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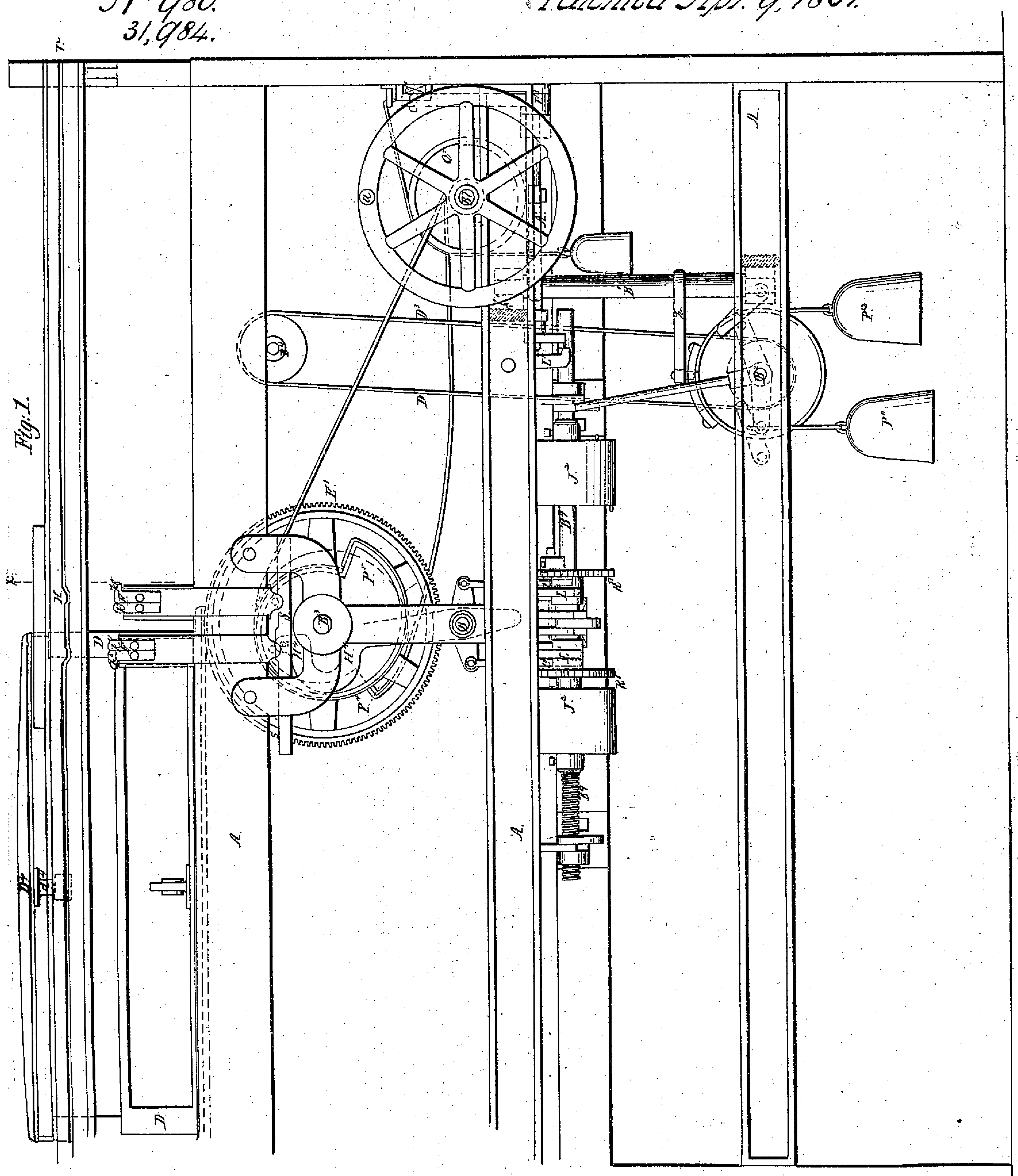
J. K. & E. E. Kilbourn.

Knitting Mach.

No. 980.
31,984.

Patented Apr. 9, 1861.

Fig: 1.



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Inventors: Edward E. Kilbourn, Joseph K. Kilbourn

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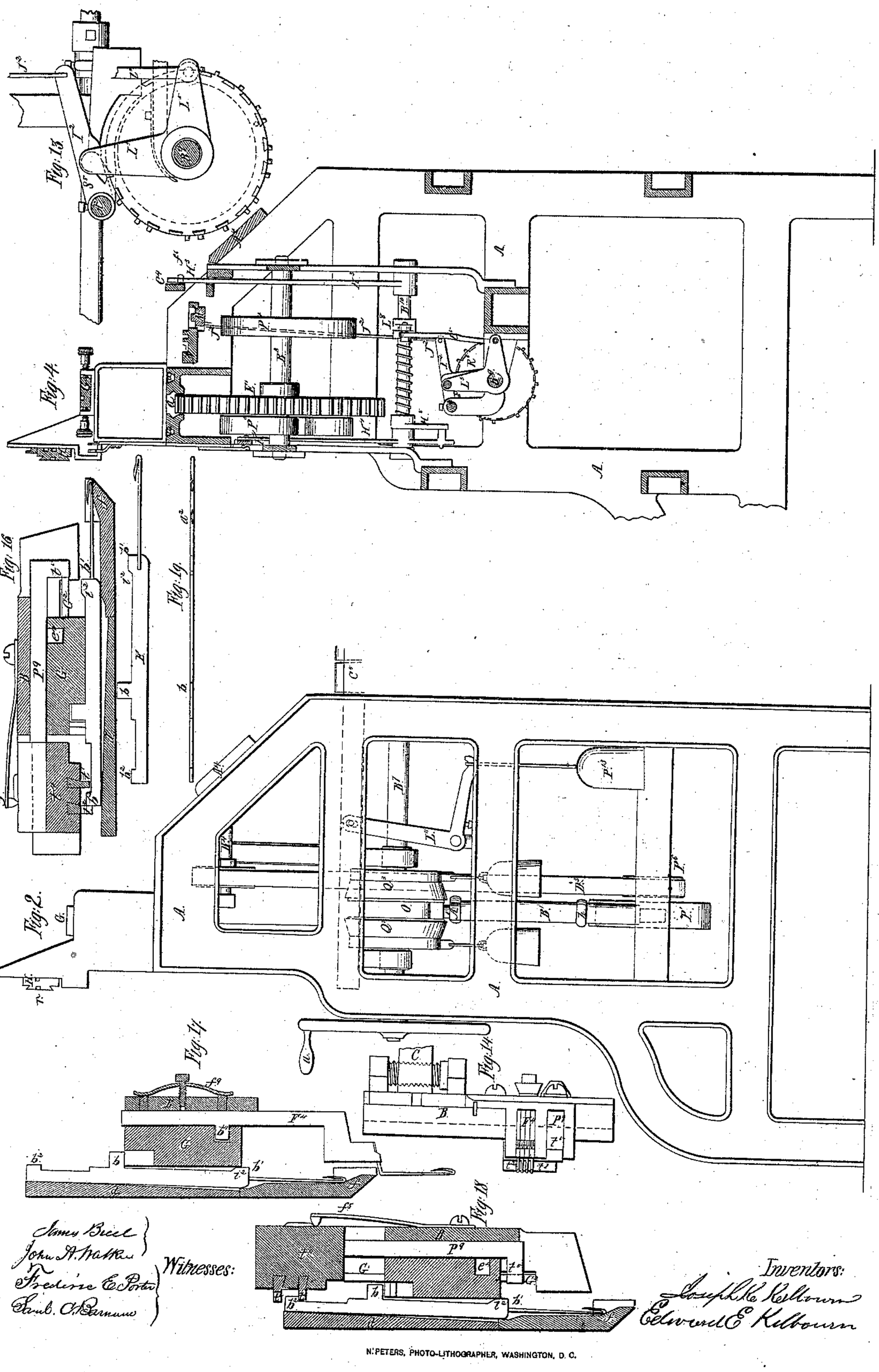

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Knitting Mach.

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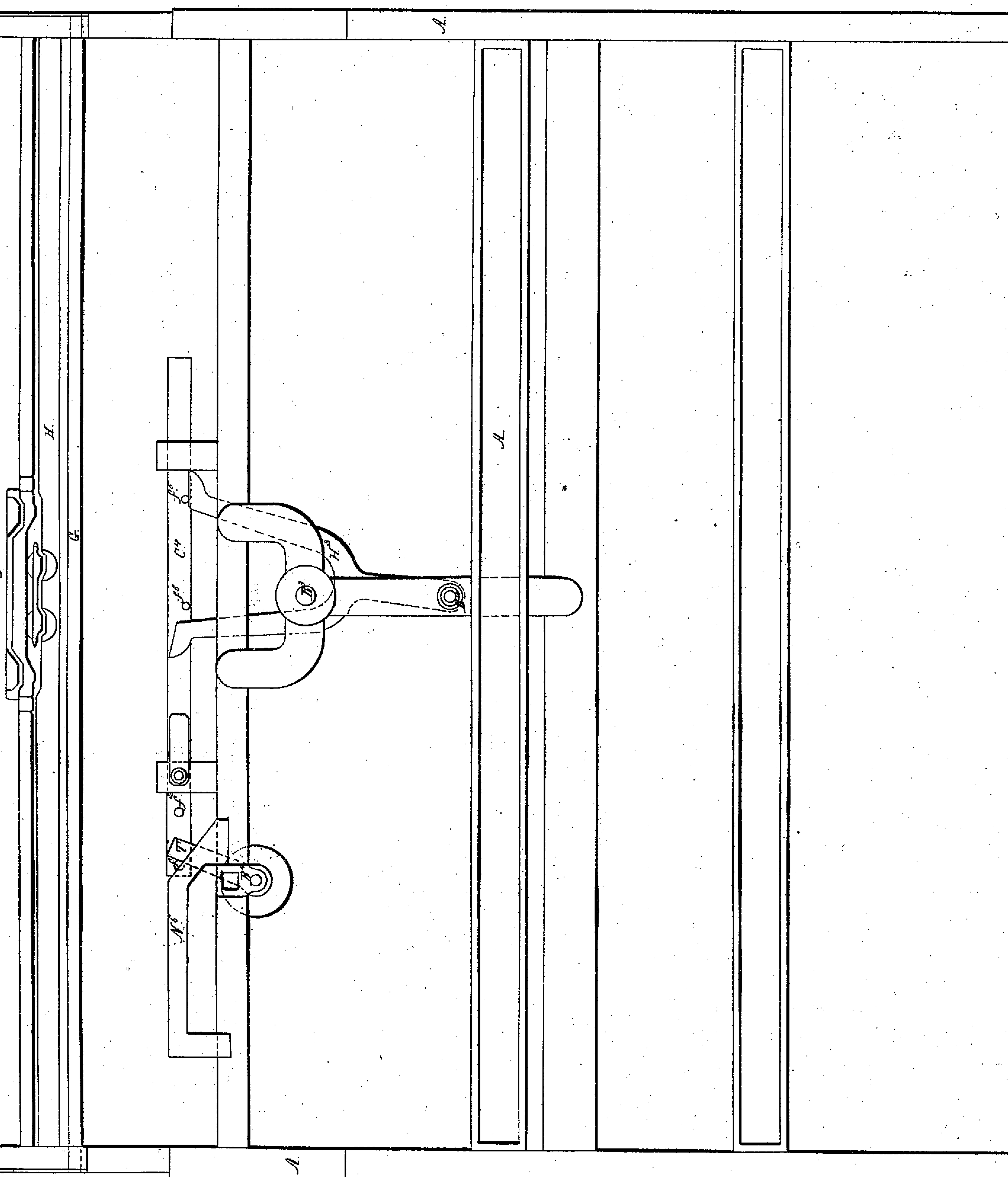
Fig. 3.



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Patented Apr. 9, 1861.

