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M. D. STONE
CALENDERING APPARATUS

3,027,827

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2 Sheets-Sheet 1

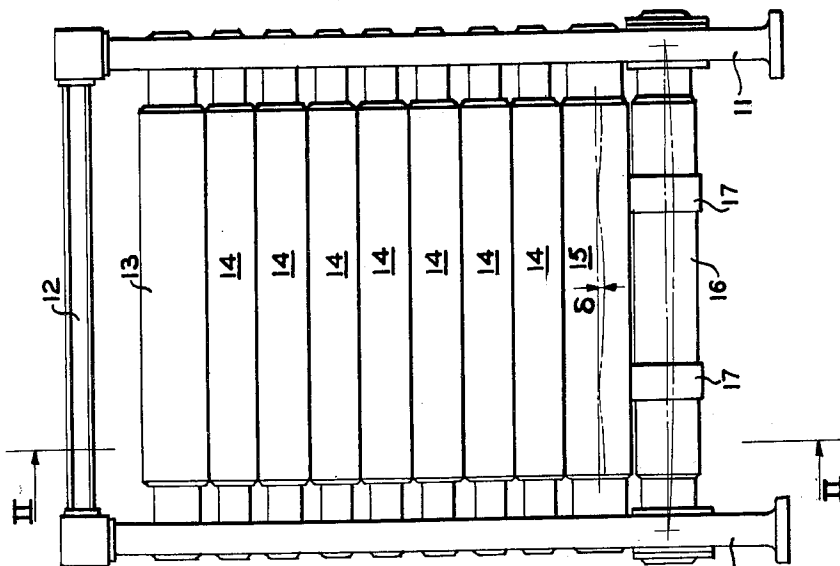


Fig. 1

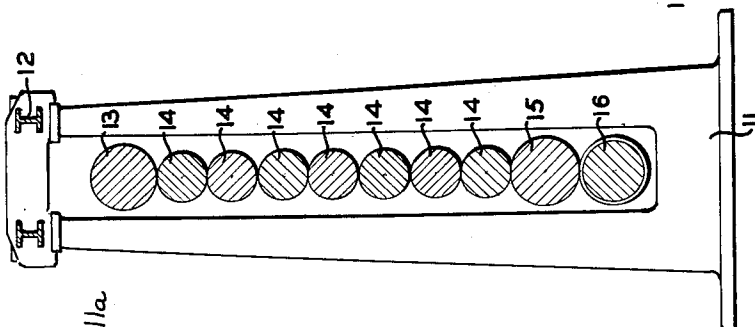


Fig. 2

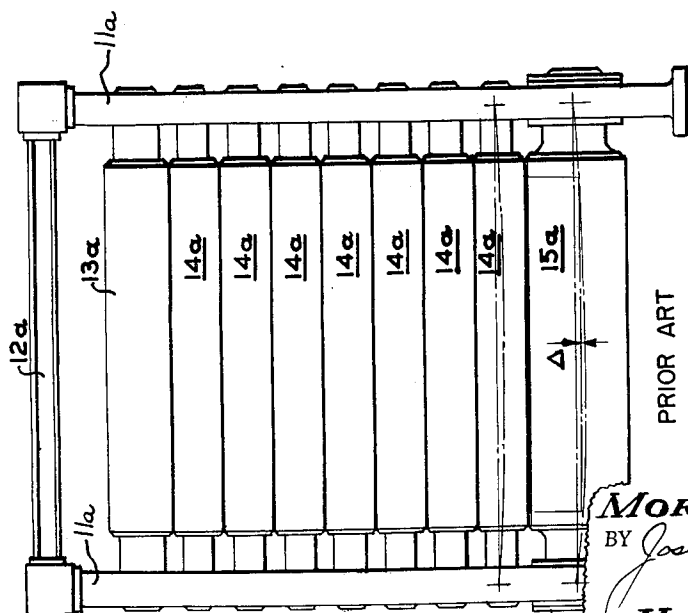


Fig. 3

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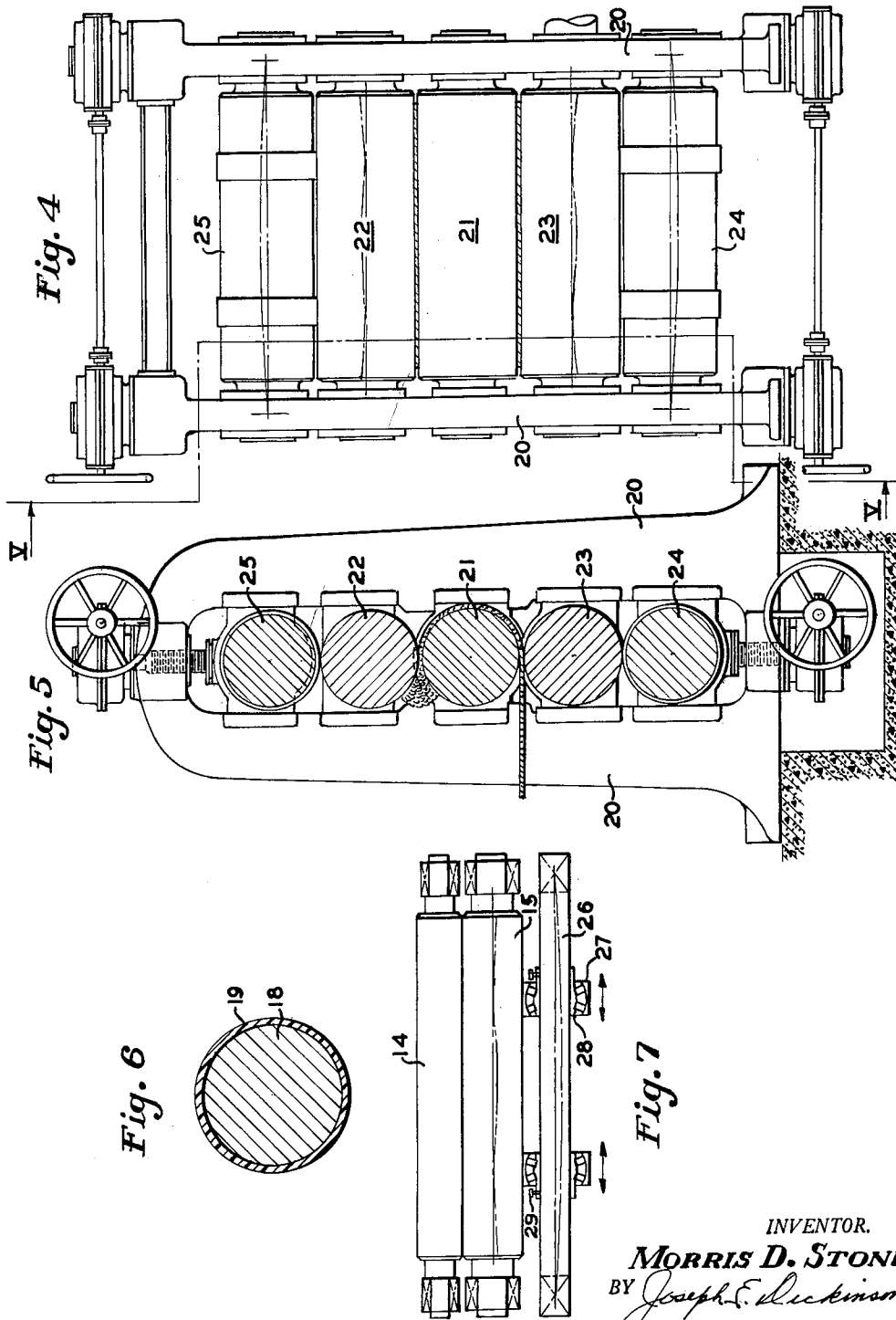
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1

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CALENDERING APPARATUS

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This invention relates to calendering apparatus as employed in the manufacturing of thin strip-like non-metallic material such as rubber, plastic, paper, textiles and the like. More particularly, the invention disclosed herein has to do with novel means adapted to render the material engaging roll or rolls non-deflective thereby to produce a calendered product characterized by a constant thickness throughout its width.

Although apparatus as presently employed in processing the aforementioned materials differs somewhat depending upon the construction characteristics and operational functions, the novel features of the present invention, as will be apparent to those skilled in the art, can be just as well realized in one of the types set forth. However, in the interest of brevity, it is felt only necessary to discuss the present invention in detail as employed in conjunction with a paper calendering apparatus and in a lesser degree as applied to a rubber calender.

