

Sept. 30, 1941.

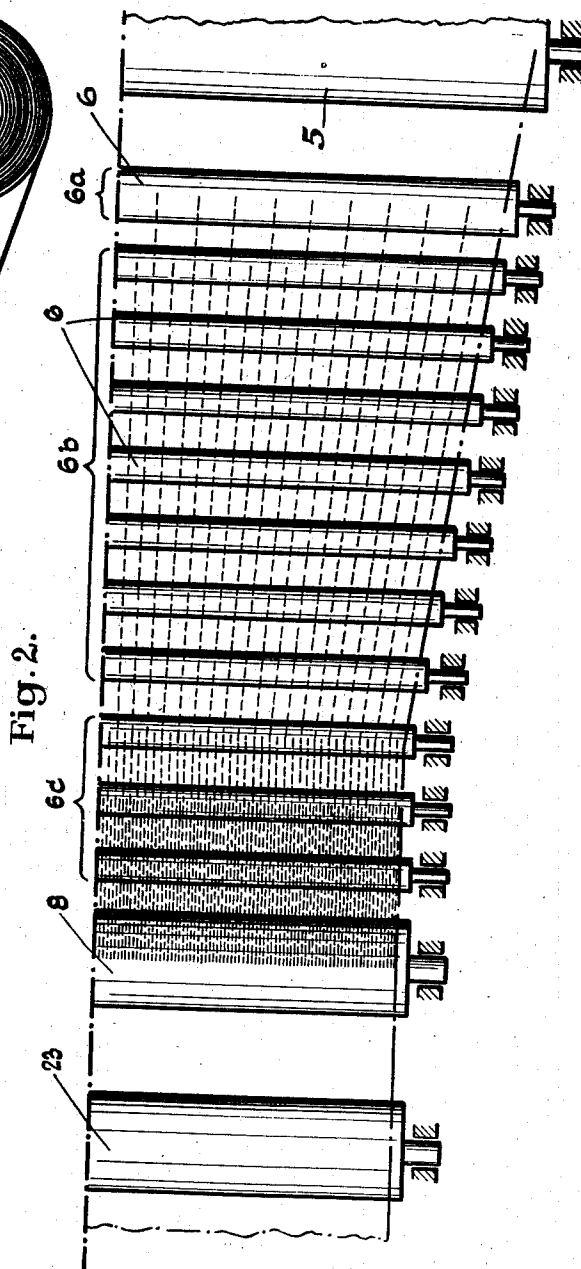
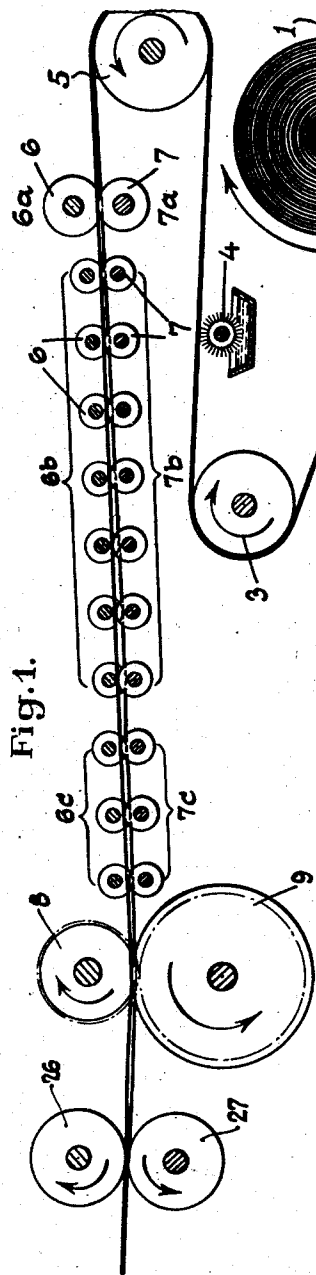
G. RUEGENBERG

2,257,429

PROCESS FOR PRODUCING ALL-AROUND EXTENSIBLE PAPER

Filed Aug. 2, 1938

5 Sheets-Sheet 1



Inventor
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Sept. 30, 1941.

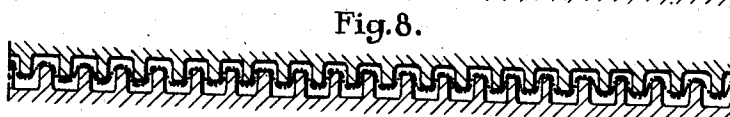
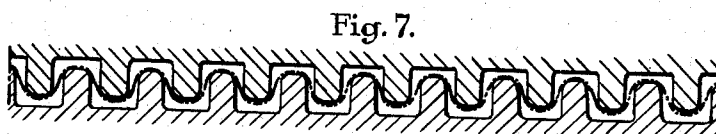
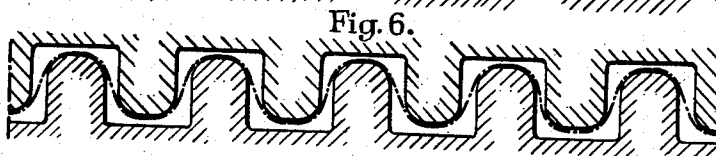
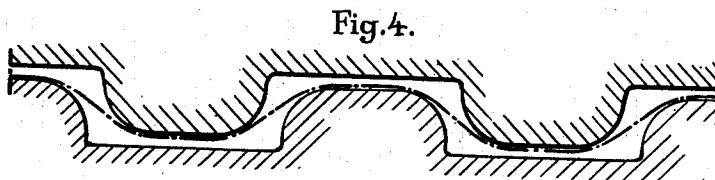
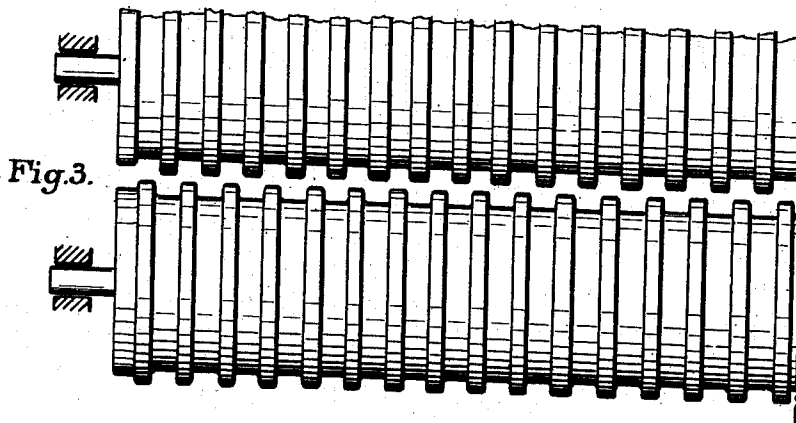
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PROCESS FOR PRODUCING ALL-AROUND EXTENSIBLE PAPER

