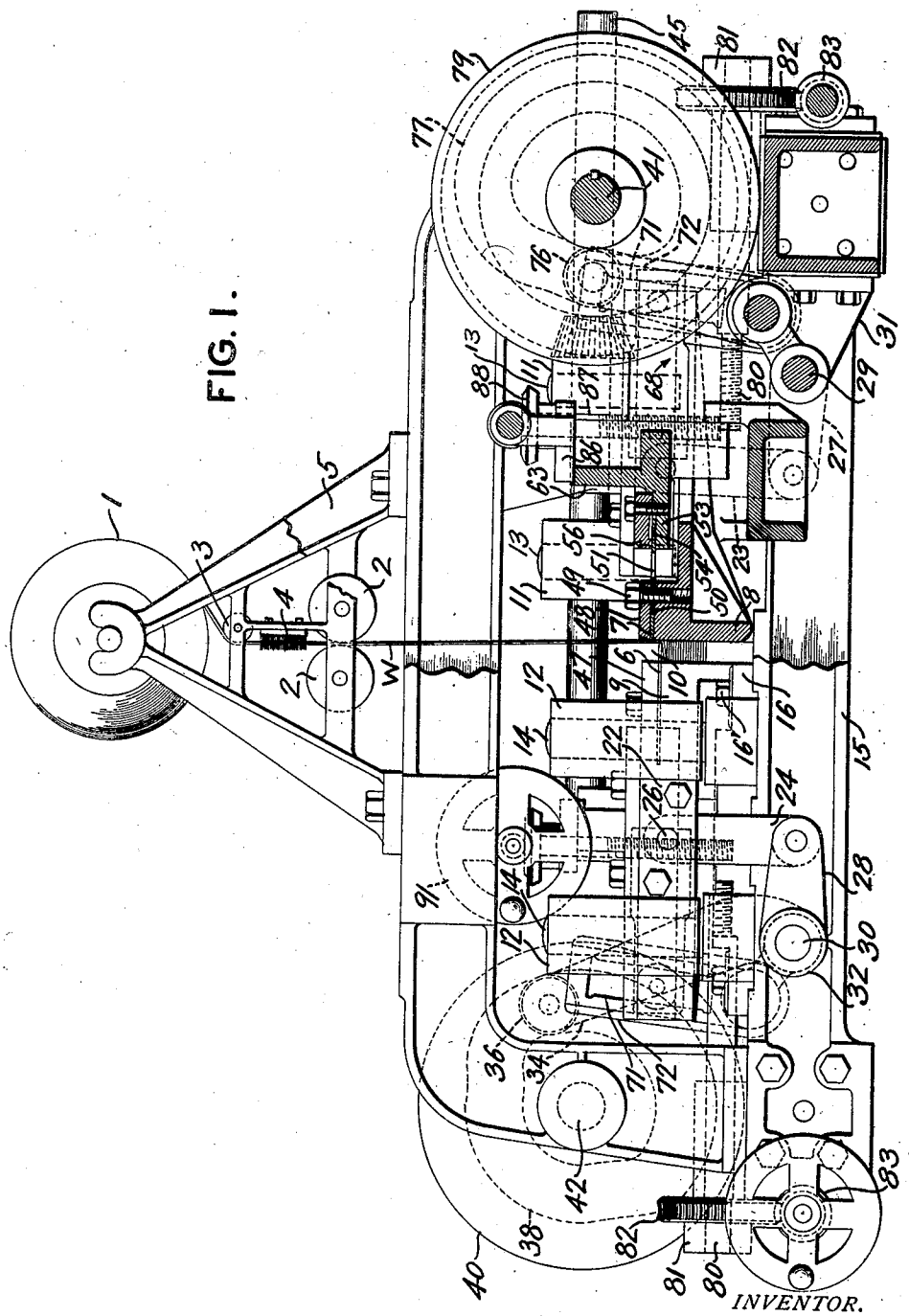
Dec. 14, 1937. E. HOPKINSON 2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Filed Nov. 2, 1929 5 Sheets-Sheet 1

FIG. 1.



INVENTOR.
ERNEST HOPKINSON
BY Walter L. Fitzpatrick
ATTORNEYS.

Dec. 14, 1937. E. HOPKINSON 2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Filed Nov. 2, 1929 5 Sheets-Sheet 2

