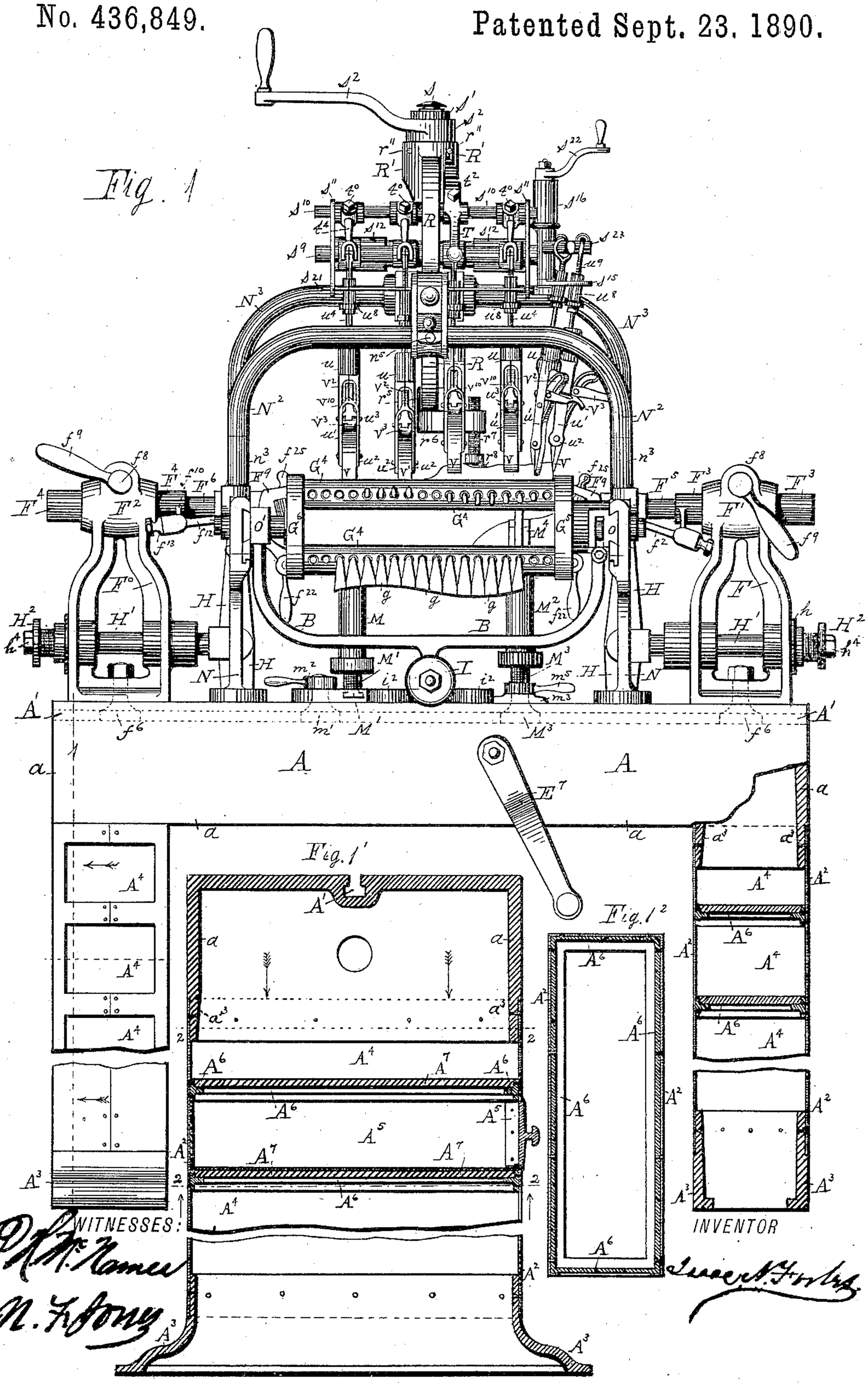
(No Model.) 9 Sheets—Sheet 1.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

Fig. 1



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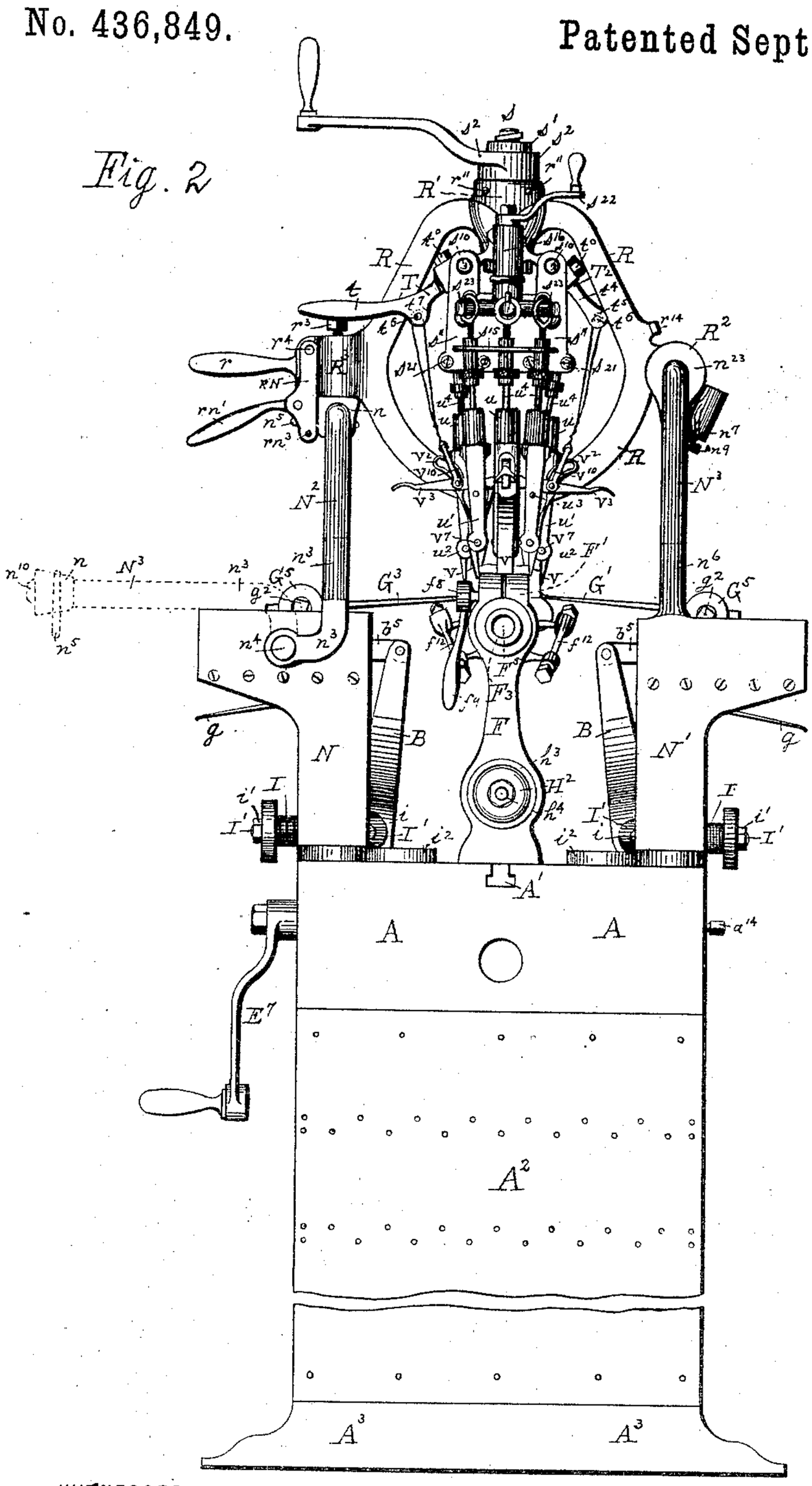
# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

Fig. 2

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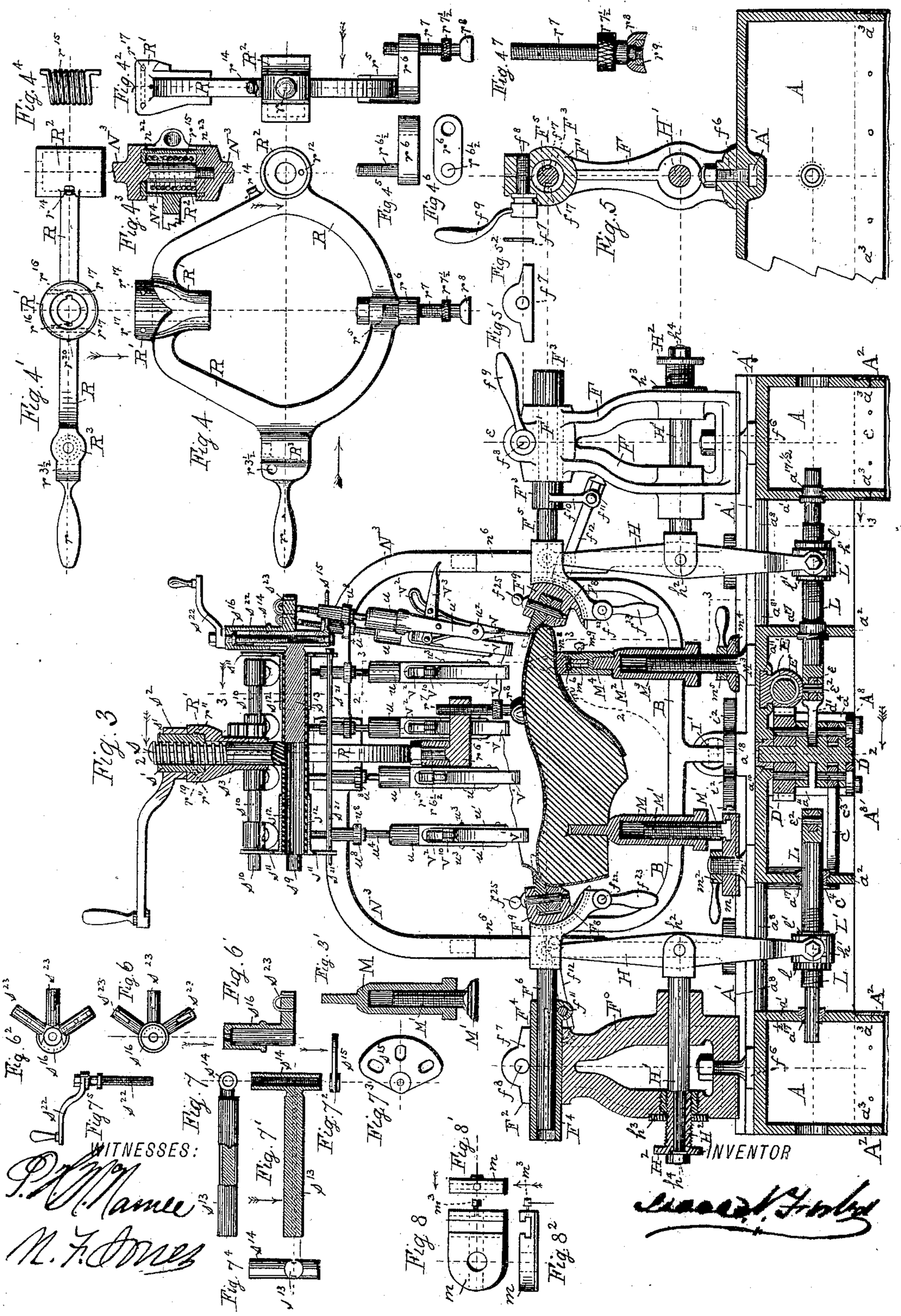
(No Model.)

9 Sheets—Sheet 3.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.



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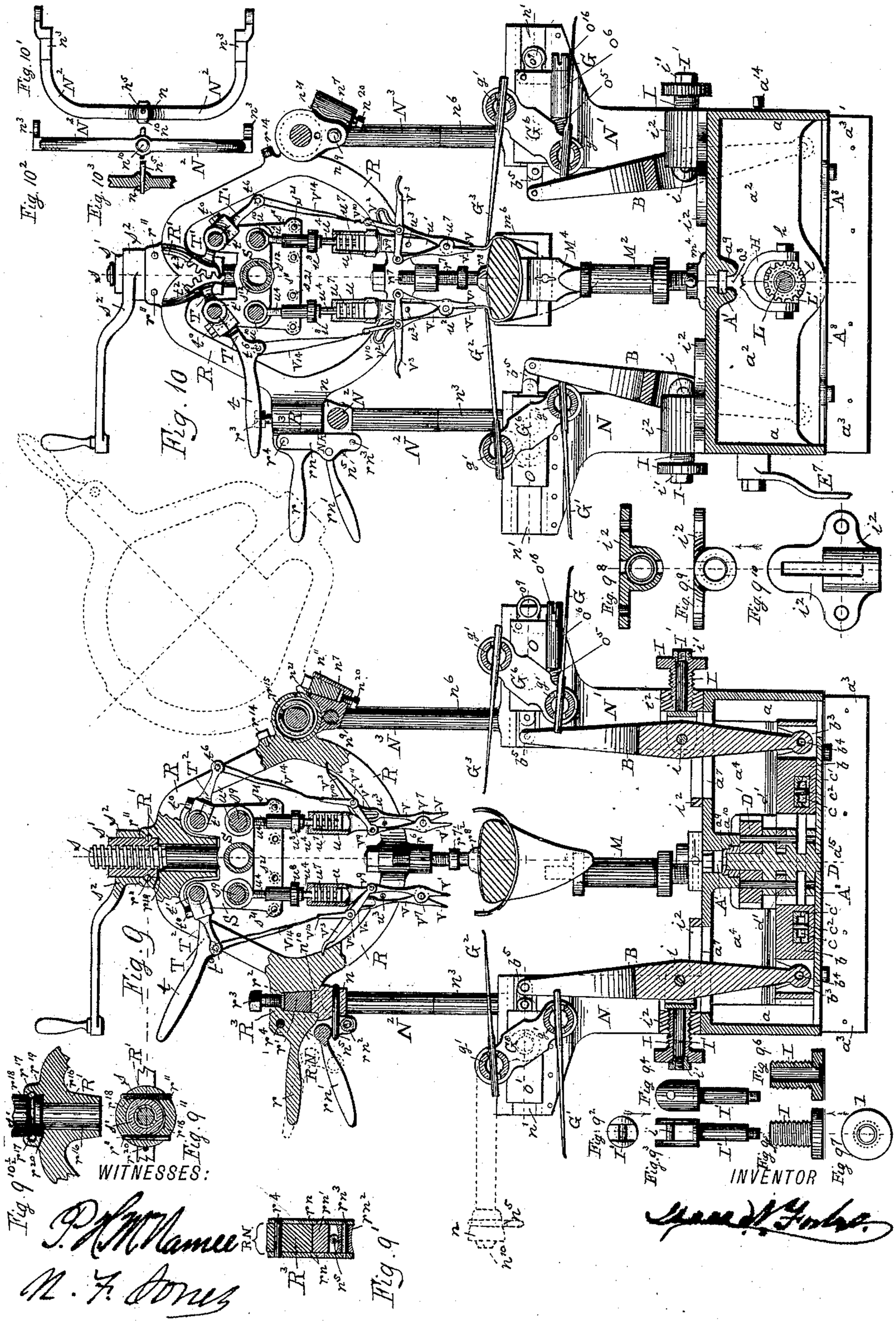
# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.



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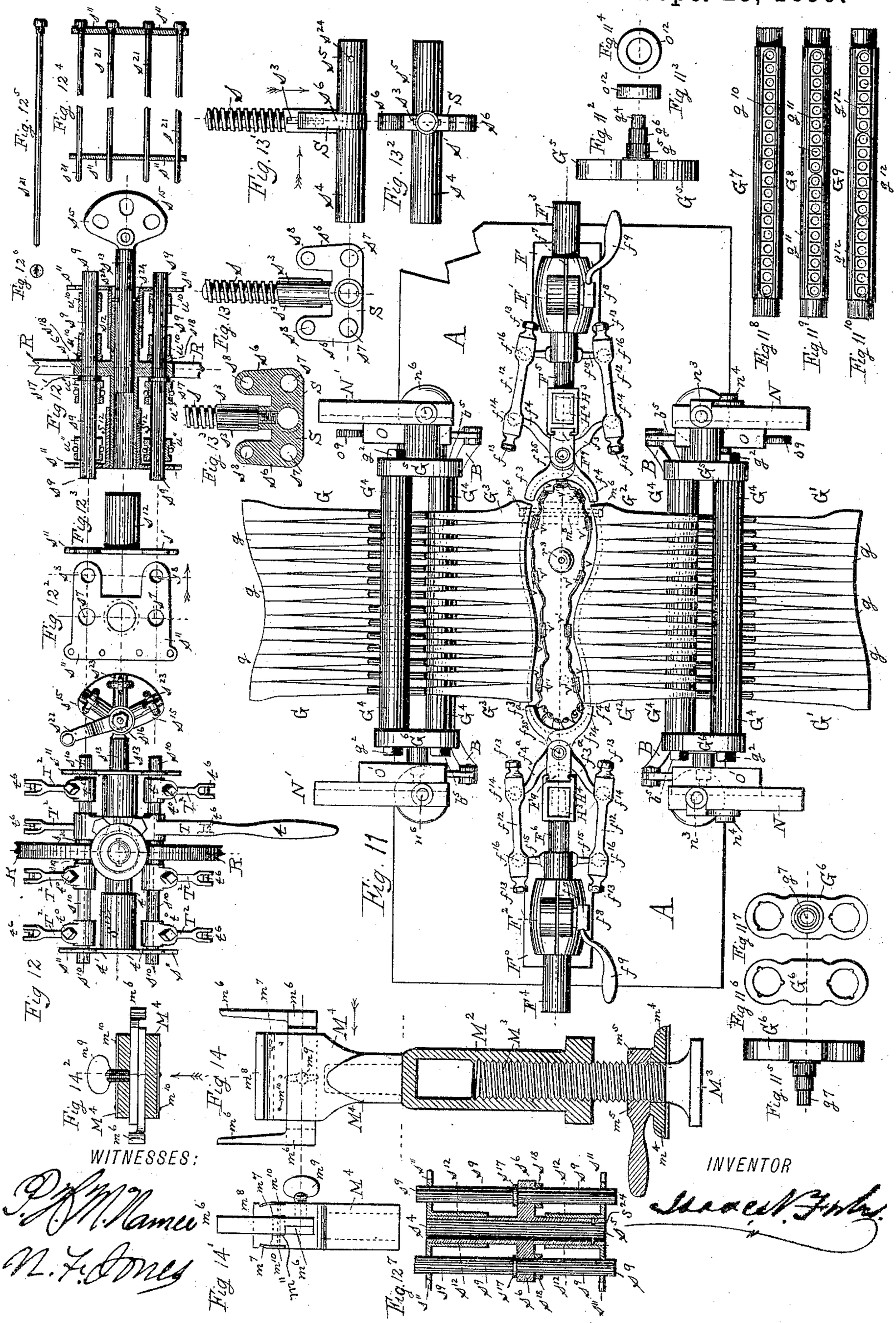
9 Sheets—Sheet 5.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.



