

Feb. 7, 1961

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2,970,339

CALENDER ROLL HAVING ADJUSTABLE CROWN

Filed Sept. 12, 1957

3 Sheets-Sheet 1

FIG. 1

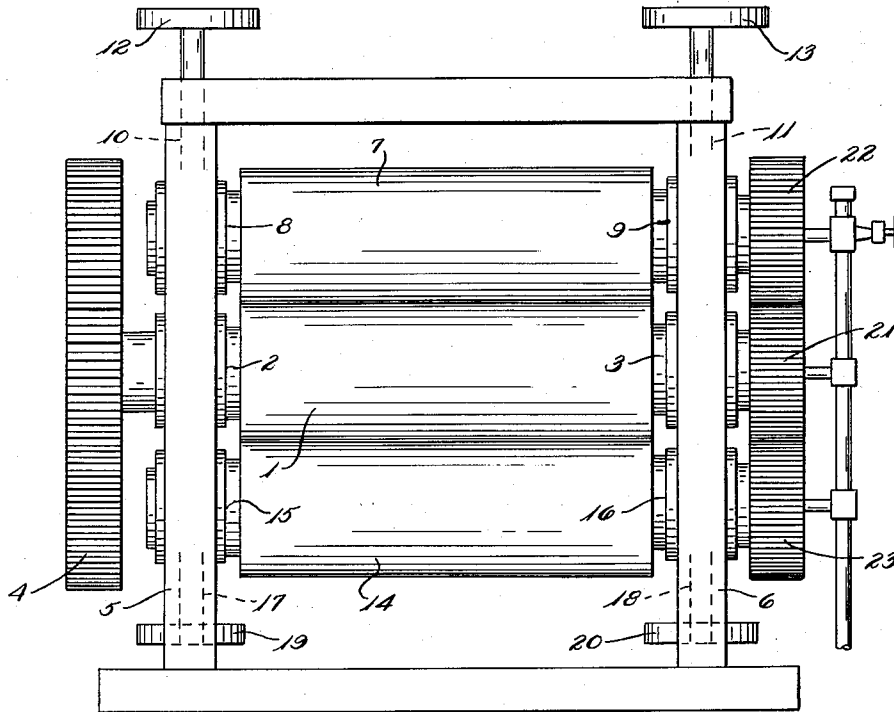
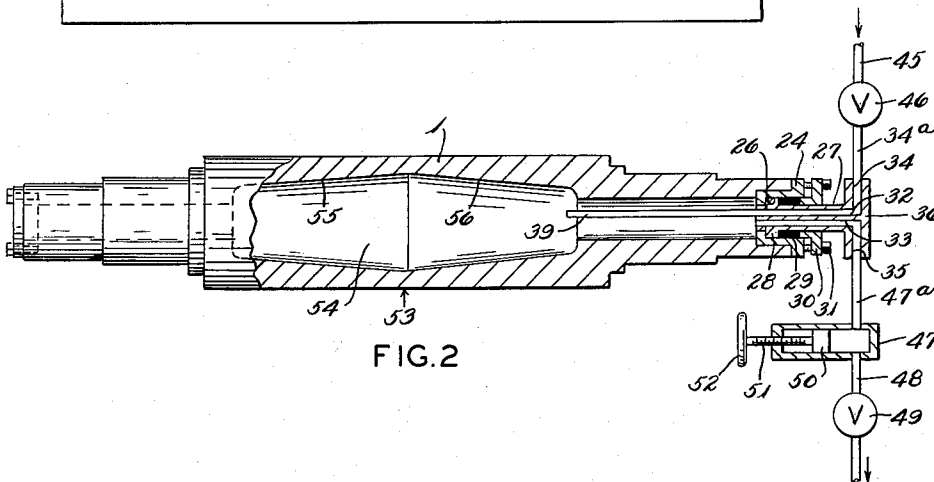