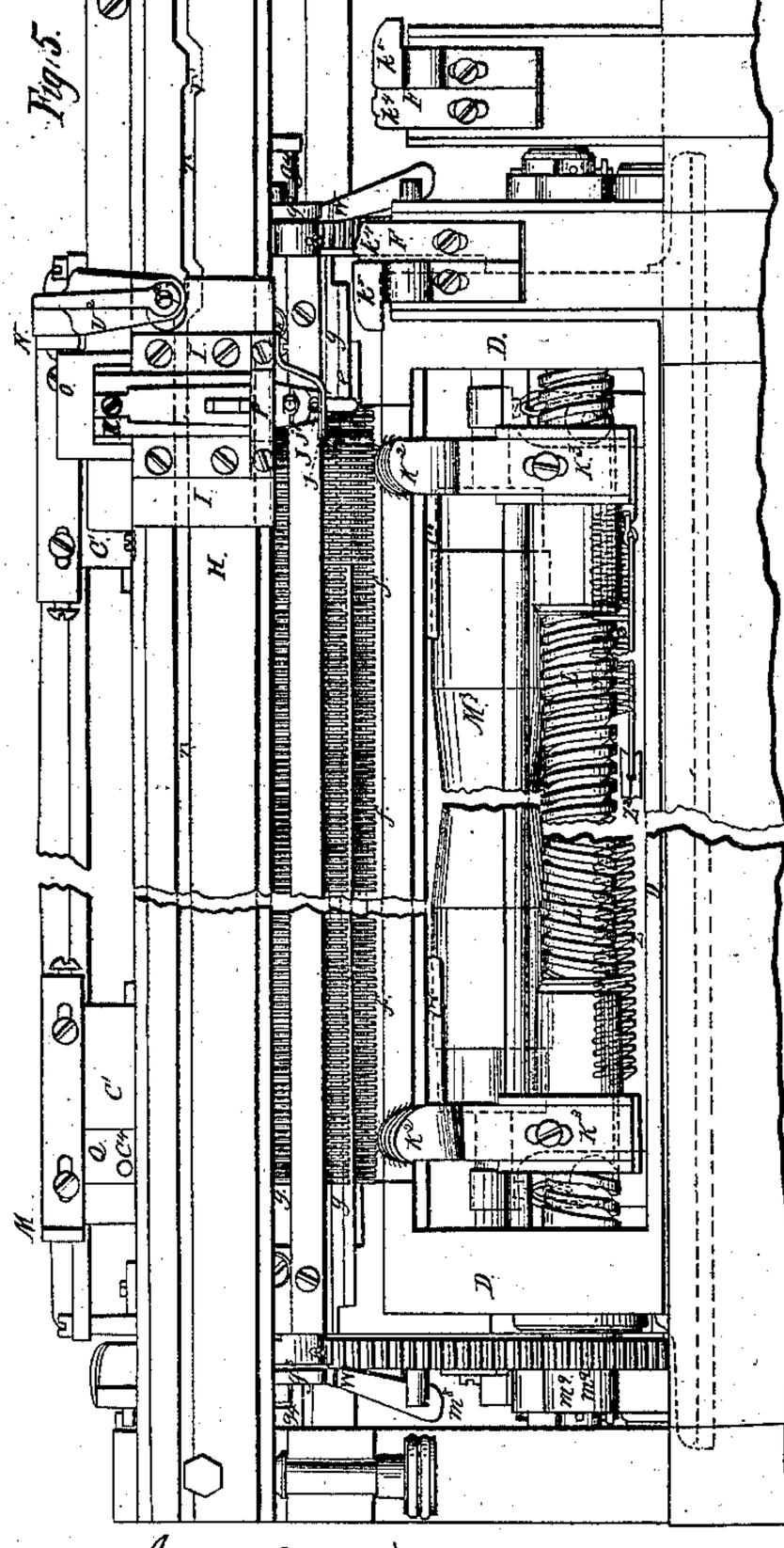

Fig. 5.

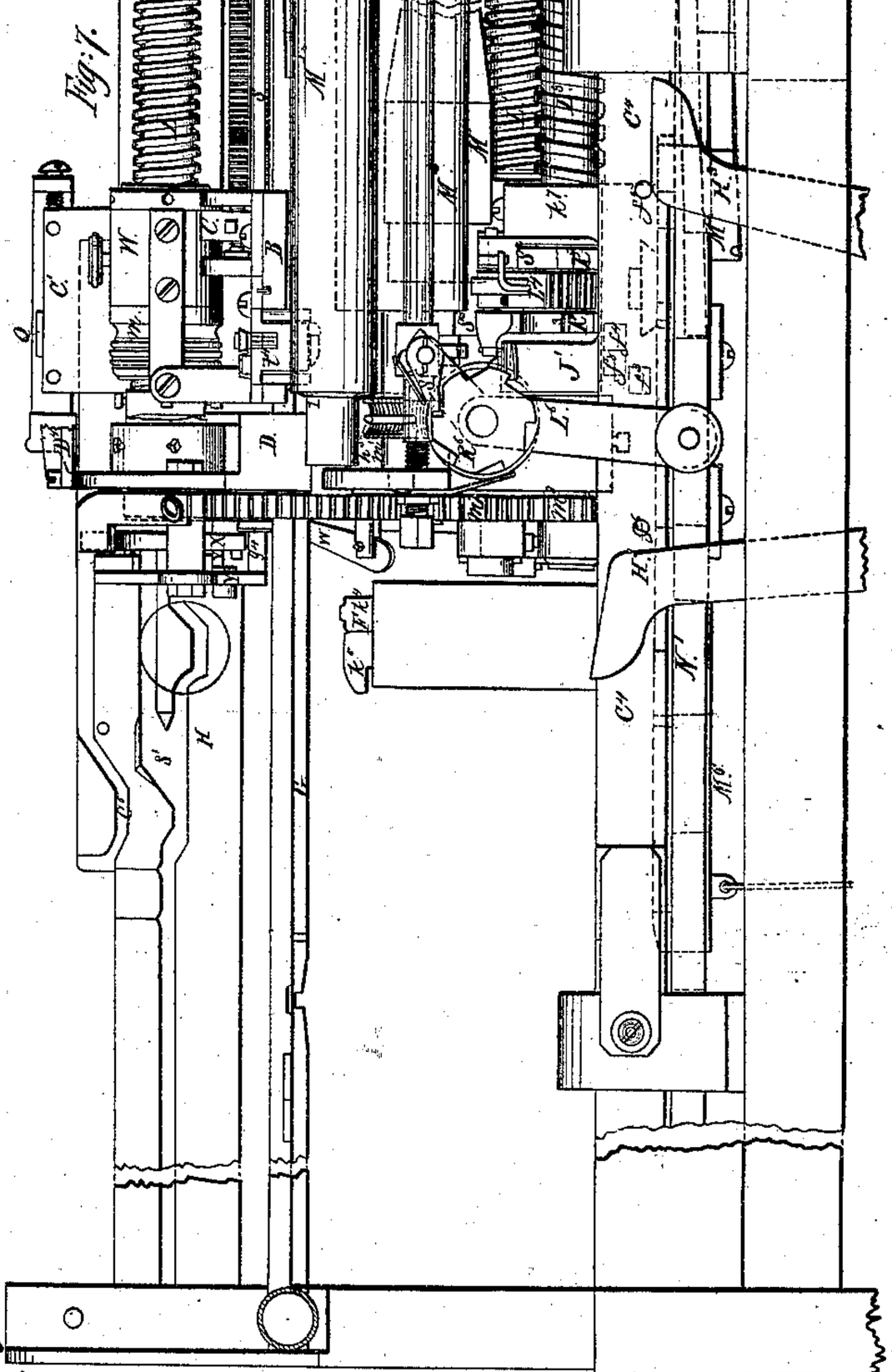

Fig. 7.

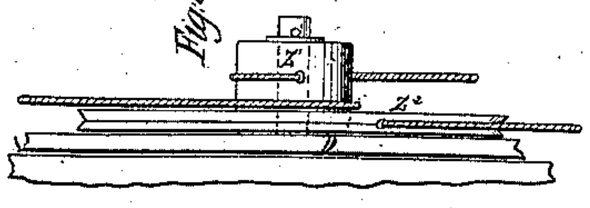

Fig. 5a.

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Fig. 6.

Fig. 10.

Fig. 9.

Fig. 8a.

Fig. 8.

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Fig. 12.

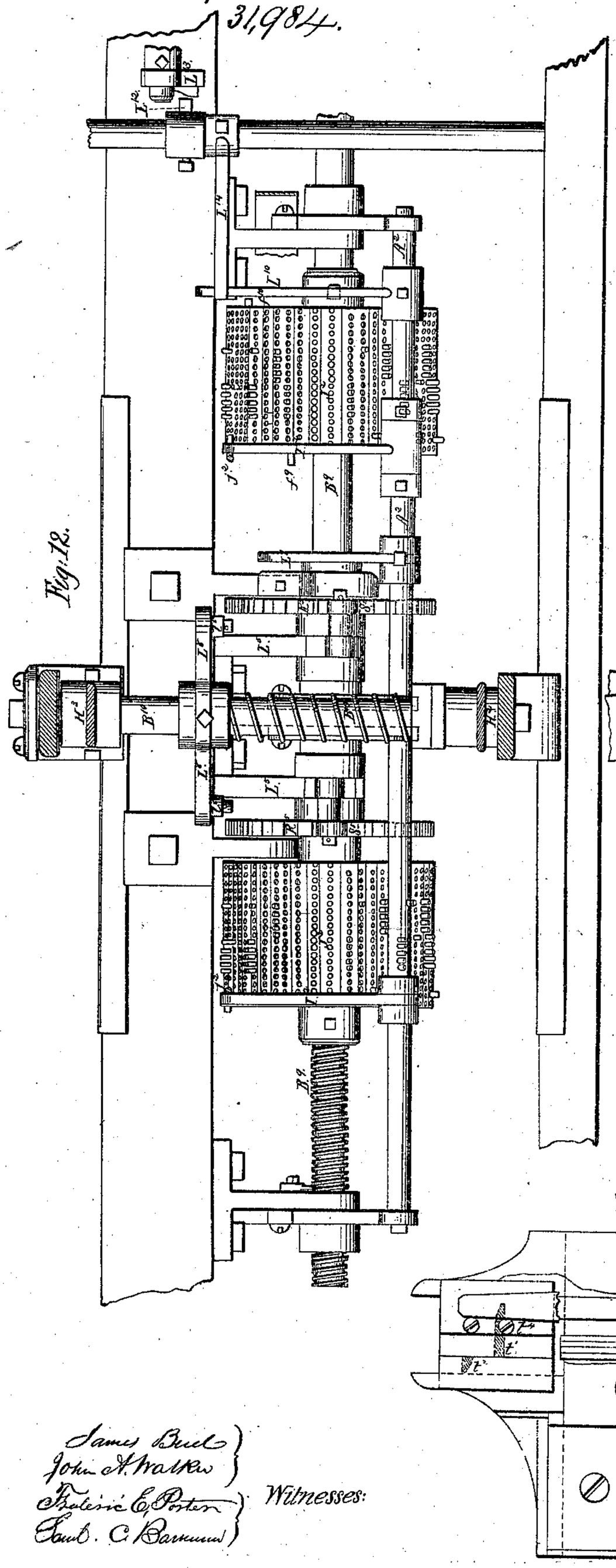

Fig. 11.

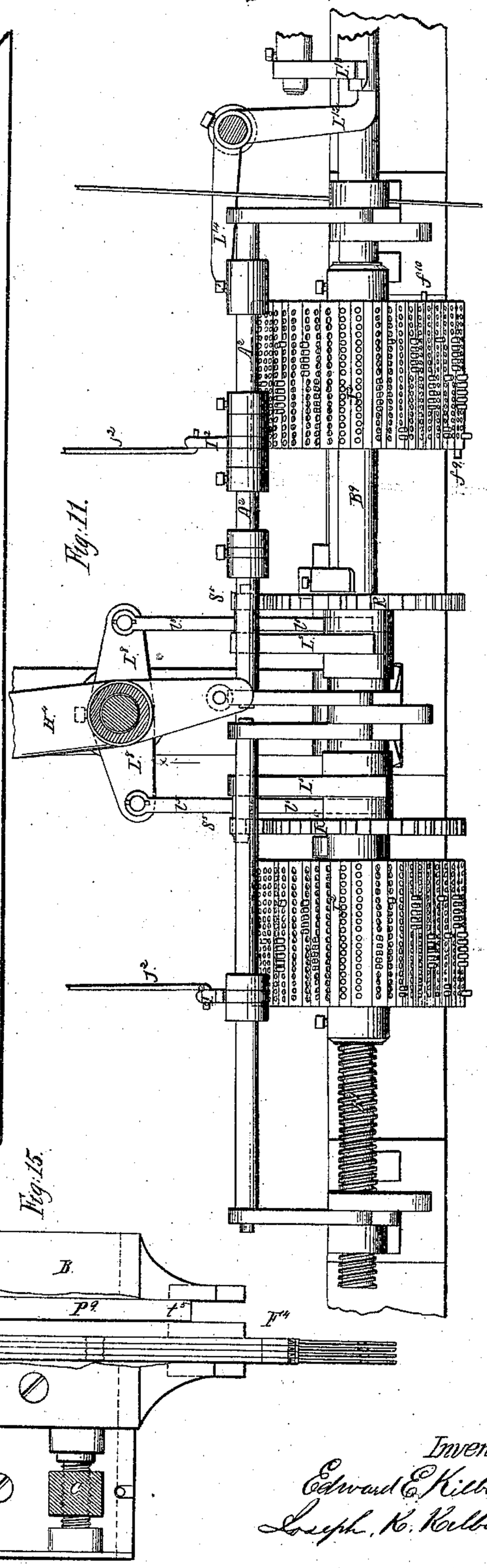

Fig. 15.

