Sheet 1. 6 Sheets.

# Kilbourn & Kilbourn.

## Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.

Fig. 1.

Fig. 2.

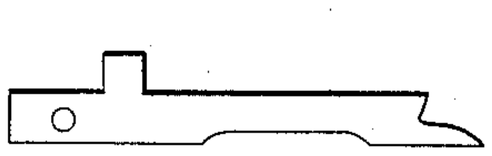


Fig. 3.

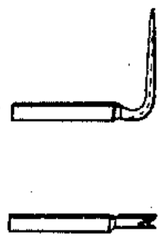
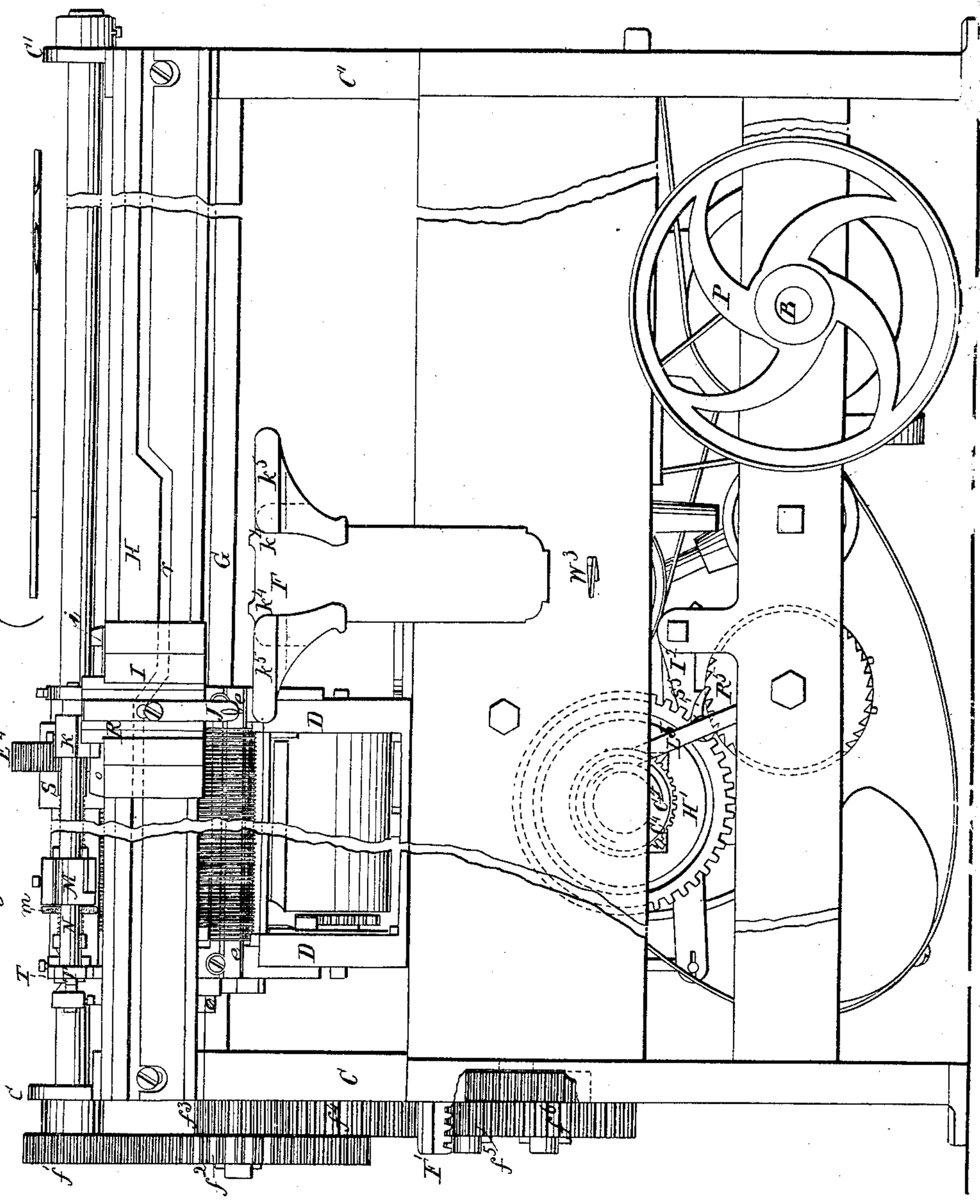


Fig. 4.



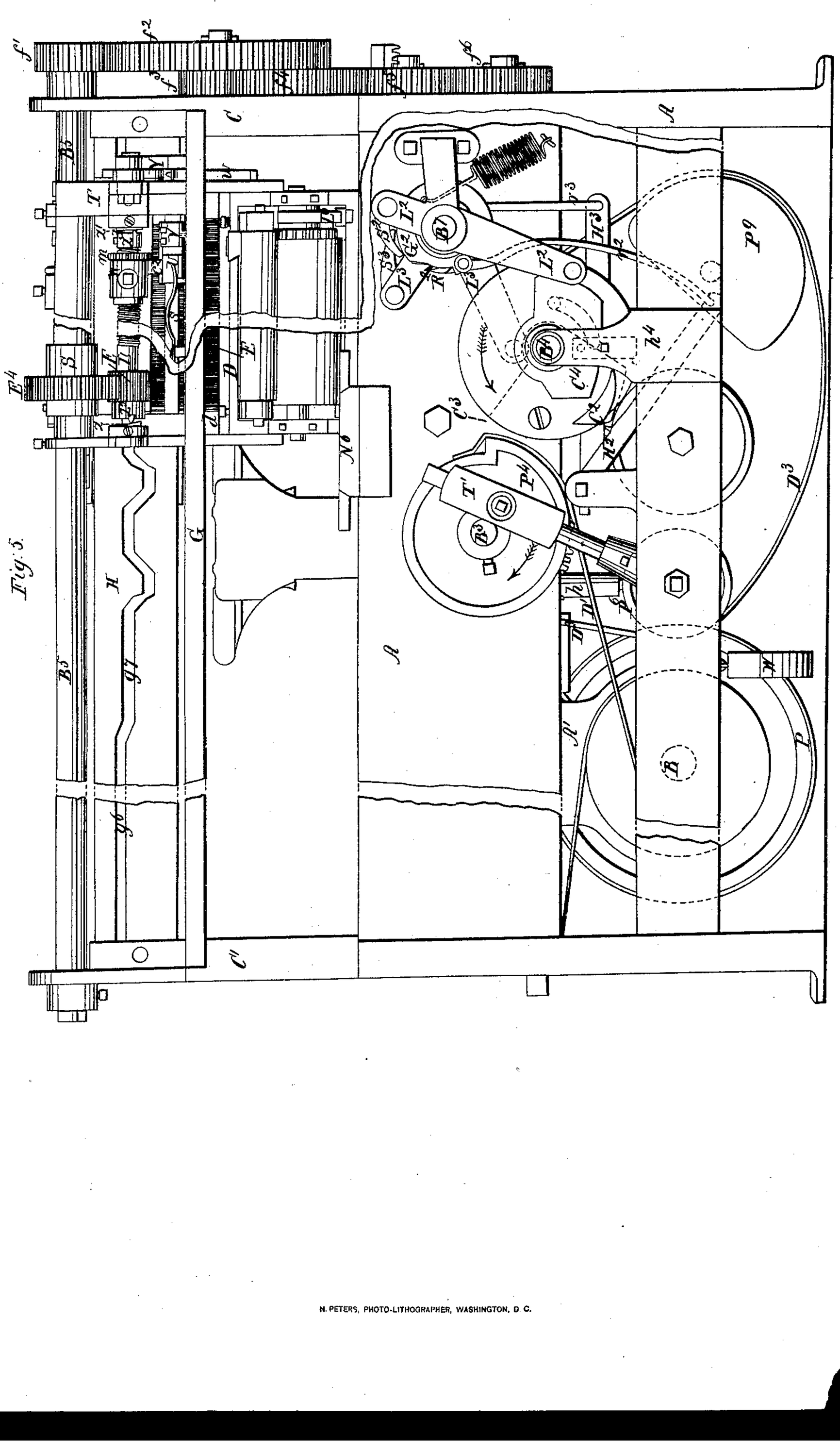
Sheet 2. 6 Sheets.

# Kilbourn & Kilbourn.

## Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.

Fig. 5.



Sheet 3. 6 Sheets.

