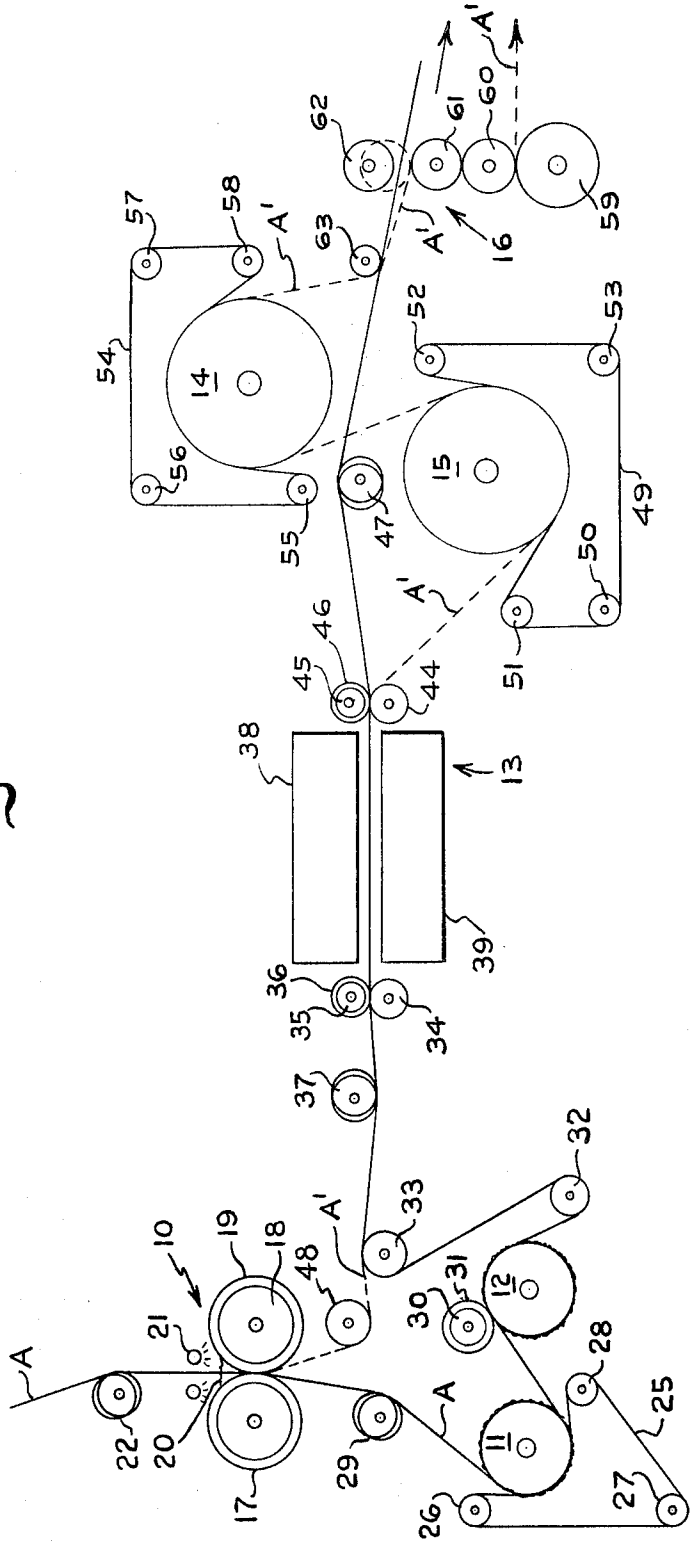
Sept. 13, 1966 G. J. PASEK ETAL 3,272,643

PROCESS FOR MAKING COCKLED PAPER

Filed Aug. 2, 1962 3 Sheets-Sheet 1

Fig. 1



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PROCESS FOR MAKING COCKLED PAPER