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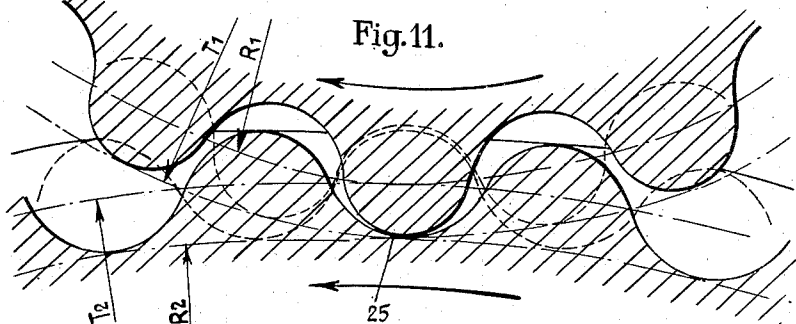
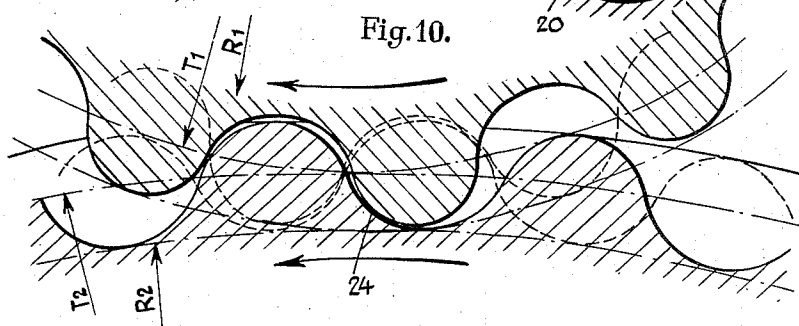
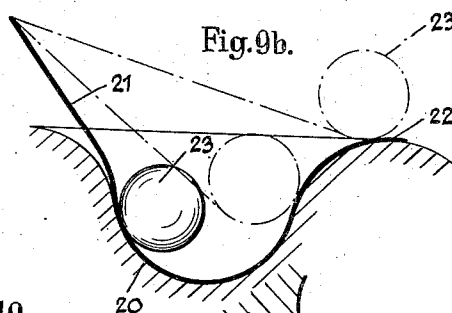
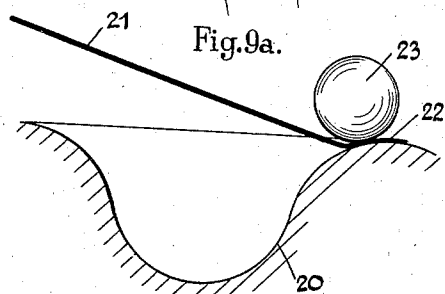
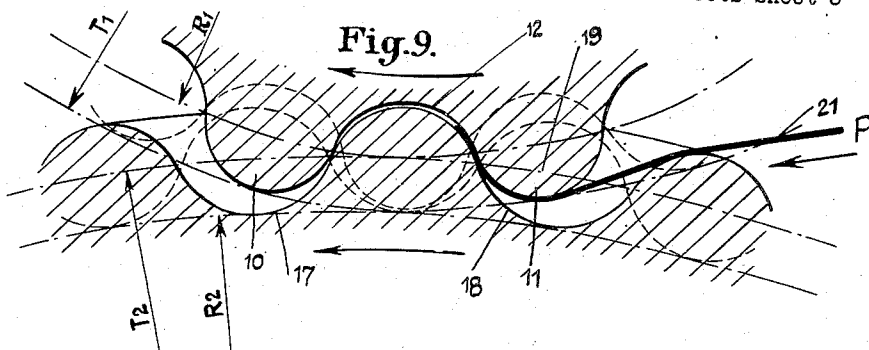
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5 Sheets-Sheet 3



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2,257,429

PROCESS FOR PRODUCING ALL-AROUND EXTENSIBLE PAPER

Filed Aug. 2, 1938

5 Sheets-Sheet 4

Fig. 12.

