

Sept. 8, 1931.

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1,822,509

MACHINE FOR MAKING PILE FABRIC

Original Filed Sept. 29, 1927 6 Sheets-Sheet 1

Fig. 1.

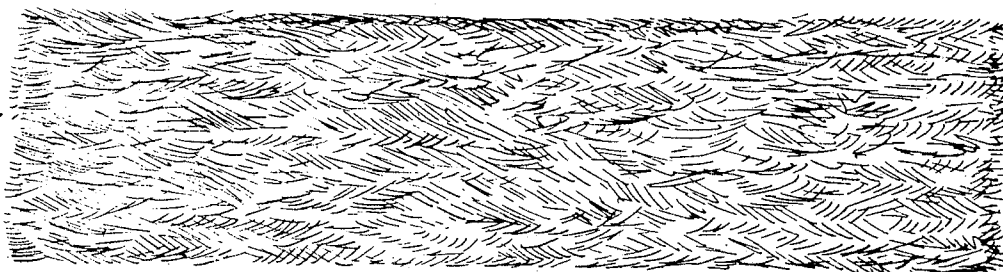


Fig. 2.

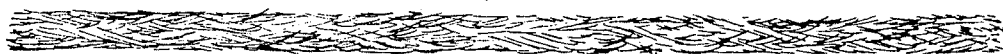


Fig. 4.

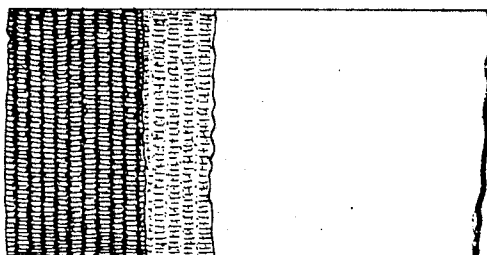


Fig. 3.

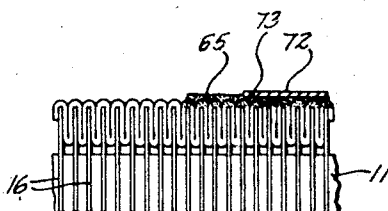
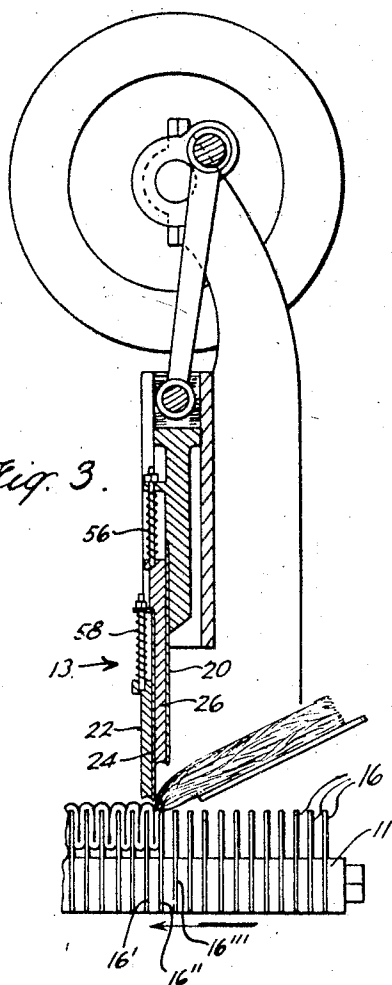


Fig. 5.

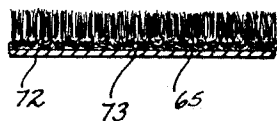


Fig. 6.

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Fig. 8.

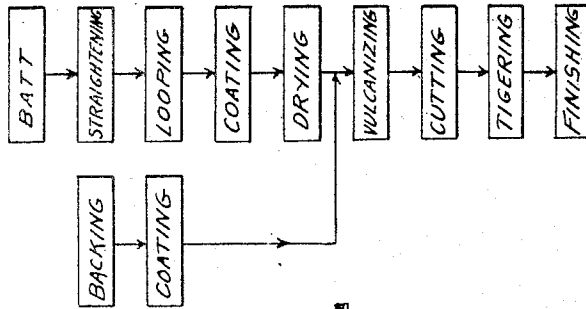
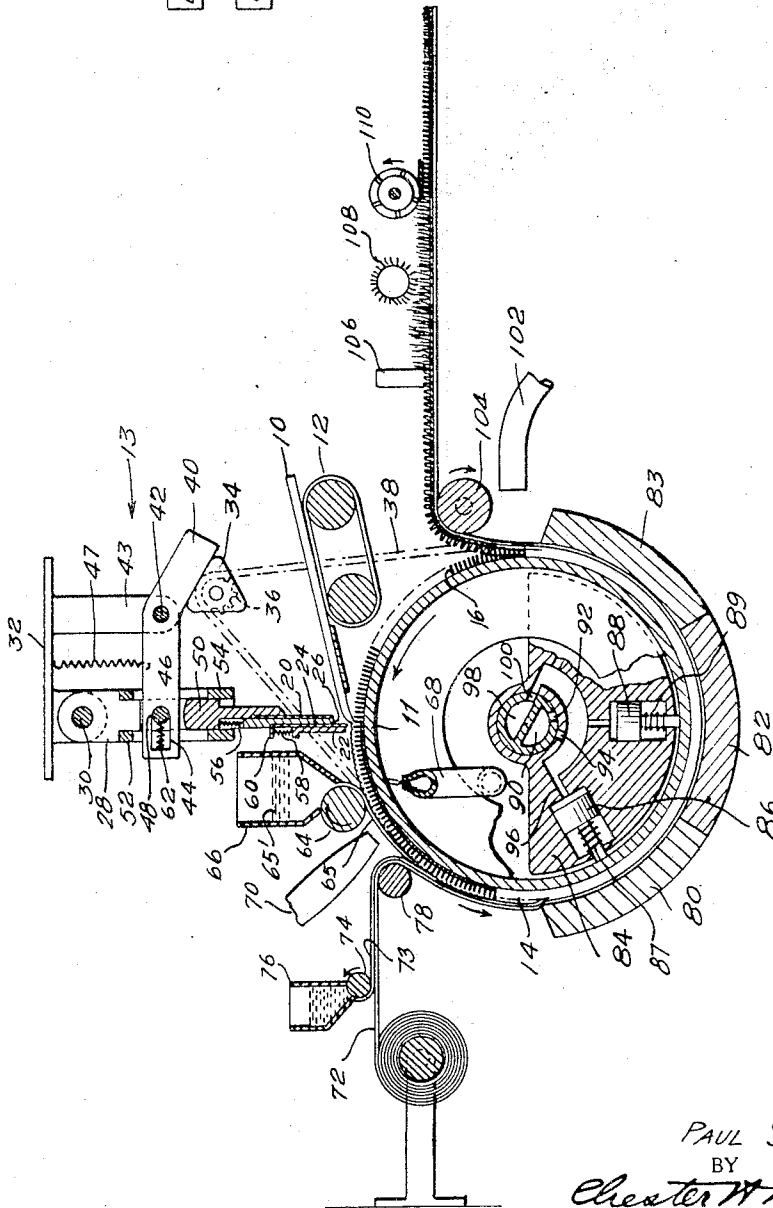


Fig. 7.



