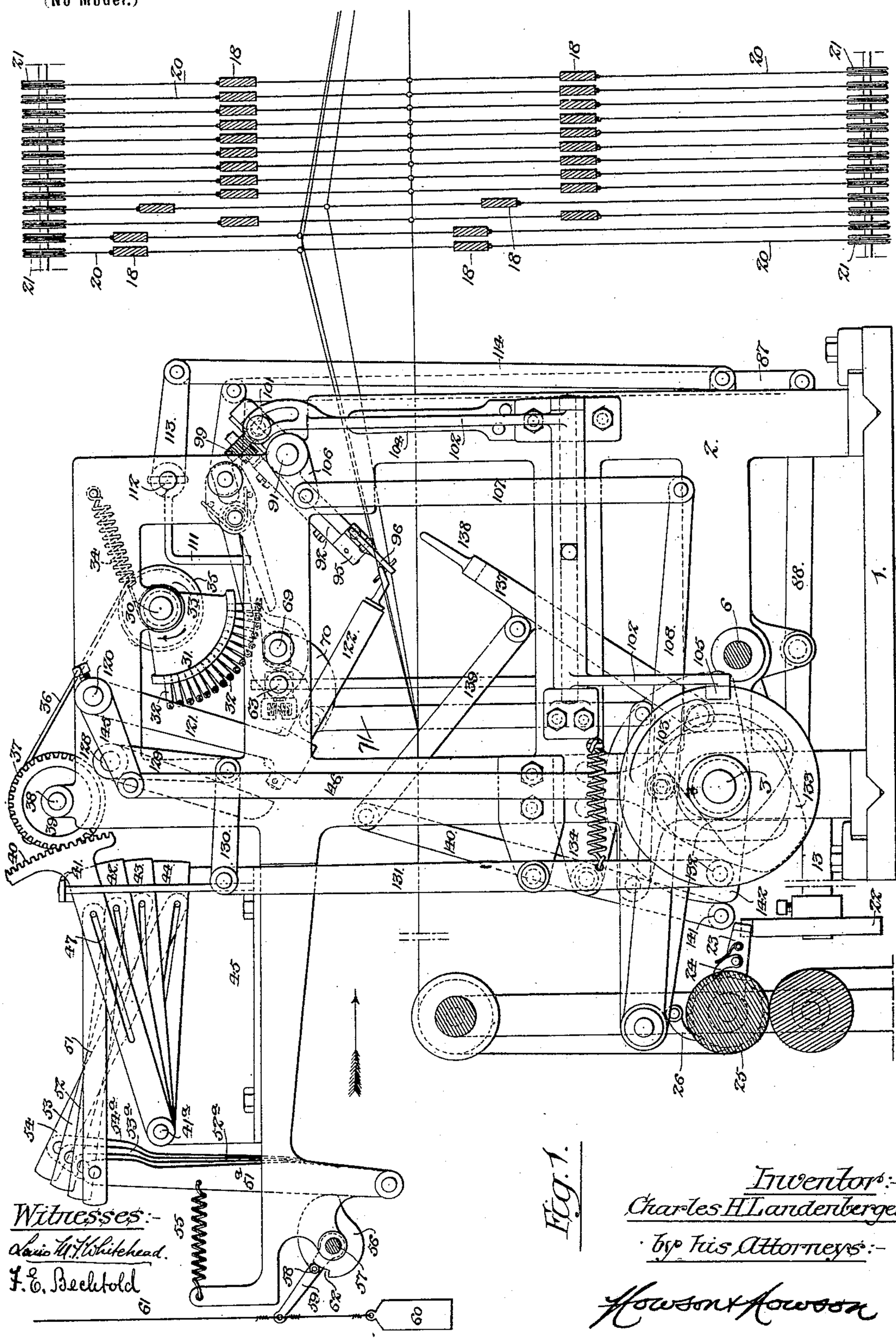
No. 706,072. Patented Aug. 5, 1902.

C. H. LANDENBERGER.

LOOM FOR WEAVING TUFTED PILE FABRICS.

(Application filed Mar. 2, 1899. Renewed Jan. 10, 1902.)

(No Model.) 8 Sheets—Sheet 1.



Witnesses:-
Louis M. Whitehead.
F. E. Beckhold

Fig. 1.

Inventor:-
Charles H. Landenberger
by his Attorneys:-
Howson & Howson

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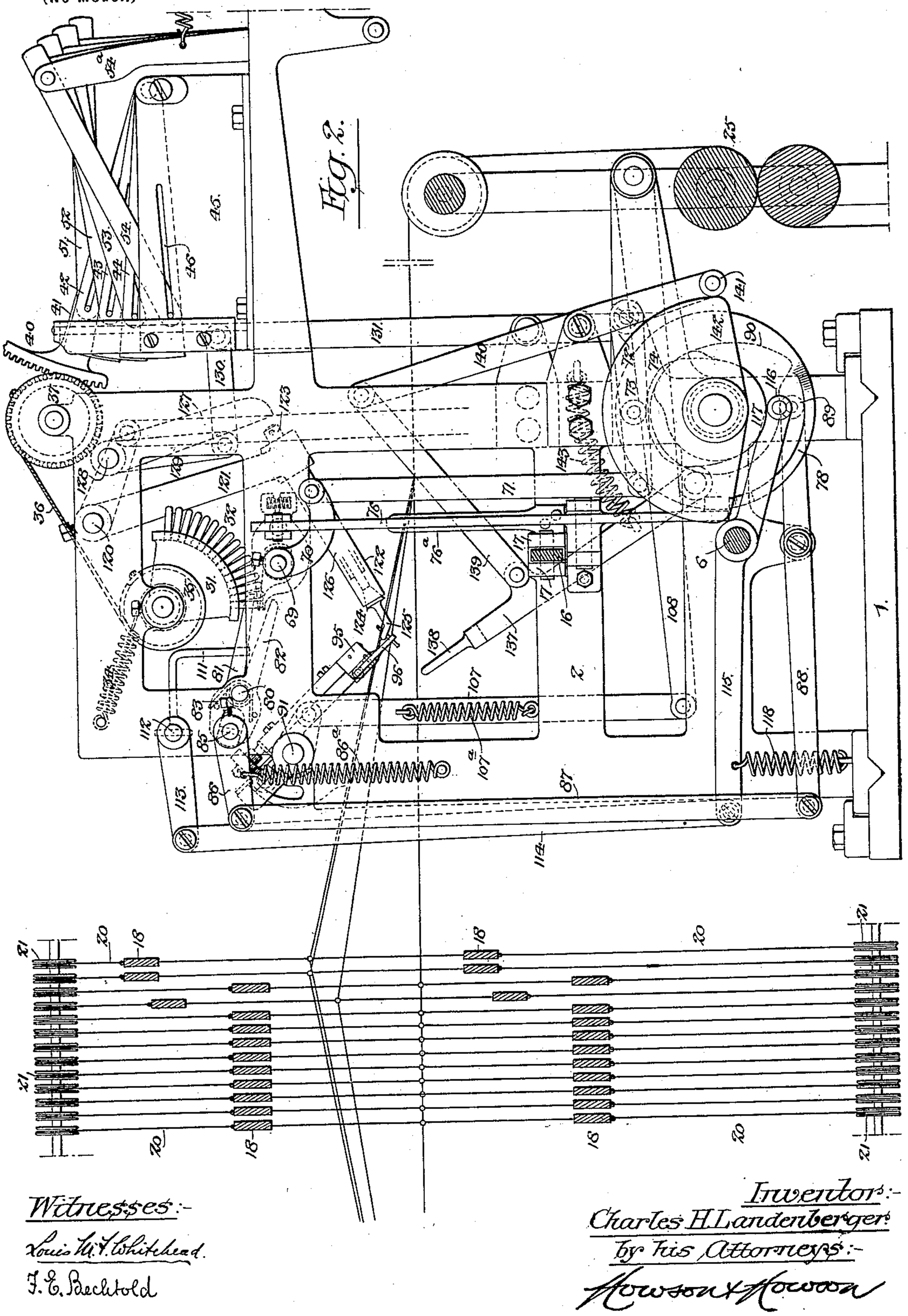
(No Model.) 8 Sheets—Sheet 2.

Fig. 2.



Witnesses:-
Louis M. T. Whitehead.
F. E. Beckstold

Inventor:-
Charles H. Landenberger
by His Attorneys:-
Howson & Howson

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(No Model.) 8 Sheets—Sheet 3.

