July 4, 1967 E. H. SCHAEFER 3,329,562

APPARATUS FOR PRODUCING UNCREPED EXTENSIBLE PAPER

Filed June 1, 1960 2 Sheets-Sheet 1

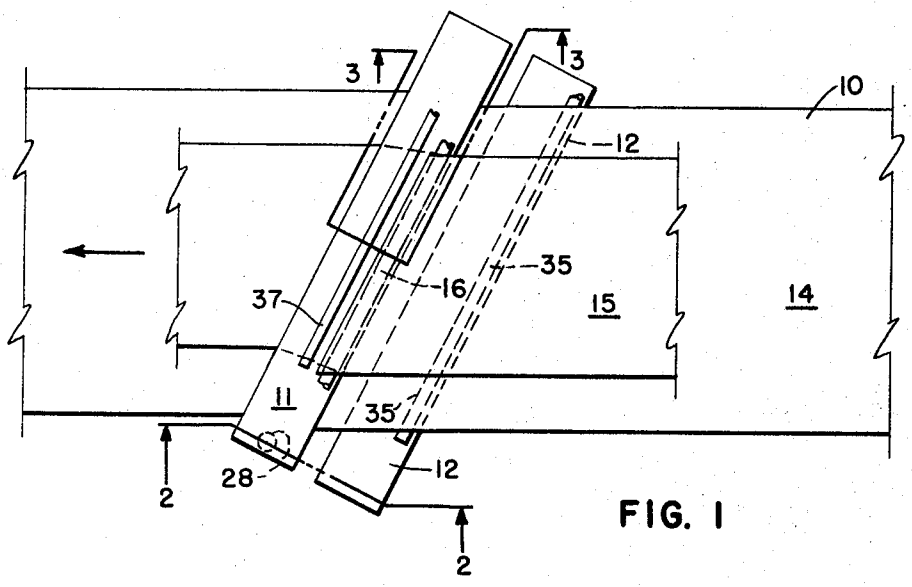

FIG. 1

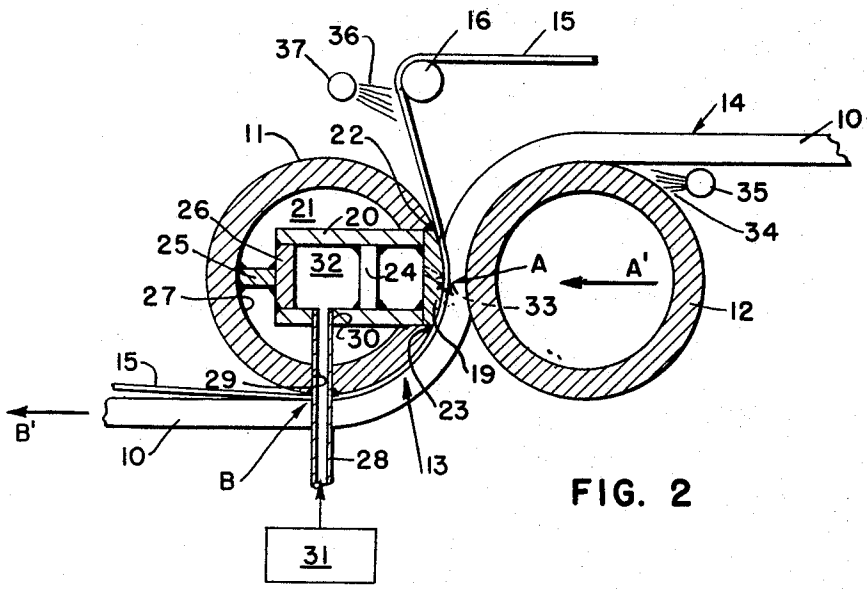

FIG. 2

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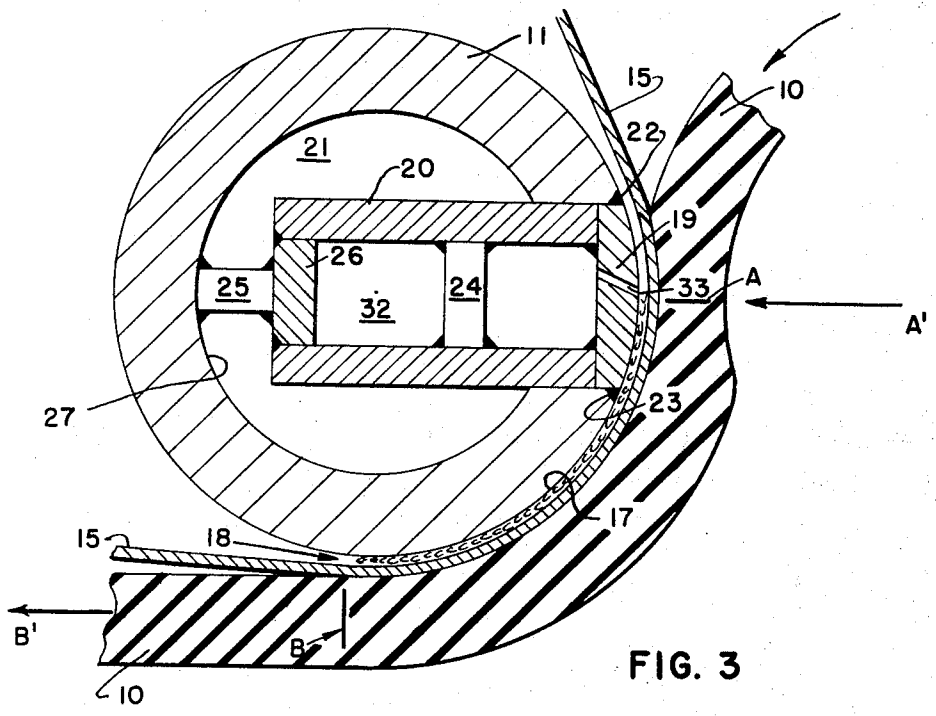

FIG. 3

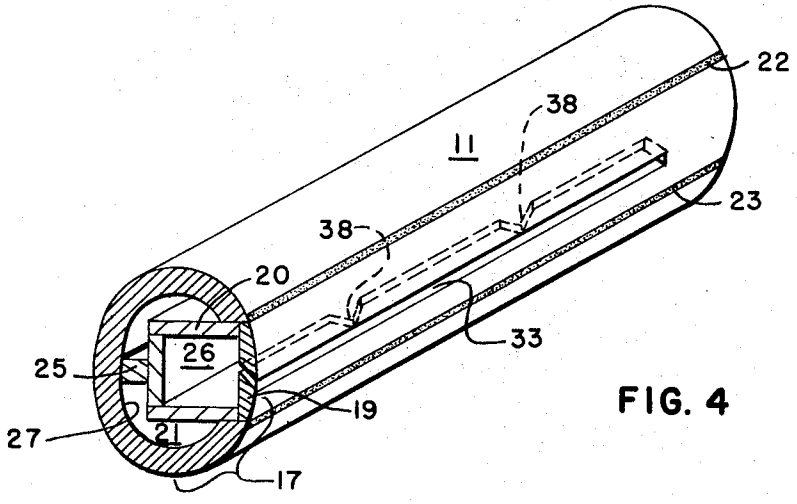

FIG. 4

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3,329,562

APPARATUS FOR PRODUCING UNCREPED EXTENSIBLE PAPER

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The portion of the term of the patent subsequent to Dec. 1, 1980, has been disclaimed and dedicated to the Public

2 Claims. (Cl. 162—361)

This invention relates to improvements in machinery for producing uncreped extensible paper. More particularly, this invention relates to a means for lubricating between a surface of a non-rotary rod and a moist paper web carried over and forced against this surface by a traveling resilient blanket.

In one type of machinery for producing uncreped extensible paper, as disclosed by Fred H. Freuler in U.S. patent application S.N. 709,732 filed Jan. 20, 1958, now abandoned, a pair of parallel rods are positioned on opposite sides of a traveling resilient blanket such that the blanket has a wrap around the first encountered or nip rod in one direction of curvature and then around the other or pressure rod in the opposite direction of curvature. The spacing of these rods is adjustable to form a nip in the traveling blanket and the blanket is tensioned to urge it strongly against the surface of said pressure rod. Additionally, the rods are adjustably mounted so that they can be placed at varying angles to the direction of blanket travel.

