(No Model.) 4 Sheets—Sheet 1.

T. MILLETT, Jr.

COPYING LATHE FOR TURNING ARTICLES OF AN IRREGULAR CONTOUR.

No. 388,900. Patented Sept. 4, 1888.

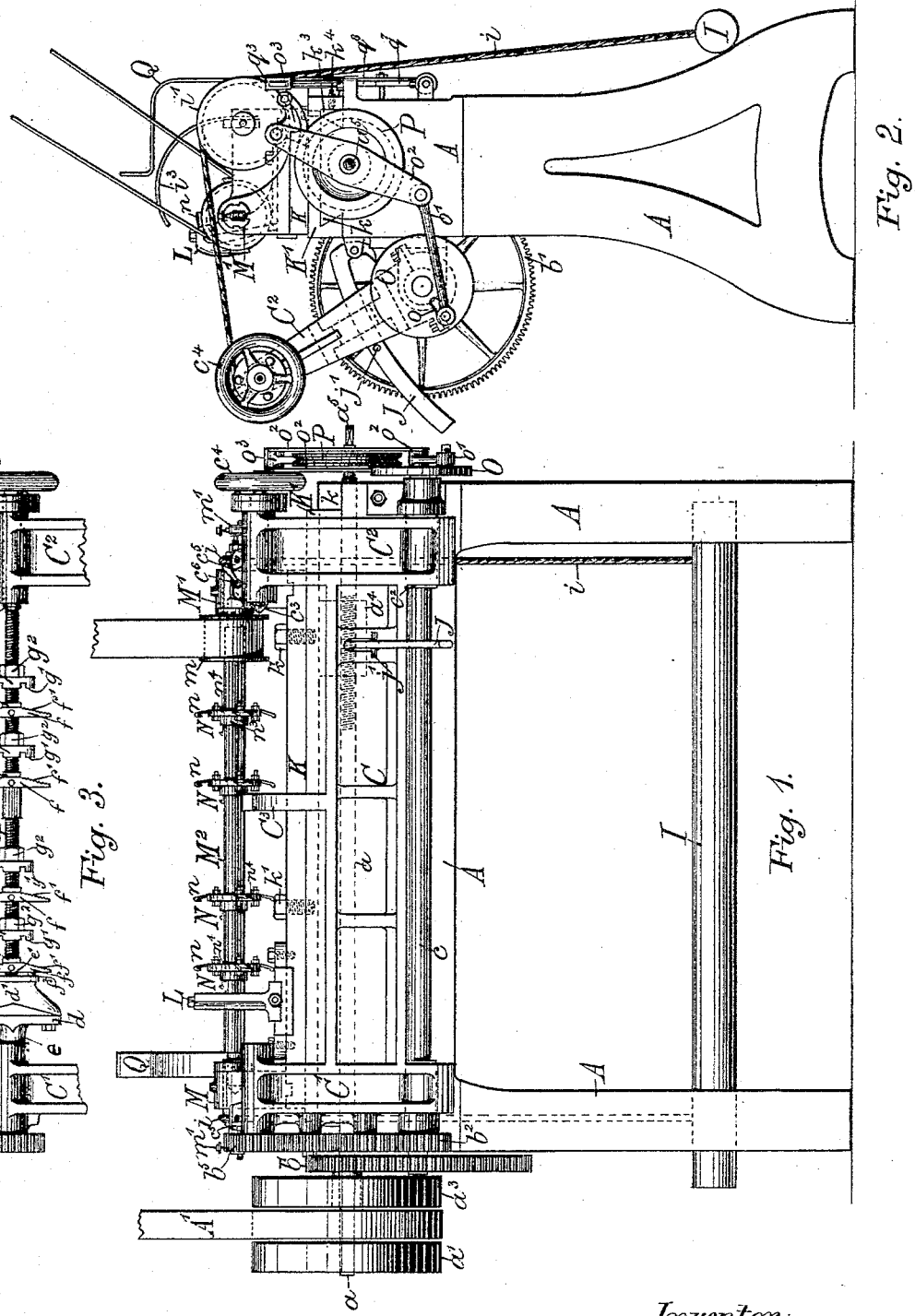

Fig. 2.

Fig. 3.

Fig. 1.

Witnesses:
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Robt. A. Blake.

Inventor:
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Henry Harrington, Levis.
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(No Model.) 4 Sheets—Sheet 2.

T. MILLETT, Jr.

COPYING LATHE FOR TURNING ARTICLES OF AN IRREGULAR CONTOUR.

No. 388,900. Patented Sept. 4, 1888.

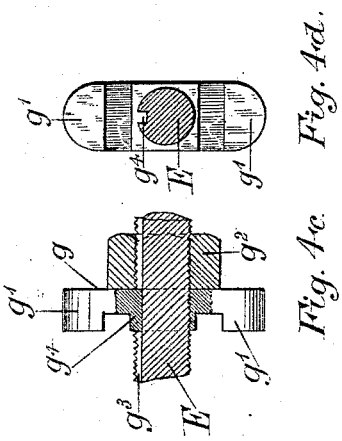

Fig. 4d.

Fig. 4c.