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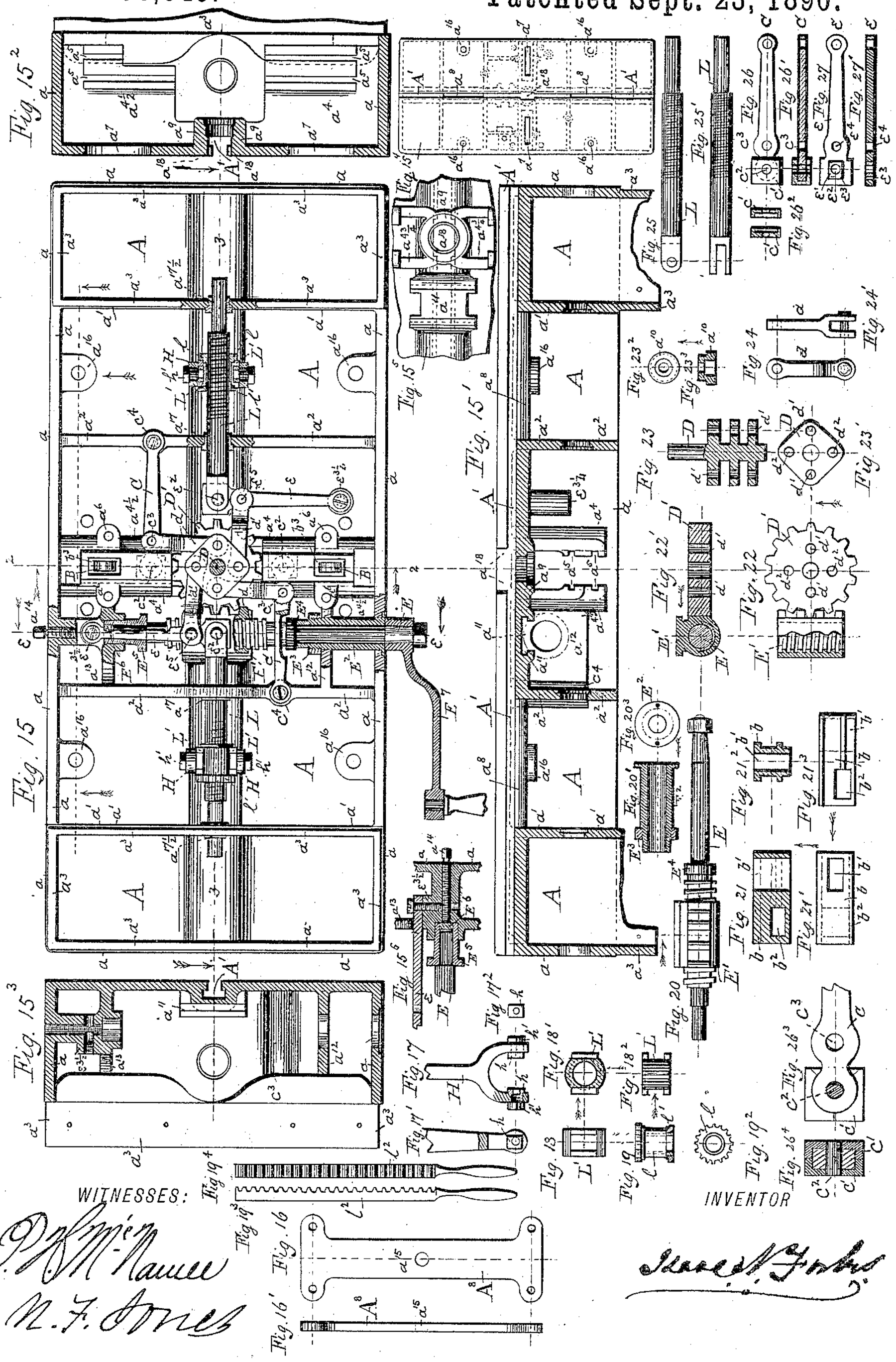
# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

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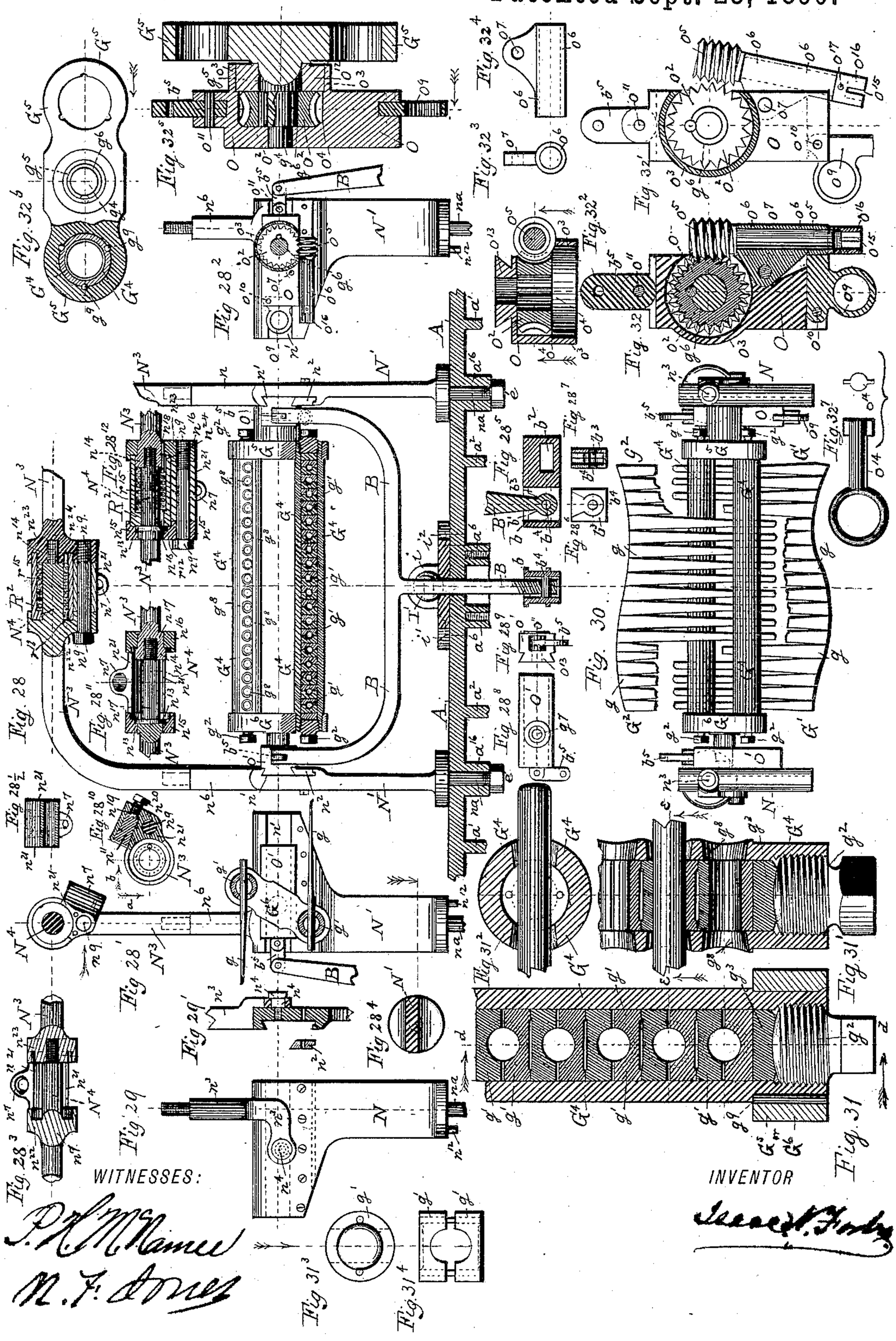
(No Model.)

9 Sheets—Sheet 7.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

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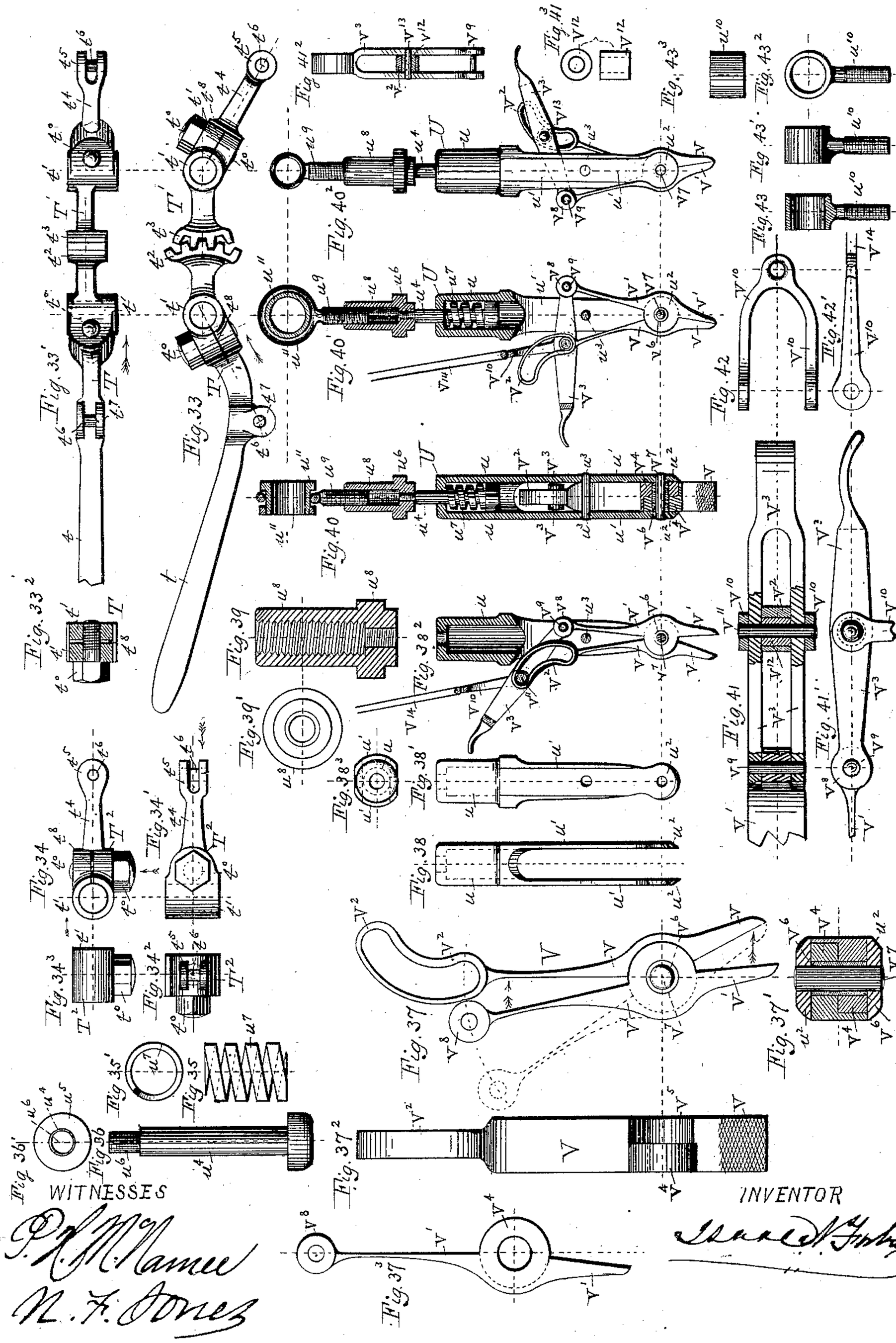
(No Model.) 9 Sheets—Sheet 8.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

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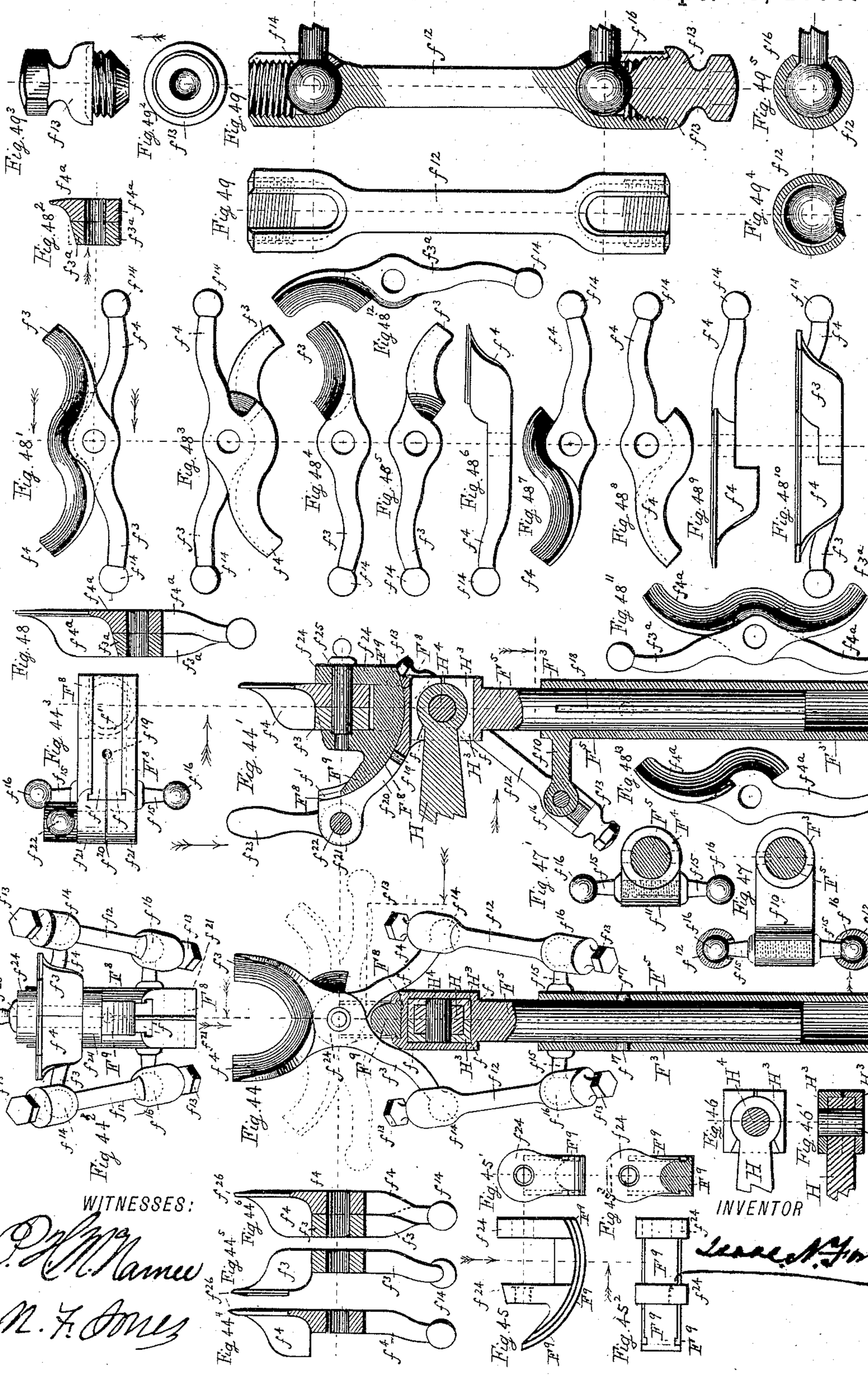
(No Model.)

9 Sheets—Sheet 9.

# I. N. FORBES.

## LASTING MACHINE.

No. 436,849. Patented Sept. 23, 1890.

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# UNITED STATES PATENT OFFICE.

ISAAC N. FORBES, OF NEW YORK, N. Y.

## LASTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 436,849, dated September 23, 1890.

Application filed March 19, 1889. Serial No. 303,927. (No model.)

*To all whom it may concern:*

Be it known that I, ISAAC N. FORBES, a citizen of the United States, residing in the city and State of New York, have invented a new and useful Lasting-Machine, of which the following is a specification.

My invention consists of an improved machine for lasting boots or shoes, whereby the entire process of shaping the upper around and to the last and insole when placed in the machine can be performed with great directness, speed, and economy, a distinguishing feature of the machine being the simultaneous movement, through a single crank or wheel by one hand of the operator, of all the mechanism required in the operation, excepting only that portion used in stretching and drawing the upper on the last, which can also be moved by the operator with his other hand at the same time. It is also distinguished by the number and completeness of its adjustments and the facility with which they can be made in all its parts to meet this most necessary requirement of a lasting-machine.

The general structure of my invention consists of, first, a table of proper shape, size, and elevation for sustaining the machinery, and, second, a proper gear beneath the table with a shaft extending to the front, to which a crank or wheel is secured for receiving the power for driving all the gear up to and including the forming-clamps at both sides and ends of the last. Part of this gear consists of four upright levers that extend through slots in the table near the opposite sides and ends thereof. They have adjustable fulcrums and connect the gear beneath the table with that above. Third, a movable and adjustable head, from which is suspended a collection of pliers for stretching and drawing the upper to the last, and which also carries the mechanism for operating and disengaging the pliers.

The mechanical devices, their form, arrangement, and combinations, by which I attain the objects of this invention, are illustrated by the accompanying drawings, in which similar letters and figures represent similar parts, except those representing sectional lines, which are fully explained.

Plate 1. Figure 1 is a front elevation of the machine. Fig. 1′ is a broken vertical sectional view on dotted line 1 1, Fig. 1, of one leg of Figs. 1 and 2, with one drawer in. Fig. $1^2$ is a sectional view on dotted line 2 2, Fig. 1′, viewed, as indicated by arrow, with table and drawer removed.

Plate 2. Fig. 2 is an end elevation of the machine, as seen from the right-hand end of Fig. 1, in which the toe is located.

Plate 3. Fig. 3 is a vertical longitudinal central sectional view through the table and most of the lower gear, also through the heel (or left hand) stand and heel and toe clamps and a part of the last-support, also through the head and last, including upper and insole, being shown by sectional lines, the balance shown full. Fig. 3′ is a view, partly in section, of a portion of the heel-stand. Figs. 4, 4′, and $4^2$ are respectively a side, end, and top view of the head-yoke. Fig. $4^3$ is a horizontal central section of the hinge-joint of the same. Fig. $4^4$ is a view of the spring of said hinge. Figs. $4^5$ and $4^6$ are respectively a side and top view of the extension which carries the downhold or last-fastener. Fig. $4^7$ is a side view, partly in section, of the downhold. Fig. 5 is a vertical transverse section of the stand for the toe-lasting devices. Figs. 5′ and $5^2$ are respectively a side and end view of the stop-plate for the clamp-head of said stand. Fig. 6 is a top view of the piece forming the extension-bearings for the toe-pieces. Figs. 6′ and $6^2$ are respectively a vertical central section and a bottom view of the same. Figs. 7 and 7′ are respectively a top view, partly in section, and a vertical section of the shaft and threaded sleeve forming a part of the support for the toe-pliers. Fig. $7^2$ is a side view of the guide-plate for hangers which carry said pliers. Fig. $7^3$ is a top view of the same. Fig. $7^4$ is an end view of the part shown in Figs. 7 and 7′. Fig. $7^5$ is a side view of the adjusting-screw for the toe-plier support. Figs. 8, 8′, and $8^2$ are respectively a top, end, and side view of the base of the heel-stand.

Plate 4. Fig. 9 is a vertical cross-sectional view of Fig. 3, generally on dotted line 2 2, viewed as indicated by arrows, ready for lowering the adjustable part of the head for connecting the pliers to the upper for stretching it, also showing the position of head by dotted lines when thrown back out of the way after having stretched the upper, and shows the front bridge brought down to leave clear

space for tacking or otherwise securing the upper to the insole previous to removing the last, with tooth-gear lever for opening the side pliers simultaneously removed. Fig. 9′ is a vertical transverse section of the locking device for the head. Figs. $9^2$, $9^3$, and $9^4$ are respectively an end, top, and side view of the slide-piece of the fulcrum for the side levers. Figs. $9^5$, $9^6$, and $9^7$ are respectively a side, sectional, and end view of the adjusting-screw sleeve for said fulcrum-piece. Figs. $9^8$, $9^9$, and $9^{10}$ are respectively a sectional, end, and top view of the fulcrum-bearing stand or plate. Figs. $9^{10\frac{1}{2}}$ and $9^{11}$ are respectively a vertical section, partly in elevation, and a horizontal section of a portion of the yoke and adjusting devices for the side pliers. Fig. 10 is a cross-vertical view, part sectional and part full, of Fig. 3, on dotted line 3 3, (see arrows,) with pliers in contact with upper after having stretched the same and slackened down to permit the side and end clamps to press the upper into position around and upon the bottom edge of the last, holding the same until the pliers are thrown open, the head thrown back, the front bridge pulled down, and upper secured to the insole. Then the side and end clamps are withdrawn by reversing the crank and the last removed. Figs. 10′ and $10^2$ are views of front bridge $N^2$. Fig. $10^3$ is a sectional view of broken part of same.

Plate 5. Fig. 11 is a top view of part of the machine with head and bridges removed, with upper in position around the last on the insole brought there by the side and end clamps, which hold that position until the upper is made fast to the insole ready for the clamps to be withdrawn for the removal of the last. A portion of the plier-jaws that grasp the upper are shown in section. Fig. $11^2$ is a view, from the upper inner side of cross-head $G^5$, of the vise-tubes which carry the side-lasting fingers or clamps. Figs. $11^3$ and $11^4$ are respectively a top and end view of the bushing-bearing for the inner journal of said cross-head. Figs. $11^8$, $11^9$, and $11^{10}$ are side views of modified forms of the vise tubes or holders for the side-lasting fingers. Fig. 12 is a top view of the head, showing a portion of the yoke with the nut and crank removed. Fig. 12′ is a horizontal sectional view, part full, showing a portion of the head. Figs. $12^2$ and $12^3$ are respectively an end and side view of one of the end sleeve-plates of the head. Fig. $12^4$ is a top view broken showing said plates in section, the guide-rods in place thereon. Figs. $12^5$ and $12^6$ are respectively a side and end view of one of said rods detached. Fig. $12^7$ is a horizontal section, part full, of a portion of the frame of the head. Figs. 13, 13′, and $13^2$ are respectively an end, side, and top view of a portion of the frame of the head with its adjusting-screw. Fig. $13^3$ is a sectional view, part full, of a modified form of the same. Fig. 14 is an elevation of the toe-stand, partly in section. Fig. 14′ is a side view, and Fig. $14^2$ a horizontal sectional view, part full, of the toe-bearing of said stand.

