whereby, when they are used in paper-making machinery, for example to pick up and transport a wet paper web produced by a wet-end machine, they wet or "work in" quickly and have little tendency to entrap fines from the web. Felts treated in accordance with the invention may be used in any part of paper-making machinery where conventional felts may be used, but the new felts have greatest utility when used as pick-up felts in paper-making-machine press sections.

Conventional felts for use in, say, the press section of a paper-making machine are seriously deficient in two major respects: (1) they require a wetting or "working in" period of about four hours before becoming sufficiently wet to perform their intended function of picking up a wet paper web from the wet end of a paper-making machine and transporting the web through water-extraction means such as pressure nip and suction means in order to extract water from the web of paper, and (2) fines from the paper have a tendency to become permanently lodged in the felts on contact therewith. The suction usually employed to force air through the web of paper and thence through the felts in order to extract water from the web of paper rather quickly causes the fines to clog the interstices between the woven warp and filler strands of the felts, even though felt cleaners are mounted on the machine for cleaning the felts. These two deficiencies of conventional felts necessitate frequent felt changes and greatly increase the "down time" of paper-making machinery and therefore contribute substantially to the cost of paper manufacture.

An object of this invention is to remedy the deficiencies noted above. In particular, an object of the invention is to provide a felt for paper-making machinery which wets or "works in" much faster than conventional felts and which does not permanently entrap fines from a paper web transported by the felt but releases them readily in response to the passage of a cleaning fluid such as air through the felt as the felt traverses cleaning and dewatering apparatus.

These and other objects of the invention are attained by the provision of a paper-making-machine felt which has a finish imparting to the felt water and oil repellency.

An understanding of further aspects of the invention may be obtained from a consideration of the following detailed description of representative embodiments thereof and the accompanying drawing, in which the sole figure is a schematic elevation showing the mounting of paper-press felts treated in accordance with the invention in a paper-press section adjacent to the wet end of a paper-making machine.

The figure shows a wire **10**, which may be a conventional forming wire of a wet-end machine, trained about a roll **11** and transporting a wet web **12** of newly-formed paper in the direction indicated by the arrow. The word "paper" is used in a generic sense to include paper, paperboard, and similar products. A roll **13** provided with suction means **14** removes the wet paper web from the wire **10**, and the web **12** adheres to a pick-up felt **15**

trained about the roll **13** and about guide and tension rolls **16**.

The suction means **14** is stationary, and the circumference **20** of the roll **13** is perforated and rotatable about the axis **21** of the roll **13**. Accordingly, the wet paper web **12** is transported on the felt **15** from the wire **10** to a first suction and pressure nip **22** formed by the roll **13** and a plain rotatable roll **23**. The rolls **13** and **23** are made to rotate in the directions shown by the arrows. In traversing the circumference of the roll **13** between the wire **10** and the nip **22**, the wet web **12** has water extracted therefrom by the passage of air into the web **12** and thence into the pick-up felt **15** and the circumference **20** of the roll **13**. The suction and pressure nip **22** extracts additional water from the web **12** by a combination of suction and pressure.

As a given part of the circumference **20** of the roll **13** rotates beyond the suction means **14**, centrifugal force causes the perforations in the circumference **20** to give up the water contained therein to a save-all **25** mounted adjacent to the roll surface **20** and on the opposite side of the roll **13** from the portion of the roll **13** about which the pick-up felt **15** and web **12** are trained.

Owing to the different surface characteristics of the roll **23** and the felt **15** and to the relative position of the roll **23** with respect to the terminal end of the suction box **14**, the web **12** is trainable around the roll **23**. The web **12** is in fact so trained and passed through a suction and pressure nip **26** formed by the roll **23** and a roll **27** having a rotatable foraminous circumferential surface and a stationary suction-producing means **24** mounted therein for applying suction to the web **12** as it passes through the nip **26**. The roll **27** is made to rotate in the direction shown by the arrow. A second press felt **28** is trained with the web **12** through the nip **26**, where it facilitates the extraction of additional water from the web **12**, and about tension and guide rolls **29**.

The web **12** adheres to the surface of the roll **23** to a point beyond the nip **22** and from that point is trained away from the roll **23** and about a guide roll **30** and onto a third press felt **31**. The press felt **31** transports the web **12** through a third suction and pressure nip **32** formed by a roll **33** having a rotatable foraminous circumference and stationary suction means **34** therein and a rotatable plain roll **35**. The rolls **33** and **35** are made to rotate in the directions shown by the arrows. The third press felt **31** is also trained about guide and tension rolls **36**.