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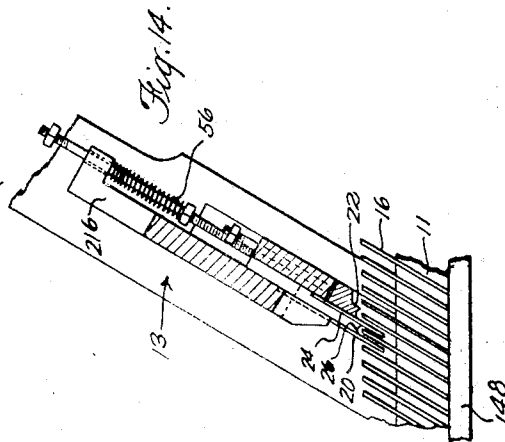
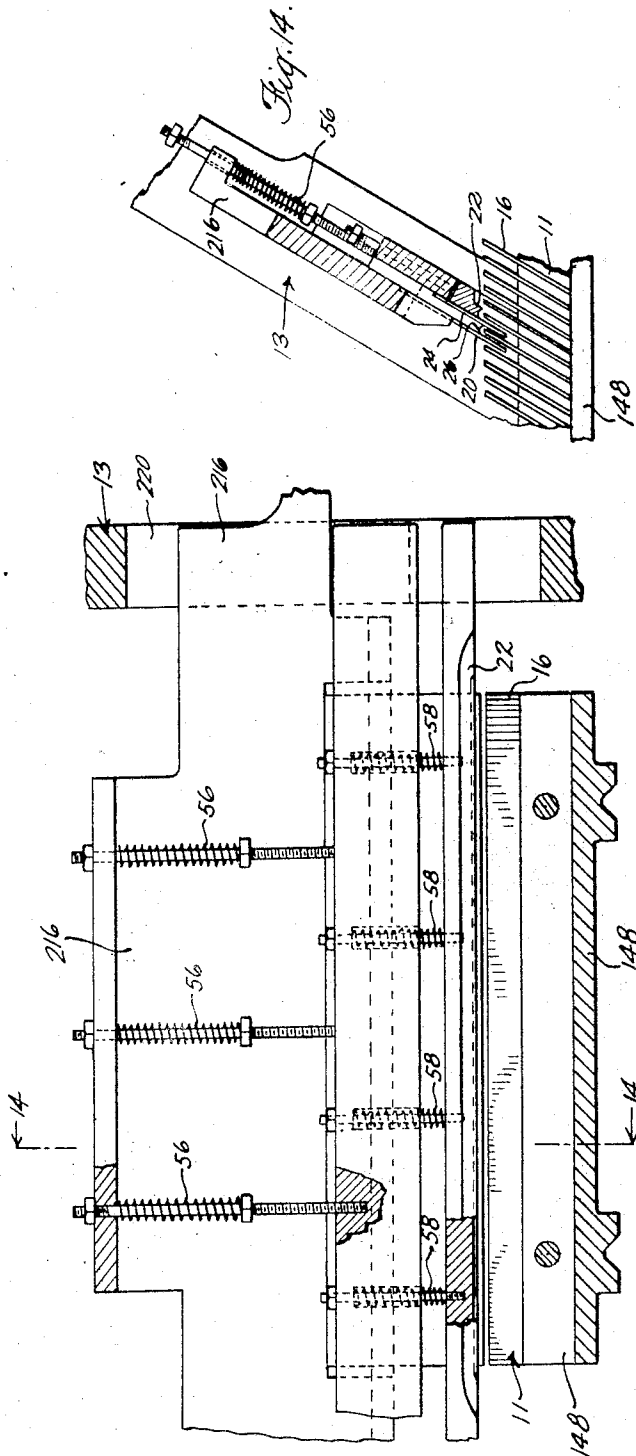
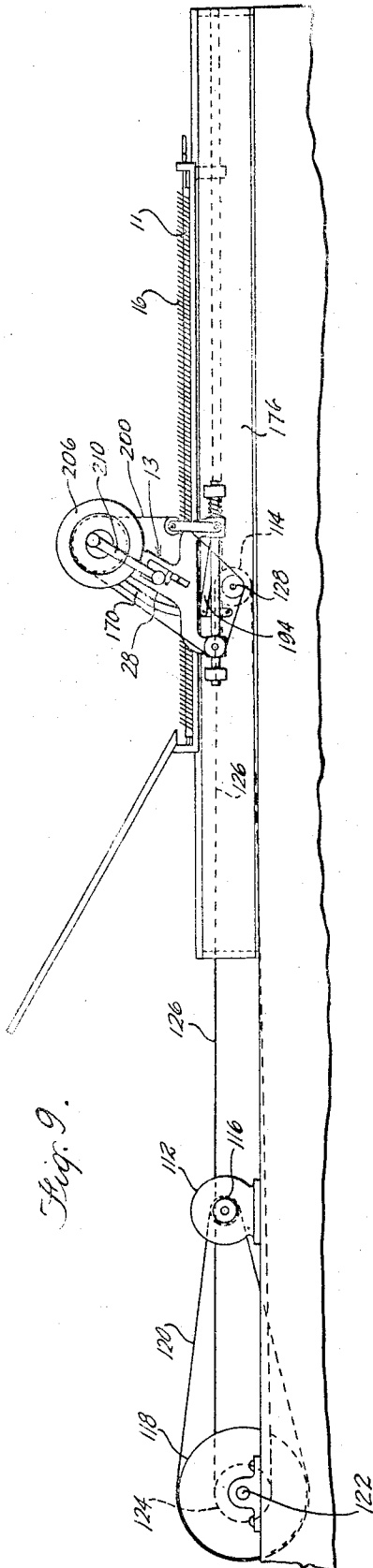
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MACHINE FOR MAKING PILE FABRIC

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Fig. 13.
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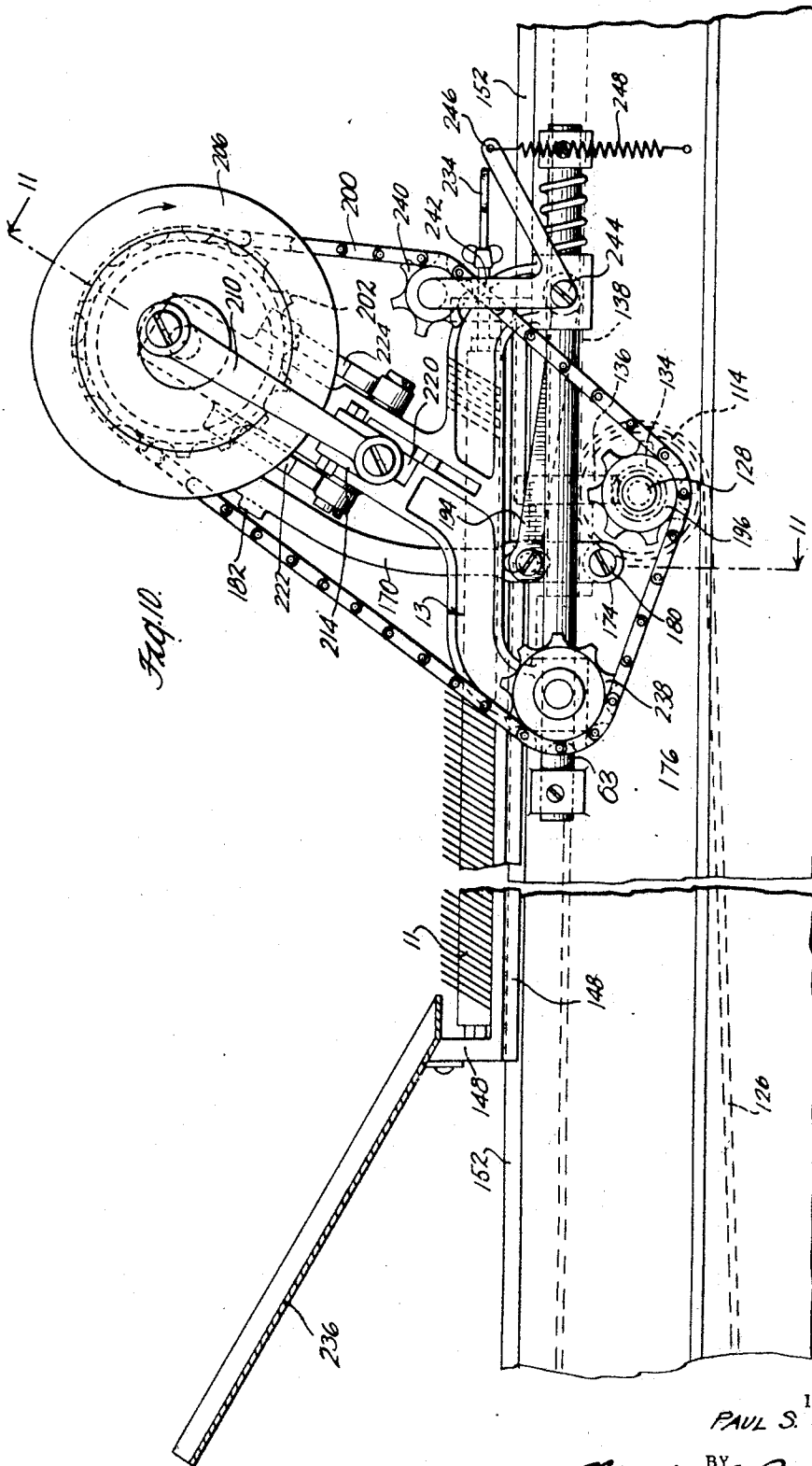
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MACHINE FOR MAKING PILE FABRIC

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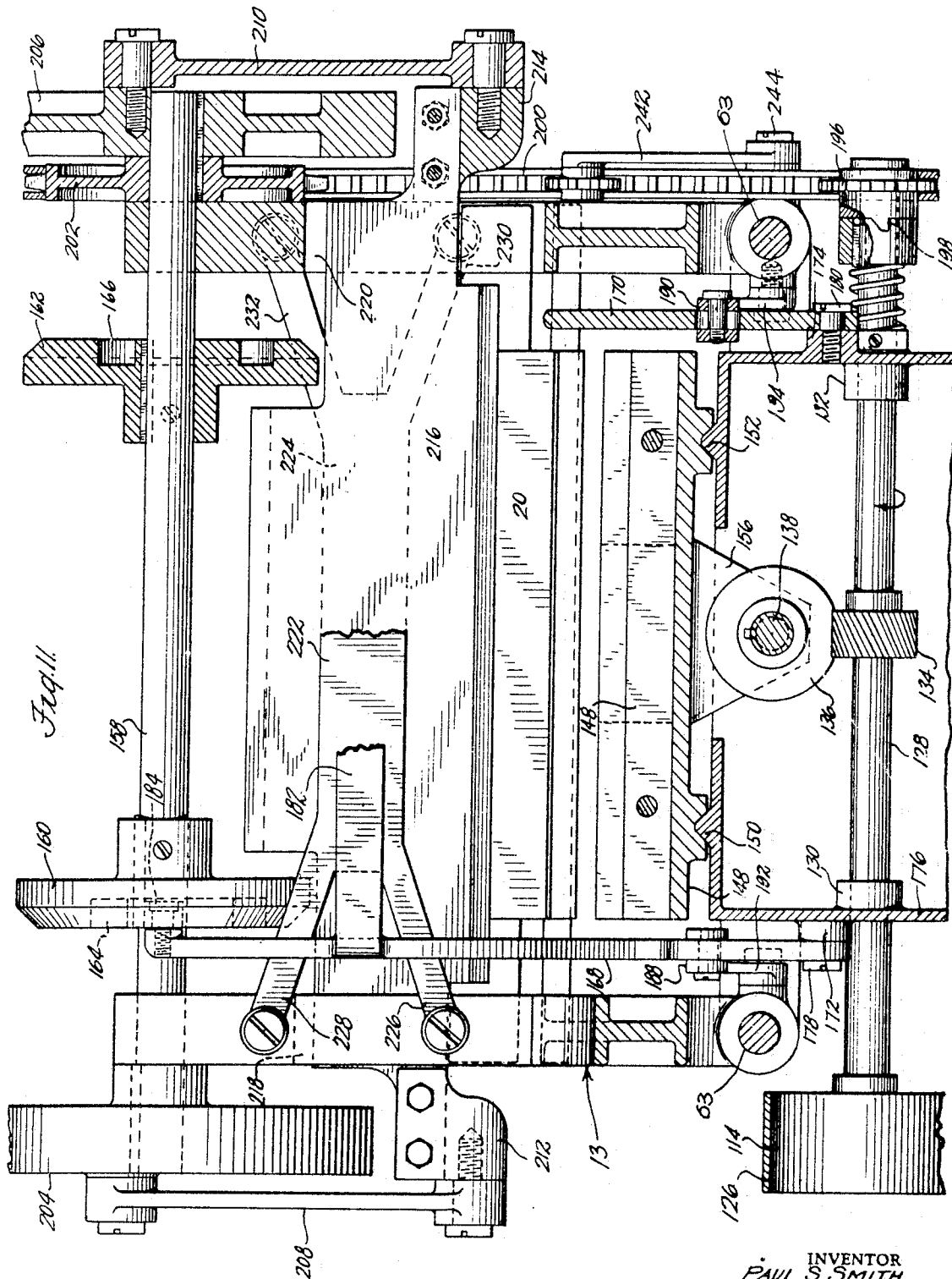
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6 Sheets-Sheet 5