Plate 6. Fig. 15 is a bottom view of the table, including gear complete, (except Plate $A^8$, Figs. 16 and 16′, removed,) part broken and part sectional, mainly full view. Fig. 15′ is a longitudinal vertical central sectional view of Fig. 15 upon dotted line 3 3, Fig. 15, viewed, as indicated by arrows, with gear removed. Fig. $15^2$ is a vertical central cross-sectional view of Fig. 15 on dotted line 2 2, (indicated by arrows,) with gear removed. Fig. $15^3$ is a vertical cross-sectional view of Fig. 15 on dotted line *e e*, viewed, as indicated by arrows, with gear removed. Fig. $15^4$ is a top view of the table reduced in size. Fig. $15^5$ is a broken portion of the bottom part of the table, showing the center hub $a^9$ and connecting-ribs $a^{4\frac{3}{4}}$, connecting also with guide-extensions $a^4$ $a^{4\frac{1}{4}}$, and showing a recessed projection $a^{11}$, (which is shown also in Figs. 15′ and $15^3$ and on Plate 3, Fig. 3, with nut E′ in position.) Fig. $15^6$ is a vertical sectional view of a broken portion of the table A on dotted line *e e* of Fig. 15, through flange *a*, rib $a^{13}$, bosses thereon, and connections, showing connecting-lever *e*, stop-bearing $E^6$, stop-bearing flanged sleeve $E^5$, and a portion of screw-shaft E, also end set-screw $a^{14}$ and hinge-bolt in connecting-bearing $e^{3\frac{1}{4}}$, illustrating their relations to each other. Fig. 16 is a bottom and Fig. 16′ an edge view of the bearing-plate for the central flanged shaft. Fig. 17 is an elevation, partly in section, of one of the levers for operating the end-lasting devices. Fig. 17′ is a similar view at right angles to Fig. 17. Fig. $17^2$ is a side view of one of the bearing-pieces carried by said lever. Fig. 18 is a side, and Fig. 18′ a transverse section, of one of the guide-bearings which is engaged by said pieces. Fig. $18^2$ is a top view of the same. Figs. 19 and $19^2$ are respectively a side view, partly in section, and an end view of one of the screw-sleeves for said bearings. Figs. $19^3$ and $19^4$ are respectively a side and a top or bottom view of a handled rack-bar for rotating the screw-sleeves. Fig. 20 is a side view of the main screw-shaft and toothed nut. Fig. 20′ is a sectional view of the bearing-sleeve for said shaft. Fig. $20^3$ is an end view of the same. Figs. 21, 21′, $21^2$, and $21^3$ are respectively a longitudinal section, a top view, a cross-section, and a side view of one of the slide-bearing guide-pieces. Figs. 22 and 22′ are respectively a top and sectional view of the toothed nut and engaging gear-wheel. Figs. 23 and 23′ are respectively a vertical section and top view of the central flanged shaft. Figs. $23^2$ and $23^3$ are respectively a bottom and vertical sectional view of the bushing-bearing for the upper end of the flanged shaft. Figs. 24 and 24′ are respectively a top and side view of one of the connecting-rods. Figs. 25 and 25′ are respectively a top and side view of one of the screw-slide shafts. Figs. 26 and

26′ are respectively a top and vertical sectional view of one of the horizontal side levers and its side joint-pieces in position. Fig. $26^2$ shows said joint-pieces in section and detached. Fig. $26^3$ is a top view of a portion of a lever having one of said joint-pieces applied thereto. Fig. $26^4$ is a transverse section of the same, showing both of said pieces in place. Fig. 27 is a top view, and Fig. 27′ a vertical section, of one of the horizontal end levers.

Plate 7. Fig. 28 is a vertical sectional view, part full, showing a portion of the table, the back bridge, and stands, looking from the inner side and the holding devices and actuating-lever for the side-lasting fingers or clamps. Fig. $28\frac{1}{2}$ is a vertical sectional view of the hinge and stop-piece for the head-yoke. Fig. 28′ is an elevation, partly in transverse section, showing the back bridge, the lasting-fingers, and a portion of their holding and actuating devices. Fig. $28^2$ is an elevation, partly in section, looking in the opposite direction, illustrating the means for changing and adjusting the side-lasting fingers. Fig. $28^3$ is a top view, partly in horizontal section, of the central portion of the back bridge. Fig. $28^4$ is a horizontal section near the base of one of the side-lasting-finger stands. Fig. $28^5$ is a vertical central section of one of the slide-bearing blocks and a portion of the side lever which it actuates. Fig. $28^6$ is a side view of one of the side pieces which form a part of the slide-hinge joint for the lower end of said lever. Fig. $28^7$ is a vertical transverse section of two of said pieces in their proper relation. Fig. $28^8$ is a side view of one of the slides which carry the journals of the vise-clamp for the side-lasting fingers. Fig. $28^9$ is an elevation of the same from the inner end. Fig. $28^{10}$ is a transverse sectional view of portions of the hinge and stop-joint for the head-yoke, showing a modified construction. Fig. $28^{11}$ is a longitudinal horizontal section, part full, of the same, showing also portions of the bridge-piece. Fig. $28^{12}$ is a vertical section of the same, part full, with the yoke and spring in place. Fig. 29 is an elevation showing one of the front bridge-stands and hinged extension. Fig. 29′ is a sectional view, part full, of the same, looking from the outer side. Fig. 30 is a top view of the lasting-fingers and their holding devices. Fig. 31 is a vertical longitudinal section of a portion of one of the vise-tubes and its clamping parts. Fig. 31′ is a horizontal and Fig. $31^2$ is a transverse section of the same, showing one of the finger-clamps in place and partly broken away. Fig. $31^3$ is an end view of one of the vise-clamping pieces. Fig. $31^4$ is a side view of two of such pieces in their proper relation. Fig. 32 is a vertical central section of the means for changing and adjusting the side-lasting fingers or clamps. Fig. 32′ is a side view of the same, partly in section, showing the securing and adjusting worm out of gear. Fig. $32^2$ is a transverse central sectional view of the bearing-slide, worm-gear, and worm. Fig. $32^3$ is an end and Fig. $32^4$ a side view of the hinged worm-bearing sleeve. Fig. $32^5$ is a horizontal section of the bearing-slide and worm-gear, showing also one of the cross-heads turned into a horizontal plane. Fig. $32^6$ is an end view, partly in section, of one of said cross-heads, showing one of the vise-tubes in position. Fig. $32^7$ illustrates by side and end view the key for turning the worm to adjust the side-lasting fingers.

Plate 8. Fig. 33 is an elevation showing the lever-gear for disconnecting the side pliers. Fig. 33′ is a top view of the same. Fig. $33^2$ is a transverse section of the same. Figs. 34, 34′, $34^2$, and $34^3$ are respectively a side and opposite end views of one of the disconnecting side-clamp arms. Figs. 35 and 35′ are respectively a side and end view of one of the hanger-springs. Figs. 36 and 36′ are respectively a side and top view of one of the hanger-bolts. Figs. 37 and 37′ are respectively a side view and cross-section of a pair of the pliers. Fig. $37^2$ is a view from the inner side of one of the members of said pliers. Fig. $37^3$ is a side view of the other member. Fig. 38 is an elevation of one of the frame-pieces of the hanger. Fig. 38′ is an elevation of the same at right angles to the previous figure. Fig. $38^2$ is a vertical sectional view of the frame-piece with a pair of the pliers in place therein in their open position. Fig. $38^3$ is a top view of the frame-piece. Fig. 39 is a vertical section, and Fig. 39′ a top view, of the adjustable screw-sleeve for the hanger. Fig. 40 is a vertical sectional view, part full, of one of the adjustable spring side hangers. Fig. 40′ is a sectional view at right angles to Fig. 40, with the pliers closed. Fig. $40^2$ is a side view of one of the toe hangers and pliers. Fig. 41 is a top view, part in section, of the plier-operating lever, showing its connection with the pliers. Fig. 41′ is a side view of the same. Fig. $41^2$ is a plan view, partly in section, of the toe-plier-operating lever, showing its connection with the cam-arm of the pliers. Fig $41^3$ illustrates by end and top view the friction-roller of said lever. Fig. 42 is a side view of the disconnecting-levers. Fig. 42′ is an edge view of the same. Figs. 43, 43′, $43^2$, and $43^3$ illustrate, by sectional, side, end, and top views, a modified form of bolt for suspending the hanger.

Plate 9. Fig. 44 is a bottom view, partly in section, of the toe-clamp or lasting device with its appurtenant parts. Fig. 44′ is a vertical sectional view, part full, of the same. Fig. $44^2$ is an elevation of the same from the inner side. Fig. $44^3$ is an inner end view of the sliding shaft and holder for the heel or toe lasting clamps. Fig. $44^4$ is a vertical sectional view of one of the toe-lasting jaws or clamps. Fig. $44^5$ is a similar view of the other jaw. Fig. $44^6$ is a similar view of the two combined. Fig. 45 is a side view of the quadrant bearing-piece which fits in the holder or clamp shown in Fig. $44^3$ and carries the lasting-jaws. Figs. 45′, $45^2$, and $45^3$

are respectively a top, inner side, and horizontal section of the same. Fig. 46 is a side view of the upper end of one of the slide-actuating levers with one of its slide-hinge pieces. Fig. 46′ is a vertical transverse section of the same. Fig. 47 is a transverse section of the sliding shaft, showing the inner end of the adjustable sleeve with its ball-bearings for the jaw-actuating rods. Fig. 47′ is a similar view of the sliding shaft and sleeve for the heel-jaws, with the jaw-actuating rods removed. Fig. 48 is a sectional view of the heel jaws or clamps. Fig. 48′ is a bottom view of the toe-lasting jaws or clamps open. Fig. $48^2$ is a vertical transverse sectional view of the heel clamps or jaws open. Fig. $48^3$ is a top view of the jaws shown in Fig. 48′. Figs. $48^4$, $48^5$, and $48^6$ are respectively a bottom, top, and inner side view of one of the toe-lasting jaw-pieces. Figs. $48^7$, $48^8$, and $48^9$ are respectively a bottom, top, and an inner side view of the other piece of the clamp. Fig. $48^{10}$ is an inner side view of the two toe-lasting jaws or clamps wide open. Fig. $48^{11}$ is a bottom view of the two heel-lasting jaws or clamps wide open. Fig. $48^{12}$ is a bottom view of one of said jaws. Fig. $48^{13}$ is a bottom view of its mate. Fig. 49 is an inner side view of one of the socketed connecting-rods for actuating the heel or toe clamps or jaws. Fig. 49′ is a horizontal sectional view of the same, showing the bearing-balls and one of the bearing-plugs in place. Figs. $49^2$ and $49^3$ are respectively an inner end and side view of one of the bearing-plugs. Fig. $49^4$ is a transverse section of the connecting-rod, taken through its bearing-socket. Fig. $49^5$ is a similar view with the ball in place.

*Description of table.*

A, Fig. 1, represents the table, with a plane top surface, in which is a T-groove A′, extending centrally from end to end. It has a proper thickness of metal beneath for equal strength and a recess $a^{18}$ (see Plates 3 and 6, Figs. 3, $15^2$, and $15^4$) cut out equal to the outside of the bottom part of the T-slot A′ in width, and in length equal to the length of the bolt-head $m'$ and the head of stand-shaft $M^3$.

Around the entire outer surface of the table is the flange $a$, with an extension $a^3$ at each end, upon which the sheet-metal legs $A^2$ are secured by rivets or bolts, as required. Cross-connecting ribs $a'$ and $a^2$ are cast for strength to the table, and bushed bearings $a^{17}$ $a^{17\frac{1}{2}}$ are fitted, and in which the slide-screw shafts L L fit and work, and at opposite sides in the middle of the table beneath are cast guides $a^4$ $a^{4\frac{1}{2}}$ dressed out with grooves $a^5$ (see Fig. 15′) in each side, in which tongued slide-bearing pieces $b$ fit. (See Plate 6, Figs. 21 to $21^3$, inclusive.) Guides $a^4$ (see Plate 6, Figs. 15, 15′, $15^2$, and $15^5$) extend straight their full length on the bottom, while their mates $a^{4\frac{1}{2}}$ are cut from the bottom up and from their inner ends to their bosses $a^6$, (see Figs. 15, 15′, and $15^2$,) allowing space for connecting-levers C and rods $d$ to work. The extensions $a^{4\frac{3}{4}}$ of the upper portion of the castings of these guides connect to the center hub $a^9$, (see Plate 6, Figs. $15^2$ and $15^5$,) thus adding support to their several parts. Upon the outer sides of the cast-guides $a^4$ $a^{4\frac{1}{2}}$ are bosses $a^6$, which form supports to the guides $a^4$ and $a^{4\frac{1}{2}}$, and are provided with threaded holes in which threaded bolts fit for securing bearing-plate $A^8$ (see Plate 6, Figs. 16 and 16′) in position by bolts. (See Plates 3 and 4, Figs. 3, 9, and 10.)

At the opposite sides in the middle of the table are slots $a^7$, (see Plates 4 and 6, Figs. 9, $15^2$, and $15^4$,) through which the side-arm-connecting levers B B pass for connecting the lower with the upper side gear. Between ribs $a'$ and $a^2$ slots $a^8$ (see Plates 3 and 6, Figs. 3, 15′, and $15^4$) are cut through the table for the entire distance, and in width equal to the top portion of the T-slot A′, through which the end shifting connecting-levers H H pass and work, connecting the lower and upper end gear together.

In the center of the table is a hub $a^9$, (see Figs. $15^2$ and $15^5$,) having a bearing-bushing $a^{10}$, (see Plate 6, Figs. $23^2$ and $23^3$,) in which the upper end of the three-flanged center shaft D fits. (See Plates 3 and 4, Figs. 3 and 9.) Near the hub is recessed guide $a^{11}$, (see Plates 3 and 6, Figs. 3, 15′, $15^3$, and $15^5$,) dressed out, forming a guide for the nut E′, in which it fits for working to and fro upon its shaft. Short ribs $a^{12}$ and $a^{13}$ connect cross-rib $a^2$ to the backs of bosses $a^6$ (see Plates 3 and 6, Figs. 3, 15, 15′, and $15^3$) with a bearing-hole through rib $a^{12}$ and in rib $a^{13}$. A hole through the front flange $a$ of the table is recessed, in which a sleeve-bearing $E^2$ fits and is secured in position by nut $E^3$. (See Plate 6, Fig. 15, in position, and Figs. 20′ and $20^3$, disconnected and shown in two views.) The main screw-shaft E, which is operated by the front crank $E^7$, fits and works at its front end in this sleeve-bearing $E^2$, having its other end in sleeve-bearing $E^5$, that is driven in the boss of the rib $a^{13}$. (See Figs. 15, $15^3$, and $15^6$.) In the back end of sleeve-bearing $E^5$ stop-bearing $E^6$ fits against the end of shaft E and is pressed by set-screw $a^{14}$, that passes through flange $a$ and its connections for taking up slack motion. (See Plate 6, Figs. 15 and $15^6$.)

Holes are bored in line from end to end of table through flanges $a$, $a'$, and $a^2$. The holes in $a'$ and $a^2$ are of different sizes to accommodate the different sizes of bearing-bushes required for the two portions of the end slide-screw shafts L L that fit and work in them. (See Plates 3 and 6, Figs. 3 and 15, in position and detached in Figs. 25 and 25′.) In the cross-connecting ribs $a^2$ are bosses $c^4$, in which holes are bored and threaded for receiving the hinge screw-bolt, by which the outer ends of connecting-rods C C are secured. Projections $e^{3\frac{1}{4}}$, extending below from the main plate of the table, and $e^{3\frac{1}{2}}$ from the rib $a^{13}$ above set-screw connection, are similar points of connectio (see Plate 6, Figs. 15, 15′, and $15^3$)

where the ends of connecting-rods *e* are hinged by screw-bolts, which pass through the ends of the rods and screw in their respective bearings.

$A^2$ represents the table-legs, (see Plate 1, Figs. 1, 1′, and $1^2$, also broken connections to table on Plate 3, Figs. 3 and 5,) constructed mainly of sheet metal fitted to frames, with T or L frames $A^6$ inside at proper distances apart, riveted or otherwise secured thereto for drawers to suit, which fit between. The upper parts of the legs are fitted to the flanges $a^3$ $a^3$, which are extensions of the flanges *a a*, at each end of the table, and to extensions of ribs *a′* across the table (see Plates 1 and 6, Figs. 1, 1′, $1^2$, and 15 to $15^3$, inclusive) and riveted to their bases $A^3$. (See Plates 1 and 2, Figs. 1 and 1′.)

$A^7$ are the bottoms, on which the drawers rest.

$A^4$ are spaces in the legs for drawers.

$A^5$ is a drawer constructed of sheet metal, secured to the cast-metal end. Lock-drawers are placed in the legs under both ends of the table and extend across it. The space can thus be utilized as a receptacle for such tools, appliances, and duplicate parts of the machine, &c., as may be required, and if more room is needed the entire remaining space beneath the table can be shelved for the purpose.

*Gear beneath the table.*

On Plate 6, Fig. 20, E represents a screw-shaft.

E′ is a toothed slide-nut on shaft E, and Figs. 22 and 22′ (two views) show nut E′ in gear with the toothed wheel D′.

$E^2$ (see Figs. 20′ and $20^3$) is a flanged bearing-sleeve for crank-shaft E, which passes through flange *a* and rib $a^{12}$. (See Fig. 15.) $E^3$ is a nut which secures said bearing-sleeve in position.

$E^4$ is a stop-collar on shaft E for limiting the travel in its guide *a″* of slide-nut E′ on crank-shaft to prevent damage when tightening the end and side clamps around the upper on the last, and is also a guide for adjustments of side and end clamps. These adjustments should be made when the nut E′ is back against the stop-collar $E^4$, and the side and end clamps are closed around the last. They are made by means of the side and end adjustable screw-fulcrums of levers B B and H H, respectively, and the possibility of injury to either last or upper that otherwise might occur is thus prevented.

D, Figs. 23 and 23′, is a three-flanged vertical center shaft (shown also on Plates 3 and 4, Figs. 3 and 9, in position) secured by pins to the tooth gear-wheel D′.

In Figs. $23^2$ and $23^3$, $a^{10}$ is bearing-bushing, in which the upper end of shaft D works and which is driven in hub $a^9$ for purpose of renewal when required. It is shown in position on Plates 3 and 4, Figs. 3 and 9, with bearing-plate $A^8$, Figs. 16 16′, which latter forms a lower bearing $a^{15}$ for the three-flanged center shaft, and is secured to bosses $a^6$, as before stated. (See it in position in Figs. 3, 9, and 10, Plates 3 and 4.)

*b*, Figs. 21, 21′, $21^2$, and $21^3$, are tongued and mortised slide-bearing guide-pieces, which fit in grooves $a^5$ in guides $a^4$ and $a^{4\frac{1}{2}}$. They have horizontal mortises $b^2$, in which the combined slide and hinge joint, hereinafter described, fits and works, and to which the ends of connecting-levers C fit and are secured. They also contain vertical mortises *b′*. These vertical mortises *b′* in slide-bearing pieces *b* (see Plates 4, 6, and 7, Figs. 9, 15, 21 to $21^3$, 28, $28^5$, $28^6$, and $28^7$) form the outer bearing-surface in which the combined slide hinge-joints connecting with the lower ends of armed levers B fit and work. These combined slide hinge-joints also are more fully described hereinafter.

C C, Figs. 26 and 26′, are two views of the connecting-lever C, hinged to its bearing $c^4$ in rib $a^2$, (see Plates 3 and 6, Figs. 3 and 15,) its opposite end forming part of the combined slide hinge-joint, which fits and works in mortise $b^2$ of slide-bearing pieces *b*, previously described. (See Figs. 26, 26′, $26^2$, $26^3$, and $26^4$, Plate 6.)

*d* (see Figs. 24 and 24′, isolated and in position, Fig. 15) are connecting-rods, which connect at $c^3$ with rod C (see Figs. 26, 26′, $26^3$, and $26^4$) and at their other ends to opposite sides and between the two lower flanges of the three-flanged center shaft D (see Plates 3 and 6, Figs. 3 and 15) and are secured by hinge-pins which pass through the ends of rods *d* and the two lower flanges between which they fit. (See Plates 3, 4, and 6, Figs. 3, 9, and 15.)