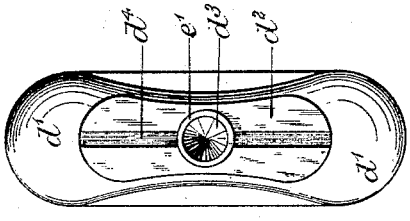

Fig. 4b.

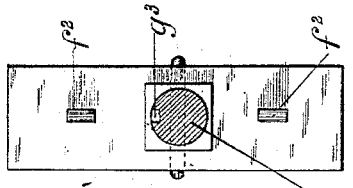

Fig. 4a.

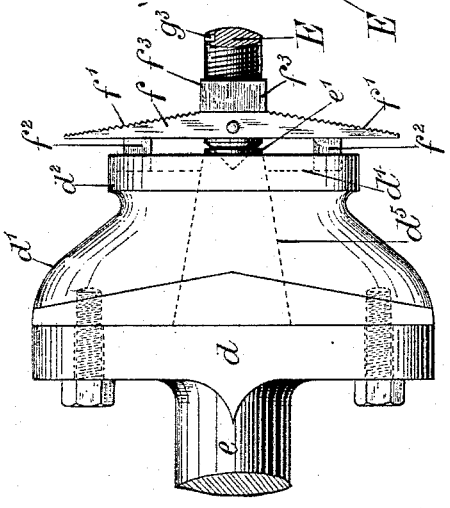

Fig. 4.

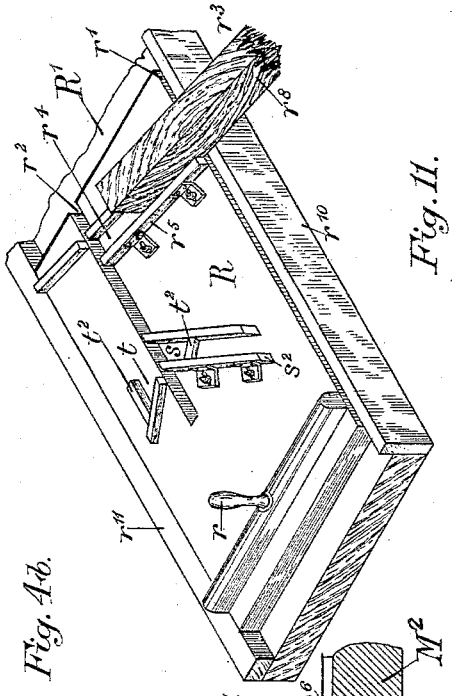

Fig. 11.

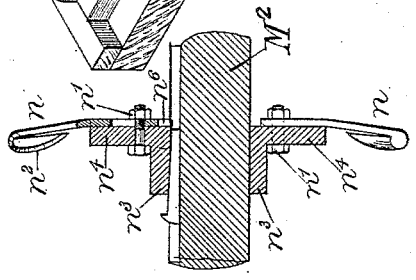

Fig. 5a.

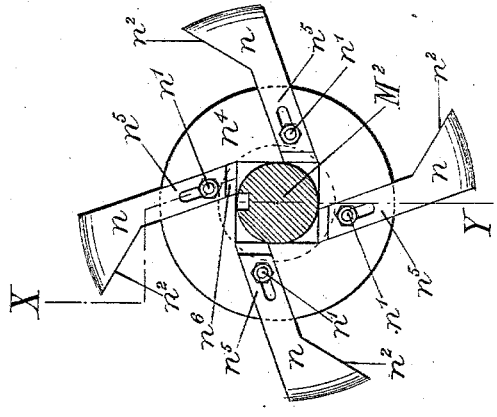

Fig. 5.

Witnesses:
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(No Model.) 4 Sheets—Sheet 3.

T. MILLETT, Jr.

COPYING LATHE FOR TURNING ARTICLES OF AN IRREGULAR CONTOUR.

No. 388,900. Patented Sept. 4, 1888.

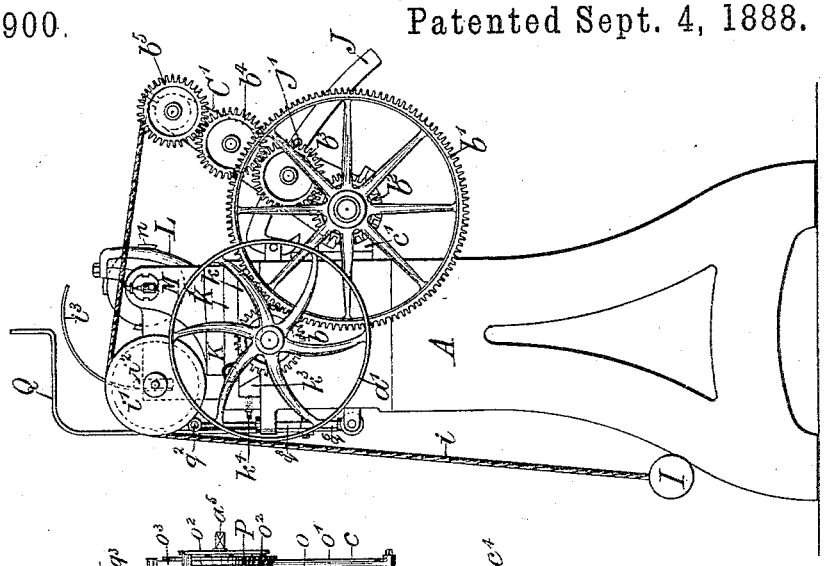

Fig. 7.

