

April 2, 1940.

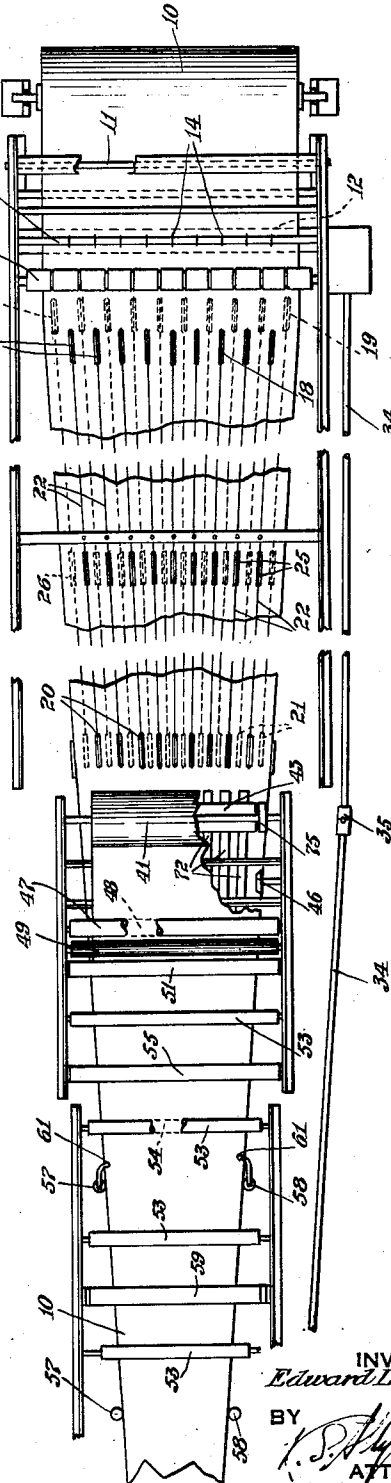
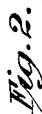
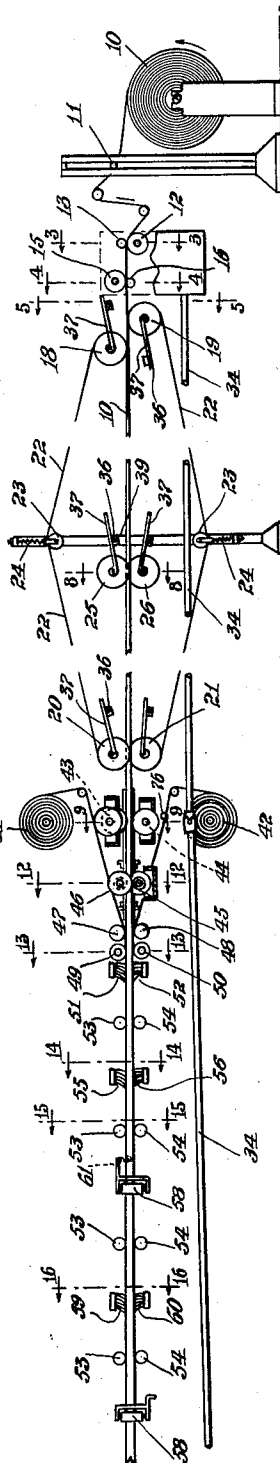
E. L. BENEDICT

2,196,006

MACHINE AND PROCESS FOR PLAITING

Filed Dec. 10, 1937

4 Sheets-Sheet 1



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April 2, 1940.

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2,196,006

MACHINE AND PROCESS FOR PLAITING

Filed Dec. 10, 1937

4 Sheets-Sheet 2

Fig. 1a

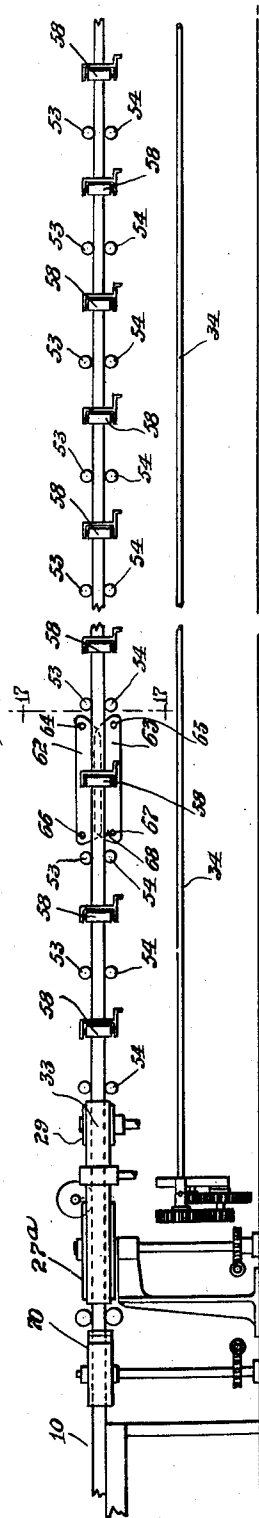
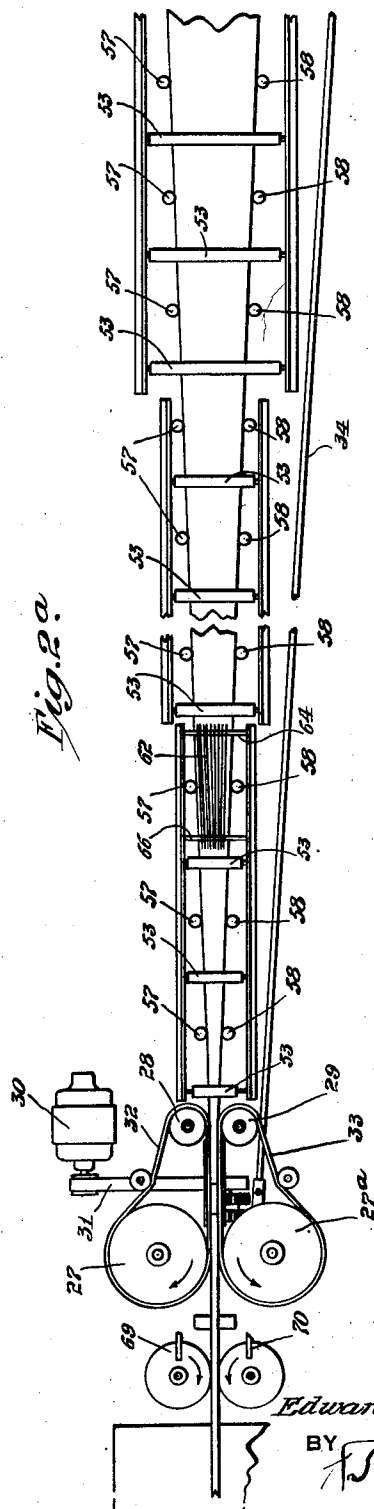