*e e* are connecting-levers. (See Plate 6, Figs. 27 and 27′, disconnected, and connected in Fig. 15.) They have mortises $e^3$ at one end, in which small slide-bearing blocks *e′* fit, having holes through which connecting hinge-pins $e^2$ pass for connecting with ends of slide-screw shafts L L. (See said shafts on Plate 6, Figs. 25 and 25′, disconnected, and connected on Plates 3 and 6, Figs. 3 and 15.) The opposite ends of connecting-levers *e e* are hinged by threaded bolts, which screw in their bearings $e^{3\frac{1}{4}}$ $e^{3\frac{1}{2}}$. (See Figs. 15, 15′, and $15^3$.) Rods *d′ d′* are connected (in the same manner as *d d* to connecting-rods *e*) by hinge-pins to levers *e e* at $e^4$ $e^4$ by pins $e^5$, (see Figs. 15, 27, and 27′,) and at their opposite ends are connected between the two upper flanges of shaft D at ninety degrees (90°) from the connections of rods *d d*, above mentioned, so that rods *d d* and rods *d′ d′* will not only be upon different planes, but upon opposite quarters, and hence will not interfere with the working of each other. These rods *d′ d′* are hinged by hinge-pins which pass through the ends of the connecting-rods and the two upper flanges of shaft D, and also through the toothed gear-wheel D′, thus securing it in proper position relative to the hinge-pins, thereby connecting

parts L L *b b* not only with the toothed gear-wheel, but also with the toothed rack on the flanged slide-nut, which, with its shaft, must work in harmony of movement with all the other parts.

L L (see Plates 3 and 6, Figs. 3, 15, 25, and 25′) are screw-slide connecting-shafts, which fit in bearing-bushings $a^{17}$ $a^{17\frac{1}{2}}$, driven in holes through cross-ribs $a'$ and $a^2$ in the lower part of the table, where they are placed centrally with it parallel to its upper surface and in line under the T-groove A′. Their centers should be placed the same distance from the top of the table as the center of the space between the two upper flanges of flange-shaft D, in which the ends of connecting-rods $d'$ $d'$ fit, (see Plates 3, 4, and 6, Figs. 3, 9, and 15,) and on the same plane with connecting-levers *e e*. Hence care should be taken in placing the hinge-bearings $e^{3\frac{1}{4}}$ $e^{3\frac{1}{4}}$ that they also are the proper distance down from the top of the table—viz., equal to the distance of the center of the screw-slide shafts L L less one-half the thickness of the connecting-lever E. The centers of the horizontal mortises $b^2$ $b^2$ in bearing-pieces *b b* should be the same distance down from the top of the table as the distance to the center of the space between the two lower flanges of the three-flanged center shaft D to bring them on the same plane with each other and their connecting-rods *d d* and levers C C. (See Plates 3, 4, and 6, Figs. 3, 9, and 15.) Hence the hinge-bearings $c^4$ $c^4$, upon which the ends of connecting-levers C C are hinged, should be upon the same plane less one-half the thickness of the lever, and care should also be taken to bring the pressure upon the same line as nearly as possible as the hinge-pins of the levers C C and the points of engagement of side levers B B in slide-bearings *b b*. (See Plates 4 and 6, Figs. 9 and 15.)

Shafts L L are provided with adjustable screw-guide bearings composed of three separate pieces. The outside guide L′ is recessed upon opposite sides to fit slide-bearing pieces *h h*, which fit and are carried by the hinge-bearing bolts *h′* in the opposite arms of shifting lever H. (See Plate 6, Figs. 15, 17, 17′, $17^2$, 18, 18′, $18^2$, 19, and $19^2$.) The guide L′ is also bored through and the hole recessed upon opposite ends to fit the flanged toothed sleeve-nut *l*, which fits the screw upon the shaft L inside and fits the hole in the guide outside. Said sleeve-nut is provided with a separate end flange, and when put together and the end flange riveted fast the sleeve-nut *l* is left free to turn upon the screw-shaft L, thus providing for end adjustments by screwing the adjustable screw-guide bearings L′ L′ to and fro on the screw-slide shafts L L to suit all extreme variations requiring accommodation in the various lengths of lasts. The solid flange on sleeve-nut *l* is toothed for turning it by application of a handle toothed rod $l^2$, (see Plate 6, Figs. $19^3$ and $19^4$,) racked to fit it and by which it can be pushed or pulled, as required, quicker than can be done by the fingers direct; or, if the latter is preferred, the toothing of the flange may be dispensed with and a surface, milled or otherwise, as desired, be substituted. If preferred, the flanged nut *l* may be dispensed with and the sleeve-bearing L′ may be made to fit the outer surface of the screw-shaft L and separate nuts placed on shaft L at opposite ends of L′ for end adjustment, instead of the flange-nut *l*.

*h h* (see Figs. 17, 17′, and $17^2$ detached) are slide-guides in which the hinge-bolt pins *h′* *h′* of the shifting-lever H H fit. (See plates 3 and 6, Figs. 3 and 15, connected.)

$E^7$ is the main crank, and drives all gear in the table. It is bent out to pass the projecting end of the adjustable screw-fulcrum, is provided with a handle and a tapered hole to fit the tapered end of crank-shaft E, and is secured in position by a nut on end of the shaft. (See plate 6, Figs. 15 and 20.)

$a^{14}$ (see Figs. 15 and $15^6$) is a set-screw extending from the back of the table through the flange *a* and its connections to the short rib $a^{13}$ against the stop end bearing $E^6$ in the stop flanged sleeve-bearing $E^5$, that is driven in the boss on rib $a^{13}$ and in which the back end of crank screw-shaft E fits. This set-screw $a^{14}$ is designed to take up the lost motion in crank-shaft by pressing against the stop $E^6$, the other end of the crank-shaft being held firm endwise by stop-collar $E^4$ on the shaft against which the end of the sleeve $E^2$ must be brought by the nut $E^3$, thus preventing the possibility of lost end motion in screw crank-shaft E.

$E^5$ (see Figs. 15 and $15^6$) is the stop flanged sleeve-bearing for the back end of the crank screw-shaft E. It is driven tight in its bearing in the boss of rib $a^{13}$, and the front or flanged end is the stop which limits the nut E′ in its travel on the crank-shaft. Hence the opening of the heel and toe or end clamps and the side clamps (see Plates 5 and 6, Figs. 11, 15, and $15^6$) around the last are governed in their movements by the limitation of the travel of the flanged nut E′ upon the crank-shaft E at that end in opening the clamps.

$b^3$ $b^3$ (see them on Plates 4 and 7, Figs. 9 and 28, connected, and on Plate 7, Figs. $28^5$, $28^6$, and $28^7$, disconnected) are hinge slide-bearings which fit the lower ends of armed levers B B, and which form part of the combined slide-hinge joint that is fully described hereinafter.

*Connection of upper and lower gear.*

B B (see Plates 1, 2, 3, 4, 5, and 7, Figs. 1, 2, 3, 9, 10, 11, and 28) are side armed levers for connecting the lower actuating mechanism with the upper side clamp-gear, the lower ends of which levers pass down through cross-slots $a^7$ $a^7$ on opposite sides of the table A, (see Plates 4 and 6, Figs. 9, $15^2$ $15^4$,) the ends being rounded to fit the counter-bores of the side pieces $b^3$ of the hinge slide-joint, (see

Plates 4 and 7, Figs. 9, 28, $28^5$, $28^6$, and $28^7$,) in which they are hinged. Said pieces fit in the vertical mortises $b'$ $b'$ in slide-guide bearings $b$ $b$. The levers B have holes in each below their center, through which hinge-pins $i$ pass and secure the levers to the slide-pieces I′ of their respective adjustable fulcrum-bearings, and at a proper distance above sufficient for clearance the levers are divided into two arms of equal lengths straight and curved to suit the spaces and connections required. They are connected at their upper ends by short connecting-rods $b^5$ $b^5$ to slide-bearing guides $o$ and $o'$. (See Plate 7, Figs. 28, 28′, and $28^2$.)

H H (see Plates 3 and 6, Figs. 3, 17, 17′, and $17^2$) are end levers connecting the lower to the upper end or heel and toe clamp gear. They pass up through the slots $a^8$ $a^8$, (see Plates 3 and 6, Figs. 3, 15′, and $15^4$,) and the lower end of each is divided, like a common shifting-lever, in two equal arms, in which hinge screw-bolts $h'$ fit, the inner ends of which form hinge-pins for slide-bearings $h$, which bearings fit in the recesses on opposite sides of the guide-bearings L′. (See Plates 3 and 6, Figs. 3, 15, 17, 17′, and $17^2$.) These bearings guide and control the lower ends of levers H when power is applied to the crank and transmitted to them through the shaft E, the shafts L, and their connections.

The end levers H H are hinged centrally by hinge pins or bolts $h^2$ (see Plate 3, Fig. 3) to their adjustable fulcrum-bearings. Their upper ends, like the lower ends of armed levers B and the end of connecting-rods C, have the same class of jointed bearings and motions, and being constructed upon a new principle, are therefore original, and I designate these jointed bearings as the "combined slide hinge-joints." They possess two entirely different and independent motions—a hinged central and a straight slide—each ample, simple, and serviceable, qualities essential and desirable, and will be made the subject of a special patent hereafter. They are constructed as follows: First, the end of each lever or shaft H must be rounded to suit with a hole in the center thereof; second, the hinged slide-bearing pieces $H^3$, which are composed of two pieces of equal size and thickness corresponding with the mortise-bearing $f$, in which they fit, are bored through their centers and counterbored to fit the rounded end of lever H in depth equal to half the thickness of the lever, and also recessed to the same depth from the counterbore to their surfaces in shape corresponding with the required movement of the lever or shaft H when working in it; third, a hinge-pin $H^4$, which passes through and fits the hole in end of lever H and bearing-pieces $H^3$ flush with their surfaces; fourth, a mortise $f$, in which the outer surface of the slide-hinge bearing-pieces fit.

For illustration of the combined slide-hinge joint, as far as described and illustrated here, see Plates 4, 6, 7, and 9, Figs. 26, 26′, $26^2$, $26^3$, $26^4$, 28, $28^5$, $28^6$, $28^7$, 44, 44′, 46, and 46′.

*Description of gear above the table.*

H′ H′ are adjustable fulcrum-bearing shafts (see Plates 1 and 3, Figs. 1 and 3) for adjusting end clamp-shafts $F^5$ $F^6$ to correspond with the different lengths of lasts. Their inner ends are recessed out, thus leaving a jaw upon each with a hole bored through for pin. Between these jaws lever H fits with a corresponding hole, through which a hinge-pin $h^2$ fits in both, thus hinging the end levers H H to their respective adjustable fulcrum-bearings. These adjustable fulcrum-shafts H′ H′ pass through their respective stands F $F^0$, the outer ends being turned smaller to fit in adjustable flanged screw-sleeves $H^2$ $H^2$ with screw-nuts $h^4$ $h^4$ upon their ends. The screw-sleeves $H^2$ are slightly recessed on their outer ends to receive a corresponding projection on the inner face of nuts $h^4$ made to fit them, thus forming a stop with a shoulder at the outer ends of the smaller portion of shafts H′ H′, between which and the inner shoulder the screw-sleeves $H^2$ $H^2$ fit and work, and by means of the milled flange on their projecting ends the sleeves $H^2$ $H^2$ are turned in threaded bushings $h^3$ $h^3$ for adjustment of the shafts H′ H′ and the fulcrum-pins $h^2$ carried thereby, by which means speedy and accurate adjustments are obtained of the heel and toe clamps to the lasts in position. The bushings $h^3$ $h^3$ are of malleable metal, which is essential for a durable thread continually in use, and are screwed into the stands F $F^0$.

$f^6$ $f^6$ are bolts with long T-heads. They fit the T-slot A′ in the table and the holes in the bottom of the respective stands F $F^0$ for bolting them firmly to the table. (See plates 1 and 3, Figs. 1, 3, and 5.) By loosening the nuts on the bolts the stands F $F^0$ are adjustable, if required.

M is an adjustable screw-flanged stand-tube with a tapered stem upon the top, which enters the holes in the heels of the lasts that rest upon its shoulder, the screw fitting the screw-stand shaft M′. (For descriptive illustrations of M M′ and $m$ $m'$ $m^2$ $m^3$ (see Plate 3, Figs. 3, 3′, 8, 8′, and $8^2$.) The lower end of screw-stand shaft M′ is grooved each side, leaving a T-shaped end which fits the cross T-shaped groove in the adjustable plate $m$.

$m'$ is a T-headed bolt which fits T-slot A′ in the table, passes through adjustable stand-plate $m$, and holds it firmly by the handle-nut $m^2$.

$m^3$ is a set-screw with a pin for a handle that holds the stand-shaft M′ in position laterally.

Sleeve M is adjustable vertically to suit the required height for lasts, the flange below being milled for convenience in screwing up or down, and its stand is also adjustable both transversely and longitudinally at will to suit the various requirements of lasts.

$M^2$ (for descriptive illustrations of $M^2$, $M^3$, $M^4$, $m^3$, $m^4$, $m^5$, $m^6$, $m^7$, and $m^8$, see Plates 3 and 5, Figs. 3, 14, 14′, and $14^2$) is an adjustable stand-screw tube for supporting the toe of the last. It has a stem upon the top which

fits in the toe-rest $M^4$. It also fits the screw of the adjustable screw-stand shaft $M^3$, and is adjustable vertically to suit the required height of lasts by screwing the tube $M^2$ up or down on the shaft $M^3$ to suit, and shaft $M^3$ is adjustable in T-groove A′ in the top of the table to suit the different lengths of lasts.

$m^4$ is a tongued washer which fits the upper portion of groove A′ in table. It also fits the stand-shaft $M^3$, which passes through the hole in the center.

$m^5$ is a nut with a handle for screwing the stand-shaft $M^3$ firmly to the table. (See Plates 3 and 5, Figs. 3, 14, 14′, and $14^2$.)

$M^4$ is an adjustable toe-rest to accommodate the width near the toe of the various sizes of lasts. It has a hole in its base for a working fit upon the stem of shaft $M^2$. The upper portion is grooved out from the top down, or laterally mortised, in which the horizontal bars $m^6$ $m^6$ fit, side by side, and are adjustable, and from the top of these bars up the groove is increased a little inside, thus leaving a small shoulder upon opposite sides, in which a piece $m''$ fits, filling the space in the groove from the shoulders up, and upon opposite sides outside even with the shoulders are recesses in which side clamps $m^7$ $m^7$ fit. (See Figs. 14, 14′, and $14^2$.) These side clamps curve in a little at the top for holding rubber $m^8$, which forms an elastic rest for toe of the last. These clamps, the two sides, and the piece between are all riveted firmly together by rivets $m^{10}$, leaving a mortise in which the adjustable bars $m^6$ $m^6$ of side guides fit.

$m^6$ $m^6$ are adjustable side guides to fit the opposite sides of lasts near their toes and direct them centrally to the toe-clamp.

$m^8$ is a piece of rubber or other yielding substance secured by clamps $m^7$ in the top of toe-rest, which yields to the pressure upon the last from the last-fastener and prevents damage to the upper.

I (see Plates 2 and 4, Figs. 2, 9, and 10, in position, and $9^5$, $9^6$, and $9^7$, detached) are side flanged adjustable fulcrum screw-sleeves which screw in stands $i^2$. They are bored to fit the shafts I′ I′ and recessed in the ends to fit the nuts $i'$, that are screwed on the ends of the shafts upon which the sleeves have a working fit in the space between the shoulder and the nut. The flanges of sleeves I are milled for convenience of screwing in or out, and it is by their movement that adjustment of the side clamps is made to fit different lasts.

I′ I′ (see Plate 4, Figs. 9, $9^3$, $9^4$, and 10) are the adjustable slide-pieces of the fulcrums with jaws, between which levers B B fit, and to which they are hinged by the pins $i$.

$i^2$ are adjustable fulcrum screw-stands (see Plate 4, Figs. 9 and 10, in position, and $9^8$, $9^9$, and $9^{10}$, detached,) which are secured by bolts to the table at its opposite sides, and in which adjustable bearings I fit, and are screwed for adjusting side clamps G G′ $G^2$ $G^3$, (see Plates 4 and 5, Figs. 9, 10, and 11,) through adjustable side-armed levers B and their connections.

F and $F^0$ are adjustable end bearing-stands in which end fulcrum-shafts H′ H′ fit, by which speedy and accurate end adjustments of the heel and toe or end clamps to the last are attained when set in harmony with their gear-connections. These stands are dressed on their bottoms with small tongue or guide pins to fit the top of groove A′ in table, having bolt-holes in which bolts $f^6$ fit. The heads of these bolts, fitting in the T-shaped slot A′ in top of table, pass up through the bases of the stands, and with nuts screwed on top, hold the stands F and $F^0$ firmly in position, while they are also adjustable on the table, if required, in cases of extreme difference in length of lasts. Ordinary differences can always be accommodated by means of the adjustable fulcrums H′ H′. The inner portions of the stands at each side of the nut are recessed to make room for the wrench in turning the nut. The upright portions of the frames are each T-shaped in cross-section with suitable projections or bosses, in which the adjustable screw-fulcrum, sleeves, and shafts fit. The upper ends of the stands are of suitable form for clamps, and bored out to receive the sleeves $F^3$ $F^4$. The clamp-heads F′ and $F^2$ are split open lengthwise with a boss on each side, through which the screw-bolt $f^8$ passes. The screw-bolt has a bent handle $f^9$ on one end, the opposite end being threaded in the boss, which permits of tightening or loosening at will, for adjustment of the sleeves $F^3$ and $F^4$, that can thus be securely clamped and held in any required position. To avoid danger of bending the clamps by too heavy pressure, a plate $f^7$ is inserted in the open cut in each of the clamp-heads F′ $F^2$, through which the clamp-bolt passes. (See Plates 3 and 5, Figs. 5, 5′, $5^2$, and 11.)

The adjustable connecting-sleeves $F^3$ at the toe and $F^4$ at the heel (see Plates 3, 5, and 9, Figs. 3, 11, 44, 44′, 47, and 47′) have near their front ends projections $f^{10}$ $f^{11}$, Figs. 47 and 47′, with a threaded hole through each in which arms $f^{15}$ are screwed in opposite sides solid up to their collars with balls $f^{16}$ on their outer ends, which fit in the side socket-joints of the outer ends of connecting-rods $f^{12}$ and the holes therein. (See, also, Figs. 49 to $49^5$, inclusive.) The projection $f^{10}$, Fig. 47, on sleeve $F^3$ for the toe attachments is made deeper than the projection $f^{11}$, Fig. 47′, on sleeve $F^4$ for the heel, in order to place balls $f^{16}$ $f^{16}$ upon the respective arms $f^3$ and $f^4$ of the clamps on a line as near as possible with the average angle required of the respective heel and toe clamps to fit the different lasts, and that the rods $f^{12}$, which connect balls $f^{14}$ and $f^{16}$ together, shall correspond in average inclination with their respective heel and toe clamps.

Holes are bored through opposite sides of the sleeves $F^3$ and $F^4$, in which guide-pins $f^{17}$

are driven, having their inner ends slightly flattened to fit in corresponding grooves $f^{18}$ (see Figs, 5, 44, and 44′) cut in each side of toe and heel shafts $F^5$ and $F^6$, in which they fit and keep the sleeves from turning, or, if preferred, guide-pins may be driven through opposite sides of the clamp-heads F′ and $F^2$ and corresponding grooves made in the outside of the sleeves $F^3$ $F^4$ for the pins to work in instead of grooves in the sides of the clamp-shafts $F^5$ $F^6$.

The adjustable slide end (or toe and heel) clamp-shafts $F^5$ and $F^6$ (see Plates 1, 3, 5, and 9, Figs. 1, 3, 11, 44, 44′, $44^2$, $44^3$, 47, and 47′) are of the same construction in every respect, except that one is for the right or toe and the other for the left or heel end of the machine. They have near their front (inner) ends mortises *f*, forming the outer bearing, in which the combined slide hinge-joints of the upper ends of end levers H fit and work. They also have curved extensions at their front ends, forming segmental bearings $F^8$, which contain a T-shaped groove *f*′, turned out in the inner part, in which the segmental clamp-bearing pieces $F^9$ fit. About the middle of the curved extension is the hole $f^{19}$, from which to the end is the clamp $f^{20}$, with an open cut separating its two parts. (See Figs. 44′, $44^2$, and $44^3$.) At their ends are the bosses or ears $f^{21}$, in which are the clamp-screw bolts $f^{22}$ with handle $f^{23}$, by which the clamp-bearings of shafts $F^5$ and $F^6$ can be tightened or loosened at will and their segmental counter parts $F^9$, that are clutched by them, can be adjusted and completely clamped and held in position, as required. These shafts being right and left hand with clamp-bolts entering from their front sides, the bolt-holes and screws must be in harmony therewith.