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Knitting Mach.

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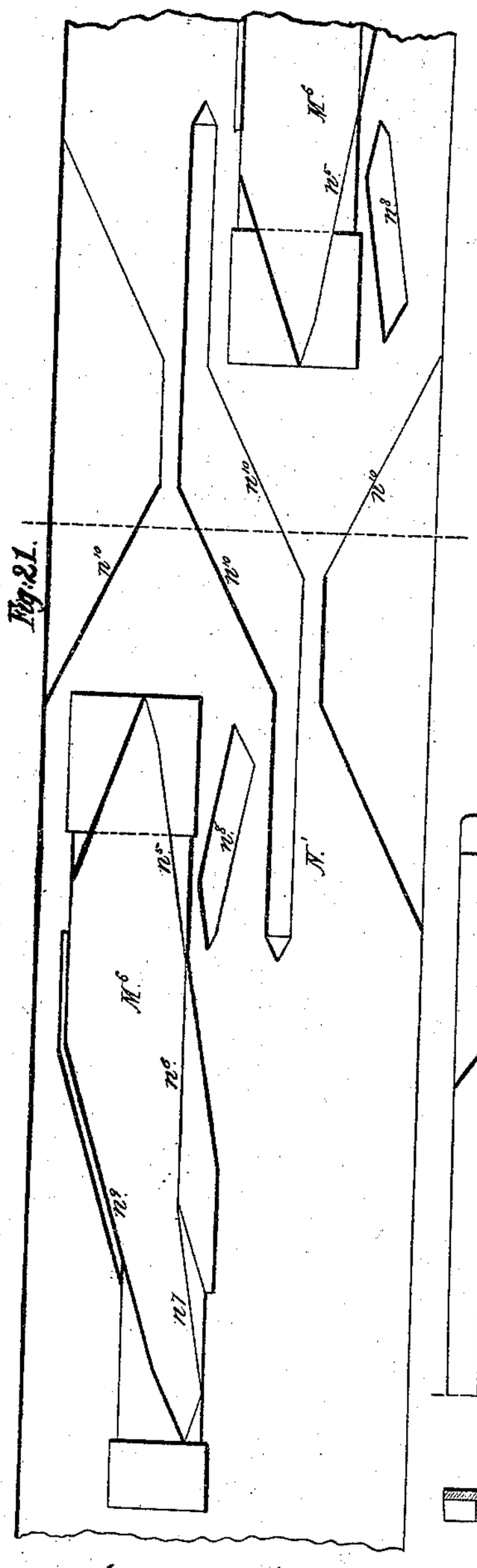

Fig. 21.

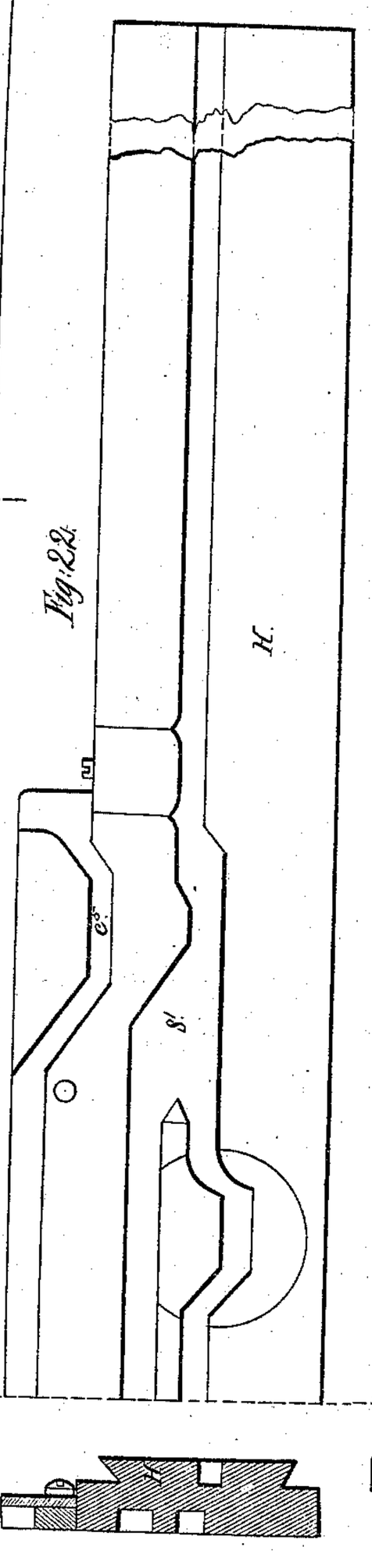

Fig. 22.

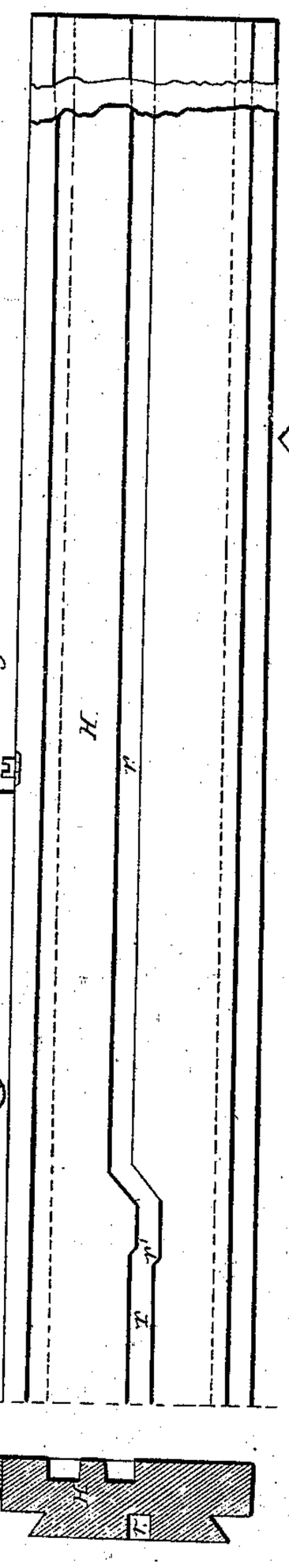

Fig. 23.

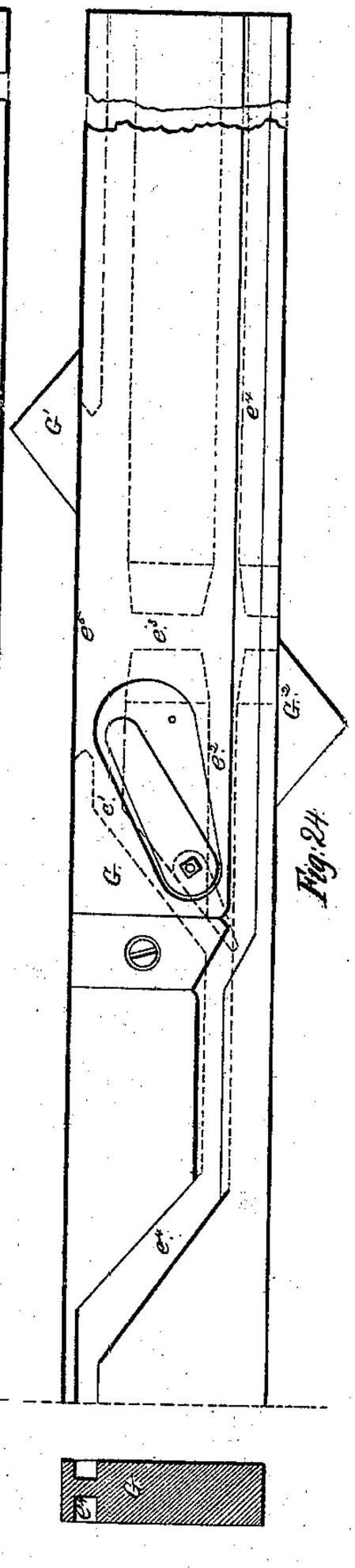

Fig. 24.

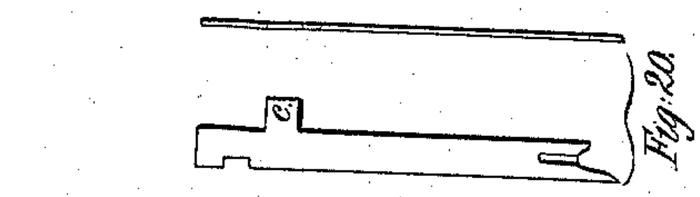

Fig. 20.

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UNITED STATES PATENT OFFICE.

J. K. KILBOURN AND E. E. KILBOURN, OF NORFOLK, CONNECTICUT.

IMPROVEMENT IN KNITTING-MACHINES.

Specification forming part of Letters Patent No. **31,984**, dated April 9, 1861.

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 Machinery; and I do hereby declare that the following is a full, clear, and exact description of our said invention, reference being had to the accompanying drawings, in which—

Figure 1 represents a front elevation of a knitting-loom embodying our improvements, with certain parts of the mechanism removed to avoid confusion. Fig. 2 represents an end view of the same. Fig. 3 represents a rear elevation of the same. Fig. 4 represents a vertical transverse section of the same at the line *x x* of Fig. 1. Fig. 5 represents a fragmentary front elevation of the machine, upon an enlarged scale; and Fig. 5ª represents an elevation of the controlling mechanism of the whip-roll springs. Fig. 6 represents a plan of the machine corresponding with Fig. 5. Fig. 7 represents a rear elevation of the same, corresponding with Fig. 5. Fig. 8 represents a transverse section of a portion of the machine, showing the end of the needle-carriage and the parts adjacent thereto. Fig. 9 represents a transverse section of the needle-carriage and parts adjacent thereto. Fig. 10 represents a front elevation of the slide-block that carries the sinker-lifter and transferring-prong. Fig. 11 represents a front view of the pattern mechanism, corresponding in scale with Fig. 5. Fig. 12 represents a plan of the same. Fig. 13 represents a transverse section of the same at the line *x x* of Fig. 11. Fig. 14 represents a front elevation of one of the selvage-needle carriages, and Fig. 15 a plan of the same. Figs. 16, 17, and 18 represent transverse sections of the selvage-needle carriage and the parts adjacent thereto, with the movable parts in different positions. Fig. 19 represents views of a needle and needle-slide suitable for the machine, and Fig. 20 corresponding views of a sinker. Figs. 1, 2, 3, and 4 are drawn upon a scale of one-quarter inch to the inch. Figs. 5 to 13, inclusive, are drawn upon a scale of half-inch to the inch; and Figs. 14 to 20, inclusive, are drawn of the full size. Figs. 21, 22, 23, and 24 represent views of portions of the cam-bars of the machine, of the full size.

The object of our invention is mainly to produce knitted fabrics of varying width—such, for example, as the sheets of fabrics employed to form the legs of knit drawers and the sleeves of knit shirts with selvage-edges. Our improvements are applicable, however, to other knit fabrics—as, for example, those in which ornamental patterns are produced by the transferring of stitches.

Previous to our invention it has been suggested that a selvage-edge could be produced upon knitted fabrics of varying width by employing the same needles to knit the selvage-stitches the whole length of the fabric, the number of intermediate needles being varied according to the desired variation in width, and the selvage-needles at the opposite sides of the fabric being drawn nearer together or moved farther apart, according as the number of intermediate needles was diminished or increased.

A patent was granted in Great Britain to William Colton the 16th day of October, 1855, in the specification of which detached pieces of mechanism are described with a view to knit upon this system; but no practical mechanism is described in the specification or represented in the drawings of this patent for imparting the proper movements to the selvage-needles and to other members of a knitting-machine for widening and narrowing the fabric automatically, nor is any provision made for transferring the stitches when the fabric is narrowed.

The knitting-machine represented in the accompanying drawings is designed to produce selvage-edge work of varying width by the lateral movement of the selvage-needles at the opposite sides of the fabric toward and from each other, and by varying the number of intermediate needles in operation; and our invention consists in certain mechanism by means of which the whole work of knitting selvage-edged fabrics of varying width is effected automatically, according to a predetermined pattern or design.

Our invention is divided into parts, the first of which consists in the combination of a needle with automatic mechanism for causing it to move laterally or travel past the gang of needles employed in the knitting-machine, so that the said traveling needle is made to take the

place of one of the needles in the gang at different parts thereof, as desired.

