March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Filed Jan. 17, 1955 6 Sheets-Sheet 1

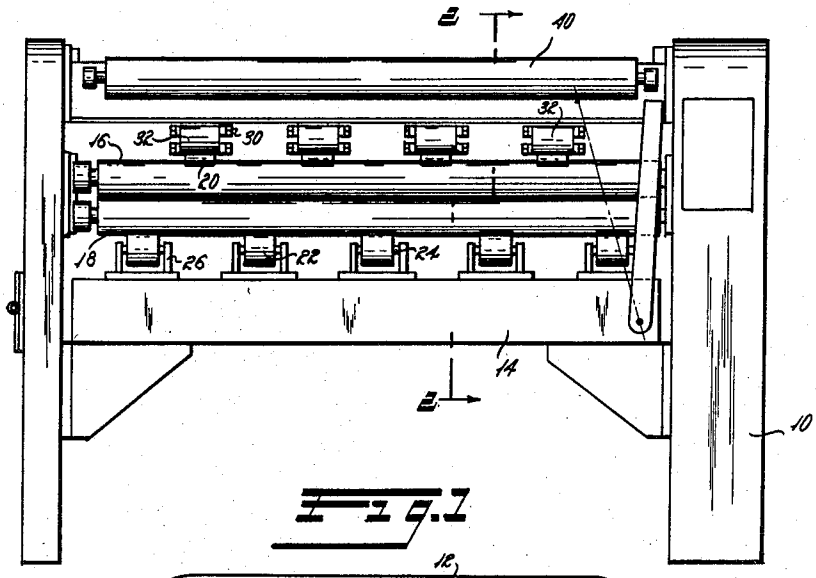


FIG. 1

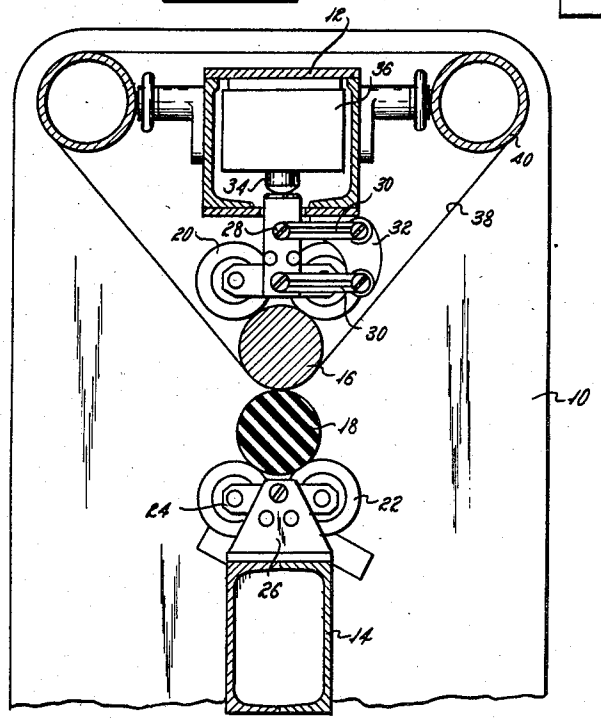


FIG. 2

INVENTOR

EDUARD KUSTERS

BY Strauch, Nolen & Diggins

ATTORNEYS

March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Filed Jan. 17, 1955

6 Sheets-Sheet 2

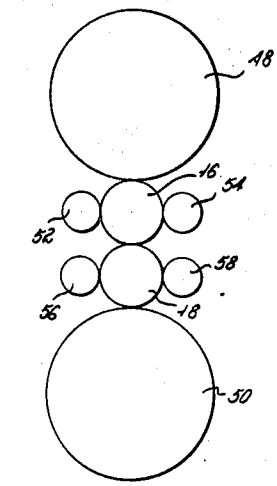


Fig. 4

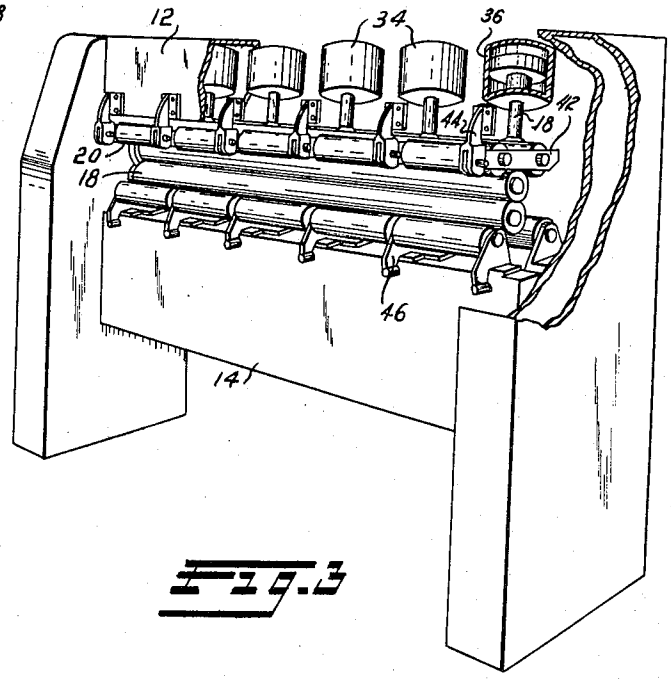
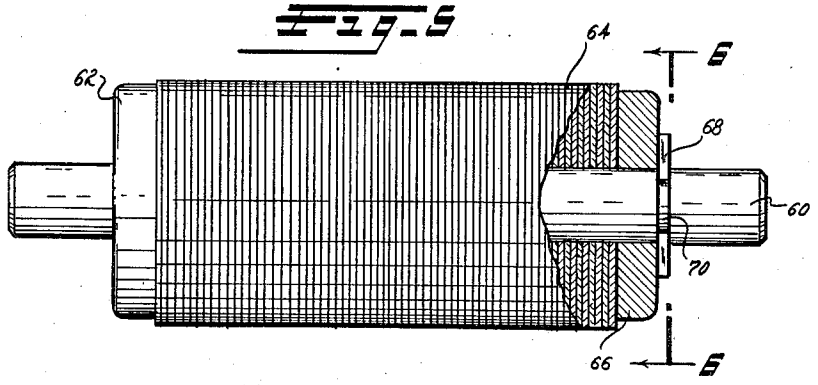