# Kilbourn & Kilbourn.
# Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.

Fig: 6

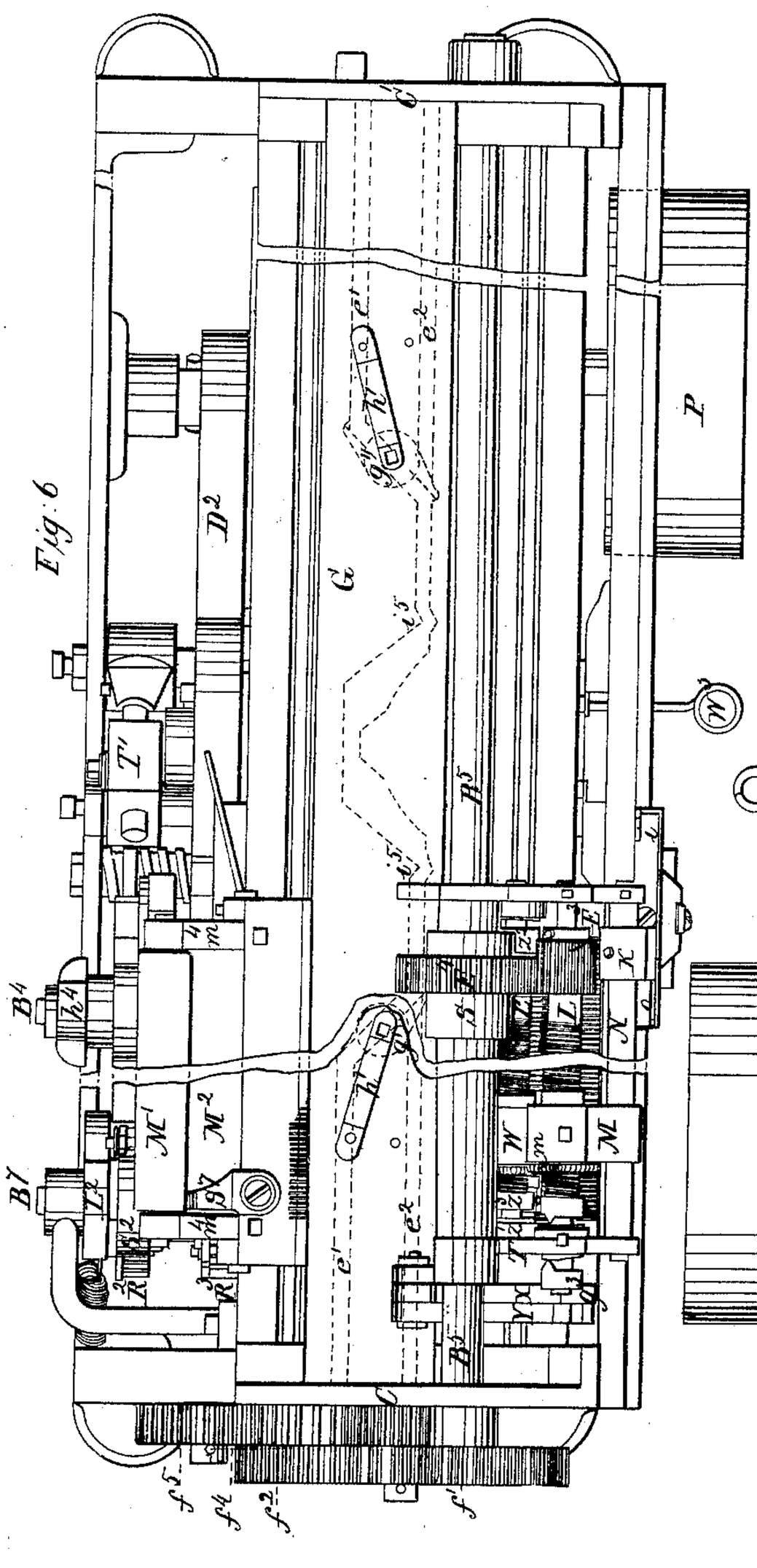
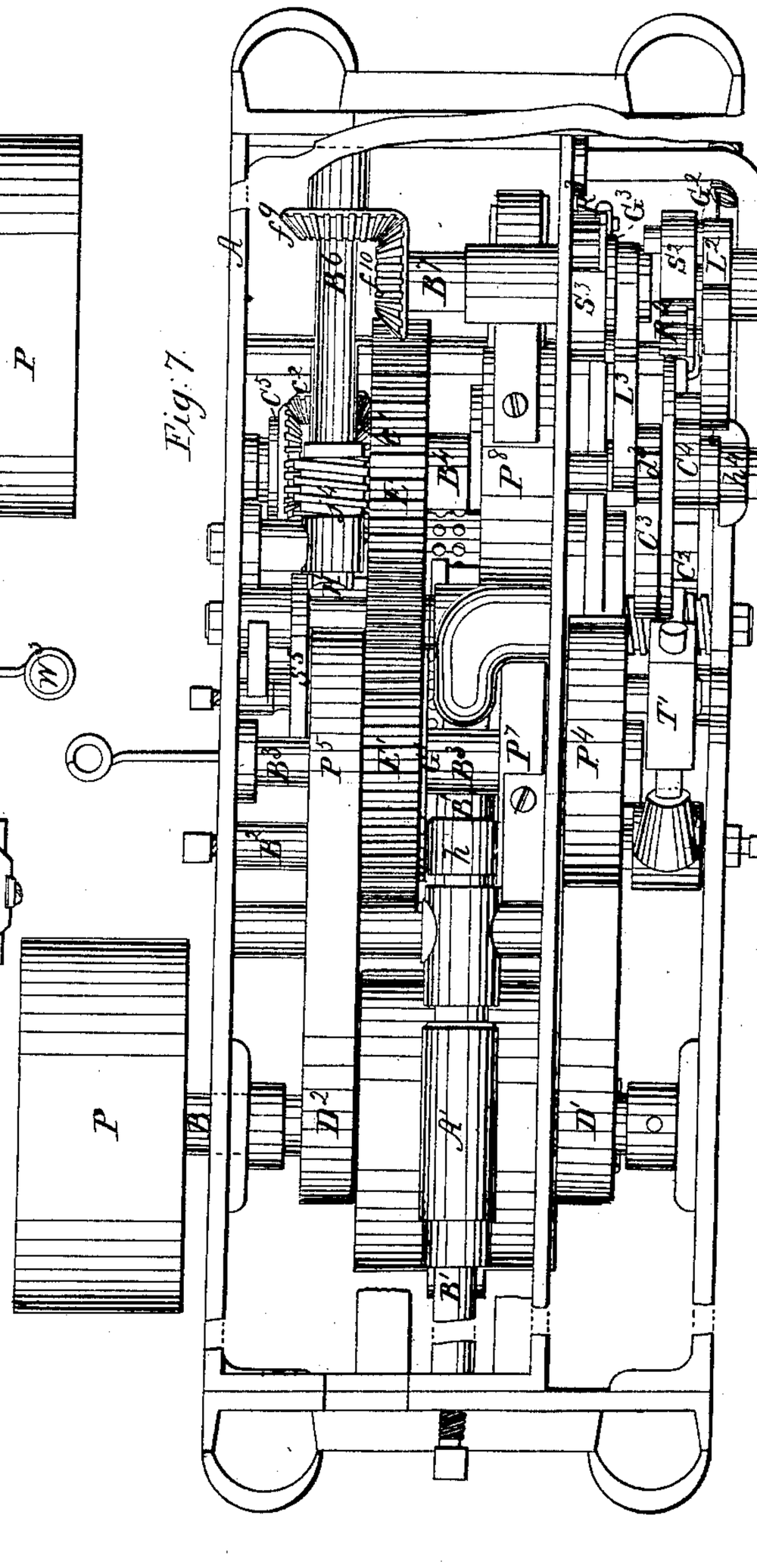


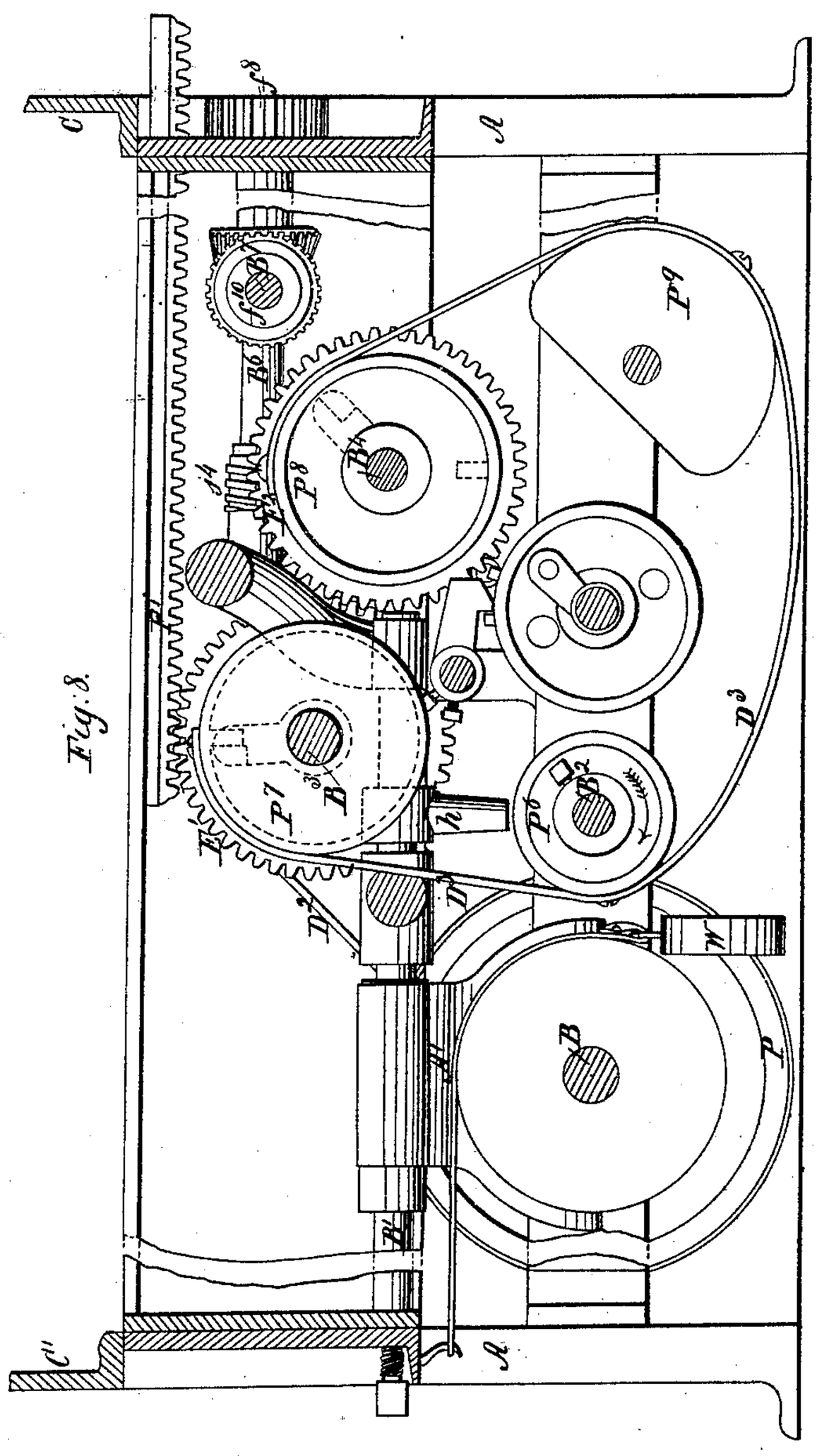
Fig: 7.



Sheet 4. 6 Sheets.

# Kilbourn & Kilbourn.
## Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.



# Kilbourn & Kilbourn.

## Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.

Fig. 9.

