No. 876,932. PATENTED JAN. 21, 1908.

L. H. BLOOD.

METAL WORKING MACHINE.

APPLICATION FILED APR. 5, 1900.

6 SHEETS—SHEET 1.

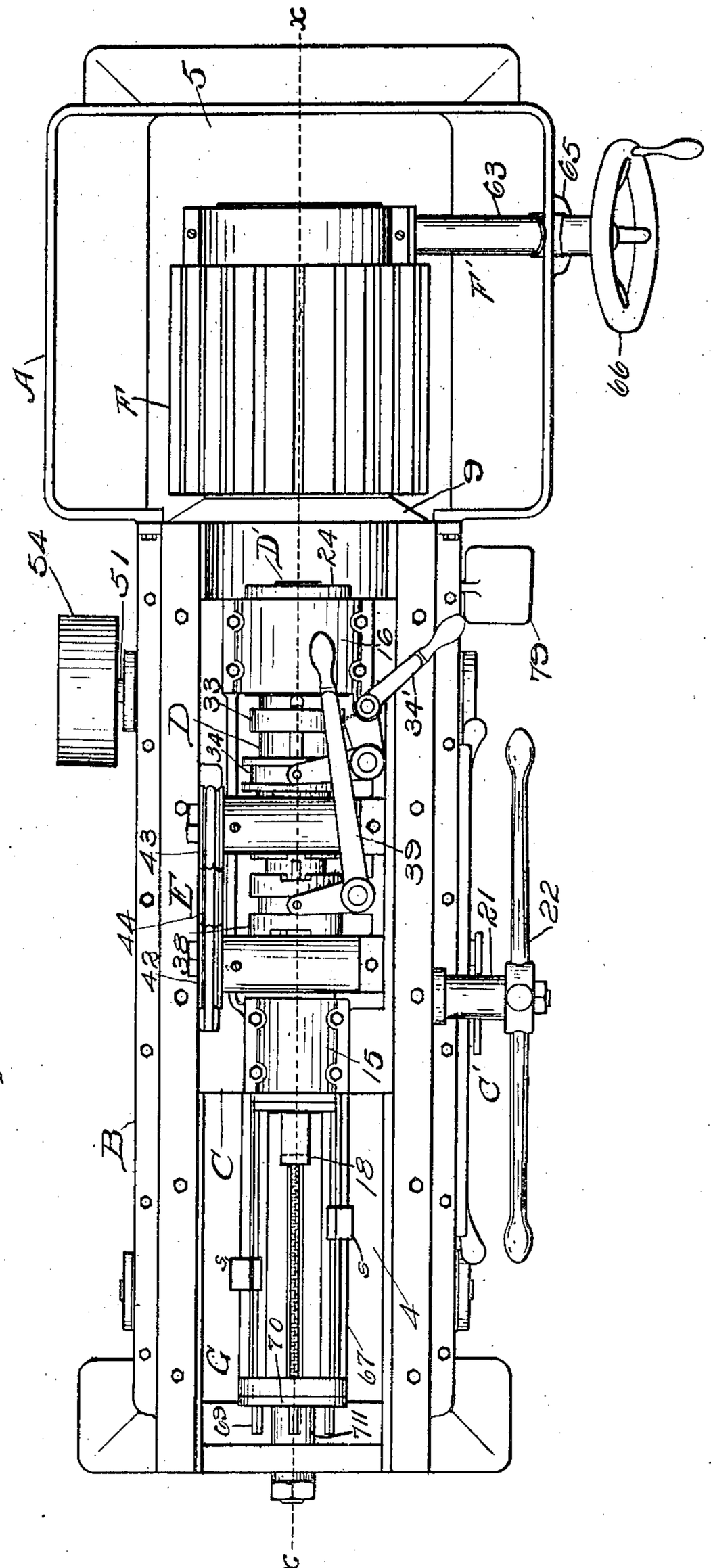

Fig: 1.

Witnesses.
M. H. Flynn.
L. C. Woods.

Inventor:
Louis H. Blood
by L. C. Whitney. Attorney

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6 SHEETS—SHEET 2.