Fig. 3

Fig. 5



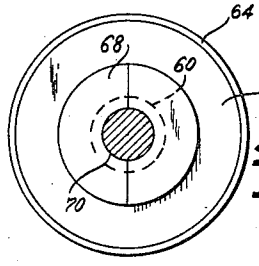


Fig. 6

INVENTOR
EDUARD KUSTERS

BY Strauch, Nolan & Diggins

ATTORNEYS

March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

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Fig. 1

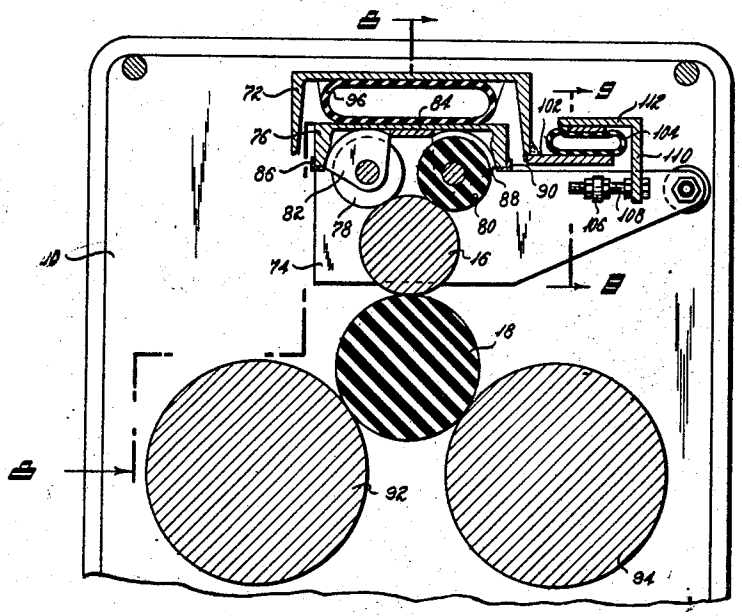
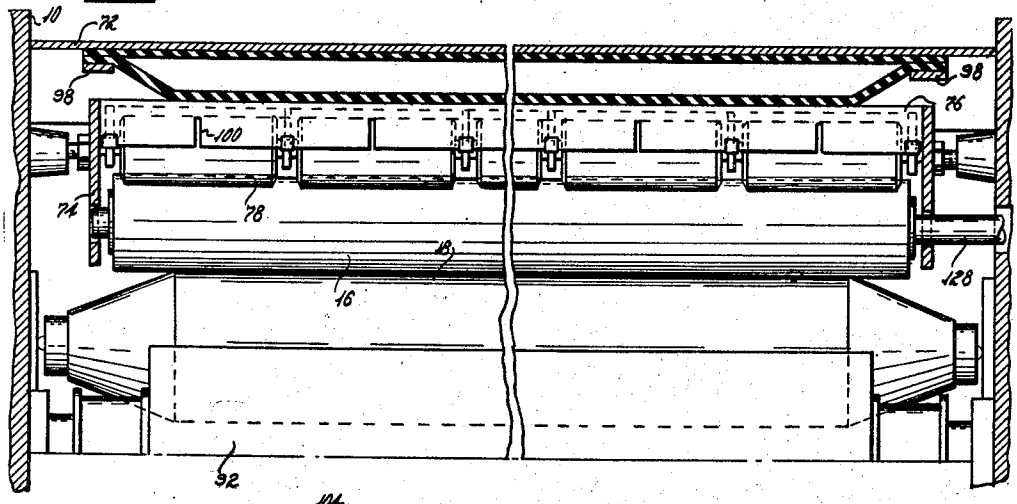


Fig. 2



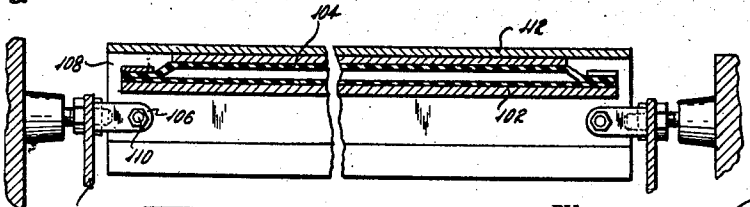


Fig. 3

INVENTOR
EDUARD KUSTERS

BY Strauch, Nolan & Riggins
ATTORNEYS

March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Filed Jan. 17, 1955

6 Sheets-Sheet 4

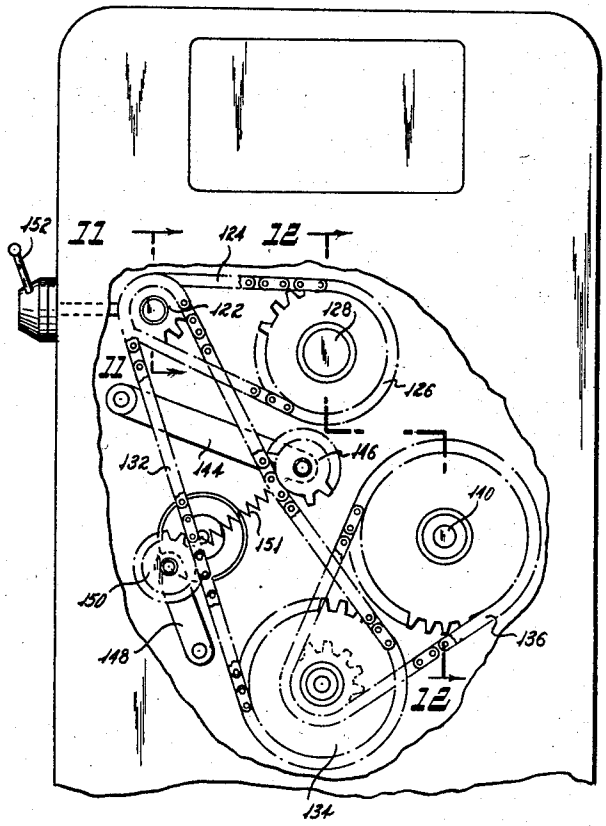


Fig. 10

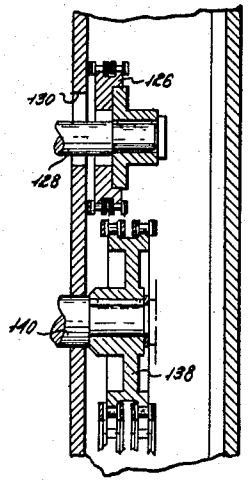


Fig. 12

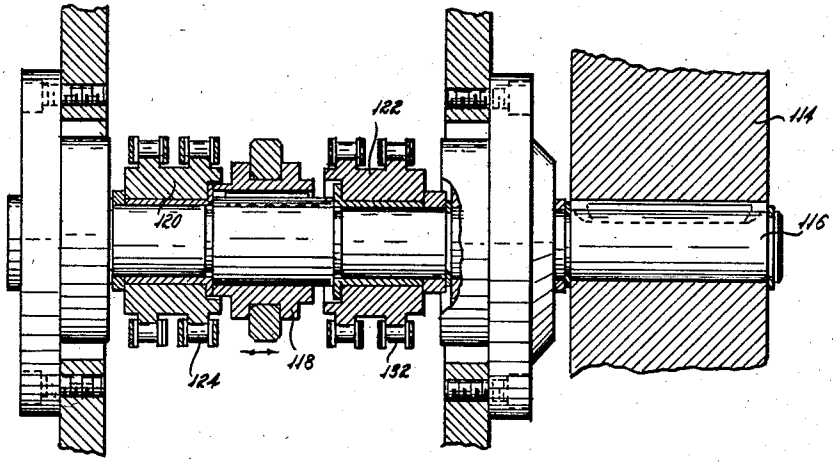


Fig. 11

INVENTOR

EDUARD KUSTERS

BY Strauch, Nolan & Diggins

ATTORNEYS

March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Filed Jan. 17, 1955 6 Sheets-Sheet 5

