Feb. 6, 1968 W. H. HOGE 3,367,008

FILLED CALENDER ROLL

Filed April 13, 1966

FIG. 1

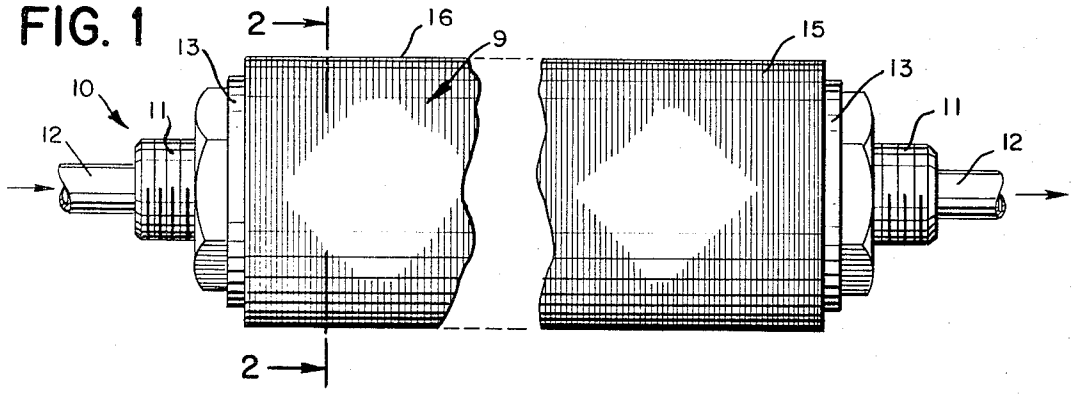


FIG. 2

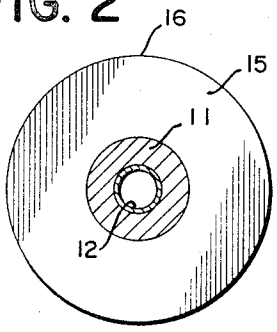


FIG. 3

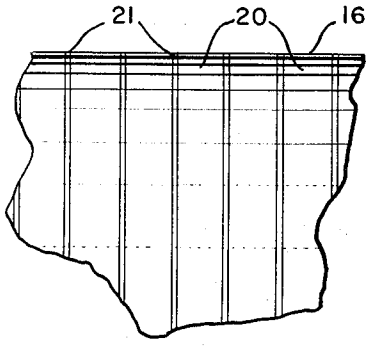
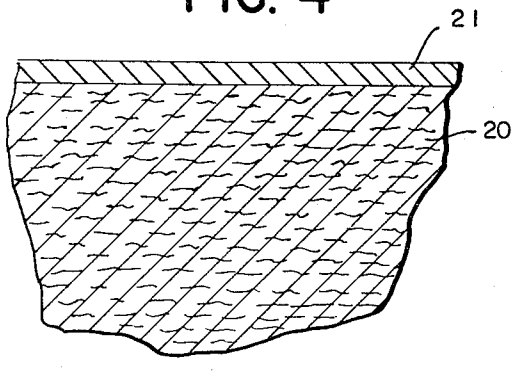


FIG. 4



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FILLED CALENDER ROLL

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The present invention relates to calender roll filling paper and to calender rolls incorporating such paper and, more particularly, to a new and improved filled calender roll and filling paper therefor, which is characterized by significantly improved resistance to degradation by heat.

In the finishing of paper it is often desirable to direct a web through a supercalender stack of alternate metal and fiber-filled calender rolls, the nips of which subject the traveling web to sufficient pressure and rolling friction to smooth, to polish, and to provide many other desirable properties and characteristics thereto. The alternate, fiber-filled calender rolls typically are comprised of metal cores having axially spaced end plates and having the spaces between the plates filled with a large plurality of disks comprised of cotton, paper, or like fibrous materials, maintained under axial compression.