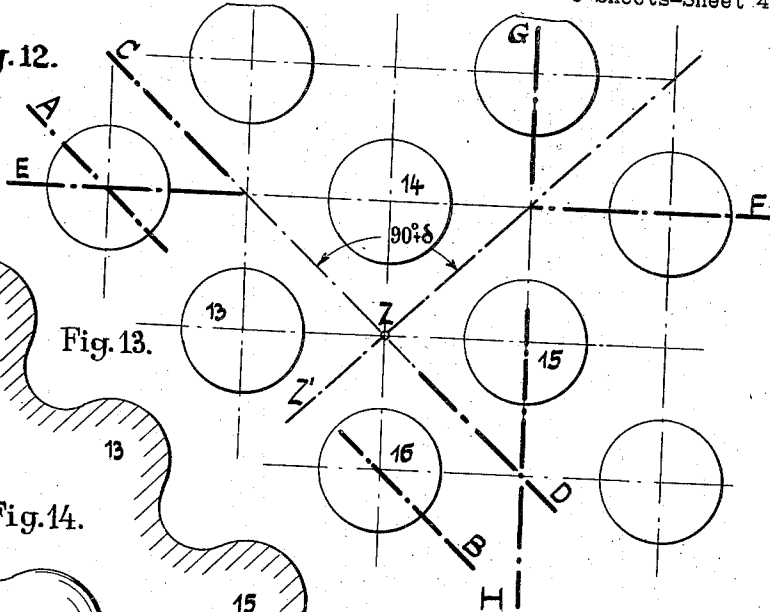


Fig. 13.

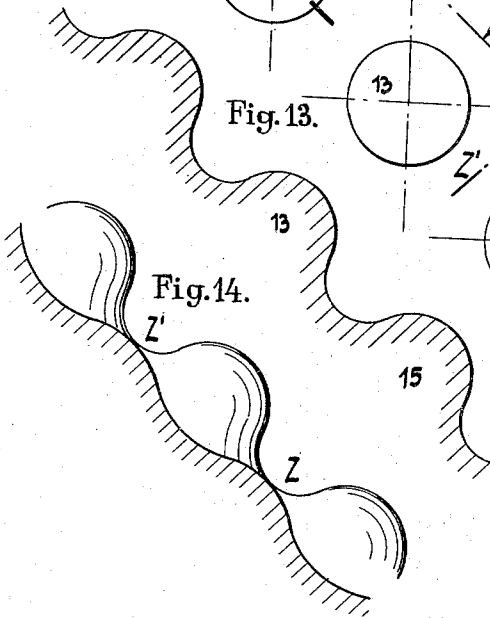


Fig. 14.

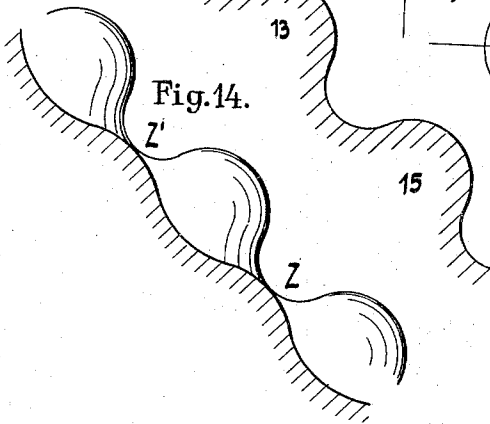


Fig. 15.

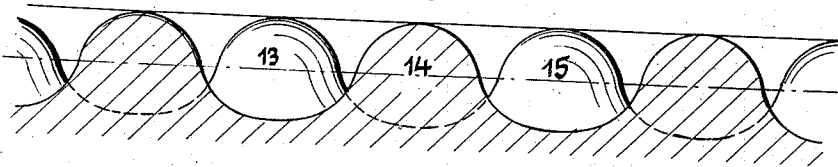
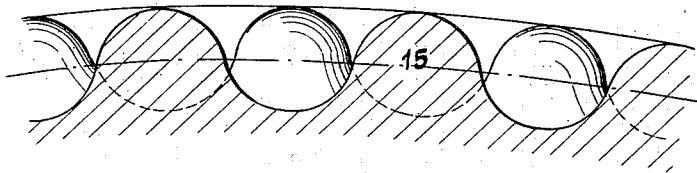


Fig. 16.



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2,257,429

PROCESS FOR PRODUCING ALL-AROUND EXTENSIBLE PAPER

Filed Aug. 2, 1938

5 Sheets-Sheet 5

Fig.17.

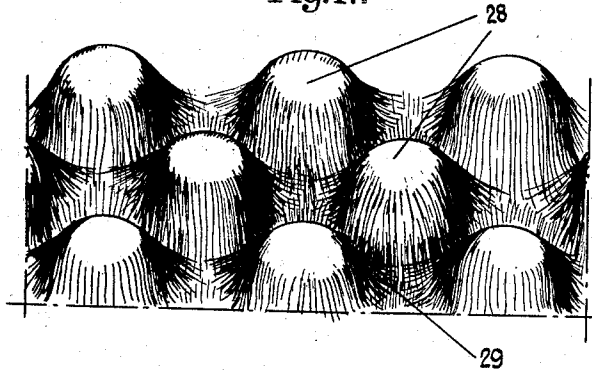
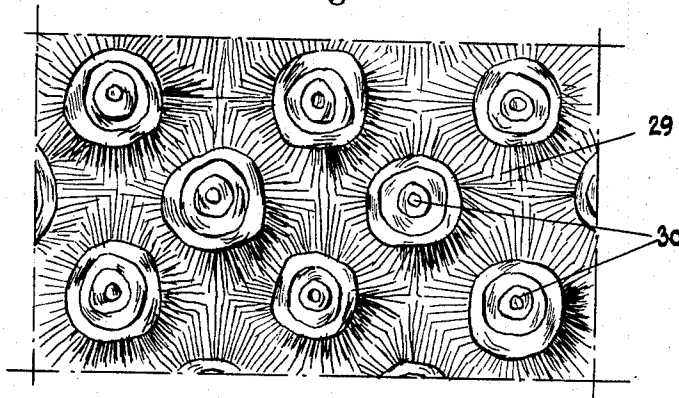


Fig.18.