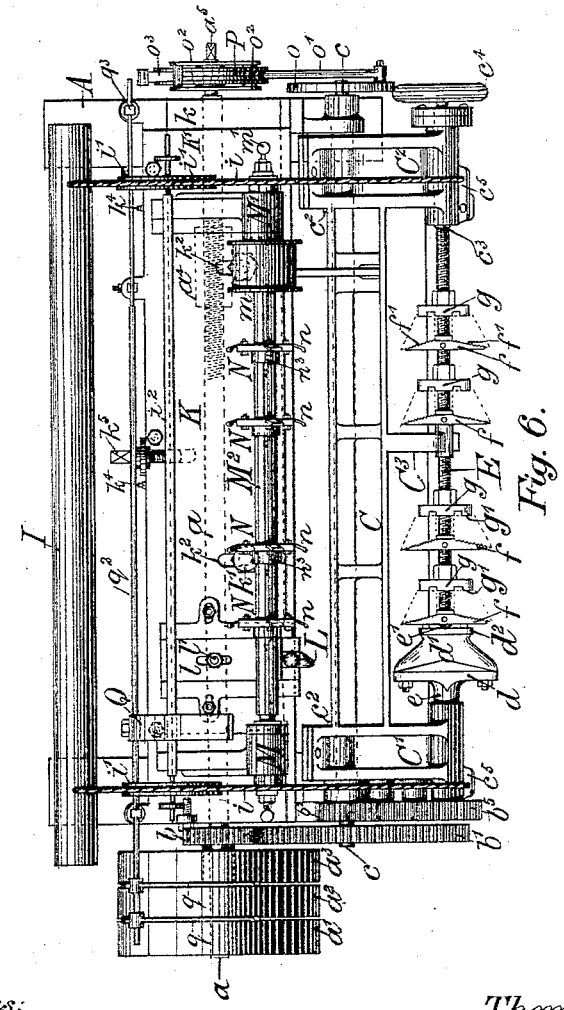

Fig. 6.

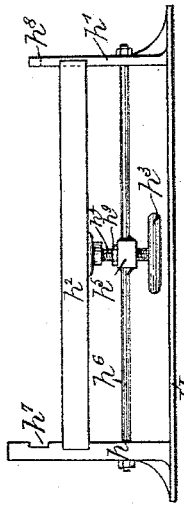

Fig. 8.

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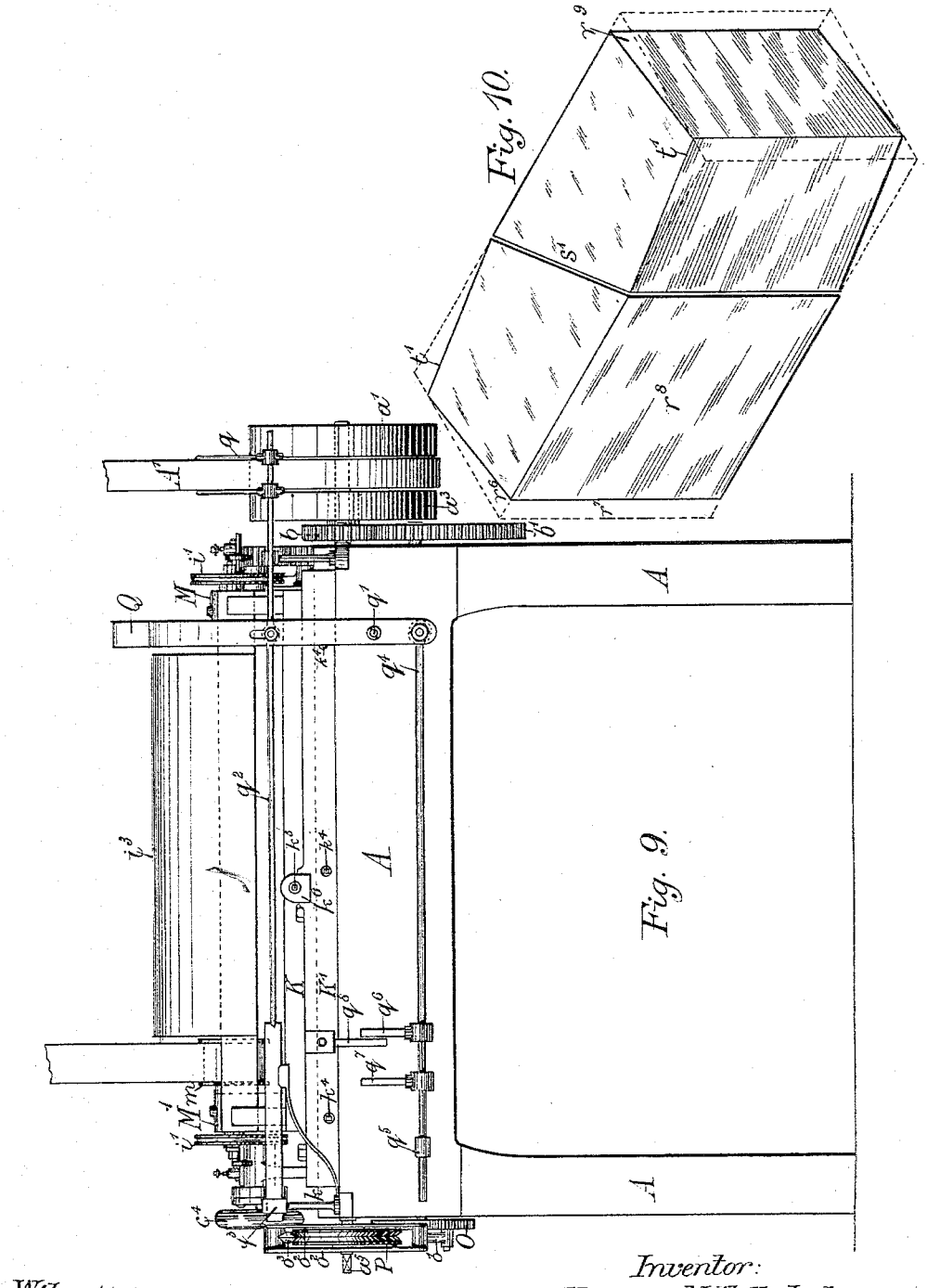
(No Model.) 4 Sheets—Sheet 4.