Our invention consists, further, in the combination of a traveling needle with automatic mechanism for withdrawing the needle whose place the traveling needle is to occupy from the gang at work previous to the substitution of the traveling needle in its place.

Our invention further consists in the combination of a traveling needle with automatic mechanism for reinserting the other needle of the gang whose place has been occupied by the traveling needle after the latter has been removed therefrom.

Our invention further consists in the combination of a traveling needle with a mechanical device for transferring the stitch from the needle that is withdrawn to an adjacent needle, so as to avoid the dropping of the stitch.

Our invention further consists in the combination of a traveling needle operating at the selvage of the fabric with a thread-guide (that delivers the yarn to the needles) by devices which cause the thread-guide to vary its delivery of yarn in correspondence with the change in the position of the traveling needle relative to the other needles of the machine.

Our invention further consists in the combination of a traveling needle with a series of needles which move to and fro past a thread-guide, but do not travel laterally to each other.

Our invention further consists in the combination of a traveling needle operating at the selvage of the fabric with mechanism for reversing the movement of the needle-carriage (or other device by whose reversal the direction in which the yarn is fed to the needle is changed) in such manner that the movement is reversed sooner or later, according as the traveling needle is moved toward or from the farther end of the gang of needles at work.

Our invention consists, further, in the combination of the sinkers of the series of needles with a traveling device for withdrawing the sinkers which happen to be at the selvage of the fabric from their places in the series, whether the work be widened or narrowed, so that no folds of yarn are formed at the selvage, and that the yarn to form the selvage-loops is drawn by the action of the needles from the adjacent stitches, whereby the tightening of the fabric at the selvage is promoted.

Our invention consists, further, in the combination of the sinkers with a traveling device for moving a portion of them beyond the end of the gang of needles at work above their ordinary level at the times the thread-guide is descending and rising, so that they are out of the way of the thread-guide at these times, whereby the employment of a thread-guide of a breadth greater than the space between two adjacent sinkers is permitted, so that the thread-guide may be of any desirable breadth and strength in a machine having a sufficient number of sinkers to form wide work with the capacity to form narrow work.

Our invention consists, further, in the combination of suitable devices for griping the yarn with mechanism that causes them to act at the time the selvege-needles are forming their loops, so that the yarn to form these loops is of necessity withdrawn from the adjacent stitches of the fabric, which griping furthers the tightening of the fabric at the selvage.

Our invention consists, further, in the combination of the griping devices with the mechanism for operating them and the needles in such manner that the gripe upon the yarn is relaxed in time to prevent the breaking of the yarn by the backward movement of the needles.

Our invention consists, further, in the combination of the thread-guide with devices for depressing it immediately after the last needle in the series of needles at work has been fed with yarn and before that needle is withdrawn into its nosing, so as to insure the seizure of the thread by the barb of the needle.

Our invention consists, further, in combining with a knitting-machine for forming a fabric of variable width, traveling temples at the selvage of the fabric to relieve the selvage-needles of the lateral strain resulting from the take-up mechanism, the said temples being so arranged and operated that their positions are varied with the variations in the width of the fabric.

Our invention consists, further, in combining with the take-up rolls, a straining or whip roll having a barrel of increased diameter at those parts where the wider portions of the work pass over it, so as to keep the selvage strained whether the work widen or narrow.

Our invention consists, further, in mechanism for varying the strain upon the sheet of fabric in proportion to the increase or decrease of its width, so that the strain upon each part of the fabric is about the same whether it increase or decrease in width.

Our invention consists, further, in combining with under supports forming a bearing for the needles outside of the sinkers, a thread-guide arranged in such manner that its lower side is inclined to the direction in which the sinkers move, and operated in such manner that when it is depressed it moves in the direction of its length, or, in other words, at an acute angle to the direction in which the sinkers move, whereby the depression of the delivery end of the thread-guide below the level of the needles in a machine having under supports of the above description can be effected at the time the selvage-needles are forming the loops.

The several parts of the present invention are embodied in a flat-knitting loom represented in the accompanying drawings. The knitting of the yarn in this loom is effected by a series of needles and sinkers, which are supported on a carriage and are caused to traverse in front of a thread-guide, which delivers yarn or thread. In this machine motion is imparted

to the needles and sinkers by the grooves of stationary cam-bars, along which the needles and sinkers are caused to reciprocate, and four traveling needles are employed at each end of the fabric to form the selvage thereof.

The various operating parts of this loom are supported by a strong rectangular frame, A, having legs, which hold the needles at a convenient distance from the floor for the operator who tends the machine. In the upper side of this frame are two longitudinal V-shaped grooves, *a a*, Fig. 4, which extend from end to end of the frame and form ways to support and guide a carriage, D, that carries the needles and sinkers. This needle-carriage D is of rectangular form, and is constructed to move to and fro upon the frame, its lower side being fitted with V-shaped feathers, which slide in the V-shaped grooves in the top of the main frame. The needle-carriage carries the needles and sinkers, which are arranged in series whose members alternate, so that there is a needle for each space between two adjacent sinkers. The length of the needle-carriage between its end plates must be sufficient to receive sufficient needles and sinkers to knit the widest work required, together with the machinery for moving them, to effect the widening and narrowing. In the machine represented in the drawings this length is thirty-three inches, and the machine is adapted to produce work not exceeding twenty-five and three-fourths inches in width. This needle-carriage is caused to move alternately to and fro in opposite directions by means which are substantially the same as those described for operating the needle-carriage in our patent of the 12th day of October, 1858. The lower side of the carriage has a rack, F′, secured to it, which slides in a groove, *a*, Fig. 4, in the frame, and the teeth of this rack engage with those of a cog-wheel, E′, secured to a shaft, B^3, that extends transversely across the machine, and is caused to turn alternately in opposite directions by means of the driving-shaft B^7, to which the power is applied. The driving-shaft is turned by a belt acting upon the fast pulley P, or by the hand of an attendant operating upon the crank-handle *a*, and revolves continuously in the same direction; and in order that a reciprocating motion may be imparted by it to the cog-wheel shaft, it is fitted with a sleeve, O, which is caused to turn with the shaft B by means of a feather sliding in a corresponding groove in that shaft, and has two friction-cones secured to it. These friction-cones may be brought alternately in contact with either one of a corresponding pair of hollow friction-cones, Q^2 Q^3, that are secured to hubs which run loosely upon the driving-shaft, by sliding the sleeve endwise by means of a shifting-arm, A′, which has a friction-roller that runs in the groove formed by the backs of the two solid friction-cones. The shifting-lever A′ extends from a rock-shaft, B′, which is fitted with a second arm, *h*; and the latter is fitted with a pin that is received in a helical groove formed in the rim of a block secured to the drum P′ of a rock-shaft, B^2. Hence by turning the rock-shaft B^2 in one direction or the other the helical groove moves the rock-shaft B′, and the sleeve is shifted to throw one or other friction-cone into action and make the hollow cone corresponding therewith revolve with the driving-shaft. The hub of each hollow cone is fitted with a drum that has a strap or belt secured to it, and the two straps D′ and D^2 are wound in opposite directions upon the eccentric-barreled or cam-formed drums P^4 P^5, secured to the cog-wheel shaft B^3. Hence when one friction-cone is in action the cam-drum corresponding therewith is caused to turn and revolve the cog-wheel shaft in one direction, and when the other friction-cone is revolved the other cam-drum is caused to turn and revolve the cog-wheel shaft in the opposite direction to the first.

In order to shift the friction-cones so as to reverse the movement of the needle-carriage, the rock-shaft B^2 is fitted with a pulley P^6, and the latter is connected by straps D^3 with a corresponding pulley secured to a rock-shaft, B^4, above. This second rock-shaft has an arm, T, Fig. 3, secured to it, which projects upward in a position to be struck on opposite sides by two pins, f' f^2, that project from a slide-bar, C^4. The slide-bar slides in standards secured to the frame of the machine, and is fitted on its inner face with pins f^3 f^4, Figs. 6 and 8, and in dotted lines in Fig. 7, which are struck at proper times, as will be hereinafter described, to move it and cause its pins f' f^2 to strike and move the arm T and shift the friction-cones through the agency of the rock-shafts B^4 B^2 B′, straps D^3, helical block, and rocking arms *h* A′. The rocking of the rock-shaft B^2 is aided by the momentum of two weights, P^{11} P^{12}, Fig. 1. Each of these weights depends from a lever, as shown in dotted lines, and each weight-lever bears upon a pin secured to a beam whose arms extend in opposite directions from the rock-shaft, so that when the rock shaft is put in motion the momentum of the weights tends to rock it further and bring the proper friction-cone into action. From the obliquity of the arms of this beam to each other, one of the two weights—P^{11}, for example—is acting with its full force when the rock-shaft is turned to its extreme limit in either direction, while the other weight is acting but partially, and therefore does not counterbalance the first. Hence the preponderating force of the weight that is lowest is made available to hold the rock-shaft in its extreme position and keep the friction-cone in action in its proper place.

The needles, as shown at Fig. 19, 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 needles are arranged in three series, there being two series of traveling needles (one for forming the selvage at each side of the work) and a series of intermediate needles, more or

less of which are brought into operation, according to the size of the space between the two sets of selvage-needles, as determined by the width of the work to be produced. The stem of each intermediate needle has a second groove, a^2, Fig. 19, in its stem to receive the point of the transferring-prong, as hereinafter described, and each needle-stem is secured to a needle-slide, E, which is shown at Fig. 19, of the full size. These slides are arranged to slide transversely to the direction in which the carriage is moved in a series of grooves formed in a block of brass, *d*, which extends from one end of the carriage to the other and forms a bed for the needles. Each of these needle-slides is square-headed at its front extremity, b', and has a snug or nib, b^2, at its rear end. Each needle-slide has also a snug or nib, *b*, at a point intermediate between its ends, by means of which it is moved to and fro in the operation of knitting. These snugs *b*, when the needles are operating, are received in and operated by a cam-groove formed in the lower side of the needle-cam bar G, which extends from one end of the machine to the other, and is supported by the end plates thereof. The form of this groove is shown of the full size in dotted lines in Fig. 24. The cam-groove, after extending a certain distance from the center of the machine, divides into two branches, e' and e^2, having a movable switch at their intersection, which can be turned to cause the snugs of the needles to traverse in either branch. When the machine is knitting they traverse in the hinder branch, e'; but the forward branch is useful to cause the needles to be projected forward for inspection and repair. The two branches of the cam-groove are crossed by a cross-groove, e^3, which permits the removal and replacement of any needles which require to be removed for repair. The needles project forward from the bed in which their slides lie, and pass through a corresponding series of 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. The grooves of this nosing have at bottom a V form, so that when the needles are depressed they are caused to place themselves at equal distances apart, whereby the uniform width of the fabric is secured and the transference of a stitch from needle to needle is insured. The traveling selvage-needles are also each secured to a slide, F^4, Fig. 17, which is carried by a separate carriage, that is mounted between the end plates of the needle-carriage and moves with it without changing its position thereon so long as the work produced remains of the same width. As the present machine is constructed to widen and narrow the work at each side thereof, there are two of these selvage-needle carriages, B and B, one for each selvage, and each carriage in this instance carries four selvage-needles, whose stems are bent downward, so that the needles project in the same plane and to the same distance as the intermediate needles. Each of the selvage-needle slides has a snug, b^4, formed upon it, which is received in a groove, e^4, formed in the upper side of the needle-cam bar G, and shown of full size at Fig. 24, so that as the selvage-needle carriages are carried along with the needle-carriage the selvage-needles are caused by the oblique portions of the cam-grooves to move, in knitting, transversely to the length of the carriage in the same manner as the intermediate needles.

A second block of metal, *g*, is supported at the front side of the needle-carriage by the end plates thereof. This block has a series of grooves formed in it similar to those of the needle-bed to receive and guide the shanks or slides of the sinkers. The lower edge, *e*, Figs. 5, 8, 9, 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 a 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. Each sinker-slide has a snug, *c*, upon it, which is received in a cam-groove formed in the inner face of the sinker-cam bar H. This cam-bar, like the needle-cam bar, extends from one end of the machine to the other, and is supported by the end plates thereof. The form of its groove is shown of the full size at Fig. 22.