Fig. 2a



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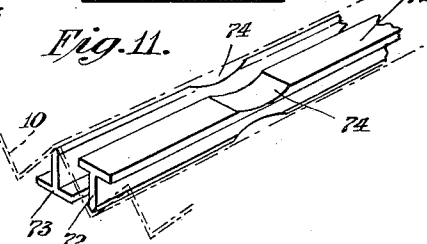
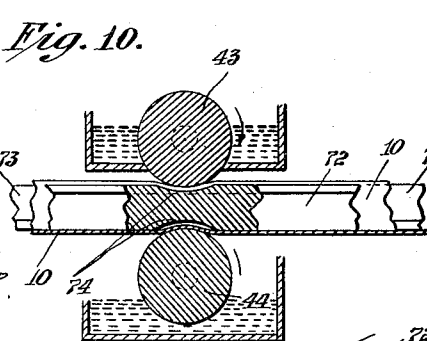
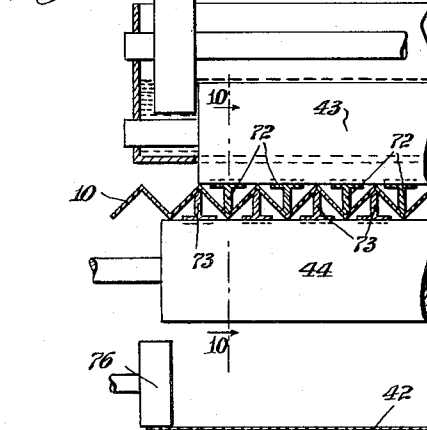
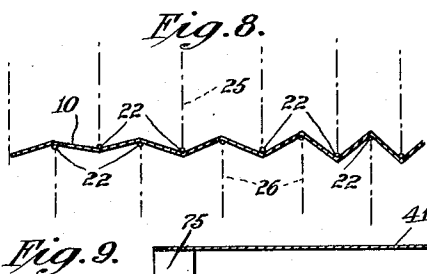
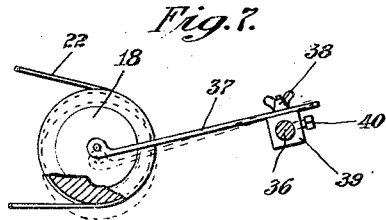
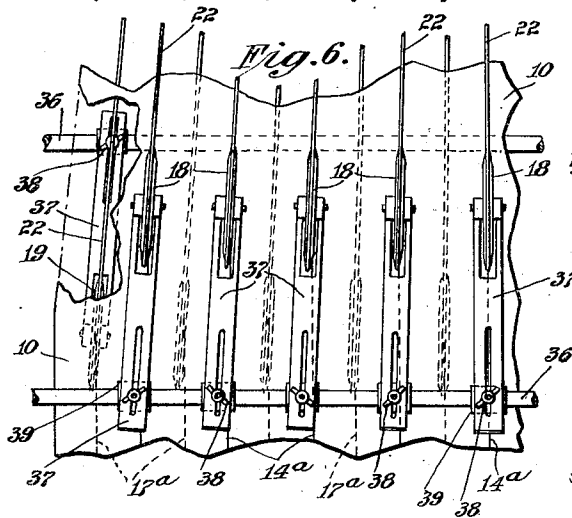
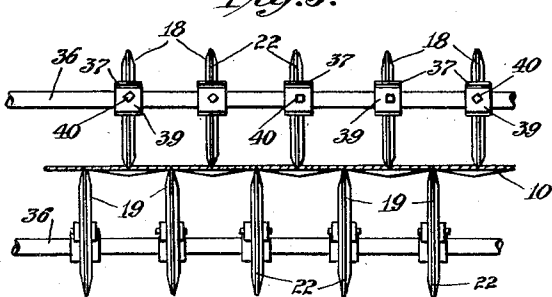
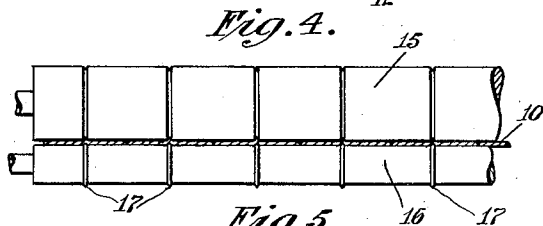
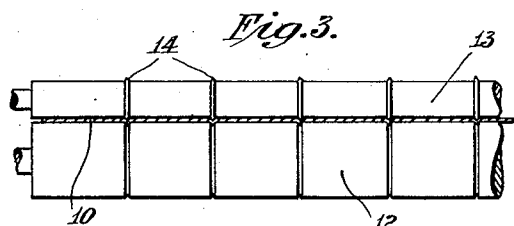
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MACHINE AND PROCESS FOR PLAITING

Filed Dec. 10, 1937

4 Sheets-Sheet 3



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2,196,006

MACHINE AND PROCESS FOR PLAITING

Filed Dec. 10, 1937

4 Sheets-Sheet 4

Fig. 12.