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Fig. 2

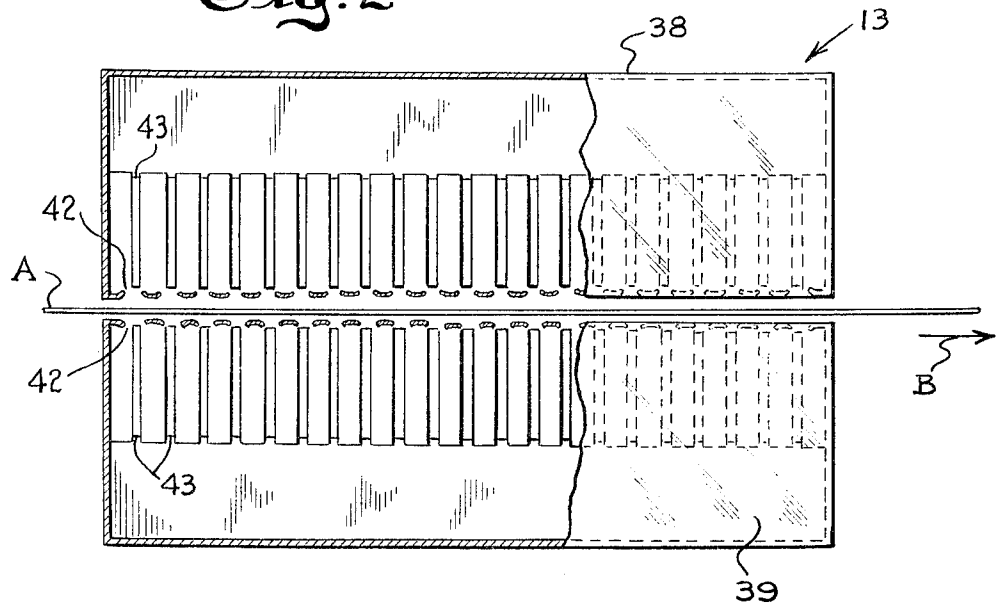
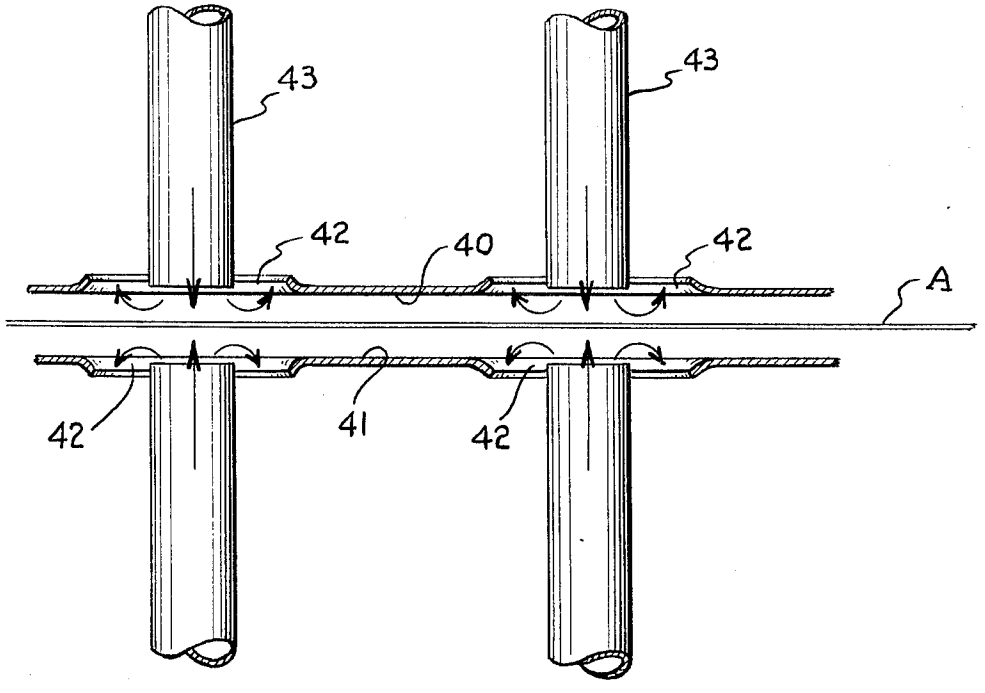