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UNITED STATES PATENT OFFICE

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PROCESS FOR PRODUCING ALL-AROUND
EXTENSIBLE PAPERGottfried Ruegenberg, Dusseldorf-Oberkassel,
GermanyApplication August 2, 1938, Serial No. 222,730
In Germany August 4, 1937

7 Claims. (Cl. 154—33.05)

The object of the present invention is to provide an improved process for making all-around extensible paper, i. e. paper which is elastic or stretchable in all directions.

Crepe paper (damp-crepe) is known to be a very extensible and elastic kind of paper. This is made on what is called the "creping cylinder" of a paper-making machine, a moist paper web being so crowded or held back on said cylinder by means of a scraper or "doctor" roll that the paper, in consequence of a close formation of folds which run transversely to the longitudinal direction of the paper web, is extensible in the longitudinal direction. A defect of this form of creping however, consists in the fact, first, that the paper is extensible only in the longitudinal direction and, second, that the one-way fold formation thereof affords or opposes only a slight resistance to tensional stress in the longitudinal direction of the paper web. This second defect prevents in particular the mechanical further treatment of such paper, as for instance its making into paper bags.

Processes generally utilisable for the production of paper which is elastic both longitudinally and transversely have not hitherto been known.

The present invention independently concerns a special process and apparatus for making a novel extensible paper as described in my co-pending United States application Serial No. 222,729, filed August 2, 1938. Said paper is characterized by having at numerous places distributed over its surface, heaped up (raised) accumulations or concentrations of the material in the form of folds, creases, or the like, running radially and otherwise in all directions (with reference primarily to said heaped up areas or points), so that these accumulations will provide for and have the effect of an unusually great elasticity and extensibility of the paper sheet in all directions.

Such paper can be used with great success in those places of manufacture where heavy mechanical stresses of the paper occur at different points. For example, it can be used most advantageously in making paper bags for packing purposes, as a substitute for linen or sail-cloth coverings, for wall-papers, as insulating layers for sound, heat and moisture, and the like. Such paper moreover can be easily impregnated in known manner with bitumen or other agents and be also provided with known metal reinforcements, e. g. with wires, bands, and the like.

According to the present invention, the paper

obtains or is given the desired all-around extensibility and elasticity by being made into small folds or fold groupings at many points distributed over the surface of the paper in any desired arrangement and density, which folds are not parallel to each other. The direction and design arrangement of these small folds concentrated into "fold nests" distributed in any desired number and density over the surface, can be as desired, as may also be their form, but in preferred particular they will be directed in ray, ring, star or other criss-cross relations over the area of the web. The degree of extensibility of the paper is determined by the number and density of these collections of folds, this extensibility, by virtue of a symmetrical arrangement of the fold nestings, being made uniform or equal in all directions. The fact that the paper is heaped (gathered) up at many places in the surface individually into short small folds which as such are not connected with each other and run or extend in all directions, imparts to the paper, with great local all-around extensibility and elasticity, a considerable resistance to deformation from tensional stress in any direction.

In the making of this paper having an all-around extensibility, the invention contemplates and makes provision for a sufficient paper surface at the separate places for the formation of the "fold nests," and for the same to be uniformly distributed. To this end, the continuous paper web is first gathered up transversely (i. e. by a transverse action) to the running direction in corrugated (wave) form, so as to be contracted with a grooving or ribbing in said running or the longitudinal direction, and then is gathered up also in the longitudinal direction (i. e. by longitudinal contracting action) between cylinders rolling over or in contact with each other, the surfaces of which cylinders are provided with suitable complementary elevations and depressions. The elevations and depressions which effect the gathering up in the longitudinal direction of the paper web at the same time fulfill the purpose of uniformly distributing the gatherings or contractions of the paper surface in the transverse and longitudinal directions and to so fix or constitute said surface that, on further treatment of the paper web, the local heaping up of the paper surface is maintained.

The paper surface (material) heaped up in this way at or in the raised places is made in a further working step into small folds. This is effected according to the fineness and arrange-

ment of the folds to be attained, between one or more pairs of cylinders having smooth (flat) or suitably engraved surfaces. In order that in this working step the elevations of the paper surface shall not be squeezed down backward to the running direction, whereby the heaping up of the material would be partially counteracted, it is advisable for the cylinder coming into contact with the more highly embossed (raised) side of the paper web to be given a certain lead or advance with respect to the other (counter) cylinder in the surface movement, so that the raised places of the paper surface drawn therebetween will be partially pressed or evened before the closest engagement or bite of the cylinders.

According to the invention, a calender-like device is employed for the production of this paper, said device including pairs of cylinders connected in series, which are made and work in three principal groups.

The first main group which receives the paper web, said web being preferably previously moistened with liquid or steam, serves to initiate a heaping or gathering up of the paper in its transverse direction. This group consists of one or more pairs of cylinders working together or against each other and the surfaces of which, in longitudinal section, are formed with, for example, a helically corrugational or tooth-shaped profile, said cylinders thus presenting in regularly spaced distances apart elevations and depressions in their axial direction.