FIG. 2



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3 Sheets-Sheet 2

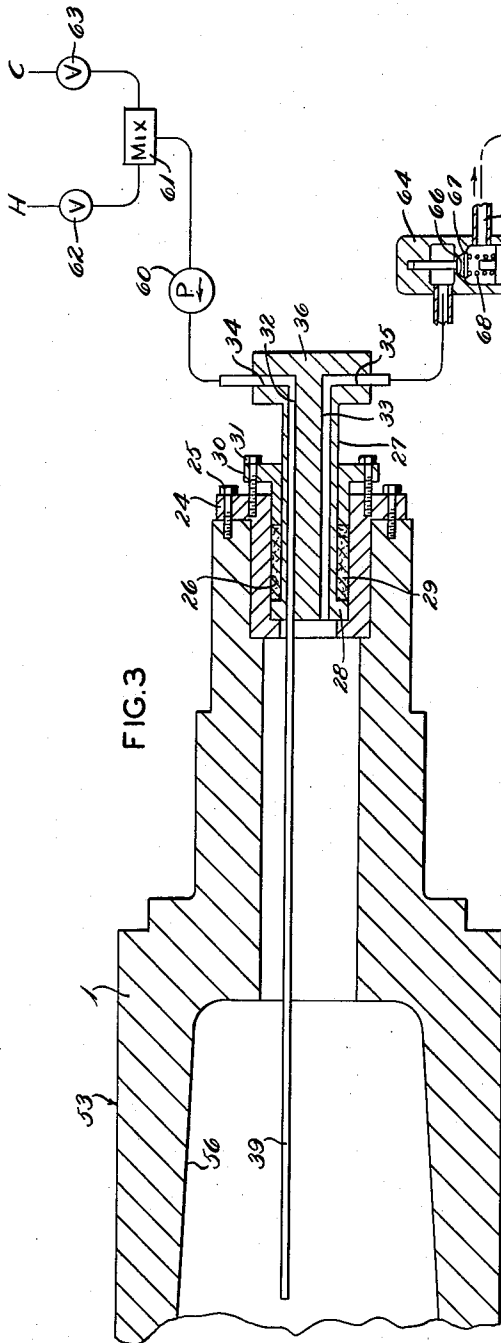


FIG. 3

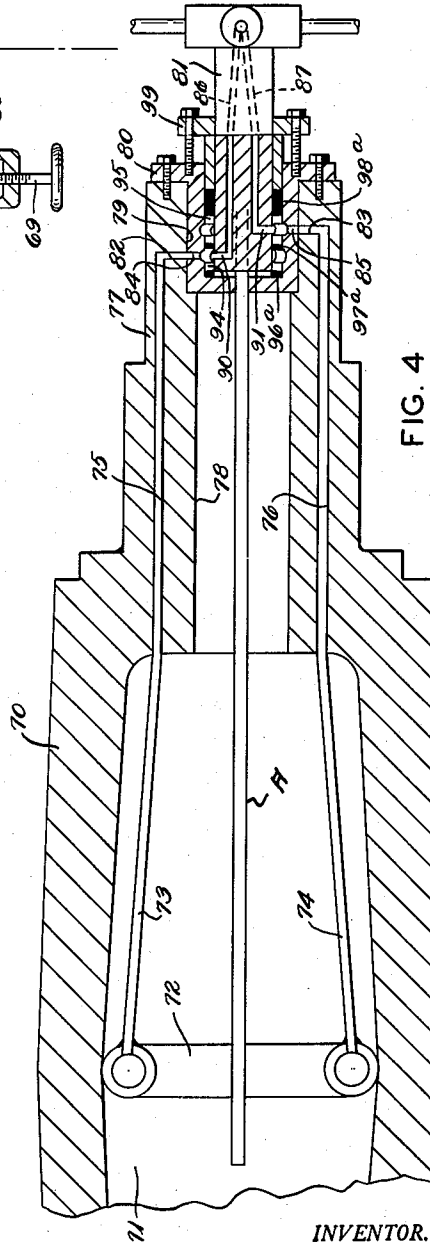


FIG. 4

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3 Sheets-Sheet 3

FIG. 5

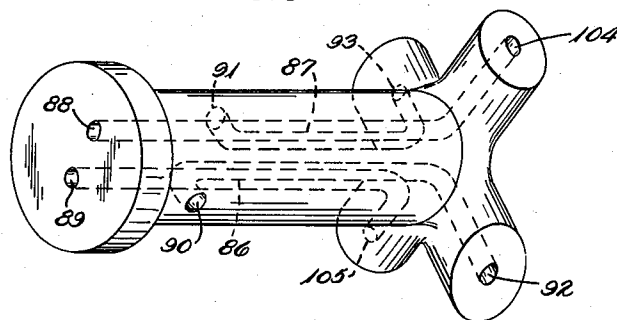
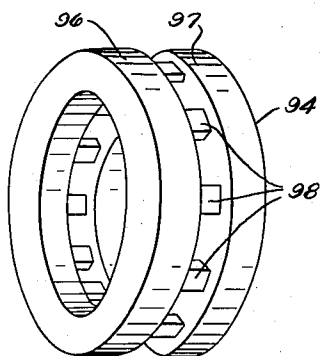


FIG. 6

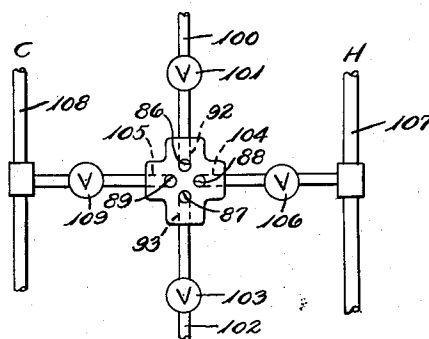


FIG. 7

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2,970,339

CALENDER ROLL HAVING ADJUSTABLE CROWN

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4 Claims. (Cl. 18—2)

This invention relates to calenders for sheeting rubber, plastic or other similar materials and especially to a roll therefor having an adjustable crown.

In the manufacture of rubber, plastic and similar materials, it is desirable to provide machines having at least one pair of cooperating rolls to form the material from a mass thereof into sheet form.

The pressure required to roll a sheet of such material from a batch thereof increases rapidly as the desired thickness of sheet product is reduced. The pressures required ordinarily are so great as to cause the rolls to bow or deflect and to overcome the consequent increase in thickness along a medial zone of the rolled sheet, it has been common practice to provide calender rolls whose working faces are crowned or in other words whose diameters are made slightly larger at the centers of the working faces than at the margins of the working faces.

One difficulty experienced with crowned rolls is that if the crown is correct for rolling one composition to a certain thickness, it is incorrect for rolling the same composition to a different thickness or for rolling a different composition the same thickness.

It has also been proposed to provide complex adjusting mechanisms for throwing the axes of calender rolls out of parallel to counteract bowing of the rolls. Such efforts have encountered many mechanical difficulties and have not been too satisfactory.