$F^9$ $F^9$ (see Plates 3, 5, and 9, Figs. 3, 11, 44, 44′, $44^2$, and $44^3$) are bearing-pieces which form the segment of a circle on the back part, and are shaped as counter parts to fit in the T-shaped recessed circular bearings *f*′, and on their front part have bearing projections $f^{24}$, (see Figs. 44, 44′, $44^2$, 45, 45′, $45^2$, and $45^3$, Plate 9,) in which the side pieces of end clamps $f^2$ $f^4$ or $f^{3a}$ $f^{4a}$ fit with a hole through each, in which a hinge-pin $f^{25}$ fits, and between which the end clamps $f^3$ $f^4$ or $f^{3a}$ $f^{4a}$, as may be, fit and work. (See Figs. 44 and 44′.) The hole and pin fitting it are made smaller in part of the lower projection to permit sloping off the heel-clamps at bottom, as shown on Fig. 44′, without weakening that part of the bearing-pieces $f^{24}$.

$f^3$ $f^4$ or $f^{3a}$ $f^{4a}$ are the two mated sides of the end (or heel and toe) clamps. When placed together, with the hinge-pin $f^{25}$ through them, they form a variably-curved and continuously-smooth front face with surface-joint, hinged with a straight central joint, that in whatever position placed when working leaves no opening on face of the clamp to catch and injure the upper, although formed of curves having different radii. (See Plates 3, 5, and 9, Figs. 3, 11, 44, 44′, $44^2$, $44^3$, $44^4$, $44^5$, $44^6$, and 48 to $48^{13}$, inclusive, which fully illustrate them.) One of said clamps or jaws has a reversely-curved surface concentric with the hinge pin or pivot, and the other terminates at its inner end in an edge which is adapted to fit said curved surface in all positions of the jaws.

Fig. 44 is the bottom view of Fig. 44′, turned upside down with a part of the clamp-shaft $F^5$ broken and sectioned, with clamp-bolt $f^{22}$ removed, and shows also the combined slide-hinge bearing; also the bearing-piece $F^9$, sectioned on line 3, Figs. 44′ and $44^3$; also sleeve $F^3$ for toe-shaft $F^5$, the balance shown full.

Fig. 44′ is a side and sectional view of Fig. 44, being centrally sectional all except a part of end slide-clamp shaft $F^5$ and hinge-pin $f^{25}$, which are full.

Fig. $44^6$ represents the clamp sides $f^3$ $f^4$ as they would be seen on dotted line, Fig. 44, as shown by arrows, with the balance of the figure removed, and is the toe or right-hand end clamp.

Fig. 48 represents the two clamp sides $f^{3a}$ $f^{4a}$ of the heel-clamp viewed from the same position as that of Fig. $44^6$, and made the same, except the inner face of the bottom half of the clamp, which is dressed off more than the toe-clamp, Fig. $44^6$, to conform to the difference in shape between the heel and toe ends of a last.

In Fig. 44′ the toe-clamp is shown, and the dotted line represents the shape of the inner face for a heel-clamp, as in Fig. 48.

$f^{26}$ are the projecting upper portions of the heel and toe clamp mates $f^3$ $f^4$ $f^{3a}$ $f^{4a}$, which gather in and press upon the upper over the insole as they approach the last and hold it until secured to the insole. The main front face of each of the mates $f^3$ $f^4$ $f^{3a}$ $f^{4a}$ is equal in depth to the two combined at their hinge. (See illustrations, Plate 9.)

To fully understand Figs. $44^6$ and 48, Plate 9, it must be borne in mind that the two sides $f^3$ $f^4$ $f^{3a}$ $f^{4a}$ are together, as shown in Fig. 44, viewed as indicated by arrows on dotted line of that figure turned upside down, with balance of the figure removed.

Figs. $44^4$ and $44^5$ are parts of Fig. $44^6$ shown separately, the part $f^4$ being taken up bodily and set over to the left, and $f^3$ being simply rolled over, the other side up.

In Figs. 44 and 44′ the end clamp-bearing piece $F^9$, hence the clamp $f^3$ $f^4$, is set straight with the end clamp-shaft $F^5$, and not upon the angle at which said piece and jaws would require to be to fit the toe of a last, as shown on Plate 3, Fig. 3, with the end clamp fitting the last and upon a line with the connecting-rods $f^{12}$, which position is readily given to them by slackening the bolt $f^{22}$ by means of the handle $f^{23}$, which slackens the clamp $f^{20}$ and permits the adjustment of bearing-piece $F^9$ with its end clamp at any angle to fit the last, whether heel or toe, and when fitted bolt

$f^{22}$ is at once tightened, which tightens clamp $f^{20}$ on end clamp-bearing $F^9$ and locks it firmly until readjustment is required.

Figs. 48, $48^2$, $48^{11}$, $48^{12}$, and $48^{13}$ are the two side pieces $f^{3a}$ and $f^{4a}$ of the heel-clamp in different positions. Fig. 48, as above shown, is indicated by arrow on dotted line, Fig. 44, turned right side up with clamp closed, and Fig. $48^2$ is a cross vertical central sectional view of the same shown wide open, though Fig. 44 is toe-clamp; and Figs. 48 and $48^2$ are heel-clamps.

Fig. 48′ shows the two side pieces $f^3$ and $f^4$ of the toe-clamp bottom side up and wide open. Fig. $48^3$ is the same turned right side up. $f^3$ at the center joint is the lower side piece of the toe-clamp, and $f^4$, its mate, is the upper side piece at the the center joint of the toe-clamp. Figs. $48^4$ and $48^7$ show the bottom sides of the respective pieces $f^3$ $f^4$ separated, and Figs. $48^5$ and $48^8$ show the top sides of the same pieces separated. Figs. $48^6$ and $48^9$ are the front face views of the two respective pieces.

Fig. $48^{10}$ is the front face view of $f^3$ $f^4$ wide open. Fig. $48^{11}$ is the bottom view of Fig. $48^2$, showing the two side pieces $f^{3a}$ and $f^{4a}$ of the heel-clamps together as they belong, wide open and turned bottom side up, and Figs. $48^{12}$ and $48^{13}$ show the two separate pieces $f^{3a}$ and $f^{4a}$ turned bottom side up. These heel and toe clamps are what are herein termed "end" clamps.

Fig. $44^2$ is the front face view of Fig. 44. Upon the opposite ends from the jaws of the two side pieces $f^3$ and $f^4$ and $f^{3a}$ and $f^{4a}$ of the end clamps are arms, curved, as required, to suit each other in opening and closing, and also to suit their respective connecting-rods $f^{12}$. They have balls $f^{14}$ on their outer ends, the centers of which are in the plane of the line or joint between the two halves or sides $f^3$ $f^4$ $f^{3a}$ $f^{4a}$ when mated together. (See Plate 9, Figs. $44^2$, $44^6$, 48, $48^{10}$, and $48^{11}$.) When placed in position ready for working, said balls $f^{14}$ occupy one end of their respective connecting-rods $f^{12}$, the sockets at the other end of the latter being occupied by balls $f^{16}$ of the arms $f^{15}$, that are firmly screwed in their bearings near the ends of their respective adjustable sleeves $F^3$ $F^4$. When thus in position, the balls $f^{14}$ are on opposite sides of the clamp-hinge pin $f^{25}$, each ball being the same distance from the clamp-hinge and each clamp-jaw of the same length. Hence each ball remains upon the same plane with its mate in the same clamp and each side works alike.

When the sleeves $F^3$ and $F^4$ (see Plates 1, 3, 5, and 9, Figs. 1, 3, 11, 44, 44′, and $44^2$) are adjusted, as required, to suit the ends of the last and the gears of the machine, and are firmly clamped by the clamp-heads F′ and $F^2$, they hold the balls $f^{16}$ of socket-joints in the outer ends of connecting-rods $f^{12}$ firmly in place, while the inner ends of the rods, being connected by balls $f^{14}$, are free to respond to the movements of the mechanism below the table through the connecting-levers H, which, acting through the combined slide-hinge joint at $f$, the side connecting-ball, and socket-joints in inner ends of rods $f^{12}$ and their connections with the arms of heel and toe clamps $f^3$ $f^4$ and $f^{3a}$ $f^{4a}$, cause the simultaneous and corresponding movement of both clamps at the ends of the last.

On Plates 1, 3, 5, and 9, Figs. 1, 3, 11, 44, 44′, $44^2$, and 49 to $49^5$, inclusive, are full illustrations of the ball-and-socket jointed side connecting-rods $f^{12}$, with their ball-and-socket joints near the ends of each. They furnish complete automatic adjustable joints for ample accommodation to the various lines of motion required.

The inner ends of the socket screw-plugs $f^{13}$ are dressed with sockets to fit the balls, and their corners or edges are beveled. Their shoulders are made concave to inclose the convex ends of connecting-rods into which they are screwed, thereby preventing possibility of the rods opening from their sides. Referring to the description of this ball-and-socket joint with side connections of a connecting rod or shaft, its illustrations in the accompanying drawings, and its obvious utility, and knowing of no prior invention or use of it, I claim it as an original invention of my own, to be hereinafter made the subject of special application for a patent.

G and G′, $G^2$ and $G^3$ (see Plates 4, 5, and 7, Figs. 9, 10, 11, 28, 30, 31′, and $31^2$) are the side-forming clamps for operating directly on the upper and bringing it on and over the sides of the last. They are composed of a series of fingers $g$, flattened on the front part and rounded into parallel shanks at their other ends to fit the finger-clamps $g'$ in vise tubes or frames $G^4$, in which they are held. (See Plate 7, Figs. 31′ and $31^2$, where said clamps are shown in broken portions of increased size and in position on Plate 4, Figs. 9 and 10.) The front ends of the fingers are dressed to correspond approximately with the average shape of the side lines of a last, whether for right or left foot or inner or outer side of the last. (See Plate 5, Fig. 11, and Plate 7, Fig. 30.) The outside fingers may be a little wider or narrower than the others on their outer edges, if required, to better fit the spaces between the end and side clamps for various lengths of lasts. For the complete adjustment of these fingers the holes or slots, as may be, in the vise-tubes $G^4$ are sufficiently large to permit them to move laterally and vertically. Each of the clamps that secure them in the tubes is independent of its fellows and movable in its place. The whole, when clamped together as one body, is movable vertically by revolving the tubes that contain them on their respective cross-head journals, which form a horizontal axis. They are thus made perfectly adjustable in every direction, can be moved either singly or collectively, inward or outward, upward or downward, or turned in their

clamps to any required position, so that their ends can be made to conform to any outline or form of last that can possibly be used, and when this is done and they are locked in their vise-tubes they will be securely held there.

In each end of each vise-tube $G^4$ is a set-screw $g^2$, (see Plate 7, Figs. 28, 31, 31′, and $31^2$,) with an intervening bearing-piece $g^3$ that presses against end of the entire series of finger-clamps in each tube, and fastens them securely in whetever position they may be placed.

There are double sets of the side clamps, $G^2$ and $G^3$ being for the right and G and G′ for the left foot last. (See Plates 5 and 7, Figs. 11 and 30.) The set in use belong in the two upper vise-tubes, and are adjusted to fit the two sides—inner and outer—of the last then in the machine. When the last is changed from right to left, or vice versa, the change of clamps is made by disconnecting the screw-gear shown in Fig. 32 and throwing it into the position shown in Fig. 32′, which is done by throwing the hinged stop-stud $o^9$ out of its position in Fig. 32, (see Plate 7,) when the clamps and the clamp-frames on each side, including the two vise-tubes $G^4$ and their cross-heads $G^5$ and $G^6$, can be revolved on their respective cross-head journals, so as to bring the lower tubes with their clamps into position above for working.

$G^4$ (see Plates 1, 4, 5, and 7, Figs. 1, 9, 10, 11, 28, 30, 31, 31′, and $31^2$,) are the vise-clamp tubes or frames in which finger-clamps $g'$ fit. They have finger-holes $g^8$ or slots, as in modifications $G^7$, $G^8$, and $G^9$, (see Figs. $11^8$, $11^9$, and $11^{10}$, Plate 5,) through which the shanks of fingers $g$ pass to their bearings between the finger-clamps $g'$. They are bored out straight their entire length, and have a female screw cut in each end, in which set-screws $g^2$ fit. They are also shouldered on the outside at each end to exact equal length, and turned to fit the holes at each end of the cross-heads $G^5$ and $G^6$. The finger-holes $g^8$, opposite each other in the tubes, or the slotted modifications of them shown in Figs. $11^8$, $11^9$, and $11^{10}$, Plate 5, are made slightly larger than the shanks of the fingers and enlarged outwardly to permit the latter to play freely in all directions when being adjusted, and are placed opposite the centers of their clamps $g'$ in the tubes. (See Plate 5, Figs. 28, 31, 31′, and $31^2$.)

$G^7$, $G^8$, and $G^9$ (Plate 5, Figs. $11^8$, $11^9$, and $11^{10}$) are tubes or frames having modifications of the openings in opposite sides of the tubes through which the shanks of fingers are inserted, consisting of slots instead of finger-holes, all other component parts remaining the same. In Fig. $11^8$ the tube has one continuous slot on each side of the tube extending almost the entire distance between the cross-heads. Fig. $11^9$ shows the slot divided into two parts by a junction of the two opposite sides midway of the tube, which is thus stiffened and strengthened. Fig. $11^{10}$ shows a division of the slot into three equal parts by two similar connections, and in this manner any number of connections can be made, as may be deemed advisable for convenience or to add strength to the tube; but whatever number may be used the separations between the slots must be placed centrally between two fingers and occupy no more space than that between two holes when the latter only are used, and when slots of considerable length are used instead of holes the tubes should be increased in thickness for sufficient strength.

$G^5$ $G^5$ are the cross-heads belonging to the end of the tubes toward the right-hand end of the machine. (See Plate 7, Figs. 28, $28^2$, 32, 32′, $32^5$, and $32^6$.) $G^6$ $G^6$ are those on the left-hand end. (See Plates 5 and 7, Figs. $11^5$, $11^6$, $11^7$, 28, 28′, and 30.) In the holes at the end of their respective cross-heads the ends of the vise-tubes $G^4$, or their modifications $G^7$, $G^8$, $G^9$, fit, and are placed by the following method of adjustment: They are first placed with their finger-holes—or slots, as may be—in such position relative to a central line drawn longitudinally through the cross-heads as will bring the fingers $g$ on an average line approximating to and best suited for making the final accurate adjustments required to fit the uppers on the lasts. This permits the cross-heads to stand at any required angle, whether vertical or inclined. The cross-heads are set in the position indicated in the illustrations on Plates 4 and 7, Figs. 9, 10, and 28′, for the reasons that while the fingers are nearly horizontal, in which position they are most convenient for accurate adjustment to the last, the cross-heads are set obliquely to them, which permits of greater length of fingers, and consequently greater range at their extremities in making the adjustments for working the upper tube, and at the same time prevents that greater side extension of fingers when at rest in the lower tube from interfering with the crank $E^7$, which would otherwise necessitate an increased width of table. When the relative position of the finger-holes or slots to the cross-heads has been adjusted, as above described, the vise-tubes are placed in the holes in the cross-heads, are driven in, riveted, and pinned fast. (See Figs. 31, 31′, and $32^6$, Plate 7.)

On Plate 5, $g^7$, Fig. $11^5$, are the journals of the left-hand cross-heads $G^6$ of the vise-tubes $G^4$ or $G^7$, $G^8$ or $G^9$, the two outer sections of which fit and work in slide-bearing pieces $o'$.

$g^4$ $g^5$ are the journals for the journal-bearings of the right-hand cross-heads $G^5$ of the vise-tubes.

$g^6$ are bearings on cross-head journals of cross-heads $G^5$, upon which worm gear-wheels $o^2$ are driven and pinned. (See Plates 5 and 7, Figs. $11^2$, $11^3$, $11^4$, $28^2$, 32, 32′, $32^5$, and $32^6$.)

$g'$, Figs 28, 31, 31′, $31^2$, $31^3$, and $31^4$, Plate 7, are finger-clamps. They are composed of two

equal parts. In constructing them a shaft is turned to a working fit in the vise-tubes $G^4$ and cut at right angles to its line into pieces of equal size that are in thickness slightly less than one-half the distance between the centers of finger-holes in the tubes when holes are used, and when slots are used then slightly more than one-half the width of the fingers, so that when in position, screwed up solid, the fingers will not bind on each other at their flat ends. One face of each piece is to be faced true to fit the corresponding face of another, and the other face is to be slightly recessed, leaving an annular bearing-surface around it of sufficient width to bear the pressure it has to sustain without injury. When thus prepared, the pieces are put together with one or two thicknesses of paper between their even faces and placed in a true jig, held firmly, and bored through centrally with half the hole in each, so that when turned or changed in position relative to each other any two pieces will fit and work together as the two halves of one clamp. Where the operation cannot be performed with sufficient accuracy for this, then they should be pinned together. (See Figs. $31^2$, $31^3$, and $31^4$ with pin in.) The size of the holes to be bored should correspond with the shanks of the fingers, so that when screwed up tight the clamps will hold the fingers firmly.

*o o* are slide journal-bearing pieces containing the screw or worm gear. (See Plate 7, Figs. 28, $28^2$, 30 to 32 inclusive.) They have a longitudinal dovetail male bearing $o^{13}$ upon one side, and on the opposite side is a flange projection $o^3$, bored out to the depth of the outer surface of the piece, then reduced in size, leaving a shoulder and bore continued, producing a recess in which worm-wheel $o^2$ fits and works. From thence through the piece is a small bearing-hole in which the smaller section of the journal of cross-head $G^5$ fits and works. It also has a recess in which a hinge bearing-sleeve $o^6$ for the worm-shaft fits and works, which is hinged by hinge-pin $o^7$. It is also recessed in the end in which hinge stop-stud $o^9$ fits and works, which is hinged by pin $o^{10}$. It is also recessed through the boss projection for room in which worm or screw shaft $o^5$ connects with the worm-wheel $o^2$ for adjustment of side clamps. The worm may be thrown in or out of gear at will, as shown in the two positions in Figs. 32 32′. When out of gear, side clamps are left free to be reversed on their frame-journals at will, to suit either right or left foot last. When in horizontal position, worm-shaft $o^5$ is thrown in gear and hinged stop-stud $o^9$ (see Fig. 32) secures it there. By inserting and turning the key $o^{14}$ in the key-seat $o^{15}$ a more perfect and vertical adjustment of side clamps upon the upper on the last can be attained, if required, through the worm-gear than that made through the adjustable side fulcrums only.

If preferred, the hinge of bearing-sleeve $o^6$ may be dispensed with and the sleeve or other bearing may be secured solid to the bearing-piece *o* and the worm-wheel and worm-shaft left permanently in gear with cranks secured to worm-shafts, which can be turned at will for reversing the side clamps as required.

Each bearing-piece *o* has a front hinge projection, to which connecting-rod $b^5$ is hinged at one end, its other end being hinged to one arm of connecting-lever B.

$o^5$ is the worm or screw shaft above referred to, which fits worm-wheel $o^2$. It has a shoulder next to the worm or screw and a screw-thread at its opposite end, upon which fits a screw stop-collar $o^{16}$, screwed up against a shoulder on the shaft $o^5$, with a hole through each in which pin $o^{17}$ is driven, thus holding the collar from turning. This collar has a key-seat $o^{15}$, in which key $o^{14}$ fits for side clamp vertical adjustments.

$o^6$ is an adjustable hinged sleeve-bearing. It is bored out to fit the worm-shaft $o^5$ between the shoulder of the worm and its stop-collar $o^{16}$, which prevents end motion of worm-shaft. It has a hinge projection which fits the recess in bearing-piece *o*, which is dressed out for that purpose. Through its projection is a hinge-hole corresponding with holes through bearing-piece *o*, through which hinge-pin $o^7$ fits and hinges bearing $o^6$ in position.

$o^{12}$, Fig. $32^5$, is a bearing-ring which fits the flange projection $o^3$ of bearing-piece *o*. It is driven down to the shoulder therein, and is bored out for bearing in which the large section of the journal of cross-head $G^5$ fits and works.

Fig. 32 is a longitudinal sectional view of Fig. $32^5$, as indicated by dotted line, shown by arrows thereon.

Fig. $32^2$ is a cross sectional view of Fig. 32 with cross-head journal and bearing-ring $o^{12}$ removed.