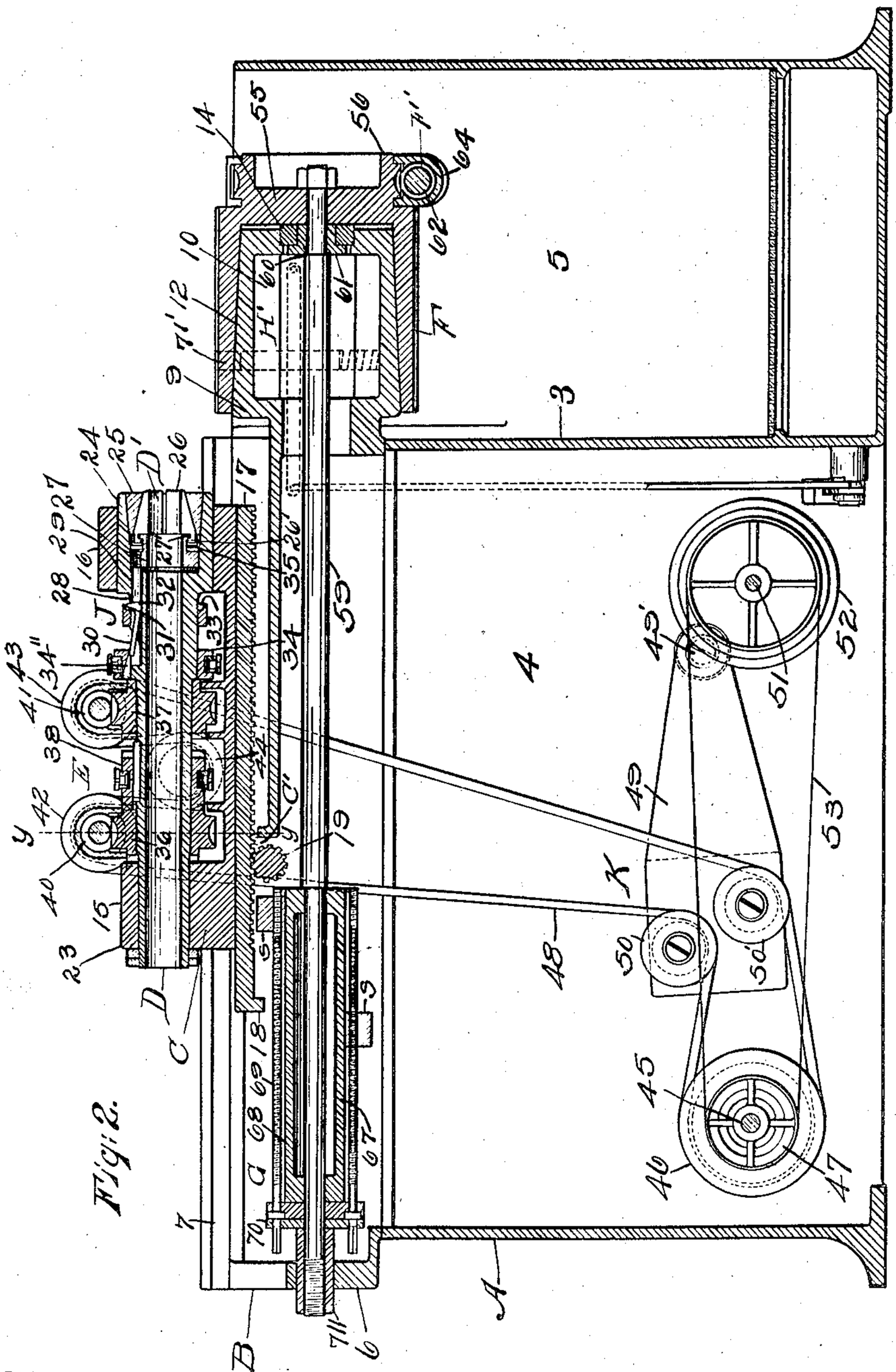

Fig. 2.

Witnesses.
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6 SHEETS—SHEET 3.

Fig. 4.