The elevations and depressions of these cylinder profiles run (transversely) as ring-shaped collars around the cylinders. Upon the passage through or between these cylinders, the paper web is formed with corrugations or similar elevations and depressions running in its longitudinal direction, and the formation of which as the result give the paper an accordion-like gathering or accumulation of foldings towards the centre with a corresponding reduction of its width.

The pair or pairs of cylinders working together are engaged with each other in such a manner that a ring-shaped elevation of the one cylinder comes opposite a recess of the other cylinder.

This first main group of one or more pairs of cylinders is followed by a plurality of subsidiary groups or cylinders in groups, working in series, the latter being progressively formed with an increased or greater number of ring-shaped (elevation and depression) profiles so that the corrugations of the paper web heaped up within the subsidiary groups will be progressively increased or subdivided by said subsidiary cylinders down to the desired multiplicity or fineness, e. g., until the number of corrugations by each following group is increased correspondingly to the desired subdivision.

Within a single or a plurality of these subsidiary groups the paper web running through in longitudinal wave formation is contracted by the accumulated folds to the desired extent in such manner that the distance apart of the respective corrugations is gradually reduced at the expense or with a reduction of the depth of the corrugations.

To this end, the cylinders of these subsidiary groups working in pairs opposite each other are so constructed in known manner that each pair of cylinders in succession has a closer profile arrangement and correspondingly deeper (closer) engagement than the preceding one. In order to take into account the quality of the paper dealt

with and the result to be attained, the distances apart of the pairs of cylinders can be made adjustable. Interchangeable or adjustable profiles can also be used. It is thus possible to considerably vary the quotients attained by the reduction in width and the length of the paper web between these pairs of cylinders, which reduction is hereinafter briefly termed the "degree of gathering."

The separate pairs of cylinders also are preferably and in known manner arranged adjustably with respect to their distance from each other.

Preferably the profiles of the cylinders are so chosen and adjusted with respect to each other that the paper web, as far as possible, comes into contact only with the cylindrical circumferential parts (ridges) of the annular bulges of the two cylinders, at which the circumferential speed of the two cylinders or rolls coincides; at all other places the paper is stretched as freely as possible between the parts (i. e. between the grooves) of the cylinders contacted. This obviates the paper being exposed to supplementary stresses in consequence of contact with parts of cylinders having different circumferential speeds, which might cause damage.

The second principal group of the improved device consists of a pair of cylinders more massively designed in their dimensions and of which one is provided on its surface with more or less strongly pronounced tipped (semi-globular) elevations which roll in corresponding depressions in the surface of the countercylinder. In this pair of cylinders, into which the paper web coming from the first pair of cylinders is introduced, preferably at a slight inclination, e. g. of about 10° to the common tangent of the two cylinder circles, the surface of the paper web which has been formed into corrugations transversely to the running direction in the first working operation is changed in form by the accumulation of the material being made into or onto the tipped elevations. The material necessary for forming these elevations in the running direction is, according to the invention, obtained by the special relative conditions of sizes and movement at the individual places for which provision is made.

The conditions of movement according to the invention and the relative dimensions of the two cylinders causing these conditions, differ essentially from the known or ordinary arrangement of stamping cylinders or rolls.

In the known arrangement, the surfaces of the two cylinders have a common mean circumferential speed; that is, the theoretical rolling circles of the revolving movement of the cylinders are located in the centre between the maximum and the minimum diameters of the engraved cylinder surface. Thus, the elevations of the one cylinder, taking into consideration the thickness of the material to be stamped, fit as exactly as possible into the depressions of the countercylinder. The stamping of the web of material between such cylinders therefore takes place always by stretching the fibrous structure of the material; that is, not with a heaping up of the material but by reducing the quantity (thickness) of the material at the stamped places with a certain rupturing and possible destruction of the structure.

In the device of the invention however, the cylinders are, on the contrary, so formed that the paper web is steadily drawn and rolled by the elevations of the one cylinder, which are preferably arranged in staggered sequence, into the depressions of the countercylinder, so that at each place material is so amply supplied that the

raised form in the paper is produced without stressing the fibres.

This unrestricted drawing and rolling in is attained by the surface of the one cylinder with the depressions, which is suitably extended in cross-section, being given a relatively accelerated circumferential or revolving movement, that is, a lead or advance, with respect to the surface of the countercylinder having the elevations. A particularly favorable rolling over condition is attained, in general, for instance when the mean surface of the cylinder provided with the depressions has a lead of about 5 to 10% as compared with its said countercylinder. The toothed wheel (driving gear) appertaining to the one cylinder has then a pitch circle which is smaller than the mean diameter of the said cylinder, while the pitch circle of the toothed wheel appertaining to the other cylinder is correspondingly greater than the mean diameter of said other cylinder.

The two cylinders are preferably adjustable to a fine degree with respect to each other, both in the radial axial direction, and also in the direction of movement of the paper web.

The essential feature of this arrangement is that the formation of the elevations in the surface of the paper does not take place by stamping at the expense of a stressing or stretching of the fibres, that is, by weakening the material at these places, but by a drawing together of the paper surface and thus by a heaping up of the paper at and around the raised parts and in their vicinity, which will take the form of small folds running for example radially or in ray form therefrom, or upon the lines of some other figure. By this heaping up of the paper, it is given or attains, even in the raised stamped condition existing after the second working operation, great extensibility or elasticity in all directions.

