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SYNTHETIC ARTICLE

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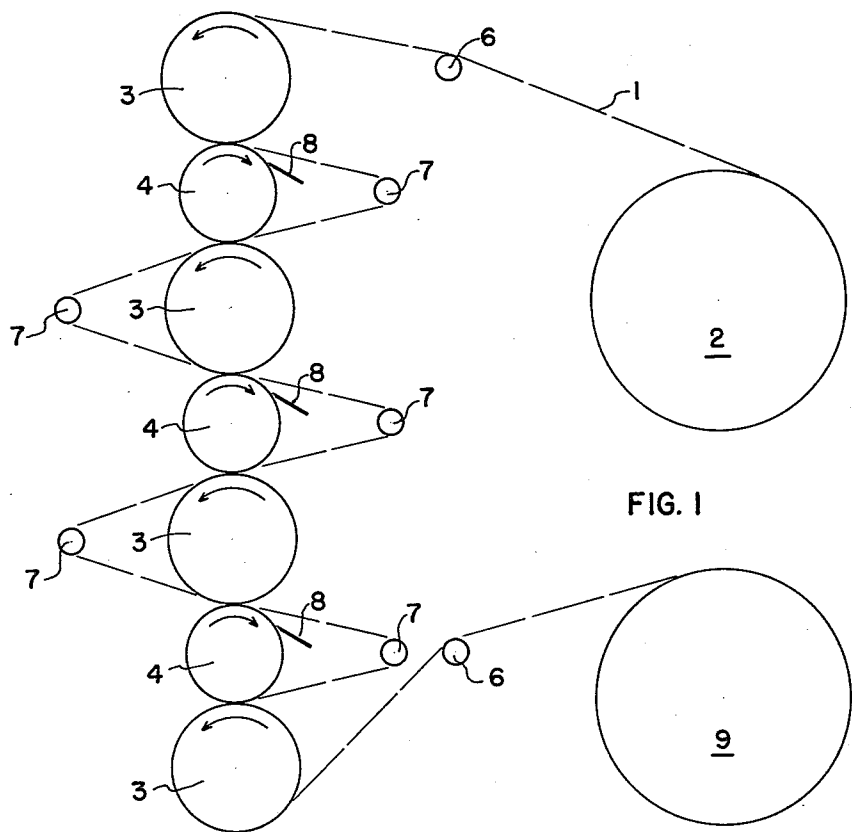


FIG. 1

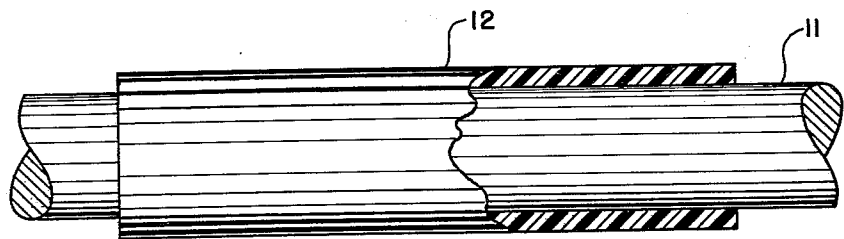


FIG. 2

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SYNTHETIC ARTICLE

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1 Claim. (Cl. 100-162)

This invention relates to the supercalendering of paper and more particularly to improved supercalender rollers.

Supercalendering has long been used in certain finishing operations in the manufacture of paper to impart special characteristics to the paper, such as smoothness, gloss, density and transparency. As distinguished from calendars, supercalenders comprise a vertical stack of rolls in which some of the rolls are made of a comparatively non-yielding material, commonly called hard rolls, and others of a yieldable material, commonly called soft rolls. Generally the hard rolls are made of chilled steel and the soft rolls are made of pressed paper or other pressed or woven fibrous material.

In the fabrication of soft rolls, discs are cut out of the fibrous stock and are axially positioned onto a metal roll shaft or mandrel. Pressure is applied to this stack of discs, end castings are attached to the roll shaft to hold the pressed series of discs in position, and the entire assembly is turned and polished in a lathe to provide a uniformly smooth surface and constant diameter over the entire axial length of the roll. For convenience, this material as assembled onto the shaft of a soft roll is referred to as a roll cover.

Most commonly, the supercalender stack is arranged with alternate hard and soft rolls, though for some purposes several hard or soft rolls may be run together. Paper to be supercalendered is threaded through the stack of rolls from top to bottom and between the nips of the several rolls. The paper may be led over fly rolls between passages through the various nips of the supercalender stack.

When the supercalender is in operation, the paper passes downwardly through the stack and is progressively subjected to increasing pressures at successive nips due to the weight of the rolls and any additional weight which may be applied at the top roll of the stack. As the paper passes between the nips of adjacent hard and soft rolls, the soft roll yields or deforms to accommodate the hard roll causing a rubbing action against the surface of paper. This rubbing action develops shear forces across the paper which are responsible for imparting the desired surface characteristics to the paper as it is passed through the supercalender. Also, for some purposes, the rubbing action can be accomplished by friction calendering wherein adjacent hard and soft rolls are driven at different peripheral speeds.