In the manufacturing of various types of papers, the calendering operation plays a vital part in the perfection of the finished product both as to its uniformity in thickness across its width and in the surface properties, i.e., smoothness, luster or shine of the paper's surface. Whether it be a machine calender, breaker calender, smoothing calender or supercalender, the lower supporting roll, or what is commonly referred to as the king roll, is subject to the entire weight of the other rolls of the stack, plus the external pressures applied to the assembly by means of screws or other means. The lower roll being supported normally only at its ends deflects under this weight to a greater or lesser extent depending upon its length so that the material passing between the rolls would have an objectionable pressure and thickness across its width. To obviate this undesirable condition the king roll and one or more other rolls of the stack are provided with a crown, i.e., the roll surfaces are shaped in such a fashion as to provide a gradually increasing diameter from the ends to the center of the roll. In this manner the inherent deflection is compensated for whereby a uniform pressure is obtained at the nip of the two cooperating rolls. However, crowning of the rolls is effective only for the particular calculated pressure and paper width for which it was designed and only under such conditions does it afford a uniform pressure at the nip of the cooperating rolls. Inasmuch as the calendering pressure must be adjustable and the nips frequently changed to meet the optimum operation conditions for the many types and grades of paper which are normally produced, this requires a different crowned roll or rolls for each operation from which it is obvious that the convenience and economy of the operation are seriously jeopardized.

The present invention provides means in the form of a supporting roll adapted to engage with the bottom roll of a calender stack at two spaced predetermined points across the length thereby limiting materially the deflection of bottom roll and the rolls of the stack are thus provided with true horizontal calendering surfaces at the nips to yield a sheet having a constant thickness throughout its width. This supporting roll may take the form of an arbor having lands located thereon at points equidistant from its ends and spaced from each other by a distance of approximately .55 of the desired width of the material to be calendered. There are various forms for applying the principle of a land roll to control and limit the deflection

2

of other rolls, such as in a rubber calender, where it may be feasible to provide several landed rolls in order to take advantage of the invention herein disclosed. Normally, when a roll is subjected to pressure and supported at its ends, the deflection curve is a continuous arc extending from either end of the roll, with the greatest degree of deflection at the center thereby tending to cause the greatest variation in cross-sectional thickness at the center of the sheet, unless compensated for by crowning. In a calender incorporating the features of the land supporting roll, as herein disclosed, the roll which is to be rendered non-deflective is free at its ends permitting the ends of the roll to deflect in a direction toward the supporting land roll and the portion of the roll intermediate the two points engaged by the lands also to deflect toward the supporting land roll. The net result of this action is therefore to reduce very greatly the magnitude of the deflection of the calender roll which, for practical purposes, may be considered to be negligible.

Accordingly, the principal object of this invention is to provide an external supporting roll for one or more rolls of a calendering apparatus having a body portion and a pair of enlarged diameter portions spaced apart from one another and equidistant from the perpendicular axis of the roll whereby the deflection of the calender rolls is greatly reduced.

It is another object of this invention to provide a supporting or backing up roll, having lands spaced along its length, for one or more rolls of a calendering apparatus of which the lands are spaced apart from one another a distance of the order of .55 of the width of the material being calendered.

It is a still further object of this invention to provide a roll having lands composed of replaceable sleeves made of a material softer than the calender rolls thereby to prevent marking of the calender roll surfaces.

It is another object of this invention to provide a roll having lands which are adjustable axially so as to provide the most optimum calendering conditions.

These objects, as well as the various other novel features and advantages of this invention, will become apparent when the following detailed description is read in conjunction with the accompanying drawings of which:

FIG. 1 is a front elevational view of a paper calender incorporating the features of the invention herein disclosed;

FIG. 2 is an end sectional view taken on lines II—II of FIG. 1;

FIG. 3 is a front elevational view of a paper calender constructed in accordance with the practice of the prior art;

FIG. 4 is a front elevational view of a rubber calender in which the features of the present invention have been incorporated;

FIG. 5 is a sectional end view taken on lines V—V of FIG. 4;

FIG. 6 is a sectional view of a modified form of the supporting roll shown in FIGS. 1 and 4, and

FIG. 7 is a view showing the lower rolls of the calender illustrated in FIG. 1 with which there is employed another modified form of supporting roll.