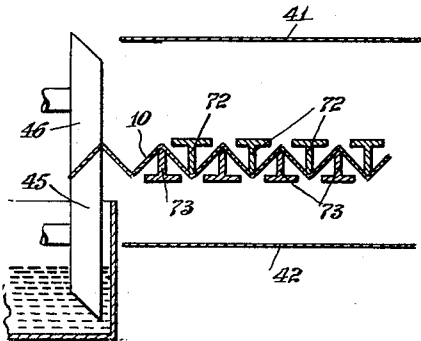


Fig. 13.

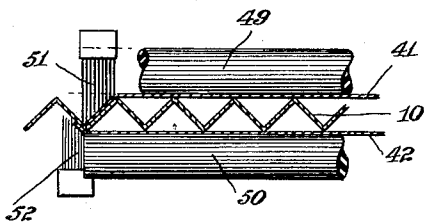


Fig. 14.

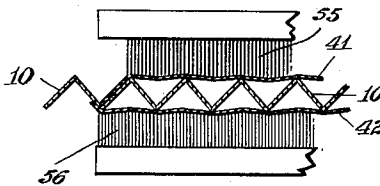


Fig. 16.

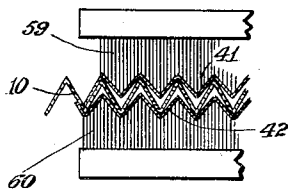


Fig. 15.

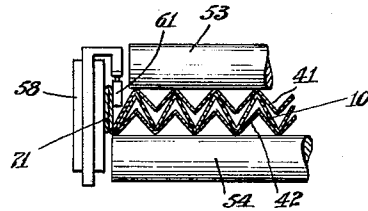


Fig. 17.

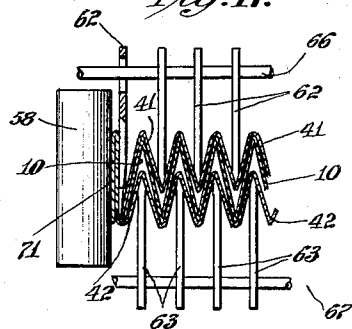


Fig. 18.

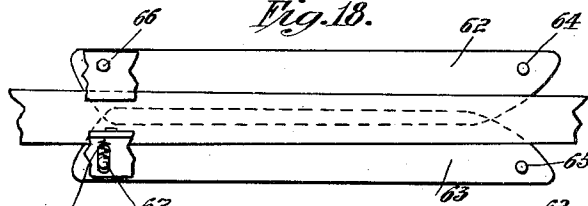


Fig. 19.

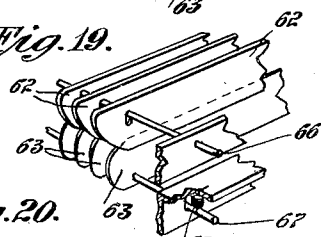
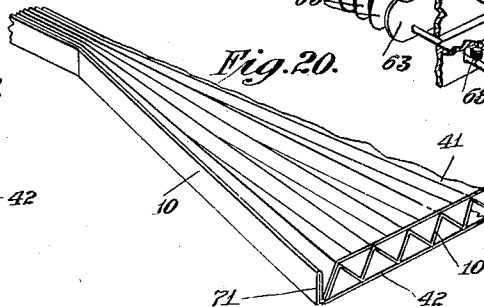


Fig. 20.



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2,196,006

MACHINE AND PROCESS FOR PLAITING

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Application December 10, 1937, Serial No. 179,134

29 Claims. (Cl. 154—32)

This invention relates to a method and apparatus for forming a plaited foundation of paper or the like for supporting on the foundation folds, sheets of flexible material secured on each side of the foundation. One kind of flexible material to be supported by the foundation is thin metal foil for thermal insulating purposes as is described by my copending Patent Number 2,101,836 dated December 14, 1937, filed October 21, 1936, of which this application is a continuation in part.

An object of this invention is to provide a machine for simply and cheaply producing the desired product.

Another object is to provide a machine capable of forming this product with minimum danger of tearing either the foundation or the secured sheets.

Another object is to make a machine which is substantially automatic and requires a minimum of operating attention.

A further object is to provide a machine and process for forming the foundation plaits gradually both longitudinally and transversely.

Referring to the drawings

Fig. 1 is a side elevation of an end portion of a machine.

Fig. 1a illustrates the other end portion of the same machine, which due to its great length cannot be illustrated in Fig. 1.

Fig. 2 is a top plan view of a machine illustrated in Fig. 1.

Fig. 2a is a top plan view of the portion of the machine illustrated in Fig. 1a.

Fig. 3 is a view of the scoring rolls on the line 3—3 of Fig. 1.

Fig. 4 shows the scoring rolls on the line 4—4 of Fig. 1.

Fig. 5 is a view looking toward the forming dies to the right from the line 5—5 of Fig. 1.

Fig. 6 is a partial top plan view of the beginning of the forming dies.

Fig. 7 is a side view showing the mounting of one of the rollers at the beginning of the forming dies.

Fig. 8 is a section through the plaited foundation at about the line 8—8 of Fig. 1.

Fig. 9 is a section along the line 9—9 of Fig. 1.

Fig. 10 is a section on the line 10—10 of Fig. 9.

Fig. 11 is a partial perspective showing how the mandrels are recessed under the adhesive rolls of Fig. 10.

Fig. 12 is a section on the line 12—12 of Fig. 1.

Fig. 13 is a view on the line 13—13 of Fig. 1.

Fig. 14 is a view on the line 14—14 of Fig. 1.

Fig. 15 is a view on the line 15—15 of Fig. 1.

Fig. 16 is a view on the line 16—16 of Fig. 1.

Fig. 17 is a view on the line 17—17 of Fig. 1a.

Fig. 18 is an elevation of the ironing fingers of Fig. 17.

Fig. 19 is a partial perspective of the rear end portions of these fingers.

Fig. 20 is a partial perspective of the product made by the machine and process of this invention.