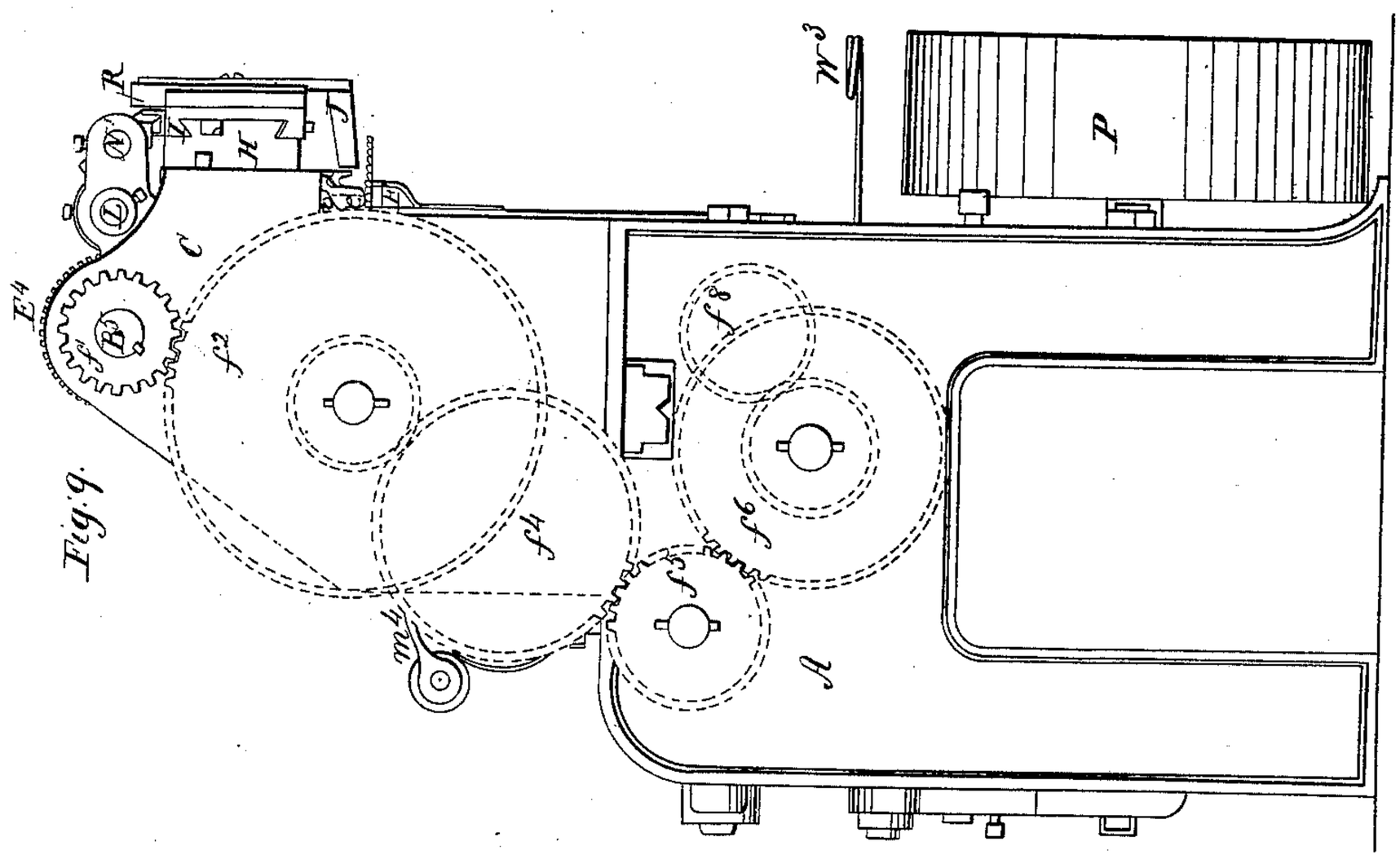
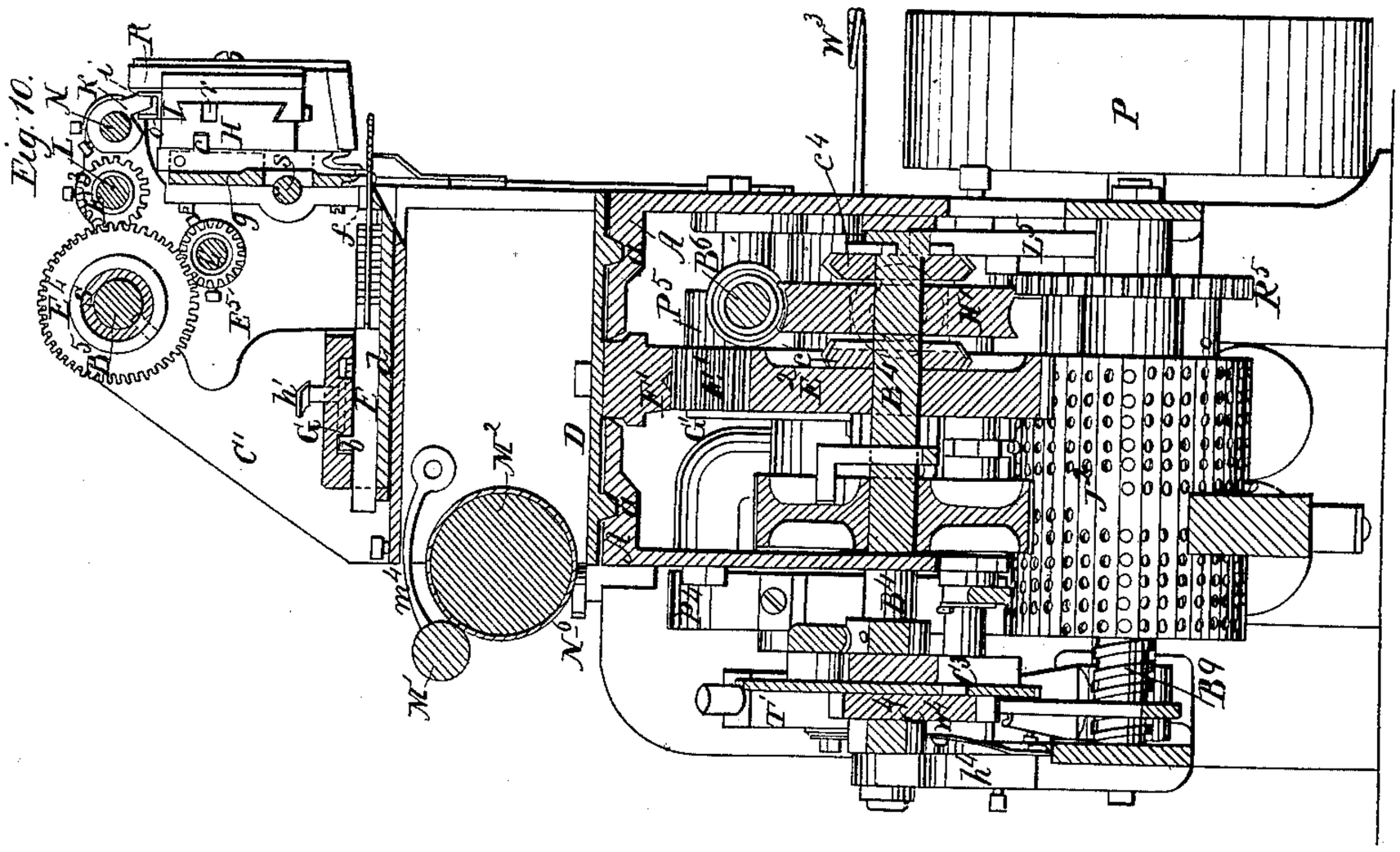



Fig. 10.



Sheet 6. 6 Sheets.

# Kilbourn & Kilbourn.

## Knitting Mach.

No. 21,762. Patented Oct. 12, 1858.

Fig. 17.

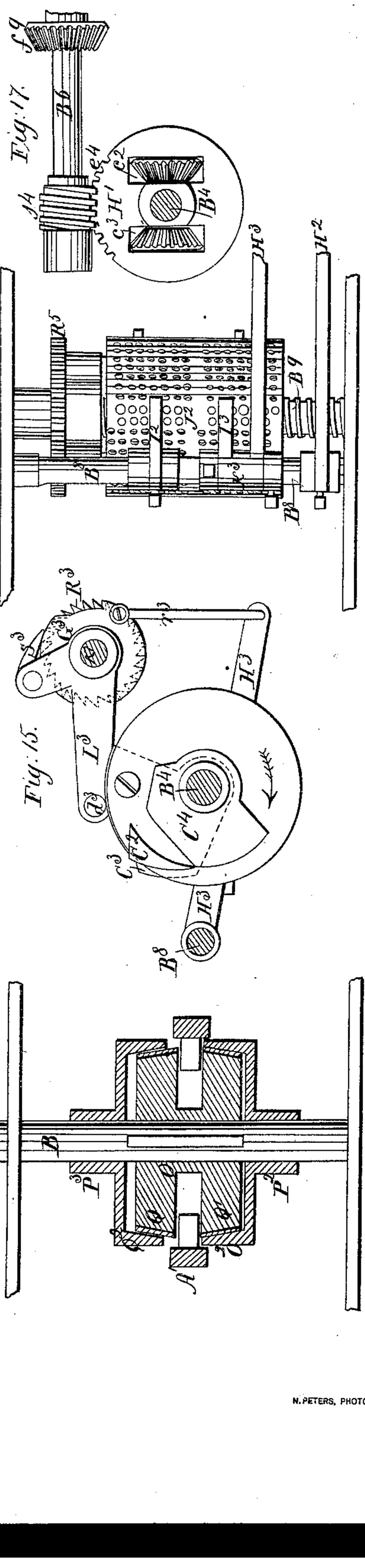



Fig. 14.




Fig. 15.




Fig. 16.




Fig. 13.

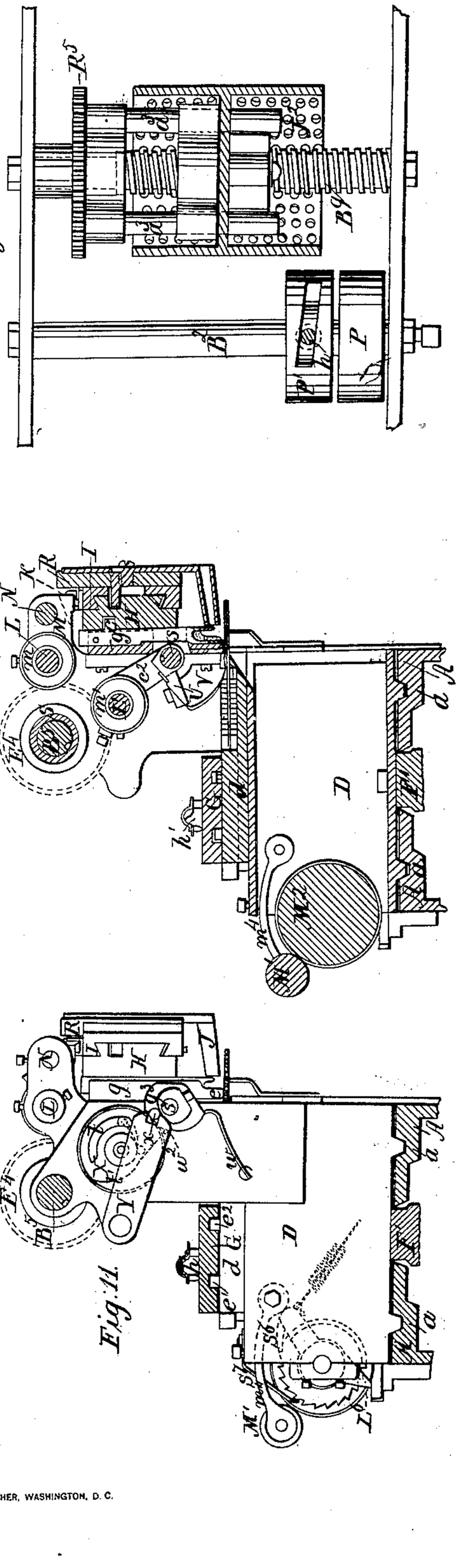



Fig. 12.




