

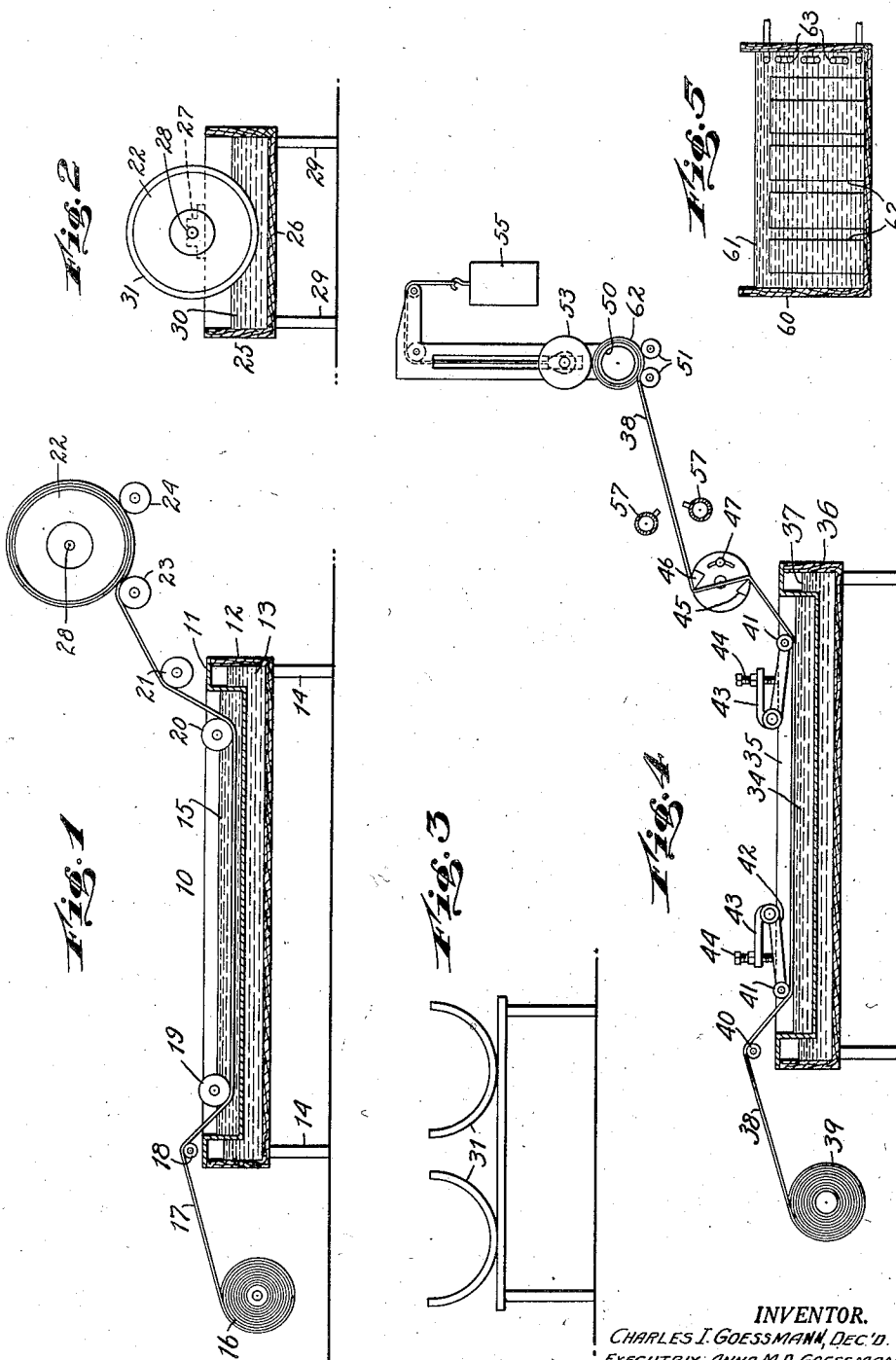
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C. I. GOESSMANN

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INVENTOR.
CHARLES I. GOESSMANN, DEC'D.
EXECUTRIX, ANNA M.D. GOESSMANN

BY *Frederick S. Davenport*

ATTORNEYS.

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Charles I. Goessmann, deceased, late of Providence, R. I., by Anna M. D. Goessmann, executrix, Brooklyn, N. Y.

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6 Claims. (Cl. 154—50)

This invention relates to the art of paper making and has for its object the production of a durable, horn-like material from absorbent pulp paper, by fixing therein desirable added colloidal protein matter.

The present application is a division of co-pending application Serial No. 664,811, filed April 6, 1933, and since issued as Patent No. 1,944,886, dated January 30, 1934.