Fig. 4



Sept. 13, 1966 G. J. PASEK ETAL 3,272,643

PROCESS FOR MAKING COCKLED PAPER

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Fig. 3

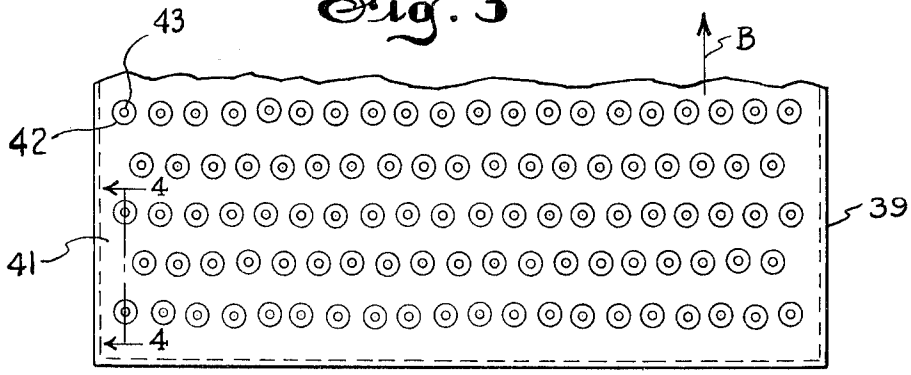


Fig. 5

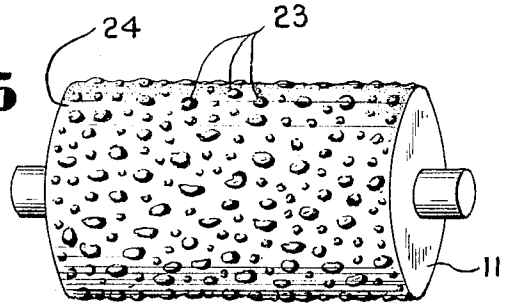
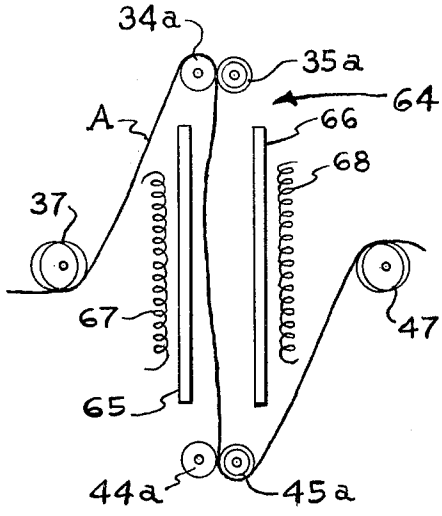


Fig. 6



United States Patent Office 3,272,643 Patented Sept. 13, 1966

3,272,643

PROCESS FOR MAKING COCKLED PAPER

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4 Claims. (Cl. 117—11)

Our invention relates to the manufacture of paper and, more particularly, to a method and apparatus for producing a paper having a cockled finish.

Prior to our invention, cockled finished paper has generally been made off or separate from the papermaking machine. Previously manufactured smooth finished paper has been drawn from reels through a sizing bath, and the paper has then been air dried, such as by means of the well-known festoon drier which supports the paper in the form of loops between traveling spaced rods. The cockles in the paper, which are spots that are warped or bulged from the general plane of the sheet, are produced on account of excessive and uneven shrinkage during drying.

It is an object of the present invention to provide an improved method and apparatus for manufacturing cockled paper which is operative at considerably higher speeds than conventional apparatus so that the paper may be provided with this finish directly from the papermaking machine, without the necessity of first storing the paper in reel form.