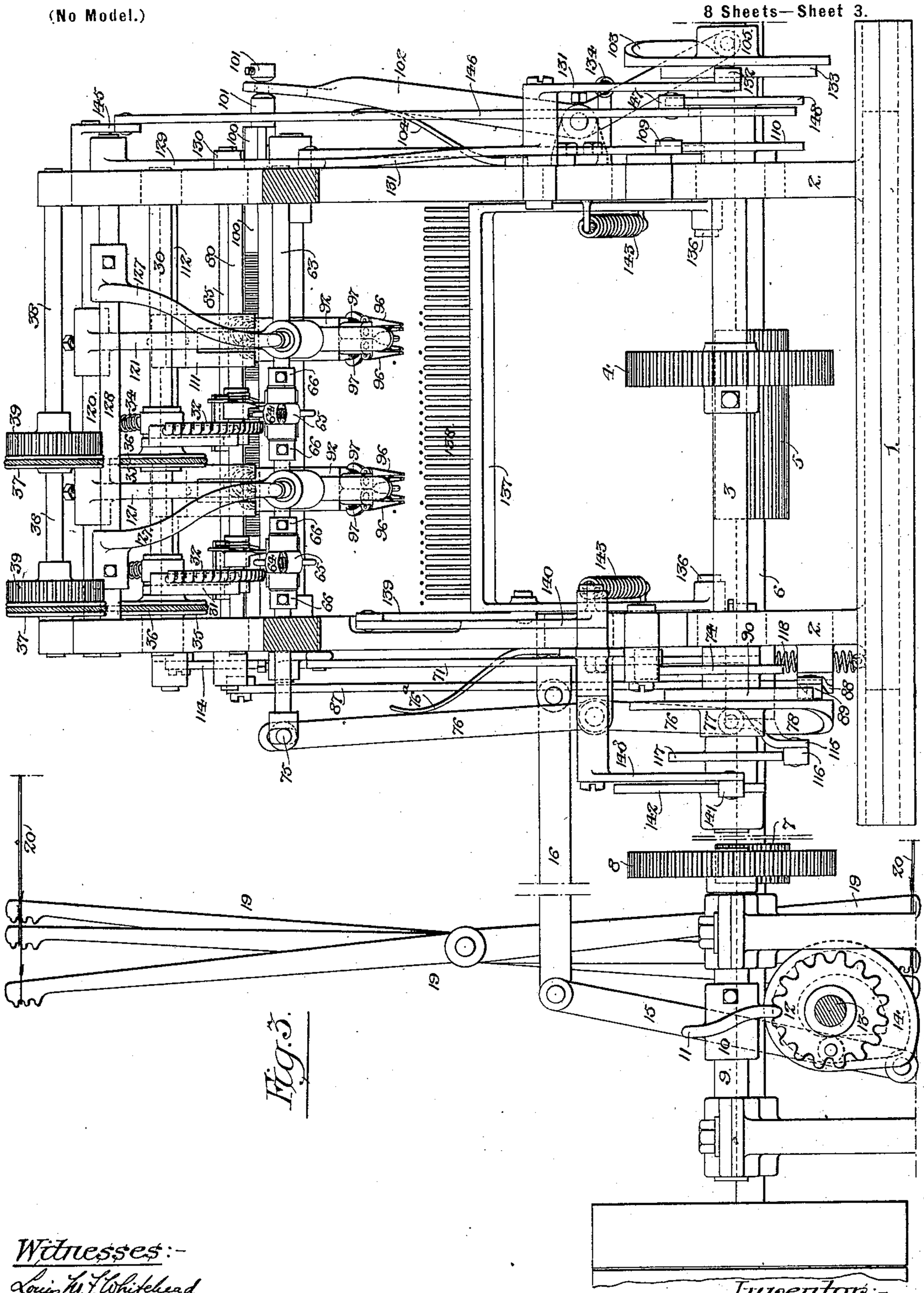

Fig. 3.

Witnesses:-
Louis M. T. Whitehead
F. E. Bechtold

Inventor:-
Charles H. Landenberger.-
by His Attorneys:- Howson & Howson

No. 706,072. Patented Aug. 5, 1902.

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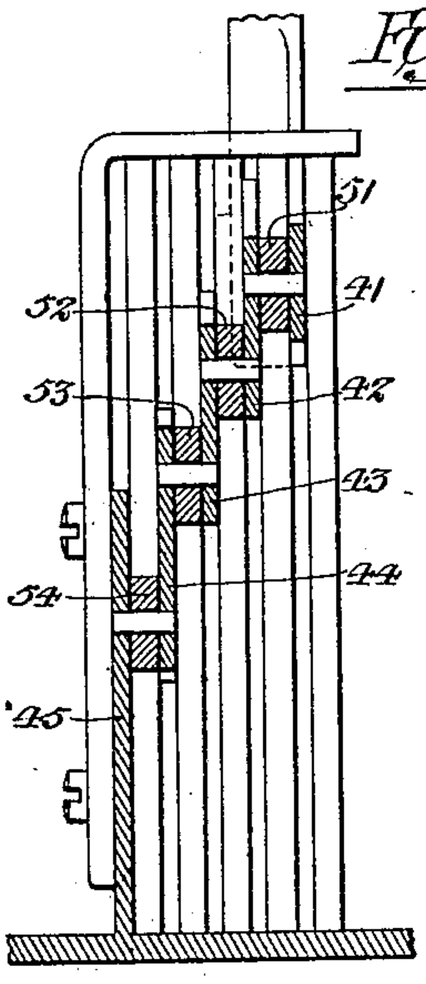
(No Model.) 8 Sheets—Sheet 4.

Fig. 4.



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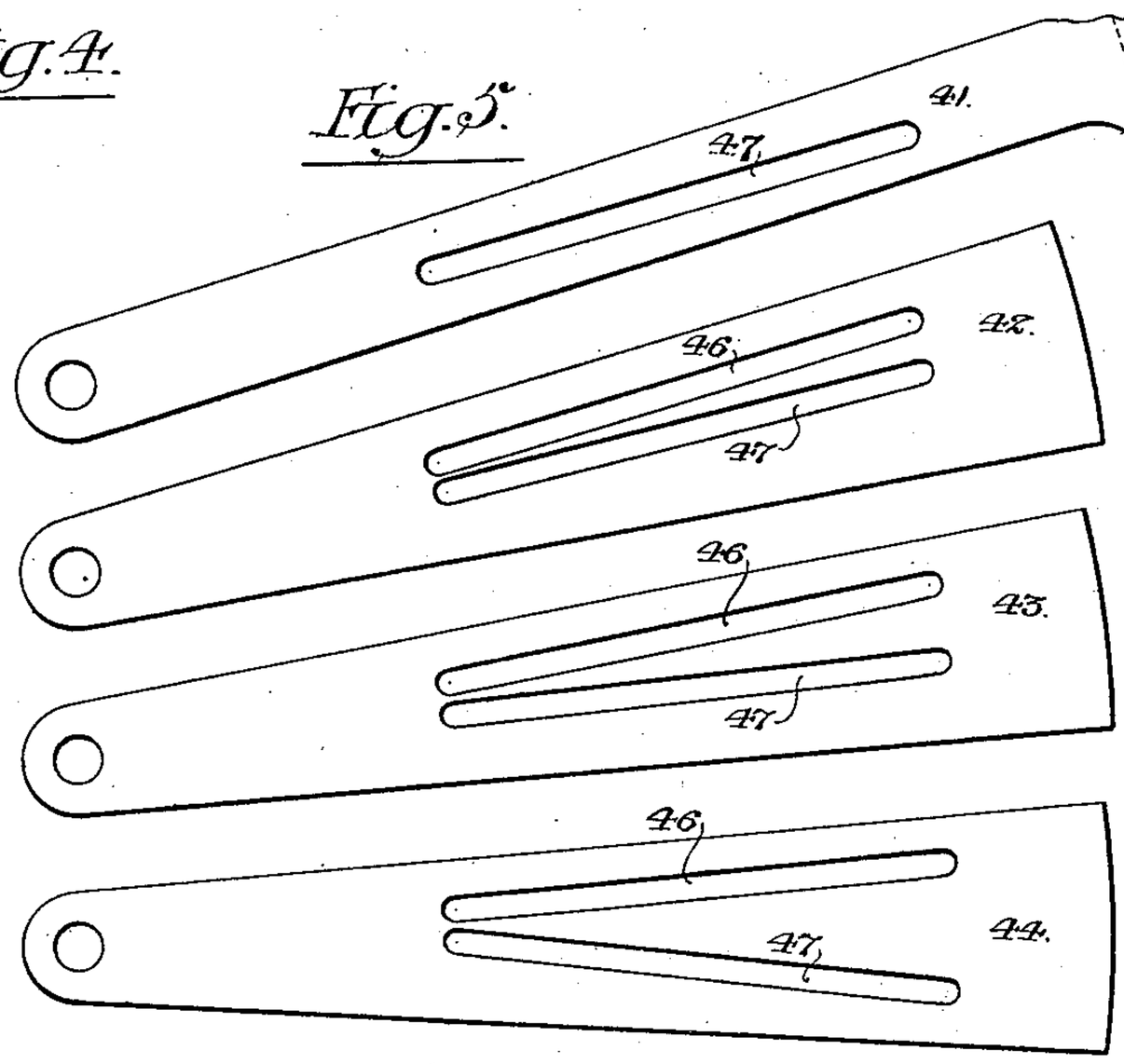

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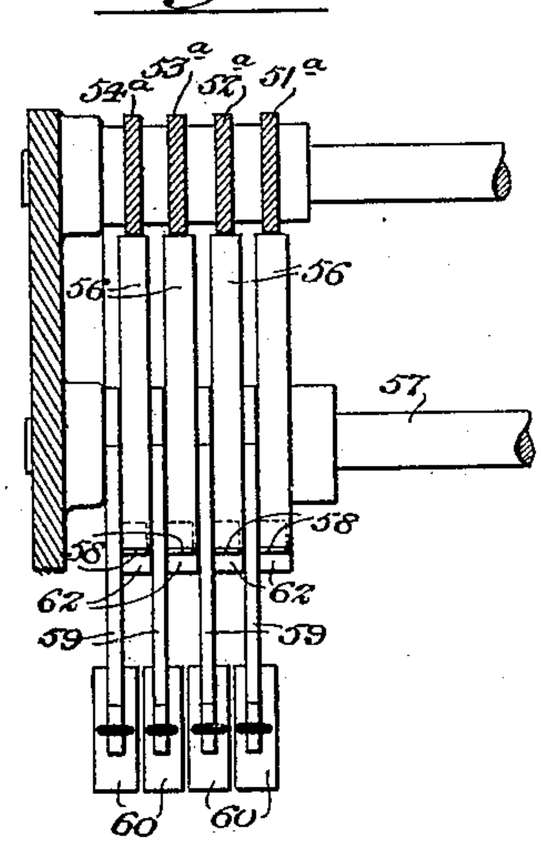