Soft roll covers heretofore used by the paper industry have persisted in causing great difficulty in the continuous operation of supercalenders. In order to produce a supercalendered paper having uniform surface characteristics, it is necessary that the face of the roll cover be perfectly smooth and the diameter of the roll cover be held to close dimensional tolerances, usually within 0.001 inch. However, when the roll cover is subjected to localized momentary overloads, the surface of the roll cover may become permanently deformed. This necessitates stopping the supercalendering operation, removing

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the roll from the stack, machining it back to tolerances, and reinstalling the roll in the stack. Not only is this a time-consuming task, but also it is one that results in considerable expense to paper manufacturers due to the time that the high-speed and expensive equipment is held idle.

Momentary overloads of the type discussed above may commonly be encountered when a tear in the paper occurs that causes a wraparound or a double thickness of paper to pass between the rolls. (This is referred to as "snapping a tail.") Also the roll covers may be damaged when foreign objects accidentally pass between the rolls.

Even if all momentary overloads are avoided in the operation of the supercalender stack, the life of the soft roll covers is still necessarily limited. The high forces that are encountered develop elevated temperature in the roll cover that cause them to degrade and char and thus lose their necessary resiliency. Accordingly, it is necessary to shut down the supercalender at frequent intervals, remove the rolls from the stack, place the soft rolls in a lathe and turn down the degraded outer surface. Eventually, of course, after these roll covers have been refinished a number of times, there is insufficient fibrous material left and the roll cover must be discarded and the shaft refurbished with a new one.

Despite the known difficulties encountered in the use of conventional soft rolls, no satisfactory alternative has been found despite the more than half century that supercalenders have been in operation. Ideally, a supercalender roll should have a low coefficient of thermal expansion to provide dimensional stability under localized temperature fluctuations, it must have the necessary resiliency and modulus of elasticity to yield against the hard roll and transmit shear forces to the surface of the paper, and it should be sufficiently resilient to recover from deformations caused by localized overloads. It is known that the paper industry has for many years been attempting to find suitable materials for the fabrication of supercalender roll covers that meet these requirements. While fiber rolls in many respects are far from satisfactory, they are best material known to date for such use.

It has now been discovered that a closer approach to the ideal characteristics of a soft roll cover can be obtained by the use of certain synthetic resinous materials for supercalender roll covers.

It is, therefore, an object of this invention to provide improved roll covers.

Another object of this invention is to provide supercalender roll covers that have increased life and greater resistance to localized overload conditions.

Yet another object of this invention is to provide supercalender rolls with improved wear life that are capable of operating more efficiently for prolonged periods of time.

Briefly, the objects of this invention are achieved by the use of certain synthetic resinous materials, and particularly polycarbonate materials, in the fabrication of the supercalender roll covers.

Many synthetic resinous or plastic materials have been used for fabricating soft roll covers for supercalenders but none has as yet proved suitable. Various plastic materials suffer from high coefficients of thermal expansion, high internal friction, brittleness, and unsatisfactory moduli of elasticity. Of these two factors, the internal friction and the modulus of elasticity are quite important. With respect to the modulus, it is important

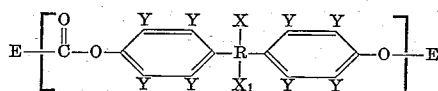
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that it should not unduly decrease with increasing temperatures. If this occurs, the resiliency of the roll cover will be lost at elevated temperatures and thus not provide sufficient shear forces to perform the desired polishing operation. It can be appreciated that the high forces necessary to calender the paper are developed by maintaining a comparatively narrow nip. If the resiliency of the roll cover is reduced, as by elevated temperatures, the nip will widen and accordingly reduce the unit pressure applied to the paper as it passes between the rolls.

With respect to internal friction (more precisely, the hysteresis loss on mechanical deformation), it is important that it should not increase appreciably with increasing temperatures. At the imposed frequency of operation of the supercalender rolls, the internal friction results in a heat buildup within the roll. If the internal friction increases with increasing temperatures of the roll, an unstable thermal condition may develop. Furthermore, due to the high coefficient of thermal expansion of many plastic materials, as compared with the steel roll or conventional fiber rolls, a momentary overload is accompanied by an increase in temperature which in turn causes an expansion of the diameter of the roll at the point of overload, which expansion will in turn cause a further overload and corresponding temperature increase, etc., and again an unstable thermal condition may result. For example, it is known that certain plastic materials are satisfactory as roll covers as long as no momentary overload or slight variability in the thickness of the paper is encountered. However, when these momentary overload periods develop, these materials become thermally unstable under the impressed load and rapidly fail at the point of localized overload. For this reason, resinous materials have not proved satisfactory for use as soft roll covers.