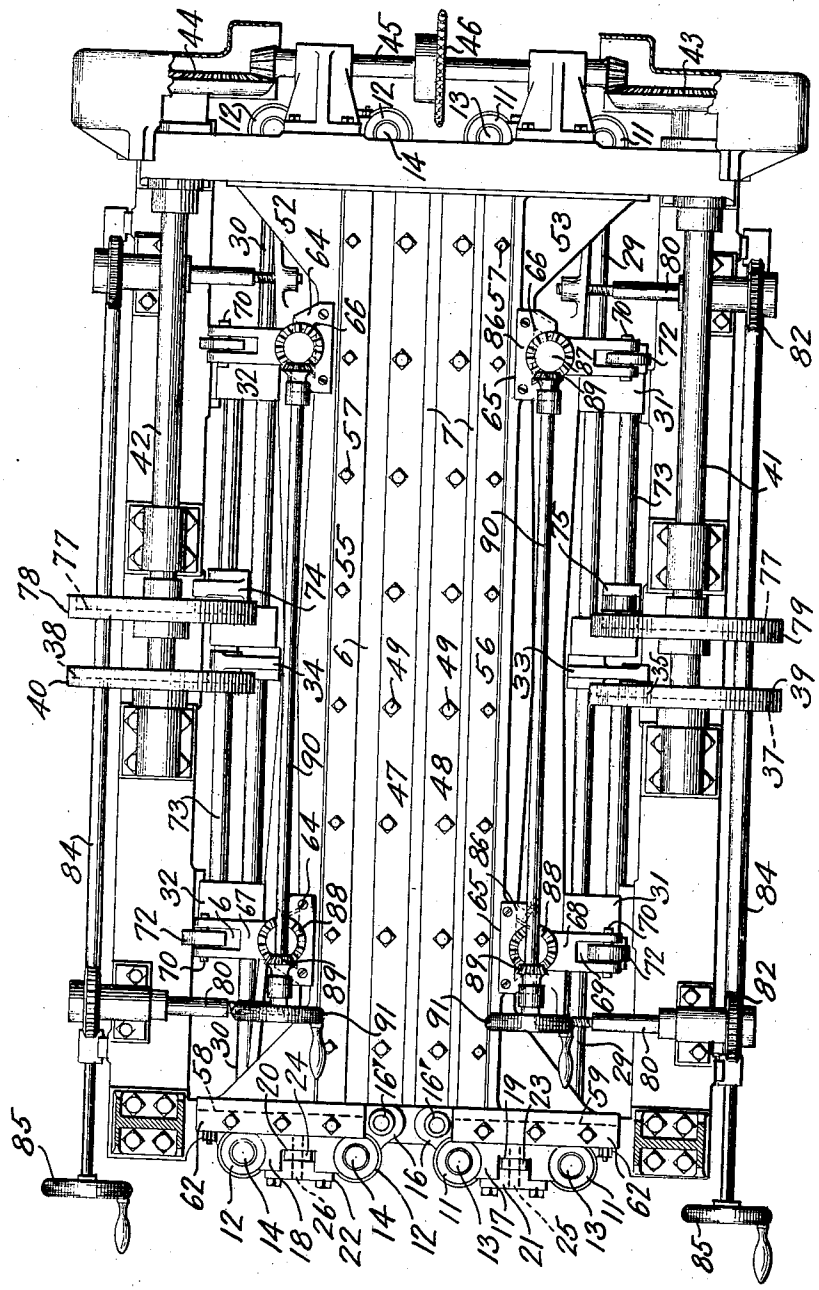


FIG. 2.

INVENTOR.
ERNEST HOPKINSON
BY Walter L. Fipes
ATTORNEYS.

Dec. 14, 1937. E. HOPKINSON 2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Filed Nov. 2, 1929 5 Sheets-Sheet 3

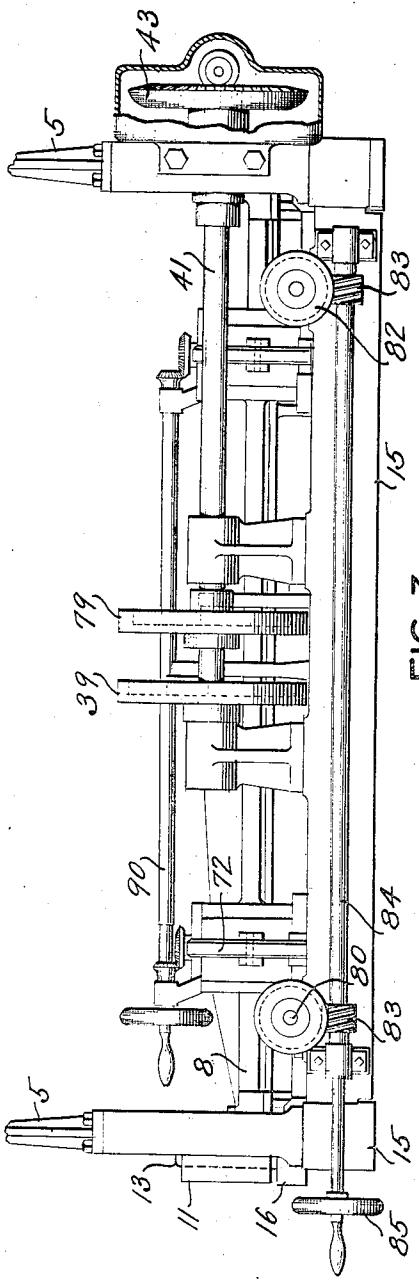


FIG. 3.

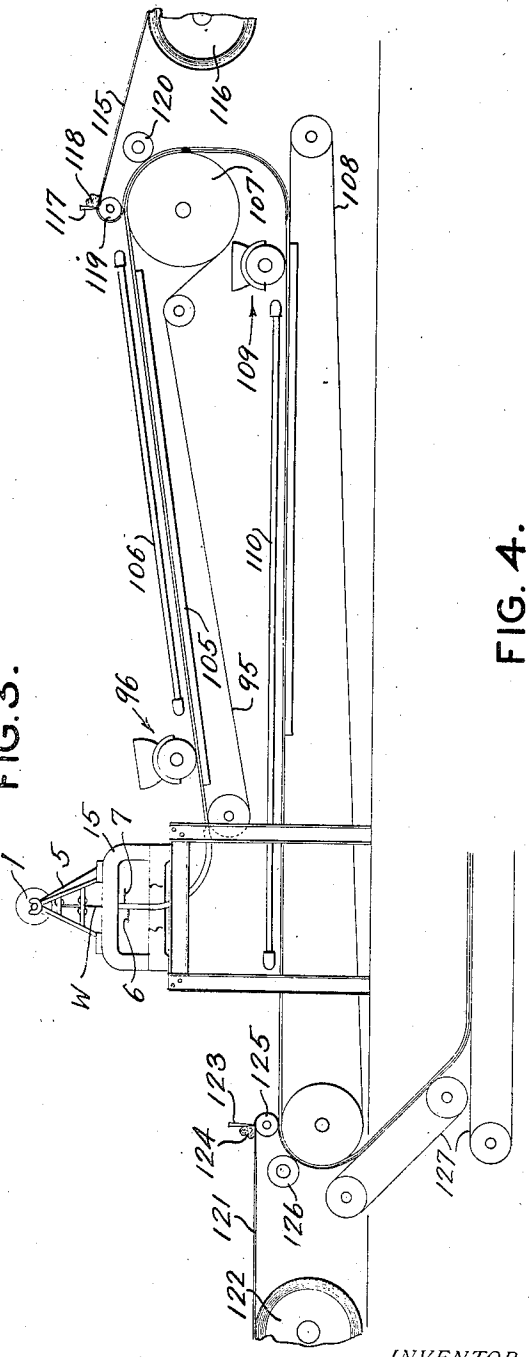


FIG. 4.

INVENTOR.
ERNEST HOPKINSON.
BY Walter S. Lupes
ATTORNEYS.

Dec. 14, 1937. E. HOPKINSON 2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Filed Nov. 2, 1929 5 Sheets-Sheet 4

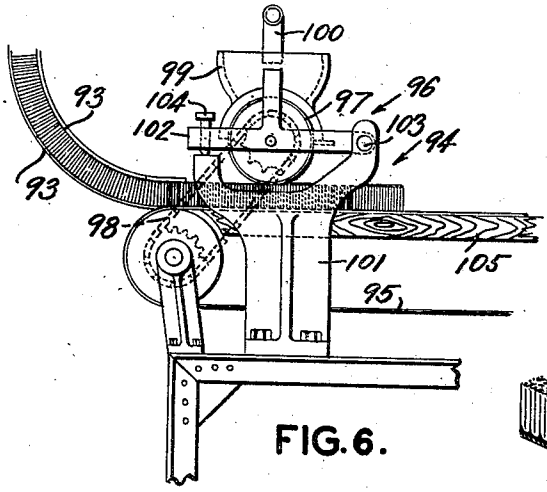


FIG.6.