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MACHINE FOR MAKING PILE FABRIC

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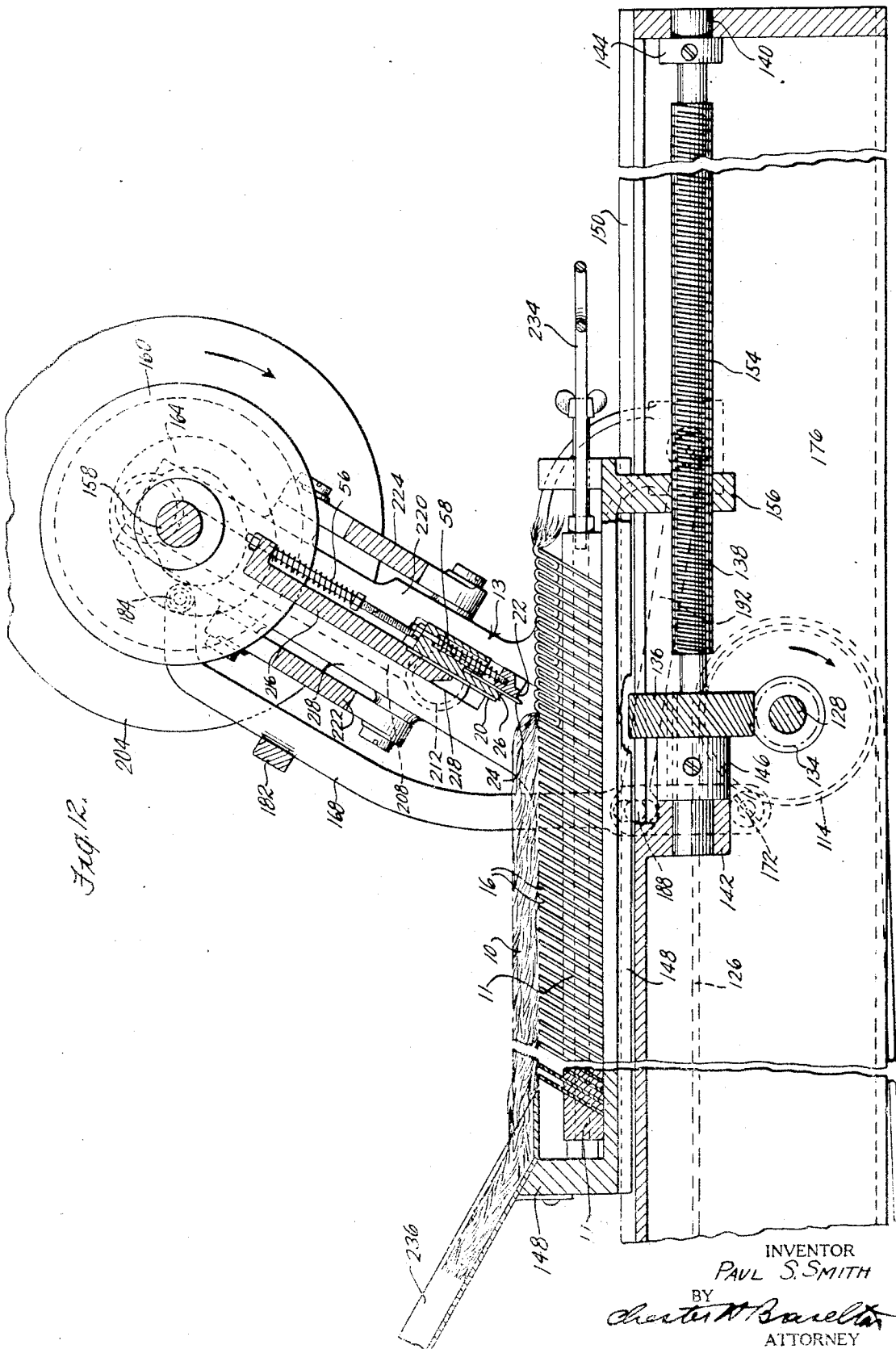


Fig. 12.

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UNITED STATES PATENT OFFICE

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MACHINE FOR MAKING PILE FABRIC

Application filed September 29, 1927, Serial No. 222,756. Renewed May 20, 1930.

This invention relates to apparatus for the making of pile fabrics. More particularly the invention relates to apparatus comprising a machine adapted for looping or folding material such as unwoven stock or the loose fibres of a batt and to supplemental apparatus adapted for forming a cemented pile fabric from unwoven stock.

By means of the apparatus which I have devised, a pile fabric may be made from unwoven stock without the preliminary step of forming a roving or spinning the fibres into a yarn, whereby a considerable economy in the cost of manufacture and in the cost of equipment is attained. By the apparatus which I have devised and herein disclosed, a pile fabric may be made either as a continuous or as an intermittent process, although the apparatus herein specifically claimed is particularly adapted for the intermittent operation or production of carpets, rugs or similar material.

One object of my invention is to provide a suitable form of apparatus for carrying out the process steps hereinafter described by means of which the desired pile fabric product may be formed.

Another object of my invention is to provide a form of apparatus for the making of cemented pile fabrics which is particularly adapted for the production of individual units.

Another object of the invention is to provide a loop-forming machine which is particularly adapted for the formation of a series of regular loops in close proximity to each other in which the formed loops may be rigidly held in place during the loop forming operation.

A further object of the invention is to provide a mechanism which is adapted to rapidly fold a batt into a series of uniform loops, the bases of which are arranged in substantially a single plane and to provide means adapted to hold the loops in place while a cementing medium is applied to the base of the loops and a textile material or other flexible backing is united thereto.

A further object of the invention is to provide a machine for the production of pile

fabrics in which the loose fibres in the form of a batt may be used in contra-distinction to yarn, cord, string, roving or other similar materials which have heretofore been suggested, whereby a pile fabric product suitable for upholstery and various other uses may be produced. In accordance with this object, a batt of loose fibres is employed in which the individual fibres are preferably arranged in a general direction longitudinally of the batt, whereby a larger proportion of the fibres will become attached after the batt is looped and the cement is applied than would be the case if the fibres were arranged in all directions. In the machine which I have devised, the fibres are acted on in the loop-forming portion thereof to arrange a large proportion of the non-parallel fibres of the batt substantially parallel therein before the looped portion of the batt is connected to the backing. It is to be understood however, that the looping machine which I have devised is operative upon a batt whether or not the fibres thereof are arranged more or less in parallelism and might be used for yarn or other material to produce the desired folding or looping action.

By means of the method hereinafter described, a pile fabric may be made, utilizing fibres of a character which cannot be spun except in admixture with other fibres, and which are of relatively little value, although it is to be understood that fibres of substantially any kind, including animal, vegetable, and mineral fibres, may be used if desired, either in admixture, or separately, in the production of my product. In the making of rugs or carpets, for example, I preferably employ hair which is unsuitable for spinning, such as goat hair, which has comparatively little value, but which, however, is better adapted for the making of my product than fibres which may be spun, for the reason that the internal friction in the rugs or carpets made therefrom—that is, the friction produced by the rubbing of the pile fibres against each other,—will be materially less, whereby the wearing qualities of my product are greatly enhanced. The dif-

ference in the wearing qualities is apparently due to the fact that fibres such as wool fibres, which are readily spun, have minute projections on the surface of the fibres which cause interlacing, or adherence of the fibres to each other, whereas hairs, such as goat hairs for example, have a surface on which there are few projections, so that there is little tendency of the fibres to adhere to each other. When a pile carpet or rug containing wool fibres is stepped on, the fibres of the pile rub against each other and the friction produced causes a considerable wear, resulting in a gradual disintegration of the carpet. In the product which I have devised, permitting the use of goat fibres, the individual fibres rub against each other, when the carpet is stepped on, without substantial friction, and consequently comparatively little wear is produced. Furthermore, by the use of a cementing medium, composed, in the preferred embodiment of my invention, of vulcanized rubber, together with a flexible backing of a textile fabric, a cushioning effect is produced when the material is stepped on.

With these and other objects in view, the invention comprises various features hereinafter described and more particularly defined in the claims.