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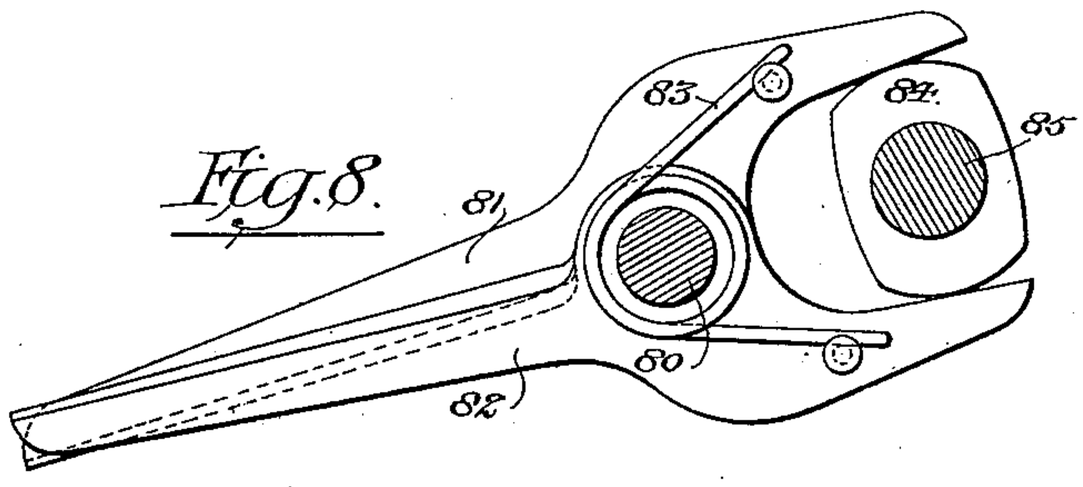

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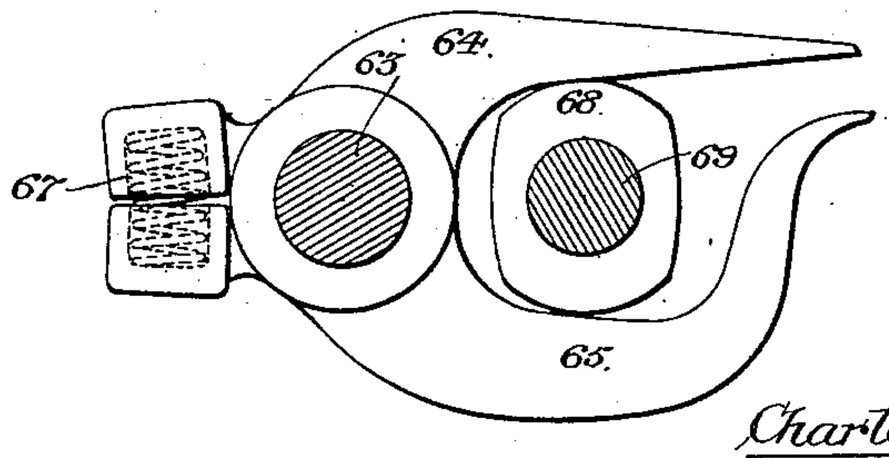

Witnesses:-
Louis M. T. Whitehead.
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Inventor:-
Charles H. Landenberger.
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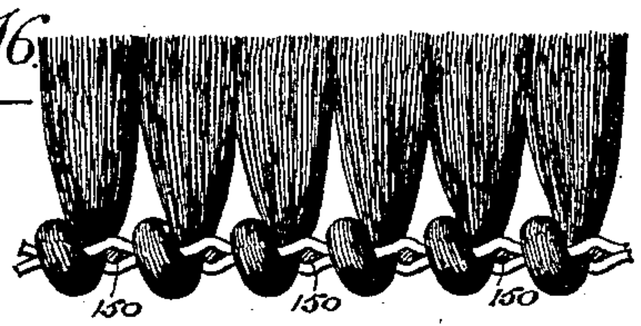
Fig. 16.



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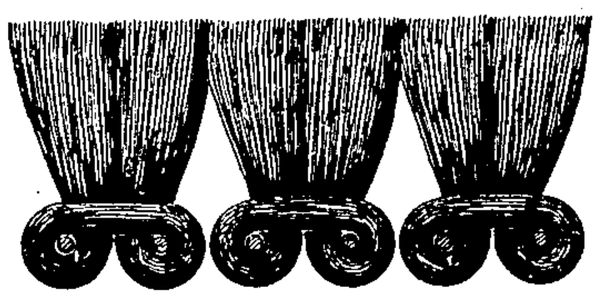

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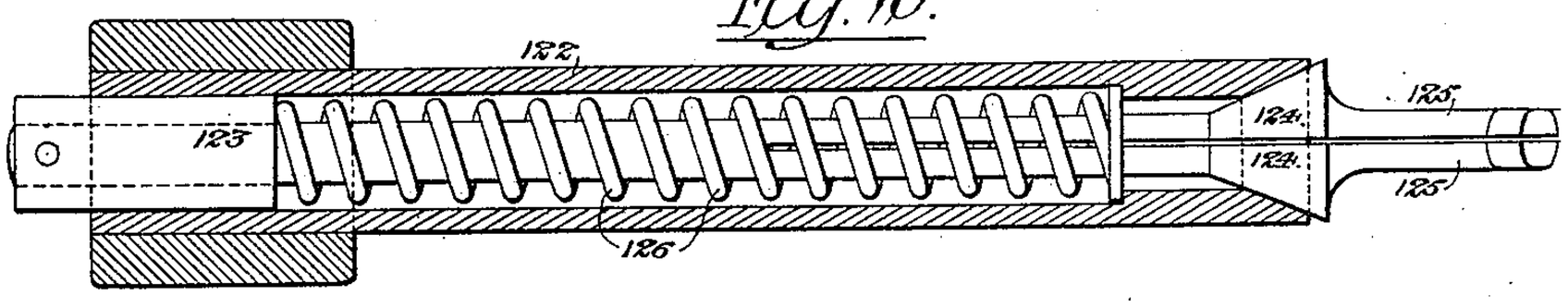

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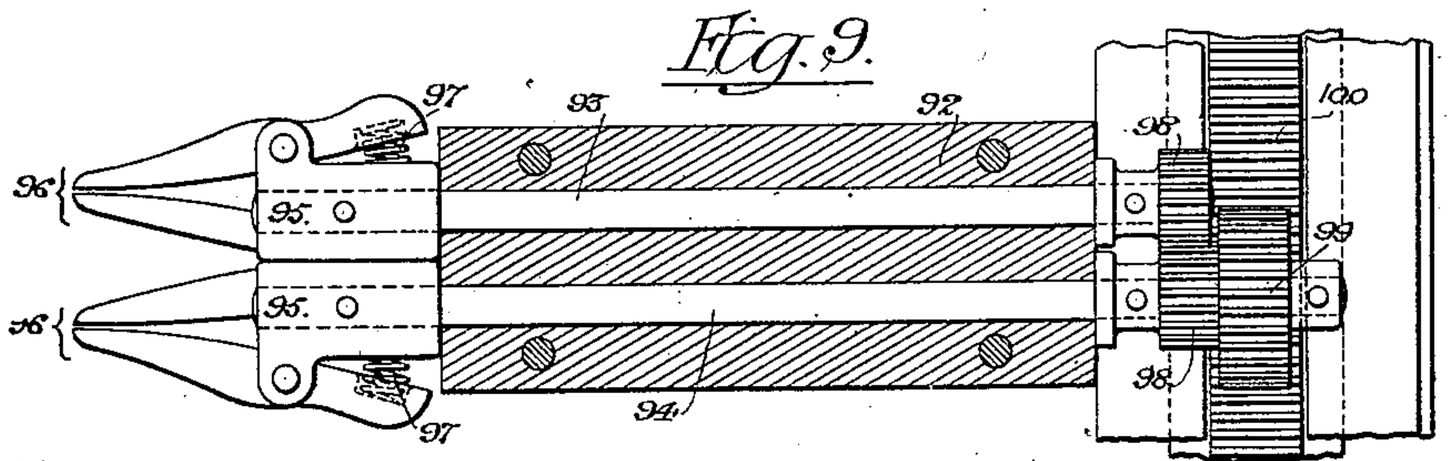

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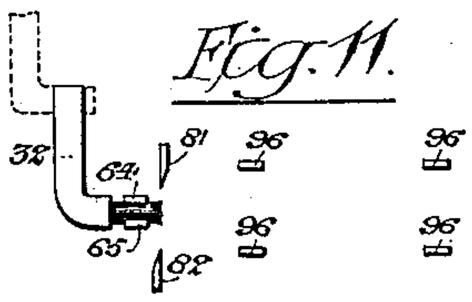

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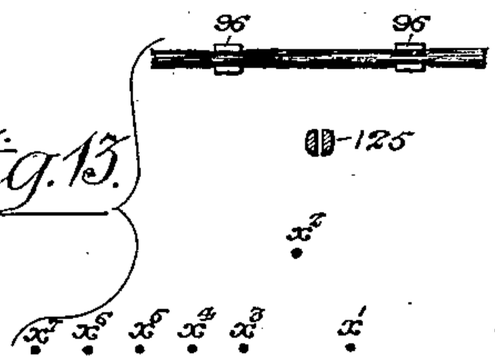
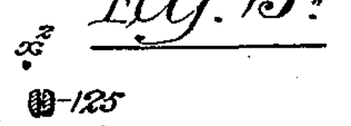


Fig. 15a.



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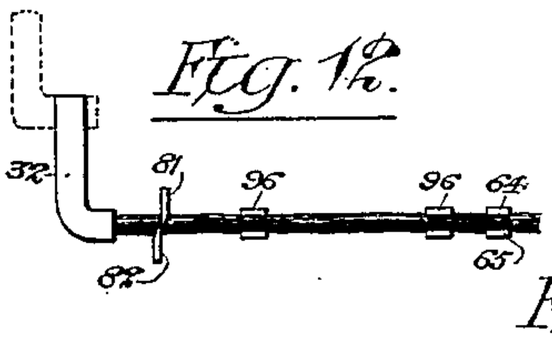


Fig. 13b.