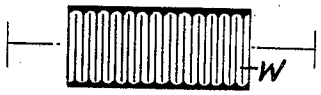


FIG.8.

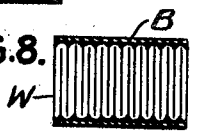


FIG.9.

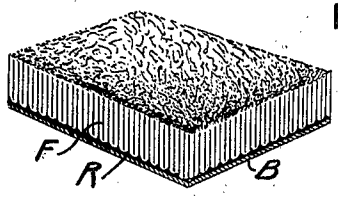


FIG.10.

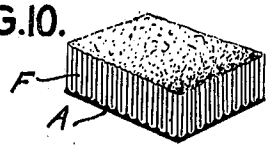


FIG.11.

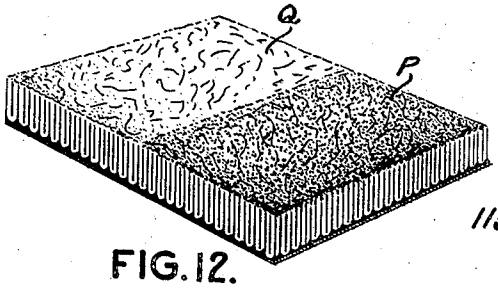


FIG.12.

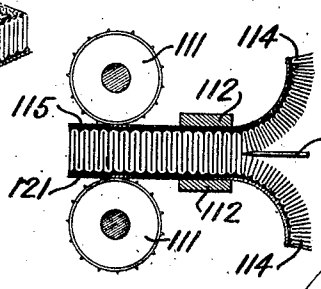


FIG.7.

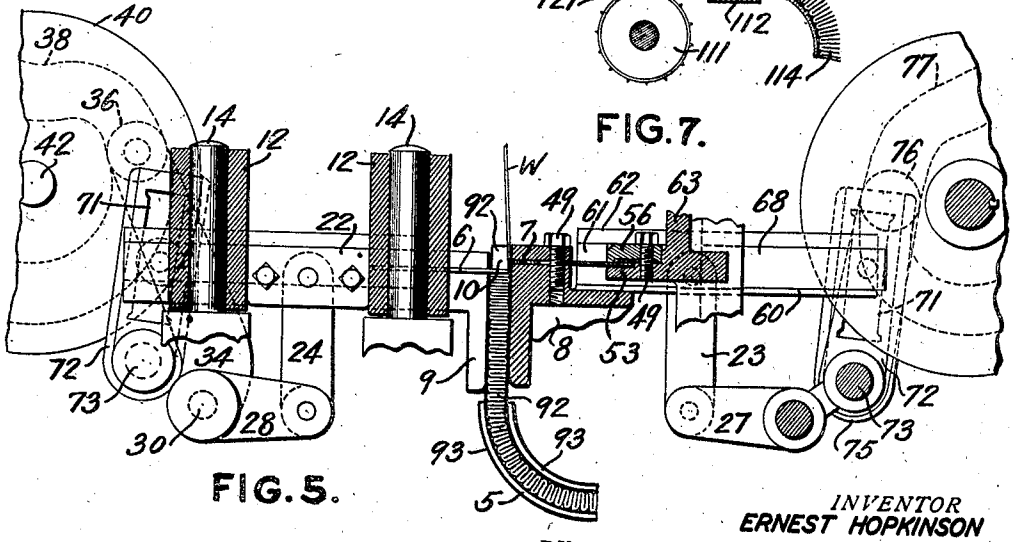


FIG.5.

INVENTOR
ERNEST HOPKINSON

BY

Walter L. Phipps
ATTORNEY

Dec. 14, 1937. E. HOPKINSON 2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Filed Nov. 2, 1929 5 Sheets-Sheet 5