Fig. 32′ is a full view of Fig. 32, except that bearing-flange $o^3$ is sectioned at the surface of the plate, with stop-stud hinge $o^9$ thrown back and worm out of gear.

There are two of the bearing-pieces *o*, one being right and the other left hand. One fits in the bearing in front bridge-stand N, the other fits in bearing in the opposite back bridge-stand N′, the right-hand end of the machine being preferable.

*o′* is a slide-journal bearing-piece, which is bored out to fit the two sizes of the outer ends of journals of cross-head $G^6$. Like bearing-pieces *o o*, before described, it has dovetailed male slide-bearing $o^{13}$ upon one side and a front hinge projection to which connecting-rod $b^5$ is hinged at one of its ends, the other being hinged to connecting-lever B. Thus each one of the bearing-pieces *o′* is connected with one arm of lever B in the same manner that its mate *o*, before described, is connected with the other arm of the same lever. There are two of these pieces, being right and left hand, corresponding with their mates *o* and

fit dovetailed bearings in opposite front and back bridge-stands.

N N and N′ N′ are front and back stands, being right and left hand, containing slide-bearings in which slide and journal bearing-pieces *o* and *o′* fit and work. (See Plates 1, 2, 4, 5, and 7, Figs. 1, 2, 9, 10, 11, 28, 28′, $28^2$, 29, 29′, $29^4$, and 30.) They also constitute stands for the bridges, already referred to. Their bases are dressed to fit and rest upon the table with dowel-pins $n^{12}$, which fit in corresponding holes in the table. They have screw-shaft extensions $n^5$, which pass through the table and boss $a^{16}$, and are firmly secured by nut below. From their bases upward these stands are flat with parallel sides, and at a proper elevation extend horizontally edgewise with a slight side projection inward, having on its inner face a recessed bearing $n'$, in the lower portion of which a tongued bearing-strip $n^2$ fits and is held by screws, thus forming the lower edge of the bearing $n'$. These pieces are designed for taking up lost motion produced by wearing, the screw-holes being slotted slightly for that purpose; or the pieces may be dispensed with, if desired, and the recessed bearings $n'$ made solid without the adjustable pieces. These bearings are dovetailed in shape, and the slide-bearing pieces *o* and *o′* fit and work in them. The two front stands N N are cut off at top of the horizontal projections, and the lower ends of extensions $n^3$ of the front bridge $N^2$ are hinged to them. The lower parts of these bridge-extensions are formed with shoulders that project sidewise over the outer face of the bridge-stands N, and that fit and rest on top of the stands when the bridge is up. The feet are elbowed to an angle of about ninety degrees and flattened, with edges rounded, and are secured to the outer faces of the horizontal stand projections by hinge bolts or rivets $n^4$. (See Plates 1, 2, 4, 5, and 7, Figs. 1, 2, 9, 10, 10′, $10^2$, 11, 29, 29′, and 30.) The upper ends of front bridge-extensions $n^3$ are turned, shouldered, and threaded to fit a corresponding thread in the lower ends of front bridge $N^2$, to which they are secured, so that when turned down the bridge rests on top of and is supported by the horizontal projections of stands N, thus removing it entirely out of the way, so that the upper can be tacked or otherwise secured to the insole, the lasts removed, and replaced by others without obstruction. If preferred, the extension $n^3$ may be dispensed with and the entire front bridge $N^2$ be composed of one piece.

$n^6$ are extensions of back bridge-stands N′. (See Plates 2, 3, 4, and 7, Figs. 2, 3, 9, 10, 28, 28′, and $28^2$.) They are unbroken continuations of the main part of the stands corresponding in form to the upright portion of the front extensions $n^3$, and have their upper ends shouldered and threaded in a similar manner to fit the lower ends of the back bridge $N^3$.

$N^3$ is the back bridge connecting the two back stands N′ N′. It is mainly composed of two pieces bent down at their ends, bored and threaded to fit the screws on upper ends of back-stand extensions $n^6$, or may be connected directly with back-bridge stands N′ N′, if desired. When solid back-hinge collars $n^{22}$ $n^{23}$ are used, as shown on Figs. 28, 28′, $28^3$, Plate 7, care must be taken in constructing not only the hinge and stop-boss and bendings, but with screw-joint connections of $N^3$ and $n^6$ to see that the two opposite ends of the bridge are of one length and stand correct relative to each other as they belong. When the joints are screwed solid together and the two parts secured at $N^4$, the two ends, measuring from center of head-hinge, should be of equal length and the stands N′ of equal height.

Another method for making the junction between the two halves of the back bridge is as follows: Figs. $28^{10}$, $28^{11}$, and $28^{12}$, Plate 7, are modifications of back-bridge hinge and shafts $N^3$, as shown in Figs. 28, 28′, and $28^3$, with shafts $N^3$ broken, whose bridge-hinge collars $n^{22}$ $n^{23}$ are solid and made of the same pieces as the bridge-shafts are, while these now under consideration have separate collars $n^{15}$, left hand, and $n^{16}$, right hand, fitting upon the respective parts of the bridge-shafts, which shafts at these parts are constructed in harmony, being turned to fit their respective separate collars. The boss-bearing $n^{14}$ forms a stop-shoulder against which its collar $n^{16}$ fits. Each shaft where its collar fits is turned a little larger than the shaft itself, to permit the collar to be driven on conveniently after the shafts are bent. The shaft upon which $n^{15}$, the left-hand collar, fits has a stop-collar $n^{13}$ turned on the shaft and which fits in collar $n^{15}$. These collars $n^{15}$ and $n^{16}$ are driven on after the two ends of the back bridge $N^3$ $N^3$ are bent and finished at both ends to fit each other and bridge-stand extensions $n^6$. When in position, holes are bored in the joints between the collars and their bearing-seats and pins driven which secure them firmly. The stop-center piece $n^{21}$, Fig. $28\frac{1}{2}$, is then placed in position with dowel-pins through it, as shown in Fig. 28′, which are driven or screwed in to prevent it turning and the bolt $n^9$ screwed up tight against the center piece $n^{21}$ and against the stop-boss bearing $n^{14}$ and stop-collar $n^{13}$, with the hinge-hub $R^2$ and spring $r^{15}$ in position, thus assisting to firmly hold the two halves of the back bridge together. This method is less troublesome to construct than that shown in Figs. 28, 28′, and $28^3$.

Fig. $28^{11}$ is a horizontal longitudinal central sectional view, part full, of Fig. $28^{12}$, with hub $R^2$ and spring $r^{15}$ removed, as indicated by arrow *b*, Fig. $28^{10}$, the latter being a cross vertical central sectional view of Figs. $28^{11}$ and $28^{12}$ with the hub $R^2$ and spring $r^{15}$ removed.

Fig. $28\frac{1}{2}$, Plate 7, is a longitudinal vertical central sectional view of a central piece $n^{21}$, which fits between the bridge-collars $n^{22}$ $n^{23}$,

as shown in Figs. 28, 28′, and $28^3$, or between collars $n^{15}$ $n^{16}$, as shown in modifications, Figs. $28^{10}$, $28^{11}$, and $28^{12}$. It has holes in each end (see Fig. 28′) with corresponding holes in the collars, in which dowel-pins are inserted to prevent it turning. It has a hole bored through, corresponding with the holes in collars, in which bolt $n^9$ fits. Upon the center is a projecting stop-boss $n^7$ with a hole in which a rubber stop-plug $n^{11}$ fits, with disk $n^{19}$ beneath, and set-screw $n^{20}$ for setting up the rubber when required. The inside is bored to form a seat for hinge-hub $R^2$, and is held firmly in position by the screw-bolt $n^9$.

$N^2$, the front bridge, (see Plate 4, Figs. 9 and 10,) has its lower ends fitted and joined to their stand-extensions $n^3$ in the same manner as are the lower ends of the back bridge, and as before described. It is lower than the back bridge. The difference in height between them is equal to half the thickness of front projection $R^3$ added to half the thickness of front-bridge shaft $N^2$, in order to hold the head-yoke R horizontal. The latter is hinged on the back bridge (see Plates 2, 3, and 4, Figs. 2, 3, 4, 9, and 10) and has the head-lock R N, which projects below the level of its hinge, and is locked to the pin $n^5$ in top of the front bridge, the rubber plug $r'$ resting on projection $n^{10}$ in top of center boss $n$. (See Plate 4, Figs. 9, 10, 10′, $10^2$, $10^3$.)

R′, Plates 1, 2, 3, and 4, Figs. 1, 2, 3, 4, and 10, is a central boss in the top portion of yoke R, with a hole for screw-shaft S to work in; also an oil-hole $r^{20}$ and bearing for washer $r^{19}$ and nut $s'$ with guide-bearing grooves $r^{16}$, in which male bearing-guides $s^3$ on opposite sides of the shaft fit and work; also, with lock-nut pin-holes $r^{17}$ through opposite sides of the upper part of boss R′, and with a portion of the outside upon the right hand, Figs. $4^2$ and 10, dressed off to form a space in which the disconnecting tooth-gear $t^2$ and $t^3$ of tooth-gear levers T and T′ play; and upon the back portion of yoke R above the hinge is a tapered stop-plug $r^{14}$, which fits in the hole upon the rubber stopper $n^{11}$ to take the jar and prevent injury in turning the head back, which would be produced without an elastic stop.

$R^2$ (see Plates 2, 3, and 7, Figs. 2, 4, 4′, $4^2$, $4^3$, $4^4$, 28, and $28^{12}$) is the spring hinge-hub of yoke R. It is bored out from one end of the hub of sufficient size and depth for room for the hinge-spring $r^{15}$ to fit and work, leaving the opposite end of the hub of sufficient thickness for journal-bearing on that end, with the hole reduced to fit journal $N^4$ and with a small hole $r^{12}$ through the inner projection for inserting the end of spring $r^{15}$. (See Figs. 28 and $28^{12}$, Plate 7.) When the head is thrown back, the spring may be quite slack, and when thrown forward the spring may be sufficiently tight to carry as much of the weight of head as may be desired. The opposite end of the spring is inserted in a hole $n^{24}$ in the end of bearing-collar $n^{23}$, Fig. 28, the latter being part of the bridge; hence stationary and forming a point of resistance for the spring. Said collar forms also a recessed bearing to fit large hole in end of hub $R^2$. The spring-stop-connection hole $n^{24}$ is also shown in modification, Fig. $28^{12}$, in the end of hinge-bearing boss $n^{14}$.

$R^3$ (see Plates 3 and 4, Figs. 4, 4′, 9, and 10) is a front stop projection or boss of yoke R with a projection on each side and a hole through it, tapering a little from the lower portion up part way, then of reduced size, and threaded to the top for set-screw $r^3$ therein. Beneath the set-screw is a round flat plate $r^2$, and under it is a rubber stop-plug $r'$, which fits the tapering part of the hole and against which the projection of center stop-boss $n^{10}$ upon the front bridge strikes, thereby preventing injury from the concussion. (See Fig. 9, Plate 4.)

$r^4$ is the hinge-pin of head-lock R N (Fig. 2, Plate 2, and Fig. 9, Plate 4) for securing the head firmly to the front bridge as it is brought over and locked. It brings the step $r^8$ down tight upon the bottom of the insole secured to the last, thus holding the last firmly in position for lasting.

$r\ n'$ is the handle of head-lock R N, Plate 2, Fig. 2. $r\ n^2$, Fig. 9, is the lock sheave or roller. $r\ n^3$, Figs. 9′ and 10, is the sheave-pin shouldered between the opposite sides of the lock and riveted to them, leaving the sheave free to play. When the head is brought forward upon the bridge-stop $n^{10}$ and handle $r\ n'$ pressed down, the sheave or roller passes beneath the lock-pin $n^5$, and the yoke R is thus firmly secured to the front bridge $N^2$. The head is then in position for operating the pliers. (See Plates 1, 2, 3, and 4, Figs. 1, 2, 3, 9, and 10.)

The two sides $r\ n$ of the lock R N are composed of separate pieces with the stems of the cross at end of the handle riveted firmly therein, thus holding them firmly in position relative to each other and to the handle. (See Plate 4, Figs. 9, 9′, and 10.)

$r$ is handle of the yoke R. $r^5$ is a boss at the bottom part of the yoke. It has a hole through it in which the screw-shaft $r^{6\frac{1}{2}}$ is firmly held by a nut on top of the boss, thus securing the knee $r^6$ of said screw-shaft in position. (See Plate 3, Figs. 3, 4, $4^2$, $4^5$, and $4^6$.)

$r^7$ is the last-fastener, having an adjustable screw-bolt with a milled collar $r^{7\frac{1}{2}}$ and a movable step $r^8$, with a recess in its bottom in which a collar $r^9$ fits. A stem from bottom of screw-bolt $r^7$ passes down through the step and collar, with a shoulder resting on the latter, against which it is riveted with room for the step to work, thus permitting the bolt to be turned in screwing down while the step stands still, pressing against the bottom of the insole. (See Plate 3, Fig. $4^7$.)

$r^{11}$ are nut-lock pins that fit in holes $r^{17}$ and in the grooves of the nut $s'$. $r^{18}$ is said lock-pin groove in nut $s'$, turned thereon, corresponding in size and position with the pin-

holes $r^{17}$ and also with the lock-pins $r^{11}$. The lock-pins $r^{11}$ when in position are thus fixed in the boss R′, with one half projecting into the groove of the nut, locking the latter in its place also, so that when the nut is turned by the crank $s^2$, which is firmly secured thereto, the shaft $s$ is raised or lowered, as required, and when the head is turned backward, on its hinge $R^2$ the nut $s$ and all its attachments are held from slipping out. (For illustrations see Plates 3 and 4, Figs. 3, 4, 4′, $4^2$, $4^5$, $4^6$, $4^7$, 9, $9^{10\frac{1}{2}}$, $9^{11}$, and 10.)

S is the main workable or vertically-movable frame of the head (see Plates 4 and 5, Figs. 9, and 12 to $13^3$, inclusive) carried by the screw-shaft $s$, Fig. $13^3$. The latter may be made of a separate piece from the balance of frame and screwed therein. It may also be made, if desired, as shown in Fig. 13, where the whole frame is made from a solid piece.

$s^4$, Figs. 12′ and $12^7$, Plate 5, is the long or heel end of frame-bearing tube. $s^5$ is the short or toe end of same. Tube $s^5$ has pins $s^{24}$ driven or screwed inside and opposite each other, extending inward sufficiently to form guides, and slightly flattened to fit corresponding grooves in toe-shaft $s^{13}$ to keep it from turning. (See Plate 3, Figs. 7, 7′, and $7^4$, and Plate 5, Figs. 12′ and $12^7$.) The inside of the tube is bored to fit the shaft $s^{13}$, and the outside turned off to fit the holes in sleeves $s^{12}$ of frame-plates $s^{11}$.

$s^9$ $s^9$ (see Figs. 12′ and $12^7$, Plate 5) are hanger-shafts with solid collars $s^{17}$ on each. These shafts are driven through bearing-holes $s^7$ in the frame S, from the left-hand side up to their collars against side of the frame S and collars $s^{18}$ placed on the opposite side. (See Figs. 12′ and $12^7$.)

$s^{10}$ (see Plates 1, 3, 4, and 5, Figs. 1, 3, 9, 10, and 12) are disconnecting-lever rock-shafts with solid collars $s^{19}$ on each. These shafts fit and work in bearing-holes $s^8$, Figs. 13 and $13^3$, in frame S, with their collars close against the left-hand side of the frame and separate collars $s^{20}$ on the opposite side.

$s^{11}$ are adjustable frame-sleeve plates. (See Plates 1, 2, 3, 4, and 5, Figs. 1, 2, 3, 9, 10, 12, 12′, $12^2$, $12^3$, and $12^7$.) They have projecting sleeves $s^{12}$ that are bored out to fit upon tubes $s^4$ and $s^5$ of frame S, with holes $s^7$ and $s^8$ through the plates corresponding with holes $s^7$ and $s^8$ in frame S, and also have four smaller holes for adjustable frame-guide rods $s^{21}$, with screw-holes in one of the plates in which these rods screw, while they have a working fit for adjustment in the other plate. (See Figs. 12 to $12^7$, inclusive.)

$s^{13}$ (see Plates 3 and 5, Figs. 6, 6′, $6^2$, 7, 7′, $7^2$, $7^3$, $7^4$, $7^5$, 12, and 12′) is the adjustable main shaft of the toe-hanger frame, having guide-grooves corresponding with guide-pins $s^{24}$, which fit and work therein.

$s^{13}$ fits and works in tubes $s^4$ and $s^5$ for end adjustment of toe-pliers to suit the various lengths of lasts. It has a vertical cross-head screw-tube $s^{14}$, in which crank-screw shaft $s^{22}$ fits and works. This cross-head fits in the hole in the vertical portion of adjustable toe-bearing piece $s^{16}$, which is bored out to near the upper end with a smaller hole through the top, which fits the space between collar and hub on the screw-shaft $s^{22}$, the collar fitting in the larger bore of the tube. (See Fig. 3.) It has a recess cut out from the bottom up to its collar equal to the size of shaft $s^{13}$ at the cross-head, thus permitting a vertical motion down to the collar and up as required. There are three extension-bearings $s^{23}$, upon which the toe-plier hangers are suspended by their hanger-eyebolts $u^9$. (See Figs. 6, 6′, $6^2$, $40^2$, and 42.) These bolts correspond with the bearings $s^{23}$, each of the latter having staples to secure the toe-hangers in position.

$s^{15}$ is a guide-plate which fits and is screwed fast to the bottom of cross-head $s^{14}$, with a dowel-pin to hold it in position. It has three elongated guide-holes through which adjustable hanger-sleeves pass, and it controls the play of the toe-hangers and supports them when the hinged head is thrown back.

$s^{16}$ is the independent adjustable and workable toe-hanger bearing-piece above referred to, (see Plates 3 and 5, Figs. 3, 6, 6′, $6^2$, 7, 7′, and $7^5$,) which has through its crank $S^{22}$ an independent motion that enables it to draw the upper over the toe and vary the tension at that part of the last at any time, as may be required, irrespective of the action of the side pliers.

The adjustable flanged sleeves $u^{11}$ for sustaining position of side pliers fit on shafts $s^9$. The eye or ring of the hanger-bolt $u^9$ fits the sleeve between the flange and ring, which permits the ring to move freely and gives play to the pliers in all directions. (See Plates 5 and 8, Figs. 12′, 40, and 40′.)

T is a disconnecting toothed gear-lever for releasing the various side-pliers from their hold on the upper, and is clamped firmly on the front disconnecting rock-shaft $s^{10}$. This disconnecting mechanism is composed of the following parts and connections, (see Plates 5 and 8, Figs. 12, 33, 33′, and $33^2$, and Plate 5, Fig. 12:) Two segment-gears $t^2$ $t^3$, engaging each other, the former carried by lever T and the latter by the rear rock-shaft $s^{10}$ through the medium of clamp-arm $T^2$, clamp-bearings $t'$ of levers T T′, divided upon one side by cuts $t^8$, surrounding shafts $s^{10}$ and adapted to be secured thereon by bolts $t^0$; clamp-arms $T^2$, mounted by clamp-bearings $t'$ and bolts $t^0$ on said front and rear shafts $s^{10}$, and provided with outwardly-extending arms $t^4$, which have ears $t^5$; suspending-pins $t^6$, mounted in ears $t^5$ of the parts $T^2$, and also in similar ears carried by arm T′ and in corresponding ears $t^7$, formed on lever T; a handle $t$ formed with lever T, and wires $v^{14}$ which connect pins $t^6$ with the clamping-levers of the pliers.

Loose collars are placed on each of the shafts $s^{10}$ at the right-hand side of frame S, and solid collars on same shafts at opposite side of frame, as before described. The lever

T is placed against the side of collar $s^{20}$ and firmly clamped on the front shaft, and T′ is similarly placed and clamped on the back one, thus securing levers T and T′ permanently in position. This brings the gears $t^2$ and $t^3$ in contact, and by raising or lowering the end handle $t$ both disconnecting-shafts $s^{10}$ and all their connections act in unison. (See Plates 4, 5, and 8, Figs. 9, 10, 12, 33, and 33′.) The clamp-lever arms $T^2$ are separately placed and clamped in pairs opposite to each other on the two shafts $s^{10}$, and with the pair attached directly to the levers T and T′ are connected, through the wires $v^{14}$, with all the side pliers. These clamp-lever arms all correspond in form and dimensions with the clamp and arm $t^4$ at the end of T′, and the details of their construction are illustrated on Plate 8, Figs. 34, 34′, $34^2$, and $34^3$. The office of these tooth-gear clamp-levers and of their connections is to disconnect all the side pliers simultaneously by a single motion, that of raising the handle $t$ of lever T, which releases not only lever T and the arms of T′, but all the separate arms $T^2$ on shafts $s^{10}$ are released and all the side pliers are opened at the same time.