In operation, a moist paper web is fed onto the traveling blanket and is carried by it through the nip and along the pressure rod surface. The effect of the nip and the change of curvature in the blanket causes the blanket surface carrying the web to contract, and this together with the pressure exerted in a normal direction against the web causes compaction of the fibers of the web while its surfaces are prevented from creping to produce uncreped extensible paper. To produce a form of this paper in which the direction of maximum extensibility is at an angle to blanket travel, the machine is operated with the rods disposed at an acute angle to the blanket.

However, when the rods are placed at an acute angle to the direction of blanket travel, they cannot be freely rotated since the traveling blanket would then run off the ends of these rods. Thus, these rods are held stationary. This, however, results in high friction forces due to the sliding contact of the underside of the blanket against the nip rod and the sliding contact under normal pressure of the web against the surface of the pressure rod.

As disclosed in U.S. patent application S.N. 709,732, a hydrodynamic lubricating film is therefore used to reduce the friction between the underside of the traveling resilient blanket and the nip rod, and a silicone lubricant in water solution is sprayed on the web prior to the nip to reduce the friction between the web and the surface of the pressure rod. While the hydrodynamic lubricating film provides a substantially friction-free bearing between the traveling blanket and the nip rod, the silicone solution only partially eliminates the friction between the traveling web and the pressure rod resulting in a high power requirement for the machine. The use of additional silicone solution does not sufficiently further reduce the friction forces and furthermore produces objectionable marks on the paper web.

Pressurized air as is sometimes used as a lubricant, also is unsatisfactory in the instant case because of the variation in the pressure exerted by the blanket against the web as it travels along the pressure rod surface. At the start of this travel, this pressure is relatively high, but from this point on it progressively decreases in magnitude. Thus

should air be used as a lubricant, its pressure must be high so it can enter between the web and the surface of the pressure rod at the point of highest pressure therebetween, but at a subsequent point of travel along the surface of this rod where pressure exerted against the web is lower in magnitude, the high pressure of the air would force the blanket off the rod. When this occurs, compaction of the web takes place without the benefit of normal pressure exerted against it to prevent creping of its surfaces, and thus the paper produced is unsatisfactory.

According to the present invention, a film of steam is provided as lubrication between the traveling paper web and the surface of the non-rotary pressure rod. This steam is supplied to a chamber formed within the rod and is forced from this chamber through a slot in the rod so that it enters between the rod and the web at the point of highest pressure therebetween. From this point of entry the steam flows in the direction of blanket travel and thus forms an efficient lubricating film between the web and the pressure rod surface. Further, while following the flow path just mentioned, the steam loses heat to the paper web so that a portion of the steam condenses. This condensation does not adversely affect the paper web whatsoever, but rather has the desirable effect of causing a gradual reduction in the pressure of the steam. Thus, the pressure of the steam decreases in magnitude from its point of entry to the end of its travel along the surface of the pressure rod in approximately the same manner as the pressure exerted by the blanket against the web varies as the web travels along this surface. As a result, there is no tendency on the part of the steam to force the blanket from the pressure rod to an extent which would permit the web to crepe.

It is accordingly a prime object of the present invention to effectively lubricate between a traveling paper web and a stationary rod surface.

A further object is to lubricate between this paper web and rod surface without harmful effect on the paper web.

A still further object is to provide a lubricant between a stationary rod surface and a traveling paper web urged against this surface by a variable normal pressure, wherein the pressure of said lubricant varies in the same manner as said normal pressure varies.

Further objects and advantages of the present invention will be better understood from the specification which follows and the drawings forming a part thereof in which:

FIG. 1 is a partial plan view of a machine for producing uncreped extensible paper which embodies the teachings of the present invention;

FIG. 2 is a side view projected from FIG. 1 and partly in section along line 2—2 of FIG. 1;

FIG. 3 is an enlarged side view in section along line 3—3 of FIG. 1; and

FIG. 4 is an isometric view, partly in section of the non-rotary pressure rod of the machine shown in FIG. 1.