FIG. 1

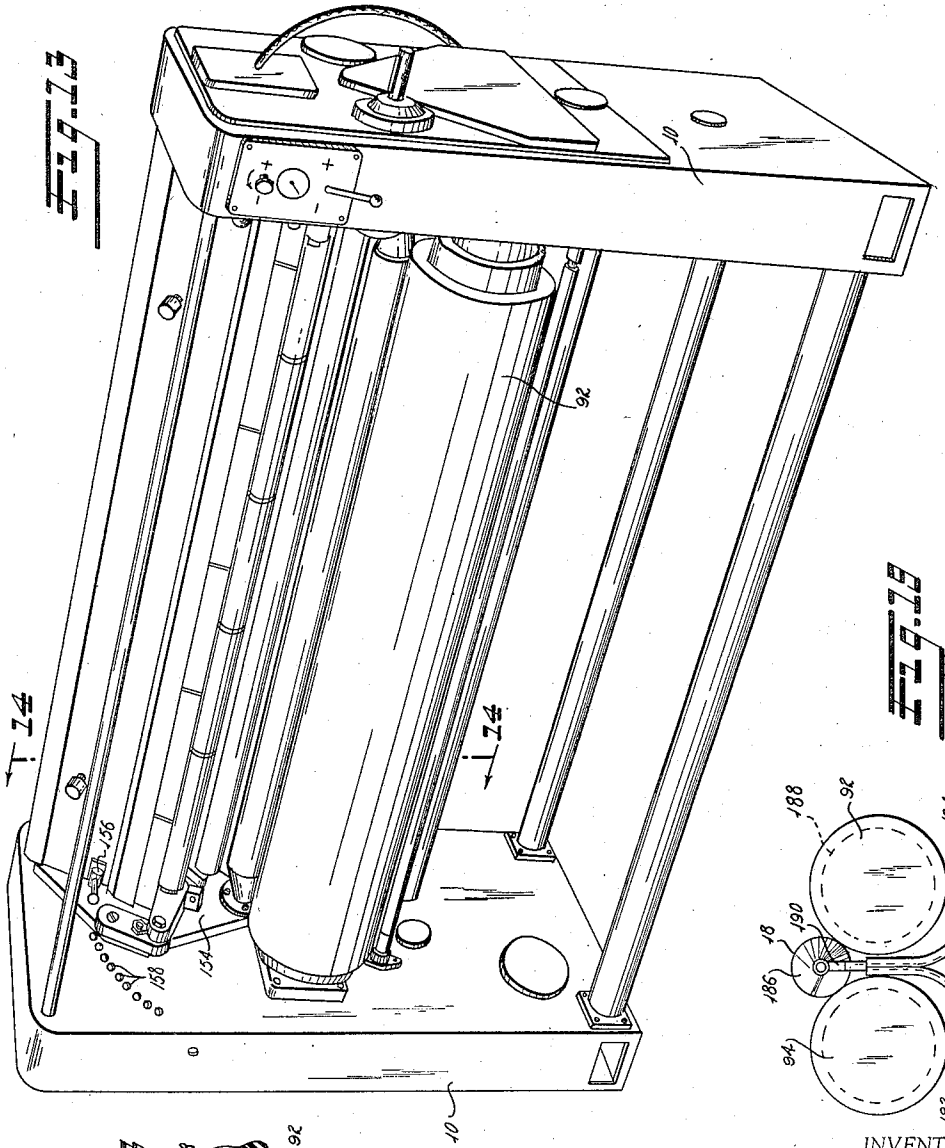
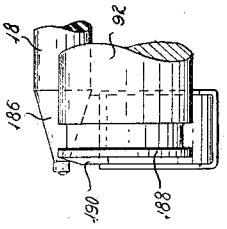


FIG. 3

FIG. 2



INVENTOR
EDUARD KUSTERS

BY Strauch, Nolan & Diggins
ATTORNEYS

March 24, 1959 E. KUSTERS 2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Filed Jan. 17, 1955 6 Sheets-Sheet 6