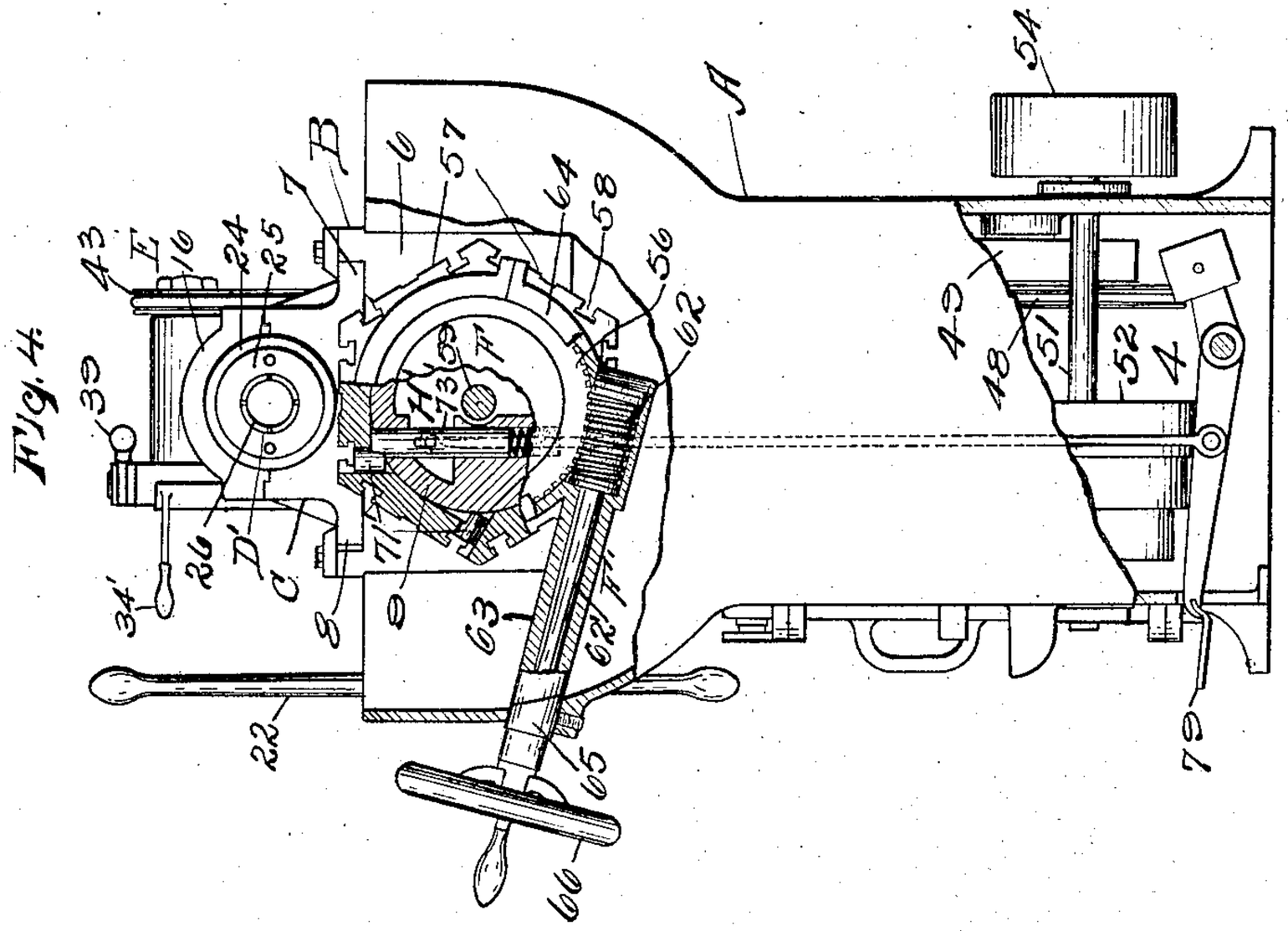
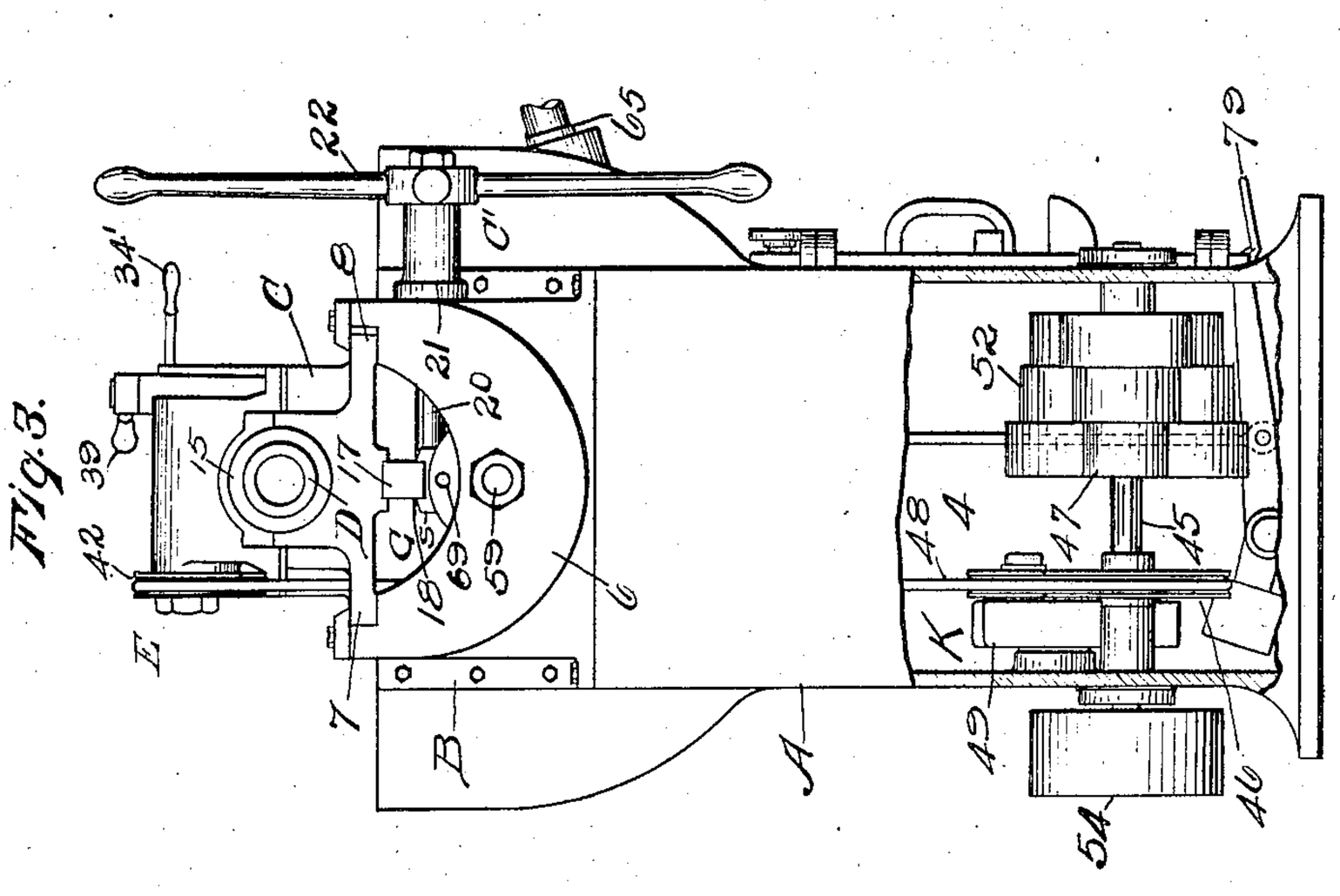


Fig. 3.



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6 SHEETS—SHEET 4.