A primary object of the invention is to take advantage of the inventor's discovery that the drying, without extraneous pressure, of paper pulp which has been impregnated with a protein colloid that has later been jellified or congealed and thereafter rendered insoluble, will produce such a condensing and hardening of the impregnated mass due to shrinkage force as to produce a tough, horn-like, dense and insoluble product.

It is one of the objects of the invention that the added matter shall be so united with the original stock that the resultant mass is integral and homogeneous.

Briefly stated the process consists in impregnating raw stock paper in a heated bath prepared from colloidal protein matter and a suitable solvent; rolling the initially treated paper on a lamination drum or mandrel until the desired number of laminations is attained; squeezing out excess of the added matter; jellifying the colloid in the paper; treating the resultant mass with a fixing or coagulating agent which renders the colloid matter insoluble; and drying the final product in a cool, dry or heated atmosphere without extraneous pressure. If the final product is to be in tubular form the product is preferably dried on the mandrel, but if the final product is to be in sheet form it is slit and removed from the drum preferably before drying and is then pressed flat and dried.

It will be seen by the above terse description that a soluble colloid is first added to the raw stock, then jelled so as to anchor the soluble colloidal matter, then rendered insoluble therein, and then the whole mass dried.

In the drawing, which forms a part of this specification, is shown diagrammatically means for carrying out the steps of the process.

Fig. 1 is a diagrammatical representation of a heated impregnating bath and means for passing therethrough the paper to be treated, the same being shown in vertical longitudinal section;

Fig. 2 is a diagrammatical representation of the chilling and fixing bath with the roll of im-

pregnated paper in position therein, the same being shown in section;

Fig. 3 is a diagrammatical sketch showing segments of the impregnated and fixed lamination of paper cut from the roll on which it has been formed;

Fig. 4 is a diagrammatic view similar to Fig. 1, showing a modification of the process; and

Fig. 5 is a diagrammatic view in vertical section, showing a fixing bath in which tubular stock is being fixed.

In the drawing, the reference numeral 10 indicates an impregnating assembly comprising a bath 11 fitted over a tank 12, which tank is adapted to contain a suitable heating medium 13. If desired this tank 12 may be mounted on supports 14. The bath 11 contains an impregnating medium 15 of colloidal protein matter, such as glue, gelatine, casein, dried blood, albumen, or other nitrogenous colloid dissolved in water, or any other suitable solvent, and preferably used hot.

The assembly also includes means, not shown, for supporting a roll of raw stock paper 17, such as wood pulp paper, rag paper, or such other kind of paper as is adapted to absorb a relatively large amount of moisture.

The paper is fed through the bath 15 by being passed over a guide roller 18 and under immersion rollers 19 and 20, thence over the enlarged guide roller 21, which also serves to express a goodly quantity of the excess of the impregnating fluid which adheres to the stock. The free end of the stock is secured to the laminating cylinder 22, which is driven by drive rollers 23 and 24 actuated by suitable means, not shown.

The laminating cylinder which is first covered with paraffin impregnated paper, or other suitable non-adhesive covering, rests on rollers 23 and 24, and as the stock is wound on said cylinder a major part of the impregnating fluid is squeezed out of the stock. The stock is wound on this cylinder until the desired number of laminations is attained. Then the web of paper is severed and cylinder 22 with the paper thereon is removed bodily and transferred to a chilling and fixing bath 25 which consists of a tank 26 having open bearings 27 at each end thereof and adapted to receive the axle 28 of the lamination cylinder.

Tank 26 may be mounted on supports 29, if it is so desired. Tank 26 contains a chilling bath 30 which consists of such a solution of such congealing agent as cold water or cold brine, or agents best adapted to congeal and render jelly-

like the particular colloidal protein matter being held in suspension in the impregnating tank.

The congealing bath may be cold water alone or a cold solution of salt, alum, formaldehyde, paraldehyde, chromates, di-chromates, or other suitable coagulant medium and this chilling bath is maintained at a temperature of about 45 degrees Fahrenheit during the chilling operation which takes place immediately after the lamination is completed. The result of this cooling in the presence of a coagulant is to form a jelly-like mass of coagulated colloid imbedding the fibers of the stock.

To render this jelly-like material insoluble, it may be treated with chrome alum, tannin, dichromate of potash, formaldehyde, or any other suitable fixing agent simultaneously with congealing. In practice the above named fixing agents are added directly to the cooling bath. It is obvious, however, that the fixing or coagulating may be effected by removing bodily the laminated paper and the cylinder on which it was formed from the congealing bath to a new bath consisting solely of the desired coagulating or fixing agent and its proper solvent.