Fig. 11.

# UNITED STATES PATENT OFFICE.

JOSEPH K. KILBOURN AND EDW. E. KILBOURN, OF NORFOLK, CONN.

## IMPROVEMENT IN KNITTING-MACHINES.

Specification forming part of Letters Patent No. **21,762,** dated October 12, 1858.

*To all whom it may concern:*

Be it known that we, JOSEPH K. KILBOURN and EDWARD E. KILBOURN, of Norfolk, in the county of Litchfield and State of Connecticut, have invented certain new and useful Improvements in Knitting-Machines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, in which—

Figure 1 represents a side view and plan of a needle of the full size, together with its slide; Fig. 2, a side view of a sinker and sinker-slide of full size. Fig. 3 represents a side view and rear view of a transferring-hook of the full size. Fig. 4 represents a front elevation of the machine of half the full dimensions. Fig. 5 represents a rear elevation of the same. Fig. 6 represents a plan of the machine; Fig. 7, a horizontal section of the machine at the line *x x* of Fig. 3; Fig. 8, a vertical longitudinal section of the machine at the line *x x* of Fig. 6. Fig. 9 represents an elevation of one of the ends of the machine; Fig. 10, a vertical transverse section of the machine, following the line *x x* of Fig. 5. Fig. 11 represents a view of one end of the needle-carriage. Fig. 12 represents a transverse section of the needle-carriage at the line ※ ※ of Fig. 6; and Figs. 13, 14, 15, 16, and 17 represent views of parts of the machine detached from the remainder to render their construction and operation more clear.

Our invention has reference to that class of machines by means of which yarn is knit into fabrics; and the main object of our invention is to cause the various devices in the machine which operate directly upon the yarn to narrow and widen the fabric automatically, according to a previously conceived design or pattern.

Our invention consists in transferring the stitches from the needles upon which they have been formed to other needles in a series of needles, for the purpose of narrowing the fabric and for other purposes, by means of transferring-hooks operated in such manner as to enter into the stitches by moving along the stems of the needles toward their points.

Our invention consists, further, in directing the operation of transferring-hooks, or their equivalents, which transfer the stitches from the needles on which they are formed to others by means of a pattern-barrel, or the equivalent thereof, so that the machine, when once set to work, accomplishes the narrowing of the fabric automatically, according to the intended pattern or design.

The widening of the fabric in our present machine is effected in the manner described in certain Letters Patent granted to us the 16th day of February, A. D. 1858, by casting the yarn over an additional needle by the operation of the thread-guide; and our present invention consists, further, in directing the movement of the thread-guide by means of a pattern-barrel, or the equivalent thereof, so that the machine, when once set to work, accomplishes the widening of the fabric automatically, according to the intended pattern or design.

In our machine the needles and sinkers are mounted in a series upon a carriage which travels alternately in opposite directions, so as to cause the slides of the needles and of the sinkers to pass in succession along the inclined portions of the grooves of certain stationary cam-bars, by which their movements in knitting are effected. When, in the operation of such a machine, the work from narrowing contains a less number of stitches than the number of needles in the series a portion of the needles and sinkers are not acting upon the yarn, and consequently the carriage need not travel as far as it must when all the needles are at work; and our invention consists, further, in varying the travel of the carriage in proportion to the widening and narrowing of the work.

Our invention also consists in varying the periods of time at which the pattern-barrel or its equivalent is moved in proportion to the widening and to the narrowing of the work.

Our invention also consists in various other improvements by means of which the operation of a knitting-machine is improved, as will more fully appear in the following description.

The several parts of our invention are embodied in the flat-knitting loom represented in the accompanying drawings. As the machine necessarily comprises a great number of parts, we have deemed it best, in order to prevent confusion, to represent the mechanism for widening and narrowing as applied to operate at one side only of the fabric, and we shall point out, in the course of the following description, the mode of applying widening and narrowing mechanism to a machine, so

that widening and narrowing may take place at both sides or selvages of the fabric.

The various operating parts of the loom are supported by a strong rectangular bed-frame, A, which should be secured to a suitable table or bench, at a convenient height for the operator who tends it. In the upper side of the frame there are two longitudinal V-shaped grooves, *a a*, Fig. 10, which form ways to support and guide a carriage, D, that is caused to traverse to and fro from one end of the machine to the other. This carriage, which we shall hereinafter call the "needle-carriage," from its office in carrying the needles, is moved to and fro alternately in opposite directions by the continuous rotation of a driving-shaft, B, to which power is applied by the application of a belt to a belt-pulley, P, secured to this shaft. The driving-shaft is fitted with a sleeve, O, Fig. 16, that is caused to turn with the shaft by means of a feather running in a corresponding groove in the shaft, and has two friction-cones, Q Q′, Fig. 16, secured to it. These friction-cones may be brought alternately into contact with either one of a corresponding pair of hollow friction-cones, $Q^2$ $Q^3$, that are formed in hubs that run loosely upon the driving-shaft B, by means of a shifting-lever, A′, which is forked to embrace a groove formed by the backs of the two solid cones. The shifting-lever depends from a rock-shaft, B′, which is fitted with an arm, *h*, whose lower end enters a helical groove formed in a drum, P′, secured to a shaft, $B^2$, so that by rocking this shaft $B^2$ in one direction or the other the shifting-lever A′ is caused to force one or other of the solid cones into contact with its corresponding hollow cone. The hub of each hollow cone has a drum, $P^2$ and $P^3$, secured to it, upon which drums belts D′ and $D^2$ are wound. The belt from the drum $P^2$ is carried to a drum, $P^4$, secured to a shaft, $B^3$, and made fast thereto. The belt from the drum $P^3$ is carried to a corresponding drum, $P^5$, upon the same shaft $B^3$, and is made fast thereto. The belts, D′, and $D^2$ are wound in opposite directions upon the drums $P^2$ and $P^3$, so that when one belt, D′, is being wound upon its drum $P^2$ (by the turning of the hub $Q^3$, to which it is secured by the action of its appropriate friction-cone Q′) the shaft $B^3$ is turned in the direction of the arrow upon the drum $P^4$, Fig. 5, the other belt, $D^2$, being meanwhile unwound, and when this latter belt, $D^2$, is being wound upon the drum $P^3$ the shaft $B^3$ is turned in the opposite direction to that indicated by the arrow upon the drum $P^4$. The shaft $B^3$, to which the drums are secured, has a cog-wheel, E′, upon it, whose teeth engage with those of a rack, F′, that is secured to the under side of the needle-carriage D, so that the turning of this cog-wheel shaft $B^3$ alternately in opposite directions by the alternate action of the two bolts D′ and $D^2$ causes the needle-carriage to move to and fro from one end of the bed-frame to the other. In the movement of the carriage the belts are wound several times upon their drums, and as each new fold of the belt thus made overlaps the preceding folds the curved surface upon which the belt is winding, while imparting motion to the carriage becomes progressively of larger diameter, and consequently winds up the belt more rapidly and tends to cause the carriage to progress in a corresponding manner.

In the operation of the machine we are describing it is desirable that the carriage should progress equably. In order therefore to compensate the irregularity that arises from the winding of the belts, the drums $P^4$ $P^3$ upon the shaft $B^3$ have eccentric barrels, as shown at Fig. 5, and each belt is secured to its drum in such manner that it is acting upon the smallest portion of the eccentric drum when it is being wound upon the bare surface of the winding-drum, and that as the belt is progressively wound upon itself it is acting upon progressively larger portions of the eccentric drum. The enlargement of the curved surface of the winding-drum is thus compensated by a corresponding enlargement in the acting surface of the eccentric drum, and the movements of the cog-wheel shaft $B^3$ and of the needle-carriage, to which it imparts motion, are equalized.

From the foregoing description it appears that the movement of the shifting-lever A′ to throw one or other friction-cone into operation effects the reversal of the movement of the carriage, and that the movement of the shifting-lever is effected by the action of the helical groove of the drum P′ upon the rock-shaft $B^2$, according as the rock-shaft is turned in one direction or the other. In order that the machine may be automatic, it is essential that the movement of the rock-shaft $B^2$ should be effected at the proper moment by some portion of the machine, and it is effected in the present instance by means of a strap, $D^3$, which is secured to a drum, $P^6$, upon the rock-shaft $B^2$, and whose ends are made fast to two drums, $P^7$ and $P^8$, whose movements depend upon the movement of the cog-wheel E′ that drives the carriage-rack F′. One of these drums is hung loosely upon the shaft of the cog-wheel E′, and is connected by a sleeve with a disk, G′, adjacent to the cog-wheel E′. The cog-wheel is fitted with a driver (shown in dotted lines in Fig. 8) which comes in contact with a snug secured to the adjacent face of the disk G′, just before the carriage reaches the end of its range of motion nearer the standard C. The drum, being thus turned by the driver, winds up the strap $D^3$ and moves the rock-shaft $B^2$ in the direction indicated by the arrow applied to the drum $P^6$ in Fig. 8. The other drum is hung loosely upon a counter-shaft, $B^4$, which, from one of its offices in the machine, we shall hereinafter call the "cam-shaft." This cam-shaft is parallel to the cog-wheel shaft $B^3$, and motion is imparted to it by means of a cog-wheel, $E^2$, and a train of beveled wheels, $c'$ $c^2$ $c^3$

$c^4$. The cog-wheel $E^2$ is of the same size as that E′ upon the cog-wheel shaft $B^3$. It is hung loosely upon the cam-shaft, and has the beveled wheel $c'$ secured to it, whose teeth engage in those of a pair of beveled pinions, $c^2$ $c^3$, whose axles are supported by an adjustable stock, H′, hanging loosely upon the cam-shaft $B^4$. The teeth of these beveled pinions engage in those of a secondary beveled wheel, $c^4$, made fast to the cam-shaft $B^4$, and the result of this arrangement is that the cam-shaft is driven in the same direction as the cog-wheel-shaft $B^3$ and at the same speed, with the capacity in the machine to vary the angular position of the cam-shaft $B^4$ with reference to the cog-wheel shaft $B^3$ by turning the pinion-stock H′ upon its axis. The cam-shaft is fitted with a driver (shown in dotted lines in Fig. 8) which comes in contact with a snug upon the face of the drum $P^8$ as the carriage approaches the standard C′ of the main frame, and causes it to turn with the cam-shaft $B^4$ to wind up the strap $D^3$, and thus move the rock-shaft $B^2$ in the opposite direction to the arrow in Fig. 8. In order that the strap may not interfere with parts of the machine which intervene between the cam-shaft $B^4$ and the rock-shaft $B^2$, it is conducted around a segment, $P^9$, situated near one end of the machine.