When the machine is operating upon fabric of a certain width a certain number of needles are operating. This number is made up of the selvage-needles at each side of the fabric and of as many intermediate needles as can operate in the space between the selvage-needles, the remaining intermediate needles being withdrawn to such positions that they are for the time inoperative. The intermediate needles at work at any one time we term the "working-needles" or "workers." When the fabric is to be narrowed at either side the intermediate needle next inside of the selvage-needles at that side of the work is withdrawn, and the series of selvage-needles is moved inward by the movement of their carriage inward on the needle carriage, or toward the center thereof, so that the innermost selvage-needle occupies the place of the withdrawn needle. When, on the other hand, the work is to be widened, the selvage-needles are moved outward the space of a needle or stitch from the number of the intermediate needles at work, and an additional intermediate needle is brought into action in the space made by the outward movement of the selvage-needles. In order to effect these movements of the selvage-needles and of the intermediate needles, each selvage-needle carriage is constructed to slide upon the top of the needle-cam bar, and is connected with a bracket, C, that extends downward from a slide-block, C'. This slide-block has a sleeve, W, upon it, which is fitted with a screw-nut,

m, that fits upon a screw, L, which has a journal with collars, that turns in a bearing formed in the end plate of the needle-carriage, so that as the needle-carriage is moved to and fro the screw L, the sleeve W, the slide-block C′, and the selvage needle carriage are carried along with it, while the slide-block C′ and the selvage-needle carriage B can be made to travel upon the needle-carriage by turning the screw L.

The two selvage-needle carriages in this machine are each moved by separate screws. These screws extend in line with each other, their inner ends being supported in a hanging box, d^4, Fig. 1, which depends from a bar, d^4, that extends from one end plate of the needle-carriage to the other. The outer extremities of the screws pass through the end plates of the carriage, and each is fitted with a cog-wheel, E^5, by which it is turned at the proper time. The turning of either screw in one direction screws along the slide-block and the selvage-needle carriage connected therewith toward the adjacent end of the needle-carriage; and the turning of either screw in the opposite direction screws the selvage-needle carriage controlled thereby toward the center of the needle-carriage. The pitch of the screw is in this instance four times the space between the centers of two adjacent needles. Hence the turning of the screw one-quarter of a revolution in either direction moves the selvage-needles to or fro the space of a stitch, and either closes up the gap formed in the needles at work by the withdrawal of an intermediate needle or makes a gap for the insertion of an intermediate needle.

In order that an intermediate needle may be withdrawn when the selvage-needles are moved or travel inward, and may be reinserted when the selvage-needles are moved or travel outward, each selvage-needle carriage is provided with a sliding bar, P^9, Figs. 14, 15, 16, 18, which slides transversely in a groove formed in the carriage. The hinder end of this slide-bar has the form of a block, t^4, whose front side projects downward within the range of a cam, G′, secured to the hinder edge of the needle-cam bar, so that as the needle-carriage, in its movement toward the end of the machine, carries the slide-bar past the cam the latter pushes the slide-bar backward. The front end of the slide-bar has a finger, t^5, which depends from it within the range of a cam, G^2, secured to the front edge of the needle-cam bar, so that the slide-bar is moved forward by the action of this cam during the movement of the needle-carriage toward the center of the machine. The lower face of the block t^4 of the slide-bar is fitted with two drivers, t' and t^2. One of these drivers, t', projects downward sufficiently to strike the front edges of the rear nibs, b^2, of the slides of the intermediate needles, as shown in detail at Figs. 14, 16, and 18, and it extends across the slides of the intermediate needles from the inner side of the innermost selvage-needle outward—that is, toward the adjacent end of the needle-carriage—as shown in dotted lines at t', Fig. 15. The other driver, t^2, projects downward from the block t^4 sufficiently to strike the hinder edges or butts of the rear nibs, b^2, of the slides of the intermediate needles, as shown in detail at Figs. 14, 16, and 18, and it extends across the butts of the intermediate needles from the inner sides of the innermost selvage-needle inward, as shown in dotted lines at Fig. 15. From this construction of the parts it results that so long as the selvage-needle carriage retains the same position with reference to the intermediate needles the slide-bar is moved to and fro by the cams G′ and G^2 without moving any of the intermediate needles. When, however, the selvage-needles are caused to travel toward the center of the machine by the movement of the selvage-needle carriage by its screw L, the driver t', which we term the "narrowing-driver," being moved across the slide of the first working-needle next the selvage-needles, is borne against the rear nib, b^2, thereof by the cam G′, and draws this first needle backward out of the series of needles at work, thus making a gap in the series for the innermost selvage-needle to work in. When, again, the selvage-needles are caused to travel outward toward the adjacent end plate of the needle-carriage, the other driver, t^2, which we term the "widening-driver," being moved across the butt of the slide of the first needle outside of the series at work, is borne against the butt thereof by the cam G^2 and pushes this first needle forward, reinserting it in its position at the end of the series of working-needles in the gap formed by the outward movement of the selvage-needles. In order to permit the withdrawal and reinsertion of the intermediate needles, a gate, e^5, Fig. 24, is formed in the needle-cam groove e', so as to permit the snugs of the needles to pass out of and into the cam-groove at the times the drivers are acting upon the needle-slides; and as it is necessary that the intermediate needles, when withdrawn, should be out of the way of the traveling needle which is caused to travel over it, the needle-bed is hollowed out, as shown at Fig. 18, so that when an intermediate needle is withdrawn from the series of workers the needle and needle-slide drop into the hollow sufficiently to bring the head of the needle below the range of motion of the traveling needle that takes its place in knitting. As the needle-slides are light and do not tend to fall into the hollow with sufficient rapidity, an inclined plane, i^2, Fig. 18, is formed upon the head of each needle slide in a position to be acted upon by the lower front corner of the needle-cam bar G at the time the needle-slide is being drawn backward. When an intermediate needle is withdrawn it remains in its withdrawn position with its snugs *b* outside of the cam-groove, and is consequently inoperative or idle until it is again reinserted to take its place among the number of working-needles.

In the present machine, where traveling

needles are employed only at the selvages of the fabric, all the needles outside of the inner edge of the narrowing-drivers t' at each end of the needle-carriage D remain inoperative or idle, and all inside of the narrowing-drivers are workers, and co-operate with the selvage-needles in forming the fabric. The width of the fabric, therefore, in this machine depends upon the position of the selvage-needles, and the fabric is narrowed and widened as these selvage-needles are moved inward and outward. When the machine is in operation the rapid movement of the carriage past the cams G' and G^2 causes the slide-bar to move with considerable force, and tends to cause it to strike against the adjacent edges of the needle-cam bar. In order to prevent this striking, and also to prevent a rebound, the slide-bar is acted upon by a friction-brake, f^8, which, bearing upon a plate secured to the upper side of the slide-bar P^9, retards its movement. The slides of the selvage-needles, from their weight, acquire considerable momentum, which is counteracted by leather friction-pads that are pressed upon their upper edges through holes in the plates above the slides by means of a spring, f^9.

When a needle is withdrawn from the workers and rendered inoperative, and the traveling selvage-needle takes its place, it is necessary that the loop upon the needle withdrawn should be transferred to the next needle nearer the center of the needle-carriage, as otherwise the stitch would be dropped. This transference is effected at the proper moment by combining with the traveling needle a transferring-prong, V, Figs. 9 and 10, which is made to enter into the loop to be transferred from the hinder side thereof, to hold it while the needle is withdrawn, to carry the loop laterally to the next needle, to present it to this next needle when it moves forward, and, finally, to withdraw from the loop, leaving it upon the needle. One of these transferring-prongs is provided for each selvage-needle carriage; and in order that it may have these various movements, each transferring-prong V is secured to an arm or stock which projects from a sleeve, U, that is traversed by a rock-shaft, *s*. Each rock-shaft *s s* extends from the center of the needle-carriage outward and projects through its end plates, so that its projecting end may be in a convenient position to be operated upon. The rock-shaft is slotted from end to end, and a feather is secured in the prong-sleeve U to traverse in the slot, so that the stock and transferring-prong V may be rocked backward or forward by rocking the rock-shaft, whatever position the transferring-prong may occupy between the end plates of the needle-carriage. The sleeve of the transferring-prong is located between the cheeks of a pair of fingers, t^3, Figs. 9 and 10, which project downward from the slide-block C', that carries the selvage-needle carriage, so that as the selvage-needle carriage travels outward or inward upon the needle-carriage the transferring-prong is moved in the same direction and to the same extent. The prong is so situated with respect to the needles that it is always over the intermediate working-needle next the selvage-needles, and is consequently ready to enter the loop thereon before the needle is withdrawn from among the workers; and as the transferring-prong is carried laterally with the selvage-needles, it carries the loop upon it to the right position to deliver it up to the next adjacent needle, which in turn becomes the needle next the selvage-needles, and the head of this needle, in moving forward to receive yarn from the thread-guide, enters the stitch on the transferring-prong, which is then withdrawn. In order to insure the entrance of the stitch by the needle, the under side of the transferring-prong is grooved longitudinally, so as to guide the head of the needle into the stitch. The rocking of the rock-shaft at the proper times to cause the transferring-prong to enter a loop and withdraw from one is effected by the turning of the screw L, that causes the selvage-needle carriage to travel upon the needle-carriage (which screw, from its office, may be termed the "widening and narrowing screw") in the following manner: The end of this rock-shaft *s* projects beyond the end plates of the carriage-frame, and is fitted with a disk, g^3, having a pin in its face near its rim. The outer end of this pin is received in a slot formed in a boss, g^4, which is secured to the front end of an L-formed lever, Y, that is pivoted at the intersection of its arms to the end plate of the needle-carriage. The arms of the lever are fitted with snugs h' h^2, (shown in dotted lines in Fig. 8,) which project from their faces within the range of motion of a series of pins, x, which are made fast to a disk, X, that is secured to the widening and narrowing screw L, so that during each quarter of a revolution of this screw one pin, acting upon one arm of the lever Y, causes the rock-shaft and the transferring-prong moved by it to rock outward, and another pin, acting on the other arm of the lever Y, causes them to rock inward. As in the present machine the same screw L is employed for both widening and narrowing, the pins x are turned when widening is effected; and as during this operation no transference is necessary, it is desirable that the transferring-prong should then remain inoperative. In order to accomplish this, one of the snugs, h^2, of the lever Y is secured to a latch, (also shown in dotted lines in Fig. 8,) which, instead of being fixed fast to the arm of the lever, is pivoted thereto. A pin is placed in the face of the lever below this latch to prevent it from yielding when the pin of the screw-disk bears down upon the snug h^2, which it does when the screw is turned to narrow the work, and consequently when this happens the lever is moved. When, however, the screw is being turned in the opposite direction to widen the work, the pin of the screw-disk bears up against the snug

of the latch, and the latter, turning on its pivot, permits the pin to pass the snug h^2 without imparting motion to the lever Y, and consequently without rocking the rock-shaft and the transferring-prong operated thereby.

In order to hold the transferring-prong in its position either forward or backward, the hub g^3, Fig. 8, of the rock-shaft *s* has two notches formed in its periphery, into one or other of which a spring-catch, *w*, engages to hold the rock-shaft until it is moved by the operation of the pins on the bent lever. In the operation of the machine it is necessary that the stitch to be transferred should be taken off the needle to be withdrawn from the workers before it is withdrawn, and consequently before the selvage-needle carriage is caused to travel inward to move the narrowing-driver so that it can act upon the needle. The selvage-needle carriage must not therefore be moved inward before this taking off is effected, although its screw be turned to rock the transferring-prong and effect the taking off of the stitch. This pause in the movement is effected in the manner described in the patent of the 12th day of October, 1858, aforesaid, by causing the screw to move endwise as it turns. In order to effect this, the widening and narrowing screw L is fitted with a cam-collar on each side of its bearing in the end plate of the needle-carriage. These cam-collars have each four snugs upon their faces, which bear against corresponding inclined planes formed upon the adjacent faces of the bearing in the end plate of the needle-carriage, so that as the screw is turned a portion of its quarter of a revolution these inclined planes, bearing against the snugs, cause the screw to move endwise outward as fast as its threads tend to screw the slide-block and selvage-needle carriage inward, while during another portion of its quarter of a revolution the snugs pass over portions of the inclined planes inclining in directions the reverse of those first traversed by the snugs, so that the selvage-needle carriage is caused to travel inward by the combined movement of the endwise motion of the screw and its screw action in its nut in the sleeve of the slide-block, with which the selvage-needle carriage is connected. When, again, the screw is turning to rock back the transferring-prong, the snugs of its collars are again traversing parts of the inclined planes inclined in directions the same as the first, so that during this movement of the traversing-prong the selvage-carriage does not change its position. When the screw is turned in the opposite direction to widen the fabric its endwise movement is reversed. From this endwise motion thus imparted to the screw it results that the movement of the selvage-needle carriage in both widening and narrowing is effected in a shorter space of time than it could be accomplished if its movement were due only to the screw action of the screw.