In the calendering operation, substantial heat is developed in the roll filling, the extent of which is dependent upon such factors as the speed and pressure of calendering as well as resilience of the filled rolls. Moreover, in certain calendering applications, the metal rolls themselves are also heated by supplying steam thereto, thereby further elevating the temperature in the filled rolls. Operation at high temperatures has a deleterious effect on the filled rolls, which accelerates their degradation through the development of local hot spots within the roll and through cracking or other mechanical failure of the filler disks.

To the end of decelerating the thermal degradation of filled calender rolls and prolonging their effective lives, it has been proposed to fabricate the filled rolls from fiber disks composed of heat resistant material such as asbestos paper, asbestos cloth, or equivalent heat resistant sheet materials, such as paper or cloth impregnated with a heat resistant composition. Alternatively or additionally to the use of heat resistant filler material, positive cooling of the core of a filled calender roll with a circulating liquid coolant such as water has been proposed to retard the thermal degradation of the filler disks. However, these prior proposals have not resulted in a commercially practicable solution to the problem of thermal degradation.

It is the primary object of the present invention to provide a calender roll, more specifically, a calender roll filler material, which will have a superior life and an enhanced resistance to thermal degradation in comparison to known and available calender rolls and calender roll fillings. In accordance with the principles of the invention, it has been determined that the aforesaid object may be realized, i.e., that a calender filling paper or material may have its useful life in a calender roll greatly extended, by having one or both sides of the calender filler disks metallized with a film of metal of molecular thickness, the metallizing material advantageously being of the type which may be applied in a vacuum by vapor deposition techniques. Without necessarily altering the composition of conventionally available calender paper, the radial direction thermal conductivity of a filled calender roll may be greatly improved and its effective operating life thereby significantly extended.

In conjunction with the improved calender roll filling, it may be advantageous to utilize a water-cooled core shaft. By reason of the significantly improved radial heat conductivity of the new filling, heretofore unrealized advantages may be derived from the forced convection removal of heat conducted radially inward to the roll core.

For a more complete understanding of the present invention and its attendant advantages, reference should be made of the folowing detailed description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is an elevational view of a new and improved calender roll filled with metallized calender paper in accordance with the inventive principles;

FIG. 2 is a cross-sectional view of the calender of FIG. 1 taken along line 2—2 thereof;

FIG. 3 is an enlarged fragmentary view showing adjacent metallized calender disks; and

FIG. 4 is a greatly enlarged, fragmentary, cross-sectional view of the new and improved calender filling material.

With reference to FIG. 1, the calender roll **10** of the present invention may be conventional in most respects with the exception of the actual filler material **9**. Thus, the roll assembly includes a supporting core shaft **11**, the opposite ends of which are threaded to receive threaded compression caps **13** which maintain a large plurality of calender disks **15** under very high compression. The core shaft **11** advantageously includes a cooling tube **12** disposed concentrically therewith and through which water or some other coolant may be circulated to reduce the temperature of the calender roll assembly **10** during its operation. As will be understood, a filled calender roll may be assembled by stacking a plurality of the calender disks **15** on the core and then subjecting them to substantial compression by the members **13** to form an effectively solid, hard roll body. A uniform, cylindrical working surface **16** is thereafter established on the calender by turning down the edges of the compressed disks **15** in a lathe.

The actual dimensions of the calender roll are determined by the type of supercalender stack in which it is to be employed, the type of finish which is to be applied to the paper being processed in the stack, and the dimensions of the paper being finished in the stack. Accordingly, the outer diameter of the working surface **16** may range from approximately 10 to 20 inches and may have an effective length ranging between 60 and 200 inches, for example. The bore dimension of the inner disks corresponds to the outer diameter dimension of the core element **11**, which will be determined by the size of the finished calender roll and the use to which it is to be put. By way of more specific example, a filled calender roll having a length on the order of 72 inches and an outer diameter on the order of 13½ inches may have a bore of about 7 inches in diameter.