T. MILLETT, Jr.

COPYING LATHE FOR TURNING ARTICLES OF AN IRREGULAR CONTOUR.

No. 388,900 Patented Sept. 4, 1888.



Witnesses.
Chas. L. Woodruff.
Robt. A. Blake.

Inventor:
Thomas Millett, Jun.
Henry Harrington Leigh
Attorney.

UNITED STATES PATENT OFFICE.

THOMAS MILLETT, JR., OF LONDON, ENGLAND.

COPYING-LATHE FOR TURNING ARTICLES OF AN IRREGULAR CONTOUR.

SPECIFICATION forming part of Letters Patent No. 388,900, dated September 4, 1888.

Application filed February 11, 1887. Serial No. 227,331. (No model.) Patented in England June 24, 1886, No. 8,345.

To all whom it may concern:

Be it known that I, THOMAS MILLETT, Junior, a subject of the Queen of Great Britain and Ireland, residing at 42 Colvestone Crescent, Dalston, London, England, wood-turner, have invented new and useful Improvements in Copying-Lathes for Turning Articles of an Irregular Contour, (for part of which improvements I have obtained Letters Patent in Great Britain, No. 8,345, dated June 24, 1886,) of which invention the following is a specification.

My invention relates to an improved construction of turning-lathes for the production of articles of an irregular contour, and is more particularly applicable to what are known as "copying-lathes," in which a pattern article or dummy mounted on the same mandrel on which are chucked the shapes or rough pieces to be turned controls, in conjunction with a feeler on the cutter-carriage and a counterpoise, the varying distance of the cutter-axis from the mandrel-axis.

It consists in, first, improved mechanism for driving the mandrel and traversing and reversing the cutter-carriage; secondly, in an improved detachable mandrel; thirdly, in an improved chucking device for the said mandrel; and, fourthly, in an improved cutter.

I attain the several objects of my invention by means of the mechanical devices illustrated in the following figures, which are to be taken as part of this specification and read therewith, and in which—

Figure 1 is a front elevation without the dummy and mandrel; Fig. 2, an end elevation, looking at the lathe, as drawn in Fig. 1, from the right hand; Fig. 3, an elevation of the empty mandrel and the dummy with the tops of the head and tail stocks; Fig. 4, a detail front elevation of the dummy, its face-plate, and the part of the detachable mandrel engaging therewith; Fig. 4^a, a detail end elevation of the face plate on the detachable mandrel which engages with the dummy face-plate; Fig. 4^b, a detail end elevation of the dummy, its face plate, and the concave bearing projecting through the latter; Figs. 4^c and 4^d, respectively, sectional and end elevations illustrating the connection between the cramping-plates and their nuts and the detachable mandrel; Fig. 5, a side elevation of a cutter block and blades; Fig. 5^a, a sectional elevation taken on the line X Y of Fig. 5; Fig. 6, a plan of the lathe; Fig. 7, an end elevation looking at the lathe from the left hand; Fig. 8, an elevation of the filling-bench; Fig. 9, a rear elevation of the lathe; Fig. 10, an isometric view, on an enlarged scale, of a block containing the material of two shapes as cut off a length of raw material, with the subsequent severing-cuts indicated by the full lines; and Fig. 11 an isometric view of a portable sawing-gage.

The foregoing figures are all, excepting Figs. 10 and 11 and the detail Figs. 4, 4^a, 4^b, 4^c, 4^d, 5, and 5^a, which latter are on a larger scale, drawn to the same scale, and show the lathe as it would appear at the moment after a full mandrel has been chucked, the driving-belt running the while on the loose pulley.