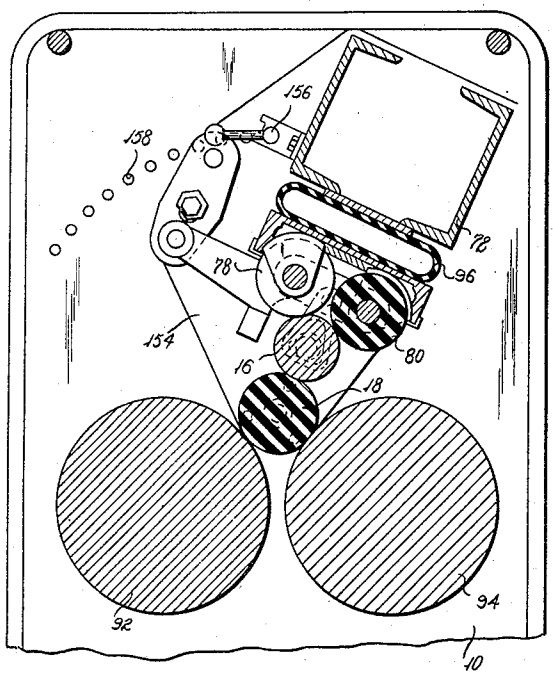


Fig. 14

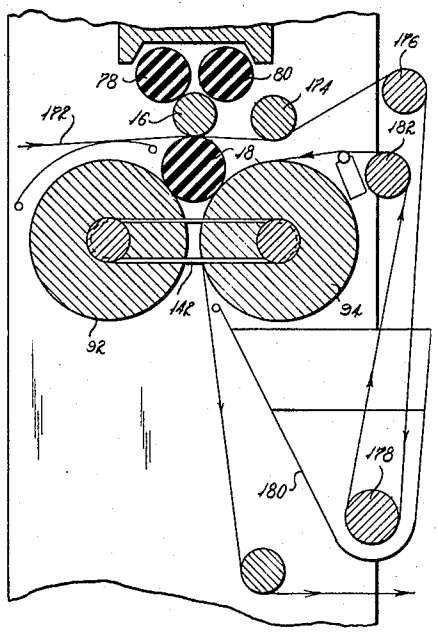


Fig. 16

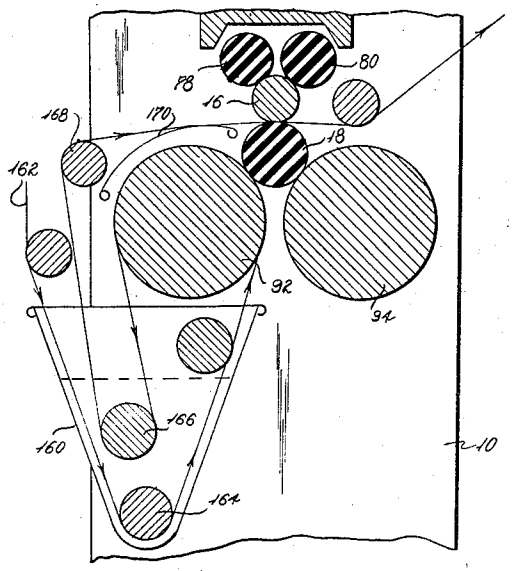


Fig. 15

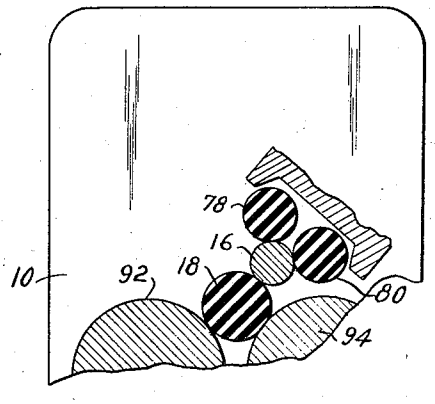


Fig. 17

INVENTOR
EDUARD KUSTERS

BY Staudt, Nolan & Higgins

ATTORNEYS

United States Patent Office 2,878,778 Patented Mar. 24, 1959

2,878,778

APPARATUS FOR SQUEEZING WEBS UTILIZING ALTERNATE HARD AND SOFT ROLLS ON DIFFERENT AXES

Eduard Kusters, Krefeld, Germany

Application January 17, 1955, Serial No. 482,329

Claims priority, application Germany February 16, 1951

14 Claims. (Cl. 118—117)

The present invention relates to methods and apparatus for treating webs of material such as textiles, paper or the like and more particularly to apparatus for squeezing such webs.

One of the principal applications of the present invention is in squeezing moisture from webs, especially textile webs. The invention has other uses and applications but for convenience and simplicity of description, it will be described in connection with the squeezing of textile webs to remove moisture.

In the treatment and finishing of textile webs there are numerous operations in which the web is subject to liquid treatment and the web is then squeezed between a pair of squeeze rolls to remove the liquid. Ordinarily one of the squeeze rolls is formed of hard material such as steel and the other roll is soft. In the prior art, this soft roll has usually been formed of rubber or steel with a rubber coating.

In order to extract the liquid, the squeeze rolls are forced together with very heavy pressure and when wide lengths of material are to be processed, the rolls must be of large diameter to withstand the pressure without deflection. When the soft roll is formed of rubber or has a rubber surface and especially when the rolls are of large diameter, the high pressure causes the rolls to make contact with each other over a relatively wide surface so that the pressure is distributed over a substantial area. Because of this large area of contact, the specific pressure diminishes so that increase of pressure accompanied by an increase in roll diameter usually results in a disproportionately small increase in specific pressure. Further, because of the acute angle of entry to the place of contact between rolls of large diameter, and because of the deformation of the surface of the soft roll, high speed operation causes substantial amounts of liquid to be carried through the rolls with the textile web.

The present invention overcomes these difficulties of the prior art. Some of these difficulties are overcome by using squeeze rolls of small diameter and supporting these squeeze rolls so as to prevent deflection even at high pressures. Other difficulties are overcome by using a soft squeeze roll having a soft yielding surface and a hard, dense core. In this way, high specific pressures may be obtained and maintained over substantial widths.

In the processing or finishing of textiles, paper or the like, squeeze rolls have heretofore been used merely for squeezing the web. The present invention also contemplates the utilization of squeeze rolls as a more active component of the treating unit and the performance of multiple operations by the squeeze roll unit as will hereinafter be more fully explained.

One of the objects of the present invention is to provide a squeeze roll assembly in which squeeze rolls of small diameter may be used at high specific pressures without susbtantial deflection.

Another object is to provide a new and improved squeeze roll system capable of obtaining high specific pressures.

Another object is to provide a squeeze roll system for webs in which the web may be subjected to a treatment liquid immediately upon exit from the squeeze roll.

Another object is to provide a squeeze roll system in which the fabric web may be subjected to a plurality of independent squeezes against a single roll.

A further object is to provide a squeeze roll assembly in which a web may be subjected to a plurality of squeezes against a single roll and in which the squeezing pressure at each squeeze may be independently varied.

Another object is to provide an improved apparatus for applying dyes, water proofing materials or the like to webs.

Another object is to provide an improved method and apparatus for treating webs with liquids.

These and other objects and advantages reside in certain novel features of construction, arrangement and combination of parts and in steps and processes as will hereinafter be more fully set forth ad pointed out in the appended claims.

In the drawings:

Figure 1 is an elevation view of a first example of the apparatus, viewed from the side in which the textile material enters;

Figure 2 is a cross-section through the apparatus on line 2—2 of Figure 1;

Figure 3 is a perspective view of a slightly modified form of apparatus;

Figure 4 shows another arrangement for supporting and loading the squeezing rollers;

Figure 5 shows a squeezing roller having a core of high density and a resilient surface, the roller being shown in longitudinal section and partly broken away;

Figure 6 is a section on the line 6—6 of Figure 5;

Figure 7 is a fragmentary vertical section of a further modified form of apparatus;

Figure 8 is a section taken on line 8—8 of Figure 7;

Figure 9 is a section taken on line 9—9 of Figure 7;

Figure 10 is a side elevation with parts broken away to show the drive for the rolls;

Figure 11 is a section taken on line 11—11 of Figure 10;

Figure 12 is a section taken on line 12—12 of Figure 10;

Figure 13 is a perspective view of a further modified form of apparatus;

Figure 14 is a section taken on line 14—14 of Figure 13;

Figures 15, 16 and 17 are diagrammatic views illustrating application of the invention to various fluid treatments of webs.

Figure 18 is an enlarged detail view showing modified forms of the lower roll used for fluid treatment of the web; and

Figure 19 is an end view of the rolls of Figure 18.

In the modification shown in Figures 1 and 2, the apparatus consists of two upright support members **10** connected by an upper transverse head **12** and a lower transverse support **14**. The squeeze rolls **16** and **18** are of relatively small diameter and extend across the width of the apparatus. Generally one squeeze roll is a hard roll and the other is a soft roll and both squeeze rolls are of such small diameter that they would not withstand the squeezing pressure without deflection.