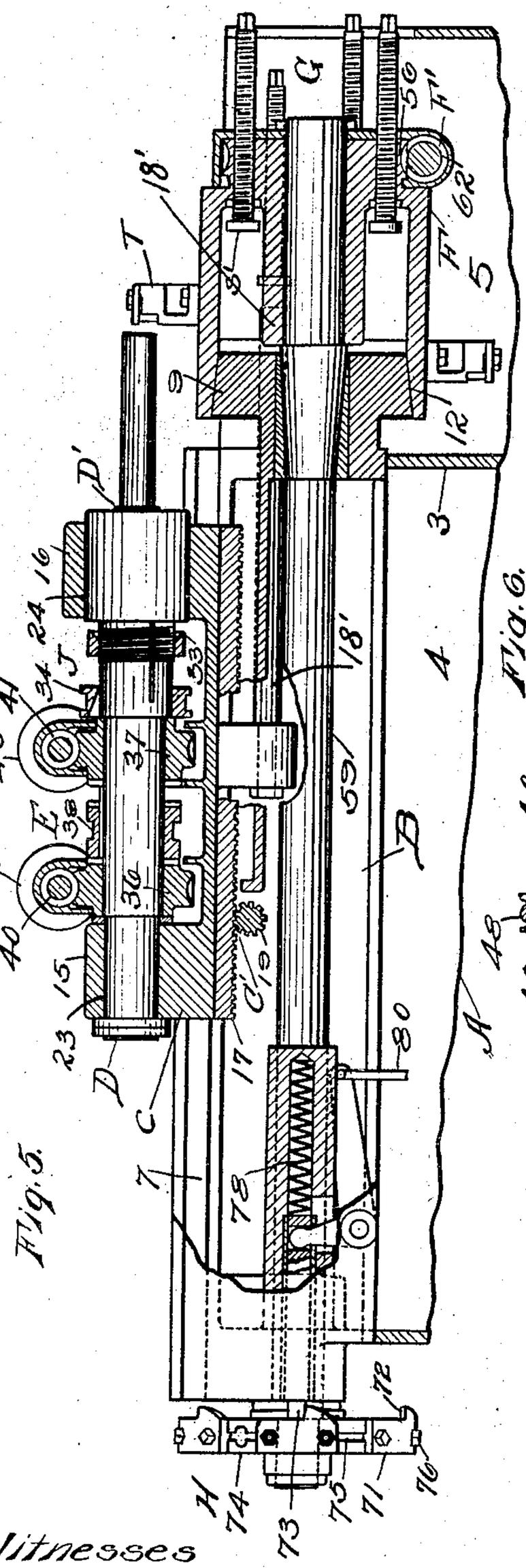

Fig. 5.

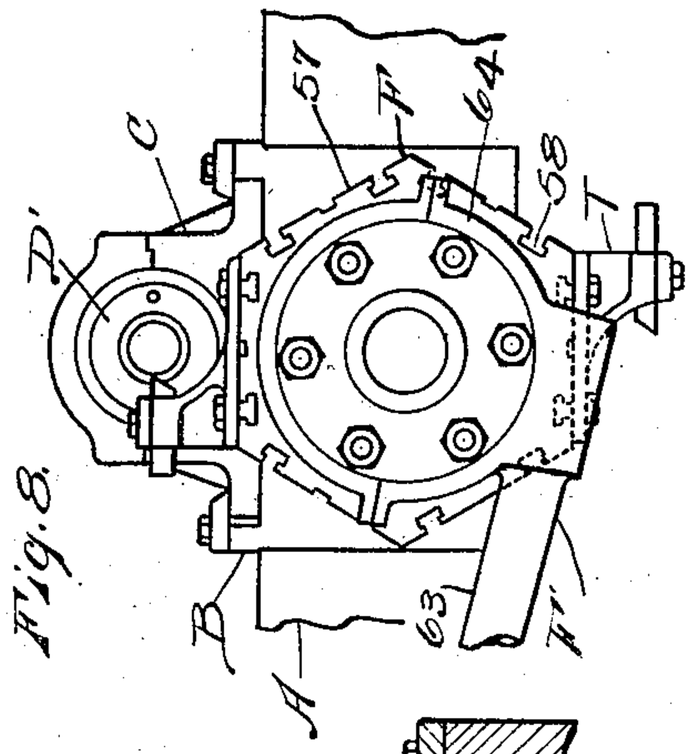

Fig. 8.

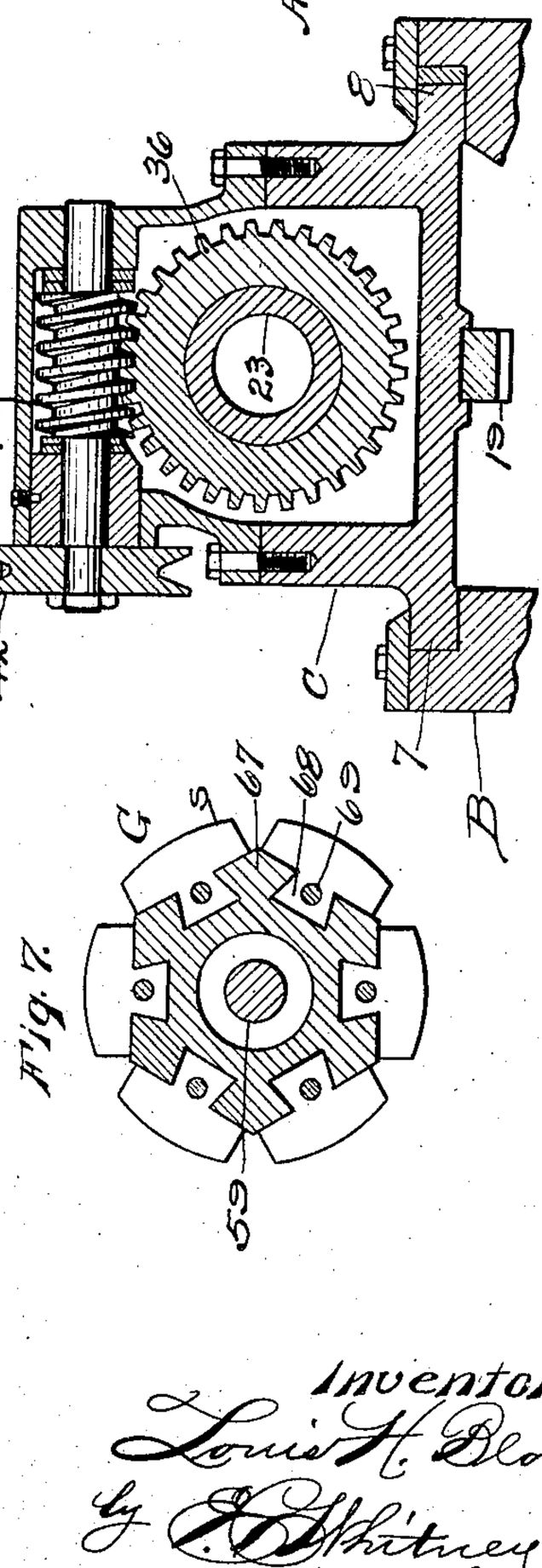

Fig. 6.