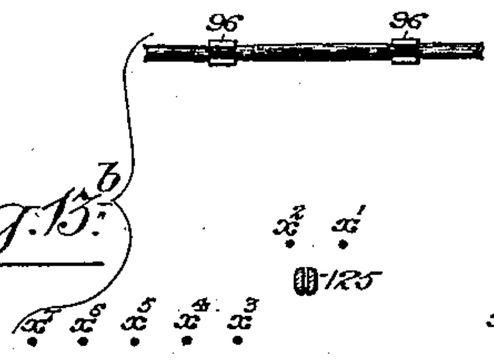
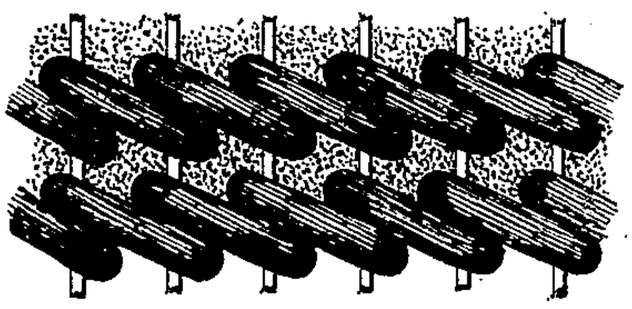


Fig. 15c.

Fig. 17a.



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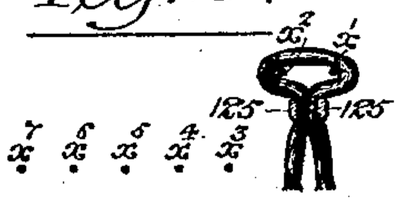

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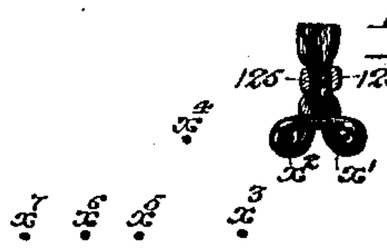

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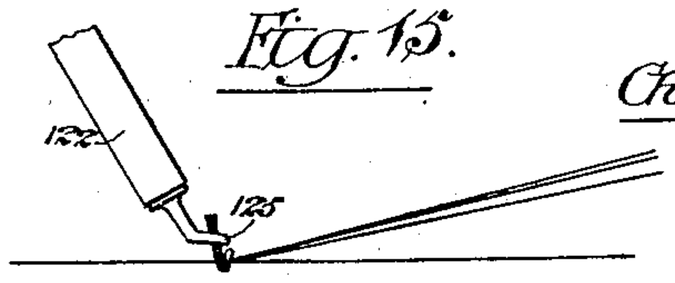

Witnesses:-
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Chas. De Cour.

Inventor:-
Charles H. Landenberger.
by His Attorneys:-
Howson & Howson

No. 706,072. Patented Aug. 5, 1902.

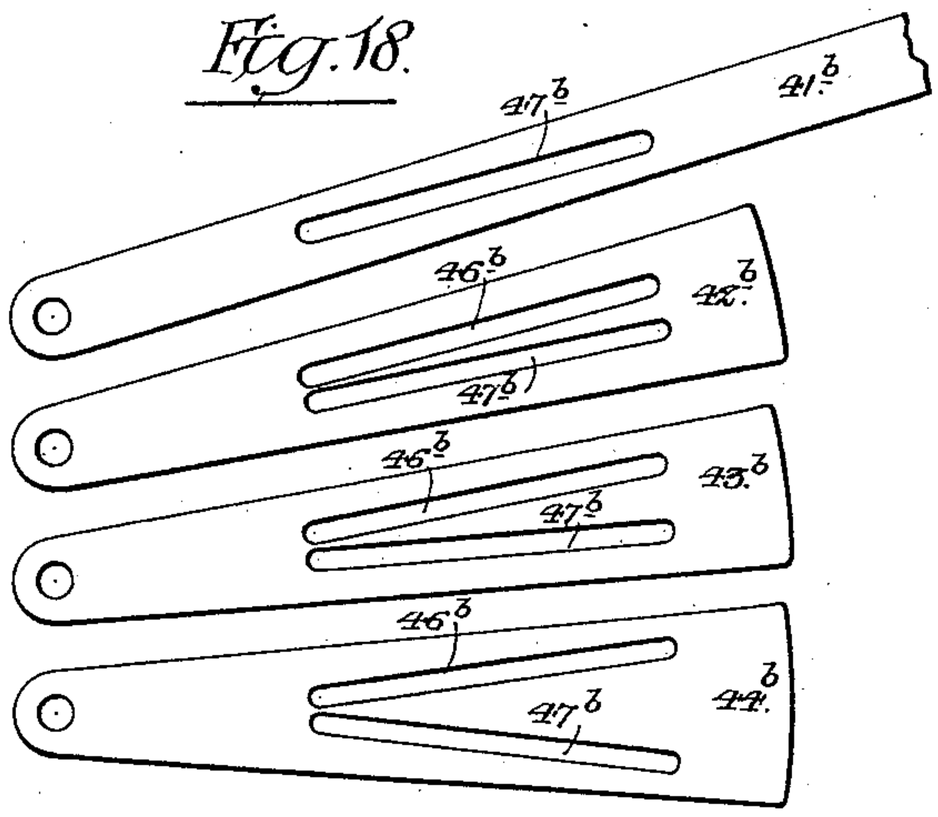
C. H. LANDENBERGER.

LOOM FOR WEAVING TUFTED PILE FABRICS.

(Application filed Mar. 2, 1899. Renewed Jan. 10, 1902.)

(No Model.) 8 Sheets—Sheet 6.

Fig. 18.



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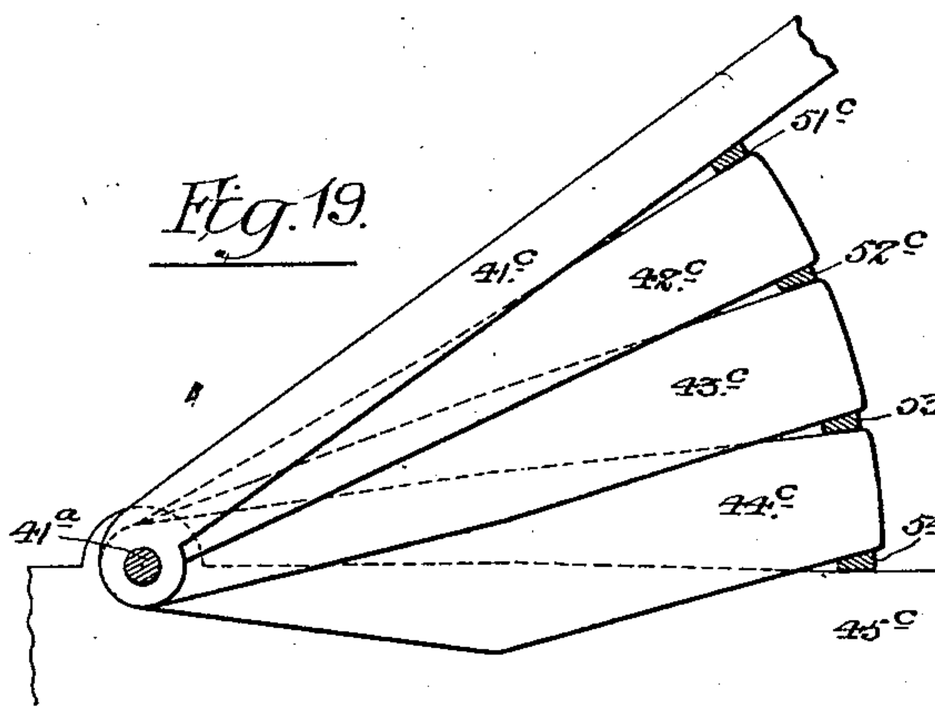

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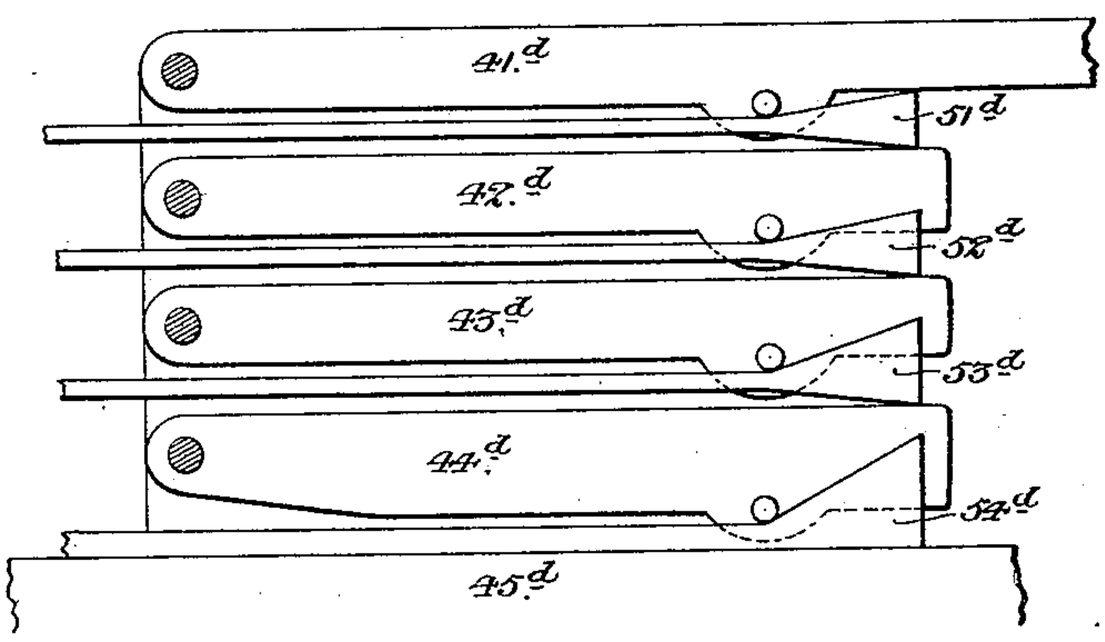

Witnesses:-
Louis H. V. Whitehead.
F. E. Beckitold

Inventor:
Charles H. Landenberger:-
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Howson & Howson

No. 706,072. Patented Aug. 5, 1902.