Throughout this specification, the term "hard roll" means a roll of hard, rigid material such as steel or other metal or ebonite or the like. The term "soft roll" means a roll having a soft, yielding outer surface such as a roll of rubber or rubber coated covered metal or a roll such as that shown in Figures 5 and 6. The "crowns" of the squeeze rolls are those portions of the squeeze rolls opposite the line of contact of the squeeze rolls. The

"crown" of the upper squeeze roll is at the top of that squeeze roll while the "crown" of the lower squeeze roll is at the bottom of that squeeze roll.

In order to prevent either vertical or transverse deflection under operating conditions the squeeze rolls **16** and **18** are supported by back-up rolls **20** and **22**, respectively, the upper back-up rolls **20** engaging opposite sides of the crown of the upper squeeze roll **16** and the lower back-up rolls **22** engaging opposite sides of the crown of the lower squeeze roll **18**.

The squeeze rolls **16** and **18** are of relatively small diameter which is determined in part by the diameters of the back up rolls. In a wide machine where high pressures are to be used, the back-up rolls especially back-up rolls of the type shown in Figure 13 must be of relatively large diameter to withstand the pressure without deflection. The large diameters result in a large V between the back-up rolls and the soft roll which rests in that V should be of sufficient diameter so that its top is well above the tops of the back-up rolls as shown in Figure 7. In one machine capable of handling cloth 54 inches in width and of exerting a pressure of about 330 pounds per linear inch, the hard squeeze roll was of steel 3¾ inches in diameter, the soft roll was 4.7 inches in diameter and the back-up rolls for the soft roll were elastic ebonite covered rolls 9⅝ inches in diameter. These sizes are not critical but gave excellent results.

The lower back-up rolls may be either a plurality of short rolls spaced along the lower support **14** as indicated in Figure 1 or they may be long rolls of hard strong material such as steel, ebonite or rubber covered steel which extend along the entire length of the lower squeeze roll as illustrated in Figure 13. In the embodiment shown in Figures 1 and 2, the short back-up rolls **22** are mounted on members **24** which are secured to brackets **26** spaced along the lower support **14**.

The upper back-up rolls **20** are mounted in T-shaped members **28** which are connected by parallel links **30** to extensions **32** of the transverse head **12**. Each bracket **28** is engaged by the piston assembly **34** which moves in a cylinder **36** within the transverse head **12**. Pressure is applied to the squeeze rolls by introducing compressed air or the like into the cylinders **36** and the parallel links **30** guide the back-up rolls **20** in a vertical direction and also prevent transverse movement of the back-up rolls **20** when a textile web is passing through the apparatus. Preferably the front back-up rolls are longitudinally displaced with respect to the rear back-up rolls to prevent scoring or the formation of grooves in the squeeze rolls during operation. Neither squeeze roll is journalled in fixed bearings and the lower squeeze roll **18** is usually placed loosely on the lower back-up rolls **22** for easy removal and replacement.

Between the upper squeeze roll **16** and the lower squeeze roll **18**, there may be arranged an endless travelling cloth or band **38** which is passed around the rollers **40**. The cloth is preferably made of a cotton fabric. In the case of printed materials, it is advisable to use a cloth with a rubberized or sized surface, in order to prevent smearing the printing ink or colors. When such a cloth is used, it collects any metal particles resulting from the weaving which would otherwise have an injurious effect on the rollers as well as the textile material when the moisture is being squeezed out.

In the modification shown in Figure 3 the upper back-up rolls **20** are mounted in supports **42** which are pivotally connected at one end to brackets **44** which are rigidly secured to the transverse head **12**. The pistons **34** engage the supports **42** to press the back-up rolls **20** toward the lower squeeze roll **18**. While there is some slight lateral displacement due to the fact that the upper back-up rolls **20** pivot as a group around the axis formed by the brackets **44**, the amount of movement is so small that the transverse component is negligible. In Figure 3 the lower back-up rolls **22** are mounted in separate brackets **46** fixed to the lower transverse support **14**.

Figure 4 shows diagrammatically a modified roll arrangement for preventing vertical or transverse deflection of squeeze rolls of small diameter. In this modification the squeeze rolls **16** and **18** are urged together by large drum like rolls **48** and **50** respectively and lateral deflection of the upper squeeze roll **16** is prevented by a pair of rolls **52** and **54** which engage the upper squeeze roll **16** along its sides. Similar rolls **56** and **58** engage the lower squeeze roll **18** along its sides to prevent lateral deflection. In this embodiment the axes of the drum like rolls **48** and **50** should lie in the same vertical plane as the axes of the squeeze rolls **16** and **18** and the axes of the rolls **52** and **54** and **56** and **58** should lie in the same horizontal plane as the axis of the squeeze roll with which they cooperate.

Ordinarily I prefer to form the upper squeeze roll **16** of hard material such as steel and the upper back-up rolls **20** of soft material such as rubber or rubber coated steel. The lower squeeze roll **18** is a soft roll and the lower back-up rolls **22** may be of either hard or soft material but are normally of hard material such as steel or ebonite.

While the improved squeezing effect without deflection may be obtained in my apparatus with soft rolls of various construction, including rubber and rubber coated steel, I prefer to use a soft roll having a hard, dense body and a soft, resilient surface. The soft resilient surface prevents bruising or damaging of the fibers of the textile web, and the dense, hard core or body prevents substantial deformation of the soft roll surface even at high specific pressure so that substantially line contact rather than area contact is maintained between the hard and soft squeeze roll.

A preferred form of soft roll and one which has been found completely satisfactory, is composed of a number of thin discs of resilient material arranged side by side on a metal core and pressed together with high axial pressure. The individual discs consist of a fleece composed of fine fibers such as cotton or other vegetable fibers or synthetic fibers such as the super polyamide fibers. These fibers, or a mixture of such fibers, are impregnated with latex and compressed and vulcanized and cut to form disks. After these discs are compressed on the metal core, a cylindrical surface is ground on the roll so that the final roll surface consists of a soft nap of latex-coated fibers. The surface layer, owing to the nap resulting from the turning, is elastic down to a depth of about 3 mm., whereas at a further depth the roll has a high density and core strength which is not substantially penetrated or deformed by the hard roll which is made, for example, of steel. Owing to this property of the squeezing roll, a much greater squeezing effect is obtained, because the surface layer of the roll apparently enters into the meshes of the fabric without any danger of the fabric being bruised or damaged and without the area of contact between the two rolls being increased to any noticeable extent.

Figures 5 and 6 show this preferred form of soft roll as actually made. A central core or shaft **60** is provided with a flange **62**. The disks **64** are placed on the shaft and tightly compressed by suitable means such as a hydraulic ram or press. A collar **66** is then placed on the shaft and secured in place by a locking ring or washer **68** which engages in a groove **70** in the shaft **60** to lock the disks in compressed condition. The unit is then cut or ground to a true cylindrical surface.