In the operation of transferring for narrowing, the transferring-prong is rocked so far forward by the movement of its rock-shaft that its heel is outside of the grooves of the nosing. Hence when it is carried laterally by the movement of the selvage-needle carriage its shank moves in the space between the front ends of the partitions of the nosing and the hinder side of the bar *e*. In order that the prong may hold the stitch upon it in a proper position for the entrance of the working-needle which is to take up the stitch, its heel must rock back into the groove of the nosing through which this needle protrudes. In order to effect this the hinder notch in the hub g^3 is so located that when the heel of the prong is out of the groove of the nosing, as it is during the lateral movement of the prong, the hinder notch is in the front of the toe of the spring-catch, and the portion of the rim on which the toe bears is inclined toward the notch, so that as soon as the pin, moved by the widening and narrowing screw, ceases to act upon the latched snug of the bent lever Y, the pressure of the toe upon this inclined part of the rim causes the rock-shaft to rock backward, thus rocking the heel of the transferring-prong into the groove of the nosing, where it is held by the engagement of the toe of the spring-catch in the hinder notch until the needle has entered into the stitch on the prong, after which the action of a pin of the widening and narrowing screw upon the snug of the upright arm of the bent lever rocks back the prong out of the stitch.

In order that the machine may operate when the parts are constructed as we have described them, the widening and narrowing screw should make three movements when narrowing is being effected, two of these taking place while the end of the needle-carriage is passing from the center of the machine toward the adjacent end thereof, and one while it is returning from that end of the machine, the three movements together in this instance comprising a quarter of a revolution of the screw. During the first of these movements the screw is turned sufficiently to cause the transferring-prong to enter the stitch on the needle, whence it is to be transferred, and this of course must take place before the needle is withdrawn by the narrowing-driver. The second movement is sufficient to move the selvage-needle carriage laterally the space of a needle, so that the innermost selvage-needle is made to travel inward to the next needle. This movement of the screw also permits the toe of the spring-catch to rock back the heel of the prong into the groove of the nosing. The third movement is sufficient to rock the prong out of the stitch. This last movement must of course be effected after the needle has been protruded through its groove in the nosing by the action of the incline in the cam-groove which effects this movement. In widening, the widening and narrowing screw in the present machine shoud make one movement while the needle-carriage is passing from the end of its range of

motion toward the center of the machine. This movement is divided into two parts, which together comprise a quarter of a revolution of the screw. During the first part of this movement the selvage-needle carriage is moved by the conjoined action of the screw on its nut and of the cam-collars, which impart an endwise movement to the screw, so that the selvage-needle carriage is made to travel rapidly outward and carry the selvage-needles from the last working-needle. This portion of the movement must of course take place before the widening-driver reinserts an intermediate needle from those out of work. During the other part of the movement of the screw the cam collars move the screw endwise as fast as it tends to screw the selvage-carriage in the opposite direction, and thus compensate the screw action, so that the selvage needle carriage does not travel farther upon the needle-carriage. In order to accomplish these movements of the widening and narrowing screws at proper times, movable cam-plates M^6, Figs. 6, 7, and 24, are employed and are made to act upon the screws in the following manner: The lower hinder side of the needle-carriage is fitted with a pair of screws, L^3 L^3, which correspond in length with the widening and narrowing screws L L, and which, for distinction, will hereinafter be called the "ratchet-screws." The inner ends of these ratchet-screws turn in a box that projects backward from the lower plate of the needle-carriage. Their outer ends protrude through the end plates of the carriage, and are each fitted with a cog-wheel, m^3. The teeth of each of these cog-wheels are made to drive the cog-wheel E^5 on the end of the corresponding widening and narrowing screw through the intervention of two intermediate wheels, m^7 and m^8, the last being made annular, so as to permit the needle-cam bar G to pass through it. Each ratchet-screw L^3 is fitted with a ratchet-carriage, J′, which has a nut in one of its standards, k^7, through which the ratchet-screw passes. The ratchet-carriage is fitted to slide upon the hinder edge of the lower plate of the needle-carriage, so that when the ratchet-screw is turned the ratchet-carriage is caused to move toward or from the adjacent end plate of the needle-carriage, according as the ratchet-screw is turned in one direction or the other. The pitch of each ratchet-screw L^3 is double that of the widening and narrowing screws, and the cog-wheel m^3 at the end of the former is twice the diameter of that upon the end of the latter, so that one-eighth of a revolution of the ratchet-screw turns the widening and narrowing screw the quarter of a revolution required in widening and narrowing the fabric, and also moves the ratchet-carriage the same distance as the selvage-needle carriage and in the same direction.

Each ratchet-screw L^3 is fitted with two ratchet-wheels, R^2 and R^3, whose teeth incline in opposite directions. These ratchet-wheels slide freely endwise upon the ratchet-screw, but compel the latter to turn with them by means of feathers which slide in a longitudinal groove in the ratchet-screw, as shown in Fig. 9. The two ratchet-wheels have between them a pawl-block, L^4, which is arranged to both oscillate and slide endwise freely on the ratchet-screw. This pawl-block carries two pawls, S^2 S^3, Figs. 7 and 9, which are pivoted to its opposite sides, point in opposite directions, and are arranged to act one on each ratchet-wheel, each pawl being pressed toward its ratchet-wheel by a spring, so as to insure its engagement with the teeth thereof. The ratchet-wheels and pawl-block are confined between the cheeks of the ratchet-carriage J′, so that they are caused to travel with it as it is moved along the needle-carriage by the ratchet-screw. The lower side of the pawl-block is furnished with cog-teeth, as shown in Fig. 9, which engage in the teeth of a rack, T^4, that is fitted to slide in the bottom of the ratchet-carriage in directions crosswise to the movable cam-plates, and the lower face of the rack T^4 has a pin, f^7, projecting from it sufficiently to be acted upon by the grades of the adjacent movable cam-plate M^6 when the latter is in its highest position, but which is not acted upon by the cam-plate when the latter is lowered out of track of this rack-pin. Hence it follows that if the movable cam-plate M^6 be raised in time to be within the track of the rack-pin when the adjacent end of the needle-carriage is moving outward, the rack-pin will bear against the front edge, n^5 n^6 n^7, Figs. 6 and 21, of the movable cam-plate, and one of the pawls, S^2, will act upon its ratchet-wheel R^2 to turn the ratchet-screw, and the widening and narrowing screw to narrow the fabric; and, on the other hand, if the movable cam-plate be raised in time to be within the track of the rack-pin when the adjacent end of the needle-carriage is moving inward, the rack-pin will bear against the hinder edge, n^9, Figs. 6 and 21, of the movable cam-plate, and the opposite pawl, S^3, will act upon its ratchet-wheel R^3 to turn the ratchet-screw, and the widening and narrowing screw to widen the fabric.

In order that the cam-plate corresponding with one of the widening and narrowing screws may not interfere with the rack-pin appertaining to the other of these screws, the rack-pins are located at the opposite end of their respective racks, and the cam-plates M^6 M^6, Fig. 21, are not located in the same line.

From the arrangement of the parts of the present machine it is necessary that in it the rack, after doing its work, should be brought back to a central position, which is accomplised by the action of the stationary jaws n^{10} upon the rack-pins. During this movement to a central position the pawls must not impart motion to their respective ratchet-wheels, and such motion is prevented by means of guard-plates secured to the adjacent cheeks of the ratchet-carriage in position to hold the pawls out of gear with the ratchet teeth when the rack is returning to its central position.

The movable cam-plates M^6 M^6 are hinged

fast to a stationary bar, N, which holds the stationary jaws, and they are raised in the present machine at the proper times to effect the quarterly revolution of the widening and narrowing screws by means of pattern-barrels. One of these barrels J^2 is appropriated to each movable cam-plate, and the two barrels are secured to the same shaft B^9. Each pattern-barrel has as many pin-holes in it as there are to be rows of stitches in the fabric, and each pattern-barrel revolves beneath a lever, I^2, which is connected with the movable cam plate above by means of a rod, j^2. The pin-holes are arranged in a helical line, and the end of the barrel-shaft is formed into a screw of the same pitch as the helical line, so that when the barrels are turned all the holes in each are made to pass in succession beneath the corresponding lever, I^2.

A ratchet-wheel, R^5, for each pattern-barrel is secured to the barrel-shaft B^9, and a corresponding pawl, S^5, is arranged to act upon the teeth of each ratchet-wheel. The pawl is pivoted to the arm of an L-formed lever, L^5, whose other arm is connected by a rod, l^5, with one arm of a vibrating beam, L^8. The arms of this vibrating beam project in opposite directions from a rock-shaft, B^{10}, that extends across the frame of the machine and is fitted at its hinder end with a forked arm, H^3, whose branches extend upward by the side of the sliding bar C^4. The hinder side of this sliding bar is furnished with two pins, f^5 f^6, one for each branch of the arm H^3. The front side of the sliding bar is also fitted with two pins, f^3 f^4, before described, each of which is located in a proper position to be struck by a corresponding pin, f^8, secured to the adjacent ratchet-carriage J', when that carriage is moving with the needle-carriage toward the adjacent end of the frame of the machine. From this construction of the parts it results that as the needle carriage moves toward each end of the bed-frame the slide-bar C^4 is moved by the pin of the ratchet-carriage, the vibrating lever H^3 is rocked to force one of the pawls S^5 against the teeth of its ratchet-wheel, and thus turn the pattern-barrels and move one pin-hole of each barrel from beneath the corresponding cam-plate lever, I^2, and bring a succeeding pin-hole beneath this lever, while the other pawl is drawn over the teeth of its ratchet-wheel to be in position to move it and the pattern-barrels when the needle-carriage moves in its opposite direction.

The pins f^5 f^6 upon the sliding bar C^4, which operate the forked lever H^3 and pattern-barrels, are so located with reference to their forked lever and to the pins f' f^2, that effect the reversal of the movement of the needle-carriage by acting upon the lever T of the rock-shaft B^4, before described, that the movement of the pattern-barrels is effected just before the movement of the needle-carriage is reversed. Hence if there be a pattern-pin (in the pin-hole of the pattern-barrel) which is brought under the lever of the movable cam-plate that is nearer the end of the machine toward which the needle-carriage is moving, this movable cam-plate will be raised before the needle-carriage returns, and it will be in position to act upon the rack-pin of the ratchet-carriage during the return of the needle-carriage. This rack-pin will then be acted upon by the hinder edge of the cam-plate, and the ratchet-carriage and selvage-needle carriage corresponding therewith will be made to travel toward the end of the needle-carriage, by which means, as before described, an additional needle will be brought into operation and the fabric will be widened. If, on the other hand, there be a pattern-pin (in the pin-hole of the pattern-barrel) which is brought under the lever of the movable cam-plate that is farther from the end of the machine toward which the needle-carriage is moving, that movable cam plate will be raised before the needle-carriage returns, and it will be in position to act upon the corresponding rack-pin of that ratchet-carriage which advances first during the return of the needle-carriage. That rack-pin will then be acted upon by the front edge of the cam-plate, and the ratchet-carriage and selvage-needle carriage corresponding therewith will be made to travel toward the center of the needle-carriage, by which means, as before described, one of the working-needles will be withdrawn, the gap will be closed up, and the fabric will be narrowed. Hence it follows that the arrangement of the pattern-pins in the pattern-barrels controls the width of the fabric, and this may be varied by varying the position of the pattern-pins. When the pins are withdrawn from both pattern-barrels for a number of strokes of the needle-carriage the selvage-needle carriages will retain their positions, and the fabric will be of uniform width for a number of rows of stitches corresponding with that number of strokes.

In the present machine the pawls S^5 are made reversible, so that they may be turned over on their pivots and set to turn their ratchet-wheels and the pattern-barrel backward. The length of the pawls is also such that pattern-pins which are used for widening when the pattern-barrels are turned in one direction are brought under the movable cam-plate levers at proper times to narrow when the pattern-barrels are turned in the opposite direction. This arrangement is advantageous, as it permits the machine to form continuous sheets of fabric composed of duplicate patterns produced by alternate widening and narrowing, the position of the pawls being changed by hand on completion of each pattern. In order that the machine may stop itself when each pattern is completed, two stop-pins, f^9 f^{10}, Figs. 11 and 12, are employed, one secured in each head of one of the pattern-barrels. One of these stop-pins, when the pattern-barrel is moving in one direction, is brought beneath a stop-lever, L^9, projecting from a rock-shaft, A^2, so as to rock

that shaft when the pattern-barrel reaches its limit of motion toward the left-hand end of the machine. The other stop-pin is brought beneath a second stop-lever, L^{10}, projecting from the same rock-shaft, so as to rock that shaft when the pattern-barrel reaches its limit of motion toward the right-hand end of the machine. The rocking of this shaft by the stop-pins is made to effect the stoppage of the loom in the following manner: The driving-shaft B^7 is fitted with two belt-pulleys, one of which, P, is fast to it, while the other, P^8, turns loosely upon it, and a shifting-bar, C^5, having pins which embrace the edges of the driving-belt, is employed to shift the belt from the fast to the loose pulley. This shifting-bar is connected with the arm of a bell-crank, L^{11}, whose opposite arm has a weight, P^{13}, upon it that tends constantly to shift the belt to the loose pulley P^8. This tendency is prevented, so long as the machine is running, by means of a rocking arm, L^{12}, which is inserted behind an arm, L^{13}, secured to the shaft of the weighted bell-crank L^{11}, and holds it in its position with the weight raised. A second rocking arm, L^{14}, secured to the shaft of the arm L^{12}, bears upon the arm L^{10}, that projects from the rock-shaft A^2 of the stop-levers L^9 L^{10}, so that when this rock-shaft is rocked by the stop-pins the arm L^{12} is disengaged and the weight is permitted to shift the belt to the loose pulley. From this construction it results that the machine stops itself whenever the pattern is completed, so that the attendant can reverse the pawls of the pattern-barrel and set the machine at work to duplicate the pattern in inverted order by widening the fabric where it was previously narrowed and narrowing it where it was previously widened.