The combination cooling and fixing step may be done in the same tank and at the same time, in an already prepared stock solution of "fixing" chemicals such as formaldehyde, etc., as described above, dissolved in water, made up in volume and used cold over and over again. In the standard stock bath the fixing agent is dissolved in the cold water solution.

Instead of chilling and thereby jelling the colloid carried by the paper in the fixing bath it may, as stated above, be chilled in a separate bath, in which case it is not necessary to chill the fixing bath below ordinary room temperature, although preferably the temperature of the fixing bath should be kept under 75 degrees Fahrenheit. Instead of jelling the colloid in a bath, the laminated product may stand in the open air for a while before fixing, until the colloid is at least partially coagulated by cooling and partial evaporation of moisture so as to form a homogeneous mass permeating the laminae and bonding them together. As will be pointed out more specifically hereinafter the jellifying step may, in part, at least, actually precede lamination of the paper. It will be obvious that it is not necessary to use a liquid fixing bath but a gaseous fixing agent may also be used.

When properly fixed the cylinder of laminated paper 31 is cut through parallel with the axis of the cylinder, as indicated in Fig. 3, somewhat flattened out and dried in the presence of heat and then completely flattened, preferably under pressure. If the chilled bath is used separate from the fixing bath the sheet may be cut through parallel with the axis of the cylinder as indicated in Fig. 3 immediately after chilling. These freed sheets are at once placed in the fixing bath to soak and after fixing are dried and flattened as described. It is obvious that one or more cuts may be made in the cylinder of paper in removing it from its forming cylinder.

It is within the purview of this invention to employ cut sheets instead of roll paper in carrying out the invention, the essence of which is impregnating paper stock with a solution of colloidal matter solidifying the colloidal matter, fixing the colloidal matter, and then drying the treated mass.

While the lamination cylinder may be driven by small rollers on which it rests, it is apparent at

once that it may be driven directly on its own axis if so desired.

It is also within the purview of this invention to employ pressure in the final drying operation, although it has been found that the amount of water and colloidal matter absorbed by a ton of raw stock produces sufficient pressure in coming down to dryness, due to pulling and drawing effect of the shrinking force, to cause the resultant indurated mass to shrink to approximately 80% of its original thickness, or in other words, it loses by this process one-fifth of its original fiber thickness. This has been accomplished by increasing the density or specific gravity of a paper mass from .809 Sp. Gr. to 1.192 Sp. Gr. or 50% without mechanical pressure.

The resultant product is a hard, horn-like and water-proof material somewhat like the hard fiber, vulcanized, or zinc chloride paper in common use. Paper produced by the present process has no tendency to split at the edges, is unusually tough, and is produced at much less cost than other hard fiber papers. Whereas the old processes require weeks to produce the final product, the present process is completed in a few days.

The process diagrammatically represented in Fig. 4 is quite similar to that described above. However the web of paper is not submerged in the bath but is floated on the surface of the colloidal solution so that it will not pick up a large excess of the solution, also, at least a partial jelling is effected just prior to the lamination step. The colloidal solution 34 (Fig. 4) is contained in a tank 35 provided with a jacket 36 containing a suitable heating medium 37. A web 38 of raw stock paper taken from a roll 39, passes over a roller 40 and thence under a pair of flotation rollers 41 which press the paper against the surface of the colloidal solution. The flotation rollers are supported on arms 42 pivotally mounted on the tank 35 and lateral arms 43 fixed to the arms 42 carry set screws 44 which bear against the upper edge of the tank 35. These set screws determine the depth at which the rollers will be supported in the tank and they are adjustable to allow for variations of liquid level so that the web may be maintained in a floating condition on the surface of the solution. The paper is very absorbent and although only the under face thereof is in contact with the solution, the latter thoroughly permeates the web to the upper face thereof.

The web 38 on emerging from the tank passes under a scraper 45 and over another scraper 46 so that excess solution will be removed and the web will retain only the amount that is actually absorbed in the body of the paper. The scrapers are adjustable about a common center to regulate their scraping effect upon the web and to vary the tension on the web as it passes on to the lamination mandrel. Suitable means, such as indicated at 47 may be provided for fixing the scrapers at any desired setting.