It is also an object of the invention to provide improved papermaking apparatus which is usable alternately for the manufacture of cockled finish paper or which may be used to make smooth finished paper.

In brief, we have found, according to the invention, that cockled finished paper may be made at very high speeds if the paper is preliminarily and unevenly stretched after having sizing applied to it and before the paper is dried, and we have found that the preliminary uneven stretching of the paper successfully takes the place of considerable air drying, with the same fine cockled finish being obtained as with conventional apparatus.

The invention consists of the novel methods and constructions to be hereinafter described and claimed for carrying out the above stated objects, and such other objects, as will be apparent from the following description of a preferred mode of practicing the invention, illustrated with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic side elevational view of paper cockling apparatus embodying the principles of the invention and including a pair of rolls having cockled external surfaces and including also an air float drier having top and bottom air plenums;

FIG. 2 is a side elevational view on an enlarged scale of the air float drier with the side wall being broken away to show internal construction;

FIG. 3 is a fragmentary plan view on an enlarged scale of the bottom plenum of the dried;

FIG. 4 is a sectional view on a still further enlarged scale taken on line 4—4 of FIG. 3;

FIG. 5 is a perspective view of one of the cockled surface rolls; and

FIG. 6 is a schematic side elevational view of an electrically operated drier which may be substituted for the air float drier illustrated in FIG. 1.

Like characters of reference designate like parts in the several views.

Referring to FIG. 1, the illustrated apparatus may be seen to comprise, in general, a size press **10**, cockled surfaced cylinders **11** and **12**, an air float drier **13**, can driers **14** and **15**, and a calender **16**.

The size press **10** comprises a pair of rolls **17** and **18**, each of which preferably is of the type having a cover **19** of yieldable rubberlike material. The rolls **17** and **18** have a nip between them for containing a body **20** of sizing which is supplied into the nip from suitable conduits **21**. The sizing **20** is made up with the usual constituents of sizing for paper, principally starch and water. The paper web A passes into the size press **10**, and preferably a conventional mount hope roll **22** is provided just ahead of the size press **10** for spreading and smoothing the paper. The web A may be taken in dry condition directly from a conventional Fourdrinier papermaking machine for on-the-machine operation, or alternately, the web A may be taken from a paper supply roll (not shown) for off-the-machine operation.

The cylinders **11** and **12** are provided with "cockled" surfaces, that is, surfaces provided with rounded, randomly and irregularly shaped bosses **23** of random spacing and size which are raised from a cylindrical roll surface **24** (see FIG. 5 showing the roll **11**). Although the bosses may vary drastically in height and size while still obtaining the advantages of the invention, we have found that the bosses **23** may well vary in height from .005 inch to .05 inch, and the largest transverse dimension or diameter of the bosses may well vary from ⅛ inch to ½ inch. The rolls **11** and **12** are preferably hollow and are heated in any suitable manner, such as by the application of steam to them, preferably being maintained at 100 to 300 degrees Fahrenheit surface temperature.

An endless felt **25** extends about a part of the periphery of the roll **11**, the felt being held in the form of a loop by means of guide rolls **26**, **27** and **28**. A mount hope roll **29** is provided between the press **10** and the roll **11** so that the web A passes onto the surface of the roll **11** after passage over the mount hope roll, with the felt **25** being arranged to hold the web A in forceful contact with the surface of the roll **11**.

A roll **30** having a covering **31** of yieldable rubberlike material has a pressure nip with the cylinder **12**, and the web A passes through this nip and is thus held in forceful contact with the cylinder **12**.

A pair of guide rolls **32** and **33** are provided for the web A for guiding it subsequent to its passage over the cylinder **12**. The web A passes between a pair of pull rolls **34** and **35** having a nip between them at one end of the air float drier **13**, and the roll **35** preferably has a yieldable rubberlike covering **36**. A mount hope roll **37** is preferably provided between the roll **33** and the rolls **34** and **35**.