The invention is illustrated in the accompanying drawings, in which

Fig. 1 is a plan view of a section of a batt showing the loose fibres thereof arranged in the same general direction longitudinally of the batt;

Fig. 2 is a vertical longitudinal section of the batt shown in Fig. 1;

Fig. 3 illustrates the preferred method for forming folds or loop sections in a batt and a mechanism or form of apparatus adapted for forming the loops between the "wires" or spacing elements of a chase;

Fig. 4 is a top plan view of a series of loop sections as formed by the loop forming machine showing a portion of the sections coated with cement and a portion of the coated section covered by a flexible backing member;

Fig. 5 is a longitudinal section of a chase showing the loop sections of a batt in place between the spacing elements or "wires" of a chase, and showing a section of the loops having a cement coating applied to the surface or base portion of the loop sections and another section to which the backing member has been attached;

Fig. 6 illustrates a section of the completed pile fabric product after the loop sections have been cut and the pile has been tigered and sheared to obtain a substantially uniform pile height;

Fig. 7 illustrates a form of apparatus for carrying out my invention, showing the

means by which the various method steps may be accomplished;

Fig. 8 is a flow chart illustrating the preferred sequence of steps in carrying out the method;

Fig. 9 illustrates a form of mechanism embodying loop-forming elements similar to those of Fig. 3, but in which the "wires" of the chase and the inserting blade and loop-holding means are inclined at an angle so as to form loop sections which are inclined to the plane of the bases or exposed surface of the loops;

Fig. 10 is an enlarged detail view in elevation showing the mechanism by which the looping blade is operated and by which the desired movement of the piling mechanism relative to the "wires" of the chase is obtained;

Fig. 11 is a detailed cross-section of the loop forming mechanism taken on the section line 11—11 of Fig. 10;

Fig. 12 is a detailed sectional view in elevation showing the loop-forming mechanism in the position which is assumed when it is moved from one position to another along the chase;

Fig. 13 is an enlarged fragmentary sectional view in front elevation of the loop-forming blade and loop holding blade together with the presser-feet for holding the base portions of the loop in the position assumed at the end of the loop-forming operation; and

Fig. 14 is a detailed sectional view taken on the section line 14—14 of Fig. 13.

The machine embodying my invention in its preferred form is illustrated in Figs. 9 to 14 inclusive and is particularly adapted for the making of cemented pile fabric by the method hereinafter disclosed.

In the making of the cemented pile fabric, the raw stock to be used for forming the pile, consisting of hair, wool, jute, or other fibres, or mixtures thereof, is preferably first prepared by passing it through a picker, or lumpers, as the nature of the stock may require, to more or less separate the fibres, and to remove foreign material. The stock is then put on a garnett or a carding machine, with the object of disintegrating the fibrous masses remaining in the stock and to form the fibres into a lap or batt of substantially uniform thickness. The fibres are preferably arranged on an endless carrier in such a manner that the greater portion of the fibres will be arranged longitudinally of the batt, but satisfactory results may be obtained without laying or arranging the fibres longitudinally, as would result, for example, by the use of a Blamire lapper, which folds the web initially formed at the doffer of the carding machine into folds transverse to the longitudinal direction of the lap. I prefer, however, to lay the fibres

in a general direction longitudinally of the batt, as may be accomplished by providing a wider and thicker batt than that desired to be used, and then drafting or drawing it between rollers, at the same time narrowing the batt, until the desired width and thickness are produced. By means of this drawing or drafting action, the fibres will be arranged substantially in parallelism, whereby the loss of material resulting from arrangement of fibres transversely to the batt is reduced to a minimum. The thickness of the batt should be regulated in accordance with the pile density desired in the finished product and in accordance with the character of the fibres used, as will be apparent to those skilled in the art.

Referring more particularly to the drawings, the various steps of the method and apparatus for carrying out my invention may now be described. After a batt 10 of the desired thickness and width has been formed as above described, it is preferably carried by means of an apron or conveyor belt 12, moving at an appropriate speed, by which it is delivered to the chase 11 of a loop forming machine 13 of suitable form. In Fig. 7 of the drawings is illustrated a form of piling machine, or loop-forming machine adapted for continuous operation, which consists primarily of a drum 14 having a width preferably somewhat greater than that of the pile fabric which is to be made. The drum may be suitably mounted on bearings and is preferably driven at a low constant speed. The drum may be driven by any suitable means, although I preferably employ a worm wheel, which is attached to the circumference of the drum, and which is engaged by a worm.

To the cylindrical surface of the drum are attached a multiplicity of spacing elements comprising thin plates or so-called "wires" 16 which are preferably arranged parallel to the axis of the drum and are spaced apart at the desired intervals so as to provide the desired number of loops per inch in the final product. These "wires" are preferably rigidly fastened to the drum and correspond in function substantially to that of the loose "wires" of a loom, which are used to form a pile in the ordinary woven pile fabric. The "wires" have been illustrated in Figs. 3 and 7 of the drawings, as being arranged radially to the drum, whereby the fibres in the loops formed in the batt will be arranged mainly in a direction substantially at right angles to the surface of the batt formed by the base of the loops. It is to be understood, however, that the "wires" or plate members of the chase are preferably sloped or inclined as shown in Figs. 10, 12 and 14, so that the looped fibres, or the pile in the final product, may have a definite angular direction or "lay". A lay

of about 30° with the vertical is preferably employed, and the plates are preferably arranged at an angle sloping in the direction of movement of the batt, in which case the loop-forming mechanism, hereinafter described, will be inclined at substantially the same angle in a direction toward the conveyor belt 12. By sloping the mechanism and "wires" in this direction, as described, rather than the opposite direction, the drag on the fibres is increased, resulting in an increased movement of the fibres into parallelism, and the bunching effect on the "wires" which takes place when the "wires" are sloped in the opposite direction is thus avoided.

Immediately above the drum 14 is arranged an inserting mechanism 13 which comprises a loop forming blade 20 adapted to pass centrally between the "wires" 16 on the drum, forcing the batt into the space between adjacent "wires" to a distance depending on the adjustment of the mechanism, the travel of the inserting or loop-forming blade being adjusted to provide the desired depth of the loop sections. In order to hold the batt in place during the operation of the piling blade, so as not to displace the loops already formed, a holding means for the last formed loop is provided, which preferably comprises means for holding each side of the loop in contact with the adjacent "wires," and a blade adapted to pass into the loop portion to hold the remaining portion of the loop in place. The means which I employ preferably comprises a presser foot 22 adapted to hold one side of the base portion of the loop against the adjacent "wire" or plate 16' as shown in Fig. 3 of the drawings and a holding blade 24 which is forced downwardly into the last formed loop into the position previously occupied by the loop forming blade. In order to hold the remaining side of the base portion of the loop, a second presser foot 26 is provided which is moved downwardly to engage the portion of the loop above the "wire" 16'', whereby the last formed loop is held rigidly in place, permitting a new loop to be formed without disturbing the previously formed loops. In the formation of the new loop the loop forming blade 20 descends on the adjacent batt section between the "wires" 16' and 16'', forcing a portion of the batt in the form of a loop into the space between the adjacent spacing elements. In the loop-forming mechanisms as illustrated in Figs. 3 and 7 of the drawings, the holding blade is made integral with the presser foot or loop-holding means 26, although it is to be understood that these may be made separately and separately operated, if desired.

The presser feet 22 and 26, and loop-holding and loop-forming blades 24 and 20 are

preferably held in a frame 28, in which they are actuated by suitable means. In the form illustrated in Fig. 7 of the drawings the frame 28 is pivoted at 30 on a bracket 32, which may be attached or held in place in any suitable manner. In order to operate the mechanism, a cam 34, mounted in any suitable way, is operatively connected to the cylinder or drum 14 so as to be rotated in timed relation therewith. For this purpose, a gear 36 may be mounted on the cam shaft and a chain passing over the gear and connected to a corresponding gear mounted on the drum 14 may be used, although any other suitable driving means may be employed. Operatively connected to the cam 34 is a lever 40 which is pivoted at 42 on an arm 43 of the bracket 32, and is connected to the frame 28 by means of a pin and slot connection 48, 44, a slot 44 being formed in the arm 46 of the lever 40, and a pin 48 being connected to a sliding member 50, which is arranged to move in the frame 28 between guides 52 and 54. As shown in the drawings, the piling blade 20 is rigidly connected to the slidable member 50, and the presser foot 26 is mounted so as to be movable with respect to the member 50, being preferably held in spring-pressed engagement with a portion of the member by a spring 56, the presser foot 22 being similarly mounted with respect to the presser foot 26, being resiliently held by means of a spring 58 engaging a lug 60 on the auxiliary piling blade and adapted to force the presser foot 22 downwardly. A spring 62 is employed for forcing the pin 48 in a direction to move the piling mechanism forwardly when it is released from engagement with the last formed loop, so as to be in a position for forming the next or new loop in the batt when the drum and loop-forming mechanism have been brought into the required relative position for operation.

In the operation of the loop-forming mechanism, the presser foot 22 first descends on one side of the base portion of the loop which has just been formed and is held in pressure engagement by means of the spring 58 against the base portion of the loop above the "wire" 16'. After the presser foot 22 has been seated, the loop-holding blade 24 is forced downwardly in the space between the "wires" 16' and 16'' and between the sides of the loop therein until the blade reaches the extreme top or end portion thereof corresponding to the exposed end of the pile in the final product. At the same time that the blade 24 is moved into position, the presser foot 26, which is preferably integral therewith, moves into engagement with the other side of the base portion of the loop above the wire 16'', and is held in pressure engagement therewith by means of the spring member 56. In the subsequent

downward movement of the inserting or piling blade 20, which is actuated and moved into loop-forming position by the corresponding additional downward movement of the arm 46, being actuated by the cam 34 against the lever 40, and the pin 48 moving forwardly in the slot 44 compressing the spring 62 therein, the loop forming blade 20 is forced downwardly against the adjacent portion of the batt 10, dragging the batt portion into the space between adjacent "wires" 16'' and 16'''. (See corresponding "wires" of Fig. 3). During this movement it is apparent that the loop-forming blade 20 will stretch the material and pass over substantially one-half the length of a loop section, the loop being also dragged over the edge of the "wire" 16''', whereby the fibres are dragged more or less into parallelism, in a direction corresponding to the original longitudinal direction of the batt, or in other words at right angles to the exposed surface of the batt at the base portion of the loops.