U, Fig. 40, Plate 8, is a hanger, of which there are several portions. $u$ is the main body or case, consisting of a hollow cylinder bored out from below. $u'$ are side extensions of cylinder $u$, the metal being cut out between the two sides equal to the diameter of the cylinder-bore and their outsides dressed a little flat or left round, as desired. (See Figs. 38, 38′ $38^2$, $38^3$, 40, 40′, and $40^2$, Plate 8.) $u^2$ are the rounded ends of the sides $u'$, being of sufficient size to cover the large joint of the plier. $u^3$ is a stop-pin driven through the two sides $u'$, just below the cross-lever $v^3$ in the space between the arms of the pliers, and which stops them from tipping out of place when pressure is applied to the end of lever $v^3$ to close or open the pliers. $u^4$ is a connecting-bolt with a head on the lower end which fits the bore in the hanger-cylinder $u$, the body fitting and passing through a hole in top of the hanger-piece U. It has a screw on the upper end which screws tight in the lower end of an adjustable screw-sleeve $u^8$. $u^7$ is a coiled spring that goes in the cylinder $u$, with the lower end resting on the inside of the bolt-head and the upper end against the inside of the end of cylinder. (See Plate 8, Figs. 35, 35′, 36, 36′, 40, and 40′.)

$u^8$, Figs. 39 and 39′, is an adjustable connecting screw-sleeve of increased size, with internal screw-threads, the lower end of which fits the screw $u^6$ on the upper end of the bolt $u^4$ and the upper end fitting either the hanger-eyebolt $u^9$ or its modification, the hanger-sleeve bolt $u^{10}$. (See Plates 5 and 8, Figs. 12′, 40, 40′, $40^2$, 43, 43′, $43^2$, and $43^3$.) These adjustable sleeves are free to turn, there being a milled flange on the lower part of each. The bolt $u^4$, being solid thereto, but free to turn in the cylinder of the hanger, permits the adjustable sleeve to turn for screwing up or down upon either the hanger-eyebolt $u^9$ or its modification, the hanger-sleeve bolt $u^{10}$. While neither of these bolts nor the pliers are permitted to turn, still by the adjustable screw-sleeves and their connections complete vertical adjustment of the pliers is permitted to reach the bottom surfaces of the various lasts, and their varying elevations, unless in exceptional cases, are fully provided for by this arrangement.

$u^9$, Figs. 40, 40′, and $40^2$, is the adjustable hanger-eyebolt for the side pliers. If required, the adjustable flanged sleeve $u^{11}$ may be used. (See Figs. 40 and 40′.) These sleeves assist in keeping the hanger-eyebolts in position while working the machine better than to simply slip the eye bolt along the hanger-shaft $s^9$ without the flanged sleeve. Being placed between the flange and the ring that is driven on the body of the sleeve, the eyebolt is thus confined in a recess, but with plenty of play. (See Figs. 40 and 40′.) For the toe-hangers (see Fig. $40^2$) the eye hanger bolts without the sleeves are to be used, they being secured in position by staples $s^{23}$. (See Plates 3 and 5, Figs. 6, 6′, $6^2$, and 12.)

Figs. 43, 43′, $43^2$, and $43^3$ are different views of an adjustable hanger sleeve-bolt $u^{10}$, which may, if required, take the place of the eyebolt $u^9$ and dispense with the adjustable sleeve $u^{11}$ for all or part of the side hangers for general steady work; but where great variations require lateral motion for the ends of pliers eyebolts $u^9$, with sleeves $u^{11}$, are preferable to sleeve-bolts $u^{10}$, which should fit the hanger-shafts $s^9$, and would not permit sufficient lateral motion for ends of the pliers.

The length of the hanger-bolts $u^4$ should vary for varying the lengths of the different hangers to suit the different crooks of the several lasts at the various average points of suspension of plier-hangers over the last, they being suspended from straight hanger-shafts over the bottoms of crooked lasts.

The difference between the hanger-shafts and the average lasts at the different average points of suspension gives the difference between the lengths of the bolts $u^4$ required, which produces the difference in different lengths of the respective hangers. The bolts should have sufficient vertical play in main hanger-case $u$, between its upper end and the adjustable screw-sleeve $u^8$, for sufficient movement at the end of pliers for all requirements.

V, Plate 8, Figs. 37, $37^2$, &c., is a spring-plier with cam. $v$ is that side of the plier containing the cam $v^2$. $v'$ is its mate. Both these sides $v$ and $v'$ are flattened to act as springs, and should be of proper length to afford sufficient spring to conform to the variable thickness of the uppers to which they are required to fasten. $v^3$ is a cross-connecting lever. $v^4$ is the male portion of the main joint of each half at its hinge. $v^5$ is the female portion of each half in which $v^4$ fits. $v^6$ is the bearing hinge-bushing of the main

joint. $v^7$ is the hinge-pin of the main joint of the pliers, which passes through the hinge-bushing, and also through the holes in lower portion of hanger side extensions $u'$, and is riveted slightly at its ends in the sides of the hanger-extension, the inner sides of which press against the bearing-bushing $v^6$, thus connecting the plier to the hanger at its main hinge-joint.

$v^8$ is the hinge-boss on the end of the short side $v'$ of plier V.

The cross-connecting lever $v^3$ is divided at one end in two equal parts to near the opposite end, with space between sufficient for the thickness of the upper ends $v^2$ and $v^8$ of the two side pieces $v$ and $v'$ of the plier V, (see Plate 8, Figs. $37^2$, $37^3$, 40, 41, 41′, and $41^2$,) which fit and work therein. The upper end $v^8$ of the short half or plier fitting in the open end of lever $v^3$ with hinge-pin $v^9$ driven through the two sides of the lever with working fit in the plier. (See Figs. $38^2$, 40, 40′, $40^2$, 41, 41′, and $41^2$.)

$v^{10}$ is a connecting-clevis for attaching the wires $v^{14}$ to the side pliers. The inner sides of the clevis fit the outsides of the lever $v^3$, embracing them with cam $v^2$ and sleeve $v^{12}$. Pin $v^{11}$ passes through clevis $v^{10}$, and the two sides of the lever $v^3$ also through the sleeve $v^{12}$ and cam $v^2$. This pin should be driven tight through the two sides of lever $v^3$, leaving the other parts embraced therein free to play on the pin for working. (See Figs. 41, 41′, $41^3$, 42, 42′.) The outside of bearing-cam is thicker than the inside part to enable it to receive the pressure in fastening the pliers to the upper, and the inside portion simply has to open the pliers only as outer ends of the levers $v^3$ are raised. The connecting-wires $v^{14}$ are secured to the clevis $v^{10}$ at their lower ends, and at their upper ends to connecting-pins $t^6$. They thus connect the various side pliers to the disconnecting-levers T T′ and the arms $T^2$. (See Plates 4 and 8, Figs. 9, 10, $38^2$, and 40′.)

Fig. $40^2$ is a toe-hanger, complete, with plier connected thereto without the clevis, which is not used with the toe-pliers.

$v^{13}$ is the bearing pin or rivet of the toe-plier passing through the cross-lever $v^3$, sleeve $v^{12}$, (see Figs. $41^2$ and $41^3$,) and cam $v^2$. (See it on Plate 8, Figs. $38^2$, 40′, 42, and 42′ shown detached, and on Plates 1, 2, and 4, Figs. 1, 2, 9, and 10, connected.)

Fig. 9, Plate 4, shows the handle of tooth-gear lever T up, with its gear and that of its mate T′ broken off and removed from their clamps. It also shows clamp-arms $T^2$ in full and wires $v^{14}$ and their connections, with pliers open and the workable portion of head screwed up, whereas in Fig. 10 the pliers have hold of the upper, with the workable portion of the head screwed up sufficiently to allow the clamps to press the upper over the insole on the last.

The mode of operation of the machine is as follows: The head being thrown back, the last, with upper and insole in place thereon, is mounted upon sleeve M and supported and centered at the toe by guides $m^6$. The front bridge is then turned up and the head turned down, bringing holder $r^8$ in contact with the insole and secured by lock R N. The side and toe pliers having been individually engaged with the edge of the upper by the depression of their closing and locking levers $v^3$, the vertically-movable portion of the head is bodily raised by the rotation of crank $s^2$. If desired, an independent stretching of greater amount at the toe is given by turning crank $s^{22}$. Side crank E is then rotated, operating, through screw-shaft E, toothed nut E′, gear D′, shaft D, rods $d$ $d$, levers C C, slides $b$ $b$, levers B B, and connecting-links $b^5$ $b^5$ to advance the side-lasting clamps, and operating at the same time through rods $d'$ $d'$, levers $e$ $e$, slide-shafts L L, and levers H H to advance the slides $F^5$ $F^6$ and toe and heel clamps carried thereby. The pull of the relatively-stationary links $f^{12}$ operates to close the jaws of said clamps and effect the lasting of the heel and toe. As the side and end lasting clamps engage the upper, the pliers are slightly lowered by a reverse motion of crank $s^2$ sufficiently to enable the upper to yield to said clamps and to be forced inward and downward upon the insole. The pliers are now to be detached, the toe-pliers individually by lifting or striking up the ends of levers $v^3$ and the side pliers by raising the handle $t$ of lever T up, which instantly turns the disconnecting-shafts $s^{10}$ $s^{10}$ and all that is clamped fast thereto in harmony therewith, and opens all the side pliers at once; hence disconnecting them from the upper. The toe-pliers having been disconnected by hand, the head is unlocked from the lock-pin $n^5$ of the front bridge. The head with all its parts can then be turned backward to the position indicated by dotted lines of yoke, (see Fig. 9,) the front bridge turned down, as also indicated by dotted lines, and the entire space in front of the back bridge $N^3$ left clear to permit tacking or otherwise securing the upper to the insole on the last, which is still held in place by the end and side clamps after the last-fastener has been removed. When the upper is secured to the insole, reverse turning of main crank $E^7$ releases the clamps from around the last, which is then removed, and its place is ready for another, which, if a duplicate of the one removed, is forthwith subjected to a repetition of the operation without the necessity of any adjustment of the clamps; but if the next is a mate to the one just removed the worm or screw shaft $o^5$, Fig. 32, Plate 7, must be thrown out of gear and the vise-tubes $G^4$ on each side revolved, so as to bring the under ones on top, where they are locked fast, adjusted to the last, and are then ready for a repetition of the operation previously performed.

In case another last much different in form or size from the one last used is placed in the

machine, the necessary adjustments required to fit it are to be made as hereinbefore described, and the manipulation of the machine proceeds as before, in the performance of which, when followed through all the stages that have been described, it will be seen that the power applied to main crank $E^7$ has been the sole moving force for all the machinery from that crank to the clamps that have shaped the upper of a boot or shoe around the last.

While I have hereinafter claimed certain parts and combinations thereof as constituting my invention, it will be understood that I do not confine myself to the exact shapes or arrangements described, but that such claims extend as well to any parts or combinations thereof which are substantially the same, though differing somewhat in shape, appearance, or operation from those herein illustrated and described.

I do not claim, broadly, in this application the combination of two sets of side-lasting devices and a revoluble holder or carriage therefor.

I do not in this application claim, broadly, the revoluble side clamps, nor the carriers constituting a part thereof having a series of separate clamping-pieces, the same being the subjects, in part, of my pending application, Serial No. 312,484, filed May 29, 1889.

I claim—

1. The herein-described lasting-machine table, consisting of the combination of the rigid base-pieces having upwardly-extending flanges, the top having downwardly-extending flanges, and the hollow sheet-metal legs fitting and secured to the flanges of said top and bases, substantially as set forth.

2. The herein-described lasting-machine table, consisting of the combination of the rigid base-pieces having upwardly-extending flanges, the top having downwardly-extending flanges, the hollow sheet-metal legs fitting and secured to the flanges of said top and bases, transverse rectangular frames $A^6$, secured within and stiffening said legs, and drawers fitting within the legs and supported by said frames, substantially as set forth.

3. In a lasting-machine, the combination, with the table, of a toe stand or rest having a transverse mortise, side guides for the toe having lateral shanks adapted to fit and independently adjustable in said mortise, and a set-screw in the rest adapted to simultaneously clamp both guides when adjusted, substantially as set forth.

4. In a lasting-machine, the combination, with a table having a longitudinal T-groove, of a bolt having a head which engages said groove, a plate having a perforation for said bolt, and a lateral T-groove, a clamping-nut engaging the upper end of the bolt, a stand-shaft having a head which engages said lateral groove, a set-screw for clamping said stand-shaft in place, and a vertically-adjustable screw sleeve or tube engaging the stand-shaft and adapted to form a rest for the last, substantially as set forth.

5. In a lasting-machine, the combination, with the lasting devices and upright levers connected therewith at their upper ends, of a vertical oscillating shaft, means for actuating the same, horizontal sliding pieces connected with the lower end of said levers, adjustable fulcrums supporting the levers, whereby their inclinations relative to said slides may be regulated, and connections between said sliding pieces and the said shaft, substantially as set forth.

6. In a lasting-machine, the combination, with the lasting fingers or clamps and upright levers connected therewith at their upper ends, of a vertical oscillating shaft adapted to turn in planes substantially parallel with the bottom of the last, a toothed wheel on the same, a sliding nut, a rack carried by the nut and engaging the toothed wheel, a screw engaging said nut, means for actuating said screw, and connections between the lower ends of said levers and the shaft, substantially as set forth.

7. In a lasting-machine, the combination, with the lasting fingers or clamps and upright levers connected therewith at their upper ends, of a vertical oscillating shaft adapted to turn in planes substantially parallel with the bottom of the last, means for actuating the same, horizontal slides engaging the lower ends of said levers, and connections between the slides and said shaft, substantially as set forth.

8. In a lasting-machine, the combination, with a lasting-clamp, a lever, and a slide having a recess or mortise, of the herein-described combined slide hinge-joint, having the two side pieces forming a socket engaging the lever and which are situated in and held in place by said recess or mortise, substantially as set forth.

9. In a lasting-machine, the combination, with lasting devices and an actuating-lever connected therewith, of an adjustable screw-fulcrum comprising a part having a screw-thread engaging a corresponding thread formed in a fixed part of the table or frame and a second part hinged to said lever engaging and longitudinally movable with said first-mentioned threaded part and adapted to permit the rotation of the latter, substantially as and for the purpose of speedy, sensitive, and accurate adjustment of the lasting devices, as set forth.

10. In a lasting-machine, the combination, with lasting devices and an actuating-lever connected therewith, of an adjustable screw-fulcrum comprising a screw-sleeve engaging by its screw-thread a fixed part and having an internal bearing, and a fulcrum-bearing piece adapted to support said lever having a journal fitting said internal bearing and held from endwise movement in said sleeve, sub-

stantially as and for the purpose of speedy, sensitive, and accurate adjustment of the lasting devices, as set forth.

11. In a lasting-machine, the combination, with the heel and toe and side lasting devices and horizontal slides carrying the same, of actuating-levers connected with said slides, adjustable screw-fulcrums carrying the levers and adjustable in directions transverse thereto, and mechanism, substantially as described, connected with the levers whereby they are simultaneously operated, substantially as set forth.

12. In a lasting-machine, the combination, with lasting devices and an actuating-lever connected therewith, of an adjustable screw-fulcrum connected with and adapted to carry and regulate the position of said lever and having an external projecting head adapted to be grasped by the hand for speedy, sensitive, and accurate adjustment of the lasting devices, as set forth.

13. In a lasting-machine, the combination, with lasting devices and upright levers connected therewith at their upper ends, of a vertical oscillating shaft, means for actuating the same, horizontal sliding pieces, adjustable connections between the lower ends of said levers and said sliding pieces, adjustable fulcrums supporting the levers, and connections between said sliding pieces and said shaft, substantially as set forth.

14. In a lasting-machine, the combination, with lasting devices and upright levers connected therewith at their upper ends, of a vertical oscillating laterally-flanged shaft, means for actuating the same, and connections between the lower ends of said levers and the flanges of said shaft, the ends of said connections where they join said flanges being situated in different planes to permit free movement of said shaft, substantially as set forth.

15. In a lasting-machine, the combination of a series of lasting fingers or clamps, a tube or frame having lateral openings for the shanks of said fingers, a series of clamping-pieces situated in said tube or frame and interposed between the shanks, and means for forcing said pieces and shanks together in a direction longitudinally of the tube or frame to secure the fingers, substantially as set forth.

16. In a lasting-machine, a pair of smooth-jointed end-lasting jaws or clamps pivoted to each other, the one having a reversely-curved lasting-surface concentric with the pivot and formed with curves having different radii therefrom, and the other terminating at its inner end in an edge which is adapted to fit said curved surface in all positions of the jaws, substantially as set forth.

17. In a lasting-machine, the combination, with the end-lasting jaws or clamps longitudinally movable and adjustable in vertical planes, of connecting rods or links, one of which is universally jointed to each of the rear ends of said jaws and universally jointed at their outer ends to a relatively fixed portion of the machine, substantially as set forth.

18. In a lasting-machine, the combination, with the end-lasting jaws, of connecting rods or links provided at their ends with universal joints, comprising plugs beveled at their inner edges, as described.

19. In a lasting-machine, the combination, with the table or stationary frame, of a frame or yoke hinged thereon upon a horizontal axis and carrying the lasting-pliers and a counterbalancing-spring engaging, respectively, said stationary and hinged frames and adapted to be compressed by the downward movement of the latter and to assist in raising the head, substantially as set forth.

20. In a lasting-machine, the combination, with a hinged head-yoke and a head carrying the side pliers, of a vertical screw-shaft and nut connecting said yoke and head and adapted to raise the latter, a second independent plier-support for the end pliers, and a second adjustable screw-shaft mounted in the end of said head and sustaining and adapted to raise said support and the toe-pliers, substantially as set forth.

21. In a lasting-machine, the combination, with the main frame, the head, and the hinged head-yoke or frame, of an elastic buffer situated between said frames and adapted to receive the impact of the hinged frame and a set-screw engaging and adapted to advance said buffer, substantially as set forth.

22. In a lasting-machine, the combination, with a lifting mechanism, of pliers connected with said mechanism through the medium of the pivot of their jaws and means for closing said jaws, the pliers and their closing mechanism being freely oscillatory on said pivot or hinge, substantially as set forth.

23. In a lasting-machine, pliers having a spring-arm, a cam-slot in one arm, and a lever independent of the pliers-support pivoted to the other arm and having a transverse projection or pin situated in said slot, substantially as set forth.

24. In a lasting-machine, pliers consisting of two pivoted jaws and a closing mechanism for the same, all suspended and freely oscillatory upon a hinge substantially parallel with the edge of the last and situated between the handles and jaws of the pliers, substantially as set forth.

25. In a lasting-machine, the combination, with the head, of a plurality of pliers, a rock-shaft mounted in said head, and flexible connections between said shaft and the pliers for disconnecting the latter, substantially as set forth.

26. In a lasting-machine, the combination, with the heel and toe last stands, the end clamp-stands, and side and end levers, of the table A, with a longitudinal groove A′, recess $a^{18}$ therein, and slots $a^{8}$ extending through,

and cross slots $a^7$, as and for the purposes set forth.

27. In a lasting-machine, the combination, with the levers B B, the slides $b$ $b$, and their actuating mechanism, of the table A, with cross-guide bearings $a^4$ $a^{4\frac{1}{2}}$ on each side having bearing-grooves $a^5$ $a^5$ therein, as and for the purposes set forth.

28. In a lasting-machine, the combination, with suitable lasting devices, the end levers H H, and slide-shafts L L, of the table A, with cross-ribs $a'$ $a^2$ on each side of the center between it and the ends, forming bearing-guides or frame-work through which screw slide-shafts L L fit and work, for the purposes set forth.

29. In a lasting-machine, the combination of the table A, provided with the longitudinal groove A', the longitudinal slots $a^8$, and the transverse slots $a^7$, the end stands F' F$^0$, and bolts $f^6$, secured in said groove, the heel and toe stand also provided with beaded bolts whereby they fit and are secured in said groove, the end levers H, passing through said longitudinal slots, the side levers passing through said transverse slots, mechanism for actuating the lower ends of said levers, and lasting devices connected with the upper ends of said levers, substantially as set forth.

30. In a lasting-machine, the combination, with suitable lasting devices and in the operating mechanism for the same, of the slide E', shaft E, vertical shaft D, plate A$^8$, and the table A, having guide-bearing $a^{11}$, cross connecting-ribs $a^{12}$ $a^{13}$, and bosses $a^6$, which also form bearings for plate A$^8$, as and for the purposes set forth.