The figures illustrate the lathe as adapted for turning eight boot-heels at once, although I wish it to be distinctly understood that my invention is not confined to the production of heels for boots or shoes, inasmuch as by merely exchanging the dummy and adjusting the feeler, the movable face-plates on the shape-mandrel, and the cutter-blocks on the cutter-spindle, according to the length of the shape to be operated on, it will produce any other articles of irregular outline, such as lasts or gunstocks.

The first part of this invention, consisting in improved mechanism for driving the mandrel and reversing the cutter-carriage, is as follows:

A is the bed and legs of the lathe, A′ the driving-belt, and *a* the cutter-carriage traveling and reversing shaft carrying three pulleys, a' a^2 a^3, of equal diameter, on its outer end. The first pulley, a', is keyed on the shaft *a*, and is for reversing the cutter-carriage; the middle one, a^2, is the loose pulley; and the third, a^3, is the driving-pulley, and also loose upon the shaft *a*.

The spur-pinion *b* is fast to the driving-pulley a^3 and concentric therewith. It engages with the spur-wheels *b′*, fast on the end of the shaft *c*, rotated in two brackets, c' c', projecting from the front of the lathe-bed, for the purpose of actuating the traveling gear of the cutter-carriage.

In carrying this part of my invention into effect I prefer to make use of a rocking-chair

or vibrating mandrel-frame, which consists of a horizontal beam, C, a head-stock, C′, and a tail-stock, C^2, both of which are continued below the beam to form the bearings by which the frame is carried upon sleeves c^2, (shown in dotted lines in Figs. 1 and 6,) projecting inwardly from the brackets c' c', and which sleeves also serve in part as bearings for the shaft c, which they protect from being worn by the vibrating motion of the mandrel-frame.

C^3 is an open bearing aligned with the head and tail stocks for the purpose of preventing the mandrel E from being sprung out of line by the pressure of the cutters against the shapes. There may be more than one of these, according to the length of the lathe.

The tail-stock C^2 is fitted with the well-known adjustable back center, c^3, and hand-wheel c^4. The top of the stock is split for a short distance and expanded for the same into two tabs, c^5, which can be tightened upon the back center by a closing-screw, c^6, for the purpose of preventing it being moved backward.

The live-mandrel e in the head-stock C′ is driven from the spur-wheel b' through a line of intermediate gears, b^2 b^3 b^4, mounted on axes projecting from the outer side of the head-stock, the last-mentioned one, b^4, engaging with one, b^5, fast on the end of the live-mandrel. The mandrel has formed upon it a face-plate, d, to which the dummy, through which an extension, d^5, of the mandrel e passes, as indicated by the dotted lines in Fig. 4, is bolted.

The dummy d' illustrated in the figures is of the same contour as two heels placed front to front and separated by a distance equal to that separating the fronts of two heel-shapes when the latter are fixing in the mandrel E, which separating-distance is in the dummy represented by solid dummy material with plain surface, although my invention does not confine me to the use of a double dummy. For instance, when it is required to turn a gun-stock or any article the whole surface of which can be cut in a lathe, a single dummy—that is, one representing only one article—is used. A dummy, single or double, has incorporated with it a face-plate, d^2, through which projects a concave bearing, d^3, formed in the nose e' of the extension d^5 of the mandrel e, and dividing a groove, d^4, in the face-plate d^2, as illustrated in detail in Figs. 4 and 4^b. The groove d^4 receives the dogs f^2, projecting from the back of the left-hand face-plate, f, as shown in Fig. 4, whereby the rotary motion of the live-mandrel e is communicated to the detachable mandrel E when the latter is in the lathe.

The second and third parts of my invention, consisting in an improved detachable mandrel and chucking device for the same, are constructed as next described.

E is my improved detachable mandrel. It is a round bar screwed from end to end, and has a long longitudinal groove, g^3, formed, preferably, along the top, which receives feathers g^4, projecting inwardly from the cramping-plates next described, as illustrated in detail in Figs. 4^c, 4^d. Upon this mandrel are the face-plates f—single or duplex, (by duplex face-plate I mean one which projects equally from opposite sides only of the mandrel, as illustrated, as distinguished from one which projects equally in every direction,) as may be required by the shape of the article to be turned—and cramping-plates g, with tightening-nuts g^2, arranged in sets upon the mandrel for the purpose of holding the shapes in the manner illustrated in Fig. 6, each face-plate and cramp being made to hold as many shapes as there are finished articles represented by the dummy. As many sets, or only one set, may be used with one mandrel as may be desired and according to the length of the lathe. The mandrel passes centrally through both duplex face plates and cramping-plates. The cramping-plates are capable of a free lateral motion upon the mandrel in either direction, the feathers above mentioned engaging in the groove in the mandrel and preventing any motion around it. The face plates and cramping-plates have their respective and opposite faces, f' g', formed according to the top and bottom faces, respectively, of the shape to be turned, in order that the latter may be gripped firmly without packing being required, and held securely by simply advancing the cramping-plates toward their respective face-plates and screwing up the tightening-nuts g^2. Accordingly, the face-plates illustrated being for boot-heels, have their faces f' cut with teeth and sloping away from the mandrel, and the cramps g with projections g'. The slope of a face-plate is the same as that of the top face of the heel-shape before it is hollowed, and the projections g', from the face of a cramping-plate g, are in cross-section less than the area of the bottom face of the heel. Steps f^3 project from the face-plates, upon which rest the sides of the shapes which will be the fronts of the heels when the cut is finished. The sloping faces f', projections g', and steps f^3 are all modified as may be required to suit the contour of the articles to be turned.