As illustrated in Fig. 1 the paper or other fibrous material for the foundation 10 is wound upon a supply roll and after passing through usual tensioning devices travels between the scoring rolls 12 and 13. Where this paper is used to support and space thin metal foils a craft paper weighing about seventy pounds (70 lbs.) to 1440 square feet is used. The scoring rolls as well as the adhesive rolls and pull-out, later to be described, all travel at such a uniform speed as to give the paper the desired rate of travel through the machine.

A convenient speed of operation has been found to be about 120 linear feet per minute and the machine has been run at a speed for the paper as high as 200 to 250 feet a minute, indicating that possibly higher speeds might be obtainable.

As shown in Fig. 3 the scoring rolls comprise the roll 12 having the peripheral depressions indicated into which is pressed the paper by the cooperating roll 13 having the projecting ribs 14 which press the paper into the depressions of the roll 12. These rolls give the paper a preliminary crease or fold so as to make the subsequent plaiting by forming dies easier.

Fig. 1 shows how the paper next passes to another set of scoring rolls 15 and 16 similarly but oppositely constructed so as to provide opposite folds in the paper midway between those formed by the preceding scoring rolls. In this second set of scoring rolls the grooved roll 15 is located above the cooperating roll 16 carrying the projecting rib 17 which press the paper into the grooves illustrated. The preliminary folds or scores 14a and 17a are arranged alternately and equidistantly apart as shown in Fig. 6.

After leaving the scoring rolls the paper travels to the forming dies for plaiting it. These forming dies include a plurality of narrow rollers which gradually overlap one another an increasing amount as the paper travels through the machine.

In the preferred embodiment illustrated the forming dies include rollers 18 arranged as shown in Figs. 5, 6 and 7 across the top of the paper

while a corresponding set of rolls 19 is arranged on the underside of the paper. At a distance from these rolls are additional sets of rolls 20 and 21 also located on opposite sides of the paper and a number of narrow belts or wires 22 pass around the substantially aligned pairs of rolls both above and below the paper. For tensioning the wires 22, rolls 23 are provided under influence of the springs 24, each roll 23 both above and below the paper being individually controlled by a spring 24 cooperating with the stationary frame as illustrated and adjustable in tension. Intermediate the forming die rolls are additional rolls or idlers 25 and 26 for guiding the wires and paper. Instead of these forming die rolls being parallel to the travel of the paper they are arranged at an angle as shown in Figs. 2 and 6 for the purpose of gradually forming the plaits. The degree of this taper or gradual lateral compression of the paper is preferably such that the taper or inclination is uniform from the time the paper enters the forming rolls until it is tightly compressed in the pull-out device at the opposite end of the machine.

In the particular example illustrated when paper thirty-eight inches (38") wide is used the taper is so gradual that the pull-out device, to be described later, is located about fifty-four (54) feet away in order that no undue or dangerous stresses may be imparted which might cause the paper to tear. As shown in Figs. 2 and 6 these forming dies are precisely aligned to the taper just described.

At the far end of the machine from the scoring rolls is located the pull-out device shown in Figs. 1a and 2a as comprising rollers 27 and 27a as well as opposed rollers 28 and 29, either or both sets of which may be positively driven by the electric motor 30 through the belt 31 and gear not illustrated.

Leather belts 32 and 33 pass around the rollers indicated and these rollers and their belts are arranged so as to laterally compress the plaited paper as it passes between them. These rollers and their belts may be yieldable and operated under the influence of a tension spring or springs tending to laterally compress the folded paper passing between them. In order that this pull-out device as well as the scoring rolls and adhesive rolls and any other parts of the machine which may be positively driven, may have the same speed they are all connected through the longitudinally extending drive shaft 34 connecting these positively driven rolls with the motor 30. While a belt 31 is used on the motor it will be understood that no belt or belts are used between the shaft 34 and any of the driven rolls, thus insuring precise operation of all rolls at the same linear speed. At the wide or initial end of the machine the shaft 34 is provided with a universal joint in order that this shaft may be located conveniently close to the machine.

The forming dies previously referred to are preferably driven by the friction between the paper and the rolls and wires. As shown in Figs. 6 and 7 each of the substantially horizontally aligned rolls is mounted upon the same supporting bar, the rolls 18 being mounted and supported by the cross bar 36.

In order to give each of the rolls a precise alignment or direction toward the pull-out device separate arms 37 are provided, each arm being adjustable in a horizontal plane by means of the bolt illustrated containing a wing nut 38. The supporting end of each arm 37 is slotted to receive

this bolt while the opposite end of each arm is bifurcated to provide a bearing for the forming roll. In Fig. 6 it may be seen that the arm 37 at the right end of this figure is more nearly but not quite normal to the cross bar 36 while the arm 37 and roll 18 at the left side of Fig. 6 is more steeply inclined. The angular difference in the arrangement of rolls and arm is gradual and depends on the taper, described previously, determined by the remoteness of the pull-out device.

The arms 37 especially with the median rolls 25 and 26 are not arranged to have the rolls on the same level, the rolls nearest the center being arranged to give the paper a steeper or sharper plait as is shown in Fig. 8. This arrangement of the forming die rolls at different levels may be accomplished by adjusting the plug 39 at the precise desired angle on the cross bar 36 by means of the set screw 40.

At the beginning of the forming dies the longitudinal and lateral overlap of the rolls and wires 22 is only slight but as the paper continues to travel between the wires, the wires on opposite sides of the paper overlap an increasing amount so that the paper becomes gradually plaited as it travels longitudinally. In order to prevent unduly stressing the outer edges or sides of the paper it has been found desirable to form the plaits of gradually increasing depth toward the center from the edge so that the plaits are first formed deeper in the center than at the edges.