In accordance with the principles of the present invention, the new and improved filler disks **15** are made from papers **20** which are especially receptive to a vacuum deposited metallized coating or super thin film **21** and are especially stable during the application of the film. A preferred sheet is manufactured from a 100% cotton rag furnish and has a basis weight of approximately 40 pounds per ream, a moisture content of approximately 3%, and a light size press-applied coating of a fully hydrolyzed high viscosity polyvinyl alcohol. The treated paper has the metallic film applied thereto when it is transported as a web through a metallizing chamber maintained under a vacuum of approximately 0.5 to 2.0 microns of mercury, in which aluminum or some other metal is heated to its vaporization point. The metallic vapor is condensed upon one or both sides of the moving paper to form an extremely thin, vapor-deposited metallic film **21** thereupon, the thickness of which may be on the order of 3 millionths of an inch. Although the film thickness is not measurable by ordinary measuring techniques, one accepted basis for measuring the thickness of deposited metal films of this type is by measuring electrical resist-

ance in the plane of the sheet, which for the film **21** may be within the range of approximately 3 to 20 ohms per square. For a more detailed description of the method and techniques of depositing thin films and ascertaining their thicknesses, reference may be had to such works as "Vacuum Deposition of Thin Films" by L. Holland, John Wiley & Sons, Inc., 1960.

While the new filler paper **20** is especially well suited for the purposes of the present invention, being receptive to a vapor deposited coating and being stable during the vacuum deposition process, it should be understood that many of the known conventional calender papers may be provided with a vacuum deposited metal film to enhance its properties in accordance with the teachings of the present invention.

When the new metallized paper disks **15** are initially assembled on the core shaft **11** of the calender roll, they are approximately only 40% of their ultimate density. However, they are subjected to sufficient pressure between the compression elements **13** to increase their density to the ultimate value, approximately 500 disks (of paper of 40 pounds per ream initial basis weight) per inch of calender roll face. As will be understood, of course, the nature of the treatment and the specific caliper and basis weight of the base sheet **20** will cause variation in the number of calender disks per inch.

It will be appreciated that a calender roll made from metallized paper in accordance with the teachings of the present invention will be free of localized hot spots, will have better thermal conductivity, and therefore will greatly outperform and outlast conventional calender rolls. Particularly advantageous results may be realized through the utilization of the new, metallized filler paper in combination with a water-cooled core shaft. The new filter material enables generated heat to be conducted efficiently in a radially inward direction, from thhe calender nip to the core shaft of the roll, from which it may be removed by the circulating cooling fluid.

Although the concepts of the invention are applicable to a wide variety of filler papers, optimum benefits are realized using papers of relatively low basis weight, which result in a high relative proportion of radial heat-conducting paths. Also, where desired, the paper may be metallized on both sides.

It should be understood that the specific embodiment of the invention herein illustrated and described is intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

What is claimed is:

1. In a calender roll of the type comprising a supporting core element and a plurality of paper disks supported thereupon under compression by a pair of axial elements, the improvement wherein a film of metal condensed from its vapor state is applied to said paper disks on at least one of the sides thereof.

2. A calender roll in accordance with claim **1**, in which said metal is aluminum.

3. A calender roll in accordance with claim **1**, in which said coating is approximately 3 millionths of an inch in thickness.

4. A calender roll in accordance with claim **1**, in which said paper has a basis weight of approximately 40 pounds per ream.

5. A calender roll in accordance with claim **1**, in which said coating has a specific resistivity of from about 3 to 20 ohms per square.

6. A calender roll in accordance with claim **1**, in which said paper disks are coated with fully hydrolyzed high viscosity polyvinyl alcohol.

7. In a calender roll of the type comprising a supporting core element and a plurality of cellulosic disks supported thereupon under compression by a pair of axial elements, the improvement wherein a substantially continuous heat conducting, vaporized metal film is applied to said cellulosic disks on at least one of the sides thereof, said vaporized metal film extending between the face of said roll and said core element and providing a heat conducting path therebetween.

8. A calender roll in accordance with claim **7**, in which said core element includes an internal passage through which a cooling medium may flow freely.

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