A standard rubber covered roll 4¾ inches in diameter was compared with a roll 4.7 inches in diameter made as shown in Figures 5 and 6 and when squeezed against a 3¾ inch steel roll at a pressure of 330 pounds per linear inch the results were as follows:

	Static Arc of Contact (mm.)	Pressure (lbs./sq. in.)
Present Roll	7.4	1,130
Rubber Roll	8.7	990

Creased viscose rayon was run through the apparatus under full pressure at 40 yards per minute and, when the roll shown in Figures 5 and 6 was used, the rayon was undamaged.

The soft roll may also be provided with a covering in the form of a thin adherent film of artificial material, especially a material of the class consisting of superpolyamides. The covering film can be made, for example, by uniformly applying the super-polyamide dissolved in alcohol to the turned roller, and, after evaporating the solvent, heating for 3–5 minutes to 160–180° C. The film thereby becomes insoluble and the surface of the roller is made continuous and resistant to wear. A roll which has become somewhat damaged can be repaired easily and with little expense in a similar manner.

Another form of squeeze roll consists of discs of vegetable or animal fibres with a binder of artificial material, for example of the class consisting of superpolyamides.

The modifications shown in Figures 1 to 6 gave superior performance over prior art apparatus but after these machines had been operated for some time, it was found that the life of the soft roll could be improved, that additional operations could be performed and that greater flexibility of squeezing pressures could be obtained by modifying the apparatus as illustrated in Figures 7 to 17 inclusive.

Referring first to Figures 7 to 12, inclusive, the spaced upright supports **10** are connected by a rigid cross frame **72** and the upper squeeze roll assembly is carried by side frames **74** which are pivotally connected to the uprights **10** at one side of the cross frame **72**. A channel **76** is rigidly connected to the side frames **74** and extends across the apparatus between the uprights **10** in vertical alignment with the cross frame **72**.

The upper squeeze roll assembly includes an upper squeeze roll **16** which is normally a hard roll and is loosely rotatable in the side frames **74**. As in the previous modifications, the upper squeeze roll **16** preferably has a relatively small diameter and deflection of the upper squeeze roll under pressure is prevented by a plurality of short front back-up rolls **78** and a plurality of short rear back-up rolls **80** spaced along the length of the upper squeeze roll. The back-up rolls are normally formed of relatively soft material such as rubber or rubber coated steel and each end of each back-up roll is tapered.

Each front back-up roll **78** is rotatably journalled in a pair of flat, segment shaped members **82**. The channel **76** is provided with a longitudinal shoulder **84** for receiving one flat face of the segment shaped members **82** and a strip **86** is secured along the front edge of the channel **76** and engages the other flat face to fasten the members **82** and the front back-up rolls **78** to the channel **76**. Similar segment shaped members **88** carry the rear back-up rolls **80** and are secured in the channel **76** between the shoulder **84** and a strip **90**. Due to the segmental shape of the members **82** and **88**, both vertical and transverse deflection of the upper squeeze roll **16** is prevented. The front and rear back-up rolls are preferably out of alignment with each other so that the spaces between adjacent front back-up rolls **78** are not in alignment with the spaces between adjacent rear back-up rolls **80**.

The bottom squeeze roll assembly comprises two parallel back-up rolls **92** and **94** which are rotatably journalled in the uprights **10**. The lower back-up rolls **92** and **94** are usually of hard strong material such as steel, ebonite or the like and the lower squeeze roll **18** is normally soft and can be formed of soft, yielding material such as rubber but is preferably of the type shown in Figures 5 and 6 and described above. Normally, the lower squeeze roll **18** is also of relatively small diameter and deflection is prevented by the lower back-up rolls **92** and **94**.

The mechanism for applying pressure to the squeeze rolls and for opening the squeeze rolls for threading is described and claimed in assignee's co-pending application Serial No. 482,279 filed concurrently herewith by Kurt Quoos et al. entitled Squeeze Roll Apparatus. This mechanism comprises an inflatable tube **96** which is located between the cross frame **72** and the channel **76** and extends substantially the entire length of the upper squeeze roll **16**. This tube **96** may be formed of any suitable material having the necessary strength and flexibility. A heavy rubber tube or hose reinforced with cord has been found satisfactory.

The tube **96** may be sealed at its opposite ends by clamps **98** and may be connected by piping and a suitable valve to a source of high pressure air or gas (not shown). When at rest, the tube **96** is flat and when pressure is applied the tube **96** tends to assume a cylindrical form and exerts an even pressure over substantially the entire length of the upper squeeze roll **16**.

In order to enhance the ability of the upper squeeze roll **16** to yield to local inequalities of pressure throughout its length, slots **100** are cut in the sides of the channel **76** so that the channel may more readily flex under excessive or unequal stress. These slots **100** are normally located near the center of each upper back-up roll.

In order to lift the upper squeeze roll assembly away from the lower squeeze roll assembly, the cross frame **72** is provided with a shelf or bracket **102** which carries a second inflatable tube **104**. Each side frame **74** has a projecting lug **106** to which an angle section **110** is rigidly secured by bolts **108**. One arm **112** of the angle section **110** rests on top of the inflatable tube **104** so that when the tube is inflated, the upper squeeze roll assembly is raised. The two tubes may be connected to the high pressure air by a single valve or may be controlled by separate valves but high pressure air should not be admitted to both tubes simultaneously.

The liquid extraction by the present apparatus is substantially superior to that obtained by apparatus of the prior art even on relatively narrow webs (9 to 12 inches). In comparative tests at the same loading and speed the mangle of the present invention extracted from 1% to 9% more water from heavy twill, from 3.3% to 14.3% more water from sheeting and from 3.5% to 16.5% more water from raised flannel than prior art apparatus. This superior extraction can be obtained over very wide widths while in prior apparatus, substantial increases in width may be accompanied by reduced extraction unless there is a disproportionately large increase in pressure.

Referring to Figures 10 to 12, power is supplied from a suitable source such as an electric motor, not shown, to a pulley **114** secured to a shaft **116** journalled in one of the uprights **10**. A clutch **118** is slidably keyed to the shaft **116** and gears **120** and **122** are loosely rotatable on the shaft **116** for selective operation by the clutch. The gear **120** is connected by a chain **124** to a gear **126** which is fixed on the shaft **128** of the upper squeeze roll **16**. As shown in Figure 12, the shaft **128** passes through an oversized opening **130** in the wall of the upright **10** to permit raising and lowering of the upper squeeze roll. The gear **122** is connected by a chain **132** to an idler **134** which is connected by a chain **136** to a gear **138** fixed on the shaft **140** of one of the lower back-up rolls. The two back-up rolls are preferably connected by a belt **142** as shown in Figure 16.