C. H. LANDENBERGER.

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(No Model.) 8 Sheets—Sheet 7.

19

Fig. 21.

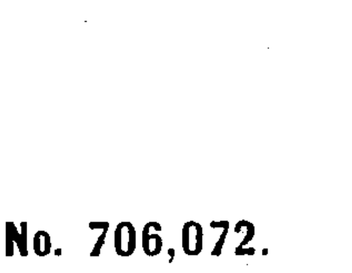
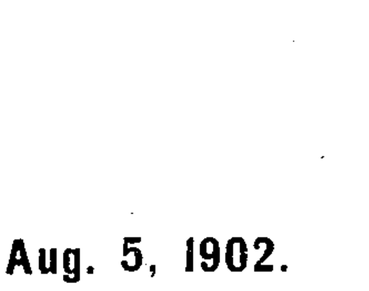


Fig. 22.

Fig. 23.

Fig. 24.



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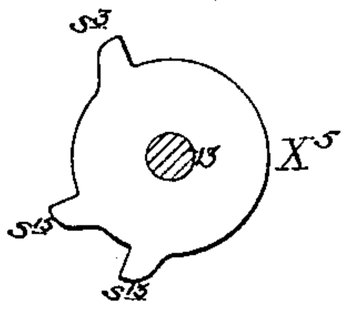

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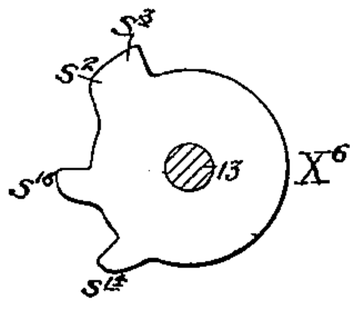

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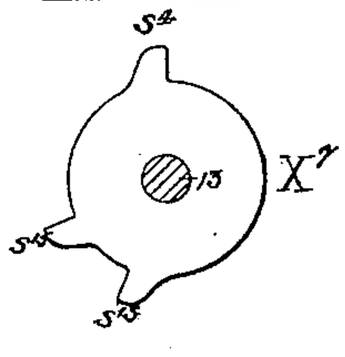

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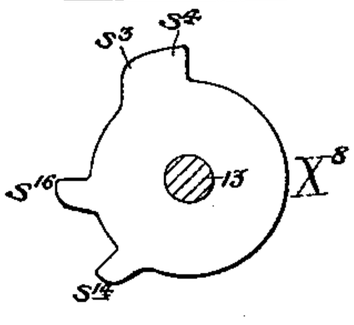

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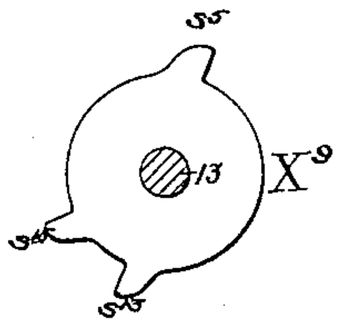

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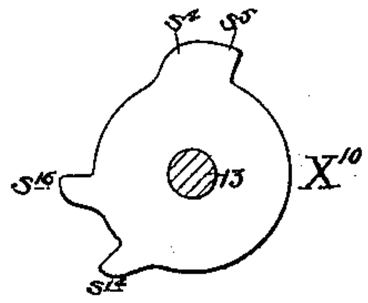

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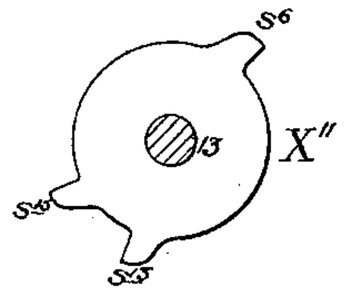

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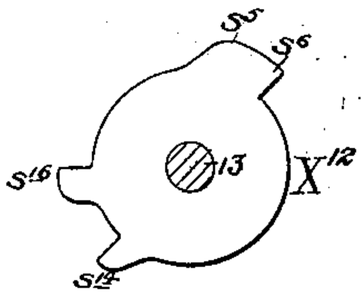

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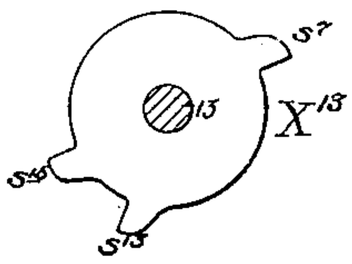

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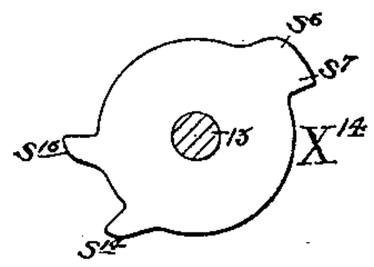

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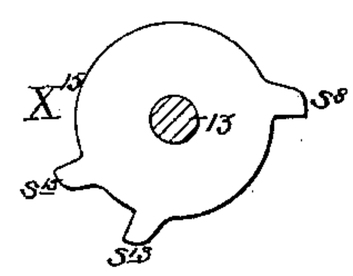

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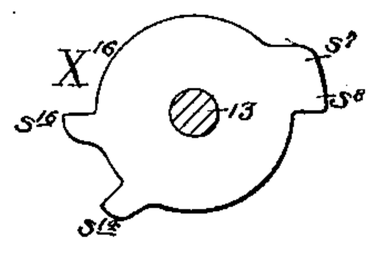

Witnesses:-
Herman E. Metius.
F. E. Beckbold

Inventor:-
Charles H. Landenberger,
by his Attorneys:
Howson & Howson

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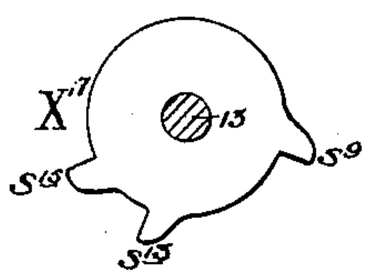
LOOM FOR WEAVING TUFTED PILE FABRICS.

(Application filed Mar. 2, 1899. Renewed Jan. 10, 1902.)

(No Model.) 8 Sheets—Sheet 8.

Fig. 37.



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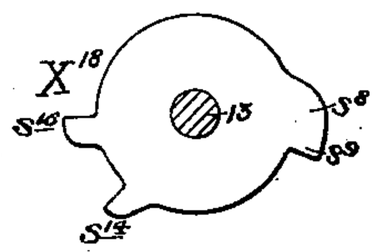

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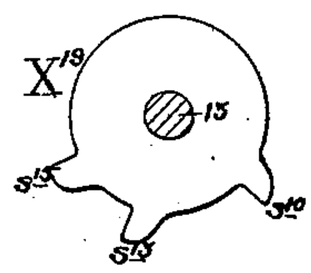

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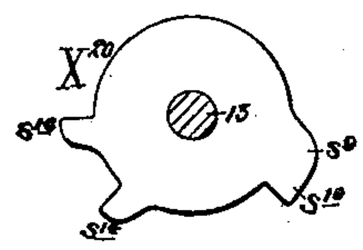

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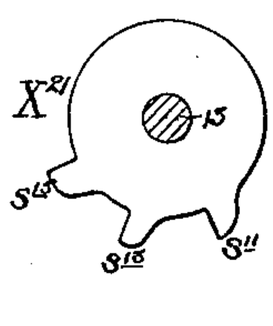

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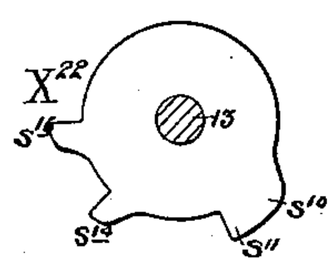

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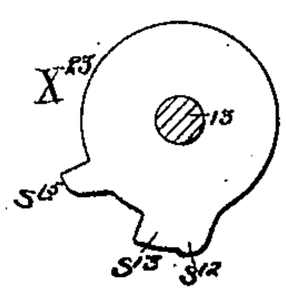

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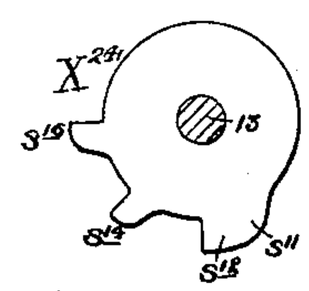

Witnesses:—
Herman E. Metius
F. E. Beckbold

Inventor:—
Charles H. Landenberger:
by his Attorneys:—
Howson & Howson

UNITED STATES PATENT OFFICE.

CHARLES H. LANDENBERGER, OF PHILADELPHIA, PENNSYLVANIA.

LOOM FOR WEAVING TUFTED PILE FABRICS.

SPECIFICATION forming part of Letters Patent No. 706,072, dated August 5, 1902.

Application filed March 2, 1899. Renewed January 10, 1902. Serial No. 89,216. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. LANDENBERGER, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented certain Improvements in Looms for Weaving Tufted Pile Fabrics, of which the following is a specification.

The object of my invention is to provide machinery for weaving pile fabrics of that class in which short lengths of pile-thread are secured to the warp-threads of the fabric by looping or knotting them thereon, my invention comprising certain features of construction and combinations of parts, whereby the formation and application of the knots of pile-thread are effected automatically and pile-forming knots of any desired color are produced.

In the accompanying drawings, Figure 1 is a view of one end of a loom constructed in accordance with my invention, showing in section the ground-warp-controlling heddles and the mechanism for taking up the woven fabric. Fig. 2 is a similar view of the opposite end of the loom. Fig. 3 is a view looking in the direction of the arrow, Fig. 1, and omitting the mechanism for operating the pile-yarn controller and also the mechanism for taking up the finished web. Fig. 4 is an enlarged transverse section of the mechanism for operating the pile-yarn controller. Fig. 5 is an enlarged view showing the separate levers of said mechanism detached from each other. Figs. 6 to 10 are enlarged views illustrating features of construction not sufficiently shown in the general views. Figs. 11 to 15 are diagrams illustrating the successive steps in the formation of a pile-knot in accordance with my invention. Figs. 16 and 17 are enlarged diagrams illustrating a piece of fabric woven in accordance with my invention. Fig. 17ª is an enlarged view illustrating a modified form of fabric, and Figs. 18, 19, and 20 are views illustrating certain modifications of the pile-yarn controller. Figs. 21 to 44, inclusive, are views of cams which may be employed for operating the warp-controlling heddles of the loom.