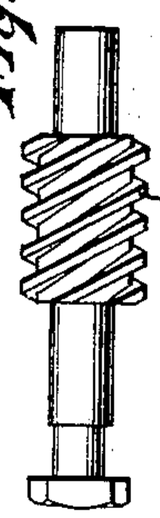

Fig. 14.

Fig. 7.

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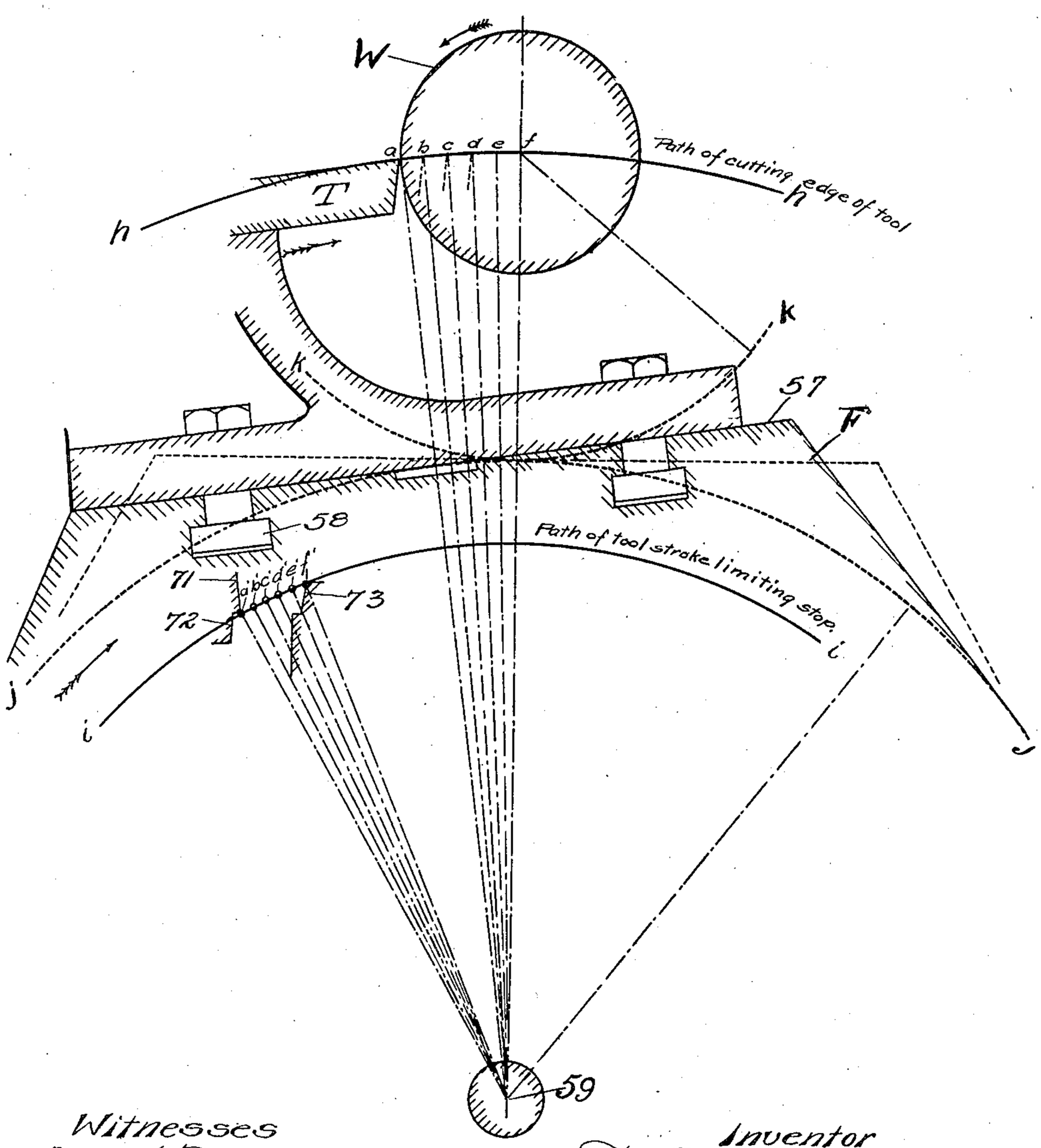
6 SHEETS—SHEET 5.

Fig. 9.



Witnesses
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No. 876,932. PATENTED JAN. 21, 1908.

L. H. BLOOD.

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APPLICATION FILED APR. 5, 1900.

6 SHEETS—SHEET 6.

Fig. 10.