There follows then or next according to the invention a working of the paper in the third cylinder group. This consists of one or more pairs of cylinders following each other, between which the paper is so treated that the excess, i. e. the accumulations or gathering of paper material heaped up at the raised places, is made or pressed down into small folds. The arrangements of these folds, like the final form of the surface of the paper, are here determined by the nature of the surface engraving of these cylinders of the third group. To this end, these cylinders can be made as smooth rollers, so that they simply compress the elevations of the paper surface. They can also be made as profiled rolls. In order that in the smoothing operation effected by this cylinder group, the elevations of the paper web shall not be squeezed down backward to the running direction whereby a part of the heaping up effect will be lost or counteracted, it is advisable to give the surface of the one cylinder a certain lead or advance as compared with the other.

For the purpose of better and full understanding, the invention will now be described further with reference to the annexed drawings which diagrammatically illustrate the improved device and its details, by way of example.

In said drawings:

Figure 1 shows diagrammatically the general arrangement of a device constructed according to the invention;

Figure 2 is a plan view corresponding to Figure 1;

Figures 3, 4, 5, 6, 7 and 8 respectively show by way of example, in diagrammatic representation, the profiles of the consecutive pairs of cylinders of the first group;

Figures 9, 9a, 9b, 10 and 11 show by way of example the profile design and method or manner of engagement of the second group of cylinders;

Figure 12 shows in plan representation a portion of the surface of a cylinder of the second group;

Figure 13 is a section on the line A—B of Figure 12;

Figure 14 is a section on the line C—D of Figure 12;

Figure 15 is a section on the line E—F of Figure 12;

Figure 16 is a section on the line G—H of Figure 12;

Figure 17 represents in perspective view the surface appearance of the treated paper after leaving the second cylinder group; and

Figure 18 represents in plan view the surface (final) appearance of the treated paper after leaving the third cylinder group.

Referring to the details of the drawings, the reference numeral 1 indicates a roll of paper from which the paper web 2 is carried over a guide roller 3 through a moistening device 4 and over a further guide roller 5 to and between the cylinders 6, 7 of the first group of cylinders, which gather the web transversely into longitudinal corrugations or folds. This first group of cylinders is subdivided into a plurality of subsidiary groups 6a—7a—6b—7b and 6c—7c of cylinders like 6 and 7, in the first of which subsidiary groups the aforesaid cylinders 6, 7 are inclined as the first pair and in this instance alone compose said first subsidiary group.

Thus, the first subsidiary group 6a—7a, which in the example shown consists of the single pair of cylinders 6, 7, but which can consist of a plurality of pairs of cylinders, has for its object to initiate the corrugational gathering or folding of the web by first gripping the paper at a comparatively few points and gathering it up crosswise or in the transverse direction into a few large folds, with the least possible friction at the sliding points.

The pair or pairs of cylinders of the first subsidiary group 6a—7a, and the distance between these cylinders and the guide roller 5 determine the above-defined amount of check, that is, the quotients between the reduction of width and the length or extent of corrugation (web accumulation). In accordance with their purpose, the cylinders of the group 6a—7a are formed with a comparatively wide profile, by which corrugations of comparatively great length or depth viewed in the transverse direction, are produced. The depth of engagement between the pairs of cylinders 6a—7a depends upon the desired amount of check or accumulation, which again has to depend upon the width and the kind of paper. In treating wide webs of, for example, 2 meters in width, it is advantageous for the degree of shrinking, in order to avoid distortions and friction, to be made less than in the case of narrower webs, as for example a web of 50 cm. width.

The second subsidiary group 6b—7b of cylinders is or are designed to progressively further draw or gather the preliminary corrugated paper running therethrough into substantially the amount of accumulation or corrugational folding in the transverse direction finally desired for the

material and to subdivide the corrugations into suitably increased number of decreased depth.

To this end, the cylinders of said group 6b-7b have a subdivided profile of lesser depth as compared with the corresponding cylinders of the first group, the distance apart of the elevations in the cylinders of this second group decreasing more and more successively, corresponding to the desired extent of the continued heaping up of the material and the reduction of its width. The depth of engagement of the cylinders in this second group is increased in the same ratio.

The third subsidiary group 8c-7c is designed to further subdivide the corrugations produced in the paper, as also to give the paper before entry into the cylinders of the second main group a parallel guidance with compensation of the edge stresses. To this end, the profiling of these cylinders of the third subsidiary group 8c-7c (of the first main group), is so continuously or successively subdivided, that each pair of cylinders has for example twice the number of the elevations (with half the depth thereof) which the previous one had.

The facial (i. e. constructional) forms of the cylinders composing the described first main group in subsidiary grouping are represented diagrammatically and by way of example in Figures 3 to 8.

Figure 3 illustrates a suitable form of the cylinder profile in general.

Figure 4 illustrates the profiling or facial form of the cylinders such as 6, 7 of the first subsidiary group 6a-7a, with a comparatively coarse subdivision.

Figures 5 and 6 similarly illustrate the profiling for instance of the first and last pair of cylinders in the second subsidiary group 6b-7b.

Figures 7 and 8 likewise illustrate the profiling for instance of the first and last pairs of cylinders in the third subsidiary group 8c-7c.

The second main group of cylinders is represented by the pair of cylinders 8, 9, which are preferably much larger and more solid than the cylinders of the preceding main group. The profiling or facial structure of these second group cylinders and their engagement with each other is represented in Figures 9 to 16, by way of example. It consists preferably in one of said cylinders being provided with semi-globular or tip-shaped elevations and the other being provided with corresponding depressions. Both cylinders can be made of steel, but preferably the one with the depressions is made of elastic material, e. g. pressed material. Accordingly, when using an engraved cylinder provided with the elevations, the counter cylinder can be formed by running the two cylinders together, so that the countercylinder will acquire its complementary depressions from pressure of the former.