In Figs. 1, 2, and 3, 1 represents a suitable bed-plate or foundation upon which is mounted, so as to be free to slide in a direction transversely to the ground-warp, the fixed frame 2, which carries the mechanism whereby the knots of pile-yarn are formed and applied to said ground-warp, the operating mechanism carried by this frame being driven by a transverse shaft 3, which is adapted to suitable bearings on the frame 2, so as to move transversely therewith. The shaft 3 has a spur-wheel 4, which is driven by an elongated pinion 5 on a shaft 6, parallel with the shaft 3, but adapted to fixed bearings, the length of the spur-pinion 5 being sufficient to permit the desired transverse movement of the frame 2 and the parts carried thereby without throwing the wheels 4 and 5 out of mesh. The shaft 6 also has another spur-pinion 7, which meshes with a spur-wheel 8 on a short shaft 9, likewise adapted to fixed bearings at one end of the loom, this shaft 9 having a hub 10 with a projecting tooth 11, the opposite ends of which are in different planes and are connected by an inclined portion, as shown in Fig. 3, this tooth meshing with a notched wheel 12, secured to a shaft 13, which is adapted to suitable fixed bearings at one end of the loom and is disposed at right angles to the shaft 9, so that as the latter is rotated intermittent movements of partial rotation will be imparted to the shaft 13 and to the mechanism carried thereby. On the shaft 13 is a grooved cam 14, which acts upon an antifriction-roller on a lever 15, and said lever is connected by a link 16 to brackets 17, projecting from one of the end frames 2 of the loom, so that as the shaft 13 is intermittently moved intermittent sliding movements will be imparted to the loom-frame and to the parts carried thereby, the character of the cam being such that the loom-frame will be moved in one direction by a series of successive short movements each about equal in extent to the distance between the adjoining threads of the ground-warp, and when this series of movements has been completed will be moved back again to the starting-point by a quicker return movement. The shaft 13 also carries suitable cams for operating the warp-controlling heddles 18, the series of cams being shown in Figs. 21 to 44, and said cams being so disposed as to act upon levers 19, connected to the heddles at the top and bottom by means of cords 20, running over pulleys 21, the cams being so formed as to impart to the

heddles the movements hereinafter described. The shaft 13 has at one end a cam 22, which acts upon a lever 23, carrying a pawl 24, which engages with a ratchet-wheel on the shaft of the upper take-up roll 25, back movement of the latter being prevented by a retainer pawl or detent 26, so as to impart a certain amount of take-up movement to the fabric at the desired intervals.

The ground-warp, the heddles for controlling the same, and the take-up mechanism all occupy a fixed relation to each other so far as transverse movement is concerned, but the frame which carries the knot-forming devices is, as before noted, moved transversely across the warp, so that the pile-forming knots can be applied successively to different portions of the warp, the frame 2 carrying a series of knot-forming devices, of which only two are shown in Fig. 3, although as many may be employed as the desired width of the fabric to be produced may suggest, each of these knot-forming devices operating in connection with a given section of the ground-warp, so that the transverse movement of the frame 2 need only be to the extent of the width of ground-warp intended to be covered by each knot-forming device, the joint action of the series of knot-forming devices covering the entire width of the warp.

In producing a patterned fabric it is of course necessary to use a number of different-colored yarns for the warp-knots, and I will describe at the outset the means whereby a yarn of any desired color is fed to the knot-forming devices of the loom.

To a shaft 30, extending across the frame of the loom, are hung as many segments 31 as there are sets of knot-tying devices in the loom, each of these segments having as many projecting guide-tubes 32 as there are different-colored yarns to be used, the end of each guide-tube being bent laterally, as shown in Fig. 3, so as to discharge its yarn sidewise. The hub of each segment 31 is acted upon by a strap or belt 33 and spring 34 or other equivalent mechanism, so that the said segment has a normal tendency to move in the direction of the arrow, Fig. 1. To the hub of the segment is secured a pulley 35, with which engages a belt or strap 36, which also engages with a pulley 37 free to turn on a shaft 38 at the top of the loom-frame, this pulley having secured to or forming part thereof a spur-wheel 39, which meshes with a segment 40, secured to or forming part of a lever 41, hung so as to be free to swing on a short shaft 41^a at the rear of the loom. Any desired mechanism for connecting the lever 41 to the swinging yarn-guides may, however, be employed, the mechanism shown being simply adopted for convenience. The lever 41 forms one of a series of levers 41, 42, 43, and 44, disposed side by side and all hung to the short shaft 41^a, the final lever 44 of the series being flanked by a plate 45. In each of the levers 42, 43, and 44 are formed two slots 46 and 47, a single slot 47 being formed in the lever 41 and a single slot 46 being formed in the plate 45. The slots 47 are at different angles representing a regular geometrical progression. Thus if the angle of the slot 47 in the lever 41 be assumed to represent 1 the angle of the slot 47 in the lever 42 will represent 2, the angle of the slot 47 in the lever 43 will represent 4, and the angle of the slot 47 in the lever 44 will represent 8.

In connection with the levers 41, 42, 43, and 44 are used a series of bars 51, 52, 53, and 54, the forward end of the bar 51 being interposed between the levers 41 and 42, the forward end of the bar 52 being interposed between the levers 42 and 43, the forward end of the bar 53 being interposed between the levers 43 and 44, and the forward end of the bar 54 being interposed between the lever 44 and the plate 45, and the forward end of each bar has a pin projecting laterally from each side thereof, one pin engaging with the slot 47 of the lever on the right-hand side of the bar and the other pin engaging with the slot 46 of the lever or plate on the left-hand side of the bar, as shown in Fig. 4. Movement imparted to any of the levers will therefore be transmitted to the lever 41, for each lever carries with it all of the levers in advance—that is to say, movement of the lever 44 moves also the lever 43, 42, and 41, movement of the lever 43 moves also the levers 42 and 41, but not the lever 44, and movement of the lever 42 moves also the lever 41, but not the levers 43 and 44. By reason of this construction sixteen of the guides 32 can be controlled, so as to bring any one of said guides into position to deliver its yarn to the knot-forming devices. Thus supposing the first of the guides to be in position and all of the bars 51, 52, 53, and 54 to be withdrawn forward movement of the first bar 51 will, owing to the slight angle of the slot 47 of the lever 41, effect only a slight lift of said lever, and hence such slight movement of the segment 31 as to move the second guide into position. In other words, it will effect a movement of the segment equal to the distance of one guide. Forward movement of the bar 52 will effect a movement of the levers 42 and 41, and hence of the segment 31, equal to the distance of two guides; forward movement of the bar 53 will effect movement of the levers 43, 42, and 41, and hence of the segment 31, equal to the distance of four guides, and forward movement of the bar 54 will effect a movement of the levers 44, 43, 42, and 41, and hence of the segment 31, equal to the distance of eight guides, and by moving any two or more of the bars simultaneously any desired combination of these movements may be effected and any movement of the segment to the extent of from one to fifteen of the guides can be made. As shown in Figs. 1 and 2 all of the bars 51, 52, 53, and

54 are projected and the last or sixteenth guide 32 of the series is in position to deliver its yarn to the knot-forming devices.

The bars 51, 52, 53, and 54 are hung, respectively, to levers 51^a, 52^a, 53^a, and 54^a, each of which is acted upon by a spring 55, tending to retract it, and each of said levers is also acted upon by a cam 56, each of these cams being mounted so as to be free to turn on a shaft 57 and being acted upon by an antifriction-roller 58 on a lever 59, likewise hung to the shaft 7 so as to be free to swing thereon. Each lever 59 is acted upon by a spring or weight 60, tending to depress it, and it also has a cord or wire 61, intended to lead to one of the lifters of a "lift-and-drop" jacquard-machine, so that the said lever 59 can be either raised or dropped from a mid-position. I have not considered it necessary to illustrate the jacquard-machine, as the construction of the same is well known and forms no part of my invention. Each of the cams 56 is slotted at 62 to an extent sufficient to permit play of the roller 58 throughout an arc represented by the upward or downward movement of the lever 59 from a mid-position. Hence after the cam 56 has once been moved to the position shown in Fig. 1 by the lift of the lever 59 it will remain in that position until said lever is allowed to drop below the mid-position, and after being retracted by this action will remain in the retracted position until the lever has been again lifted above the mid-position. As shown in Fig. 1 the lever 59 is elevated, having just moved the cam 56 to the position there shown. The lever then falls back until its roller 58 bears against the cam 56 at the bottom of the slot 62, so that it will be in position to move the cam in the reverse direction on a further downward movement of the lever 59. By this means either of the levers 51^a, 52^a, 53^a, or 54^a may be projected, so as to advance its corresponding bar 51, 52, 53, or 54 and permit it to remain in the projected position for as long a period as may be desirable. Hence the operation of the guides 32 is controlled by the jacquard mechanism and the position of said guides may be changed on each operation of said jacquard mechanism, or the guides may be allowed to remain in one position for any desired length of time.