The present invention has for its object to provide a calender roll having means for changing its amount of crown at the will of the calender operator.

Other objects are to provide for heating or cooling a calender roll while simultaneously controlling its amount of crown to accomplish crown adjustment without changing the axial plane of the roll, and to provide for adjusting the crown of the roll while the roll is in use.

These and other objects will appear from the following description and the accompanying drawings.

Of the drawings:

Fig. 1 is a front view of a three roll calender;

Fig. 2 is an axial sectional view of a calender roll therefor showing one form of the invention;

Fig. 3 is an axial sectional view of one end of a calender roll and showing in diagram pipe connections and valves, part of the roll being broken away, the figure illustrating a modification of the invention;

Fig. 4 is an axial sectional view of one end of a calender roll illustrating another modification of the invention, the opposite end of the roll being broken away;

Fig. 5 is a detail perspective view of a four connection mill-tee as used in the modification of Fig. 4;

Fig. 6 is a detail perspective view of one of the lantern rings of Fig. 4; and

Fig. 7 is an end view of the mill-tee of Fig. 5 showing the piping and valves.

Referring to the drawings and first to Fig. 1 thereof, this shows an example of a three roll calender such as is employed in the rubber industry. In such a calender, a center roll 1 is mounted in fixed bearings 2, 3 for rota-

2

tion by a bull gear 4, the bearings being secured in frame members 5, 6. The upper roll 7 is mounted for rotation in bearings 8, 9 which are vertically adjustable in the frame members 5, 6. Screws 10, 11 are provided to adjust the roll 7 and its bearings and may be adjusted as by rotating wheels 12, 13 fixed to screws 10, 11, or in any other manner. In similar manner, the lower roll 14 is mounted for rotating in bearings 15, 16 mounted for vertical adjustment in frame members 5, 6 and adjusted by screws 17, 18 having wheels 19, 20 secured thereto for turning them.

