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METHOD OF MAKING COCKLE PAPER

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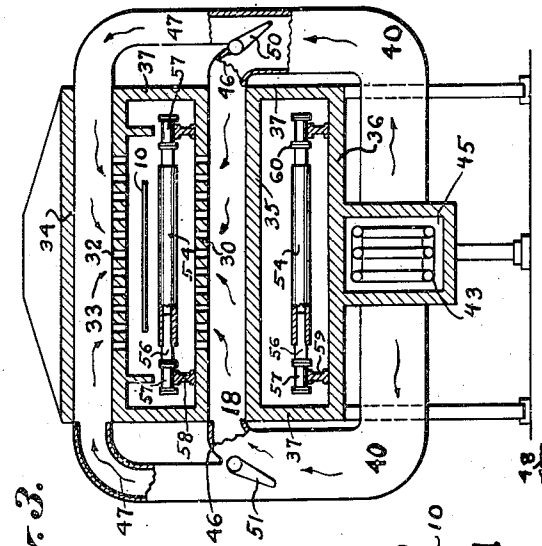


Fig. 3.

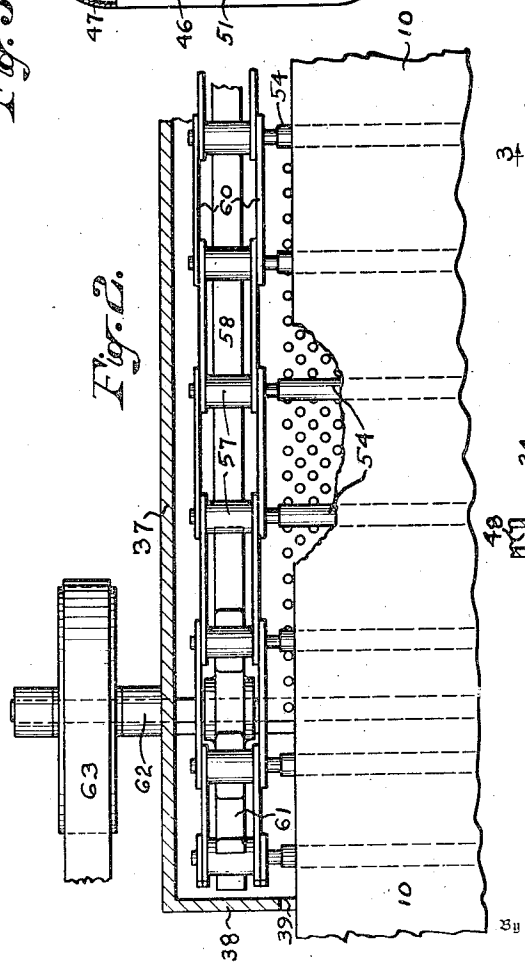


Fig. 2.

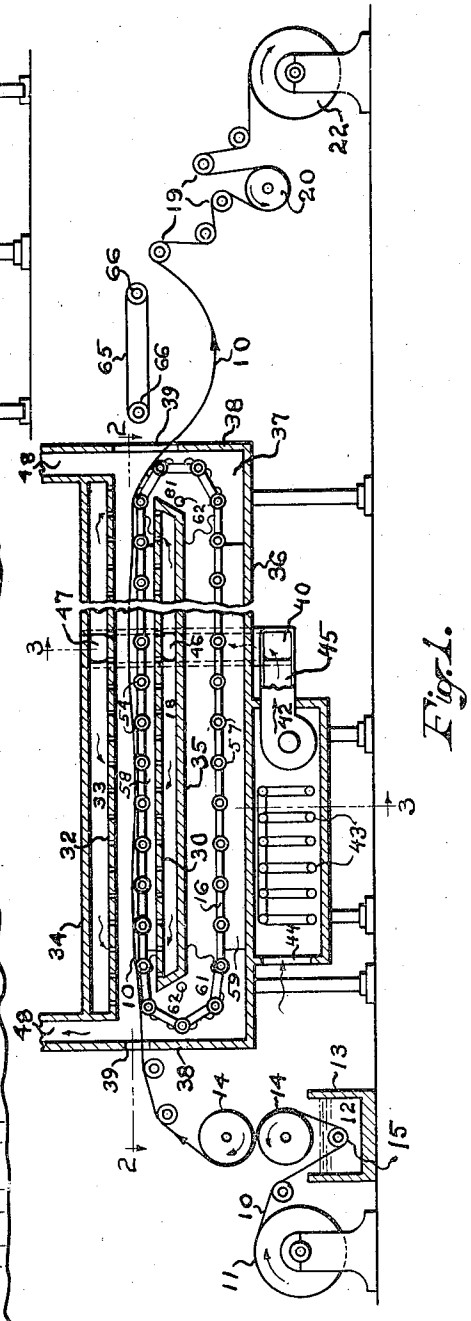


Fig. 1.