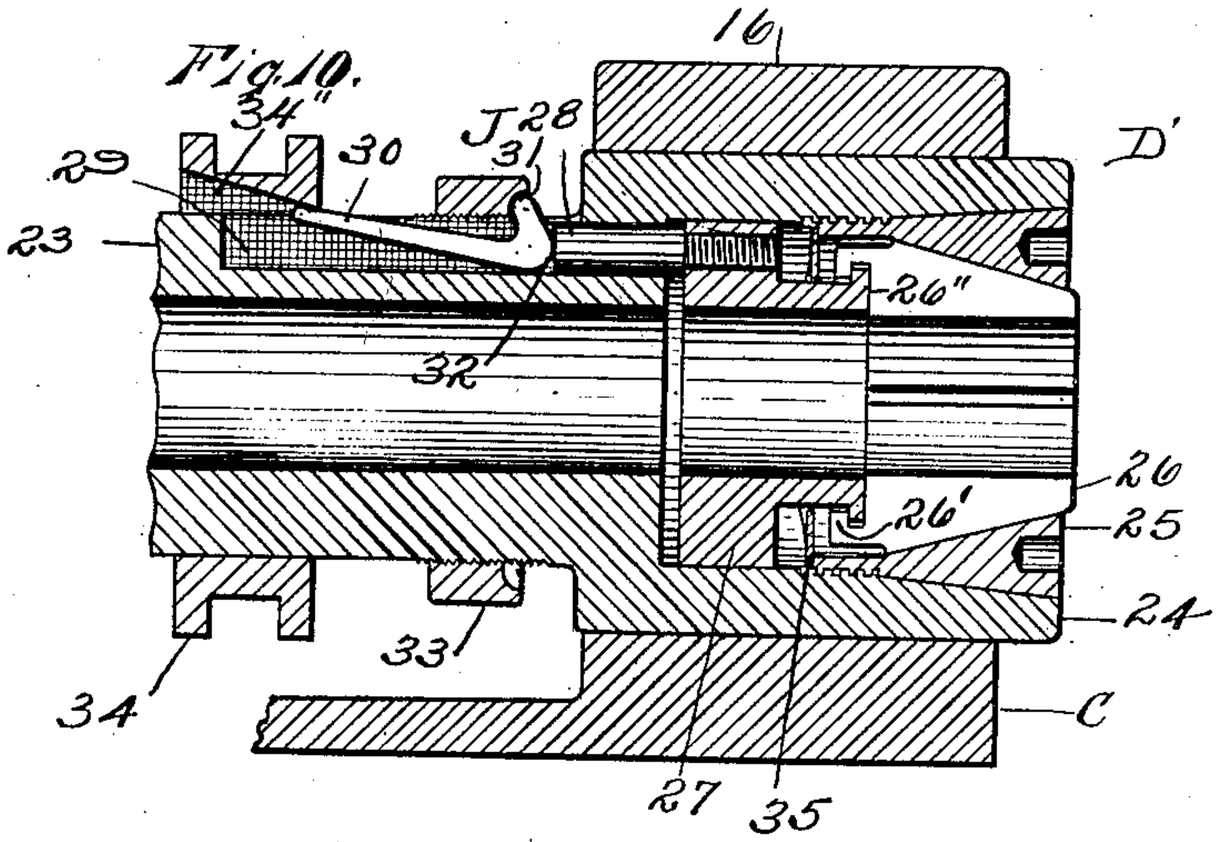


Fig. 11.

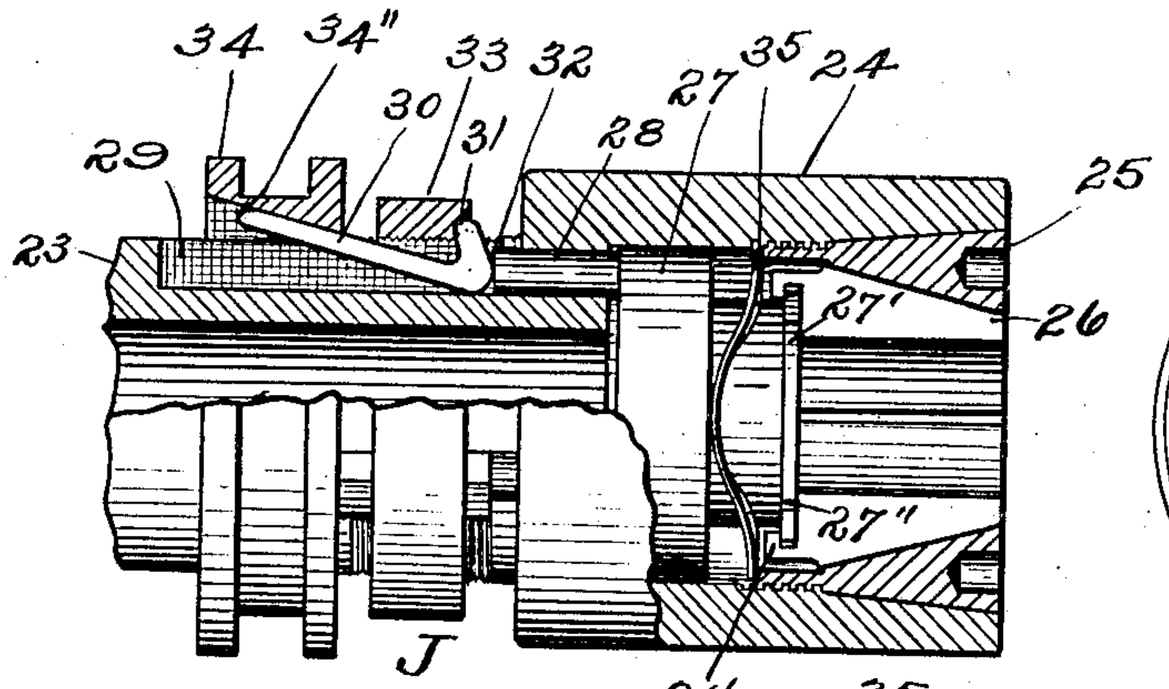
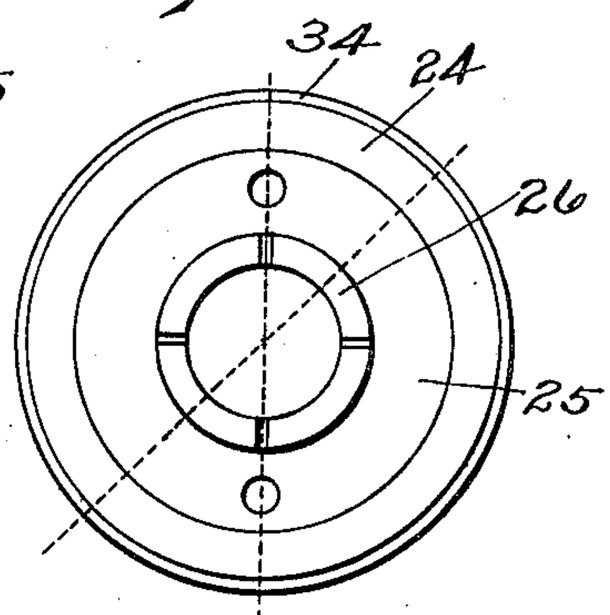


Fig. 12.