The air float drier **13** comprises a top plenum **38** and a bottom plenum **39**. The plenums are respectively provided with air return plates **40** and **41** which are substantially parallel and opposite to each other and are spaced about ½ inch to 1-inch apart. Each of these plates is provided with a plurality of air exhaust openings **42** and an air inlet jet tube **43** is disposed within each of the openings **42**. Each of the tubes **43** is centered in its respective opening **42** and terminates slightly short of the plate **40**. The openings **42** may, for example, be about 1½ inch in diameter and the jet tubes **43** may, for example, have an internal diameter of about ⅝ inch.

The web A passes between the plenums **38** and **39**, and the openings **43** are staggered in the direction of movement of the web indicated by the arrows B (see FIG. 3), the openings **42**, for example, being disposed on three-inch triangular centers. Each opening **42** and each jet tube **43** in one of the plenums is disposed directly opposite a corresponding opening **42** and jet tube **43** in the opposite plenum.

Hot air at 300 degrees to 600 degrees Fahrenheit, for example, and at velocities of 2000 and 8000 feet per

minute, for example, is supplied to the jet tubes **43**. The construction of the return openings and jet tubes is such that with air being so supplied to the plenums **38** and **39**, the air creates a controlled interference pattern and centers the web A between the opposed plenums **38** and **39**. It is contemplated that this web supporting action of the plenums shall be sufficient in itself to maintain the web A traveling substantially midway between the surfaces **40** and **41** and that the web shall be under substantially no tension as it passes between the plenums.

A pair of tension control rolls **44** and **45** having a nip between them are provided at the discharge end of the drier **13**, the roll **45** preferably having a yieldable rubber-like covering **46**. A mount hope roll **47** is provided for the web A after passage of the web between the rolls **44** and **45**, and the web may be wound on a suitable conventional reel (not shown) after passage over the mount hope roll **47**.

The cockled surfaced cylinders **11** and **12**, together with the air float drier **13**, result in a high quality cockled surfaced paper as will be hereinafter described more in detail. If it is desired that the paper produced shall be of the smooth type rather than the cockled type, other equipment now to be specifically described may be utilized. The web A′ which is to be of the smooth type, in lieu of being passed over the rolls **29**, **11**, **12** and **32**, instead is passed over a turning roll **48**, as shown in dotted lines in FIG. 1. The web A′ then passes over the rolls **33**, **37**, **34**, **35**, **44** and **45** and through the drier **13** in the same manner as the cockled finished web A. Additional drying equipment comprising the can driers **14** and **15**, which may be steam heated in accordance with conventional practice, is utilized for the smooth finished paper web A′. An endless canvas **49** is provided for the drier **15**, being supported by means of rolls **50**, **51**, **52** and **53** so that it extends partially around the drier **15**. A similar endless canvas **54** is provided for the drier **14**, the canvas **54** being supported by rolls **55**, **56**, **57** and **58**. As will be observed from FIG. 1, the web A′ passes over the drier **15** from the roll **44**, and from thence over the drier **14**, with the canvases **49** and **54** holding the web in tight contact with the driers **14** and **15**.

The calendar **16** is intended for use with the web A′ and comprises a lowermost driving king roll **59** and smaller rolls **60**, **61** and **62** disposed above and driven by the king roll. A stabilizer roll **63** is provided for receiving the web A′ off the drier **14**, and the web A′ passes between the rolls **61** and **62** of the calendar **16** from the roll **63** and from thence around the rolls **60** and **61** and through the other roll nips of the calender, to be taken from the lowermost nip of the calender for conventional reeling into a roll. The uppermost small roll **62** of the calender **16** is so mounted as to be movable upwardly off the roll **61** so that the web A may pass directly between the rolls **61** and **62** to the reel without contacting either of these rolls.