The yarn or thread is fed to the series of needles by a tubular thread-guide, J, 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 has the form of a flattened tube, the longer axis of its elliptic cross-section being horizontal. 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 this slide has a 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, and whose peculiar form is shown of the natural size at Fig. 23. Hence when the thread-guide carriage is moved longitudinally the inner end of the thread-guide is at times depressed below the range of the needles and is at other times raised above it. The thread-guide carriage is moved alternately to and fro by means of two bumpers, M and N, which are carried along with the selvage-needle carriages, and which come alternately in contact with the opposite sides of the snug *o*, secured to the thread-guide carriage. As the thread-guide to act properly must always occupy a certain position relative to the outmost selvage-needle, and as in the widening and narrowing of the work the position of the needle is changed with respect to the needle-carriage, each bumper is secured to one of the selvage-needle carriages, and is thus combined with the traveling selvage-needles, so as to move with them when widening and narrowing takes place, and thus maintain the thread-guide in its proper relative position to the outmost selvage-needle.

In order that a tight selvage may be formed by the machine we are describing, it is constructed and operated in such manner that no folds of yarn are formed for the outmost needles that are working, so that the yarn to form the selvage-stitch and the next thereto is drawn from the loops of the inner stitches. In order to accomplish this the sinker which is outside of the selvage-needle, (whatever position the latter may occupy,) and the adjacent sinker between the first two needles at the selvage, are drawn upward, (when the thread-guide has fed thread over the needle-stems,) so that their snugs are out of the range of the cam-groove that depresses them, and consequently these sinkers are not depressed to form folds of yarn, as the remainder are, by the action of the cam-groove.

It is an advantage in a machine to employ a thread-guide of sufficient breadth to resist strains. In order that this may be done in a machine having the mode of operation in knitting of the machine we are describing, an arrangement must be made to prevent the interference of the thread-guide with the sinkers. In order to effect this in this machine five of the sinkers, in addition to the two above mentioned, are withdrawn to form a space for the thread-guide as it rises to feed yarn to the needles. These, with the other two, make seven sinkers to be raised, and in the machine we are describing the whole seven are raised simultaneously by means of a lifter, *k*, Figs. 8, 9, and 10, that is secured to a slide, Q, which slides up and down in a groove in the plate of the slide-block C′. This lifter projects forward from the lifter-slide into notches formed in the hinder edges of the sinker-slides, and the lifter-slide Q is provided with a pin, c^4, which projects from its front into a cam-groove, c^5, Figs. 7 and 22, formed in the upper part of the cam-bar H, situated in front of it. The slide-block C′, as before described, moves to and fro with the traveling selvage-needles, so that these lifting devices *k* travel to and fro, and are always in the proper positions to raise the proper sinkers of the series, however the fabric be widened or narrowed.

In order that the sinkers may rise when acted upon by the lifter, a gate, *s*′, Figs. 7 and 22, is formed in the groove of the sinker-cam bar to permit the snugs of the sinker-slides to pass out of and into the cam-groove when the sinkers are raised and lowered, and as this ma-

chine is constructed to widen and narrow at each selvage a sinker-lifter is provided for each selvage needle carriage. As no loops are formed for the outer two needles, they, in receding into their nosing, tend to draw yarn both from their right and left sides to make the loops, and consequently from the thread-guide as well as from the fabric.

As it is desirable, in order to form a tight selvage; that the yarn should be drawn from the fabric alone and not from the thread-guide, the delivery of thread from the latter is checked in this machine while the needles are receding until their receding heads pass within the range of travel of the inner end of the thread-guide.

In order to check the delivery of yarn the latter is griped between two jaws, the one formed by the upper side of a cross-bar, *j*, Figs. 5, 8, and 8ª, and the other consisting of a leather pad, *j'*, which is secured to the shank of the thread-guide, so that when the latter descends (to bear the yarn down upon the selvage-needle stems) the yarn is griped between the pad and the cross-bar. As the needles recede in the nosing their heads pass inside of the line of travel of the inner end of the thread-guide, and if the yarn were griped after this passage it would be strained or broken by the drag of the needles in receding to their farthest inward positions. Hence the gripe is relaxed in the present machine by the partial raising of the thread-guide by the action of the inner slope, *r'*, Figs. 5 and 23, of the cam-groove *r*, so that the leather pad on the thread guide shank is lifted from the bar beneath. The withdrawal of the sinker outside of the selvage-needle renders it necessary to depress the thread-guide sufficiently to bear the thread down upon the stems of the needles, so that as they recede their barbs may pass over the thread, and that it may be received in their hooked heads, and this is effected at the proper moment by the form of the cam-groove. As, however, a double under support, F, is employed in this machine, and the outmost number, k^5, thereof would, from its position, prevent the descent of the thread-guide, if the latter were horizontal, and were moved vertically downward, the thread-guide is set at an angle, as shown at Figs. 5, 8, and 8ª, and is constructed so as to move in the direction of its length. This movement of the thread-guide is effected by forming the shank, which connects it with the slide R, of a spring-plate, and by securing an inclined block to its outer face in such a position that as the shank is carried downward by the descent of the slide this inclined block bears against the inner face of a cross-bar, *p'*, and forces the shank and the thread-guide connected therewith to move inward as it descends.

As the fabric is formed it passes downward and backward under the bottom of the needle-carriage to an intermittent take-up consisting of a pair of take-up rollers, M' and M^2, whose journals are supported in bearings formed in brackets that project backward from the end plates of the needle-carriage. One of these rollers, M^2, is covered with india-rubber, so that it may adhere strongly to the fabric. The other, M', merely lays against the opposite side of the fabric, and by its weight presses the fabric against the rubber surface. The lower roller, M^2, is turned to take up the work by means of a worm, M^5, whose thread engages in the teeth of a worm-wheel, *m'*, secured to the shaft of the roller near one of the brackets. The worm has a ratchet-wheel, R^6, secured to its shaft, and a pawl, S^6, is pivoted to a vibrating arm, L^6, that is hinged upon the worm-shaft, so that whenever the arm is raised the pawl catching in one of the ratchet-teeth shall turn the worm to cause the rollers to draw up the work.

The arm L^6 is raised whenever it descends by means of a fixed incline or cam, N^6, Fig. 3, secured to the frame of the machine near one of its ends over which the lower end of the lever is carried by the movement of the needle-carriage. The take-up thus described is arranged to act intermittently, according to the necessities of the machine, in the following manner: A whip-roller, M^3, is supported by radius-bars under the needle-bed in the folds of the work between the nosing and the take-up rollers, so that as the work is formed and its length increased between the nosing and take-up rollers the increasing depth of the fold in which the whip-roller lies permits the latter to descend, and this descending movement of the whip-roll is made to throw the take-up mechanism into operation. In order to accomplish this a spring-arm; h^3, is attached to the hub of one of the radius-bars B^6, in a position to catch behind the vibrating arm L^6. The position of this spring-arm is such that it engages behind the vibrating arm whenever the latter is raised by the cam, and holds it in its raised position. As, however, the knitting proceeds and the whip-roll descends, the spring-arm, rocking upward as the radius-bar B^6 turns, releases the vibrating arm, which descends by its weight, so that its pawl engages in a tooth of the ratchet-wheel on the worm-shaft. Hence when the vibrating arm is again raised by the passage of its lower end over the cam N^6 the take-up rollers will be turned by the action of the pawl, and the fabric will be taken up. The taking up of the fabric by shortening that portion which is between the take-up rollers and the nosing diminishes the depth of the fold in which the whip-roll lies, so that it is raised up. As it rises its radius-bars rock, and rock the spring-arm h^3 into a position to seize and retain the vibrating arm L^6 until a further increase in the length of the fabric lets it off. The fabric from between the take-up rollers is passed over a stationary board, A^4, Figs. 2 and 4, which extends the whole length of the main frame and prevents the fabric from interfering with the mechanism.

In the operation of a knitting-machine it is

desirable that the edges of the fabric should be strained equally with the central portion thereof by the take-up mechanism. As the fabric made by the present machine varies in width, the ordinary take-up rollers will not of themselves preserve a sufficient strain at the selvages. The strain at the selvages is equalized in the present machine by increasing the diameter of the body of the whip-roll M^3 in proportion to the increased width of the fabric. To this end the portions of the whip-roll over which the wider parts of the fabric pass are made conical, as represented at Figs. 5 and 7, while the central portion is cylindrical, so that as the fabric widens and narrows the selvage is drawn under a surface of greater or less extent, while the middle of the fabric is drawn over a surface constantly of the same extent, by which means the equability of strain is maintained.

In knitting work of variable width difficulty is experienced from the strain of the take up upon the selvage-needles as the work widens, which strain tends to drag them toward the middle of the fabric. In order to obviate this defect we have combined an adjustable temple with the widening and narrowing apparatus, so that it is moved as the work varies to maintain the selvage in its proper position, thus relieving the selvage-needle of the strain. As the machine we are describing is constructed to widen and narrow at each side of the work, it is fitted with two disk-temples, K^2 K^2, each of which is secured to a separate block, K^3, which has a screw-thread on it that is fitted upon the screw L′, which is similar to and parallel with the widening and narrowing screw above. The screws of the two temples extend right and left from a central box, d^5, Fig. 1, in which their inner journals turn. The outer end of each temple-screw extends through the adjacent plate of the needle-carriage, and is there fitted with a cog-wheel, m^9, whose teeth engage with those of the annular wheel m^8. The cog-wheel m^9 has the same number of teeth as the wheel E^5 of the widening and narrowing screw above, and the temple-screw has the same pitch as that screw, so that each temple-screw is operated to move its temple in harmony with the movement of the selvage-needle carriage above it, so as to adjust the position of that temple to the number of needles at work, and thus keep the temple in the proper position with respect to the outmost selvage-needle under all variations in the width of the fabric. The variation in the diameter of the conical ends of the whip-roller tends to change the direction in which the selvages of the fabric extend in passing from the knitting-point to the take-up rollers, and thus tends to drag the work at certain times from the temples. In order to obviate the injurious effect of this tendency, a guard-plate, c^6, Figs. 5 and 9, is secured to each temple-block to bear against the under face of the fabric and prevent the fabric from being borne out of its proper direction by the larger part of the conical whip roll.

In the operation of knitting it is also desirable that each part of the cloth throughout the whole width of the fabric should be subjected to the same strain. As the fabric in this machine widens and narrows, a special contrivance is used to increase and decrease the pressure of the whip-roll in proportion to the increase and decrease in the width of the fabric, so that the strain upon each part of the fabric shall remain about the same, whether the fabric as a whole widens or narrows. This is effected by connecting each radius-bar B^6 of the whip-roll with a spring, Z, Figs. 5 and 9, by means of a cord that passes over a pulley secured to the needle-carriage. The opposite end of each spring is made fast to a cord which is wound upon a barrel, Z′, and the cords of the two springs are wound in the same direction upon the barrel, so that by turning it in one direction the springs are strained to a greater extent to cause the whip-roll to press with greater force upon the cloth, while by turning the barrel in the opposite direction the tensions of the springs are lessened, so as to relax the pressure of the whip-roll on the work. In order to vary the tension of the springs according to the variation in the width of the work, the cord-barrel is fitted with a wheel, Z^2, upon which a cord is wound, and the end of this cord is made fast to one of the temple-blocks K^3, so that when the work widens and the temple is moved outward the cord-barrel is turned to wind up the spring-cords and strain the spring to a greater extent, and when the work narrows the inward movement of the temple-block slackens the strain upon the springs. Hence the variation in the tension of the springs, and consequently in the strain exerted on the fabric by the whip-roller, which the springs control, is made to vary with the greater or less width of the fabric being formed.