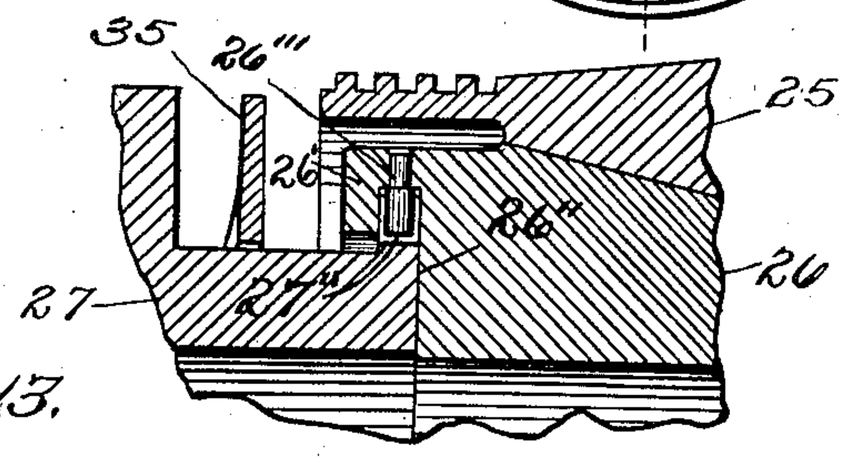


Fig. 13.

Witnesses.

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Inventor.

Louis H. Blood,

by E. G. Whitney

his Attorney.

UNITED STATES PATENT OFFICE.

LOUIS H. BLOOD, OF HARTFORD, CONNECTICUT, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO THE BLOOD MACHINE COMPANY INCORPORATED, OF WINCHESTER, CONNECTICUT, A CORPORATION OF CONNECTICUT.

METAL-WORKING MACHINE.

No. 876,932. Specification of Letters Patent. Patented Jan. 21, 1908.

Application filed April 6, 1900. Serial No. 11,741.

To all whom it may concern:

Be it known that I, LOUIS H. BLOOD, a citizen of the United States of America, and a resident of the city and county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Metal-Working Machines, of which the following is a specification.

This invention relates to that class of metal-working machines commonly known as "turret-lathes" or "single spindle" screw machines.

An object of the present invention is to furnish a metal-working machine of improved, simplified and efficient construction and organization embodying a rotative work-holder and a rotative mutiplex tool-holder having parallel axes in a common vertical plane, and one of which is disposed wholly below the other; means for advancing and retracting one holder with respect to the other; and improved adjustable stopping instrumentalities for limiting and varying successive advancing movements of one holder with respect to the other.

A further object of this invention is to provide, in a machine of the class specified, a reciprocatory work-spindle carrier having an improved work-spindle or holder; improved turret mechanism including a turret having its axis disposed parallel to, and in the vertical plane of, the axis of the work-holder and having a plurality of work-holding faces disposed in planes tangent to a common arc concentric to the axis of the turret, and the turret being so located with respect to the work-holder that said faces will be brought, on successive rotative advancing movements of the turret, successively into tangential relation with an arc concentric to the axis of said work-holder; improved turret-positioning and tool-stroke limiting means, including a bolt or abutment and independently adjustable stops or positioning-members coöperative with said bolt or abutment for limiting the extent of successive rotative movements of the turret and thereby limiting the working strokes of successive tools with respect to the work; and improved work-spindle rotating mechanism embodying means whereby said spindle may be constantly rotated during the advancing and retracting movements thereof and whereby the velocity of said spindle may be arbitrarily changed without interrupting the reciprocatory movements of its carrier.

With these objects in view the invention consists in the incorporation, in a machine of the class specified, of certain improved instrumentalities; in the particular coöperative organization of these instrumentalities; in the special construction and organization of the several parts of each improved elementary feature; and in the general coöperative organization of the parts of each elementary feature with respect to the parts of the other elementary features, substantially as hereinafter fully described and more particularly pointed out in the claims.

In the drawings accompanying and forming part of this specification, Figure 1 is a plan view of a metal-working machine embodying this invention; Fig. 2 is a central longitudinal section of the metal-working machine taken on a line corresponding with the dotted line *x*—*x* in Fig. 1, the multiplex stop-device which limits successive advancing movements of the work-spindle carrier with respect to the turret being shown in this figure as fixed to the spindle of the turret at the rear end of the machine, and the turret-positioning and tool-stroke-limiting means, which in this figure shown partly in dotted lines, being located at the forward end of the machine and partly within the turret. Fig. 3 is a rear end elevation of the machine shown in Figs. 1 and 2, with a portion of the framework broken away to show parts of the spindle driving mechanism; Fig. 4 is a front end elevation of said machine, as seen from the right in Fig. 1, with a portion of the end wall of the framework broken away and with a portion of the turret and turret rotating means in vertical section, whereby to more clearly illustrate certain details; Fig. 5 is a central longitudinal vertical section, partly in elevation, of the metal-working machine, showing a modified construction and organization of turret and tool-positioning means and spindle-carrier stopping means, the former of which is located at the rear end of the machine and the latter of which is shown located at the forward end of the machine and in direct connection with the turret proper; Fig. 6 is an enlarged vertical cross-section of the work-spindle carrier, work-spindle, a portion of the work-