The web **12** adheres to the circumference of the roll **35** to a point beyond the nip **32** and from that point is trained away from the roll **35** and about guide rolls **37**, **38**, and **39** and to apparatus such as a drying section (not shown) for further processing.

The structure of the rolls and the arrangement of the rolls and felts shown herein are disclosed in my copending application Serial No. 28,114, filed May 10, 1960, and form no part of the present invention but are set forth for illustrative purposes. Obviously, any other suitable rolls and arrangements of rolls and felts may also be used in accordance with the present invention, which relates to felts treated in a novel and highly effective manner.

Materials which may be used in treating a paper-machine felt in accordance with the invention include FC-208; Zelan FF; the homopolymer of the acrylate ester of N-propyl, N-ethanol perfluorooctanesulfonamide—

$$C_8F_{17}SO_2N(C_3H_7)CH_2CH_2OCOCH{=}CH_2$$

a polymer of the acrylate ester of N-butyl, N-ethanol perfluorooctanesulfonamide—

$$C_8F_{17}SO_2N(C_4H_9)CH_2CH_2OCOCH{=}CH_2$$

a polymer of the methacrylate ester of N-ethyl, N-ethanol perfluorooctanesulfonamide—

$$C_8F_{17}SO_2N(C_2H_5)CH_2CH_2OCOC(CH_3)=CH_2$$

a polymer of the methacrylate ester—

$$C_8F_{17}SO_2N(C_4H_9)(CH_2)_4OCOC(CH_3)=CH_2$$

a polymer of the acrylate ester—

$$C_8F_{17}SO_2N(C_2H_5)(CH_2)_{11}OCOCH=CH_2$$

a polymer of the acrylate ester—

$$C_6F_{13}SO_2N(C_2H_5)CH_2CH_2OCOCH=CH_2$$

a polymer of the acrylate ester—

$$C_4F_9SO_2N(CH_3)(CH_2)_4OCOCH=CH_2$$

the copolymer in 25:75 mole ratio of butadiene and the acrylate ester of N-ethyl, N-ethanol perfluorooctanesulfonamide—

$$C_8F_{17}SO_2N(C_2H_5)CH_2CH_2OCOCH=CH_2$$

a latex copolymer of a methacrylate ester monomer and butadiene in 70:30 mole ratio, employing the methacrylate ester of N-ethyl, N-butanol perfluorooctanesulfonamide—

$$C_8F_{17}SO_2N(C_2H_5)(CH_2)_4OCOC(CH_3)=CH_2$$

a polymer of the vinyl ester—

$$C_8F_{17}SO_2N(C_2H_5)CH_2COOCH=CH_2$$

a polymer of the vinyl ester—

$$C_8F_{17}SO_2N(CH_3)CH_2COOCH=CH_2$$

the vinyl ester—

$$C_8F_{17}SO_2N(CH_3)(CH_2)_{10}COOCH=CH_2$$

the allyl ester—

$$C_8F_{17}SO_2NHCH_2COOCH_2CH=CH_2$$

and a copolymer of the allyl ester—

$$C_8F_{17}SO_2N(CH_3)(CH_2)_{10}COOCH_2CH=CH_2$$

and maleic anhydride.

FC–208 is a trademark of Minnesota Mining and Manufacturing Co. for a substance believed to be a nonionic emulsion of a fluorocarbon resin, the resin being a polymer of a vinyl perfluoro acid ester, a polymer of a perfluoro ester of acrylic acid, or a copolymer of a vinyl perfluoro acid ester and a perfluoro ester of acrylic acid. See Herman B. Goldstein, "Properties of Cotton Fabrics Treated With Fluorocarbon Combinations With Water Repellents," Textile Research Journal, April 1961, page 378.

Zelan is a trademark of E. I. du Pont de Nemours & Co. for a substance believed to be composed, at least in part, of a long chain nitrogen complex, particularly a pyridene, and to combine with certain reactive groups of textile fibers. Cf. Handbook of Material Trade Names, by O. T. Zimmerman and Irvin Lavine, 1953 edition.

The other materials set forth above as examples of materials which are suited for use in accordance with the invention are disclosed in patents to Ahlbrecht et al., Nos. 2,803,615 and 2,841,573. Those patents also disclose methods of making the basic compounds, of polymerizing them, and of employing the materials to provide cloth with a finish imparting to the cloth water repellency and oil repellency.