31. In a lasting-machine, the combination, with suitable lasting devices and in the operating mechanism for the same, of the horizontal slide bearing-pieces, levers B B H H, and levers $e$ $e$ C C, and the table A, with connection-bearings $e^{3\frac{1}{4}}$, $e^{3\frac{1}{2}}$, and $c^4$ $c^4$, as and for the purposes set forth.

32. In a lasting-machine, the combination, with suitable lasting devices and in the operating mechanism for the same, of the side-clamp-actuating lever B, the table, the bearing stand or plate $i^2$, having an inner smooth bearing and an outer screw-threaded portion, a slide-piece carrying the fulcrum-pin and fitting the smooth bearing, and a screw-sleeve fitting said thread and engaging said slide-piece, substantially as set forth.

33. In a lasting-machine, the combination, with suitable lasting devices, of the actuating-shaft E, a table, a flanged bearing-tube E$^2$, having a nut E$^3$, stop-flanged sleeve-bearing E$^5$, and set-screw $a^{14}$, as and for the purposes set forth.

34. In a lasting-machine, the combination, with the lasting devices, shaft D, and gear-wheel D', of a toothed or rack slide-nut E', and screw-shaft E, with stop-collar E$^4$, as and for the purposes set forth.

35. In a lasting-machine, the combination, with the lasting devices and upright levers, of a toothed gear-wheel D', flanged shaft D, secured firmly thereto, with connecting-rods $d$ $d$ and $d'$ $d'$, hinged between the respective flanges or upon the opposite sides of the same, with rods $d$ $d$ located upon a plane different from that of rods $d'$ $d'$, as and for the purposes set forth.

36. In a lasting-machine, the combination, with lasting devices, the shaft D, and upright lasting-clamp actuating-levers, of connecting-levers C C and $e$ $e$, secured to their respective bearings and to rods $d$ $d$ and $d'$ $d'$ and to slide bearing-pieces $b$ $b$, and screw slide-shafts L L, as and for the purposes set forth.

37. In a lasting-machine, the combination, with lasting devices, of the flanged shaft D, plate A$^8$, with bearing $a^{15}$, sustaining flanged shaft D, and the table having a bearing for the upper end of said shaft, for the purposes set forth.

38. In a lasting-machine, the combination, with the lasting devices and upright levers, of end slide screw-shafts L L and side slide bearings-pieces $b$ $b$, as and for the purposes set forth.

39. In a lasting-machine, the combination, with lasting devices, the screw-shafts L L, and end actuating-levers H H, of adjustable screw-sleeve guide-bearings L' L' for end adjustments upon screw-shafts L L of the lower ends of end levers H H, when required, for the purposes set forth.

40. In a lasting-machine, the combination, with lasting devices, of the end levers, slide-shafts connected therewith, frame-ribs $a'$ $a^2$, and bearing-bushings $a^{17}$ $a^{17\frac{1}{2}}$, for the purposes set forth.

41. In a lasting-machine, the combination, with the side clamps, of the side-clamp levers B B, forming part of and connected with the actuating mechanism by the combined slide hinge-joint below and connecting with the side-clamp fingers above the table and hinged to adjustable screw-fulcrums between, for the purposes set forth.

42. In a lasting-machine, the combination, with the side clamps and levers B B, of adjustable screw-fulcrums in which clamp-levers B B are secured for the proper adjustments of side clamps, as and for the purposes set forth.

43. In a lasting-machine, the combination of the end clamps, levers H H, extending through the table connecting with slide screw-shafts L L beneath and to the end slide clamp-shafts F$^5$ F$^6$ above the table by the combined slide hinge-joint and hinged to adjustable screw-fulcrums between, for the purposes set forth.

44. In a lasting-machine, the combination, with lasting devices and the slide clamp-shafts F$^5$ F$^6$, of adjustable screw-fulcrums H' H' for the proper adjustments of the end slide clamp-shafts F$^5$ F$^6$, as and for the purposes set forth.

45. In a lasting-machine, the combination of lasting devices, the front side clamp and bridge-stands N N, with bearings $n'$ $n'$, also slide and journal-bearing pieces $o$ $o'$, corresponding therewith, as and for the purposes set forth.

46. In a lasting-machine, the combination, with lasting devices, the table, and hinged head, of a hinged front bridge with stop $n^5$ and lock R N, for the purposes set forth.

47. In a lasting-machine, the combination, with lasting devices, of the back side clamp and bridge-stands N′ N′, having bearings $n'$ $n'$, with slide and journal-bearing pieces $o$ $o'$ for the side-lasting devices, for the purposes set forth.

48. In a lasting-machine, the combination, with lasting devices, of a frame having a hinge-bearing, with a hinged head fitting thereto, and a spring engaging said head and frame, for the purposes set forth.

49. In a lasting-machine, the combination, with the lasting-clamps and hinged head, of the front and back clamp and bridge-stands N N and N′ N′, with faced bosses for setting upon the table, and a threaded extension $n^a$ for securing the same firmly thereto, with dowel-pins $n^{12}$, as and for the purposes set forth.

50. In a lasting-machine, the combination, with the end clamps and actuating-levers H H, of the adjustable end stands F and F⁰, with their bases fitting the surface of the table, with a guide-projection fitting the top part of groove A′, secured by adjustable bolts $f^6$ with adjustable end fulcrums and with clamp-heads, for the purposes set forth.

51. In a lasting-machine, the combination, with the end-clamping jaws and connecting-rods $f^{12}$, of the adjustable end-connecting sleeves F³ F⁴ with extension-connections $f^{10}$ $f^{11}$ and arms $f^{15}$, as and for the purposes set forth:

52. In a lasting-machine, the combination, with the end clamps and their sliding supports, of the connecting-arms $f^{15}$ with their stop-collars and screw-shafts, also with ball ends forming the male parts of ball-and-socket connecting-joints, as and for the purposes set forth.

53. In a lasting-machine, the combination, with the end clamps or lasting-jaws and a support on which they are hinged, of the adjustable and slide clamp-shafts F⁵ F⁶, with curved bearing and clamp extensions for said support, as and for the purposes set forth.

54. In a lasting-machine, the combination, with the end clamps and actuating-levers H H, of the clamp-shafts F⁵ F⁶, with a bearing-mortise $f$ in each containing the combined slide hinge-joint, as and for the purposes set forth.

55. In a lasting-machine, the combination, with lasting devices, of the end-clamp slides consisting of the curved bearings or supports F⁹ and the shafts F⁵ F⁶, each having a circular-shaped clamp-bearing extension with boss $f^{21}$ and clamp-bolt $f^{22}$, for the purposes set forth.

56. In a lasting-machine, the combination, with lasting devices, of the end-clamp slides, consisting of shafts having curved clamp-bearings F⁸ and segmental curved bearings F⁹, having projecting bearings $f^{24}$, containing a hinge-hole in which hinge-pin $f^{25}$ fits, as and for the purposes set forth.

57. In a lasting-machine, the end clamps or lasting-jaws consisting of side pieces $f^{3a}$ $f^{4a}$, with hinge-pin $f^{25}$ through the same, one of said jaws being reversely curved around its pin and formed of curves having different radii from the hinge-axis and the other fitting said curve, whereby in all positions a smooth continuous curved front face formed of various curves and having a close surface-joint is presented, as and for the purposes set forth.

58. In a lasting-machine, the end-lasting jaws consisting of side pieces $f^3$ $f^4$, with hinge-pin $f^{25}$ through the same, that in all positions present a smooth continuous curved front face having a close surface-joint, the upper portion being formed of various curves of different radii from the hinge-axis and the lower part parallel to the hinge-pin, as and for the purposes set forth.

59. In a lasting-machine, the end clamps or jaws consisting of side pieces with a ball upon the end of each piece for the purpose of forming the male part of a ball-and-socket joint, in combination with parts having sockets for said balls and means for causing said parts to actuate the jaws, as and for the purposes set forth.

60. In a lasting-machine, the combination, with the clamps or jaws, of connecting-rods $f^{12}$, with side openings and sockets for socket-joints and socket screw-plugs $f^{13}$, and means for causing said connecting-rods to operate the jaws, as and for the purposes set forth.

61. In a lasting-machine, the longitudinally-movable end-lasting jaws having the outer end of each jaw connected by ball-and-socket joints with the relatively stationary part of the machine, in combination with a longitudinally-movable support carrying said jaws and means for actuating said support, as and for the purposes set forth.

62. In a lasting-machine, the combination, with a toe-rest, of an adjustable screw-tube heel-stand M, an adjustable screw-stand shaft M′, with head, as shown, an adjustable plate $m$, with handle, set-screw $m^3$, and an adjustable bolt $m'$ with T-shaped head, and handle-nut $m^2$, as and for the purposes set forth.

63. In a lasting-machine, the combination, with a heel-rest, of an adjustable flanged screw-stand tube M² and adjustable stand screw-shaft M³, with tongued washer $m^4$, handle-nut $m^5$, with toe-piece M⁴, clamp $m^7$, elastic rest $m^8$, side guides $m^6$, and set-screw $m^9$, as and for the purposes set forth.

64. In a lasting-machine, the combination,

with lasting devices, of slide and journal-bearing pieces *o*, each containing space for worm-wheel therein and hinged sleeve-bearing $o^6$, worm-shaft and worm $o^5$, hinged stop-stud $o^9$, flange $o^3$, bearing-ring $o^{12}$, also small bearing for journal with hinge for connecting with rod $b^5$, as and for the purposes set forth.

65. In a lasting-machine, the combination, with side-lasting clamps, of the revoluble tubular holder for the side clamps and the bearing-pieces $o'$, with hinges for making connections to rods $b^5$, as and for the purposes set forth.

66. In a lasting-machine, the combination of the cross-heads $G^5$ $G^6$, with their respective journals and bearings, and vise-tubes secured firmly thereto, with end set-screws $g^2$ and finger-clamps $g'$ within, as and for the purposes set forth.

67. In a lasting-machine, the combination, with side-lasting clamps, of the vise tube or frame, finger-clamps therein, set screw or screws $g^2$, and bearing-pieces $g^3$, for the purposes set forth.

68. In a lasting-machine, the combination of the clamp-fingers *g*, secured firmly in position by finger-clamps $g'$, held in a vise tube or frame, as and for the purposes set forth.

69. In a lasting-machine, the combination, with the head and pliers carried thereby, of a central hinged frame-yoke R, having a vertical bearing R′, a horizontal bearing $R^2$, and the handle *r*, substantially as set forth.

70. In a lasting-machine, the yoke R, combined with the head and suitable lasting devices or pliers and having a hinged hub $R^2$, with spring $r^{15}$, as and for the purposes set forth.

71. In a lasting-machine, the combination, with the head and suitable lasting devices or pliers, of the back bridge, a hinged head-frame R, and spring $r^{15}$, with hub $R^2$, consisting of a hinged bearing and spring-casing containing recess $r^{12}$, with one end of spring $r^{15}$ inserted therein, the other end being inserted in spring-stop-connection hole $n^{24}$ in back bridge, as and for the purposes set forth.

72. In a lasting-machine, the combination, with the head and suitable lasting devices or pliers, of a spring-hinged yoke R, with hinged lock R N, a back bridge containing the hinge for said yoke, and a hinged front bridge having a rest for said yoke and a lock-pin $n^5$, as and for the purposes set forth.

73. In a lasting-machine, the yoke R, having a knee $r^6$, in combination with the head, suitable lasting devices or pliers, and an adjustable last-fastener $r^7$ secured to said knee, as and for the purposes set forth.

74. In a lasting-machine, the combination, with the head and suitable lasting devices or pliers, of a hinged head-frame yoke R, with stop projection $r^3$, containing an elastic stop $r'$, handle *r*, and hinged lock R N, as and for the purposes set forth.

75. In a lasting-machine, the combination, with the head and suitable lasting devices or pliers, with the head-yoke and stands N′ N′, of the back bridge $N^3$ $N^3$, with its integral parts, as and for the purposes set forth.

76. In a lasting-machine, the combination, with the head, lasting devices, and hinged supporting-frame, of a back-bridge hinge with bolt $n^9$, bearing-piece $n^{21}$, containing boss $n^7$, with elastic stop-plug $n^{11}$, disk $n^{19}$, set-screw $n^{20}$, and stop projection $r^{14}$, as and for the purposes set forth.

77. In a lasting-machine, the combination, with the head, suitable lasting devices or pliers, hinged yoke or frame, and screw *s*, of a main workable head-frame, as and for the purposes set forth.

78. In a lasting-machine, the combination, with the pliers and hangers connected with the pliers hinge-pin and independent of their arms, of the hanger-shafts $s^9$, secured to the workable main frame S, as and for the purposes set forth.

79. In a lasting-machine, the combination, with the pliers, of the disconnecting-lever shafts $s^{10}$, connected with workable frame S and with the pliers by the flexible connections $v^{14}$, as and for the purposes set forth.

80. In a lasting-machine, the combination, with lasting devices, the hanger-shaft $s^9$, and frame S, of the adjustable connection-frame sleeve-plates $s^{11}$, as and for the purposes set forth.

81. In a lasting-machine, the combination, with the hangers, and lasting devices, of the adjustable guide-rods $s^{21}$, in connection with adjustable-frame sleeve-plates $s^{11}$, as and for the purposes set forth.

82. In a lasting-machine, the combination of the pliers, the rock-shafts $s^{10}$, the clamp-toothed gear-lever T, its mate T′, and flexible connections between said shafts and the pliers, as and for the purposes set forth.

83. In a lasting-machine, the clamp-arms $T^2$, in combination with disconnecting-shafts $s^{10}$, clamp-toothed gear-lever T, its mate T′, wires $v^{14}$, and pliers connected with the latter, as and for the purposes set forth.

84. In a lasting-machine, the combination, with lasting devices, of the adjustable frame toe-shaft $s^{13}$ and adjustable piece $s^{16}$, adjustable screw-shaft and crank $s^{22}$, bearings $s^{23}$, and guide-plates $s^{15}$, as and for the purposes set forth.

85. In a lasting-machine, the combination, with the pliers, of a horizontal hanger-shaft, a screw-bolt adjustable thereon, a screw-sleeve engaging said bolt, a bolt or head $u^4$, carried by the lower end of the sleeve, and a frame-piece inclosing and movable on said bolt or head and adapted to carry the pliers, substantially as set forth.

86. In a lasting-machine, the combination, with lasting-pliers, of cylinder or frame *u*, bolt $u^4$, and spring $u^7$ within the frame and engaged by said bolt, constituting an elastic hanger

for pliers that yields to the varying pressure due to the different texture of the upper in order to produce a uniformly-tight fit upon the last, for the purposes set forth.

87. In a lasting-machine, the combination, with lasting-pliers, of hanger-frame $u$, containing side extensions $u'$, bolt $u^4$, adjustable screw-flange sleeve $u^8$, adjustable eye screw-bolt, and stop-pin $u^3$, as and for the purposes set forth.

88. In a lasting-machine, the combination of the pliers, a hanger connected therewith by their hinge-pin independently of their arms, and a spring $u^7$ in said hanger, as and for the purposes set forth.

89. In a lasting-machine, the combination, with a hanger-shaft, of a plier-hanger $u$, having an adjustable guide-sleeve fitting said shaft and provided with screw $u^9$, threaded sleeve $u^8$, and headed pin $u^4$, as and for the purposes set forth.

90. In a lasting-machine, the spring-plier V, composed of two side pieces $v$ and $v'$, with their respective parts $v^4$ and $v^5$, being the male and female parts of the main joint, also containing cam $v^2$, hinge-boss $v^8$, bushing-bearing $v^6$, hinge-pins $v^7$ and $v^9$, lever $v^3$, bearing-pins $v^{11}$ and $v^{13}$, and sheave $v^{12}$, as and for the purposes set forth.

91. In a lasting-machine, the spring-plier V, hinged by pin $v^7$ to hanger-connections $u'$ $u'$ and having lever $v^3$ and bearing-pins connecting said lever with the pliers, as and for the purposes set forth.

92. In a lasting-machine, the combination of spring-plier V and clevis $v^{10}$, connected together and to connection-cord $v^{14}$ $v^{14}$, which connects the same with connection-pin $t^6$, as and for the purposes set forth.

93. In a lasting-machine, the combination, with lasting devices, of a screw-shaft E, nut E′, tooth gear-wheel D′, flanged shaft D, connecting-screw slide-shafts L L, connecting-rods $d$ $d$, $d'$ $d'$, C C, and $e$ $e$, and slide bearing-pieces $b$ $b$, for the purposes set forth.

94. In a lasting-machine, the combination of lasting devices, side connecting-levers B B, with adjustable side screw-fulcrums and end connecting-levers H H, with adjustable end screw-fulcrums, as and for the purposes set forth.

95. In a lasting-machine, a double set of clamps upon each side of the last consisting of a right and a left foot clamp, in combination with levers B B, with adjustable fulcrum-screws, and end or heel and toe clamps with levers H H, having adjustable screw-fulcrums, in combination with a screw-gear and connections whereby the side and end clamps are simultaneously brought to or removed from the last at will by turning said screw either one way or the other, as and for the purposes set forth.

96. In a lasting-machine, a hinged head-yoke R, combined with workable frame S, nut $s'$, crank $s^2$, hanger-shafts $s^9$, and lasting devices, for the purposes set forth.

97. In a lasting-machine, a hinged head-yoke R, with hub $R^2$, containing spring $r^{15}$ and stop-plug $r^{14}$, with lock R N and last-fastener $r^7$, in combination with back bridge $N^3$ $N^3$, with head-hinge therein, center piece $n^{21}$, containing elastic plug $n^{11}$ with its connections, front hinge-bridge and connections thereof, and lasting devices, as and for the purposes set forth.

98. In a lasting-machine, the combination, with lasting devices, of a hinged head-yoke R, with its integral parts, with workable head-frame S, nut $s'$, crank or wheel $s^2$, frame sleeve-plates $h^{11}$, guide-rods $s^{21}$, hanger-shafts $s^9$, and adjustable hangers U, as and for the purposes set forth.

99. In a lasting-machine, a hinged head-yoke R, with a workable frame S, nut $s'$, crank or wheel $s^2$, frame sleeve-plates $s^{11}$, hanger-shafts $s^9$, disconnecting-shafts $s^{10}$, levers T T′, and clamp-arms $T^2$, in combination with adjustable hanger U and spring-pliers V, with their integral parts and connections, clevis $v^{10}$, and cord or rod $v^{14}$, connecting with pin $t^6$, as and for the purposes set forth.

100. In a lasting-machine, an adjustable toe-hanger shaft $s^{13}$, with adjustable bearing-piece $s^{16}$, with its projecting toe-bearings $s^{23}$, screw-shaft and crank $s^{22}$, guide-plate $s^{15}$, in combination with yoke R and workable frame S, hangers U, and pliers V, as and for the purposes set forth.

101. In a lasting-machine, horizontally and vertically adjustable spring-hangers U with their respective parts, in combination with spring-pliers V, connected with said hangers by means of and freely oscillatory upon their hinge-pins $v^7$, as and for the purposes set forth.

102. In a lasting-machine, the side clamps and end clamps, the side levers B B, the adjustable screw-fulcrums, and levers H H, with adjustable screw-fulcrums, in combination with stands F $F^0$, adjustable clamp-shafts $F^5$ $F^6$ with their concomitant parts, sleeves $F^3$ $F^4$ with their attachments, and also ball and socket jointed connections connecting adjustable sleeves $F^3$ $F^4$ to their respective heel and toe or end clamps, as and for the purposes set forth.

103. The herein-described lasting-machine table, having the longitudinal T-groove A′, the longitudinal slots $a^8$, and the transverse slots $a^7$, said slots being adapted to permit the passage and operation of the side and end lasting levers and having below the table the portions $a'$ $a^2$, provided with longitudinal bearings, substantially as set forth.

104. The herein-described lasting-machine table, having the longitudinal T-groove A′, the longitudinal slots $a^8$, and the transverse slots $a^7$, said slots being adapted to permit the passage and operation of the side and end lasting levers and having below the table the portions $a'$ $a^2$, provided with longitudinal bearings, in combination with end-lasting clamp-bearing stands adapted to fit said T-groove

and having T-headed bolts, end and side actuating levers, and longitudinal slide-shafts beneath the table, substantially as set forth.

105. In a lasting-machine, the combination, with the side-lasting devices and the end-lasting devices, including the end-lasting hinged jaws, of a single-power mechanism connected with said devices and jaws, and the connections, all substantially as described, between the jaws and stationary portions of the machine, whereby all of the said lasting devices are simultaneously operated, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

ISAAC N. FORBES.

Witnesses:
P. H. MCNAMEE,
N. F. JONES.