During the time that the loop is being formed, the cylinder or drum is preferably rotated at a constant speed, and the pile forming elements and holding means for the loops move around the pivot 30, remaining in contact with the spacing elements or "wires" until the cam 34 is rotated into the position in which the lever 40 is released, the lever 46 being then returned or moved upwardly in a clockwise direction around the pivot 42 by means of the spring 47 to its original position, thus raising the part 50 in its guides 52 and 54 and withdrawing the loop forming elements out of contact with the batt, into the position shown in Fig. 7 of the drawings. In the withdrawing operation, the loop forming blade 20 is first withdrawn, then the presser foot 26 is released, and the blade 24 is raised from between the sides of the loop, and finally the presser foot 22 is moved out of engagement with the other side of the base of the loop. As soon as the presser foot 22 is moved out of engagement with the batt, the spring 62 operates to return the pin 48, in the slot 44, into its original or initial position, moving the operative portion of the mechanism into its original position as above explained, so as to be ready to form the new loop in the batt when the cam 34 operates again to bring the loop-forming mechanism into engagement with the batt.

After forming the looped or folded portions in the batt, in the spaces between the "wires" of the drum 14, in the manner described, a cement coating is applied to the exposed surface of the batt so as to form a continuous even coating as indicated for example, at 65, in Fig. 7 of the drawings. The coating of cement material may be applied by means of a roller 64, which is fed

preferably with a solution or dispersion of vulcanizable rubber cement 65' from a tank 66. It is to be understood, however, that the cementing material may be spread onto the base of the loops by means of a scraper, or a brush, or by other means, to obtain a uniform surface. By the use of a solvent material or dispersing medium, the rubber cement penetrates to a certain extent into the base of the fibres thus embedding not only the outer exposed surface of the batt, but also the inner or interior fibres in the base portion of the loops. The amount of rubber cement employed and the fluidity of the rubber solution should be controlled so as to prevent penetration to a depth beyond the curved portion of the fibres, so as to attain a maximum binding action with a minimum amount of rubber solution. By the use of a minimum amount of rubber solution the fibre portions of the loops upstanding from the base will contain substantially no cement material, and after the rubber cement material has been vulcanized and the finishing operations have been completed, the upstanding pile in the final cemented pile fabric product will be substantially free from adhering cement portions, the cement coating forming substantially an even layer over the backing material. After the rubber cement coating has been applied to the base of the loop sections, the solvent or dispersing medium in the coating is preferably removed by means of blasts of air, which may be heated if desired, from one or more nozzles 70. In order to assist in the removal of excess solvent or dispersing medium, a heating means, such as hot air jets 68 may be applied to the interior of the drum. After the rubber cement coating has been dried sufficiently a suitable textile fabric, or other flexible backing material, is applied to the cemented surface of the folded or looped batt. I preferably employ for this purpose a burlap or other cheap textile material, although other more expensive fabrics or other suitable backing material may be used, the choice of material depending on the purpose for which the resultant product is to be used, as will be apparent to those skilled in the art. If an upholstery material is to be formed, for example, I preferably employ a fine canvas or linen, and the fibres which are used in this case should be correspondingly of fine quality. The material 72 to be used as a backing is preferably first coated with a thin coating 73 of a vulcanizable rubber cement material, which is preferably similar to the coating employed for coating the exposed surface 65 of the looped batt.

After the textile backing has been coated and suitably dried, it is united to the coated batt surface by passing it over a suitable roller 78 into pressure engagement with the

looped fibre surface and the cement material is then preferably vulcanized to form a substantially integral medium between the base of the fibres and the textile material applied thereto.

The step of vulcanizing may be carried out by the use of steam heated molds 80, 82 and 83 for example, and the vulcanizing process may be made a continuous one by means of the form of apparatus indicated in Fig. 7 of the drawings. This device comprises a weighted member 84 suspended on the axis of the cylinder or drum and having a center of gravity below the points or line of support at the axis of the drum. The molds or vulcanizing members 80, 82 and 83 are preferably applied to the uncoated surface of the flexible backing member 72, and, in order to apply the molds to the material with a suitable pressure during the vulcanizing step, a series of piston cylinder units 86, 88, which are spring actuated to apply pressure, are preferably employed, a pressure fluid being used for releasing the pressure and permitting return of the molds to the initial position after being moved through a predetermined distance in pressure contact with the drum.

The operation of the vulcanizing molds is substantially as follows:

After the molds have traveled in contact with the united backing and coated looped batt through a predetermined distance, which may be regulated as desired, depending upon the set of the ports 92 and 94, a pressure fluid from the central chamber 90 passes through the port 92 and through port 94 which is then in registration therewith, and passes through the passageway 96, for example, into the cylinder of the piston cylinder unit 86, and exerts a pressure on the cylinder head against the spring 87 whereby the mold 80 is released from pressure engagement with the corresponding surface of the product. In a similar way, the molds 82 and 83 are released simultaneously with the release of the mold 80, and the center of gravity of the element 84, to which the molds and cylinder units are attached, having been displaced to the right during the counter clockwise rotation of the drum, the weight element 84 returns to the position shown in Fig. 7 of the drawings, in which the center of gravity of the combined elements is directly below the axis of the drum. When this position is reached, the pressure fluid in the cylinders exhausts into the chamber 98 through the passage 100, and the molds 80, 82 and 83 are then again brought into pressure contact with the surface of the drum by means of the springs 87, 89, and the corresponding spring forcing the mold 83 to the surface of the drum. A new section of the coated material is thus brought under the vulcanizers, and the vulcanization

of the material then proceeds until the operation, as above described, is repeated, whereby the product is gradually fed around the cylinder or drum 14 in a continuous movement and is drawn out of the "wires" or chase continuously by a suitable mechanism.

Instead of completing the vulcanizing operation on the drum as has been described, it is apparent that the material might be vulcanized by giving it only a set-up cure on the drum and thereafter completing the cure by passing it in the form of festoons through a heated chamber, although the method which has been above described is preferable in most cases.

Before being drawn out of the chase, the material on the drum is preferably cooled by means of a cold air blast or other suitable cooling means 102, the material being then stripped from the chase by passing over a roller 104 or other suitable means, into engagement with a shearing device or cutter 106 for cutting the exposed tops of the loops, thus releasing the individual fibres in the material and producing a pile surface. Thereafter the material may be steamed if desired, and is then preferably tigered by means of a brush 108 to remove dead stock or loose fibres and to straighten the fibres of the pile. The material is then put through a finishing operation including a re-shearing of the pile by means of a cutter or shearing device 110 to produce a uniform height, or level pile surface, and thereafter the material may be brushed or cleaned and rolled or cut into any desired lengths.

The sequence of steps of my method, as indicated in the flow chart of Fig. 8, and the manner in which the pile fabric product may be made having now been disclosed, the preferred form of mechanism, hereinafter claimed, for performing the looping operation may now be fully described.

The essential elements of the preferred form of piling or loop-forming mechanism is shown in Fig. 3 of the drawings as comprising a straight chase 11, in place of a curved or cylindrical chase, shown in Fig. 7, and a reciprocating loop-forming blade and loop-holding means operated through a fly-wheel and connecting rod, the loop-forming elements being moved with the chase during the loop-forming operation, and thereafter returned into a position to form the next successive loop. In this form of looping machine the chase is preferably moved in a linear path by means of a screw which is operatively connected to the chase, and may be rotated or operated in any suitable manner. The piling or loop-forming elements may be operated so as to successively bring the loop-forming elements into the desired relative positions with respect to the "wires" or separators of the chase to attain

successive looping action which may be accomplished, for example, by means of a cam action in a manner to be described.

Referring more in detail to the drawings illustrating the preferred form of the loop-forming machine, the numeral 13 indicates the mechanism heretofore referred to as a piling mechanism which comprises the essential loop-forming elements of the device and is preferably slidably mounted on stationary rods or support shafts 63 as shown more particularly in Figs. 10 and 11. This mechanism may be driven from any suitable source of power such as a motor 112 which may be connected to a drive pulley 114 associated with the piling mechanism, through suitable reduction gears or pulleys. I preferably connect the drive pulley 116 of the motor 112 with another larger pulley 118 by means of a belt 120, the pulley 118 being mounted on a shaft 122, on which a smaller pulley 124 is also fixed, so as to rotate with the larger pulley, the smaller pulley 124 being connected by means of a belt drive 126, to the pulley 114 through which power is transmitted to provide the desired relative movement of the chase and piling mechanism, and the operation of the loop-forming elements. The pulley 114 may be keyed or otherwise fixed to a shaft 128, mounted in bearings 130 and 132 in the frame of the machine, a gear 134 being also mounted on the shaft and preferably keyed thereto. The gear 134 meshes with a driven gear 136, mounted on a shaft 138, to which it is keyed or otherwise fixed, the shaft 138 being suitably mounted in the framework of the machine in bearings 140 and 142, as shown more particularly in Fig. 12 of the drawings. The shaft may be held in place so as to prevent longitudinal movement thereof by means of lugs or sleeves 144, 146, which may be connected to the shaft by means of set screws, for example, permitting the parts to be readily disconnected if desired. The abutting sleeve 146 may be integrally connected with the gear 136 so as to form a rigid connection, or any other suitable form of construction may be used by means of which the gear 136 will be rigidly connected to the shaft 138.

In order to provide a construction in which the chase containing the "wires" or separators is to be moved with respect to a relatively stationary piling mechanism, the chase 11 is preferably fixed in a carriage 148, which in turn is slidably mounted on ways 150 and 152, a worm drive being preferably employed for moving the carriage along the ways. A thread 154 may be formed on the shaft 138, the screw-threaded portion of the shaft being adapted to engage a screw-threaded lug member 156 on the carriage 148, whereby a positive uniform movement of the carriage and chase through the desired distance, corresponding to the desired

length of the finished pile fabric, may be attained.