With reference to FIGS. 1 and 2 in which the present invention is shown to be incorporated in a paper calender, the calender comprises essentially spaced vertically disposed frames 11 which at their bases are secured to suitable foundations and at their tops connected together by means of separator beams 12 thereby to provide a very rigid structure. Each frame is provided with a vertically extending window into which there is received a stack of rolls consisting of a top roll 13, a series of intermediate smaller diameter rolls 14, a bottom roll 15 of the same diameter as roll 13 and directly below this

3

bottom roll a supporting roll 16. The roll ends in the case of the rolls 13, 14 and 15 are freely mounted in the frames being provided with babbitt or roller bearings each having individual chock or bearing housings which serve to guide the rolls vertically in the windows so that by reason of the construction very little pressure is actually imposed upon their bearings. The bearings for the supporting roll 16 being subject to the entire weight of the stack are usually of the water-cooled babbitt or roller type, but they may also be of the anti-friction type. Although not shown, pressure applying means may be provided at the top of the calender which may be of the pneumatic, hydraulic or mechanical type whereby additional but controlled pressure may be applied to the top roll 13 and transferred thereby through the intermediate rolls 14 to the bottom roll 15 and land supporting roll 16.

The enlarged diameter or land portions 17 of the supporting roll 16 are symmetrically located with respect to the center line of the calender and for best results the distance between the lands should be of the order of .55 of the width of the paper to be calendered. In the particular form shown, the supporting roll 16 is positively driven and the remainder of the rolls of the stack rotated by friction but alternately the bottom roll 15 might be driven.

A conventional calender is illustrated in FIG. 3 and it consists of a pair of frames 11a secured at their bases to a suitable foundation and connected together at their upper portions by suitable separator beams 12a. Each frame is provided with vertical openings or windows within which the ends of top roll 13a, intermediate rolls 14a and king roll 15a are slidably mounted in suitable bearing supports. Although not shown in the drawing, adequate pressure applying means normally mounted at the top of the calender may be employed for impressing upon the rolls the controlled pressure required for carrying out a particular calendering operation.

To better understand the remarkable effect that the lands exercise in maintaining the bottom roll 15 straight and undeflected, reference is made to the diagrammatic illustrations shown in FIG. 1 of the improved calender and FIG. 3 of a calender constructed in accordance with the prior art. By comparing the relative deflections of the bottom roll 15 of the improved calender with the king roll 15a of the conventional calender, the advantages gained by employing a supporting or backing roll with lands are apparent to one skilled in the art. It is of interest to note that in the improved calender the bottom roll 15 is of a greatly reduced diameter as compared with the king roll 15a of the conventional calender of FIG. 3, the reduction being made possible by the employment of the additional supporting roll 16. The king roll 15a of the conventional calender is usually crowned so that under predetermined rolling conditions the roll, although deflected during the calender operation, will maintain the nip in substantially a true horizontal plane. However, as mentioned heretofore, by reason of the varying conditions under which the calender will be required to perform, the crown given to the king roll 15 will not properly compensate for the roll deflection under any conditions other than normal. Thus, it is apparent that the paper being processed will have characteristic objectionable variations in its transverse cross-sectional thickness.

In the improved calender shown in FIGS. 1 and 2, it is not necessary to employ crowned rolls inasmuch as the deflection of the bottom roll 15 is so reduced that for all practical purposes it may be considered to be negligible. This is attained by reason of the novel arrangement and the character of the supporting roll 16 as disclosed in the present invention. Although as shown in FIG. 1, the supporting roll 16 will deflect between points fixed by its bearings, the deflection of the roll axis will not particularly affect the bottom roll 15. The lands 17 are located approximately midway between the center and

4

ends of the king roll 15, preferably being spaced from each other by a distance of .55 of the width of the paper being calendered. As clearly shown in FIG. 1, the resistant pressure provided by the presence of the supporting roll 16 at its points of contact with the roll 15, instead of the axis of the roll 15 deflecting in a continuous arc, as in the case of the conventional calender shown in FIG. 3, the axis will be displaced somewhat as shown by the deflection curve in FIG. 1. It is noted that since the outer ends of the roll 15 are not fixed, the deflection thereof will be in a direction toward the supporting roll 16 as will be the portion of the roll 15 intermediate the two points engaged by the lands. The net result of this action is therefore to reduce greatly the magnitude of the deflection of the king roll to such an extent that for all practical purposes it may be considered to be negligible and the nips of the stock will be characterized by essentially parallel cooperating surfaces so that the paper being calendered will issue from the last nip possessing a uniform thickness throughout its width. Considering the deflection at the center of the roll with respect to the edge of the paper as Δ , it has been determined that the maximum deflection of the bottom roll 15 within the width of the paper of the calender disclosed, δ , herein will be of the order of .005 Δ , for the same roll diameter.