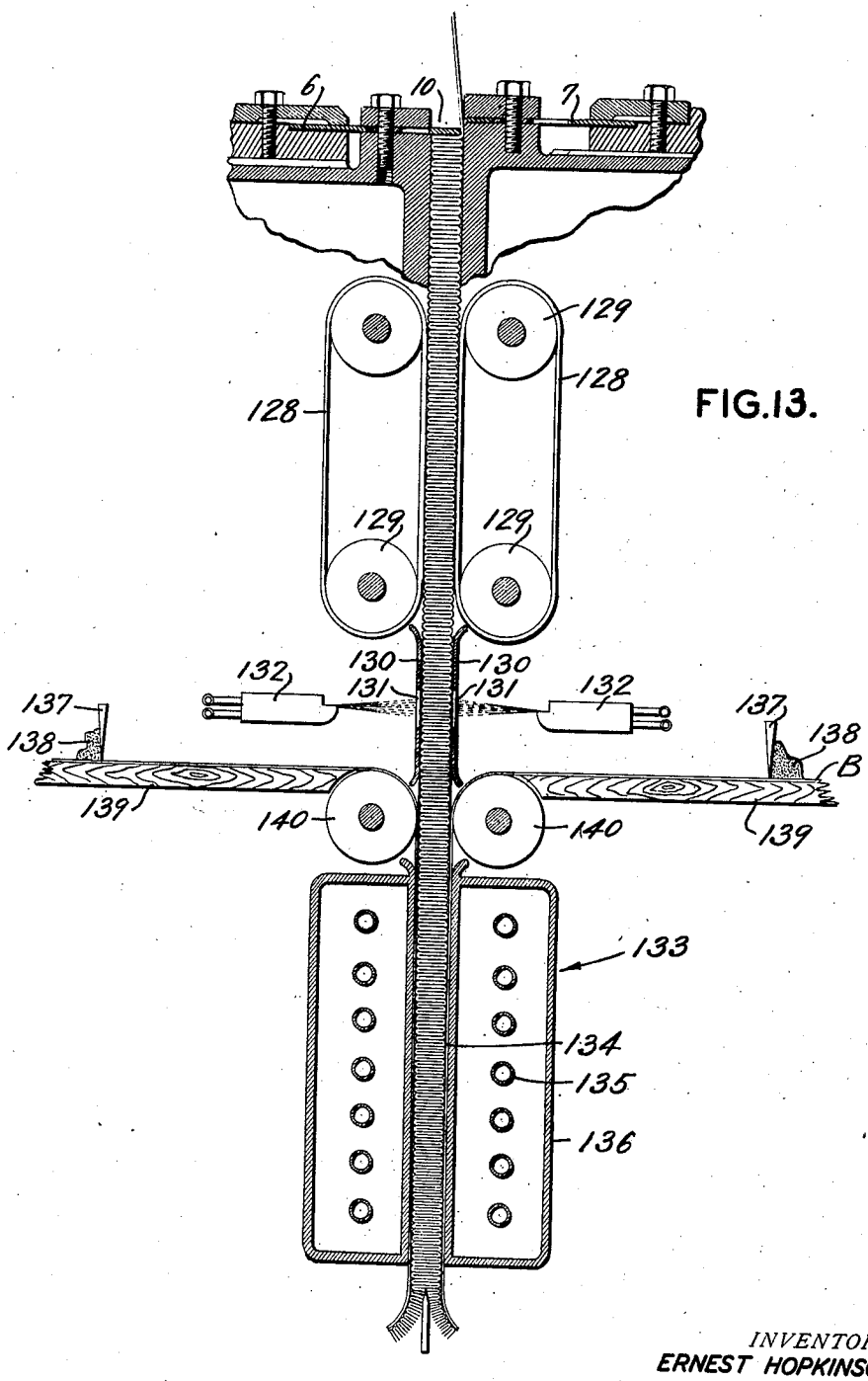


FIG.13.

INVENTOR.
ERNEST HOPKINSON
BY
Walter L. Fikes
ATTORNEYS.

Patented Dec. 14, 1937

2,101,905

UNITED STATES PATENT OFFICE

2,101,905

PILE FABRIC AND PROCESS FOR MAKING THE SAME

Ernest Hopkinson, New York, N. Y., assignor, by mesne assignments, to United States Rubber Company, New York, N. Y., a corporation of New Jersey

Application November 2, 1929, Serial No. 404,457

16 Claims. (Cl. 154—2)

This invention relates to pile fabrics, to a process for manufacturing pile fabrics and to a machine for manufacturing pile fabrics in accordance with that process.

Heretofore in the manufacture of pile fabrics it has been usual to weave the pile into a backing of woven fabric, the fabric serving to secure the pile in place. The free ends of the pile have heretofore been formed by cutting off the top portions of the loops formed by weaving the yarn into the fabric. Such an article is unduly expensive because of the type of backing. The process of making such an article is unnecessarily complicated by the type of backing employed and is rendered costly because of the operations necessary in securing the pile into the fabric. That process is further wasteful in that, in cutting off the top portions of the loops to form the free ends of the pile, a considerable amount of fibre is wasted. In addition machines capable of making pile fabric with a fabric backing are necessarily complicated in order that they may carry out the operations of weaving the pile into the fabric backing.

It is an object of this invention to provide a pile fabric in which the fibres forming the pile are secured solely by an adhesive. Another object of this invention is to provide a pile fabric having a high degree of flexibility. It is also an object of this invention to provide a process for making a pile fabric in which the pile is secured together solely by adhesive. It is a further object of this invention to provide a process for making two pile fabrics at one operation. Another object of this invention is to provide a process whereby the loops in the folds of fibrous material making up the pile are secured together at both faces of the folds, and further to separate such sheet between the faces formed by the loops of the fold. It is also an object of this invention to provide a machine for manufacturing the pile fabric herein described according to the process herein described.

Other objects and advantages of the present invention will appear from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is an end elevation partly broken away with parts in section of the pile fabric machine of this invention;

Fig. 2 is a top plan view of the pile fabric machine of this invention with parts broken away;

Fig. 3 is a side elevation partly broken away of the pile fabric machine of this invention;

Fig. 4 is a diagrammatic view of the entire machine;

Fig. 5 is a detail view partly in section of the web folding mechanism of the pile fabric machine;

Fig. 6 is a detail view of the adhesive applying apparatus;

Fig. 7 is a detail view of the cutting apparatus;

Figs. 8, 9, 10, 11 and 12 are views of the products;

Fig. 13 is a view partly broken away and in section of a modification of the machine of this invention.

According to the process of this invention, a web of fibrous material is continuously advanced. The web may be composed of a plurality of strands placed side by side in parallel relation or the web may be composed of a matted or felted material or it may be a sheet of paper, or any other material having the strength and flexibility necessary for folding. The fibrous material may be either vegetable or animal fibres such as cotton, jute, hemp, sisal, flax, wool, hair, and in addition artificial fibres such as artificial silk.

The mechanism for continuously supplying the web may conveniently take the form, in the case of a plurality of juxtaposed strands, of a beam 1 or in lieu thereof a creel from which the strands individually may be drawn. The web is drawn from the source of supply by rollers 2 driven from any suitable source of power, not shown. The web W passes through the rollers 2 which contact therewith and by friction draw the web from a source of supply and advance the web continuously to the folding mechanism. A roller 3 is conveniently provided for properly aligning the web with the rollers 2. Where the web is composed of a plurality of strands in side to side parallel relation, an expansion comb 4 of conventional construction is provided for maintaining the strands in proper alignment and properly spaced. A frame 5 of suitable construction is provided for carrying the parts described as shown in Fig. 1, the various rollers in the beam being rotatably mounted in the frame and the comb fixed thereto in any well known manner.

The next step in the process consists in forming folds in the web as it advances continuously. The folds are formed in succession and the folds are arranged in contiguous relation and are of equal depth.