In operation, for making cockled finished paper, the web A travels as shown in full lines in FIG. 1. The web A may be substantially dry in being drawn from an off-machine reel, or in being drawn directly from a paper-making machine, to the size press **10** and may, for example, have about six percent moisture content. Although the size press **10** may be arranged to cause the web A to pick up various amounts of sizing, a 30 percent pickup is usual at which a pound of paper entering the size press emerges from the press to weigh 1.3 pounds. Eventually, most of this increased weight is lost; the web after drying and cockling may, for example, be left with only a three percent increase in weight. The amount of sizing imparted to the web may be changed particularly by changing the pressure between the rolls **17** and **18**. As has been mentioned, the sizing is of conventional chemical makeup, being principally starch and water, mostly the latter; and the water evaporates during the drying process to leave only the solids on the paper.

The web A passes over the rolls **11** and **12** and thus has the outlines of the bosses **23** impressed or embossed on it. In impressing the shapes of the lands **23** on the paper, the cylinders **11** and **12** are preferably heated, such as by the application of steam to the rolls in a conventional manner, the heating being to 100 degrees to 300 degrees Fahrenheit, for example; and the cylinders **11** and **12** thus have a preliminary drying effect on the paper. The felt **25** and the roll **30** maintain the paper in close contact with the surfaces of the rolls **11** and **12** so as to accentuate and assure this embossing action. As will be understood, if desired, a roll **30** may be substituted for the felt **25** and a felt **25** may be substituted for the roll **30**, since both the roll **30** and the felt **25** function in much the same manner to assure close contact of the web A with the respective cylinders **11** and **12**. It will be understood also that an embossing roll may be substituted for the soft surfaced roll **30** for either of the cylinders **11** and **12**, with the embossing roll having a cockled surface similar to that on the respective cylinder **11** or **12** but having a boss of the same size and shape as each surface depression in the cylinder **11** or **12** to thus have a surface meshing engagement with the respective cylinder **11** or **12**.

The cylinders **11** and **12**, particularly since the web A is relatively wet with sizing as it passes over the cylinders, thus cause a physical distortion of the web A by the cockled surfaces of these rolls to give the web an embossed cockled finish which corresponds in pattern with the surfaces of the cylinders **11** and **12**. This preliminary cockling of the web A insures the subsequent development during drying and retention after drying of the cockled effect, and the cockled effect is accentuated, enhanced and made permanent due to the particular mode of drying the web that is provided by the air float drier **13**, under zero web tension and with the web being supported only on air as it is being dried. The web A passes between the plenums **38** and **39** in the direction indicated by the arrow B in FIG. 3 and floats between the plenums, being supported solely by the air impinging on the web A from the jet tubes **43**. The pull rolls **34** and **35** and the rolls **44** and **45**, which act as tension control rolls, are so driven that the web A is under substantially zero tension as it passes between the plenums **38** and **39**, and there thus is no substantial tendency for the precockled finish on the paper to be drawn out of it. The mount hope rolls **29** and **37** prior to and subsequent to the cylinders **11** and **12** in the path of the web A function to maintain the paper web spread smooth in accordance with conventional operation of such rolls.

The web A, subsequent to drying by the drier **13**, is passed over the mount hope roll **47** to be wound on the conventional reel.

Although we prefer the air float drier **13** for drying the web A and producing the accentuated cockled effect on the web, other drying devices in which the web A is under substantially zero tension may be used instead, such as an electrical radiant drier **64** shown in FIG. 6. The drier **64** comprises a pair of opposite, closely spaced, panels **65** and **66**, heated respectively by electric heater elements **67** and **68**. Rolls **34***a* and **35***a* corresponding to the rolls **34** and **35** and rolls **44***a* and **45***a* corresponding to the rolls **44** and **45** are so driven that the sheet A is slack as it passes between the panels **65** and **66**. The panels **65** and **66** apply radiant heat on the web A and dry it as it passes downwardly between the panels **65** and **66**.

If it is desired to produce smooth finish paper, the path of the web is changed to that indicated by the web A′. The web A′ passes through the press **10** substantially directly to the drier **13**, exclusive of the cylinders **11** and **12**. Sizing may or may not be used in the press **10**, as desired; however, if no sizing is used, it is contemplated that the web shall not be completely dry as it passes to the drier **13**.