Fig. 8 shows the approximate arrangement of the folds or plaits in the paper adjacent the rolls 25 and 26. Fig. 8 thus shows that the wires 22 on opposite sides of the paper overlap one another in a vertical plane a gradually increasing amount from the edge of the paper to the center, the center of the paper being indicated by the right side of Fig. 8. This gradual taper or gradual formation of plaits and forming dies both longitudinally as well as laterally is believed to be an important safeguard against undue stressing and possible tearing of the paper. The longitudinal taper extends substantially uniformly through practically the entire length of the machine, but the lateral taper or difference in overlap of the forming dies extends but a short distance beyond the ends of these forming dies, being taken care of principally in these dies.

After passing the forming dies the plaited paper is caused to engage or have applied to only the folds, fragile metal foil sheets 41 and 42 from the supply rolls indicated. Before the foils are brought in contact with the paper only the folds of the paper are coated with adhesive by means of the rolls 43 and 44 on opposite sides which pass through the liquid adhesive bath or supply tanks illustrated and contact with only the folds or bent edges of the plaited paper. Each edge portion of the paper may also be coated with adhesive by the roll 45 passing through the adhesive tank illustrated in Fig. 12.

The opposite narrow edge roll 46 holds the paper during its engagement by the adhesive roll 45. After being thus provided with adhesive the paper passes between the rolls 47 and 48 which apply the metal foil sheets 41 and 42 to the paper along only its folds. Closely adjacent the foil applying rolls 47 and 48 are opposed soft rubber rolls 49 and 50 which tend to iron out or slightly shape the foils over the adhesively coated folds in the paper as shown in Fig. 13. Inasmuch as an edge portion of the foils has been coated with adhesive as shown in Fig. 9, this coated edge portion of the foil is brushed down

into contact with the paper by a soft bristle or air brushes 51 and 52 shown in Fig. 13. Throughout the remaining length of the machine at frequent intervals there are provided upper and lower guide rolls 53 and 54 between which the plaited paper is caused to pass.

After the foil coated paper has travelled a short distance additional brushes 55 and 56 shown in Fig. 14 may be provided for brushing the foils in between the plaits of the paper as the paper becomes laterally compressed in its travel. These and other brushes described may be either soft bristles so as not to injure the fragile foils or may be jets of escaping compressed air arranged to accomplish the same purpose.

For laterally controlling the taper the desired amount throughout the remaining length of the machine there are a number of guide rolls 57 and 58 arranged on vertical axes as shown in Figs. 2 and 2a. Still further advanced are additional brushes 59 and 60 shown in Fig. 16 for further brushing the foils in between the folds in the foundation and thus insuring the foils becoming plaited with the paper. In order to cause the adhesively coated edge of the paper to be folded over a small guide roll 61 on a vertical axis is located closely adjacent one of the guide rolls 58 so that the paper may take the form shown in Fig. 15 at its edge. The same type of roll 61 is used on the opposite edge of the paper.

Throughout quite an extent of the machine nothing further is done to the paper and foils except control their gradual longitudinal taper, that is, their gradual reduction in width.

Adjacent and at a convenient distance ahead of the pull-out device are located a number of smoothing or ironing fingers 62 and 63 comprising a number of thin wooden blades shaped as shown in Figs. 17 to 19 inclusive mounted at their forward ends upon transverse bars 64 and 65 and tapered in depth as well as thickness so as to enter and press the foils against the folded sides of the paper without damage to either. At their rear ends these wooden fingers are arranged to float, being mounted upon a cross bar 66 illustrated. Their weight is all that presses the upper set of wooden fingers into and between the foil folds. These fingers may be separately yieldable or separately floating at their rear ends upon the cross bar 66 or they may be arranged so that they will float only as a unit at their rear. The lower set of ironing fingers 63 is raised to contact with the foils on the underside of the paper near their folds by also being mounted on a cross bar 67 and this cross bar being raised into contact with the foils by means of a light spring 68 illustrated. These ironing fingers reduce the tendency for any folds or kinks to occur in the metal foils between folds in the paper.

After passing through the pull-out device and being laterally compressed by whatever desired pressure is applied in the pull-out device, the lateral compressed paper and foils pass between the cutters 69 and 70 which shear or cut off the laterally compressed and folded paper into lengths of the desired amount, depending on the size or speed of these cutting rolls.

Before the plaited paper engages the adhesive rolls 43 and 44 it passes between a number of mandrels 72 and 73 each of general T shape and oppositely arranged, the edge of the stem being rounded and extending beyond the top of the adjacent T mandrel in order that the folds of the paper may be raised and only the folds caused

to cooperate with the adhesive rolls. Beneath the adhesive rolls 43 and 44 the mandrels are recessed as shown at 74 so that the adhesive rolls coat the paper folds over the recessed portions of the mandrels and thus enable the paper to yield slightly over the recesses 74. The mandrels may also be recessed beneath the contacting rolls 47 and 48 if desired, but are preferably not recessed where the soft rubber rolls 50 and 51 cooperate with the paper to press the foils over the paper folds. These mandrels extend from just before the paper engages the adhesive rolls 43 and 44 to just beyond the soft rubber rolls 50 and 51 and no further.

Instead of the T shaped mandrels illustrated, mandrels of generally cross section may be used but these latter provide more friction than do the T shaped mandrels since the paper contacts with these T shaped mandrels only along their folds. These T bars are not parallel but are also disposed to conform to the taper of the paper folds shown in Fig. 2 and described above. By the time the paper has reached the mandrels the lateral taper previously described has almost but not entirely been eliminated.

Any such lateral taper at the mandrels is of extremely small amount and due to very thin spacers being placed under the central mandrels compared to those of the sides so that the paper folds at the center mandrels may be steeper by only a few hundredths of an inch. However this slight lateral taper to the paper in the mandrels has been found desirable.