The mechanism for forming the folds in the web W conveniently takes the form of plates or blades 6 and 7 which are mounted in parallel relation and for reciprocating movement parallel

to one another, that is reciprocating movement in a plane perpendicular to the direction of movement of the web. In addition as will be later described the blades are mounted for reciprocating movement in a direction parallel to the direction of movement of the web. In making the folds in the web, the blades 6 and 7 operate in the following fashion: As shown most clearly in Figs. 1, 5 and 13 the blade 6 is in extended position. In that position the edge of the blade 6 holds the web against the face of a casting 8 which extends across the entire width of the web. The blade 6 holds the web W thereby preventing the withdrawal of the previously formed loops while the blade 7 moves from the position shown in Fig. 1 to the left, thus forming a fold in the web W. When the blade 7 reaches its fully extended position its edge clamps the web against the face of the casting 9. The castings 8 and 9 carry cap plates 48 and 47 respectively later to be described which cooperate with the blades 6 and 7 in the formation of the folds therebetween. As soon as the blade 7 effectually secures the web W against the face of the casting 9, the blade 6 is withdrawn, leaving the formed loops between the face of the castings 8 and 9. When the blade 6 has been fully withdrawn the castings 8 and 9 then move parallel to the direction of movement of the web W. The casting 9 moves upwardly and the casting 8 moves downwardly. Inasmuch as at this time the blade 6 is fully withdrawn, it clears the last formed fold in the web, and inasmuch as the blade 7 is fully extended and holds the web against the face of the casting 9, it carries the last formed fold in the web downwardly in the slot 10 between the faces of the castings 8 and 9. When the castings 8 and 9 have reached the full extent of their movement, they then stop and the blades 6 and 7 are in a position which is reverse to that shown in Fig. 1. At that time the blade 6 moves outwardly to the right until it reaches its fully extended position, in which position its edge holds the web against the face of the casting 8. Then the blade 7 is withdrawn, the castings 8 and 9 move in a direction parallel to the direction of motion of the web, but in the reverse of the last described movement of the castings 8 and 9 to bring the blades and castings to their original position as shown in Fig. 1. This operation has involved the formation of two folds in the web W.

The construction of the machine whereby the castings 8 and 9 operate in a direction parallel to the direction of movement of the web W will now be described. The castings 8 and 9 extend from end to end of the machine and at their lateral extremities the castings 8 and 9 carry sleeves 11 and 12 respectively, which sleeves are rigidly secured thereto or are unitary therewith. The sleeves 11 and 12 fit and slide upon posts 13 and 14 respectively which are rigid with castings 16 secured to the base of the machine 15 by bolts 16'. Brackets 17 and 18 are carried by the castings 8 and 9 respectively and extend between the sleeves 11 at each end of the castings 8 and between the sleeves 12 at each end of the casting 9 respectively. The brackets 17 and 18 are recessed as indicated at 19 and 20 (Fig. 2) and blocks 21 and 22 are secured on the brackets 17 and 18 respectively and bridge over the recesses 19 and 20 so as to form a slot between the bottom of the recesses 19 and 20 and the faces of the blocks 21 and 22 respectively. Links 23 and 24 extend into the last described slots in the brackets 17 and 18 respectively. The links 23 and 24 are rotatably secured to the castings 8 and 9 by the pins 25 and 26. The links 23 and 24 connect at their other extremities with radius arms 27 and 28 rigidly fixed to shafts 29 and 30 rotatably mounted in brackets 31 and 32 rigidly carried in any suitable manner on the frame of the machine. The shafts 29 and 30 extend from end to end of the machine as shown in Fig. 2, the links 23 and 24 being connected to the radius arms 27 and 28 at the ends of the shafts 29 and 30 respectively. Intermediate of the extremities of the shafts 29 and 30, cam levers 33 and 34 are carried rigidly fixed to the shafts 29 and 30 respectively. The cam levers 33 and 34 carry cam followers 35 and 36 respectively which ride in slots 37 and 38 of cams 39 and 40 respectively. The cams 39 and 40 are rigidly secured upon the shafts 41 and 42 respectively which are rotatably supported in suitable bearings carried on the frame 15 of the machine. At the extremities of the shafts 41 and 42 are fixed bevel gears 43 and 44 which mesh with bevel gears carried on the extremities of the shaft 45 upon which is rigidly fixed a sprocket 46. Power is supplied from any suitable source through the sprocket 46 and shaft 45 to the shafts 41 and 42 and thereby to the cams 39 and 40 so as to effect the operation of the castings 8 and 9 through the motion transmitting mechanism hereinabove described. As the cams 39 and 40 rotate the oscillations of the cam levers 33 and 34 cause the links 23 and 24 to move vertically as shown in Fig. 1 thereby moving the castings 8 and 9 vertically upon the pins 13 and 14. The cam slots 37 and 38 are so designed as to cause the castings 8 and 9 to move in opposite directions when moving and simultaneously to remain stationary.

The mechanism for effecting the reciprocation of the blades 6 and 7 in a plane perpendicular to the direction of movement of the web W will now be described. The blades 6 and 7 slide upon top faces of the castings 8 and 9 and are held in sliding relation therewith by cap plates 47 and 48 respectively.

The cap plates 47 and 48 are secured to the castings 9 and 8 respectively by screws 49 arranged at intervals along the cap plates 47 and 48. Washers 50 of a slightly greater thickness than the blades 6 and 7 are positioned between the cap plates and castings in order properly to space them so as to permit free sliding movement of the blades 6 and 7 therebetween. The plates or blades 6 and 7 are provided with slots 51 adapted to accommodate the washers 50 and screws 49. The plates 6 and 7 are secured to frames 52 and 53 respectively. The frames 52 and 53 extend from end to end of the machine and provide ledges 54 upon which the rear margins of the blades 6 and 7 may be secured. Clamping bars 55 and 56 are secured to the frames 52 and 53 by any suitable means such as bolts 57. The clamping bars 55 and 56 secure the rear margins of the blades 6 and 7 to the frames 52 and 53 respectively. At their lateral extremities the frames 52 and 53 are positioned in ways 58 and 59 respectively. The ways 58 and 59 are formed in the lateral extremities of the castings 8 and 9. At their lateral extremities castings 8 and 9 have formed therein ledges 60, see Fig. 5, and are provided with projections 61 on the top of which are secured gib plates 62. The space between the gib plates 62, the ledges 60 and the projections 61 forms the way in which the frames 52 and 53 slide. The gib plates 62 are secured to the projections 61 by screws or in any other suitable manner. Thus

it is seen that the plates or blades 6 and 7 may be moved independently of the brackets 8 and 9 in a direction perpendicular to the direction of movement of the web W, but that the plates or blades 6 and 7 are carried by the castings 8 and 9 in movements parallel to the direction of the motion of the web W.