The air float drier **13** is supplied with air at such temperatures and velocity to partially dry the web A', and drying of the web A' is completed by the driers **14** and **15**. The web A' is held in tight contact with the driers **14** and **15**, and since the peripheral surfaces of the driers **14** and **15** are smooth, the web A' with a smooth finish results. The finish of the web A' is made even smoother by the calender **16**, in accordance with well-known principles of operation of paper calenders.

It will be understood that conventional driving mechanism can be utilized in connection with the various rolls and cylinders of the apparatus. The rolls **17** and **18** of the size press, the cylinders **11** and **12** and the driers **14** and **15** may, for example, be driven along with various others of the rolls. As has been mentioned, the rolls **34** and **35** and the rolls **44** and **45** are so driven that the web is slack as it passes between the plenums **38** and **39**, and the web A is also preferably maintained quite slack subsequent to passage from the cylinder **12** to the drier **13**. Heating of the driers **14** and **15** and of the cylinders **11** and **12** is accomplished by conventional heating devices. The cylinders **11** and **12** and driers **14** and **15** may, for example, be hollow and steam may be supplied to these cylinders.

We have found that by providing the preliminary cockling effect on the web by means of the cockled external surfaces of the cylinders **11** and **12**, with the web being partially dried by these cylinders, a highly satisfactory cockled product is produced. It is not necessary that the cylinders **11** and **12** be effective for long durations of time on the web A; the time of contact with the web by the cylinders may be less than a second. Under some conditions, only one of the cylinders **11** and **12** may be utilized; however, particularly for heavier grades of paper, we prefer the use of both cylinders **11** and **12**. The desirable ultimate cockled finish of the product may be considered to be the effect of the initiation of the cockled effect by the simulated cockled surfaces on the cylinders **11** and **12**, which physically distort the wet web to have a simulated cockled finish, followed by the completion of the drying of the web at a minimum tension as it passes through the drier **13**. The drier **13** effective subsequently on the precokcled web A has been found not only to retain the cockled effect previously produced by the cylinders **11** and **12** on the web, but to develop and increase the cockling, so that a fine quality end product is obtained. The above described apparatus, including the cylinders **11** and **12** and the air float drier **13**, may be used to replace the conventional lofting operation, including the festoon drier, with resultant savings in space and capital cost, large reductions in operating costs and waste, and increased production. In this connection, it may be mentioned that a festoon drier commonly is operated at 150 to 200 feet per minute while the cockling apparatus described herein will operate satisfactorily between 400 and 1000 feet per minute, for example, while still producing a very satisfying cockled product.

Great savings may be had by the herein described apparatus, since it can be operated in tandem with an ordinary papermaking machine, permitting the production of either cockled or flat paper at will, and eliminating a separate cockling or lofting operation. The illustrated apparatus may be used in tandem with a papermaking machine, since its speed matches that of conventional papermaking machines effective at present for making bond grades for which the apparatus is particularly useful.

Due to the increased speed with which the web A passes through our apparatus, the penetration time of the sizing solution into the web is decreased as compared to time of penetration with conventional relatively slow cockling apparatus using a festoon drier. The physical distortion or precockling of the paper web A produced by the cylinders **11** and **12** has been found especially desirable to compensate for the reduced penetration time of the sizing solution, and the cylinders **11** and **12** permit

the use of wider ranges of the constituents of sizing solution, wider ranges of viscosities of sizing solution, and a wider range of weights of base sheets. The precockling step results advantageously in the development of a satisfactory cockled finish after subsequent drying in spite of any web tensions which otherwise might tend to destroy the cockled finish.