Since the adhesive rolls 43 and 44 have parallel axes it will be understood that any slight difference in height of the paper folds near the center of the foundation sheet may be taken care of within the recesses 74 so that the recesses 74 in the stems of the mandrels possess a two-fold function in enabling the paper to yield from contact with the adhesive roll and also yield a slight amount due to the folds in the longitudinal center of the paper being slightly higher than those at the edges and gradually tapered. Any such lateral taper to the mandrels as has just been described may also be taken care of by recesses in the stems beneath the attaching rolls 47 and 48. Since this slight lateral taper is of the order of only a few hundredths of an inch it will be understood that the soft rubber rolls 50 and 51 will not be affected and will press the foils down over the mandrels more than one or two hundredths of an inch.

For coating the edges of the foils with adhesive so that these foils may be pressed against the foundation at their edges the adhesive rolls 75 and 76 shown in Fig. 9 are used. The manner in which the lateral edges of the foils are attached to the foundation is shown in Figs. 13 to 17 inclusive and Fig. 20.

By giving the foundation the lateral taper described and shown in Fig. 8 it is possible to have the tension applied to the paper more nearly uniform across the full width thereof. The foils used are thin and fragile being preferably from about .0003 to .005 inch in thickness. Where the material described is for other uses than for thermal insulating purposes the plaited foundation may be coated on one or both sides with other materials such as heavier or lighter paper or other fibrous sheets. The shafting 34 connects and positively drives not only the scoring rolls but also the adhesive applying rolls at the same linear speed as the pull-out and therefore avoids any tendency to tear the paper due to

it passing between rolls of different speeds in some parts of its travel.

The formation of double thickness of paper at lateral edges of the foundation adapts the material to be attached to studding or other framing members with less danger of tearing. The continuation of the substantially uniform longitudinal taper throughout the length of the machine from the forming dies to the pull-out is an important feature and after passing through the foil applying and brushing apparatus enables the plaited foundation to float or twist as may be desired to conform to changes in local tension in the sheet due to changes in density or non-uniformity of the paper.

While this machine has been described for attaching sheets of foil or other material to opposite sides of the plaited foundation it will be understood that it is also adapted for applying only one sheet, that is to only one side of the foundation.

The ironing fingers 62 and 63 are shown in Fig. 17 as being laterally spaced apart considerably more than is the case in actual practice since from Fig. 2a it can be seen the folds are quite close together and so are these fingers. This wider separation of the fingers in Fig. 17 is shown in order that the layers of material may be shown with greater clarity. It should be understood that these ironing fingers 62 and 63 are closely enough spaced so that they are effective in smoothing the sides of the foils to a considerable extent and not merely the folds.

Instead of having the rolls for coating the foundation folds with adhesive located as shown, they may be more conveniently located between the pairs of rolls 20 and 21 and the rolls 25 and 26 so that the foundation folds are brought into contact with the adhesive rolls by the wires 22. This modified arrangement enables a very thin layer of adhesive to be applied to only the fold in the paper, gives the adhesive a longer time to set, and enables the length of the friction creating mandrels to be shortened. When the adhesive rolls are located as just described the mandrels need only extend under the foil applying rolls and the soft rubber rolls. In this last case the great precision previously described in mounting the mandrels can be eliminated and they can all be mounted alike though, of course, they must all conform to the inclination of the paper folds.

I claim:

1. The method of forming accordion plaited unit material which comprises feeding a sheet of flexible material, forming longitudinal folds on opposite sides of the material, coating the peaks of the folds on opposite sides of the material with an adhesive, applying flexible sheet material to the coated folds on opposite sides of the plaited material, and laterally compressing the unit.

2. The method of forming material which comprises applying a substantially flat sheet of metal foil to a travelling plaited fibrous foundation with the aid of adhesive applied to the peak portions of the folds of said foundation, laterally compressing the foundation and pushing the foil sheet into the foundation between folds.

3. The method of forming accordion plaits longitudinally in a sheet of flexible material which comprises scoring said sheet longitudinally where the plait folds are to be located, and gradually folding said sheet longitudinally thereof along the scored portions in such manner that the folds

adjacent the edges of the sheet are first formed gradually less deep than are the folds in the longitudinal central portion.

4. The method of forming accordion plaited unit material which comprises feeding a sheet of flexible material, forming longitudinal folds on opposite sides of the material, coating the peaks of the folds on at least one side of the material with an adhesive, applying flexible sheet material to the coated folds of the plaited material, and laterally compressing the unit and simultaneously bringing the second sheet of material between the folds of the first sheet to form in the second sheet plaits of less depth than those in the first sheet, the lateral compressing of the material being substantially uniform with its travel.

5. An apparatus for forming accordion plaits longitudinally in a sheet of flexible material which comprises longitudinally tapered forming dies on opposite sides of the material and between which said sheet is passed, means for feeding the material, said dies being vertically overlapped a gradually increasing amount longitudinally of the travel of material and laterally thereof from the side edges of the material to the longitudinal center thereof.

6. In a machine for plaiting a flexible material, the combination with a plurality of longitudinal plait forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a gradual longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies.

7. In a machine for plaiting a flexible material, the combination with a plurality of longitudinal plait forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a gradual longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, guide rolls between said dies and compression rolls for engaging both sides and the top and bottom of said material.

8. In a machine for plaiting a flexible material, the combination with a plurality of longitudinal plait forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a gradual longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, mandrels between said dies and rolls, inclined to accord with the taper of the material folds, and each having an edge within a fold of the material.

9. In a machine for plaiting a flexible material, the combination with a plurality of longitudinal plait forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, mandrels between said dies and rolls, inclined to accord with the taper of the material folds, and each having an edge within a fold of the material, an adhesive applying rolls engaging the material fold outside the mandrels, and each mandrel being slightly recessed on its edge below the adhesive roll whereby the material is capable of yielding slightly in the application of the adhesive.

10. The process of forming a longitudinally plaited unit which comprises scoring a sheet of flexible fibrous material, forming plaits in said

material, coating the folds on each side of the material with an adhesive, attaching a sheet of flexible material to the folds on each side, brushing the second mentioned material between the coated folds, compressing the unit gradually as it is moved after being scored, and cutting off the compressed unit in substantially equal lengths.