In order to maintain the chain **132** tight regardless of the direction of rotation, a pivoted arm **144** carries at its outer end a gear **146** which meshes with one reach of the chain **132** and a second pivoted arm **148** carries at its outer end a gear **150** which meshes with the other side of the chain. A spring **151** urges the two gears together.

When the clutch **118** is shifted by means of the handle **152** to drivingly engage the gear **120**, power is supplied through the chain **124** to the upper squeeze roll **16** and the lower back-up rolls merely idle. When the clutch is shifted to drivingly engage the gear **122**, power is supplied through the chain **132** and the idler **134** to the lower back-up roll and the upper squeeze roll merely idles. The purpose of these different drives will be described in detail later.

Another modified form of apparatus is illustrated in Figures 13 and 14 in which the uprights **10** and the lower squeeze roll assembly are substantially identical with those of Figures 7 to 12. The entire upper squeeze roll assembly, however, is mounted on end plates **154** which are pivotally secured in the uprights **10** on an axis which coincides with the axis of the lower squeeze roll **18**. Thus the entire upper squeeze roll assembly, including the upper squeeze roll, back-up rolls, pressure tubes and upper squeeze roll raising mechanism, are pivotable as a unit about the axis of the lower squeeze roll and may be locked in any selected angular position by a bolt or pin **156** which enters into one of a row of holes **158** in the upright **10**.

When the lower back-up rollers are hard and extend the length of the squeeze roll **18**, there is not only a squeeze or nip between the upper squeeze roll **16** and lower squeeze roll **18** but there is also a squeeze or nip between each of the lower back-up rolls and the lower squeeze roll **18**. These additional nips may be advantageously employed in the processing of webs such as textiles as illustrated in Figures 15 to 17 inclusive.

Referring first to Figure 15, a dyeing operation can be advantageously performed by securing a dye tub or tank **160** between the uprights **10** beneath one of the lower back-up rolls. An open width of fabric **162** enters the tub **160** and passes under a guide roll **164** at the bottom of the tub then up between the lower squeeze roll **18** and the back-up roll **92** where the excess dye is squeezed out. The web then passes back into the tank **160**, under a second guide roll **166**, out over a third guide roll **168** and then between the squeeze rolls **16** and **18** where the dye is again squeezed out.

The dye squeezed out between squeeze rolls **16** and **18** drains into the V-shaped trough or throat formed by the lower squeeze roll **18** and the back-up roll **92** so as to form an effective dye bath. The web enters this dye bath immediately after being squeezed between the lower squeeze roll **18** and the back-up roll **92** so that it expands from the squeezing while submerged in the dye liquor and thus is more effectively saturated with dye than is possible in prior art apparatus. Of course this operation is not limited to dyeing and may be used with other processes such as water-proofing or the like. If desired a shield **170** may be placed over the lower back-up roll.

Figure 16 shows the apparatus as employed for starching or sizing textile webs. In this operation, the cloth **172** enters between the squeeze rolls **16** and **18** directly from prior wet operations such as washing. The squeeze in the present apparatus is so effective that sufficient moisture is removed by squeeze rolls **16** and **18** that the cloth is ready for further processing. From the squeeze rolls **16** and **18** the cloth passes guide rolls **174** and **176** and under a guide roll **178** positioned near the bottom of a tank **180** secured to the uprights **10** beneath the lower back-up roll **94**. From the tank, the cloth passes upward over a guide roll **182** and the excess starch or other treating liquid is removed by passing the cloth between the lower squeeze roll **18** and the back-up roll **94**. The cloth

then passes under a guide roll **184** and leaves the apparatus.

When the upper squeeze roll assembly is in vertical position as illustrated in Figures 15 and 16, the pressure between the lower squeeze roll and each lower back-up roll is a function of the angle which the plane of the axis of the lower squeeze roll and the lower back-up rolls make with the vertical. For example, if this angle is 45°, and the pressure between the squeeze rolls **16** and **18** is ten tons, the pressure between the lower squeeze roll and each lower back-up roll will be approximately seven tons. When the upper squeeze roll assembly is pivoted about the axis of the lower squeeze roll, the pressure between the lower squeeze roll and either of the lower back-up rolls may be selectively varied from substantially zero to approximately equal to the full squeeze pressure of ten tons. For example, in Figure 17, the pressure between the lower squeeze roll **18** and the left hand lower back-up roll **92** is substantially equal to the full squeezing pressure while the pressure between the lower squeeze roll **18** and the right hand lower back-up roll **94** is very slight. In the starching or sizing operation illustrated in Figure 16, this variation of pressure at the second squeeze may be used to advantage to control the amount of starch in the cloth after it leaves the second squeeze without diminishing the squeezing pressure exerted on the cloth entering between the squeeze rolls **16** and **18**.

When the apparatus is to be used for wet finishing I prefer to form the ends of the lower squeeze roll and lower back-up rolls as shown in Figures 18 and 19. The trough formed by the lower squeeze roll **18** and lower back-up roll holds the processing liquid which flows outward toward the ends of the rolls. The outer end of the lower squeeze roll is tapered as indicated at **186** and the outer end of the lower back-up roll is provided with a groove **188**. A wiper **190** secured to the upright **10** engages the tapered end portion **186** of the lower back-up roll and wipes away the liquid from this portion of the roll. This wiper may be formed of suitable soft, flexible material such as rubber. Beneath the wiper **190** is provided a pair of divergent troughs **192** and **194** which extend outward beneath the lower squeeze rolls and return the liquid to the appropriate tank or vat **160** of **180** respectively.

In treatments of webs as illustrated in Figures 15, 16 and 17 the web is elongated due to the squeezing pressure and treatments between the first squeeze and the last squeeze. The selective drives shown in Figures 10, 11 and 12 compensate for this elongation so that there will be no pile-up of the web between the two squeezers.

In each instance, the roll causing the last squeeze is driven directly from the source of power and the roll causing the first squeeze is driven by friction from the directly driven roll. For example, in Figure 15, the upper squeeze roll **16** is driven and the lower back-up roll receives its driving force by friction from the upper squeeze roll. The slip between these friction drives equalizes and compensates for the stretch or extension of the fabric due to the squeezing between the lower back-up roll and the lower squeeze roll. In Figure 16, the lower back-up roll would be driven and the upper squeeze roll driven by friction from the lower back-up roll.

From the foregoing it will be apparent that I am able to accomplish the object of my invention and provide novel apparatus and method for treating textiles and other webs. The invention has been described primarily with reference to the treating of textile fabrics but it is to be understood that the methods and apparatus are equally applicable to the treatment of paper and other webs and to processes other than dyeing, sizing, starching and water proofing.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore

to be considered in all respects as illustartive and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

The present application is a continuation in part of application Serial No. 267,112 filed January 18, 1952, entitled "Apparatus for Squeezing Moisture from Textile Material," now abandoned.