The filling-bench illustrated in Fig. 8 is constructed and operated as follows:

H is the base, and h h' two standards, between which a horizontal bar, h^2, with a plain top surface can be raised or lowered by a hand-wheel, h^3, actuating a screw, h^4, (suitably connected to the under side of said bar,) in a nut, h^5, formed in the center of the tie-rod h^6.

An empty mandrel, E, is supported horizontally in the frame by causing the dogs f^2 to engage in corresponding holes formed in the inner face of the standard h within the slot h'. The opposite end of the mandrel lies in a slot, h^8, formed in the top of the standard h'. The bar h^2 is adjusted so that its top face is separated from the axis of the mandrel E by a distance equal to one-half the thickness of the shapes to be chucked. The locking-nut h^9 is then tightened up and the shapes fitted into the mandrel by placing them on the bar in position between the face-plates

and their respective cramping-plates and locking them there by screwing up the locking-nuts g^2. The standards are marked with gages to facilitate the adjustment of the horizontal bar. A fitted mandrel lying in the bench presents the same appearance as the mandrel and shapes drawn in Fig. 6.

While the lathe is at work the dummy d' is kept in touch with the feeler L, described farther on, by means of a counterpoise, I, connected to the stocks of the mandrel-frame by cords i i, passing over pulleys i' i', carried upon continuations of the bar i^2, to which the movable dust-guard i^3 is fixed.

J is a curved bar hinged to the face of the lathe-bed and projecting through the horizontal beam C of the mandrel-frame. Its outer end carries a transverse pin, j', against which the mandrel-frame rests when it is pulled back out of work away from the feeler for the purpose of changing mandrels. The angle which the mandrel-frame makes with the front of the lathe bed when it is resting against the pin j' is too obtuse for the weight of the counterpoise I to affect it.

The cutter-carriage consists of two plates, K and K'. The lower one or saddle, K', embraces a strong V-projection, k, formed upon the top of the lathe-bed, and has formed upon its under side a solid screwed nut, a^4, which engages with a screwed part of the shaft a, whereby the rotation of the latter in either direction travels the carriage to the right or the left accordingly. The upper plate, K, engages with the saddle K' by means of two guide-pins, k', acting also as set-screws, which pass through parallel slots k^2 and enter the saddle underneath. I provide a tightening-slip, k^3, controlled by set-screws k^4, to compensate for the wear of the faces of the V-slide. A transverse motion at right angles to the direction of the longitudinal travel of the carriage can therefore be given to it by actuating the traversing-screw k^5, working in an independent bracket, k^6, fixed to the back of the saddle.

L is the feeler with which the dummy is kept in contact by the counterpoise I while the cut is on. It is capable of a transverse adjustment in a slide, l, formed for that purpose on the plate K of the cutter-carriage. A set-screw, l', is provided, which passes through a slot formed in the base of the feeler into the said plate K.

I wish to point out that in consequence of the mandrel-frame vibrating through a longer arc than it has hitherto been the practice to give to this part of a copying-lathe the feeler in a lathe constructed according to my invention need not overhang the cutter-carriage much, and may be stationary while the lathe is at work, inasmuch as by the long vibration of which the mandrel frame is capable—viz., through an arc of ninety degrees—a wide and thin dummy can be kept in touch with a stationary feeler.

M M' are the standards in which the cutter-spindle M^2 is rotated by a driving-belt driven independently of the driving-pulley of the lathe and passing round a shrouded pulley, m. Proper lubrication of the cutter-spindle is provided for by means of self-acting lubricators m'.

The fourth part of my invention relates to an improved construction of cutter.

N N are the cutter-heads, each head consisting of a boss, n^3, and a disk, n^4. They correspond both in number and position with the number of face-plates on the mandrel E. The planes in which the cutters stand at the moment the lathe is started is that which contains the left-hand sides of the respective shapes. The heads are keyed upon the spindle M^2, in which a longitudinal key-seat is cut for the full length of the spindle for the purpose of allowing them to be adjusted in any desired position. There are four cutter-blades, n, upon each head, fixed thereto, edge on—that is, edge to the front—in grooves formed in the sides of the disk by means of bolts and nuts n' passing through slots in the cutter-shank and bolt-holes in the disk. The grooves are not radial to the axis of the disk, but are parallel with diameters thereof. The back edge of each blade is straight, and the outer end thereof is bent round into the shape of a letter U, as shown in elevation in Fig. 5^a. In the act of forging the cutter the metal of the said U-shaped end is drawn or extended forward, thereby producing a U-shaped leading cutting-edge, n^2, upon said forwardly-extended end, as shown in Figs. 5 and 5^a. The rectangular shank n^5 fills and is supported by the sides of the groove n^6, instead of the blades being (as has frequently been the practice to make them) bolted to flat arms projecting from the periphery of the head in a plane passing through the axis of the cutter spindle and twisted through a right angle to bring the cutting-edge to the front. Each of my cutters, from one extremity to the other, is forged in one piece, and being without any twist and fixed to the disk of the head edge of the cutter to the front and side of the cutter flat to the disk and in the same plane they offer the fullest resistance of which their shanks are individually capable to the strain to which they are severally subjected during the operation of cutting.