Any suitable means may be employed for automatically stopping the carriage at the ends of its path of travel as will be apparent to those skilled in the art. I may, for example, terminate the screw-threads of the worm near the ends of the shaft, as indicated in Fig. 12 of the drawings, and a tripping means may be used in connection with the carriage for shifting the belt 126 to an idler, or means may be employed for automatically cutting off power from the motor.

In the preferred construction of my invention, the carriage is given a uniform continuous movement through its path of travel and I provide means whereby the piling or loop-forming mechanism may be operated during the time that the carriage or chase is in motion, or more specifically, I preferably provide means for moving the piling mechanism uniformly with the chase while the loop-forming mechanism is in operation in contact with the batt and for returning the mechanism after the loop has been formed to its original position in readiness to perform the next looping operation. The means provided for attaining the desired forward and return motion of the piling mechanism to coincide with the movement of the carriage during the loop-forming operation, comprises two cams 160 and 162, having cam grooves 164 and 166 therein respectively, which are preferably mounted on the shaft 158, and serve to actuate two rods 168 and 170 to which the frame of the piling mechanism 13 may be connected, the rods being pivoted at fixed points, such as 172 and 174 on the frame 176 of the machine, for example. The rods may be pivotally mounted on the frame by means of set screws 178 and 180 and are preferably connected by means of a bar 182 to attain a rigid construction, the rods being operated together by means of roller 184 connected to the outer ends of the rods and running in the grooves 164 and 166. The rods 168 and 170 are preferably connected at intermediate points 188 and 190, on the rods, to the frame 13 by means of connecting rods 192 and 194, respectively, by means of which the frame 13 containing the piling or loop-forming element is moved or reciprocated on the rods or support shafts 63 with the reciprocatory movements of the rod members 168 and 170, controlled by the form of the cam grooves 164 and 166.

It will be clear, therefore, that as the carriage containing the chase or form 11 is moved uniformly along the ways 150 and 152 by means of the screw-threaded lug 156 connected thereto, which is engaged by the rotating screw member 154, the piling mechanism 13 will be moved forward at the same rate, during the folding operation, by means

of the corresponding movement of the cams 160 and 162, the rods 168 and 170 being actuated by the movement of the cam members, and the path of the grooves 164 and 166 in the cams being properly designed to attain the desired movement, the mechanism being then brought back transversely of the spacing elements or "wires" 16 to its initial position relative to the stationary frame member 176. In other words, the piling blade 20 and associated means for holding the batt or material while the loops are formed therein, will be uniformly moved the same distance as the chase 11 while a loop is being formed, and as soon as the folding mechanism is released or raised from the batt 10, or from between the separators of the chase 11, the mechanism 13 will be returned to its initial position through movement of the rods 192 and 194, actuated by the rods 168 and 170 through the corresponding movement of the rollers 184 and 186 in the grooves 164 and 166 of the cams.

In order to attain reciprocating movement of the folding blade 20 and the loop-holding elements connected therewith, the shaft 158 may be driven from the shaft 128 by means of a chain and sprocket connection, for example, or by any other suitable driving means by which the loop-forming operation of the folding mechanism may be maintained in synchronism with its forward and return movement, above described. The reciprocatory movement of the piling mechanism may be obtained by the movement of the blades and presser feet in guides, being connected to fly-wheels 204 and 206 by means of connecting rods 208 and 210. The fly-wheels 204 and 206 are preferably mounted on the shaft 158 which is preferably driven from the shaft 128. A sprocket 196 may be mounted on the shaft 128 by means of any suitable form of connection such, for example, as a release coupling 198, and is connected to a sprocket wheel 202 on the shaft 158 by means of a chain 200, whereby when the shaft 128 is rotated by means of the drive pulley 114, the rotary movement is transmitted to shaft 158 on which fly-wheels 204 and 206 are also mounted, these fly-wheels being preferably mounted on the ends of the shaft as shown in the drawings. The fly-wheels 204 and 206 are preferably connected by means of the connecting rods 208 and 210 to brackets or extension members 212 and 214, respectively, which are directly connected to a piling plate 216 on which the piling mechanism or loop-forming elements are mounted. The piling plate as shown in Figs. 11 and 12 of the drawings may be slidably mounted between guide members 218 and 220, so as to be accurately guided into the spaces between the "wires" or separator plates of the chase when the

chase has been previously adjusted in position. Suitable brace members 222 and 224 (see Fig. 12) having arms 226, 228, and 230, 232 may be suitably attached to the guide members at the sides of the piling mechanism so as to form a more rigid construction.

If desired, means may be provided for holding one or more of the separators or "wires" rigid during the loop-forming operation, so as to prevent undue flexing or bending of the spacing elements while the loop material is being forced into the spaces between them. For this purpose I preferably employ a rigid bar having a curved edge over which the batt may readily pass during the operation of the machine, the bar being preferably held against the separator by means of two arms or fingers, one located on each side of the machine and pivoted to the frame of the piling mechanism. The ends of the fingers or arms holding the bar are preferably rigidly connected thereto in a manner so that when the bar is brought against a separator to be supported during the loop-forming operation, the portion of the bar in contact therewith will lie flat against the upper edge of the separator which is the portion subjected to the greatest strain. A cam may be employed for lifting the arms while the piling head or frame is moved into position for the next loop-forming operation so as to prevent the bar from being caught by the separator over which it passes. By having the arms or bar operating members pivoted to the frame of the piling mechanism, the bar will be moved forward therewith during the loop-forming operation, in which the mechanism moves forward at the same rate as the spacing elements or "wires", and the bar will be lifted thereafter and then returned with the piling mechanism a distance corresponding to the distance between the center lines of the "wires", so as to be in a position to engage the next separator to be supported during the next loop-forming operation. The bar and holding fingers have not been shown in the drawings in order to avoid unduly complicating the illustration of the invention, but the manner in which this device may be applied will be apparent to those skilled in the art, and it is obvious that the supporting means for the separators or "wires" may be varied in any suitable way to accomplish the desired result, and furthermore, that the supporting means may be entirely omitted if desired, by having the separators sufficiently strong to withstand the pressures or strains to which they are subjected during the loop-forming operation.

The mode of operation of the preferred form of the loop-forming machine, which is

shown more particularly in Figs. 9 to 14 inclusive, is as follows:

Assuming that a carpet or rug of given dimensions is to be made, a chase or form 11, of a size preferably slightly greater than that of the rug to be made, is inserted in the carriage 148. The chase or form 11 may be held in the carriage by clamping means, for example, and a handle 234 may be attached to the chase to assist in inserting or removing the chase or form from the carriage, although for forms or chases of a large size automatic means may obviously be employed for the insertion and removal of the forms.

Referring more particularly to Fig. 12 of the drawings, the folding operation is initiated with the carriage 148 at the extreme left of the figure, and a batt 10 is drawn over the chase preferably overhanging the first wire as indicated in the drawings, the batt being fed from a chute 236 which is preferably attached to the carriage 148, although the chute may be suspended or positioned independently of the folding machine. In place of the chute feeding means, a conveyor belt may obviously be employed, if desired. When the machine is in readiness to be operated, the motor 112 is started, and the machine may then be put into operation by means of a belt shifter, for example, whereby the belt 126 is made to drive the pulley 114. By this means, the shaft 128 is caused to be rotated, and the carriage 148 is moved to the right along the ways 150 and 152 through the engagement of the gear 134 on the shaft 128 with the gear 136 on the shaft 138, the worm 154 thereon engaging the screw-threaded lug 156 which is attached to the carriage. Simultaneously, with the movement of the carriage along its ways, the piling mechanism 13 (see Fig. 10) is operated through the rotation of the gear or sprocket 196 on the shaft 128, the sprocket being connected through a chain drive 200 to a sprocket 202 on the shaft 158 (see Fig. 11) on which the fly-wheels operating the piling blade through connecting rods are mounted. The chain 200 engaging the sprocket 196 passes over an idler sprocket 238 (see Fig. 10) and from thence passes over the driven sprocket or gear 202 on the shaft 158 and then passes over a compensating device to hold the chain taut, which preferably comprises a movable gear wheel 240 connected to a bell crank lever 242 pivotally mounted on the frame of the machine by means of a screw 244, the arm 246 of the lever being connected by means of a spring 248 to the frame of the machine so as to hold the sprocket wheel 240 in pressure contact with the chain. Through the rotation of the shaft 158, by means of the chain drive above described, the fly wheels 204 and 206 are rotated and the connecting rods 208 and 210 attached thereto are simul-

taneously reciprocated, whereby the piling head 216 connected thereto is moved to and fro between the guide members 218 and 220, providing the desired movement of the piling blade 20 and the parts associated therewith. The guide members 218 and 220 may be slotted bars, for example, or, if desired, independently mounted members spaced apart the desired width may be employed to guide the piling head in its movement. Fig. 12 of the drawings shows the piling blade and associated loop-holding means in the position assumed when they are disengaged from the batt, or drawn out of contact with the "wires" 16. Fig. 14 shows, on the other hand, the position assumed by the looping elements during the folding operation when the blades are in their lower-most position, before being withdrawn from between the separators. The preferred arrangement for connecting the loop-forming and loop-holding blades and parts associated therewith is shown in Figs. 13 and 14 of the drawings. As the piling head 216 moves downwardly between the guide members 218 and 220, the presser foot 22 first moves into engagement with the base portion of a loop above a separator or "wire", such as 16' of Fig. 3, for example, the presser foot being held in pressure engagement by means of springs 58 (see Fig. 13). In the further downward movement of the piling head, the holding blade 24, which is preferably integrally attached to the presser foot 26, moves downwardly until it reaches the bottom portion of the last-formed loop, and the presser foot 26 simultaneously comes into engagement with the portion of the batt which is to form one side of the base portion of the new loop, whereby the folded or looped portion of the batt is rigidly held in position, permitting a new loop to be formed without displacing or disturbing those already formed between the separators. In the further downward movement of the piling head 216, the loop-forming blade 20 engages the batt and drags it into the space between the separating plates or "wires" corresponding to 16'' and 16''', (Fig. 3) the movement of the batt over the edge of the piling blade and its movement over the upper edge of the separator corresponding to 16''' serving to straighten the fibres, or in other words to lay the fibres to a greater or less extent in parallelism, so that the predominating direction of the fibres in the loop sections is in an up and down direction substantially at right angles with the plane of the base of the loops. In the foregoing description, the portion of the loop members which is in contact with the upper edge of the "wires" or, in other words, the portion which has been engaged by the presser feet, is referred to as the base portion of the loop sections, whereas the extreme lower portion of the

loop-members, or in other words, the portion which is projected furthest into the space between the "wires" is preferred to as the top portion of the loop-sections. It will be apparent that after a flexible backing member has been cemented to the base portion of the loop sections, and the resulting product is removed from the chase or form 11, the portion of the loop-sections referred to as the top portion becomes the top surface or exposed pile surface, which as above described in connection with Fig. 7 of the drawings, and indicated in the flow chart of Fig. 8, is to be sheared to form the finished pile surface of the rug or carpet.