What is claimed and desired to be secured by United States Letters Patent is:

1. Apparatus for treating a web with liquid, comprising a hard upper squeeze roll, a pair of spaced support rolls beneath said upper squeeze roll and spaced from said support rolls, being parallel to the upper squeeze roll and lying in a substantially horizontal plane, a soft lower squeeze roll carried by and between said support rolls, means for urging said squeeze rolls into squeezing engagement, treatment liquid containing means, means for guiding a web upward between one support roll and the lower squeeze roll, and means for guiding said web through said treatment liquid containing means and between said squeeze rolls whereby treatment liquid expressed at said squeeze rolls flows onto the web emerging from between said support roll and said lower squeeze roll.

2. Apparatus as defined in claim 1 including means for varying the pressure between said one support roll and said lower squeeze roll without varying the pressure between the squeeze rolls.

3. Apparatus as defined in claim 1 in which the means for urging the squeeze rolls into squeezing relation comprises roll means engaging opposite sides of the crown of the upper squeeze roll and pressure means operatively connected to said roll means for urging the upper squeeze roll toward the lower squeeze roll.

4. Apparatus as defined in claim 1 including a bracket pivotally mounted for swinging movement about the axis of the lower squeeze roll, means for mounting the upper squeeze roll, roll means and pressure means on said bracket, and means for locking said bracket in predetermined angular relation to said support rolls.

5. Apparatus for treating a web with a liquid which comprises a pair of substantially horizontal squeeze rolls rotatably mounted in spaced vertical planes, means for urging said rolls together under squeezing pressure, means for guiding a web upward between said squeeze rolls, means for supplying treatment liquid to the trough formed by the upper surfaces of said squeeze rolls adjacent their point of contact, means for rotating said squeeze rolls, a container for said treatment liquid and means on the ends of said rolls for returning excess treatment liquid to said container.

6. Apparatus for treating a wet web with liquid comprising a hard upper squeeze roll, a pair of spaced support rolls beneath and spaced from said upper squeeze roll, said support rolls being parallel to the upper squeeze roll and lying in a substantially horizontal plane, a soft lower squeeze roll carried by and between said support rolls, means for urging said squeeze rolls into squeezing engagement, treatment liquid containing means, means for guiding the wet web between said squeeze rolls to express liquid from the web, means for guiding the web through the treatment liquid containing means and means for guiding said web between the lower squeeze roll and one support roll to express excess treatment liquid.

7. Apparatus as defined in claim 6 including means for varying the pressure between said one support roll and said lower squeeze roll without varying the pressure between the squeeze rolls.

8. Apparatus as defined in claim 6 in which the means for urging the squeeze rolls into squeezing relation comprises roll means engaging opposite sides of the crown of the upper squeeze roll and pressure means operatively connected to said roll means for urging the upper squeeze roll toward the lower squeeze roll.

9. Apparatus as defined in claim 6 including a bracket pivotally mounted for swinging movement about the axis of the lower squeeze roll, means for mounting the upper squeeze roll, roll means and pressure means on said bracket, and means for locking said bracket in predetermined angular relation to said support rolls.

10. Apparatus as defined in claim 6 including means at the ends of the support rolls and lower squeeze roll for separating liquid expressed by said squeeze rolls and the treatment liquid expressed by said lower squeeze roll and said one support roll and means for returning expressed treatment liquid to said container.

11. Apparatus for squeezing webs including an upper roll assembly and a lower roll assembly, the lower roll assembly comprising a pair of spaced parallel horizontal supporting rolls of hard material and a soft squeeze roll having a soft yielding surface, said soft roll being positioned between and supported throughout substantially its entire length by the supporting rolls, the upper roll assembly comprising a hard squeeze roll above and parallel to said soft squeeze roll, means including back-up rolls engaging the upper surface of said hard squeeze roll on each side of the plane of the axes of said squeeze rolls for applying resilient pressure urging said hard squeeze roll into squeezing relation with said soft squeeze roll, said means applying resilient pressure to said hard squeeze roll at spaced points throughout the length of said hard squeeze roll, means for pivoting the upper roll assembly on the axis of said soft squeeze roll and means for locking said upper roll assembly in adjusted position.

12. Apparatus for squeezing webs including an upper roll assembly and a lower roll assembly, the lower roll assembly comprising a pair of spaced parallel horizontal supporting rolls of hard material and a soft squeeze roll having a soft yielding surface, said soft roll being positioned between and supported throughout substantially its entire length by the supporting rolls, the upper roll assembly comprising a hard squeeze roll above and parallel to said soft squeeze roll, means including back-up rolls engaging the upper surface of said hard squeeze roll on each side of the plane of the axes of said squeeze rolls for applying resilient pressure urging said hard squeeze roll into squeezing relation with said soft squeeze roll, said means applying resilient pressure to said hard squeeze roll at spaced points throughout the length of said hard squeeze roll, said back-up rolls being of soft, yielding material.

13. Apparatus for squeezing webs including an upper roll assembly and a lower roll assembly, the lower roll assembly comprising a pair of spaced parallel horizontal supporting rolls of hard material and a soft squeeze roll having a soft yielding surface, said soft roll being positioned between and supported throughout substantially its entire length by the supporting rolls, the upper roll assembly comprising a hard squeeze roll above and parallel to said soft squeeze roll, means including back-up rolls engaging the upper surface of said hard squeeze roll on each side of the plane of the axes of said squeeze rolls for applying resilient pressure urging said hard squeeze roll into squeezing relation with said soft squeeze roll, said means applying resilient pressure to said hard squeeze roll at spaced points throughout the length of said hard squeeze roll, said back-up rolls comprising a set of rolls on each side of the plane of the axes of the squeeze rolls, each set comprising a plurality of short, axially spaced coaxial rolls, and in which pressure is applied independently to each back-up roll, a flexible support extending over the hard squeeze roll, means for mounting each back-up roll on said support and single pressure means acting uniformly across the length of said support for urging the upper roll assembly toward the lower roll assembly.

14. Apparatus comprising a hard squeeze roll, soft back-up rolls engaging said hard squeeze roll on each

side of the crown of said hard squeeze roll, a second squeeze roll parallel to said hard squeeze roll, said second squeeze roll having a soft outer surface and a hard, dense core, a pair of parallel hard back-up roll sets engaging the second squeeze roll throughout its length on each side of the crown of said second squeeze roll, each back-up roll set comprising a plurality of spaced coaxial short rolls opposite said hard squeeze roll and resilient pressure means acting independently on each back-up roll for urging said squeeze rolls into squeezing relation, drive means for said rolls and means for selectively operatively connecting said drive means to said hard squeeze roll or to one of said hard back-up rolls.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,878,778 March 24, 1959

Eduard Kusters

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 19, for "ad" read —— and ——; column 8, line 44, for "of 180" read —— or 180 ——; column 9, line 1, for "illustartive" read —— illustrative ——.

Signed and sealed this 11th day of August 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON

Commissioner of Patents