The movement of the strap $D^3$ by turning the rock-shaft $B^2$ operates the shifting-lever A′. As, however, the movement of the cog-wheel shaft $B^3$ stops the moment the friction-cone in operation is disengaged, it is necessary to provide means to continue the movement of the rock-shaft $B^2$ until the other friction-cone is engaged. This is effected in the present machine by means of a tumbling-bob, T′, which is made fast to the rock-shaft $B^2$, and which by its momentum carries the rock-shaft over in either direction to the farthest limit required to throw either friction-cone into operation.

In order to prevent the slacking of the belts D′ $D^2$, which impart motion from the driving-shaft to the cog-wheel shaft by the momentum of the winding-drums $P^2$ $P^3$ during the unwinding of either strap by the winding up of the other, the periphery of each hollow cone is fitted with a friction-strap, which is pressed in contact with it by a weight, W, of sufficient force to cause the friction of the strap to which it is secured to overcome the momentum of the hollow cone and its drum.

The needle-carriage contains the needles and sinkers, which constitute two series whose members alternate so that there is a needle between each two sinkers. The needles, as shown at Fig. 1, have the ordinary hook-formed head, the barb of the hook being received, when depressed, into a corresponding groove in the shank or stem. The stems of these needles differ from the needles hitherto used in knitting-machines in being constructed with a secondary groove, $a^2$, Fig. 1, whose office in knitting will be hereinafter described. Each needle is secured to a slide having a snug, *b*, upon it, by means of which the slide, with its needle, is moved to and fro. The sinkers, as shown at Fig. 2, are of the ordinary form, and the shank of each one has a snug, *c*, by means of which it is moved to and fro.

The needle-carriage D is of rectangular form and is mounted upon the bed-frame, its lower side being fitted with V-shaped feathers, which slide in the V-shaped grooves in the top of the main frame. Upon the upper side of this carriage there is a block of metal, *d*, which extends its entire length and has a series of transverse grooves in it to receive and guide the slides E of the needles, for which it forms a bed. The needles project forward from this bed and pass through a corresponding series of transverse grooves in a bar, *f*, which extends along the front side of the carriage and forms a nosing or series of orifices into which the needles are withdrawn to cast off the loops, and from which they are protruded to receive yarn to form new loops. The grooves of this nosing have at bottom a V form, so that when the needles are depressed they are caused, by the forms of the grooves, to place themselves at equal distances apart and to occupy always the same positions, whereby the uniform width of the stitches is secured, and the transferring of stitches from needle to needle by the prongs of transferring-instruments is insured.

A second block of metal, *g*, is supported at the front side of the carriage by means of standards. This block has a series of grooves in it similar to those of the needle-bed, and it forms a bed to receive and guide the shanks of the sinkers. The lower edge, *e*, of this sinker-bed overlaps the nosing from which the needles protrude, and forms a bar against the lower side of which the barbs of the needles are pressed, by the action of the support F beneath, to close them, so that when they are drawn into the orifices of the nosing they may pass through and cast off the loops already formed. The needle-bed *d* is surmounted by a stationary needle-cam bar, G, which is supported by the standards C C′ of the main frame of the machine, and has a cam-groove in its lower face to receive the snugs *b* of the needle-slides, and thus impart motion to the needles as the carriage is moved from one end of the frame to the other.

The form of the cam-groove is shown in dotted lines at Fig. 6. It will be perceived that the cam-groove forks into two branches, $e'$ and $e^2$, into either one of which the needle-snugs may be made to travel by turning a switch, $g'$. This mode of constructing the needle cam bar has been devised in order to cause the needles to be projected forward to their farthest limit when the carriage is approaching the end of its travel, so as to place them in a convenient position for inspection and repair. When the machine is making a fabric of uniform width the snugs of the needle-slides may be permitted to travel in the forward branch of the cam-groove; but when narrowing is being effected the snugs must be caused to travel in the rear branch of the cam-groove, so as to draw the

needles into their orifices and leave the loops which are to be transferred upon the transferring hooks. The switch *g'* is controlled by a spring-lever, *h'*, by meaas of which it may be moved and secured in the desired position to open either branch of the cam-groove. The snugs of the sinkers are received into a cam-groove in the hinder face of the sinker-cam bar H, which is supported in the proper position immediately in front of the sinker-bed *g* by the standards of the main frame, so that the proper up and down movements are imparted to the sinkers as the carriage moves to and fro.

The yarn or thread is fed to the series of needles by means of a tubular thread-guide which is situated in front of the sinkers, and is fitted to a carriage that slides longitudinally upon ways secured to the front side of the sinker-cam bar H. This thread-guide J has the form of a flattened tube whose upper and lower edges will readily enter the space between the needles, and whose thickness is such that it will readily pass through these spaces. Its shank is secured to a slide, R, which slides vertically in a broad dovetailed groove formed in the face of the thread-guide carriage I. The hinder side of the slide has a snug or pin projecting from it, which passes through a vertical slot in the thread-guide carriage, and is received into and operated by a cam-groove, *r*, formed in the front side of the cam-bar H, so that when the thread-guide carriage is moved longitudinally from one end of the machine to the other the thread-guide J is alternately depressed below and raised above the level of the needles by the operation of the inclined portions of the cam-groove *r* upon the pin traversing in the groove. The thread-guide carriage is moved alternately to and fro by means of the bumpers K and M, which are carried along with the needle-carriage, and which come alternately in contact with the corresponding snugs, *i* and *o*, secured to the thread-guide carriage. These bumpers are hung upon a traverse-bar, N, that is supported by the standards of the needle-carriage. As the machine thus described is adapted to widening and narrowing at one side of the fabric only, only one of the bumpers, M, need be moved. The other bumper, K, is made fast to the traverse-rod N by a set-screw, so that when it has been properly adjusted it remains in its position. The movable bumper M is fitted with a nut, *m*, which is traversed by an adjusting-screw, L, by the turning of which the bumper is moved along toward one or the other end of the needle-carriage, according as the screw is turned in one direction or the other. The pitch of this screw is equal to the distance between the centers of the adjacent needles, so that by turning it one or more revolutions the bumper is moved along one or more needles.

The shank of the adjusting-screw L is fitted with a cog-wheel, $E^3$, whose teeth engage in those of a similar wheel, $E^4$, secured to a sleeve, S, which slides longitudinally upon a shaft, $B^5$, and is moved to and fro with the needle-carriage. This shaft $B^5$ is slotted from end to end, and the sleeve S of the cog-wheel $E^4$ is fitted with a pin, or with a feather, which, sliding in the slot of the shaft, forces the cog-wheel $E^4$ to turn with the shaft, when the latter turns, in whatever position the needle-carriage may be at the time. The object of moving the bumper M is to vary the movement of the thread-guide carriage upon which it acts, and thus vary the position of the thread-guide with respect to the needles. So long as the bumper M remains in the same position with respect to the needle-carriage and thread-guide carriage the thread-guide will be caused to descend and rise by the action of its cam-groove between the same pair of needles; but if the bumper-screw L be turned a revolution, so as to move the bumper toward the standard T of the needle-carriage after the thread-guide has descended by the operation of the first inclined part of the cam-groove that it reaches, and before the thread-guide is caused to ascend by the action of the opposite inclined part of the cam-groove, the thread-guide carriage, with the thread-guide, will be permitted to lag behind the distance of a needle, and the thread-guide, in ascending, will cast the thread over an additional needle, thus widening the work the extent of a stitch. As the widening-screw L is turned by the operation of the slotted shaft $B^5$ the movement of this latter shaft at the proper time effects the widening of the fabric. This same slotted shaft $B^5$, in this instance, also imparts movement to the mechanism by which the narrowing of the fabric is effected. We shall therefore proceed to describe this latter mechanism before describing the means of moving the slotted shaft $B^5$.

The narrowing of the fabric in our machine is effected by transferring the selvage-stitches from the needles on which they have been formed to needles nearer the opposite selvage of the fabric, and this operation is effected by means of transferring prongs or hooks which are operated in such manner as to enter the stitches upon the needles from the inner side of the sinkers, and while the needles are retained in their exact positions by the V-shaped grooves of the nosing in which they lie when the transferring-hooks begin to operate. These transferring-hooks are operated by a rock-shaft, *s*, that lies in a recess in the back of the sinker-bed *g*. That portion of this rock shaft which is between the standards of the needle-carriage is slotted from end to end, and it is fitted with a stock, U, to which the transferring-hooks V are secured. The stock is fitted with a feather that enters the slot of the rock-shaft, so that although it may be moved longitudinally along this rock-shaft, it is caused to rock with it and to turn the points of the transferring-hooks outward or inward, in whatever position the stock may be upon the shaft.

The transferring-hooks in the present instance are two in number, although this number may be increased or diminished, as may be desired, according to the kind of work being

made. Each hook is curved, as shown in Figs. 3 and 12, and each has a groove formed in its lower side of sufficient depth to guide the head of the needle into the stitch which may be upon the transferring-hook. These transferring-hooks, when the stock is not being moved longitudinally, are supported above the selvage-needle and the next one thereto; and when the rock-shaft *s* is turned in one direction their points moving forward traverse the secondary grooves $a^2$, Fig. 1, of the needles, enter and pass through the stitches upon these needles, and retain these stitches while the needles are withdrawn inward, whereby the stitches are shi ted to the transferring-hooks. The transferring-hooks, with the stitches upon them, are then moved along the carriage the space of a needle before the needles are again protruded, so that the heads of the needles, in protruding, may traverse the grooves in the lower sides of the transferring-hooks, may enter the stitches, and may take the stitches off from the transferring-hooks; and as the needle which now enters the selvage stitch is the next one nearer the opposite selvage of the machine, the fabric will be narrowed the width of a stitch. In order to move the transferring-hooks longitudinally along the series of needles, the stock U is slotted to admit the extremity of an arm, $c^2$, that extends from a hub, W. This hub is fitted with a nut, $m'$, that is traversed by a screw, L′, similar to the widening-screw L, and which for distinction we shall hereinafter call the "narrowing-screw." The pitch of this narrowing-screw, like that of the widening-screw, is equal to the distance between the centers of a pair of needles, so that the turning of it a revolution carries the hub W, and by its arm the stock U, the width of a stitch. The narrowing-screw is fitted with a cog-wheel, $E^5$, whose teeth engage with those of the same wheel $E^4$ that drives the widening-screw L, so that these two screws are moved simultaneously by the turning of the slotted shaft $B^5$, and the thread-guide and transferring-hooks are caused to maintain their proper relative positions, whatever positions they may occupy in respect to any particular needles. In the machine we are now describing the rocking of the shaft *s* to protrude and withdraw the transferring-hooks is effected by the revolution of the narrowing-screw in the following manner: the end of this screw passes through one of the standards, T, of the needle carriage, and its protruding extremity is fitted with a snail-cam, X, the eccentric portions *t t′* of whose volutes, acting upon a pin which is secured to a lever, Y, and projects within their range of motion, move this lever alternately in opposite directions. The lever Y is pivoted at one end to the adjacent standard T of the carriage. Its opposite end is forked to embrace a pin, *x*, which is secured in an excentric position to a hub, $g^3$, made fast to the extremity of the rock-shaft *s* of the transferring-hooks, so that as the lever is moved to and fro by the turning of the snail-cam X on the narrowing-screw the rock-shaft *s* is caused to rock to protrude the transferring-hooks and to withdraw them.