In FIGS. 4 and 5 a rubber calender has been arbitrarily selected for illustrating the features of the present invention in connection with a calender other than of the type for processing paper. The form shown is a three-roll type calender including vertical housings 20 rotatably supporting a fixed center roll 21 and vertically disposed outer rolls 22 and 23 adapted to engage the opposite sides of the roll 21 which are adjustable in the usual fashion relative to the roll 21. The rolls in a conventional calender are normally supported at their ends so that they are permitted to deflect between their bearings thereby causing the rubber sheet delivered by the calender to have a non-uniform thickness across its width. To obviate this condition, the outer rolls 22 and 23 are each supported by land rolls 24 and 25 constructed in a similar fashion to the roll proposed for the paper calender and arranged on the same vertical centerline as the rolls 22 and 23. External pressure is supplied by suitable means, not shown in detail, to the two ends of the two supporting rolls 24 and 25. As in the case of the paper calender, the arrangement of the lands centrally with respect to the centerline of the calender and spaced apart by a distance of the order of .55 of the width of the material to be processed will restrict the deflection of the rolls 22 and 23 so effectively that for all practical purposes it may be considered to be negligible, thereby causing a product to be yielded having a uniform thickness throughout its width.

In FIG. 6 a modified form of the land roll is illustrated in which a roll is provided having a metallic center body portion 18 and two land portions 19 made up in the form of sleeves of paper, rubber, mica or the like, which materials are capable of carrying the pressures involved but are of such softness compared with the main body of the roll 15 that no marking of the roll 15 can take place. The sleeves are replaceable so that after they have become worn, the rolls are removed from service and the sleeves slipped off and new ones substituted therefor. Normally, the roll having the lands made out of the same material as the main body thereof will be satisfactory. However, when extremely large pressures are to be encountered the use of the modified form as shown in FIG. 6 may be more desirable.

It may be desirable in connection with a calender adapted to process material covering a wide range of widths to provide for adjustment of the land portions axially either towards or away from one another. In FIG. 7 a supporting roll incorporating these features is diagrammatically illustrated. By axially adjusting the lands, the distance between them may be maintained substantially of the order of .55 of the width of the mate-

5

rial being processed. In this construction a non-rotatable shaft 26 is provided and adapted to carry two adjustable lands 27 which are rotatably supported by means of spherical roller bearings 28 mounted on the shaft. The inner races of the bearings extend outwardly and are provided with suitable set screws 29 adapted to be drawn up tight against the shaft 26. Not only does this arrangement provide for ready adjustment of the lands but it also permits the outer races of the bearings to move angularly on deflection of the shaft and relative to their inner races whereby full rolling contact will be maintained between the lands and the bottom roll.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a calender for processing material having a substantially uniform thickness across its width comprising at least one pair of material engaging rolls between which the material to be calendered is passed, a supporting roll for at least one of said material engaging rolls, a pair of lands on said supporting roll in contact with said material engaging roll at points spaced apart from one another by a distance less than the width of the strip to be reduced, the spacing of said points bearing a direct relationship to the width of material being processed and of the order of .55 thereof, thereby to control and limit the extent to which said material engaging roll is deflected during the calendering operation, said lands being made of a material softer than said supported material-engaging roll thereby to prevent marking of said roll.

2. In a calender for processing material having a sub-

6

stantially uniform thickness across its width comprising at least one pair of material engaging rolls between which the material to be calendered is passed, a supporting roll for at least one of said material engaging rolls, a pair of lands on said supporting roll in contact with said material engaging roll at points spaced apart from one another by a distance less than the width of the strip to be reduced, the spacing of said points bearing a direct relationship to the width of material being processed and of the order of .55 thereof, thereby to control and limit the extent to which said material engaging roll is deflected during the calendering operation, said lands consisting of spherical anti-friction bearings adapted to rotate relative to said supporting roll.

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