It has now been found that certain synthetic resinous materials, and particularly polycarbonates may function quite satisfactorily when fabricated into soft roll covers. While it is true that the coefficient of thermal expansion for these materials is substantially greater than that of paper and steel, nonetheless the internal friction apparently does not increase significantly with increasing temperatures and stable thermal conditions can be maintained. Further, polycarbonate materials are advantageous as compared to fiber roll covers in that they have a much greater resistance to damage, as when a "tail is snapped," and they are self-repairing in that marred surfaces tend to roll out and disappear within a short period of time. Also, polycarbonate rolls run at much cooler temperatures and therefore are less liable to cause damage to paper by overheating. As these materials have a lower internal friction, power requirements are reduced and, further, it is possible to use doctor blades in connection therewith to prevent wraparounds. In this latter regard, it should be noted that it is advantageous to engage doctor blades in touching relationship with the rolls to protect the rolls and remove foreign material from their surfaces. Due to the characteristics of fiber roll covers, these doctor blades can not be usefully employed due to the destructive effect of the doctor blade upon the fiber roll itself. The polycarbonate roll covers here discussed, however, are not subject to such damage and doctor blades may be used in connection therewith.

The polycarbonates found useful in the practice of this invention may be described as polyaryl carbonates having the following general structure:



in which the end groups —E— may be hydrogen, alkoxy or aryloxy groups;

The —R— groups may be of several general types or

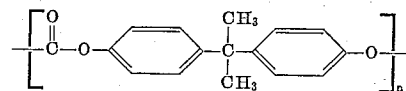
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missing altogether, as, for example, alkylene or alkylidene, and, as a second general class, either oxygen, a phenylene ether, or a sulphone link;

The —X—'s may be hydrogen, alkyl or aryl substituents;

And, the —Y—'s most commonly may be hydrogen or they may be other substituents such as halogens, alkyl or aryl groups or any other common aromatic substituents.

The most common and readily available of the aromatic polycarbonates have the following general structure and may be conveniently prepared by reacting bisphenol-A with phosgene:



Polycarbonates of this type are marketed, for example, by the General Electric Co., Farbenfabriken Bayer A.G., and Mobay Chemical Co., and are sold under the respective trade names Lexan, Makrolon and Merlon.

With reference to the accompanying drawings:

FIG. 1 is a diagrammatic end view of a supercalendering machine; and,

FIG. 2 is a side view partially in section of a roll according to the invention.

With reference to FIG. 1 there is shown a roll of uncalendered paper 2 which is supported by a suitable unwinding mechanism (not shown) adapted to feed material to the supercalender. The web of paper 1 is led from the feed roll 2 over a guide roll 6 and is threaded through the supercalender stack of alternate hard rolls 3 and soft rolls 4 in a manner that causes the paper to pass between adjacent nips of the hard and soft rolls 3 and 4. Fly rolls 7 may be provided to lead paper away from the rolls between passes through the nips of adjacent rolls. Advantageously doctor blades 8 may be provided to protect the soft rolls and remove foreign material from their surface. Similar doctor blades (not shown) may be used in conjunction with the hard rolls. The doctor blades 8 are supported by suitable mechanisms (not shown) to engage them in touching relationship with the soft rolls. When the paper has passed through the calender stack it may be led over guide roll 6 and rewound by a suitable rewind mechanism (not shown) into a roll of supercalendered paper 9.

It is apparent that FIG. 1 is a schematic rendition of a supercalender machine and the details for maintaining the rolls in alignment as by means of a suitable frame having bearings for the various roll journals, as well as the unwind and rewind mechanisms and their supporting brackets or frames, are not shown. These details have been omitted for purposes of clarity since they are well known in the art and do not form a part of this invention.

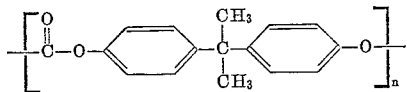
FIG. 2 illustrates the construction of the soft rolls 3. A steel shaft 11 supports the surrounding roll cover 12. The plastic roll cover of the type described in this invention may conveniently be prepared by extrusion. The extruded roll cover 12 may then be attached to the steel shaft 11 by any suitable means but it is preferred to affix the roll cover 12 firmly to the shaft 11 by a sweat-on or shrink fitting process.

I claim:

Apparatus for supercalendering paper comprised of a vertical stack of rolls and a frame means, said stack of rolls comprised of a series of alternate hard and soft rolls mounted for rotation and held in vertical alignment and touching relationship to each other by said frame means; means for feeding paper to be supercalendered into said

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stack of rolls and means for withdrawing paper after it has passed through said stack of rolls; drive means for driving at least the lowermost roll of said stack of rolls; characterized in that at least a substantial outer portion of said soft rolls is comprised of a polyaryl carbonate 5 having the structural formula:



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