The frames 52 and 53 have vertically extending lugs 63 to which are secured blocks 64 and 65 on frames 52 and 53 respectively. The blocks 64 and 65 are provided with wedge slots or ways 66 in which the links 67 and 68 slide, the links 67 and 68 being provided with way followers of a shape corresponding to that of the ways 66. The way followers of the links 67 and 68 fit the ways 66 tightly enough to maintain the links 67 and 68 substantially rigid. The links 67 and 68 are bifurcated at their free extremities as indicated at 69 and a block is pinned between the bifurcations as indicated at 70. The blocks are arranged to slide in rectangular slots 71 formed in radius arms 72, which radius arms are rigidly fixed upon shafts 73. The shafts 73 are mounted for rotation in the brackets 31 and 32 carried by the frame of the machine. The shafts 73 have rigidly fixed thereon cam levers 74 and 75 corresponding respectively to frames 52 and 53 and blades 6 and 7. The cam levers 74 and 75 carry cam followers 76 which ride in cam slots 77 in cams 78 and 79 respectively. Cams 78 and 79 are rigidly fixed upon the shafts 42 and 41 respectively driven as before described. The rotation of the cams 78 and 79 effects oscillation of shafts 73 through the cam levers 74 and 75 which in turn oscillate the radius arms 72 thereby effecting reciprocation of the frames 52 and 53 through the links 67 and 68. Reciprocation of the frames 52 and 53 carries the blades 6 and 7 in reciprocation.

The cam slots in the cams 78 and 79 are so made that one blade is always stationary when the other is moving. The cam slots in all four of the cams 39, 40, 78 and 79 are arranged so that the following cycle of operations takes place. Referring to Figs. 1 to 5, the blade 7 moves to the left to fully extended position, when the blade 7 stops the blade 6 is withdrawn to the fully withdrawn position, the castings 8 and 9 being stationary at that time. After the blade 6 has reached its fully withdrawn position the blades 6 and 7 both remain stationary relative to the castings 8 and 9, and the castings 8 and 9 move in a direction parallel to the web, the casting 9 moving upwardly and the casting 8 moving downwardly until the relative positions of the blades 6 and 7 are reversed. When the castings 8 and 9 have reached the full extent of their movement they stop, and the blade 6 moves to the right to its fully extended position, the blade 7 then is withdrawn to its fully withdrawn position and the operation of the blade 7 is followed by the movement of the castings 8 and 9 in a reverse direction to that before described until the parts reach their original positions as shown in Figs. 1 and 5.

The machine is constructed so as to permit of adjustment of the castings 8 and 9 relative to one another so as to adjust the width of the opening 10 and the machine is also adjustable to provide for increased or decreased length of the stroke of the blades 6 and 7 so as to accommodate the stroke of the blades 6 and 7 to the spacing between the castings 8 and 9.

As before described the posts 13 and 14 upon which the frames 8 and 9 are reciprocable are carried in castings 16 secured to the frame 15 of the machine by bolts 16'. The apertures in the frames 16 through which the bolts 16' pass are elongated slots so that by loosening the bolts 16' the castings 16 may be moved upon the frame of the machine thereby moving the posts 13 and 14 and carrying the castings 8 and 9 with them so as to adjust the castings 8 and 9 relative to one another. In order to provide for the adjustment of the castings 16 on the frame 15 of the machine, there are provided screws 80 threaded into apertures in the castings 16. Screws 80 are carried rotatably in bearings 81 on the frame of the machine, and upon rotation of the screws 80 the motion of the castings 16 is effected provided the screws 16' are loose. The screws 80 carry rigidly the worm wheels 82 cooperating with worms 83 carried rigidly upon shafts 84 rotatable in suitable bearings carried by the frame 15 of the machine. The shafts 84 carry hand wheels 85 by which the operation of the screws 80 may be effected so as to adjust the spacing of the castings 8 and 9. When the castings 8 and 9 are satisfactorily adjusted, the screws 16' are tightened to secure the castings in place.

The mechanism for effecting the adjustment of the stroke of the blades 6 and 7 is as follows: As before described the frames 52 and 53 to which the blades 6 and 7 are attached carry the blocks 64 and 65 having vertical ways 66 in which the links 67 and 68 are fitted for movement. At the top of the blocks 64 and 65 are provided the brackets 86 in which are rotatably supported the screw threaded shafts 87. Shafts 87 carry rigidly bevel gears 88 with which cooperate the bevel gears 89 secured upon shafts 90. The shafts 90 are rotatable in bearings carried by the brackets 86 and are provided with hand wheels 91 operable to rotate the screws 87. The screws 87 are threaded into apertures in the links 67 and 68 so that upon rotation of the screws 87 by manipulating the hand wheels 91 the links 67 and 68 are moved in the ways 66 of blocks 64 and 65. The movement of the links 67 and 68 in the ways 66 causes a corresponding movement of the blocks carried in the slots 71 of the radius arms 72 thereby shortening or lengthening the effective radius of the arms 72, which causes a corresponding shortening or lengthening of the stroke of the blades 6 and 7.

The next step in the process of this invention involves applying to the faces of the folded web formed by the loops of the folds an adhesive material which will secure the folds together in fixed relation. The adhesive employed may be and preferably is a water dispersion of rubber such as rubber latex which may or may not contain vulcanizing ingredients. In lieu thereof rubber cements or rubber dissolved in organic solvents may be employed, or any other suitable adhesive of either animal or vegetable origin which will satisfactorily secure the folds together permanently may be employed.

The step of applying the adhesive to the faces of the folded web may be carried out in any suitable manner, a suitable mechanism for effecting that step being disclosed in Figs. 4, 5 and 6.

The folded web as it leaves the channel 10 between the castings 8 and 9 is guided at the lateral edges of the folded web by guides 92 which may take the form of steel bars which are positioned at the ends of the slot or aperture 10 and which support the lateral edges of the folded web as it issues from a folding mechanism.

The guides 92 are provided with top and bottom plates 93 which support the faces of the

folded web as it issues from the folding machine. The guide 92, 93 is conveniently curved as shown in Figs. 4 and 5 so as to carry the folded web from the folding mechanism to the conveyor 94. As the folded web issues from the guide or chute 92, 93, the conveyor belt 95 advances it to the right as shown in Fig. 4 and carries the upper face of the folded web beneath the adhesive applying machine 96. The adhesive applying machine preferably takes the form of a roller 97 driven conveniently by the chain 98 from the conveyor. The roller 97 passes underneath the vat 99 which rests upon the upper surface of the roller and supplies adhesive thereto. The roller 97 may have indentations in the surface in order better to carry the adhesive. The adhesive may be supplied to the vat 97 through a pipe connection 100 as may be convenient. The adhesive applying mechanism is carried by the frame 101 and is adjustable thereon by the bar 102 supporting the roller 97 and vat 99 which bar 102 is pivoted at 103 in the frame 101 and is adjustable by the screw 104 so as to accommodate the machine to the thickness of the folded web. The conveyor is conveniently provided with the support 105 over which the belt 95 passes. As the folded web with the adhesive applied to the upper surface thereof is carried on by the conveyor belt 95, it passes beneath the heating coils 106 or any other suitable form of heating apparatus so as to set the adhesive.