Roll 1 drives rolls 7 and 14 through a gear 21 fixed to roll 1 and gears 22 and 23 fixed to rolls 7 and 14 respectively and meshing with gear 21.

For regulating the temperature of the individual rolls, each roll is made hollow so that cold or hot water or steam may be circulated therethrough. To accomplish circulation while permitting the roll to rotate, a cap member 24 is secured to an end of the roll, as by bolts 25 and is bored to provide a cylindrical recess 26. A connector body 27, commonly known as a "mill-tee," having an outwardly extending flange 28, is rotatably mounted in the recess, a packing 29 is mounted thereabout, and a gland 30 is secured over the packing by bolts 31.

The body 27 has an inlet passage 32 and an outlet passage 33 extending therealong from its inner end to positions outside the roll where they connect with radial passages 34 and 35, respectively, extending in opposite directions through a head 36 of the body. The body 27 is prevented from rotating by an inlet pipe 37 and an outlet pipe 38 secured to passages 34 and 35, respectively, or by any other means while the roll may rotate because of the slip connection. A pipe 39 may be secured to the inlet passage 32 and may extend for a distance within the roll to more uniformly distribute the heating or cooling medium.

The inlet pipe is ordinarily connected to a control valve (not shown) connecting it to a cold water supply and also to a control valve (not shown) connecting it to a hot water or steam supply. These valves may be hand controlled valves or may be thermostatically controlled to provide the desired temperature of the roll.

It is a feature of the present invention to provide for adjusting the crown of a calender roll by pressure applied internally. In one form of the invention, this is accomplished by filling the roll with a liquid or other flowable material and placing the liquid under pressure sufficient to expand the roll to a degree to provide the desired crown. As shown in Fig. 2, the roll 1 may be any calender roll and is of the same construction as the rolls of Fig. 1 and has the same slip connections communicating with inlet passage 34 and outlet passage 35, respectively. In this form of the invention, the inlet passage 34 is connected by a pipe 34a to a supply of fluid, indicated by the pipe 45, by a shut-off valve 46 and the outlet 35 is connected to a pressure cylinder 47 by a pipe 47a. Cylinder 47 is also provided with a drain line 48 normally closed by a valve 49. A piston 50 in cylinder 47 may be moved lengthwise thereof by a hand screw 51 controlled by a hand wheel 52.

With the arrangement of Fig. 2, the roll may be filled with water or other liquid by closing valve 49 and opening valve 46. Valve 46 is then closed and the liquid in the rolls may be placed under pressure by moving the piston 50. This results in expansion of the roll 1. Now the center of the roll is more yielding under pressure than the ends of the rolls which have a smaller bore and thicker walls. This results in the diameter of the roll being increased more at the center than at the ends providing a crown depending in amount upon the internal pressure.

In order to provide more uniform expansion, the roll

3

is preferably machined throughout its bore so that the wall surfaces are uniformly concentric. In Fig. 2, the working face of the roll is indicated by the numeral 53. This face may be initially cylindrical but is preferably machined to be initially slightly crowned. To provide further for greater expansion of the roll 1 at the center of its working face, the cavity 54 is machined to provide walls which progressively decrease in thickness from the ends of the roll face to its center as by making the surfaces 55, 56 conical.