Air velocities of 2000 to 8000 feet per minute from the jet tubes **43** of the drier **13** may be considered moderate and will not damage the web A which is unsupported in passing between the plenums **38** and **39**. Since the web is supported by the air jets from the plenums **38** and **39** rather than by other guides or rolls, a minimum tension of the web is maintained which is particularly desirable for cockling, even though the web passes horizontally through the drier **13**. With the drier **13**, the web A substantially as a slack sheet is floated between opposed cushions of hot air while still being dried at a high rate. It may be understood that if desired, the temperatures of the air from the two plenums **38** and **39** may be varied, particularly to control the cockling effect on the paper.

It will be understood that although minimum tension is maintained on the web A as it passes through the drier **13**, the tension on the web may be increased subsequent to the rolls **44** and **45** for satisfactory reeling, since the web A is dry at this time.

Due to the fact that long loops of festooned paper are not required with the present apparatus, large amounts of paper are not wasted in threading and starting and stopping the apparatus as with conventional machines.

The tension on the web A' for making flat finished paper is preferably higher than that on the web A for minimizing any cockling tendencies of the web, but unduly high tensions of the web A' should be avoided. For flat finishing, it is contemplated that the air float drier **13** shall still carry the larger drying load, and the drier cylinders **14** and **15** shall finish the drying operation as well as insuring flatness due to the smooth external surfaces of the driers **14** and **15**. It is contemplated that, under normal conditions, only two steam heated cylindrical driers **14** and **15** will be needed because of the high rates of drying obtainable by the air float drier **13**. In this connection, it may be noted that the overall length of the drying section of the herein described machine for producing the flat finished paper, including the drier **13** and the two cylinders **14** and **15**, is less than a conventional multi-cylinder drier section following a size press.

The herein described apparatus for initiating the cockle with positive physical distortion and for keeping the precockled web under minimum tension advantageously produces a controlled cockle size and intensity of cockling. At the same time, any appearance of having mechanically embossed the web is avoided, since final drying of the web is by the air float drier **13** independent of the heated cockle surfaced cylinders **11** and **12**.

We wish it to be understood that the invention is not to be limited to the specific methods and constructions shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

We claim:

1. In a method for making cockled paper, the steps which comprise, utilizing a dry paper web and passing it through a bath of liquid sizing, subsequently traveling the paper web as so wetted over a rotating cylinder which is heated to between 100° F. and 300° F. surface temperature and holding the web forcefully in contact with the cylinder as it passes over the cylinder, said cylinder having an uneven external surface comprising a plurality of bosses which are of irregular spacing and size and shape and are between .005 inch to .05 inch in height and have diameters or largest transverse dimensions of ⅛ inch to ½ inch so that the cylinder patterns the web in partially drying it, and subsequently completing the drying

of the web while maintaining the web under a minimum tension.

2. In a method for making cockled paper, the steps which comprise, applying a moist paper web in contact with a heated surface having a plurality of bosses of random spacing and size and of rounded, irregular and random shapes so as to partially dry the web, and subsequently completing the drying of the web while maintaining the web under a minimum tension.

3. In a method for making cockled paper, the steps which comprise, utilizing a dry paper web and passing it through a bath of liquid sizing, subsequently traveling the paper web as so wetted over a heated rotating cylinder and holding the web forcefully in contact with the cylinder as it passes over the cylinder, said cylinder having an uneven external surface comprising a plurality of bosses of random spacing and size and of rounded, irregular and random shapes so that the cylinder patterns the web in partially drying it, and subsequently completing the drying of the web while maintaining the web under a minimum tension.

4. In a method for making cockled paper, the steps which comprise, utilizing a dry paper web and passing it through a liquid bath so as to wet the web, subsequently traveling the paper web as so wetted over a rotating heated cylinder in contact with one surface of the web and subsequently passing the paper web over a second rotating heated cylinder in contact with the other surface of the

web, each of said cylinders having an uneven external surface comprising a plurality of bosses of random spacing and size and of rounded, irregular and random shapes so as to have an irregular partial drying effect on the web as it passes over the cylinder, and subsequently completing the drying of the web while maintaining the web under a minimum tension.

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