The amount of heat supplied by the heating unit 106 is determined by the nature of the adhesive material, whether it is one which merely requires drying or one which requires drying and curing or vulcanization as well. The finished product may be one in which the pile is supported or fixed in place solely by the adhesive material which forms, as well, the backing. If that type of product is desired, the next step in the process consists in applying the adhesive to the other face of the folded web. To apply the adhesive to the other face of the folded web according to the machine in Fig. 4 the web is carried over the roller 107 and passed on to the conveyor 108. As will be evident from the operation of the machine in Fig. 4 the uncoated face of the folded web will be uppermost when it reaches the conveyor 108. The conveyor 108 carries the web beneath the cement applying machine 109 similar in all respects to that shown at 96 in Fig. 6 where adhesive is applied to the uncoated face of the web. The web is then conveyed beneath the heating unit 110 which sets the adhesive.

At this stage in the process the article consists of the folded web having adhesive on both faces thereof. In order to produce pile fabric from such an article it is next cut along a plane intermediate the faces to which the adhesive is applied. Such a cutting operation may be effected as shown in Fig. 7 by feeding the folded web through rollers 111 between supporting bars 112, and to the continuously operating knife 113 of a conventional type, which serves continuously to cut the folded web along a plane intermediate the faces of the folded web so as to form the sheets of pile fabric 114.

Where the finished article is to have a backing, it is convenient to apply that backing immediately after the cement is applied to each of the faces, although the backing may be applied after adhesive has been applied to both faces of the folded web, or if desired the adhesive by which the backing is stuck to the face of the web may be employed for securing the folds of the web together.

Apparatus for applying the backing is shown in Fig. 4 where the backing 115 is drawn from supply roller 116 and passed beneath the doctor blade 117 where adhesive 118 is spread upon the face of the backing. As the backing leaves the doctor knife 117 it passes around roller 119 and is brought into contact with the face of the folded fabric as it is moved along conveyor 95. The roller 120 is provided for pressing the backing into intimate contact with the face of the folded web. Where the backing is applied as shown in Fig. 4 the adhesive may be applied by the machine 96 or not as desired. If the adhesive is not applied to the face of the folded web a sufficient amount of adhesive must be supplied to the backing 115 to adequately secure the folded web to the backing as well as to adequately fix the folds in the web. As the folded web with the backing 115 applied thereto advances it passes on to the conveyor 108. If desired adhesive may be applied to the other face of the web by the machine indicated at 109. Whether or not adhesive be applied by the machine 109 to the other face of the web, a backing 121 is applied to the web from the roller 122, doctor knife 123 being provided for applying adhesive 124 to the backing, which backing is rolled on to the face of the web by the roller 125. Roller 126 is provided for rolling the backing and face of the web into intimate contact. The web with the two backings applied thereto is then conducted away by suitable conveyors 127 and it may be passed through any suitable heating unit to set the adhesive applied to the backing and to vulcanize the adhesive if it be of a vulcanizable nature.

The adhesive material found most satisfactory for securing the folds of the web together and also for securing the backing to the web has been found to be a latex compounded with vulcanizing ingredients.

The folded web with the backings 115 and 121 are finally fed to the cutting machine shown in Fig. 7 which divides the folded web between the faces thereof so as to form a pile fabric.

While the preferred method and mechanism for applying adhesive and backings to the folded web is illustrated in Figs. 4 and 6, other methods and mechanisms may be employed for accomplishing the same result. For instance the process may be modified so as to apply the adhesive to both faces of the folded web simultaneously and to apply backings to both faces of the folded web simultaneously. Mechanism for carrying out such a process is illustrated in Fig. 13. As shown in that figure the folded mechanism is of a construction like that hereinbefore described. As the folded web passes from the folding mechanism, travelling belts 128 passing over pulleys 129 driven from any suitable source of power are provided for advancing the folded web. By controlling the speed of the belts 128 the spacing between the folds of the web may be controlled. If the belts travel at faster speed than the folded web is supplied from the folding mechanism, the folds will be opened to a degree proportionate to the difference in speeds. If necessary the belts 128 may be driven at a slower rate of speed than the web normally advances from the folding mechanism thereby causing the folds to be more tightly compacted. The adhesive may be applied to the folded web

either before or after passing through the belts 128 and preferably after passing therethrough as shown in Fig. 13 in which case the folded web passes between supporting plates 130 which extend across the entire faces of the folded web and lend support thereto to maintain it in folded condition. The plates 130 are provided with apertures 131 which conveniently may be arranged diagonally so that no fold is left unsupported across the entire face of the web. In lieu of the blades 130 a coarse wire mesh may be employed which will lend satisfactory support to the web and also permit the passage of the adhesive therethrough. The adhesive is applied to both faces of the folded web simultaneously from spraying units 132 of any conventional construction. As before, the adhesive may be of any nature suitable to the purpose for which it is employed, that is, either rubber latex, rubber cement, or animal or vegetable adhesive. If the final product is not to have a backing other than the adhesive, the folded web with the adhesive thereon is next passed through the heater 133. The heater is provided with the channel 134 to accommodate the passage of the folded web and with steam coils 135 arranged in chambers 136 so as to supply heat in the desired quantity and at the desired temperature for setting or vulcanizing the adhesive.

If the final product is to be provided with backings B, it is convenient to apply such backings immediately after the folded web issues from the adhesive applying mechanism. As shown in Fig. 13 the backing may be brought from any suitable source of power beneath doctor blades 137 which apply adhesive 138 to the surface of the backing, the backing being supported by the table 139. The backing is drawn from the table by the rollers 140 and the motion of the advancing web. The backing B passes over the rollers 140 which press it into contact with the faces of the folded web. The folded web with the backing applied to the faces thereof then passes through the heating unit 133 for setting or vulcanizing the adhesive as this mixture may require. As the folded web with adhesive and/or backing applied thereto issues from the heated unit 133 it is conveniently divided along a plane between its faces by the cutter unit 141 of conventional construction.