In the operation of the machine it is necessary that the movements of the transferring-hooks longitudinally along the series of needles and their movement in and out by the action of the rock-shaft should not take place simultaneously. The pause in the longitudinal movement of the hooks while the narrowing-screw is turning to move the rock-shaft is effected by causing the narrowing-screw to move endwise as it turns. In order to effect this endwise movement a pair of collars, *z z′*, Fig. 5, having inclined faces, are secured to the standards of the needle-carriage, and a pair of corresponding collars, $z^2$ $z^3$, having snugs projecting from their faces, are secured to the narrowing-screw L′. The faces of the stationary collars *z z′* are inclined in such manner that during a portion of the revolution of the narrowing-screw it is moved endwise in one direction just as fast as it would otherwise tend to screw the hub W in the opposite direction, while during the remainder of its revolution the snugs, passing over parts of the stationary collars which are inclined in directions the reverse of the first, cause the screw to move endwise in the same direction as it screws the hub, while it is also screwing the hub along, so that during the latter part of the revolution of the screw the hub W, and with it the transferring-hooks, is moved longitudinally by the combined movement of the endwise motion of the narrowing-screw and its screw action upon the hub. The inclined portions of the stationary collars *z z′* are of unequal length, and that which furthers the longitudinal movement is the shorter, so that this movement of the transferring hooks is effected during a short angular movement of the narrowing-screw. The pause in the rocking of the rock-shaft *s* while the transferring-hooks are moving toward the opposite selvage is effected by the shape and length of the acting faces of the snail-cam. As the narrowing-screw L′ and the widening-screw L are both turned simultaneously by the action of the cog-wheel $E^4$ upon the slotted shaft $B^5$, the transferring-hooks will be carried longitudinally along the series of needles when the thread-guide bumper M is being moved outward to widen the fabric. During the retrograde movement of the transferring-hooks it is necessary that the stock U, to which they are secured, should not rock, as no stitches at this time are to be transferred. The cessation of the rocking of the shaft during the retrograde movement of the transferring-hooks is effected by pivoting a portion, *v*, of one of the ribs of the snail-cam to the disk thereof in such manner that in turning backward the pin of the lever Y can pass without having any movement imparted to it. The pivoted portion thus acts as a switch to direct the movement of the pin and lever Y, and this switch is held in place by a spring which is secured to that face of the snail-cam which is nearer the standard T of the needle-carriage.

In order to hold the rock-shaft *s* in its position while the snail-cam is not acting upon the rocking lever Y, a spring, *w*, is made to bear upon the rim of the hub $g^3$ on the end of the rock-shaft *s*, which is made eccentric in such manner that the pressure of the spring tends to hold it stationary after it has been rocked forward and backward to its proper positions. The spring, acting upon the rim of the hub $9^3$, also effects another operation in the machine. While the prongs of the transferring-hooks are moving longitudinally along the series of needles they are advanced so far forward as to permit their heels to clear the grooves of the nosing in which the needles lie; but before the needles are protruded it is desirable that the prongs should be in such positions that the needles, in moving forward, cannot fail to enter the stitches upon the transferring-hooks. In order to insure this operation the prongs are rocked slightly backward, so as to cause their heels to re-enter the grooves of the nosing before the needles are protruded. The grooves in the lower sides of the transferring-hooks thus form V-shaped guides above the needles corresponding with the V-shaped grooves in the nosing, and the needles being confined between the two are compelled, in protruding, to enter the stitches on the prongs. This rocking of the rock-shaft *s* to cause the heels of the prongs to re enter the grooves of the nosing is effected by the action of the spring *w* upon the hub $g^3$. The rim of the hub is formed in such manner that when the prongs are in their most forward positions the end of the spring bears upon an inclined part of the rim (shown in dotted lines at $ic^2$, Fig. 11) and tends to rock the shaft and prongs backward, and the snail-cam on the end of the narrowing-screw is of such form that, after the prongs are moved to their appropriate needles, it permits the spring, by acting upon the inclined part of the rim, to turn the rack-shaft and rock the prongs backward the distance required to cause their heels to re-enter the grooves. When this is accomplished the end of the spring finds itself in a notch where it rests, thus holding the prongs in their proper positions.

From the foregoing description it appears that the turning of the slotted shaft $B^5$ in one direction, by acting upon the widening-screw, changes the position of the thread-guide, and thus widens the work, while it at the same time, by acting upon the narrowing-screw, carries along the transferring-hooks, so that the outermost one is always over the selvage-needle and ready to remove the stitches formed thereon. The turning of the slotted shaft $B^5$ in the other direction, by acting upon the narrowing-screw, effects the transferrence of the selvage-stitches toward the opposite selvage, thus narrowing the work, while it at the same time, by acting upon the widening-screw, carries along the thread-guide, so that it is always in a proper position to feed the yarn to the selvage-needle.

In order that the machine may be automatic in its operation, the turning of the slotted shaft $B^5$ must be accomplished, according to the previously conceived design, by the operation of the machine itself, and this is effected as follows: The extremity of the slotted shaft $B^5$ projects through the standard C of the main frame, and has a cog-wheel, $f'$, secured to it, which forms the first of a train of cog-wheels, $f' f^2 f^3 f^4 f^5 f^6 f^7 f^8$, the last one, $f^8$, of which is made fast to a counter-shaft, $B^6$, that is supported in suitable bearings beneath the top of the bed frame of the machine. This counter-shaft has a beveled wheel, $f^9$, secured to it, which is driven by a corresponding beveled wheel, $f^{10}$, secured to a shaft, $B^7$. This last-mentioned shaft projects through the back of the bed-frame, and its projecting extremity is fitted with two ratchet-wheels, $R^2$ and $R^3$, Figs. 6, 7, and 15, whose teeth incline in opposite directions. Each of these ratchet-wheels has a ratchet lever and pawl appertaining to it, by which it is moved to turn the ratchet-wheel shaft to impart motion (through the beveled wheels $f^9$ $f^{10}$, the counter-shaft $B^6$, and the train of cog-wheels $f' f^2 f^3 f^4 f^6 f^6 f^7 f^8$) to the slotted shaft $B^5$. As the turning of the ratchet-shaft $B^7$ in one direction or the other, by the operation of one or other of the pawls upon its appropriate ratchet-wheel, effects a corresponding turning of the slotted shaft $B^5$ in one direction or the other, and as the direction in which the slotted shaft $B^5$ is turned effects either the widening or narrowing of the fabric, it follows that when the one ratchet-wheel is acted upon by its appropriate pawl the fabric will be widened, and when the other is acted upon the fabric will be narrowed. In the present machine the outer ratchet-wheel, $R^2$, is the narrowing-wheel, and the inner one, $R^3$, the widening-wheel. The pawl $S^3$ of the latter is pivoted to a ratchet-lever, $L^3$, which is hung upon the ratchet-shaft $B^7$, and whose tail is fitted with a pin, $d^3$, Figs. 15 and 7, which lies upon a cam, $C^3$, secured to the cam-shaft $B^4$, so that as the cam is turned the ratchet-lever is caused to vibrate and the pawl $S^3$ is caused to move to and fro. The pawl $S^2$ of the narrowing ratchet-wheel $R^2$ is pivoted to a similar ratchet-lever, $L^2$, whose tail is fitted with a pin that bears upon a cam, $C^2$ $C^4$, also secured to the cam-shaft $B^4$, so that as this shaft turns this pawl is also caused to move to and fro, as the movement of the thread-guide to widen is effected while it is traveling in its lowest position, and as this movement may be a simple continuous movement, the cam $C^3$, which operates the widening-pawl, is solidly secured to the shaft $B^4$. The movement of the transferring-hooks, on the contrary, to narrow the fabric has to be accomplished partly while the needles are protruded to their farthest limit, partly while they are withdrawn inward, and partly after they have been protruded again to take the stitches off from the transferring-hooks. The movement of the narrowing-screw is therefore intermittent; it must also be effected partly while the carriage is

traveling in one direction and partly while it is traveling in the other direction. The extent of movement of the narrowing screw during the two movements of the carriage must also be unequal in the present machine. In order to produce these intermittent and unequal movements, the cam, as shown particularly in Fig. 15, is made up of two parts, $C^2$ and $C^4$, one part, $C^2$, being fast to the shaft $B^4$ and always traveling with it, while the other part, $C^4$, is moved by a pin working in a slot in the cam-disk, so that this portion of the cam does not begin to move until the shaft has traveled a certain distance in one direction or the other and the end of the slot has been brought into contact with the pin. The loose portion $C^4$ of the cam is maintained in the position in which it is placed during the time the shaft is not imparting motion to it by means of a spring-brake, $w^4$, (seen in Fig. 10,) which being secured to the inside of the standards $h^4$, which support the cam-shaft $B^4$, bears against the cam. With a compound cam of this description the most eccentric portion $C^2$ of this cam leaves the second part, $C^4$, as the cam is turned in the direction of the arrow in Fig. 15, and thus passes outside of the pin of the ratchet-lever $L^2$, leaving the latter to be moved wholly by the second part, $C^4$, of the cam. When, however, the cam is turned in the direction of the arrow in Fig. 5 the second part of the cam remains stationary until the most eccentric part $C^2$ has closed up the space between the two, after which the two move on simultaneously forming one continuous curved rim, which passes beneath the pin of the ratchet-lever, and thus causes it to be moved by the most eccentric part of the cam. The pawls $S^2$ and $S^3$ are not permitted to act upon their respective ratchet-wheels, except when widening or narrowing is to be effected. Each pawl is therefore held out of gear with the teeth of its ratchet-wheel by means of a loose collar of sufficient diameter, upon whose periphery the pawl rides. The collar $G^2$ of the narrowing-pawl $S^2$ is fitted to turn loosely upon the ratchet-wheel shaft $B^7$, and is connected by a rod, $r^2$, with the end of an arm, $H^2$, that projects from a rock-shaft, $B^8$. This rock-shaft is fitted with a second arm, $I^2$, that rides upon a pattern-barrel, $J^2$, which is perforated to receive pattern-pins $i^2$ $i^2$. One portion of the rim of the ratchet-collar $G^2$ is notched sufficiently to let the pawl fall into the teeth of the ratchet-wheel when the notch of the collar is beneath the pawl, and as the collar is connected by the rod $r^2$ with the arm $H^2$ of the rock-shaft the pin of the pattern-barrel, operating upon the other arm, $I^2$, of the rock-shaft, effects the turning of the collar, thereby permitting the pawl to drop into the ratchet-wheel and move it, and thus direct the narrowing of the fabric. The collar $G^3$ of the widening-pawl $S^3$ is similar in all respects to that of the narrowing-pawl. It is connected by a rod, $r^3$, with an arm, $H^3$, that projects from a loose sleeve, $K^3$, on the rock-shaft $B^8$; and this sleeve is fitted with a second arm, $I^3$, that rides over another portion of the pattern-barrel $J^2$, which is also perforated to receive pattern-pins, by whose operation the action of the widening-pawl upon its ratchet-wheel is directed.