In operating the machine thus described the movement of the needle-carriage to and fro carries the needles in operation over the supports F F beneath, by whose action the needles are pressed against the bar *e* above, so as to close their barbs. These supports in the present instance are made to rise and fall in the manner described in our patent dated February 16, 1858, and are constructed in two parts, one part, k^4, of which is on the inner side of the sinkers and effects the raising of the needles, while the other part, k^5, is on the outer side of the sinkers and supports the needles during the feeding of yarn and the descent of the sinkers to form the loops. The supports are alternately raised and depressed at the proper times by means of a slide-bar, S, whose upper graded edge operates upon pins that project from the stocks of the supports. Motion is imparted to this slide-bar by a vibrating arm, H^4, that projects upward from the rock-shaft B^{10}, which, as before described, is

caused to rock, as the carriage approaches the end of its stroke in either direction, through the intervention of the slide-bar C^4 at the back of the machine and the pins f^8 of the ratchet-carriages.

When the needles or other parts of the machine are to be adjusted by hand it frequently happens that it is advantageous to prevent the under supports from acting upon the needles. In order to permit this the vibrating arm H^4 is not made fast to the rock-shaft B^{10}, but is pivoted loosely thereon; and it is driven by a pin projecting from an arm H^5, Fig. 4, which vibrates with the rock-shaft into a socket in the vibrating arm. The hub of this driving-arm is constructed to slide endwise on the rock-shaft B^{10}, so that its pin may be withdrawn from the vibrating arm H^4, thus leaving the latter free to be moved by hand to place the protuberant part of the slide-bar S between the pins of the two under supports where it does not hold up either, but leaves them in their lowest position. When the machine is in operation the driving-arm H^5 is held in place by means of a spring which is coiled upon the rock-shaft B^{10}. This spring, by forcing the driving-arm H^5 toward the vibrating arm H^4, holds the pin of the former in the socket of the latter.

When the machine thus described is in operation, and the movable cam-plate M^6, Figs. 6 and 21, is raised to narrow the fabric, the rack-pin of the ratchet-carriage passes along and is moved by the grades on the front edge of the movable cam-plate during the movement of the needle-carriage from the center toward the end of its track, and on the returning movement of the needle carriage this pin passes along and is moved by the front edge of the stationary grade n^8 before it is returned to a central position by the jaws n^{10} n^{10}. By the movement of the rack-pin, as before stated, the traveling selvage-needles and selvage-needle carriage, the transferring-hook, the ratchet carriage, and the temple-block are all moved and in the following manner: The movement of the rack-pin by the grade n^5 throws down the transferring-prong to take up the stitch on the intermediate needle next the innermost traveling needle, and the point of the prong is depressed into the secondary groove of the needle, so that the stitch on the needle can pass readily onto the transferring-prong. No movement of the selvage-needle carriage takes place at this time, as the cam-collars compensate the screw action of the widening and narrowing screw. The next grade, n^6, extends parallel with the line of travel of the needle-carriage, so that it simply holds the rack-pin and the parts operated thereby in place while the slide-pin is passing over it. During this passage the needles are being drawn by the needle-cam groove out of the stitches, and the stitch upon the needle to which the transferring-prong was applied is left upon that prong. During the first part of the movement of the rack-pin along this grade the selvage-needles are pushed forward by the action of their cam-grooves out of the nosing f, Fig. 17, so that their shanks are clear of the partitions of the nosing, and that they may be made to travel inward from the adjacent end plate of the needle-carriage. The movement of the rack-pin by the grade n^7 causes the selvage-needle, the transferring-prong with the stitch upon it, the lifter that raises the sinkers, and the driver that withdraws the working-needle all to travel inward the space of a stitch, and after the rack-pin has passed this grade the continued movement of the needle-carriage causes the driver t' to be borne back by the operation of the narrowing-cam G′, so as to withdraw the needle whose stitch has been taken off by the transferring-prong from the series at work and leave it with the idle needles. Then, as the needle-carriage approaches the end of its stroke, the pin f^8 of the ratchet-carriage, by moving the slide-bar C^4, operates the rock-shafts B^4 B^2, and reverses the movement of the needle-carriage, at the same time operating the pawls of the pattern-barrels and shifting the under supports. When the carriage returns fron the end plate of the frame the needles are moved forward in their bed by the action of their cam-grooves while the rack-pin is passing toward the stationary grade n^8, and the working-needle which is now next the selvage-needles enters the stitch on the transferring-prong. The selvage-needles are also drawn back into the nosing by their cam-groove, so that their heads are in line with those of the intermediate needles. The movement of the rack-pin by the stationary grade n^8 rocks the transferring-prong backward, so that it is withdrawn from the stitch which is left upon the needle that entered it.

When the movable cam-plate M^6, Figs. 6 and 21, is raised at the proper time to widen the fabric the needle-carriage, traveling from the end of its track toward the center of the machine, carries the rack-pin against the grade on the hinder edge of the cam-plate. The movement of the rack-pin by the first third of this grade n^9 causes the selvage-needle carriage with its needle, the widening-driver t^2, the transferring prong, the sinker-lifter, the rack-carriage, and the temple-block all to travel toward the adjacent end plate of the needle-carriage, and a gap is left for the insertion of an intermediate needle. When this movement is taking place the snugs of the selvage-needles are in the part of their cam-groove which is nearest the front of the machine, and consequently the shanks of selvage-needles are out of the nosing, so that they can travel freely past the other needles. During the passage of the rack pin over this portion of the grade the cam-collars are furthering the widening and narrowing screw in moving the selvage-needle carriage, so that the selvage-needles are moved outward the space of a stitch. During the passage of the rack-pin over the remaining two-thirds of the grade the cam-collars compensate the movement of the screw, and consequently

the selvage-needle carriage retains its position upon the needle-carriage; but as during this period the widening-driver is operated by the cam G^2, the idle-needle, uncovered by the outward movement of the innermost selvage-needle, is pushed forward into the gap left by the travel of the selvage-needles outward, and the movement of the driver for this purpose commences as soon as the selvage-needle carriage has traveled the required distance.

As there are no cam-collars on the temple-screws and ratchet-carriage screws, the temple-blocks and ratchet-carriages are moved, whenever their screws turn, in exact ratio to the turning of their screws, and their total amount of movement is exactly equal to the movement of the traveling selvage-needles.

In the operation of the machine thus described it sometimes happens that the sinker-slides are accidentally broken. When this takes place the broken slide or slides tend to spring the cam-bar H forward from the slide-block C′ of the salvage-needle carriage. Advantage is taken of this tendency in the present machine to effect its stopping when breakage takes place. To this end an arm, U^2, is extended forward from one of the slide-blocks C′, so as to overlap the cam-bar H. The overlapping extremity of this bar is fitted with a set-screw, x^2, whose head is set to just clear the face of the cam-bar when the machine is running properly. Hence when a broken sinker-slide springs the cam-bar forward the head of the set-screw jams against the face of the cam-bar and holds the needle-carriage from moving, the driving-belt meanwhile slipping on its pulley, thus notifying the attendant that breakage has occurred and that the machine requires attention.

In the machine thus described the movement of the thread-guide is effected by the bumpers projecting from the traveling selvage-needle carriages, and consequently the movement of the thread-guide depends upon the position of the selvage-needles, which are the traveling needles in this machine, so that the delivery of yarn is varied in correspondence with the position of the traveling needles relative to the other needles of the machine, more yarn being fed when the traveling selvage-needles are nearer the adjacent ends of the carriage than when they are farther therefrom. In this machine, also, the selvage-needles and the slide-bar C^4 and its connections, which effect the reversal of the movement of the needle-carriage, are combined by means of the selvage-needle carriage, the ratchet-carriage, whose rack-pin operates the slide-bar C^4, and their screws and gearing, so that the reversal of the movement of the needle-carriage, which changes the direction in which the yarn is fed to the needles, depends upon and is controlled by the position of the traveling selvage-needles, being effected sooner or later according as these traveling needles are moved toward or from the farther end of the gang of needles at work. If the needle-carriage were made stationary and the thread-guide were moved past it, as is a common arrangement in knitting-machines, the mechanism of the machine may be adapted to such a change in the construction of the machine and still retain these features.

Although the machine above described embodies all our improvements, the several parts of our invention are not limited in their application to a machine constructed as before described, as parts of it may be applied with advantage to other knitting-machines—such, for example, as those in which a part of the movements of the machine are effected by hand instead of automatically. Thus the screws may be moved by hand at suitable intervals and in a proper manner to move the ratchet-carriage, the traveling needle-carriage with its appurtenances, and the temple-block instead of automatically. Neither is the invention limited to a knitting-machine in which all parts thereof are used simultaneously, as some parts of the invention may be used without others. Thus, for example, a knitting-machine or knitting-loom may be constructed to widen the fabric upon the plan devised without narrowing it, and vice versa. Nor do we limit the invention to a knitting-machine of the precise construction of parts herein described, or to the precise mode described of imparting the requisite motion to the parts thereof, as these may be varied as circumstances may render expedient to suit particular cases or the views of different constructers or manufacturers, or to adapt the machine to various kinds of knitting. Thus, for example, the mechanism that connects the widening and narrowing screws with the temple-screws may be located upon the end plates of the frame of the machine, and its construction may be varied to adapt it to these new positions, and the connection of the screws may be made by means of cog-wheels and shafts, or by means of a chain running upon sprocket-wheels, or in any suitable manner that will accomplish the desired result.

Some of the improvements thus described may be applied to the transference of stitches at parts of the work between the selvages by arranging traveling needles at corresponding parts of the series of needles employed and adapting the mechanism that operates them to the work to be performed.

The foregoing examples are given to show that the mode of carrying the invention into practice may be modified without changing the principle thereof.

We claim as our invention and desire to secure by Letters Patent—

1. The combination of a traveling needle in a knitting-machine with automatic mechanism for causing it to travel along the gang of needles of the machine, substantially as set forth.

2. The combination of a traveling needle with mechanism for withdrawing the needle whose place the traveling needle is to occupy from

the gang at work previous to the substitution of the traveling needle in its place, substantially as set forth.

3. The combination of a traveling needle with mechanism for reinserting the other needle of the gang whose place the traveling needle has occupied after the traveling needle has been removed therefrom, substantially as set forth.

4. The combination of a traveling needle with a mechanical instrument for transferring the stitch from the needle that is withdrawn from the gang at work to an adjacent needle, substantially as set forth.

5. The combination of a traveling selvage-needle with a thread-guide by means of devices which cause the thread-guide to vary its delivery of yarn in correspondence with the change in the position of the traveling selvage-needle relative to the other needles of the machine, substantially as set forth.

6. The combination of a traveling needle with a series of needles which move to and fro past a thread-guide, but do not travel laterally to each other, substantially as set forth.

7. The combination of a traveling selvage-needle with mechanism for reversing the movement of the needle-carriage in such manner that the time at which the movement is reversed depends upon the position of the traveling selvage-needle, substantially as set forth.

8. The combination of the series of sinkers of a knitting-machine with a traveling instrument for withdrawing the sinkers which happen to be at the selvage of the fabric from their positions in the series, substantially as set forth.

9. The combination of the series of sinkers of a knitting-machine with a traveling instrument for withdrawing a portion of the sinkers outside of the gang at work from their positions in the series, substantially as set forth.

10. The combination of instruments for griping the yarn with mechanism that causes them to act at the time the selvage-needles are forming their loops, substantially as set forth.

11. The combination of griping-instruments with mechanism for operating them and the needles in such manner that the gripe is relaxed in time to prevent the breaking of the yarn by the action of the needles, substantially as set forth.

12. The combination of the thread-guide with mechanism for depressing it immediately after the last needle in the series at work has been fed with yarn and before that needle is withdrawn into its nosing, substantially as set forth.

13. The combination of traveling temples with a knitting-machine for forming work of variable width in such manner that the position of the temples is varied as the number of needles at work increase or diminish, substantially as set forth.

14. The combination of a whip-roll of unequal diameter at different parts of its length with the take-up rolls of a knitting-machine, substantially as set forth.

15. The combination of instruments for varying the strain upon the fabric between the place where knitting is effected and the take-up rolls with a knitting-machine for forming work of variable width, substantially as set forth.

16. The combination of under supports having bearings for the needles outside of the sinkers with a depressible thread-guide constructed and operated substantially as set forth.

In testimony whereof we have hereunto subscribed our names.

JOSEPH K. KILBOURN.
EDWARD E. KILBOURN.

Witnesses as to signature of Joseph K. Kilbourn:

JAMES BUEL,
JOHN A. WALKER.

Witnesses as to signature of Edward E. Kilbourn:

FREDERIC E. PORTER,
SAML. C. BARNUM.