In FIG. 1 only that portion of a machine for producing uncreped extensible paper is shown which is necessary for an understanding of the present invention. It will be understood that the numeral **10** designated a blanket which is more particularly in the form of an endless loop and which is supported on transversely disposed spaced rollers and arranged to be driven in a lengthwise direction by conventional driving means. Thus, in the operation of this machine the blanket **10** is adapted to be continuously drawn in a lengthwise direction between a pressure rod **11** and a nip rod **12** both disposed at an angle to the direction of blanket travel. Conventional means will be understood to support the rods in this desired position. Both rods are stationary to maintain proper tracking of the blanket **10**. Thus, in this type of machine, there are sliding rather than rolling friction forces

to contend with, and therein the improvements of the present invention find their greatest commercial applications.

As best seen in FIG. 2, the pressure rod **11** and the nip rod **12** are spaced from each other so that the distance between them is slightly less than the thickness of the blanket **10**. Thus, these rods form a constriction, and the blanket **10** when drawn through this constriction is nipped as at A. Additionally, the blanket **10** is arranged to pass over the nip rod **12** so that its surface **14** has a convex curvature and then to pass over the pressure rod **11** so that this same surface then has a concave curvature. Blanket surface **14** is made of rubber or some similarly resilient non-compressible material and will be understood to contract as a result of the combined effect of the nip A and the change of curvature in the blanket **10**. More particularly, this contraction in blanket surface **14** occurs during travel of the blanket **10** from nip point A to the point designated B, the last point of contact between the blanket **10** and pressure rod **11**, these two points being the start and end respectively of what will hereinafter be referred to as the shrinking nip **13** of the machine. A paper web **15** is fed over a spreader rod **16** and onto the rubber surface **14** of the blanket **10** at the nip point A of the shrinking nip **13**. Thus, when this traveling blanket surface **14** thereafter contracts during passage through the shrinking nip **13** it compacts or squeezes together the fibers of the paper web **15** and as a result imparts a controlled degree of extensibility to the paper web. During this compaction of the paper web **15** a normal pressure is applied against it to prevent creping or crinkling of the paper web surfaces.

As best seen in FIG. 3, the vicinity of point A, the magnitude of normal pressure is mainly a function of the force A′ exerted by the nip rod **12** against the underside of the blanket **10**. Although not shown, it will be understood that the support for the nip rod **12** is adjustable towards or away from the pressure rod **11** to regulate this force. Normally the nip rod **12** is arranged to press strongly against the blanket **10** so that the normal pressure exerted against the paper web **15** in the vicinity of point A is quite high. On the other hand, the normal pressure in the vicinity of point B, the last point of contact between the paper web **15** and the pressure rod **11**, is mainly a function only of the force B′ which draws the blanket **10** through the shrinking nip **13**. The normal pressure exerted against the paper web **15** in the vicinity of point B is therefore usually considerably smaller in magnitude.

This variation in normal pressure being exerted against the paper web **15** complicates the problem of providing lubrication between the web and that portion of the pressure rod surface that extends the length of the shrinking nip **13** from point A to point B. This surface portion of the pressure rod **11** is designated **17** in FIGS. 3 and 4.

It has been found however that a film of steam can successfully be used to lubricate between surface **17** and web **15** without adversely effecting compaction of the web **15**. The reason that steam is suitable for this purpose is that some of its heat is lost to the paper web **15** during travel from point A to point B. This loss of heat results in some condensation of the steam and a corresponding reduction of its pressure as it flows from point A to point B. Thus while the steam is initially introduced at a sufficient high pressure to enter between the surface of the pressure rod **11** and the web **15** at point A, this pressure gradually decreases in magnitude from this point of entry to point B. Thus, the steam film shown slightly exaggerated in FIG. 3 and designated **18** therein, which forms between the pressure rod surface **17** and the web **15** in the critical area from point A to point B only slightly lifts the blanket **10** off the pressure rod **11** and thereby substantially reduces friction forces therebetween, but otherwise does not permit creping of the surfaces of the web **15**.