In the present machine we have found it convenient to use a single pattern-barrel $J^2$, Figs. 4, 7, 10, 13, and 14, for both widening and narrowing, and this barrel is turned the space of a pattern-pin at each alternate movement of the carriage by means of a cam, $C^5$, which is secured to the cam shaft $B^4$ and operates upon a ratchet-lever $L^5$. This lever is furnished with a pawl, $S^5$, which operates upon the teeth of a ratchet-wheel, $R^5$, that is connected with the pattern-barrel $J^2$. As the pattern-barrel is thus moved the space of a pattern-pin at each alternate movement of the needle carriage, there must be as many pin-holes in it for each pawl as there are to be double stitches in the length of the fabric to be widened and narrowed, and as the large number of pattern-holes thus required would require a pattern-barrel of large diameter, which would be inconvenient in some machines, we have arranged the series of pattern-holes in two helical lines, winding around the barrel from one of its ends toward the other; and in order to cause all these holes in succession to pass beneath the arms upon which they are to act, an endwise movement is imparted to the pattern-barrel simultaneously with its rotation. In order to effect this endwise movement the pattern-barrel is hung loosely upon a stationary screw-shaft, $B^9$, and a tooth, $t^3$, is secured to the hub of the pattern-barrel to engage in the thread of the screw, so that as the barrel is turned the screw-thread, acting upon the tooth $t^3$, pushes the barrel endwise. The ratchet-wheel $R^5$ is hung loosely upon the shank of the screw $B^9$, and in order that it may turn the barrel without interfering with the endwise movement thereof it is connected with the barrel by a bayonet-clutch, whose arms $a^3$ $a^3$ extend through corresponding holes in the hub of the barrel, which thus slides along the arms of the clutch, but is forced to turn with them.

When a machine of this description with a long series of needles and sinkers is working upon narrow work it is expedient that no more motion should be imparted to the carriage than is necessary to carry the needles and sinkers that are forming stitches past the inclined parts of their respective cam-grooves. In order to save the wear and tear and the time that would be lost by imparting an unnecessary amount of movement to the carriage, we have constructed our machine in such manner that the extent of movement of the carriage is varied in proportion to the breadth of the fabric being formed at the time, the range of the motion of the carriage thus increasing as the work is widened and decreasing as the work is narrowed. It is also expedient that the pattern-barrel $J^2$ should be turned at one particular time in reference to the movement of the carriage, and it is essential that the apparatus

for widening and narrowing the fabric should be made to operate when the selvage-needle, whichever it may be, has been brought by the movement of the needle-carriage to the same part of the cam-groove, as then each needle, in the process of widening or narrowing, becomes for the time being the selvage-needle. The cams must be made to operate sooner or later upon the ratchet-levers as the work grows wider or narrower. All these variations are effected in the machine we are describing by varying the angular relation of the cam-shaft $B^4$ to the cog-wheel shaft $B^3$ by changing the position of the beveled-pinion stock H′, for it is evident that if this stock be turned on its axis to vary the position of its axles of its pinions the angular position of the secondary beveled wheel $c^4$ to the primary beveled wheel $c'$ will be changed.

In order to change the position of the pinion-stock H′ in proportion to the widening and narrowing, a series of screw-teeth, $e^4$, are cut upon its rim, and these teeth engage in the thread of a screw, $j^4$, formed upon the counter-shaft $B^6$ of the widening and narrowing mechanism, so that in proportion as the counter-shaft is turned (by the action of the pawls upon the ratchet-wheel) in one direction or the other, to widen or to narrow the work, so is the stock adjusted to vary the angular relation of the cam-shaft $B^4$ to the cog-wheel shaft $B^3$, and thus vary the times at which the acting surfaces of the cams come in contact with and operate their respective ratchet-levers to commence the movement of the widening and narrowing mechanism. As the movement of the rock-shaft $B^2$ to change the shifting-lever A′ and reverse the movement of the carriage when it is approaching the end of the machine at which widening and narrowing are effected depends upon the time at which the driver on the cam-shaft $B^4$ comes in contact with the snug of the drum $P^8$, the above-mentioned change in the angular relation of the cam-shaft with respect to the cog-wheel shaft causes the driver to operate the drum and its strap sooner or later, and thus causes the movement of the carriage to be reversed when it has approached more or less near to the standard C. As the cam $C^5$, that operates the ratchet-lever of the pattern-drum, is secured to the cam-shaft $B^4$ and moves with it, the relation between the times of the movement of the cams and of the pattern-barrel remains the same, while the movement of the pattern-barrel in relation to that of the cog-wheel $E^2$ varies with the widening and narrowing, and with the variation in the movement of the needle-carriage.

In the operation of the machine we are describing it is necessary that the sinkers should be out of the way of the transferring-hooks when the latter remove the stitches from the needles, and during the time they are carrying the stitches along and transferring them again to the needles. In order to remove the sinkers for this purpose, and at the same time that they may be in their proper positions to operate during the feeding of yarn and the formation of stitches, the cam-groove of the sinker-cam bar is constructed with a double grade, so that the sinker-snugs are traveling in the upper grade, $g^6$, and the lower extremity of the sinkers are above the bar $c$ and out of the way of the transferring-hooks while narrowing is being effected. On the other hand, the sinker-snugs are traveling in the lower grade, $g^7$, during the feeding of the yarn.

When a machine in which the needles are alternately protruded and drawn back through the stitches is in operation the protrusion of the needles tends to cause them to carry along with them the stitches through which they move by the friction of the stems of the needles upon the yarn. This tendency is injurious in its effects, as it prevents the stitches from being close up against the nosing at the time new stitches are being formed, and thus tends to render the work uneven. In order to obviate this defect we construct the cam-groove of the needle-cam bar with a protuberance, $i^5$, by the operation of which the needles are caused to protrude to a greater extent than is necessary in the formation of stitches, and that as the needle snugs pass this protuberance the needles are drawn back sufficiently to draw the stitches lying upon the needles in close contact with the nosing before new stitches are formed.

In our specification appertaining to our patent of the 16th day of February, 1858, we have described the needles as pressed upward against the bar $e$ to close their barbs by means of movable support whose upper edges are wholly on the inner side of the sinkers. When such movable supports are used in connection with automatic widening and narrowing mechanism the mechanism that operates them should be combined in such manner with the cam-shaft $B^4$, or other variable portion of the machine, that the movement of the supports varies with the widening and narrowing of the fabric.

In the machine we are now describing we have deemed it expedient to employ stationary under supports; and in order that they may not interfere with the operation of the needles and sinkers we construct each support of two parts, one of which, $k^4$, is on the inner side of the sinkers and effects the raising of the needles to close their barbs, while the other part, $k^5$, of the support is on the outer side of the sinkers and supports the needles during the feeding of the yarn and the descent of the sinkers to form the loops. By the employment of supports of this construction we are enabled to dispense with their movement, while at the same time a tight selvage is insured, as the yarn, being within the ridge of the support, is not drawn over it—an operation which tends to elongate the stitches.

The fabric, as fast as it is formed, is drawn beneath the needle-bed on the carriage by the operation of a pair of take-up rollers, M′ $M^2$, Figs. 5, 6, 10, 11, and 12, situated at the back of the carriage. The lower one, $M^2$, of these rollers has a ratchet-wheel secured to one of its

extremities, which is turned a tooth at a time to take up the work by means of a ratchet-lever, $L^6$, having a pawl, $S^6$, secured to it, which engages with the ratchet-teeth. The ratchet-lever $L^6$ is drawn back so that its pawl may engage with a new tooth by means of a spring. It is moved forward to impart motion to the take-up roller at each passage of the needle-carriage by means of a double-inclined plane, $N^6$, which is secured to the main frame of the machine. The take-up roller is prevented from retrograding while the pawl is passing to a new tooth of the ratchet-wheel by means of a spring-pawl, $S^7$, which is secured to the needle-carriage D, and which engages with the teeth of the same ratchet-wheel. The upper take-up roller is pressed toward the lower, so as to nip the fabric between the two by connecting its boxes with the carriage-frame by means of springs $m^4$; and in order to prevent the slipping of the fabric between the rollers, without the employment of an injurious amount of pressure, we have covered the lower roller with an elastic material—vulcanized india-rubber, for example—in whose surface the stitches of the fabric slightly indent themselves.

An eyelet, $W^3$, is secured to the front side of the bed-frame of the machine to guide the yarn, which is previously wound upon a suitable bobbin or tube in such manner as to deliver freely. From this eyelet the yarn is conducted to the thread-guide and passes through it, after which it is applied to the needles. When the machine is put to work the carriage is set at one end of its track and the thread-guide stands at the inner end of the whole series of needles and sinkers, so that when the carriage is moved the needles and sinkers in succession pass by the thread-guide, which, remaining stationary, feeds out the yarn to the needles as they pass. As the needles, in their movement, ride over the support the sinkers are caused, by the action of their cam-groove, to descend in succession between the needles and carry down folds of yarn, thus forming loops upon the needles. As the sinkers descend the continued progression of the carriage carries the needle-slides along the inclined portion of their cam-groove and causes the needles to be drawn into the orifices in the nosing. As this operation is taking place while the needles are riding over the highest portion of the under support they are pressed up by its action against the bar *e* of the sinker-bed *d*. The pressure thus produced closes the barbs of the needles, so that as they are drawn into the orifices they enter and pass through the series of loops of yarn previously formed, and drawing the new folds or loops with them through this previous series cast off the latter. The withdrawal of the needles into the orifices of the nosing takes place simultaneously with the ascent of the sinkers by the action of the groove of their cam-bar, so that the folds of yarn formed by the latter are rendered up to the needles as they enter the orifices. When, in the progression of the carriage, the selvage-needle has passed the thread-guide the bumper M, striking the corresponding snug, *i*, on the thread-guide carriage, causes it to move with the needle-carriage, so that no more yarn is fed by the movement of the latter past the former. While the two carriages are moving together the thread-guide is caused to descend by the action of its cam-groove and to rise again as the needle-carriage approaches the extremity of its stroke, and when the needle-carriage comes to rest the thread-guide is at the inner end of the series of needles, ready to feed out yarn when the carriage again begins to move toward the end of the machine from which it first started.