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METHOD OF MAKING COCKLE PAPER

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This invention relates to a method of making cockle paper.

Heretofore cockle paper has been made by applying a cockle stabilizing sizing to a paper web fed continuously from a supply roll and thereafter passing this web progressively through a drying chamber wherein the paper is hung in festoons on cross bars or so-called sticks which are moved forward mechanically after the paper has been hung thereon. The wet paper hangs with the full weight of each loop suspended from the adjacent sticks and the paper is therefore subjected to differences in tension from the top to the bottom of each loop. Most important, the sticks leave a mark on the paper and all marked portions must be cut out and discarded. This requires cutting the paper into large sheets and inspecting them and sorting out the defective marked portions. Thereafter the rejected sheets are again cut to a smaller size and inspected and sorted once more. This involves not only a high labor charge but particularly a very large waste of paper.

It has also been attempted to dry that sized paper by passing it back and forth over a series of positively driven rolls, but these rolls put tension on the paper which tend to pull out the cockle effect and thus to smooth out the paper. The cockle appearance is caused in part by the uneven shrinkage of the paper pulp fibres wherein they tend to curl and move somewhat during the drying operation, and this is materially aided by the sizing which in shrinkage tends to distort the paper into a bumpy and locally wrinkled appearance. It is found that any attempt at making cockle paper by methods which put tension on the paper during its wet stage tends to destroy the cockled condition and thus defeat the primary objects of the process.

The primary object of this invention is to make cockle paper by impregnating the paper with a suitable sizing and then drying the paper under such conditions that it is not subjected to a material degree of tension and its contact with supports during the drying operation is minimized so that the desired cockle effect is produced without material wastage. Further objects will be apparent in the following disclosure.

Referring to the drawings, I have there illustrated a preferred construction capable of carrying out my method, in which:

Fig. 1 is a diagrammatic elevation of the apparatus, with the dryer shown in section;

Fig. 2 is a fragmentary section taken on the line 2—2 of Fig. 1 showing a portion of the drying apparatus; and

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Fig. 3 is a vertical transverse section taken substantially on the line 3—3 of Fig. 1.

In accordance with my preferred method, a web of paper is treated with a suitable animal or vegetable sizing material, such as glue, starch, a converted starch, soy bean flour, casein, a synthetic resin, various cellulose derivatives or mixtures of these, or other suitable adhesive coating materials in an aqueous or other suitable evaporable medium. This sizing may be incorporated in or applied to the paper in various ways, such as by spraying or flowing an aqueous suspension or solution of the sizing on the surface of the paper. But I prefer to impregnate the paper by feeding a web of paper 10 progressively from a supply roll 11 or other suitable source through a sizing bath 12 of an aqueous solution of starch and glue in any desired proportions held in a vat 13, and then between massive pressure rolls 14 arranged above the vat which remove the excess of sizing and squeeze the rest into the paper. These rolls serve also to draw the paper forward from the supply roll at a uniform rate and thus present it progressively for the drying step. The paper strip is held beneath the surface of the sizing by a roll 15.

In the drying zone, the paper is dried in a horizontal position by suitably applied heat, and is moved forward under a controlled light tension. It may be moved by a suitable conveyor, such as the ladder type endless belt conveyor 16 which may slip relative to the paper as it frictionally grips the under surface thereof and thus not mark the paper materially. In the preferred arrangement, the paper is subjected to a heated air current while thus moving; and this air may be directed against the under side of the paper to give a buoyant effect that materially reduces the stick marking and the pressure of contact of the paper on the conveyor. The buoyant air current, which may be such as to float the paper strip partially or substantially fully, is derived from an air duct 18 arranged below one run of the conveyor. The paper passes through the drying zone in a substantially flat and horizontal position and under a minimum tension. It then travels over a set of guide rolls 19 and 20 which provide enough tension in the dry paper so it may be satisfactorily wound on a suitably driven winding spool 22.