My improved gear for traveling and reversing the cutter-carriage in a direction parallel with the axis of the mandrel upon which the shapes are chucked is as follows:

O is a disk fast on the end of the shaft c, and o is a radial slot formed therein. A connecting-rod, o', adjustably and eccentrically connected to the disk by a bolt and nut passing through it and the slot o, rocks the rocking lever o^2 upon the projecting end of the shaft a. The upper extremity of this lever carries a gravity friction-pawl, o^3, lying in the groove of the pulley P, keyed upon shaft a. As the friction-pawl is moved over the face of the pulley toward the front of the lathe, it slips along the groove but bites therein in its return travel. A square, a^5, is formed upon the extremity of the shaft a to receive a winch-han-

dle for the purpose of actuating the reversing-shaft *a* and effecting the return of the cutter-carriage to the left-hand end of the lathe independently of the reversing-pulley *a'*. When the lathe is to be reversed, the friction-pawl o^3 is swung over on its pivot to the front of the lathe out of the groove of the pulley P for the purpose of preventing it interfering with the reverse motion of the latter.

I make use of the following gear for reversing and stopping the lathe:

Q is the hand-lever of the strap-shifter *q*, pivoted on a stud, *q'*, its rod q^2 sliding in vertical guides q^3, fixed on the back of the lathe-bed. A rod, q^4, sliding in a guide, q^5, is pivoted to the lower end of the lever Q and carries two strikers, q^6 q^7, between which hangs a fixed stop or striker, q^8.

According to the methods of producing boot-heels in a copying-lathe followed at the present time a block of wood large enough to produce, say, six counterparts of the double dummy, is chucked and turned down until the said six counterparts are produced, and these are afterward separated by sawing. It follows, therefore, that all the excess of the mass of the block over the combined mass of the twelve heels has been wasted. I propose to prevent this waste by making all the severing cuts in the length of raw material as the same is received from the saw-mill before chucking and turning instead of afterward. The several cuts are made diagonally, as next described.

The dotted lines of Fig. 10 represent a parallelopiped containing two heel-shapes, their several faces being indicated by the full lines.

The improved sawing-gage illustrated in Fig. 11, and to be used for the purpose of economizing wood in the process of sawing out the shapes to be turned into heels in the lathe described above, consists of a rectangular plate, R, having a handle, *r*, by which it can be easily moved along the saw-table R', with its edge r' bearing against the fence r^{10}, the opposite edge sliding against a straight strip, r^{11}, upon the saw-bench. A slot, r^2, in the plate allows of the latter being pushed forward far enough for the saw to make the cuts required. The length of raw material, r^3, is fed into the guiding-groove r^4, the first cut producing the face r^6, Fig. 10. A small angular piece, r^7, cut off from the end of the length by the first cut, is waste. The angle which the first cut makes with the side r^8 of the length is of course controlled by the angle which the guiding-groove r^4 makes with the slot r^2. The sawing gage is then drawn back until the slot is clear of the saw, when the length r^3 is pushed across the slot up to the strip r^{11} and the gage again advanced, when the second cut produces the face r^9, parallel with the face r^6, but without waste. A block as cut off from the length r^3 in the way described above, and having its opposite faces, r^6 r^9, parallel and diagonal, is then laid in the guiding-groove *s*. The sawing-gage is moved forward and the block severed in the direction of the double full lines *s'*. Each half-block is then placed in the third guiding-groove *t* and cut along the lines *t' t'*. The guiding-grooves r^4 and *s* are adjustable in point of width by means of set-screws and slotted angle-plates, to which the loose sides r^5 s^2 of the respective grooves are fixed. Temporary stops t^2 are used to secure uniformity in the sizes of the shapes.

A lathe constructed according to my invention operates as follows: The cutter-spindle and carriage being over to the left, the driving-belt A' on the loose pulley, and the mandrel-frame C pulled back, a full mandrel, E, is chucked therein between the face-plate d^2 and the back center, c^3, and the frame pushed toward the lathe until the dummy *d'* bears against the feeler L. The driving-belt A' is then pulled, by means of the lever Q, onto the driving-pulley a^3, the driving-belt on the pulley *m* set in motion, (there is no necessity for stopping it during a spell of work,) and the cut is started, a second mandrel undergoing at the same time the process of being filled with shapes in the filling-bench. The revolution of the shaft *c* rotates the pulley on the end of the traveling and reversing shaft *a* at a suitable speed by means of the gravity-clutch o^3, and the screwed part of the shaft *a*, engaging the nut a^4, effects the travel of the cutter-carriage from left to right. By the time the cut is out the striker q^8 has borne against the stop q^7, thereby actuating the strap-shifter and causing it to move the belt A' onto the loose pulley a^2, from which it is moved by the hand-lever Q onto the reversing-pulley a^3, fast on the shaft *a*, the consequent rotation of which returns the cutter-carriage to the position illustrated in the figures—viz., with the cutter-carriage at the end of the reversed travel—when the striker q^8 contacts with the striker q^6, and consequently moves the belt from the reversing-pulley *a'* onto the loose pulley a^2.