During the time that the loop-forming operation is taking place, with the presser feet engaging the base portions of the loops and the holding blade engaging the last-formed loop between the separator plates, the chase or form 11 continues its movement to the right, with reference to Fig. 12, and the piling mechanism is simultaneously moved to the right, a distance corresponding to the distance between the centers of consecutive "wires", the movement of the piling mechanism being accomplished through the movement of the cams 160 and 162 (see Fig. 11) fixed on the shaft 158, the groove 164 and 166 in the cams serving to move the rods 168 and 170, which are pivoted on the frame of the machine at 172 and 174 respectively, and to which the frame of the piling mechanism is operatively connected through the pivoted arms 192 and 194. The grooves 164 and 166 of the cam members should obviously be so designed and the cams so mounted in the required relation as to produce the desired uniform movement of the frame of the piling mechanism transversely with respect to the spacing elements at exactly the required time to follow the chase during the loop-forming operation and to return the piling elements to their original position with respect to the frame of the machine after each loop has been formed.

The operation as above described continues in sequence until the chase or form 11, containing the separators or "wires" 16 has moved to the extreme right of the machine, referring again to Fig. 12 of the drawings, the machine being preferably automatically stopped by means of a tripping device on the carriage 148, the tripping device being operatively connected to the belt shifter, for example by means of which the movement of the chase and the associated mechanism above described will be arrested.

It is to be understood that instead of using a single chase or form as above described, I may employ means for feeding a series of chases into the machine, or I may employ a chain belt or endless conveyor having separators therein, operated by means of gears in any suitable manner to provide continu-

ous feeding of molds or forms for forming continuous loops. It will be apparent to those skilled in the art that if a series of forms or molds 11 are connected together in order to produce a substantially continuous operation, or if an endless conveyor having "wires" or separators therein similar to the "wires" 16 is used, the construction may be readily modified to attain the desired mode of operation in accordance with my invention, but it is to be understood that the essential elements of the mechanism as above described would remain substantially the same except for obvious changes such as may readily be made by those skilled in the art.

It will be also apparent that instead of continuously moving the form or chase 11 and maintaining the loop-forming elements substantially stationary relative to the frame of the machine, except for the movement to follow the chase during the loop-forming operation in the manner above described, the chase may be held stationary, in which case the loop-forming elements would be moved intermittently along the chase into the successive loop-forming positions as may be accomplished, for example, by connecting the worm 154 to a lug similar to the lug 156 but connected to the frame of the piling mechanism, and pivoting the rods 168, 170 and 192, 194 on an extension of the frame in which the piling blade and associated elements are movably held.

It is apparent also, that I might provide means for maintaining the piling mechanism entirely stationary relative to the main frame of the machine, and moving the chase relative to the piling mechanism only between successive looping operations, in order to accomplish the desired relative movement between the chase and the looping mechanism required for successive loop-forming operations. In the latter construction, however, the power required for stopping and starting the chase would be excessive except for machines of relatively small size, although this construction might be found to be preferable for machines adapted for forming small-size rugs, for example. It is to be understood, therefore, that while I preferably employ the form of mechanism which has been fully set forth in the foregoing description, and illustrated in detail in the drawings, I do not desire to be limited thereto, except as will appear from the annexed claims. It will be apparent, also, that the various features of the invention may readily be modified as will be apparent to those skilled in the art without departing from the spirit or scope of the invention as defined in the claims.

Having thus described my invention, what I claim is:

1. In a loop-forming machine, a form comprising a series of equally spaced spacing elements

fixed relative to each other, means for continuously and uniformly moving the said form through a predetermined rectilinear path, a loop-forming element for forming loops in a material to be operated upon, means for moving the said loop-forming element with the adjacent spacing elements along a portion of their path of movement during the loop-forming operation and for returning the said loop-forming element to its original position in readiness for the formation of the next loop.

2. In a loop-forming machine, a plurality of substantially equally spaced spacing elements, means for continuously and uniformly moving the spacing elements along a predetermined path, a loop-forming mechanism for forming loops in a material to be operated upon, and means for coordinating the movement of the loop-forming mechanism with the continuous movement of the said spacing elements to form a series of loops in said material.

3. In a loop-forming machine, a form having a series of spacing elements fixed therein, said spacing elements being arranged in substantial parallelism and substantially equally spaced, means for uniformly and continuously moving the said form through a predetermined rectilinear path, a loop-forming mechanism in relatively fixed position having a movable loop-forming element, means for successively moving the loop-forming element into and out of the spaces between the said spacing elements to form a series of loops in the material operated upon, means permitting movement of the said loop-forming element with the said spacing elements during loop-forming operations and for returning the said loop-forming element to its original position after each loop-forming operation.

4. In a machine of the kind described, a plurality of spacing elements, a loop-forming mechanism in relatively fixed position having a movable loop-forming element, means for uniformly and continuously moving the said spacing elements in a predetermined path for the formation of loops between the spacing elements in a material operated upon, means for periodically moving the said loop-forming element into the spaces between said spacing elements, means for positively moving the said loop-forming element with said spacing elements during the formation of each loop, means for withdrawing and returning the loop-forming element to its original position in the loop-forming mechanism after each loop-forming operation, a holding blade operative with said loop-forming element to hold a looped section of material in place during each loop-forming operation, and means for coordinating the operation of the loop-forming mechanism and operative parts thereof with

the movement of said spacing elements along the said path.

5 In a machine of the kind described, a form having a series of equally spaced separators therein, a loop-forming element for forming a series of loops between said separators, means for moving the said form in a rectilinear path with uniform continuous movement, co-ordinating means for periodically moving the said loop-forming element and said form relatively to each other to permit successive loop formation, means for maintaining the loop-forming element stationary relatively to the said separators during the formation of a loop, a holding blade and means for inserting the said blade into the last formed loop to hold the portion of the material, in which loops have been formed, immovable relatively to said separators while the portion in which the loop is being formed is moved by said element into place between said separators, thus forming the new loop.

6. In a machine of the class described, a plurality of spacing elements, a piling blade and operating means therefor for inserting material between the said spacing elements, a holding blade, means for moving the said holding blade into place between spacing elements in advance of the inserting operation of the said piling blade, a plurality of presser feet, and means for consecutively operating the said presser feet to hold the pile element material against adjacent spacing elements during the said inserting operation.

7. In a device of the kind described, a form having a series of fixed equally spaced separators therein; means for continuously and uniformly moving the said form along a predetermined path; a pile forming mechanism comprising means for holding material in which a loop is to be formed and means for forming a loop in each of the spaces between the separators; means for operating the loop-forming means cooperatively with the means for moving said form in order to form the said loops at predetermined positions in the said form corresponding to the spaces between the fixed separators; and means for moving the loop-forming means with the form during the formation of each loop and for returning the loop-forming means to its original position for the next loop-forming operation.

8. In a device of the kind described, a form having a series of fixed equally spaced separators therein; means for uniformly moving the said form along a predetermined linear path; a pile forming mechanism comprising means for holding material in which a loop is to be formed and means for forming a loop in each of the spaces between the separators; means for operating the loop-forming means cooperatively with

the form-moving means to permit forming the said loops at the predetermined positions between said separators, including means for moving the loop-forming means with the form during the formation of each loop and for returning the said loop-forming means to its original position in readiness for the next loop-forming operation; and means for automatically arresting the operation of the device when the desired loop-forming operation has been completed.

9. In a device of the kind described, a form having a series of fixed separators therein; means for moving the said form along a rectilinear path comprising a threaded shaft and cooperating connecting means connected to said form adapted to be moved by said threaded shaft; means for rotating said shaft by means of a gear connection; a loop-forming mechanism; a loop-forming means associated with said mechanism; means cooperating with said gear connection to move the loop-forming mechanism with said form during the formation of each loop in the material operated upon; and means cooperating with the said means for moving the loop-forming mechanism operating to move the loop-forming means successively into the spaces between said separators during the movement of the form.

10. In a device of the kind described, a series of fixed equally spaced separators, a carriage for moving the said separators along a rectilinear path; a piling head comprising means for forming loops in a material in the spaces between the said separators; a main shaft, means for driving said shaft, a threaded shaft operatively connected to said carriage to move said carriage with rotation of said threaded shaft; gear connections between said main shaft and said threaded shaft to drive said threaded shaft; an auxiliary shaft having a cam and eccentrically mounted means thereon for operating the said piling head; means connecting said main shaft with said auxiliary shaft for driving the said auxiliary shaft therefrom; means operatively connecting the said cam to a movable means pivotally connected at a stationary point, means for connecting the said piling mechanism to the said movable means so as to move the said piling mechanism in a predetermined path, dependent upon the form and movement of the said cam, the said cam being designed to produce uniform movement of said piling head with the said form during the loop-forming operation.