The upper cylinder 8 is given, for example, tip-shaped elevations 10, 11 between which there are extended depressions 12 (see Fig. 9). The form of these depressions can be seen in detail from Figure 12 and from the sectional views of Figures 13 to 16. According to these, the depressions have the form of invert spherical surfaces, so that the paper accumulation therein takes place in a diagonal direction and therefore also in every other inclined direction, to the same extent as in the longitudinal and transverse direction. This condition is fulfilled in the case of the formation of said depressions as shown in Figures 13 to 16, since here the depth of the depression from a centre Z located between

four elevation tips 13, 14, 15, 16 (see Fig. 12) to the centre Z' located between any two adjacent tips such as 13 and 16 gradually diminishes and this diminishment is to such a degree that the ratio of the geodetic line of the profiling between the tips 16 and 14 to the extent of their projection, is the same as the ratio of the geodetic line between the tips 16 and 13 to the extent of their projection. The said ratio or condition is in the present case particularly important, since the tips of the profiling on the cylinder are, according to Figure 12, arranged in staggered relation with respect to each other. This however affords a particularly favorable distribution of the surface of the paper as a result.

The cylinders are driven by means of toothed wheels or gears, the pitch circle diameter of which, also differing considerably from the usual arrangement, does not coincide with the mean diameter of their respective cylinders or the related profiled cylinder which they drive. According to the invention, the pitch circle diameter of the driving gear associated with the cylinder provided with the elevations is dimensioned considerably larger than the mean diameter of this cylinder, while, on the other hand, the pitch circle diameter of the gear associated with the cylinder provided with the depressions is dimensioned correspondingly smaller than the mean diameter of the latter cylinder. Consequently, the surface of the cylinder provided with the depressions is given a certain lead or advance as compared with the surface of the cylinder provided with the elevations.

The complementary depressions of the lower cylinder 9 are also extended somewhat in the running direction by suitable mechanical treatment or by the natural effect of the running-in, i. e. as compacted by the elevations of the cylinder 8, to the extent of the lead mentioned. Consequently, there takes place a spotwise gradually continuing drawing and rolling in of the paper web by the aforesaid tip-like projections 10, 11 into the extended corresponding depressions 17, 18 of the countercylinder (see Fig. 12).

The process is illustrated diagrammatically in Figures 9a and 9b.

Here, the reference 20 represents a curved surface on which a paper sheet 21 is first placed only at its end 22. On this end 22 is a freely movable heavy ball 23 which is allowed to roll down thereover upon the path 20. The paper is thereby pressed down in the manner shown by Figure 9b, gradually spotwise on the surface 20 of the widened depression.

Based upon Fig. 9, the rolling-in process can be regarded or described as follows:

Suppose (referring to said Fig. 9) the paper web runs between the cylinders in the direction of the arrow P. The direction of rotation of the cylinders is indicated by the curved arrow in said view. The elevation tip 19 then grips the paper sheet 21 and places it, on continued rotation of the cylinders 8, 9 point-wise, corresponding to the movement of the ball in Figures 9a and 9b in a reverse direction; on the surface of the depression 18. Here the contacting and drawing of the paper takes place essentially always only spotwise, e. g., according to Figure 10 at the point 24 and according to Figure 11 at the point 25, and so on.

The arrangement of the pitch circle and of the mean cylinder circle is, according to this Figure 9, as follows:

T1 is the radius of the pitch circle of the

toothed wheel or gear associated with the upper steel cylinder 8 provided with the elevations, and R_1 is the radius of the mean circumference of said cylinder.

T_2 is the radius of the pitch circle of the toothed wheel or gear associated with the lower cylinder 9 provided with the depressions, and R_2 is the radius of the mean circle of this latter cylinder.

From this will be seen clearly the relations in size already stated above of the radii and of the corresponding diameters. In the example of the drawing, the diameter of the cylinders is made comparatively small and consequently the difference in the size of the pitch circle diameters and the mean cylinder diameters is comparatively small. The amount of the lead of the mean circumference of the lower cylinder as compared with the upper cylinder amounts to 7% in the case of the example shown.

The lower cylinder provided with the widened depressions is given, as already mentioned at the outset, and as compared with the upper cylinder carrying the elevations, an accelerated movement of rotation, that is, a lead. Geometrically, this is expressed by the whole surface of the leading cylinder, differing from the hitherto known constructions of embossing cylinders, being only enlarged with respect to the surface of the remaining cylinder by the extent of the lead. The lead can in practice be dimensioned from 5% to 10%.

The cylinders 26, 27 of the third main cylinder group serve to smooth down to a certain extent the material coming from the second main group which is shaped strongly plastically, so as to complete in their operation the formation of the folds and make the same uniform and to give the paper a good or fairly level surface.

To this end, the cylinders 26, 27 can simply be made with smooth surfaces, but it is better to make them also somewhat profiled or engraved. This profiling or engraving would consist of lower (shallower) elevations and depressions upon the order of those in the cylinders 8 and 9 and can be carried out according to the particular purposes or intended use of the paper, in very many different ways.

Preferably, in the case of these cylinders 26, 27, that one of the same which is turned towards or opposes the stamped-out elevations formed on or in the paper web and consequently mainly performs the intended function of making (pressing) said elevations flat or working them into further folds, or otherwise altering their shape is given a lead over the other similarly to the cylinders 8 and 9. The depression areas of this leading cylinder will also preferably be widened out. Here as well, the total surface of the leading cylinder would be enlarged with respect to the surface of the following cylinder by the extent of said lead.