The action of a lathe constructed according to my invention proceeds without time being lost while a mandrel full of turned heels is being emptied and refilled, inasmuch as the two operations of replacing it with a duplicate mandrel filled with shapes at the filling-bench while the last cut was on and of reversing the lathe are both effected at one and the same time, and both are completed practically at the same moment.

I claim—

1. The combination, in a lathe for turning articles of an irregular contour, of a spur-pinion concentrically and rigidly connected to the driving-pulley and engaging with a spur-wheel fast upon the end of a shaft having its bearings in the front of the lathe and parallel with the axis of the cutters, and about which shaft the mandrel-frame vibrates, a line of intermediate gears upon the head-stock of the mandrel-frame driven by the said spur-wheel and driving the live-mandrel in said head-stock, a connecting-rod eccentrically connected by one end to the opposite end of the said shaft and by its other end to a rocking shaft

provided with a friction-pawl which engages in a groove in the periphery of a pulley fast upon the end of the shaft on which the driving-pulley rotates, which last-mentioned shaft engages, by means of a screw-thread cut thereupon, in a nut on the under side of the cutter-carriage, whereby the said shaft is adapted to impart a to-and-fro motion to the said carriage, a belt-shifter sliding horizontally in guides and engaged by projections from the cutter-carriage being adapted thereby to automatically shift the driving-belt from the driving-pulley onto the loose pulley at the end of the cut, and a hand-lever connected to the said shifter and adapted thereby to shift the driving-belt from the loose pulley onto the reversing-pulley fast on the shaft on which both loose and driving pulleys rotate, substantially as described.

2. The combination, in a lathe for turning articles of an irregular contour, of a mandrel-frame vibrating upon stationary sleeves projecting from the front of the lathe, a shaft having its bearings in the said sleeves and driven by a line of gearing on the head-stock of the mandrel-frame, which drives the live-mandrel in said head-stock, a connecting-rod eccentrically connected by one end to the opposite end of the said shaft and by its other end to a rocking shaft provided with a friction-pawl which engages in a groove in the periphery of a pulley fast upon the end of the shaft on which the driving-pulley rotates, which last-mentioned shaft engages, by means of a screw cut thereupon, in a nut on the under side of the cutter-carriage, whereby the said shaft is adapted to impart a to-and-fro motion to the said carriage, substantially as described.

3. In a copying-lathe for turning articles of an irregular contour, the combination, with the cutter-carriage, of a screwed nut engaging with a screwed shaft, on one end of which is the reversing-pulley fast thereon, and on the other end a grooved pulley in which engages a friction-pawl pivoted to the end of a rocking lever connected by a rod eccentrically attached to the adjacent end of a shaft, about the axis of which the mandrel-frame is vibrated, said grooved pulley being by the last-mentioned shaft moved intermittently, substantially as hereinbefore described.

4. In a copying-lathe for turning articles of an irregular contour, the combination, with the dummy on the live-mandrel, of a face-plate fixed or incorporated with said dummy and having a groove cut in it, a detachable mandrel, one end of which is adapted to engage with said face-plate, a face-plate fast upon said end of the detachable mandrel, and having dogs projecting from it which are adapted to engage in the said groove in the face-plate incorporated with the dummy when the said end of the detachable mandrel is engaged with the last-mentioned face-plate, substantially as hereinbefore described.

5. In combination with the screwed mandrel of a copying-lathe for turning boot-heels, a chucking device consisting of a duplex face-plate, the faces of which are cut with teeth and shaped to correspond with the slope of the top face of the heel before it is hollowed, steps projecting from said face-plate adapted for the front of the heel to rest upon, a duplex cramping-plate engaging, by means of a feather, in a groove in the mandrel, and having projections adapted to engage with the bottom faces of the heels, and a tightening-nut engaging with the screwed thread of the mandrel, substantially as described.

6. The combination of cutter-shanks of a rectangular cross-section having slots cut therein, a cutter head having grooves of the same cross-section as the said cutter-shanks cut in it and adapted to receive the said cutter-shanks, edge to the front, said grooves being parallel with diameters of the said head, the said head having also holes formed transversely in it, which holes open into said grooves respectively, and is adapted thereby to receive bolts and nuts for holding the shanks in their respective grooves and to admit of the adjustment of the cutting-edges of the cutters with reference to their respective distances from the axis of the cutter-spindle, and U-shaped leading cutting-edges formed upon the forwardly-extended U-shaped ends of the respective cutter-shanks, substantially as above described.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, this 23d day of December, 1886.

THOMAS MILLETT, JUNIOR.

Witnesses:

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