11. In a machine for longitudinally plaiting a flexible material, the combination with a plurality of forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, mandrels between said dies and rolls, inclined to accord with the taper of the material folds, and each having an edge within a fold of the material, each mandrel being of a substantially T shape in cross section with the edge of the stem of the T being slightly bevelled to fit the material fold.

12. In a machine for longitudinally plaiting a flexible material, the combination with a plurality of forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, mandrels between said dies and rolls, inclined to accord with the taper of the material folds, and each having an edge within a fold of the material, means for attaching a second flexible material to the folds on each side of said sheet, means for brushing the second material inwardly between the folds of the first material, and spring pressed fingers for ironing the second material on each side of the first material against the sides of the first mentioned folded material.

13. In a machine for longitudinally plaiting a flexible material, the combination with a plurality of forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a gradual longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies and being transversely tapered to enable a tension to be applied substantially uniformly across said material.

14. In a machine for longitudinally plaiting a flexible material, the combination with a plurality of forming dies, of a pair of compression rolls for laterally compressing the plaited material, said dies being angularly disposed on a longitudinal taper determined by the distance between said compression rolls and the beginning of said forming dies, mandrels between said dies and rolls, inclined to accord with the taper of the material folds, and each having an edge within a fold of the material, means for attaching a second flexible material to the folds on each side of said sheet, means for brushing the second material inwardly between the folds of the first material, and spring pressed fingers for ironing the second material on each side of the first material against the sides of the first mentioned folded material, and means between said second material attaching and brushing means and the fingers for pressing an edge portion of the first material against an adjacent portion thereof between folds to form a double thickness along said edge.

15. A machine for longitudinally plaiting a flexible sheet of material comprising scoring rolls

for forming alternately opposite creases, longitudinal forming dies for gradually plaiting the creased paper, a pull-out located at a distance from the scoring rolls and forming dies for laterally compressing and pulling out the plaited material, means for applying a second sheet of flexible material to each side of the plaited first material adjacent the forming dies and between said dies and pull-out, including mandrels between the plaited first material, means for adhering the second material sheets to the folds of the first material at said mandrels, said forming dies and mandrels being arranged at a longitudinal taper determined by the distance between the beginning of the forming dies and the pull-out, said forming dies being also arranged to form folds of gradually increasing depth toward the longitudinal center of the first sheet from the side edges in order to render the tension on the first sheet more nearly uniform across the material, means for brushing the sheets of second material in between the folds of the first material as the same travels beyond said mandrels, and means mechanically connecting said pull-out and scoring rolls for driving them at the same linear speed.

16. A machine for longitudinally plaiting a flexible sheet of material comprising scoring rolls for forming alternately opposite creases, longitudinal forming dies for gradually plaiting the creased paper, a pull-out located at a distance from the scoring rolls and forming dies for laterally compressing and pulling out the plaited material, means for applying a second sheet of flexible material to each side of the plaited first material adjacent the forming dies and between said dies and pull-out, including mandrels between the plaited first material, means for adhering the second material sheets to the folds of the first material at said mandrels, said forming dies and mandrels being arranged at a longitudinal taper determined by the distance between the beginning of the forming dies and the pull-out, said forming dies being also arranged to form folds of gradually increasing depth toward the longitudinal center of the first sheet from the side edges in order to render the tension on the first sheet more nearly uniform across the material, means for brushing the sheets of second material in between the folds of the first material as the same travels beyond said mandrels, guide rolls on four sides of the materials between said mandrels and pull-out for maintaining the longitudinal taper substantially uniform, the large majority of the distance between said pull-out and mandrels being free of any forming dies, mandrels, or the like whereby any non-uniformity in the first sheet of material may be free to float and effect any temporary non-uniformity in the sharpness of the material folds to adjacent the pull-out.

17. A machine for longitudinally plaiting a flexible sheet of material comprising scoring rolls for forming alternately opposite creases, longitudinal forming dies for gradually plaiting the creased paper, a pull-out located at a distance from the scoring rolls and forming dies for laterally compressing and pulling out the plaited material, means for applying a second sheet of flexible material to each side of the plaited first material adjacent the forming dies and between said dies and pull-out, including mandrels between the plaited first material, means for adhering the second material sheets to the folds of the first material at said mandrels, said forming dies and

mandrels being arranged at a longitudinal taper determined by the distance between the beginning of the forming dies and the pull-out, said forming dies being also arranged to form folds of gradually increasing depth toward the longitudinal center of the first sheet from the side edges in order to render the tension on the first sheet more nearly uniform across the material, means for brushing the sheets of second material in between the folds of the first material as the same travels beyond said mandrels, guide rolls on four sides of the materials between said mandrels and pull-out for maintaining the longitudinal taper substantially uniform, the lateral taper to the fold depth being slightly maintained in said mandrels, each of said mandrels being recessed beneath the means for adhering the second material to the first, and means between said mandrels and pull-out for ironing the second material deeply into and laterally against the sides of the folds of the first material.

18. A machine for longitudinally plaiting a flexible sheet of material comprising scoring rolls for forming alternately opposite creases, longitudinal forming dies for gradually plaiting the creased paper, a pull-out located at a distance from the scoring rolls and forming dies for laterally compressing and pulling out the plaited material, means for applying a second sheet of flexible material to each side of the plaited first material adjacent the forming dies and between said dies and pull-out, including mandrels between the plaited first material, means for adhering the second material sheets to the folds of the first material at said mandrels, said forming dies and mandrels being arranged at a longitudinal taper determined by the distance between the beginning of the forming dies and the pull-out, said forming dies being also arranged to form folds of gradually increasing depth toward the longitudinal center of the first sheet from the side edges in order to render the tension on the first sheet more nearly uniform across the material, means for brushing the sheets of second material in between the folds of the first material as the same travels beyond said mandrels, and means between said brushing means and pull-out for ironing the second material sheets deeply into the first material folds and laterally against opposite sides of each fold.