The said third main cylinder group may also if desired consist of a plurality of pairs of cylinders, working one after the other to complete the intended operation in a progressive or stage by stage manner.

It will be appreciated of course that it is important for the ratios of speed of the three main groups of cylinders to be adjusted to each other. This is done according to the invention either by all the groups of cylinders being driven from a single drive source, e. g., an electric motor, with the speed of the separate groups and pairs of cylinders being mechanically regulated between

said drive source and the corresponding group or cylinder drive, or by a drive of the different groups or the subsidiary groups by separate electric motors whose speed of rotation is jointly controlled or regulated electrically in harmony with each other.

Figures 17 and 18 illustrate the appearance, by way of example, of the paper obtained by the treatment hereinbefore described.

Figure 17 represents the appearance after leaving the second main cylinder group. Here the paper is formed with standing elevations 28, from the tips of which proceed ray-like folds 29 resulting from the first longitudinal corrugation of the web and its subsequent fold gathering upon and around the elevational parts of the molding cylinders. Figure 18 represents the paper after leaving the last main cylinder group 26, 27 in which a pressing or collapse of the elevations 28 takes place. Here said elevations are more or less folded downward in accordion fashion, so that in addition to the folds 29 running in radiating form, ring folds 30 have been formed. Naturally, the number, form and arrangement of the folds can be varied according to the profiling of the cylinders and according to the purpose or intended use of the paper.

The device described can be carried out in many ways in accordance with the object and scope of the invention. Thus, for example, all three of the main groups of cylinders can be arranged to be heated in known manner. This applies in particular with reference to the first group of cylinders. If this group is heated, the result will be that the corrugations of the paper will be brought from the outset into a comparatively permanent form, so that the paper without losing any of such shaping may run into the succeeding groups of cylinders.

I claim:

1. The process of producing an all-around extensible or elastic paper, which consists in gathering a flat paper sheet together, first in the transverse direction and then in the longitudinal direction, into folds toward center points at numerous places distributed uniformly over the surface of the paper and simultaneously with the gathering of the paper in the longitudinal direction forcing the fold accumulations thereof outwardly into and around semi-spherical raised portions formed in the sheet.

2. The process of producing an all-around extensible or elastic paper, which consists in gathering a flat paper sheet together first in the transverse direction and then in the longitudinal direction into folds toward center points at numerous places distributed uniformly over the surface of the paper and simultaneously with the gathering of the paper in the longitudinal direction forcing the fold accumulations thereof outwardly into semi-spherical raised portions which are so staggered in relation to each other that the depressions between the raised portions run at acute angles to the longitudinal axis of the paper sheet.

3. The process of producing an all-around extensible or elastic paper, which consists in gathering a flat paper sheet together first in the transverse direction and then in the longitudinal direction into multitudinous folds toward center points at numerous places distributed uniformly over the surface of the paper and simultaneously with the gathering of the paper in the longitudinal direction forcing the fold accumulations thereof outwardly into the formation of

semi-spherical raised portions or elevations, the accumulations of the material in folds in and around said elevations being fixed into folds running in radial directions from the tops of said elevations.

4. The process of producing an all-around extensible or elastic paper according to claim 4, ering a flat paper sheet together first in the transverse direction and then in the longitudinal direction into multitudinous folds toward center points at numerous places distributed uniformly over the surface of the paper and simultaneously with the gathering of the apper in the longitudinal direction forcing the fold accumulations thereof outwardly into hollow semi-spherical raised portions molded to form between opposed surfaces gripping and drawing the sheet in both longitudinal and transverse direction there-through.

5. The process of producing an all-around extensible or elastic paper according to claim 4, wherein the opposed surfaces serving to form the hollow semi-spherical raised portions upon the surface of the sheet are oppositely movable upon each other in cylindric paths and one of the same is given a lead with respect to the other in such a manner that the paper already transversely gathered together in longitudinal corrugations is, without much friction and tensional stress, drawn and pressed spotwise into depressions complementary to the elements upon which the semi-spherical raised portions are molded.

6. The process of producing an all-around extensible or elastic paper, which consists in gathering a flat paper sheet together first in the transverse direction and then in the longitudinal direction into folds toward center points at nu-

merous places distributed uniformly and regularly over the surface of the paper, and simultaneously with the gathering of the paper in the longitudinal direction forcing the fold accumulations thereof outwardly into raised portions or tipped elevations, and thereafter uniformly flattening down the said elevations of the paper sheet in a direction substantially perpendicular to the plane of the same between cylindric surfaces one of which is given a rotational lead with respect to the other.

7. The method of producing an all-around extensible or elastic paper from a web or sheet of paper material, which consists in first gathering the web or sheet transversely into longitudinal corrugations and subdividing said corrugations into a substantial multiple of small and shallow corrugations or folds, then gathering the longitudinally corrugated web or sheet longitudinally into cross-wise folds concentrated or accumulated in uniform distribution principally around a plurality of raised portions simultaneously formed in one surface of the sheet at regularly spaced points extended over the area thereof, the said longitudinal gathering or cross-wise folds being caused to assume a radiational disposition from the top centers of said raised portions and a disposition in all directions in the portions lying between said raised portions, and finally pressing or crushing the raised portions down in substantial parallel with the plane of the web or sheet, all of said folds being formatively fixed or adapted normally to retain their form and relation and to yieldably unfold or spread only upon draw or pull of the paper in any direction.

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