When the paper is wet it is very weak in structure, and it is therefore important that it be not subjected to any material degree of tension while going in this wet condition through the drying zone. An excessive tension would tend to break

the paper as well as to pull out the cockle structure which is produced by the drying operation. While various types of drying apparatus may be employed for drying the paper at a minimum of tension and without leaving noticeable stick marks, I prefer to employ a structure substantially as shown in the drawings. This comprises walls forming a long and vertically narrow space through which the paper travels on the top run of the conveyor 16 while it is substantially completely dried or to that degree required for forming the desired cockle and holding it in the paper. This space is formed by the upper perforated wall 30 of the duct 18 and the lower perforated wall 32 of a further hot air duct 33. An impervious top wall 34 and suitable connecting side walls complete the upper duct 33. The lower duct 18 has a solid wall 35 for its bottom, and suitable connecting side walls. The lower run of the conveyor 16 passes between the wall 35 and a lower horizontal wall 36 spaced therefrom. Side walls 37 and end walls 38 provide a substantially closed chamber for the dryer. The paper enters and leaves the drying chamber through the openings 39 in the end walls.

Heated air is conveyed to the upper and lower ducts 18 and 33 above and below the run of the paper 10 by means of ducts 40 through which air is blown by means of a suitable driven fan 42 arranged to draw air through a heating zone, such as over a set of steam heated pipes 43. Although the air may be recirculated, it is shown as coming from the outside atmosphere through an opening 44 in the wall of the heating compartment. The side ducts 40 receive heated air from a common duct 45 connecting with the fan chamber, and they project laterally and then upwardly on each side of the drying chamber where they communicate through lateral ducts 46 and 47 respectively with the lower and upper spaces 18 and 33 for delivering the heated air to the paper. These various passages and compartments are suitably arranged so that the heated air is forced to travel only through the openings in the perforated walls 30 and 32 into contact with the paper 10. The heated air may be exhausted to the outside atmosphere through ducts 48.

In order to adjust the relative amounts of heated air passing into the upper and lower ducts above and below the paper, I provide a pivoted flap damper 50 at the junction point between the smaller ducts 46 and 47, and this is controlled by an outside handle 51 or other suitable means. The parts are so arranged that the flap damper may be secured in any desired position, such as in a middle position so that the air will pass equally into the ducts 46 and 47; or as shown in Fig. 3, the damper may be moved to a position where the major portion of the air goes into and through the lower duct 18 and thus against the under side of the paper. In the latter case, the pressure of the air beneath the paper tends to float the paper above the conveyor 17, and the air issuing through the top wall 32 does not provide enough pressure to force the paper downwardly to a material extent.

The paper may be conveyed through the drying zone under a minimum of tension by the construction illustrated, in which the conveyor 16 is formed of cross bars or sticks 54 shaped as hollow metal tubes. A shaft 56 fits into each end of the metal tube and the outer end of each shaft is a bearing support for a roller 57. Each roller 57 at the upper run of the conveyor rides on the rail 58 suitably carried by the walls of the drying apparatus. A further rail 59 supports the lower run of the conveyor. Chain links 60 connect the shafts 56 at each side of the rollers and thus form an endless jointed ladder type of conveyor as will be apparent. This endless conveyor is driven by any suitable construction, such as the two pairs of gear shaped wheels 61 mounted on cross shafts 62 that are suitably driven, as by means of a pulley and belt drive 63 connected with a source of power. The drive gears 61 have teeth so spaced as to engage the rolls 57 which carry the cross bars 54.

I may also provide a supplemental carrier for the paper at the exit end of the drying zone which may either cooperate with or replace the endless carrier above described. This supplemental carrier may comprise an endless belt 65 made of felt or canvas or other suitable material mounted on and moved by two rollers 66 suitably driven by power mechanism. In the construction illustrated in Fig. 1, the paper 10 is shown as passing in a loop beneath that belt and not conveyed by it. But the paper may be fed across this endless belt 65, and because of the frictional grip of the belt surface, the paper will be gently pulled along. The belt 65 serves primarily when the paper is fully supported on the air currents derived from the air duct 18. In that case, the paper is moved through the drying zone without an unnecessarily high tension which would serve to break or injure the paper or to pull out the cockle thereof, since the only tension required is that slight amount required to hold the ends of the paper against the force of the supporting air current and to move it along. This frictionless support and conveyance of the paper can be delicately controlled so that very thin paper may be safely transported and dried.

In its mechanical operation, the construction as thus described, serves to draw the dry paper from the supply roll 11 through the sizing bath 12 and thence between the power driven pressure rolls 14 which press the sizing material into the fibres and pores of the paper and squeeze off any surplus that does not impregnate the paper. Then the paper is drawn gently forward by means of the frictional grip of the cross sticks or bars 54 of the endless conveyor 16 as it is subjected to the hot air currents from ducts 18 and 33 arranged above and below the paper. In order that variations in speed of the supplemental winding apparatus may not place any tension on the paper, the paper passes in a long self-supporting loop from the exit end of the drying apparatus to the rolls 19. As soon as the paper is fully dry, it may be wound on the spool 22 without destroying the cockle, and the tight roll will keep out moisture and insure that the cockle will remain until the paper can be cut into sheets and then wrapped in required sizes.