The web is laminated on a mandrel 50 which is supported on and driven by a pair of rollers 51 just as is the drum 22 on the rollers 23 and 24. In making tubular stock however the diameter of the lamination drum or mandrel is usually much smaller than that employed in making sheet stock and consequently a pressure roller 53 is adapted to bear down upon the mandrel 50 or the laminae thereon so as to furnish sufficient traction for the rollers 51 to rotate the mandrel and wind the impregnated web thereon. The pressure roller is slidable in vertical ways and is

connected to a pair of counterweights 55 (only one of which is shown in the drawing) which control the pressure on the laminated mass. The counterweights are detachably connected to the pressure roller so that they may be replaced with others of different weight. Provision is thus made for varying the pressure on the laminated mass and together with the adjustable scrapers the replaceable counterweights provide means for controlling the tightness with which the impregnated web is wound upon the mandrel.

Between the scrapers and the lamination drum or mandrel is a pair of conduits 57 disposed respectively on opposite faces of the web. Air is pumped through the conduits and directed in jets against the web. The drying and cooling effect of these air jets causes an initial partial jelling of the colloidal matter so that it becomes tacky and bonds the laminae together.

After a sufficient number of laminae have been wound up on the mandrel the web is severed, and the mandrel is removed. While the mandrel may be plunged immediately into a chilling and fixing bath it is preferable to let it stand for a while to permit a more thorough anchoring of the colloidal matter in the laminated mass. The tubes of laminated fiber are then plunged into a fixing bath to render the colloidal matter insoluble, and thereafter they are allowed to dry without extraneous pressure. Fig. 5 illustrates a tank 50 filled with a fixing solution 61 in which a number of lamination tubes 62 are immersed. The tank is provided with suitable means for keeping the fixing solution at the desired temperature particularly in summer time. As shown in the drawing a coil of pipe 63 is provided in the tank through which a cooling medium may be circulated when desired.

The lamination tubes may be removed from the mandrels either before fixing or after fixing. Preferably however they are retained on the mandrels throughout the process and until they are nearly or quite dry. This procedure not only insures even drying so that the finished product is free from distortion or warping, but it also results in a denser product. In drying, the laminated mass shrinks and grips the mandrel very tightly, producing a tension that is far greater than that which can be obtained in winding the web on the mandrel. This drying under high tension results in a denser product than can be obtained when the tube is dried off the mandrel. This densing effect is particularly marked in the earlier stages of drying because the drying proceeds from the outside of the tube inward. As the outside of the tube nears complete dryness shrinkage of the inner part of the tube tends to draw the inner surface of the tube outward so that it relieves the tight grip on the mandrel until eventually the tube may be removed from the mandrel with comparatively little effort. This same effect of drying under tension may also be used in forming sheet stock when a very dense product is desired. The treated mass after fixing may be dried without removing it from the lamination drum. After it is dried it is slit into seg-

ments which are softened with steam or moisture and then pressed flat and dried.

It will be understood of course that the preliminary partial jelling before lamination may be used in forming sheet stock as well as in forming tubes.

While it is desirable to coat the drums or mandrels with paraffin or with paraffined paper this may be dispensed with particularly when the drying is effected on the drum or mandrel. However in such case the surface of lamination cylinder must be of such a nature that the treated mass will not stick fast thereto. A polished brass surface has been found satisfactory.

The term "raw stock paper" used in this specification and in the following claims includes any paper that is not calendered or that does not contain a filler other than glue which would prevent absorption of the nitrogenous colloid employed in the disclosed process.

Minor changes may be made in the physical embodiment of the invention or in the steps of the process without departing from the spirit and scope of the invention.

Claims:

1. As an article of manufacture, a dense, horn-like and homogeneous mass of solidified colloid rendered insoluble and having embedded therein laminae of raw stock paper completely saturated with the colloid prior to hardening.
2. As an article of manufacture, a dense, horn-like and homogeneous mass of solidified animal glue rendered insoluble and having embedded therein laminae of raw stock paper completely saturated with glue prior to hardening.
3. As an article of manufacture an indurated fiber product comprising laminae of paper permanently united into a homogeneous mass by an impregnating colloid rendered insoluble after lamination, and the whole being hardened and densified to a thickness less than that of the original paper.
4. As an article of manufacture an indurated fiber product comprising laminae of paper permanently united into a homogeneous mass by an impregnating nitrogenous colloid rendered insoluble after lamination, and the whole being hardened and densified to a thickness less than that of the original paper.
5. As an article of manufacture an indurated fiber product comprising laminae of paper permanently united into a homogeneous mass by an impregnating glue rendered insoluble after lamination, and the whole being hardened and densified to a thickness less than that of the original paper.
6. As an article of manufacture an indurated fiber product comprising laminae of paper permanently united into a homogeneous mass by an impregnating glue rendered insoluble after lamination, and the whole being hardened and densified to a thickness approximately eighty per cent. of that of the original paper.

ANNA M. D. GOESSMANN,

Executrix of Charles I. Goessmann, Deceased.