The product without backing other than adhesive which is applied to hold the folds together takes the form shown in Fig. 8 before cutting the folded web between its faces. After cutting the product takes the form shown in Fig. 11 in which the pile consists of the upstanding fibres F secured together by the backing A. The nature of the product is determined by the kind of fibres employed and the depth of the pile. It is clear from the process herein described and the mechanism for carrying that process into effect that the pile may be of any desired depth and that the material may be of any of the numerous kinds herein before mentioned so that the product shown in Fig. 11 may be any of a wide variety used for a wide variety of purposes such as carpeting, for upholstering, imitation fur, tapestries, and the like. Where the adhesive for securing the pile together is of sufficient thickness, it serves of itself to provide a sufficiently strong backing and has the advantage of being more flexible than other types of a backing so that the article lends itself readily to uses such as upholstering.

The folded web with the backing applied is shown in Fig. 9. That product, after having been divided along a plane intermediate the faces thereof, produces the product shown in Fig. 10 which is composed of the pile F, the adhesive R for holding the pile together and the backing B which lends strength and durability to the product. The backing B may be of any suitable material such as an inexpensive woven fabric or wire cloth or paper or any other suitable material of sufficient strength which may be satisfactorily united to the pile by adhesives.

Where it is desired, pile fabrics of various colored designs may be made up by cutting out sections of various shape such as shown in Fig. 12 where two pieces of rectangular shape P and Q are juxtaposed and united upon a common backing. Separation may be done by hand or machine and the contour of the parts P and Q and the color of the materials from which they are made may be of whatever is desired. The pile of the fabric may be made in a large variety of colors by employing strands of variously colored fibrous material or by employing strands which are variously colored throughout the length, or the finished product itself may be printed upon so as to form a superficial coloring thereon. Or if desired designs may be printed upon the advancing web prior to folding, the designs being printed in a shape such that when folded the final design will be that desired, in which case the color of the design will extend to the full depth of the pile.

While certain methods, devices and products have been described by way of illustration of this invention, it is not intended so to limit the invention inasmuch as it may be varied in many of the details of the process and apparatus and the product may be varied within wide limits as to width, depth of pile, coloring effects, the nature of fibre employed, the nature of the backing material, the nature of the adhesive, and the order in which they are assembled in final relation.

For an understanding of the scope of the invention, reference is made to the following claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. The method of forming a sheet which comprises continuously advancing a web of fibrous material, repeatedly and successively forming folds in the advancing web with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to the faces formed by the loops in the folds, and drying the adhesive.

2. The method of forming a sheet which comprises continuously advancing a web of fibrous material, repeatedly and successively forming folds in the advancing web with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to the faces formed by the loops in the folds, and dividing the sheet along a plane between and substantially parallel to the said faces.

3. The method of forming a sheet which comprises continuously advancing a web of fibrous material, repeatedly and successively forming folds in the advancing web with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to the faces formed by the loops in the folds, applying a backing to the adhesively coated faces, and dividing the material along a plane between and substantially parallel to the faces.

4. That method of forming a sheet which comprises arranging and continuously advancing a plurality of strands in side to side parallel relation, forming folds in the strands along lines perpendicular to the direction of advance of the strands, arranging the folds in contiguous relation, applying adhesive to the faces formed by the loops of the folds, setting the adhesive, and dividing the folded strands along a plane intermediate to and parallel to the faces formed by the loops of the folds.

5. That method of forming a sheet which comprises arranging and continuously advancing a plurality of strands in side to side parallel relation, forming folds in the strands along lines perpendicular to the direction of advance of the strands, arranging the folds in contiguous relation, applying adhesive to the faces formed by the loops of the folds, setting the adhesive, adhesively applying a backing to the faces of the folded strands, and dividing the folded strands along a plane intermediate to and parallel to the faces formed by the loops of the folds.

6. The method of forming a sheet which comprises continuously advancing a web of material, rapidly and successively forming folds in the advancing web with adjacent faces of the folds in contact throughout their lengths, uniting the loops of the folds together with a substantially inextensible backing by a vulcanizable composition, vulcanizing the composition, and dividing the sheet along a plane between the faces formed by the loops of the folded web.

7. The method of forming pile fabric material which comprises continuously advancing a web of fibrous material, successively forming folds therein with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to the faces presented by the loops in the folds, and drying the adhesive.

8. The method of forming pile fabric material which comprises continuously advancing a web of fibrous material, successively forming folds in the advancing web with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to the faces presented by the loops in the folds, drying said adhesive, and dividing the material along a plane between and substantially parallel to the said faces.

9. The method of forming pile fabric material which comprises continuously advancing a web of fibrous material, successively forming folds therein with adjacent faces of the folds in contact throughout their lengths, applying a vulcanizable aqueous dispersion of rubber to the faces presented by the loops of the folds, applying a backing to the adhesively coated faces, drying and vulcanizing the rubber composition and dividing the material along a plane between and substantially parallel to the faces thereof.

10. The method of forming pile fabric material which comprises continuously advancing a web of fibrous material, successively forming folds in said advancing web with adjacent faces of the folds in contact throughout their lengths, applying an adhesive to at least one face presented by the loops in the folds and then drying the adhesive.

11. The method of making a pile fabric, which consists in passing plaited fibers between two layers of body material, causing said fibers to be adhesively secured to said layers adjacent the lines of fold and then severing the fibers between said layers to provide a multiplicity of short free fibers forming the nap of the fabric.

12. The method of making a pile fabric, which consists in plaiting fibers to form a folded web with adjacent faces of the folds in contact throughout their lengths, disposing the plaited fibers between layers of body material, causing said layers of body material to be adhesively secured to the plaited fibers adjacent the lines of fold therein, and then separating the resulting structure by severing the fibers between the points of connection to said layers of body material.

13. The cyclic method of making pile fabrics from pile material which comprises successively looping portions of the pile material, and then affixing the loop bases formed to a travelling backing cloth while crowding the affixed loop bases in juxtaposition to one another.

14. The method of forming a sheet which comprises continuously advancing a web of fibrous material repeatedly and successively forming folds in the advancing web with adjacent faces of the fold in contact throughout their lengths, adhesively securing a backing to the faces formed by loops in the fold, and dividing the material along a plane between and substantially parallel to the faces.

15. A pile fabric having a pile consisting of a series of upstanding folds of fibrous material with a side of each fold in lateral contact throughout its length with the other side of said fold and in lateral contact throughout its length with the side of an adjacent fold, and an adhesive in which the loops of the folds are embedded.

16. A pile of fabric having a pile consisting of a series of upstanding folds of fibrous material with a side of each fold in lateral contact throughout its length with the other side of said fold and in lateral contact throughout its length with the side of an adjacent fold, and a backing adhesively secured to the loops of the folds.

ERNEST HOPKINSON.