19. A machine for longitudinally plaiting a sheet of paper comprising longitudinal forming dies for gradually plaiting said paper, a pull-out for laterally compressing the plaited paper at a distance from said forming dies, said forming dies being arranged at a gradual longitudinal taper directed toward said pull-out and also at a transverse gradual taper so that the sheet is at first more deeply folded at the longitudinal central portion of the sheet than at its edges whereby the tension in the paper is rendered more nearly uniform across the sheet than would be the case if said dies formed initially similar depth folds.

20. A machine for longitudinally plaiting a sheet of paper comprising longitudinal forming dies for gradually plaiting said paper, a pull-out for laterally compressing the plaited paper at a distance from said forming dies, said forming dies being arranged at a longitudinal taper and also at a transverse taper so that the sheet is at first more deeply folded at the longitudinal central portion of the sheet than at its edges whereby the tension in the paper is rendered more nearly uniform across the sheet than would be

the case if said dies formed initially similar depth folds, said forming dies including on each side of said sheet a plurality of tensioned wires.

21. A machine for longitudinally plaiting a flexible foundation sheet comprising longitudinal forming dies for plaiting said foundation longitudinally and substantially continuously, means for attaching a second sheet of flexible material to only the folds of said foundation during travel thereof, a pull-out device for laterally compressing said sheets, said pull-out including pairs of oppositely disposed rolls longitudinally separated and provided with flexible belts between which said compressed sheets are held and pulled through said machine.

22. The method of forming longitudinal plaits in a traveling sheet of flexible material, which comprises gradually longitudinally tapering the traveling material by bringing the side edges closer together, taking slack out of the longitudinal midportion of the sheet and relieving tension on the side edge portions of the sheet by forming gradually deeper plaits in said midportion than in the side edge portions, the transverse taper in the depth of gradually formed plaits from the longitudinal central portion laterally outwardly in each direction being such that the tension in said traveling sheet is more nearly uniform across the sheet than if the transverse taper did not exist.

23. A machine for forming longitudinal plaits in a traveling sheet of flexible material, which comprises means for pulling the material through the machine and tapered plait forming dies gradually longitudinally and transversely tapered so as to maintain the tension across the sheet substantially uniform whereby the danger of rupturing the material is substantially reduced and the necessity of any sequential localized transverse movement of portions of the sheet is avoided.

24. The method of forming a unit comprised of at least two sheets of plaited flexible material connected along adjacent longitudinal plaits but having the plaits in a second sheet of less depth than those in the first, which comprises passing the first sheet between longitudinally tapered gradual plait-forming dies arranged to first form deeper plaits in the central than in the side edge portions to tend to distribute longitudinal tension substantially across the sheet, attaching the second sheet to the creases on one side of the first sheet after the first sheet has been plaited and partially collapsed laterally, continuing the lateral collapsing of the first sheet and pushing the second sheet in between the folds of the first sheet to form plaits in the second sheet of less depth than those in the first sheet.

25. An apparatus for forming a unit comprised of at least two sheets of flexible longitudinally plaited material connected along adjacent longitudinal folds but having the plaits in a second sheet of less depth than those of the first, which includes gradual longitudinal plait-forming dies, means for passing the first sheet between such dies, said dies being arranged at first to form deeper central than edge plaits to distribute longitudinal tension substantially across the sheet, means for attaching the second sheet to creases on one side of the first after the first sheet has been plaited and partially collapsed laterally, means for pushing the second sheet in between the folds of the first sheet to form longitudinal plaits in the second sheet of less depth than those in the first sheet, means for con-

tinuing the collapsing of the first sheet together with the second sheet and yieldable means engaging the second sheet to assist in forming inner folds in the second sheet intermediate folds in the first sheet.

- 5 26. An apparatus for forming a unit comprised of at least two sheets of flexible longitudinally plaited material connected along adjacent longitudinal folds but having the plaits in a second
10 sheet of less depth than those of the first, which includes gradual plait-forming dies, means for passing the first sheet between such dies, said dies being arranged to first form deeper plaits in the central than in the side edge portions to dis-
15 tribute longitudinal tension substantially across the sheet, means for attaching the second sheet to longitudinal creases on one side of the first after the first sheet has been plaited and partially collapsed laterally, means for pushing the
20 second sheet in between the folds of the first sheet to form plaits in the second sheet of less depth than those in the first sheet, means for continuing the collapsing of the first sheet together with the second sheet and means for iron-
25 ing or smoothing the second sheet substantially laterally against the first sheet.

27. A machine for forming longitudinal plaits in a sheet of flexible material and securing a
30 second sheet to the plaited first sheet which comprises longitudinally tapered plait-forming dies, means for applying adhesive to the peaks of the folds on at least one side of the sheet, means within the peaks of said folds for supporting the

same, a roll for pressing said second sheet against the peaks of the folds in the first sheet, and means for gradually bringing the folds of the first sheet closer together and folding the second sheet in between the folds in the first sheet.

28. A machine for forming longitudinal plaits in a sheet of flexible material and securing a
5 second sheet to the plaited first sheet which comprises longitudinally tapered plait-forming dies, means for applying adhesive to the peaks of the
10 folds on at least one side of the sheet, means within the peaks of said folds for supporting the same, a roll for pressing said second sheet against the peaks of the folds in the first sheet, said
15 last means being substantially rigid and slightly recessed adjacent said roll whereby the first sheet may be slightly deflected during application of the second sheet to the first.

29. A machine for forming longitudinal plaits in a sheet of flexible material and securing a
20 second sheet to the plaited first sheet which comprises longitudinally tapered plait-forming dies, means for applying adhesive to the peaks of the folds on at least one side of the sheet, means within the peaks of said folds for supporting the
25 same, a roll for pressing said second sheet against the peaks of the folds in the first sheet, said roll being substantially more yieldable than the supporting means for the peaks of the first sheet in cooperation therewith and adapted to shape the
30 second sheet over the peaks of the folds in the first sheet.

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