One preferred arrangement for introducing the steam film **18** between the web **15** and the pressure rod surface **17** is shown in FIGS. 2, 3 and 4. Starting with a pressure rod **11** that is essentially cylindrical in shape, a rectangular shaped portion of the rod is removed to make room for a similarly shaped segment **19**. Segment **19** is welded as a side wall to a structure forming a box-like member **20**, which member then is positioned within the hollow interior **21** of the pressure rod **11** and welded to this rod along the lines **22** and **23**. Before sealing the ends of the member **20**, spacer elements **24** are connected at spaced points between its upper and lower sides to provide rigidity to this member. A member **25** is connected between the opposite side wall **26** of the box-like member **20** and the inner surface **27** of the pressure rod **11** to hold the box-like member **20** in position. A pipe **28** is welded in an opening **29** in the pressure rod **11** and extends through an opening **30** in the box-like member **20**. Steam is supplied from a suitable source **31** through this inlet pipe **28** into the hollow interior **32** of the box-like member **20**. This steam is then forced out through a slot **33** milled in the segment **19** and enters between the surface of the pressure rod **11** and the web **15**. The length of the slot **33** preferably should be the same dimension as the width of the web **15**.

The point of entry of the steam into the shrinking nip **13** is essentially at point A. After entering the shrinking nip **13** at this point the steam flows in the direction of blanket travel. As previously indicated, this results in the formation of a steam film **18** between the pressure rod surface **17** and the web **15** which provides effective lubrication between this surface and web.

Apart from the use of a steam film as just described, other lubricating practices are followed to reduce the friction forces and thus the power requirement of this type machinery. For example, the pressure rod **11** and the nip rod **12** are made of a material having a relatively smooth surface. Also, since the paper web **15** does not contact the nip rod **12**, the surface of this rod can be freely lubricated. Water, designated **34** in FIG. 2 supplied through a spray pipe **35** is the preferred mode of lubricating the nip rod **12**. A diluee water solution of silicone, designated **36** in FIG. 2, is also supplied through a pipe **37** and sprayed onto the paper web **15** and has been found not to adversely affect the properties or appearance of the paper produced. Restricted to lubrication techniques not including use of the steam film **18**, a machine 60 inches wide has been successfully operated at a speed of 1000 feet per minute. The power requirement for this machine however is in excess of 192 horsepower. Only when the steam film **18** is used is this horsepower requirement substantially reduced. Experimental runs indicate this reduction to be in the order of 70 percent.

These experimental runs also have resulted in the particular design of the pressure rod slot **33** shown in FIGS. 3 and 4. Instead of using this slot, the steam at first was injected into the shrinking nip **13** through spaced ports provided in the pressure rod **11**. It was observed that the water solution of silicone used to lubricate the paper web **15** was removed in the areas of the ports but not in the areas between the ports thus leaving objectionable marks on the paper web. The use of a continuous opening across the pressure bar **11** such as slot **33**, instead of spaced ports, eliminates these undesirable marks.

After finishing some runs it was also observed that the slot **33** when arranged radially in the pressure rod **11** would be partially filled up with small rubber particles. To eliminate this plugging up of the lubrication slot **33**, and even more important to prevent damage to the rubber faced surface **14** of the blanket **10**, the slot **33** should be slightly inclined in the direction of blanket travel. An angle of inclination of 30 degrees is preferred.

It was also observed that the movement of the blanket

10 over the pressure rod 11 has a tendency to close up the slot 33. To counteract this, a series of spaced bridges 38 are left standing in the bottom of the slot 33.

While the embodiment of the invention just described is preferred, it will nevertheless be understood that the invention is not to be limited to this embodiment but that various changes may be made thereto within the scope of the appended claims.

I claim:

1. In a paper web shrinking apparatus in the operation of which a paper web is carried on a longitudinally travelling blanket along a stationary surface and is confined against said surface by said blanket under a perpendicularly applied pressure which progressively decreases in magnitude in the direction of blanket travel, the improved means of reducing friction between said traveling paper web and surface using pressurized steam, said means comprising said surface having an opening therein only in the area thereof where the paper web initially contacts said surface, and means connected between a source of steam and said opening for flowing steam through said opening between the paper web and surface, said steam entering between the paper web and surface and flowing in the direction of blanket travel and due to heat loss to said paper web having a pressure which progressively decreases in magnitude substantially as the perpendicularly applied paper web confining pressure decreases in magnitude in the direction of blanket travel.

2. A means of using steam to reduce friction between a traveling paper web and a stationary surface as claimed in claim 1, wherein the opening in said surface for flowing the steam between the paper web and surface is a continuous slot across the width of said surface, said slot having an inclination of preferably 30 degrees in the direction of blanket travel.

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