In Fig. 3 only one end of the roll 1 is shown to indicate the pipe connections, other portions being broken away and the other end of the roll being closed. The roll is identical in construction with that shown in Fig. 2. In this form of the invention, the fluid used ordinarily to heat or cool the roll is additionally employed to provide fluid pressure to increase the crown of the roll in use. For this purpose, the inlet connection 34 is connected to the outlet of a high pressure pump 60. The inlet of the pump 60 is connected to a mixer 61 which in turn is supplied by hot and cold water or other liquid by way of valves 62, 63. By adjustment of valves 62, 63, the pump is supplied by temperature controlling liquid at any desired temperature. The outlet passage 35 from the roll is connected to a pressure relief valve 64 having an outlet 65 connected to a drain. The valve has a valve seat 66 and a poppet valve 67 seated therein. The valve is held against its seat by a coil spring 68. The side of the valve opposite the spring is exposed to pressure from the roll 1 and the valve may open to exhaust under fluid pressure exceeding tension of the spring. Spring tension may be adjusted by a screw 69.

The arrangement is such that by adjustment of relief valve 64, the liquid pressure in the roll may be held at a desired amount to provide expansion of the roll to increase its crown as desired while at the same time by control of valves 62 and 63, the roll may be kept at the desired temperature by use of the same liquid. In place of the mixer 61, a heat exchanger may be provided and cooling or heating water from a single supply may be supplied therethrough to the pump 60, the temperature of the liquid delivered to the pump being provided by transfer of heat thereto from the hot and cold supplies 62, 63.

The modification of the invention shown in Figs. 4 to 7, inclusive, provides for expanding a calender roll by pressure applied from within while controlling temperature of the rolls by circulation of liquid there-through. In this form of the invention, a calender roll 70 is externally similar to the roll 1 previously illustrated and is chambered similar to the roll 1. Within its chamber 71 however and at the central plane of the roll face is an annular tubular body 72 having an outer diameter equal to the interior diameter of the roll at that position. Two tubular connections 73, 74 extend from one side of the ring and are connected to passages 75, 76 respectively, extending lengthwise of the roll neck 77 at opposite positions spaced radially from the bore 78, the connections being preferably made by welding.

The end of the roll neck 77 is counterbored, as at 79, to receive a cap member 80 having a cylindrical counter-bore for receiving a slip connection 81, commonly known as a mill-tee, the purpose of which is to provide continuous connection between fluid passages of a rotating roll and its supply pipes. In the present embodiment of the invention, it is desired to heat and expand the tubular body 72 and thereby to expand the center of the roll and for this purpose steam or pressure liquid supply and exhaust connections 73, 74 are connected through the mill-tee. Also the roll must have temperature control so connections including a supply and exhaust for chamber 71 are also provided through the mill-tee. For this purpose radial passages 82, 83 connecting with passages 75, 76 respectively are provided in the roll neck at axially spaced positions and connecting open-

4

ings 84, 85, in continuation thereof, are provided through the wall of the cap member.

The slip connection or mill-tee is shown in Fig. 5 and has four axially extending passages 86, 87, 88 and 89. Of these, passages 86 and 87 terminate in side openings 90 and 91 respectively in axial alignment with passages 84, 85 respectively. Their opposite ends terminate in radial openings 92, 93 respectively. A pair of similar lantern rings 94, 95, of which 94 is illustrated in Fig. 6, each comprise spaced parallel rings 96, 97, held in spaced relation by spindles 98. They are slidably mounted about the mill-tee within the cap 80 with their central spaces connecting passages 84, 85 to openings 90, 91, respectively. Gasket rings 96a and 97a flanking lantern ring 94 and packing ring 98a are provided to seal the joints and a gland 99 compresses the gaskets and packing ring. Passage 92 is connected to a steam supply line 100 through a valve 101 and passage 93 is connected to a drain line 102 through a valve 103.

Passages 88, 89 of the mill-tee are connected to radial openings 104, 105, respectively, in the head of the mill-tee. The opening 104 is connected through a valve 106 to a supply line 107 of steam or hot water. The opening 105 is connected through a valve 109 with a supply line 108 of cold water. By regulating valves 106, 107, the temperature of the roll may be maintained at a desired amount. By controlling the pressure of the hydraulic liquid supplied to the ring 72, which may be done by manipulating valves 101, 103, and varying the pressure on the supplied liquid, the ring 72 may be expanded to increase the crown of the roll, as desired.

It should be realized that the working roll 1 may originally be of true cylindrical outer contour, if desired, and that the other rolls 7 and 14 may be constructed like the roll 1, or may be of conventional construction and operation, as desired. A conventional spray pipe A is shown in Fig. 4 for other temperature control action.