Example I

A 1% solids (by weight) aqueous solution of a fluorocarbon resin (FC–208) was prepared and placed in an open-top tub approximately 7 feet in diameter and of a depth approximately equal to the diameter. Approximately 2 gallons of the solution were used per pound of felt to be treated. The solution was heated to about 90° F. and a single thickness of an endless woven paper-making-machine felt comprising about 75% wool and 25% nylon was passed through a nip formed by a pair of rubber-covered wringer rolls mounted above the top of the tub, a loop of the felt dipping into the heated solution. The rolls were turned to run successive portions of the felt alternately through the nip and the heated solution for a period of about one hour. The felt was dried on a metal roll steam-heated to about 200° F.

The felt was then cured for five minutes in an oven at about 250° F., washed in a mild nonionic detergent solution at about 115° F., rinsed in water at about 115° F., and dried on a metal roll steam-heated to about 200° F. The treated felt was found to have increased in weight by about 1%.

In tests conducted on paper-making-machine press sections equipped with felts treated with the fluorocarbon resin, it was found that the felts had a wetting or "working in" time of approximately 30 minutes instead of the approximate four hours required for conventional felts. It was found, further, that the felts could be used many times longer than conventional felts before being discarded on account of clogging of the interstices between the woven warp and filler strands with fines. Machine "down time" and the cost of paper manufacture were therefore reduced.

Example II

A 3% solids (by weight) aqueous solution of a pyridene compound (Zelan FF) was prepared and placed in the same open-top tub referred to in the previous example. Approximately 2 gallons of the solution were used per pound of felt to be treated. The solution was heated to about 140° F. and a single thickness of an endless woven paper-making-machine felt comprising about 75% wool and 25% nylon was passed through the nip referred to in the previous example, a loop of the felt dipping into the solution. The source of heat was removed from the solution so that the temperature of the solution dropped towards room temperature. Meanwhile, the rolls were turned to run successive portions of the felt alternately through the nip and the solution for a period of about one hour. The felt was dried on a metal roll steam-heated to about 200° F. The felt was then cured for five minutes in an oven at about 250° F., washed in a mild nonionic detergent solution at about 115° F., rinsed in water at about 115° F., and dried on a metal roll steam-heated to about 200° F. The treated felt was found to have increased in weight by about 3%.

Felts treated in accordance with this example performed substantially the same as those treated in accordance with the previous example, wetting or "working in" quickly and staying clean, soft, and open throughout their useful lives. They have been removed when worn out, but, throughout their useful lives, their performance has been uniformly good rather than changing and deteriorating in the manner of conventional felts, which receive only moth-proofing and similar treatment.

Example III

The acrylate ester

$$C_8F_{17}SO_2N(C_3H_7)CH_2CH_2OCOCH=CH_2$$

is prepared and polymerized in the manner disclosed in Example I of the previously-mentioned Patent No. 2,803,615. A latex sizing solution is prepared in the manner disclosed in the example, the latex solids content of the solution being about 1%. A conventional paper-making-machine felt is dipped into the solution, passed between squeeze rolls to remove excess solution, and dried by heating at 140° F. for 10 minutes. The treated felt, though water repellent and oil repellent when subjected to many conventional tests for water repellency and oil repellency, surprisingly wets or "works in" when used, for example, as a pick-up felt in a paper-making machine, much more rapidly than a conventional felt and shows much more resistance than a conventional felt to clogging with fines.

Example IV

The vinyl ester

$$C_8F_{17}SO_2N(CH_3)CH_2COOCH{=}CH_2$$

is prepared and polymerized in a manner similar to that described in Example I of the Patent No. 2,841,573 referred to above (see also Example II of the patent which incorporates Example I by reference). A conventional paper-making-machine felt is dipped into a 1% (by weight) solution of the polymer in xylene hexafluoride solvent, as disclosed in the patent, passed through squeeze rolls to remove excess saturant, and dried in an oven for 10 minutes at 150° C. The treated felt, though water repellent and oil repellent when subjected to many conventional tests for water repellency and oil repellency, surprisingly wets or "works in," when used, for example, as a pick-up felt in a paper machine, much more rapidly than a conventional felt and shows much more resistance than a conventional felt to clogging with fines.