11. In a device of the kind described, a loop-forming means comprising a plurality of independently operated holding feet and a blade for holding the material in which loops are to be formed in position with relation to a form having separators therein, and a loop-forming blade for forcing a sec-

tion of the said material into spaces between the said separators to form a series of loops in the said material.

12. In a device of the kind described, a loop-forming means comprising a resiliently supported holding foot adapted to engage one side of the base of a loop section, a second resiliently supported holding foot adapted to engage the other side of the base of the said loop section, a resiliently supported holding blade between the holding feet adapted to be passed between the sides of the loop section to rigidly hold the loop in place, a piling blade adapted to form a new loop in the material operated upon while the said holding feet and holding blade are in engagement with a formed loop, and means for withdrawing the said piling blade from the newly formed loop before said presser feet and holding blade are released from engagement with the said loop section.

13. In a device of the kind described, a form having a series of fixed separators therein adapted to receive sections of a material operated upon in the spaces between the separators to form a series of loops, a loop-forming means adapted to cooperate with the said separators to form loop sections in said spaces, comprising a resiliently supported holding foot adapted to engage one side of the base of a newly formed loop, a resiliently supported holding blade adapted to be passed into the loop section of the newly formed loop after the said holding foot is in place on one side of the base portion of the loop, a second resiliently supported holding foot adapted to engage the other side of the base portion of the newly formed loop when the said holding blade is in place in said loop section, and a piling blade for forcing the material adjacent the newly formed loop section into the space adjacent the newly formed loop to form a new loop, and means for withdrawing the said piling blade before the said presser feet and holding blade are withdrawn from engagement with the said newly formed loop.

14. In a device of the kind described, a form having a series of fixed separators therein adapted to receive sections of a material operated upon in the spaces between the separators to form a series of loops, a loop-forming means adapted to cooperate with the said separators to form loop sections, comprising a resiliently supported holding foot adapted to engage one side of the base of the new-formed loop, a resiliently supported holding blade adapted to be passed into the loop section of the newly-formed loop after the said holding foot is in place on one side of the base portion of the loop, a second resiliently supported holding foot adapted to engage the other side of the base

portion of the newly-formed loop, when the said holding blade is in place in said loop section, a piling blade for forcing the material adjacent the newly-formed loop section into the space adjacent the newly-formed loop to form a new loop, means for withdrawing the said piling blade before the said holding feet and holding blade are withdrawn from engagement with the said newly-formed loop, means for withdrawing the holding feet and holding blade from engagement with the said newly-formed loop in the reverse order in which they engage the said newly-formed loop, and means for automatically relatively moving said holding feet, holding blade and piling blade a distance corresponding to the distance between the centers of the said separators, so that the holding feet then engage the base portions of the said new loop and the holding blade enters the loop section thereof, whereby the said piling blade will be in position to form the next loop section to be formed.

15. In a loop-forming machine, a form having a series of spacing elements fixed therein, said spacing elements being arranged in substantial parallelism and substantially equally spaced, means for uniformly and continuously moving the said form through a predetermined rectilinear path, a loop-forming mechanism in relatively fixed position having a movable loop-forming element, means for successively moving the loop-forming element into and out of the spaces between the said spacing elements to form a series of loops in the material operated upon, means permitting movement of the said loop-forming element with said form during the loop-forming operations and for returning the said loop-forming element to its original position after each loop-forming operation, and a holding blade adapted to be inserted in a formed loop for rigidly holding the loop section of the material in place while each succeeding loop is formed.

16. In a device of the kind described, a form having a series of fixed separators therein; means for moving the said form along a rectilinear path comprising a threaded shaft and means cooperating therewith connected to the said form adapted to be moved by said threaded shaft; a gear connection for rotating said shaft, a loop-forming mechanism comprising loop-forming means adapted to move into the spaces between the said separators; means cooperating with the said gear connection to move the said loop-forming means with the said form during the formation of each loop in a material operated upon and for returning the loop-forming means into position for forming the next loop to be made, and means cooperating with the said form moving means for moving the said loop-forming

means into and out of the spaces between the said separators.

17. In a machine of the character described, a plurality of spacing elements arranged in a plane surface, a loop-forming element having a limited forward and return movement transversely of said spacing elements, means for moving the said spacing elements, means for reciprocating the loop-forming element into the spaces between adjacent spacing elements for forming successive loops, means for coordinating the movement of the loop-forming element with the movement of the said spacing elements during the loop-forming movement, and means for automatically returning the loop-forming element between successive loop-forming movements.

18. In a machine of the character described, in combination, a form comprising spacing elements arranged in a flat surface, a loop-forming element, means for reciprocating the loop-forming element between the spacing elements for forming successive loops, means for causing the loop-forming element and spacing elements to travel along together during the loop-forming movement, and means for automatically effecting relative movement between the said spacing elements and the loop-forming element to attain the desired relative position of the parts for forming a new loop.

19. In a machine of the character described, a plurality of spacing elements arranged in a single plane, a loop-forming element, means for periodically moving the said loop-forming element and said spacing elements relative to each other to permit successive loop formation, means for automatically maintaining the loop-forming element stationary relative to the said spacing elements during the formation of a loop, means for positively moving the said spacing elements, and means cooperating with the last-named means for automatically moving the said loop-forming element transversely of the spacing elements between successive loop-forming movements.

20. In a machine of the kind described, a plurality of spacing elements, a loop-forming element, means for reciprocating the said loop-forming element into the spaces between adjacent spacing elements to form successive loops, means for positively moving the said loop-forming element to travel with the said spacing elements during the loop-forming movement and means for retaining the said loop-forming element in parallelism with the said spacing elements while it remains inserted between the two spacing elements.

21. In a machine of the character described, a plurality of spacing elements arranged in a single plane, a loop-forming element, means for reciprocating the said

loop-forming element into the spaces between adjacent spacing elements to form successive loops in a material operated upon, means for positively moving the said spacing elements in a rectilinear path, means for positively moving the said loop-forming element to travel with the said spacing elements during loop-forming movements, and means for bringing the said loop-forming element to its initial position after each movement of travel thereof with the spacing elements.

22. In a machine of the character described, in combination, a series of spacing elements mounted in fixed relative position with respect to each other, a loop-forming element, means for progressively moving the said loop-forming element into the spaces between adjacent spacing elements to form successive loops in a material operated upon, means for moving the said spacing elements in a rectilinear path, means for causing the said spacing elements and said loop-forming element to travel along together during each loop-forming movement, and means for periodically effecting relative longitudinal movement between said spacing elements and said loop-forming element to put them into the required relative position for the formation of a new loop.

23. In a machine of the kind described, a plurality of spacing elements arranged in a single plane in fixed relative position with respect to each other, means for bodily moving the said spacing elements in a rectilinear path, a loop-forming element having an inserting blade adapted for successively moving into the spaces between said spacing elements, means for causing the said loop-forming element to travel with the said spacing elements while the said blade remains inserted between two spacing elements, means for retaining the said blade in parallelism with the said spacing elements while it remains inserted between two spacing elements, and means for bringing the said loop-forming element and blade to their initial position after each movement of travel with the spacing elements.

24. In a machine of the character described, a loop-forming mechanism having an inserting blade, means for actuating the said loop-forming mechanism along a rectilinear path with a forward and return movement, and means for reciprocating the said blade through one complete cycle during the forward and return movement of the loop-forming mechanism along the said rectilinear path.

25. In a machine of the character described, a form having a series of equally spaced separators therein, a loop-forming element for inserting the material operated upon between said separators to form a series of loops, means for moving the said

form along ways in a longitudinal direction with uniform movement, means co-operating therewith for periodically moving the said loop-forming element into the spaces between the separators, means for maintaining the loop-forming element stationary relative to the said separators during the formation of each loop, and means for periodically moving the said loop-forming element transversely of the separators to place the loop-forming element in position for forming a new loop after each loop formation.

26. In a device of the kind described, a carriage having a series of equally spaced separators mounted therein, means for mounting the said carriage along ways to permit movement in a rectilinear path, means for uniformly moving the said carriage along said path, a loop-forming mechanism slidably mounted to move as a whole in a limited path of movement and an inserting means forming a part of said loop-forming mechanism, means for reciprocating the said inserting means into the spaces between said separators during the movement of said carriage along said rectilinear path, means co-ordinating the movement of said inserting means with the movement of said carriage so as to obtain travelling movement of the said loop-forming mechanism with said carriage during the inserting operation and to return the said loop-forming mechanism after each loop-forming operation into the position for forming a new loop, the said co-ordinating means being operative to successively repeat the travel of the loop-forming mechanism in its path of limited movement during the formation of the new loop.

27. In a machine of the character described, a part comprising a plurality of spacing elements arranged in parallel in a plane surface, a part comprising a loop-forming element adapted to co-operate with said spacing elements to form a series of loops in a material operated upon, means for automatically moving one of said parts relative to the other part so as to successively position the parts in the required relation for forming a series of loops in the said material, means dependently connected therewith for reciprocating the said loop-forming element into the spaces between the said spacing elements, means for co-ordinating the reciprocatory movements of the loop-forming element with the movement of one of said parts to permit forming a series of loops in the said material and means for inserting a holding means into the last formed loop during each loop-forming operation.

28. In a loop-forming machine, a plurality of substantially equally spaced spacing elements, means for moving the said spacing elements along a predetermined path, a loop-forming mechanism mounted independently

of the said spacing elements and adapted to be moved bodily during the loop-forming operation along the path of said spacing elements so as to be relatively stationary with respect thereto, during said loop-forming operation, an inserting means forming a part of said loop-forming mechanism for inserting material between the said spacing elements, and means for co-ordinating the movement of said inserting means with the movement of translation of said loop-forming mechanism and of said spacing elements to continuously form new loops during the movement of said spacing elements.

In testimony whereof, I affix my signature.

PAUL S. SMITH.

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