In forming goods of varying width—which is the kind of work for which this machine is specially adapted—the automatic widening and narrowing mechanisms are brought into operation. In this case the work is commenced upon as many needles as it is to be stitches in breadth, and the thread-guide and transferring-hooks are set (by turning the slotted shaft $B^5$ by hand) so that the thread-guide and the outermost transferring-hook are in the proper positions to operate in connection with the outermost needle in operation, which becomes the selvage-needle for the time being. The pattern-barrel $J^2$ is then run back by hand on its screw-shaft, the pawl $S^5$ of its ratchet-wheel having been first thrown out of gear, and as many pattern pins are inserted in their proper holes as there are to be changes in the width of the fabric.

It will be remembered that widening and narrowing may take place at one side of the fabric at each alternate line of stitches. If, therefore, widening is to take place at the tenth line of stitches, a pattern-pin must be applied to the fifth hole in the series of holes which pass beneath the widening-collar arm $I^3$, and in the same manner as many pins are to be inserted in their proper holes as there are to be changes in the width of the fabric by widening. If the fabric is to be narrowed as well as widened, pattern-pins are to be inserted in the series of holes in the pattern-barrel which pass beneath the narrowing-collar arm $I^2$, a pin being inserted for each row of stitches at which a change is to be made by narrowing. When the machine is in operation the turning of the pattern-barrel brings the pattern-pins in proper order and at the proper times beneath their respective arms, and widening and narrowing take place, according to the design conceived by the attendant in placing the pattern-pins. The narrowing mechanism begins to operate when the selvage-needle, after having reached the center of the machine, begins to recede into its nosing. At this moment the turning of the narrowing ratchet-wheel by the operation of the appropriate cam causes the stock of the transferring-prongs to be rocked forward, so that as the needles recede they leave their stitches upon the transferring-hooks. When the sinkers, by the continued progression of the carriage, are raised out of the way

of the transferring hooks or prongs the latter, with the stitches upon them, are carried along by the action of the cam upon the ratchet-wheel until they are above the needles to which the stitches are to be transferred, and are drawn back until their heels re-enter the grooves of the nosing. Then as the carriage returns toward the center of the machine the heads of these needles, in protruding from the nosing, glide along the grooves in the lower sides of the transferring-hooks and enter the stitches, after which the rocking of the stock of the transferring-hooks by the continued action of the cam draws back the transferring-hooks, leaving the stitches upon the needles to which they have thus been transferred. As we have before stated, the widening mechanism begins to move by the action of its appropriate cam after the thread-guide has descended, and the movement is complete before it reascends.

In knitting-machines constructed previous to our invention it has been customary to transfer stitches by hand by means of a fork or "tickler," as it is technically called, whose points are entered by the hand of the attendant into the stitches on the needles from the front sides of the sinkers. In effecting this operation, even by hand, difficulty is experienced, from the fact that the parts of the needles which extend beyond the sinkers are neither supported firmly nor held in exact positions laterally, nor is their any arrangement for guiding the points of the transferring instruments into the stitches. The last difficulty is obviated in our machine by the secondary grooves in the needles, by which the points of the transferring-instrument are guided along their stems into the stitches, and the first two defects are obviated in our machine by causing the transferring-instrument to enter the stitches from the hinder sides of the sinkers, their points thus traversing the secondary grooves of the needles, while the latter are firmly supported and held rigidly in their proper positions laterally by the V-grooves of the nosing in which the needles lie at the time.

It will be evident to the skillful mechanical engineer that our machine may be modified to a great extent without affecting the principle of our invention, and we contemplate to modify the construction and arrangement of machines which embody it as circumstances may render expedient. Thus, for example, we have described the widening and narrowing mechanism as applied to one end only of the series of needles; but we have adapted the same mechanism to both ends of the series of needles. In this case a duplicate pattern-barrel and mechanism to operate the same, with the ratchet-shaft and their appurtenances, and a a train of gearing, are applied to each end of bed-frame of the machine, and the train of gearing at the right-hand end of the bed-frame is caused to operate a second slotted shaft parallel with the slotted shaft $B^5$, which, in the present machine, is in connection with the train of gearing at the left-hand end of the bed-frame. This second slotted shaft is made to operate a duplicate set of widening and narrowing screws, the widening-screw operating the bumper K and the narrowing-screw operating a duplicate set of transferring-hooks and their mechanism. A convenient way of arranging these duplicate widening and narrowing screws and the duplicate rock-shaft of the transferring-hooks is to arrange them in lines with those of the first set and to extend them from a bracket at the center of the carriage, across the slides of the series of needles with which they are to act in concert, toward the right-hand end of the bed-frame. Each set of widening and narrowing mechanism will thus act in concert with half of the whole series of needles contained in the carriage. As the two slotted shafts must extend the entire length of the bed-frame, they cannot be arranged in line with each other, but must extend side by side. In this case motion is readily communicated from the cog-wheel of the slotted shaft that is farther from its widening and narrowing screw to the cog-wheels of these series, through the intervention of an intermediate cog-wheel, which is arranged to turn freely upon the nearer slotted shaft, and whose teeth engage at one side with those of the cog-wheels upon the screws, and at the opposite side with the teeth of the cog-wheel upon the second slotted shaft. In some cases it may be deemed desirable to cause the widening and narrowing mechanisms appertaining to the needles at one end of the carriage to act in concert with a portion of the needles of the opposite widening and narrowing mechanisms. In this case the duplicate screws and rock-shafts cannot be placed in line, but must overlap each other, and the means of communicating motion to them from their appropriate slotted shafts must be varied to adapt them to these changes.

We have described a peculiar pattern-barrel for directing the movement of the widening and narrowing mechanisms, believing that this device is the best that can be used; but it is evident that a pattern-barrel of different construction may be used—as, for example, one of sufficient diameter to contain a sufficient number of pattern-holes in one belt for each arm moved by them. A pattern-barrel may be employed for widening alone, and a separate one for narrowing alone, or a pattern-chain may be employed to direct the widening and narrowing mechanisms, or a Jacquard mechanism may be employed for the same purpose. In constructing the needles the secondary grooves in their stems may extend entirely through the stems, so as to take the form of a slot, or this groove may be made to connect with the hinder end of the groove in which the barb is received, so as to form one continuous groove.

Our invention is applicable to the manufacture of fancy goods—as, for example, open-work stockings and other knitted goods in which the pattern is produced by transferring

the stitches. In such cases the transferring-hooks are set at the commencement of the knitting above those needles from which the stitches are first to be transferred, and pins are inserted in the pattern-barrel in the proper holes to effect the transference at the proper row of stitches.

The present machine is adapted only to the formation of patterns by transferring stitches laterally in one direction; but it is evident that by imparting suitable movements to the narrowing-screw, and to the rock-shaft which carries the transferring-hooks, transference may be accomplished in both directions. The transferring mechanism may also, if desired, be adapted to the transferring of stitches laterally the space of several needles at once instead of one needle at a time. Moreover, the various parts of our invention may be used simultaneously in one machine, or parts of it may be applied separately to machines where it may be found expedient to employ them.

Having thus described the various parts of our improvement and the manner of embodying the same in a working machine, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The transferring of stitches, in a knitting-machine, from the needles on which they have been formed to other needles by means of transferring-hooks, or their equivalents, which take the stitches from the needles, move along to other needles, and deliver the stitches to these other needles, operating automatically, substantially as herein set forth.

2. Arranging transferring-hooks with reference to the needles in such manner that they may enter the stitches upon the needles by moving a long the stems of the needles toward their heads, substantially as herein set forth.

3. Directing the operation of transferring-hooks, or their equivalents, for transferring stitches by means of a pattern-barrel, or its equivalent, operating substantially as herein set forth.

4. Combining the mechanism that actuates transferring-prongs with the mechanism that moves the needles of a knitting-machine in such manner that the prongs enter the stitches upon the needles at times when the latter are supported both vertically and laterally, substantially as herein set forth.

5. Combining a nosing having V-shaped grooves with transferring-prongs having corresponding grooves, the grooves of the nosing and prongs acting in concert to confine the needles and direct their heads into the stitches on the transferring-prongs.

6. Controlling the operation of the mechanism by means of which the relation of the thread-guide to the needles is changed, so that yarn is supplied to more or less needles by means of a pattern-barrel, or its equivalent, operating substantially as herein set forth.

7. Varying the extent of travel of the needle-carriage in proportion to the number of needles at work by means of mechanism operating automatically, substantially as herein set forth.

8. Varying the periods of time at which the transferring mechanism begins to operate in proportion to the number of needles at work by means of mechanism operating automatically, substantially as herein set forth.

9. Combining the widening mechani-m with the mechanism that actuates the needle-carriage in such manner that the period of time at which the former operates is varied in proportion to the number of needles at work.

10. Combining the mechanism that actuates the pattern-barrel, or its equivalent, with the mechanism that actuates the needle-carriage in such manner that the period of time at which the former is moved is varied in proportion to the number of needles at work.

11. Combining the widening mechanism and the narrowing mechanism together, when both are used in the same machine, in such manner that the movement of the one to do its work is attended by a corresponding movement of the other, so that the thread-guide and transferring-hook, or their equivalents, are both in the proper position to operate in connection with the selvage-needle.

12. Raising the sinkers out of the way of the prongs of the transferring instrument, substantially as herein set forth, so that the latter may move along the series of needles without obstruction from the sinkers, substantially as herein set forth.

13. Obtaining a pause in the endwise movement of a nut moved by a screw by causing the screw to move endwise while it is turning in the nut, substantially as herein set forth.

14. The arrangement of the pattern-holes of a pattern-barrel in a helical line, so that they may be brought in succession beneath the device upon which the pattern-pins operate by a screw or its equivalent.

15. Operating the transferring-instrument, substantially as herein set forth, in such manner that its movement is effected partly while the carriage is traveling in one direction and partly while it is traveling in the opposite direction.

16. Combining with a traveling series of needles and a rigid bar above them stationary under supports, over which the needles ride, so that their barbs may be closed by pressure against the stationary bar above them.

JOSEPH K. KILBOURN.
EDWARD E. KILBOURN.

Witnesses as to the signature of Joseph K. Kilbourn:

JOHN C. WEST,
N. L. JOHNSON.

Witnesses as to the signature of Edward E. Kilbourn:

A. G. PETTIBONE,
JOHN H. WELCH.