Thus there is provided in accordance with the invention novel and highly effective treated felts for use in paper-making machinery. The felts of the invention are particularly adapted for use as pick-up felts, where the web transported by the felt is wettest and most likely to deposit fines on the felt.

Many modifications of the representative embodiments of the invention disclosed above are possible within the spirit and scope of the invention. Accordingly, the invention is to be construed as extending to all the modifications thereof covered in the appended claims.

I claim:

1. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a polymer of a vinyl perfluoro acid ester and imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

2. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a polymer of a perfluoro ester of acrylic acid and imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

3. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a copolymer of a vinyl perfluoro acid ester and a perfluoro ester of acrylic acid and imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

4. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a pyridene and imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

5. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a solid flexible homopolymer of a compound selected from the class consisting of the acrylate esters and methacrylate esters of N-alkyl, N-alkanol perfluoroalkanesulfonamides which have in the molecule a perfluorocarbon "tail," said acrylate esters having the formula

$$R_fSO_2N(R^1)RCH_2OCOCH{=}CH_2$$

and said methacrylate esters having the formula

$$R_fSO_2N(R^1)RCH_2OCOC(CH_3){=}CH_2$$

wherein R_f is a perfluoroalkyl group containing 4 to 12 carbon atoms, R is an alkylene bridging group containing 1 to 12 carbon atoms, and R^1 is an alkyl side group containing 1 to 6 carbon atoms, said finish imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

6. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a solid flexible homopolymer of the acrylate ester of N-propyl, N-ethanol perfluorooctanesulfonamide having the formula

$$C_8F_{17}SO_2N(C_3H_7)CH_2CH_2OCOCH{=}CH_2$$

said finish imparting to said felt oil and water repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

7. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a solid flexible homopolymer of the acrylate ester of N-butyl, N-ethanol perfluorooctanesulfonamide having the formula

$$C_8F_{17}SO_2N(C_4H_9)CH_2CH_2OCOCH{=}CH_2$$

said finish imparting to said felt water and oil repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water-extraction means.

8. In a method of extracting water from a wet web of paper, the steps comprising transporting said web, by means including a paper-making-machine felt provided with a finish comprising a solid polymer of fluorocarbon vinyl-type esters of the class consisting of vinyl esters and allyl esters of perfluoroalkanesulfonamido alkylene-monocarboxylic acids, said vinyl esters having the formula

$$R_fSO_2N(R^1)RCOOCH{=}CH_2$$

and said allyl esters having the formula

$$R_2SO_2N(R^1)ROOCH_2CH{=}CH_2$$

wherein R_f is a perfluoroalkyl group containing 4 to 12 carbon atoms, R is an alkylene bridging group containing 1 to 12 carbon atoms, and R^1 is of the class consisting of a hydrogen atom and alkyl groups containing 1 to 6 carbon atoms, said finish imparting to said felt water and oil repellency, into association with water-extraction means for extracting water from said web, at least a part of said water being transferred through said felt to said water extraction means.

9. In combination, a paper-making machine formed with water-extraction means and a plurality of felt-training means and a felt trained over said felt-training means, said felt being adapted to carry a wet web of paper and being provided with a finish imparting to said felt water and oil repellency, said finish comprising a polymer of a vinyl perfluoro acid ester, and said water-extraction means being mounted to extract water from said web and transfer at least a part of said water through said felt.

10. In combination, a paper-making machine formed with water-extraction means and a plurality of felt-training means and a felt trained over said felt-training means, said felt being adapted to carry a wet web of paper and

being provided with a finish imparting to said felt water and oil repellency, said finish comprising a polymer of a perfluoro ester of acrylic acid ester, and said water-extraction means being mounted to extract water from said web and transfer at least a part of said water through said felt.

11. In combination, a paper-making machine formed with water-extraction means and a plurality of felt-training means and a felt trained over said felt-training means, said felt being adapted to carry a wet web of paper and being provided with a finish imparting to said felt water and oil repellency, said finish comprising a copolymer of a vinyl perfluoro acid ester and a perfluoro ester of acrylic acid, and said water-extraction means being mounted to extract water from said web and transfer at least a part of said water through said felt.

12. In combination, a paper-making machine formed with water-extraction means and a plurality of felt-training means and a felt trained over said felt-training means,

said felt being adapted to carry a wet web of paper and being provided with a finish imparting to said felt water and oil repellency, said finish comprising a pyridine, and said water-extraction means being mounted to extract water from said web and transfer at least a part of said water through said felt.

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