The essential feature of the yarn-selecting mechanism is the combination of the series of levers with a series of interposed separators, presenting to each other bearings which increase in angle in geometrical progression throughout the series, and this idea is susceptible of many modifications within the scope of my invention. Thus in Fig. 18 I have shown a combination of levers 41^b, 42^b, 43^b, and 44^b, in which the slots 46^b and 47^b of the levers 42^b, 43^b, and 44^b are both inclined in respect to the radial line of the lever instead of having all of the angle in the slots 47, as in the levers shown in Fig. 5, while in Fig. 19 I have shown a construction in which slotted levers are dispensed with, this construction involving the use of a series of levers 41^c, 42^c, 43^c, and 44^c, disposed like the leaves of a fan and separated from each other by interposed bars 51^c, 52^c, 53^c, and 54^c, the latter bar resting upon a fixed support 45^c, the angles of the under faces of the levers which bear upon the separator-bars increasing in geometrical progression throughout the series, the angle being least on the lever 41^c and greatest on the lever 44^c. When therefore any one of the bars 51^c, 52^c, 53^c, or 54^c is moved inwardly toward the axis of the levers, all of the levers above said bar will be moved upwardly to an extent depending upon the angle of the face of the lever resting upon said bar. In the construction shown in Fig. 20 a series of levers 41^d, 42^d, 43^d, and 44^d, hung to independent pivot-pins, is employed, these levers being separated one from another by a series of bars 51^d, 52^d, 53^d, and 54^d, the bearing-surfaces of the bars in this case increasing in angle in geometrical progression throughout the series and said inclined bearing-surfaces of the bars acting upon pins or projections upon the levers.

Upon a shaft 63, extending across the loom, are mounted a series of draft-nippers, Fig. 7, each consisting of upper and lower levers 64 and 65, hung upon said shaft 63 so as to be free to swing thereon, but longitudinally confined to the shaft by means of collars 66 thereon, the nippers being normally held in the closed position by means of a spring 67, interposed between the short arms of the levers 64 and 65, and being opened when desired by means of a cam 68, interposed between the long arms of the levers and secured to a transverse shaft 69, which has at one end an arm 70, connected by a link 71 to an arm 72, hung to the fixed frame of the machine and having an antifriction-roller 73, which is acted upon by a cam 74 on the shaft 3. One end of the shaft 63 is forked and has a pin 75, which engages with the slotted end of a lever 76, hung to a bracket on the fixed frame of the loom and having an antifriction-roller 77, which is acted upon by a cam 78 on the shaft 3, so that longitudinal reciprocation is imparted to the shaft 63 at intervals, a spring 76^a acting upon the lever 76 so as to maintain its antifriction-roller constantly in contact with the cam 78.

Mounted so as to be free to swing upon a transverse shaft 80 of the loom are a series of levers 81 and 82, the long arms of each pair of these levers projecting into proximity to the end of one of the series of guides 32 and being constructed so as to form the blades of a pair of shears, the short arms of the levers being acted upon by a spring 83, Fig. 8, tending to separate the long arms of the levers or open the shears, and said short arms of the levers being also acted upon by a cam 84, secured to a transverse shaft 85, which has at one end an arm 86, connected by a link 87 to a lever 88, hung to the fixed frame of

the loom and having an antifriction-roller 89, acted upon by a cam 90 on the shaft 3, a spring 86^a acting upon the arm 86 and tending to maintain the antifriction-roller 89 constantly in contact with the cam 90.

Upon a transverse rock-shaft 91 is mounted an arm 92, having bearings for two shafts 93 and 94, Fig. 9, each of which has at its inner end a head 95, carrying a pair of nippers 96, which I term "looping-nippers," and which are normally kept closed by means of springs 97, but which can be opened when desired by mechanism hereinafter described. The shafts 93 and 94 are geared together by means of spur-pinions 98, and one of the shafts has a spur-wheel 99, which meshes with a rack 100, free to slide in suitable guides on the loom-frame and having at one end collars 101, between which projects the slotted segmental upper end of a lever 102, which is hung to a bracket on the fixed frame and is acted upon by a cam 103 on the shaft 3 and also by a spring 104, whereby an antifriction-roller 105 on said lever is held constantly in contact with the cam 103. The rock-shaft 91 has at one end an arm 106, which is connected by means of a link 107 with an arm 108, hung to the fixed frame of the machine and having an antifriction-roller 109, which is acted upon by a cam 110 on the shaft 3, a spring 107^a acting upon the link 107 so as to maintain the antifriction-roller 109 constantly in contact with the cam 110. When the looping-nippers 96 are raised, the rear ends of the nipper-levers are brought directly beneath fingers 111, carried by a rock-shaft 112, which has an arm 113, connected by a link 114 to a lever 115, which has an antifriction-roller 116, acted upon by a cam 117 on the shaft 3, said lever being also acted upon by a spring 118, which tends to maintain the antifriction-roller 116 constantly in contact with the cam 117.

To a transverse rock-shaft 120 are secured a series of arms 121, each having at its lower end a tubular casing 122, in which is guided a rod 123, split at the lower end and having beveled projections 124, which are acted upon by the beveled lower end of the tubular casing 122. The rock-shaft 120 also has an arm 145, which is connected to a bar 146, forked at the lower end so as to embrace the shaft 3 and having an antifriction-roller 147, which is acted upon by a cam 148 on said shaft, the weight of the rod 146, arm 145, and the other connections of the shaft 120 serving to maintain the roller in contact with the cam. The projecting forked end of the rod 123 constitutes a pair of nippers 125, Fig. 10, which I term the "knotting-nippers," and which when the rod 123 is pressed inwardly by means of a spring 126 are closed together by the action of the tapered lowered end of the casing 122 upon the beveled projections 124 of the rod, the nippers 125 separating, however, whenever the rod 123 is thrust forward in the casing 122, owing to the inherent tendency of the forked end of the rod to spring apart. Each rod 123 is acted upon at the proper time by means of a tappet 127, mounted upon a rock-shaft 128, which has at one end an arm 129, connected by a link 130 to a lever 131, hung to a bracket on the fixed frame of the loom and having an antifriction-roller 132, which is acted upon by a cam 133 on the shaft 3, a spring 134 also acting upon the lever 131, so as to maintain the antifriction-roller 132 constantly in contact with the cam 133. Hung to studs 136 on the opposite frames 2 of the loom is an angular frame or yoke 137, which has a series of upwardly-projecting teeth 138, forming a comb extending across the width of the loom, and said frame 137 is connected by a link 139 to a lever 140, which is hung to a bracket on the fixed frame of the loom and has an antifriction-roller 141, acted upon by a cam 142 on the shaft 3, as shown in Fig. 2, springs 143 also acting upon the frame 137, so that the antifriction-roller 141 is maintained constantly in contact with the cam 142.

The operation of the loom is as follows, the description given applying only to one set of the knot-forming devices, as all of them operate alike: The draft-nippers are first moved very close to the end of the yarn-delivery guide 32, which is in operative position, the jaws of the nippers having previously been opened by the action of the cam 68. The arm 92 is also swung up to its highest point, and the shafts 93 and 94 are turned therein, so that the looping-nippers 96 occupy a vertical position and are opened by the action of the fingers 111 upon the rear arms of said nippers. The shears are also open, so that the parts occupy the relative position shown in Fig. 11. The jaws of the draft-nippers are now closed upon the projecting end of the yarn, and said nippers are moved laterally, so as to draw out an end of yarn between the blades of the shears and between the jaws of the looping-nippers, which are then closed upon the yarn, and the shear-blades are brought together, so as to cut off the projecting end of the yarn, as shown in Fig. 12. The draft-nippers now release their hold upon the yarn, and the looping-nippers descend and at the same time have a downwardly and inwardly swinging movement imparted to them, so that the short length of yarn is looped around a pair of ground-warps, which have been previously elevated above the general line of the warps for this purpose by a proper action of the warp-controlling heddles. The method of operating the warps is one of the main features of distinction between my improved loom and other looms of the class which have heretofore been devised. The warp is divided into sets containing any desired number of threads, one set for each of the sets of knot-forming devices employed in the loom, and each warp-thread of each set is capable of being raised or lowered without reference to any other thread of the set. For instance, if a set of warps consists of twelve pairs of threads there will be twenty-four

warp-controlling heddles, one for each warp-thread of the set, each heddle controlling one warp-thread of each set throughout the full width of the warp. Thirteen of these heddles are shown in Figs. 1 and 2. At the beginning of the weaving operation all of the heddles are down and all the threads of the warp lie at the bottom of the reed. The thread x^2 of each set of warps being raised, as shown in Fig. 13, the knotting-nippers move forward alongside of the same and then move laterally to the left, as shown in Fig. 13^a, so that ample space is afforded for raising the warp x' on the right-hand side of the same, as shown in Fig. 13^b. The looping-nippers then descend and bend the yarn carried thereby around the pair of raised warp-threads and bring its ends together beneath the same, and at the same time the knotting-nippers are thrust forward and separated, so as to lie one on each side of the yarn above the looping-nippers, as shown in Fig. 13^c. The knotting-nippers then close upon the yarn, as shown in Fig. 13^d, and finally rise, so as to draw the free ends of the yarn up between the warps x' and x^2, as shown in Fig. 14. The looping-nippers having been raised, the knotting-nippers release the knot which they have meantime drawn forward up to the beating-up point, as shown in Fig. 15. Meantime the warp x^4 has been raised, and when the knotting-nippers again move forward and laterally they push said warp x^4 to the left, so as to provide ample room for the warp x^5 of the second pair to rise on the right of the said nippers, and the operations of forming and drawing the knot are then conducted in connection with this second pair of warps in the same manner as with the first pair. The operation of forming and drawing knots between successive pairs of the warp-threads is proceeded with until a knot has been drawn between the last pair of each set, whereupon the warp is evenly divided for the insertion of a binding-shot 150, such as shown in Fig. 16, and this binding-shot having been beaten up the shed may be again evenly divided for the insertion of another binding-shot, as many of these binding-shots being employed as desired. During the introduction and beating up of the binding shot or shots the loom-frame and its appurtenances are being moved backward on the bed to their original position, and the formation of a second series of knots extending across the warp is then proceeded with. By raising above the main level of the warp the pairs of warp-threads to which the pile-forming knots are to be applied it becomes easy for the looping-nippers to loop the knot-forming yarn around said pair of warps, and by raising one thread of each pair of warps in advance of the other the entrance of the knotting-nippers between the threads of the pair is rendered certain. Hence the proper disposition of the knots upon the pairs of warps is insured, and the warps can be disposed much more closely together than is common in looms of this class. In that form of fabric shown in Fig. 17 the knots are formed by looping the pile-yarn around successive pairs of warp-threads; but if it is desired to cause overlapping of the pile-knots one warp-thread of the pair to which one knot is applied may form one of the threads of the pair to which the adjoining knot is applied, the fabric in this case being of the character shown in Fig. 17^a.