A substantial portion of the weight of the paper is supported on the air currents issuing from the lower air duct 18, but the paper remains in sufficient contact with the top run of the endless conveyor 16 so that the cross bars 54 will have sufficient frictional grip on the paper to draw it gently forward through the drying zone. The endless conveyor is driven at a speed materially greater than that at which the paper is to go through the drying zone, and the cross bars 54 will therefore slip frictionally against the paper and so leave no visible stick marks. The contact between stick and paper is so light that no marks are left even if the paper is wafted on the heated

air current into and out of contact with the cross sticks.

The construction of the dryer may be varied widely. For a thin tissue, the conveyor may be about 40 feet long. The holes in each of the plates 30 and 32 may be in a staggered arrangement about 4" apart and 1" more or less in diameter. The cross bars or sticks 54 may be 1 foot or more apart. The conveyor may be run at about 300 feet per minute and the hot air may be initially heated to about 250° F. A suitable temperature will usually range between 150° F. and 350° F. The temperature will be varied depending upon the desired rate of drying, as well as the weight of the paper sheet, the amount of water contained in it and the type of cockle desired. It may be noted that although the air temperature may be 350° F., yet the temperature of the paper will stay at the wet bulb temperature of somewhere between 100° and 120° F. in an average case. Hence the paper does not reach the temperature of 212° F. or the formation of steam and so is not injured in the drying process. Also, the rate of drying the paper may be controlled by varying the rate at which the paper passes through the dryer or by making the dryer longer or shorter in accordance with the desired results. By varying the temperature of the heated air and the rate of air flow through the drying zone, the humidity of the air will be controlled and thus the rate of drying may be regulated as desired. Several drying zones of different humidities and temperatures may be provided to give a desired controlled drying curve by providing two or more separate sets of inlet ducts 46 and 47 and, if desired, separate sources of heated air of selected temperatures which serve to introduce air of desired characteristics at different points along the extent of the drying chamber. Suitable instruments may be employed to measure the dryness of the paper and thus to indicate a proper control of the humidity. It will also be noted that in the construction illustrated, the paper is subjected to a gradually increased temperature as it approaches the air ducts 46 and 47 and thereafter to a decreasing temperature. The flow of the air currents may be controlled by fans to regulate the humidity as well as temperature of the air throughout the drying zone.

When the paper goes to the drying zone from the sizing bath, it may contain about 42% of moisture, but this is only a very slight amount of water due to the thinness of the paper, and it is readily evaporated. It is desirable to dry out the water between the paper fibres but to leave the fibres with a normal moisture content. The total dryness of the paper is preferably about 3%, and it will ordinarily be in the neighborhood of 2% to 5% by weight of total moisture, which represents a dry condition sufficient to hold the cockle in the paper. This condition of dryness of the paper is to be emphasized, since the paper must be substantially dry or in such a condition when it leaves the drying zone that the cockle will not be pulled out materially when the paper is thereafter subjected to tension, such as is involved in a winding operation, or in cutting the paper by knives and while under pressure. Some of the cockle is lost or converted to a more subtle appearance during these tensioning and pressure stages, but such change does not affect the utility and marketability of the paper. However, because of this subsequent pressure or tension stage, it is all the more desirable

to impart a high degree of cockle to the paper during the drying stage; hence the conditions of drying the paper while it is substantially flat and while it is under only a slight tension are essential to the production of a superior product. It may also be observed that the proportions of the sizing bath as well as the nature of the ingredients used may be varied widely within the knowledge of those skilled in the art.

The cross bars 54 do not impart material tension to the wet paper, since the paper is supported to a substantial extent by the air currents from the staggered holes in the lower wall 30. Thus, as the paper partially floats or waves above this conveyor, or its pressure thereon is reduced, the cross bars move along relative thereto as they draw the paper forward and this sliding movement does not leave detrimental marks. The bars move only slightly faster than the paper so that the cross sticks slide only a slight distance, such as a little more than the spacing between two sticks, and thus give a uniform appearance to such effect as is produced by the slight frictional sliding contact. The operator of the machine may vary the float condition of the paper by moving the damper 50. In fact, the paper may rest lightly all of the time on the cross bars, but because of the very light frictional engagement with the paper, the bars will slip relative thereto and any marks caused by the cross bars will be made substantially uniform along the length of the paper. Hence it will not be necessary to cut out the stick marks which have hereto created such a loss in the total amount of the final product.