The desired internal fluid expanding pressure can be supplied in the roll 1 without any control of the temperature thereof when no temperature regulation on the material being processed by the working roll 1 is required. Obviously, the roll 1 of the invention can be used for rolling any desired material in any known type of rolling or calendering operation, as long as the roll 1 can be provided with sufficient strength and other operating characteristics as is required for operating upon such given material.

In another aspect of the invention, and especially where no control of the temperature of the roll is required, it would be possible to fill such a roll with a plastic substance such as vulcanized or unvulcanized natural rubber, synthetic rubber, or the like and wherein the plastic substance is flowable, but not compressible so that it readily transmits pressure therethrough. In such instance, a roll like the roll 1 would be completely filled with the plastic substance and with the cap member supplied at one end thereof, like the cap member 24, being provided with some type of a pressure screw and end piston unit therein bearing upon the plastic material within the roll cavity so that any desired pressure can be exerted upon the roll for bowing or crowning the center portion of the roll desired amounts. Pressures of, for example, 1500 to 2000 lb. per square inch may be used to obtain the desired crowning action of the rolls. It should be realized that in all events the internal bores of the rolls of the invention need not be exactly of conical shape, but a generally conical shape would be sufficient in some practice of the invention. Also, the invention contemplates the use of rolls with cylindrical center bores as the supports for the rolls are provided at the ends thereof and the centers of the rolls will crown with the application of internal pressures thereto.

From the foregoing, it will be seen that a novel and improved type of a calender roll has been provided by

5

the invention and that small amounts of crown at the center portion of the roll can be readily provided in this roll of the invention. Obviously, rolls of this type only need to be crowned a few thousandths or ten thousandths of an inch at the center portion thereof under most circumstances but they may be crowned more than that to give excellent rolling action to provide flat calendered sheets of uniform thicknesses throughout the widths thereof, or to give other results or action, as desired. Hence, it is believed that the objects of the invention have been achieved.

While several complete embodiments of the invention have been disclosed herein, it will be appreciated that modification of these particular embodiments of the invention may be resorted to without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A cylindrical metal roll for rolling deformable material into sheets of accurate thickness and having a chamber underlying its working face and having walls decreasing in thickness towards the center of the roll, said roll and its walls being rigid and of sufficient strength to withstand normal operative forces applied thereto, incompressible but flowable material positioned within and filling said chamber, and means engaging said material for applying pressure thereto for expanding the roll to provide it with a crown intermediate the ends thereof, said means connecting to said material and being able to vary the pressure exerted thereon when the roll is rotating.

2. A cylindrical metal calender roll having a chamber underlying its working face and having walls progressively decreasing in thickness towards the center of the roll, said roll and its walls being rigid and of sufficient strength to withstand normal operative forces applied thereto, means within said chamber for expanding the roll to provide it with a crown intermediate the ends thereof, said means comprising a body of incompressible liquid confined within and completely filling said chamber, and second means engaging said liquid for applying pressure to and maintaining it on said liquid.

6

3. A cylindrical metal calender roll having a chamber underlying its working face and having walls decreasing in thickness towards the center of the roll, said roll and its walls being rigid and of sufficient strength to withstand normal operative forces applied thereto, means within said chamber for expanding the roll to provide it with a crown intermediate the ends thereof, said means comprising a body of liquid confined within and completely filling said chamber, and second means engaging said liquid for applying pressure to said liquid.

4. In a heavy duty mill for accurately sized sheet rolling action and comprising a plurality of metal rolls positioned for rolling pressure engagement therebetween, the improvement for crowning at least one of said calender rolls having an axially extending center chamber therein filled with substantially incompressible but flowable material, said center chamber connecting to at least one end of said calender roll, said calender center chamber being of twin frusto-conical shape with the bases of the cones being at the center of the roll the walls of which have sufficient strength to withstand normal rolling pressures applied thereto, and means connecting to the material in said center chamber to apply pressures to said material to produce a controllable center crown on said calender roll in the range of from a few ten thousandths of an inch to a few thousandths of an inch thereon.

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