Figs. 21 to 44 show a series of twenty-four cams mounted on the shaft 13 and intended to act, respectively, upon the levers 19 of the twenty-four warp-controlling heddles. Supposing the warps of the twelve pairs composing the set to be lettered from x' to x^{24}, the cams for operating the heddles controlling these warps are lettered, respectively, X$'$ to X^{24}, as shown. The mechanism for imparting movement to the shaft 13 is such, as shown in Fig. 3, that for every rotation of the shaft 9 the shaft 13 will have movement to the extent of one-sixteenth of a revolution. The cam 14, which operates the mechanism for traversing the knot forming and tying devices across the loom, is so formed that twelve of the intermittent movements of the shaft are devoted to moving said devices across the warp in one direction, and the remaining four movements are devoted to carrying said devices back to the starting-point. During the first twelve movements the cams operate the heddles to lift the warp-threads in pairs for the reception of the successive knots, and during the remaining four movements the cams operate the heddles to shed the warps evenly for the reception of the binding-wefts. Each of the heddle-levers 19 may have a lug or projection—such, for instance, as shown at w in Fig. 21—for being acted upon by the lugs of the cams, so that each lever can be operated by one fractional movement of the cam and quickly released when the cam makes the next fractional movement. Supposing each cam to be divided into sixteen sections, one for each fractional movement of the shaft 13, each of the cams X$'$ X^3 X^5, &c., to X^{23} may have lugs s^{13} and s^{15}, corresponding with these fractional movements of the shaft 13, so as to raise all of the heddles controlled by these cams on these two fractional movements, the other heddles controlled by the cams X^2 X^4 X^6, &c., to X^{24} remaining down, and said heddles X^2 X^4 X^6, &c., to X^{24} may have lugs s^{14} and s^{16}, corresponding with these fractional movements of the shaft 13, so as to raise all of the heddles controlled thereby during these two fractional movements, the other heddles then remaining down. This provides for the even shedding of the warp for the introduction of the binding-wefts. The lugs for operating the warp-threads in pairs for the reception of the successive knots of tufting-yarn are differently timed, so as to properly raise these warps in succession. Thus cam X^2 has a lug s', forming a continuation of the lug s^{16}, so as to hold

up warp-thread x^2 at the commencement of the operation or first fractional movement of shaft 13 and keep it up while lug s' of cam X′ raises warp-thread x'. In like manner cam X^4 has a lug s' s^2 for raising and holding up warp x^4 during the first and second fractional movement of the shaft 13, and cam X^3 has a lug s^2 for raising warp x^3 during the second movement of said shaft, and the same order is followed throughout the entire series of cams, so that, having reference to the direction of movement of the knotting devices across the work, the far thread of each pair of warps is first raised and is held up while the near thread of the pair is raised, both threads then dropping together after the tuft has been knotted thereon. On the back movement of the knotting devices the warp-threads while being evenly shedded are not raised high enough to interfere with the movement of said knotting devices, the lugs s^{13}, s^{14}, s^{15}, and s^{16} of the cams, except the lug s^{16} of the cam X^2, being in practice slightly lower than the lugs s' to s^{12} in order to effect this result.

Many modifications in the construction of the loom may be adopted without departing from the essential features of novelty in my invention. For instance, transverse movement may be imparted to the heddles and take-up mechanism instead of to the knot-forming devices, and the latter may be positively driven by means of grooved cams and springs, these and like changes being within the range of ordinary mechanical skill, and hence intended to be covered by my broader claims.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism, means for supplying yarn thereto, and provision for lifting pairs of ground warp-threads above the general level of said warp for the reception of the knots, substantially as specified.

2. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism, means for supplying yarn thereto, provision for lifting pairs of ground warp-threads above the general level of the warp for the reception of the knots, and mechanism for intermittently altering the lateral relations of the knot-forming devices and the ground-warp, substantially as specified.

3. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism, means for supplying yarn thereto, and provision for lifting above the general level of the ground-warp, first one and then the other of a pair of warp-threads intended to receive the knot, substantially as specified.

4. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism, means for supplying yarn thereto, provision for lifting pairs of ground warp-threads above the general level of the warp for the reception of the knots, and mechanism for shedding the warp for the introduction of one or more filling-threads after the formation of a row of knots across the warp, substantially as specified.

5. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism, means for supplying yarn thereto, provision for lifting pairs of ground warp-threads above the general level of the warp for the reception of the knots, and a beating-up comb acting upon said knots after they have been engaged with the warp, substantially as specified.

6. The combination, in a loom for weaving tufted pile fabrics, of knot-forming mechanism comprising a pair of looping-nippers and a pair of knotting-nippers, means for supplying yarn to the looping-nippers, provision for lifting above the level of the warp, first one and then the other of a pair of threads intended to receive the knot, mechanism for intermittently altering the lateral relations of the knot-forming mechanism and the ground-warp, means for shedding the warp for the introduction of one or more binding-wefts, after the formation of a row of knots, and beating-up devices, substantially as specified.

7. The combination in yarn-selecting mechanism for looms, of a series of levers, and a series of separators, said parts presenting to each other wedge bearings which increase in angle in geometrical progression throughout the series, the separators being interposed between successive levers of the set and each having a sliding bearing upon each of the levers between which it is interposed, with means for moving the members of one of said series of elements in respect to those of the other series, substantially as specified.

8. The combination in yarn-selecting mechanism for looms, of a movable yarn-controller, a series of levers having slots therein the slots of the different levers being at different angles, separators engaging with slots of adjoining levers, means for operating said separators, and provision for connecting the first lever of the series to the movable yarn-controller, substantially as specified.

9. The combination in yarn-selecting mechanism for looms, of a movable yarn-controller, a series of levers having slots at different angles, a series of bars having pins engaging with the slots of adjoining levers, provision for connecting the first lever of the series to the movable yarn-controller, and mechanism for reciprocating said bars, substantially as specified.

10. The combination in yarn-selecting devices for looms, of a series of levers, and a series of interposed separators presenting to each other bearings which increase in angle in geometrical progression throughout the series, and mechanism for moving the members of one of said series of elements in re-

spect to those of the other, said mechanism having as elements slotted cams, and arms having projections playing in the slots of said cams whereby said arms may have lost motion, substantially as specified.

11. The combination in a loom for weaving tufted pile fabrics, of a yarn-controller, a pair of draft-nippers, looping-nippers comprising two independent nipping devices laterally separated from each other, provision for opening and closing each nipping device, and for moving the draft-nippers from and toward the yarn-controller, a pair of shears, and means for operating said shears so as to sever the yarn drawn from the yarn-controller by the draft-nippers, substantially as specified.

12. The combination in a loom for weaving tufted pile fabrics, of a yarn-controller, a pair of draft-nippers, provision for opening and closing the same and for moving them toward and from the yarn-controller, a pair of shears for severing the yarn drawn out by the draft-nippers, means for operating said shears, a pair of looping-nippers, comprising two independent nipping devices laterally separated from each other and means for opening and closing said nipping devices and for raising and lowering the same whereby the draft-nippers can draw yarn between the open jaws of the looping-nippers when the latter are raised, and said jaws can then be closed upon the yarn and the nippers caused to descend, substantially as specified.

13. The combination in a loom for weaving tufted pile fabrics, of a pair of looping-nippers, consisting of independent nipping devices laterally separated from each other, means for opening and closing the jaws of said nippers, provision for raising and lowering the nippers, and mechanism for causing each of the nipping devices of the nippers to turn as they are raised and lowered whereby they are caused to wrap a loop of pile-yarn around a pair of ground warp-threads, substantially as specified.

14. The combination in a loom for weaving tufted pile fabrics, of a pair of nippers for laying a loop of yarn around a pair of ground-warp threads, said pair of nippers comprising independent nipping devices laterally separated from each other with knotting-nippers and means for operating the same whereby they are caused to pass between the threads of the ground-warp while closed, are then expanded so as to embrace the loop of pile-yarn, are then closed upon said loop, and then raised so as to draw the free ends of the loop between the ground pile-threads, substantially as specified.

15. The combination in a loom for weaving tufted pile fabrics, of a swinging arm carrying a pair of shafts geared together and each having a head with nippers thereon, a rack engaging with a pinion on one of said shafts, and means for swinging said arm and reciprocating the rack, substantially as specified.

16. The combination in a loom for weaving tufted pile fabrics, of knot-forming devices, a shaft having mechanism for operating said devices, a movable frame on which said knot-forming devices are mounted, a shaft provided with means for imparting movement to said frame, and means for imparting intermittent movement of partial rotation to said shaft on each rotation of the shaft which operates the knot-forming devices, substantially as specified.

17. The combination in a loom for weaving tufted pile fabrics, of knot-forming devices, a shaft having mechanism for operating said devices, take-up mechanism for the finished fabric, a shaft having means for operating said take-up mechanism, and provision for imparting movements of partial rotation to said shaft on each rotation of the shaft which operates the knot-forming devices, substantially as specified.

18. The combination in a loom for weaving tufted pile fabrics, of heddles and take-up mechanism for controlling a ground-warp, a series of sets of knot-forming devices disposed at intervals throughout the lateral extent of said warp, provision for operating said sets of knot-forming devices, and means whereby the lateral relations of the knot-forming devices and the ground-warp are changed by a succession of intermittent movements until a space of ground-warp has been covered equal to the distance between adjoining knot-forming devices of the series, substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES H. LANDENBERGER.

Witnesses:

FRANK E. BECHTOLD,

JOS. H. KLEIN.