Since the paper is held substantially flat and horizontal as it passes through the drying zone, the tension on the paper is only that which is required to pull it along in a horizontal position. Also, the paper is not supported on the cross bars to such an extent that it will sag between them and so form festoons or loops. Any such loops would prevent slippage of the cross sticks 54 and so would leave marks where the paper is supported. It is essential in this particular construction that the cross bars slide gently beneath the paper and yet impart sufficient frictional grip thereon to assure that the paper will move along through the drying zone. If the conveyor 16 is omitted, then the paper will pass over the belt 65, and because of frictional drag on the very dry paper at this point, the belt will not injure or mark the paper but will give a desired tension to move the paper forward while it is entirely supported on the lower air currents derived from the duct 18. Because of this method of fully or partially floating the paper while it is drying, I may dry it at a far greater speed than heretofore feasible. It will also be understood that the rates of movement of the feed and pressure rolls 14 and of the wind-up drum 22 and the associated rolls are suitably coordinated to insure that the paper is held loosely after it leaves the drying zone and so does not tend to impose undesired tension upon the drying paper. The wind-up roll may be run at a slightly slower rate than that of rolls 14 so as to compensate for shrinkage in the length of the paper.

It will now be appreciated that my method comprises impregnating a paper strip of desired weight and texture with a suitable aqueous sizing and then drying that paper in a substantially horizontal and flat condition to dry the paper and associated sizing under such controlled temperature and humidity conditions as to pro-

duce an uneven shrinkage and the desired cockle effect. The paper is subjected to heated air currents from beneath and preferably also from above, and these air currents may be so proportioned as to provide a buoyant effect that tends to support some of the weight of the paper, and this buoyancy may be such as to insure that the paper floats substantially fully during at least the first part of the drying stage where the paper is wet and weak in structure. Since the paper is held in this horizontal position, only a small degree of longitudinal tension is required to move it lengthwise through the drying zone. This force required to move the paper may be distributed throughout the length of the drying zone as is the case where the paper is moved forward by the cross sticks of an endless ladder type conveyor. Where that conveyor is employed, the paper tends to lag behind the sticks and thus the sticks slip along the under side of the paper and do not leave noticeable marks. If the paper is fully floated on the heated air current, then it is dragged forward by a suitable device engaging the paper after it has been fully dried so that this propelling mechanism will not destroy the cockle. It is desirable that the paper be dried to a total water content of not over 5% by weight and preferably less so that the cockle condition will not be materially destroyed during subsequent operations, such as slipping the paper into narrower strips or winding it in a roll, but wide variations may be made in temperature control depending on the requirements of the paper maker. The heat for drying the paper may be obtained from any suitable source of conductive, convective or radiant heat, such as infra red electric light bulbs or other heating devices located above and below the straight run of the paper in the drying zone, or such devices may be installed in the heating chamber where the steam pipes are located, or as desired.

Various modifications in this process will now be apparent to one skilled in the art in view of the above disclosure and it is to be understood that the above disclosure is to be interpreted as setting forth the principles of my invention and the preferred steps of the method and not as imposing limitations on the claims appended hereto.

I claim:

1. The method of making cockled paper comprising the steps of providing a strip of paper which is impregnated with water and a cockle stabilizing sizing, progressively moving the strip forward through a drying zone in a substantially flat and horizontal position with the under side of the paper strip located above a series of cross sticks moving longitudinally forward in a paper supporting position, blowing against the underside of the paper and upwardly directed buoyant current of air which prevents the paper from adhering locally to and looping between the cross sticks, while controlling the rate of paper movement at both sides of the drying zone and maintaining the paper under only sufficient tension to move it forward without destroying the cockle, and evaporating the water progressively and shrinking the paper and causing the sizing to stabilize the cockle.

2. The method of making cockled paper comprising the steps of providing a wet strip of paper impregnated with water and a cockle stabilizing sizing, progressively feeding the paper strip forward into, through and out of a drying zone in a substantially horizontal and flat condition with the aid of traveling cross sticks there beneath moving longitudinally forward faster than the strip and which frictionally engage and slip relative to the under side of the paper strip, while supporting a part of the wet weight of the strip on a buoyant current of heated air projected upwardly between the sticks and against the under side of the strip and subjecting the strip to only that light surface frictional contact with the sticks and a longitudinal tension which is sufficient to move the partially floated paper horizontally without destroying the cockled effect, and evaporating the water and shrinking the paper and thus causing stabilization of the cockle by the sizing remaining therein.

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