spindle rotating means, and a portion of the bed of the machine, said section being taken on a line corresponding with the dotted line *y*—*y* in Fig. 2 and showing those parts at the right of said line, certain elements being omitted; Fig. 7 is an enlarged cross-sectional view of the multiplex stopping device shown in Figs. 1 and 2, this figure showing the stop carrier, the spindle on which it is mounted, the adjustable stops, and the adjusting screws in connection with said stops; Fig. 8 is a front view of a portion of the turret and of the machine showing the turret and a tool on said turret in their proper relation to a piece of work carried by the work-spindle; Fig. 9 is a graphical diagram illustrating the paths of movements and successive effective working positions of the cutting edge of the tool with respect to the axis of work; and the concentric path and successive positions (corresponding to the path and successive positions of the cutting point of the tool) of one stop abutment or positioning-member which determines the extent of effective rotation of the turret and consequently limits the working stroke of the tool. Figs. 10, 11, 12 and 13 are enlarged details of the chuck instrumentalities. Fig. 14 is a detail showing the second worm of the change-speed device, this worm having a different pitch from the first worm, shown in Fig. 6.

Similar characters refer to like parts in all the figures in the drawings.

The metal-working machine, in the preferred construction and organization thereof shown in the accompanying drawings, comprises a suitable framework consisting of a base A and a bed B, the latter of which has longitudinal slide-ways of usual construction; a work-spindle carrier C supported in said slide-ways for reciprocatory movements longitudinally of the bed of the machine; reciprocating means (designated by C′) for said carrier; work-holding and rotating means consisting of a work-spindle or holder D supported for rotative movements in bearings on the carrier and having a chuck D′ at the outer end thereof and driving mechanism (designated in a general way by E) in operative connection with the work-spindle; a rotative turret F supported in advance of the slide-ways of the bed and having its axis parallel to, and in the same vertical plane as, the axis of the work-spindle and having a plurality of tool-holding faces; turret rotating means (designated by F′) in connection with said turret; a mutiplex stop-device (designated in a general way by G) embodying a plurality of independently adjustable stops disposed substantially concentrically about a common axis and movable with the turret in a curved path intersecting an abutment on the work-spindle carrier whereby to limit successive advancing movements of said carrier with respect to the turret; and turret positioning and tool-stroke limiting means (designated by H) including a plurality of positioning-members or stops disposed concentrically about the axis of the turret and adjustable in a common arc with relation to each other and a reciprocatory lock-bolt or stop shiftable into the path of the positioning-members or stops and effective for limiting successive rotative movements of the turret and consequently the effective working-strokes of the tools.

The framework of the machine may be of any desired or suitable general construction for supporting the several mechanisms and consists of a base A and a bed B. The base A, in the preferred form shown in the accompanying drawings, is of box-like construction and is divided by a vertical transverse partition 3 into two compartments 4 and 5, respectively, the rear one, as 4, of which incloses portions of the spindle-driving mechanism and the front one as 5, of which, partly incloses the turret-mechanism and constitutes a receptacle for chips, oil, etc.

The bed B, which is shown supported upon the base A, consists of an oblong recessed main portion 6 having longitudinal slide-ways 7 and 8 to receive and support the work-spindle carrier, which slide-ways terminate at their forward ends substantially in vertical alinement with the forward face of the partition 3; and a horizontally disposed turret-supporting bearing 9 formed integral with the forward end of said bed and extending outward beyond the forward end of the slide-ways. This turret bearing which is preferred axially recessed, as at 10, has a conical outer face 12 tapered on lines which would intersect each other at a point in advance of said bearing, and which bearing also has an axially recessed transverse end wall, the recessed portion of which wall is preferably shouldered to form an abutment face for a wear-plate or ring 14 secured in said recess and extending outward beyond the face of said wall. It is desired to state in this connection that the construction of the turret supporting bearing 9 may be modified without departure from this invention so long as it constitutes an integral part of the bed B.

The work-spindle carrier C, which may be of any suitable general construction, is shown as a slide fitting the slide-ways on the bed of the machine and has work-spindle-supporting bearings 15 and 16 at opposite ends thereof. This carrier also has secured to the lower part thereof, preferably midway its width, a rack-bar 17, and also has a stop abutment 18 which, in the preferred form thereof shown in Fig. 2, is formed integral with, and extends downward from the rear end of, the rack-bar 17 in position to coöperate with stops as hereinafter described. The

work-spindle carrier reciprocating means C′ is shown as a pinion 19 meshing with the rack 17 and fixed to the shaft 20 (see Fig. 3) journaled in a transverse bearing 21 on the front side of the bed of the machine; and a hand-wheel 22 fixed to the outer end of said shaft. In the above connection it is desired to say that any well known or suitable automatic means (not shown) may be provided for actuating the work-spindle carrier, and that the invention is not limited to the specific hand operated means shown in the accompanying drawings.

The work-holding and rotating means consists in the form thereof shown, of two cooperative mechanisms *i. e.*, the work-holder or spindle proper, which is designated in a general way by D, and has at the forward end thereof a chuck D′; and spindle-rotating mechanism, which is designated in a general way by E, and which is in operative connection with the work spindle. The work-spindle, which is practically a combined work-spindle and chuck in the form illustrated, consists of the main tubular portion 23 the rear end of which is supported in the rear bearing 15 of the carrier; an enlarged axially recessed chuck-head portion 24 located at the forward end thereof and supported the major portion of its length in the forward bearing 16 of said carrier. The internal face of the chuck-head or casing 24 of the spindle D is conically tapered from the extreme forward end to a point substantially midway the length of said head and is straight from this point to the rear transverse wall thereof. This head constitutes one element of the chuck D′, the other elements of said chuck consisting of an internally and externally tapered abutment-sleeve 25 fitting the conical recess of said head and preferably having a screw-threaded bearing therein; a plurality of work-grasping jaws, each designated by 26, supported within said head and having tapered outer faces coöperative with the internal tapered face of said abutment-sleeve; a thrust-member 27 supported between the rear ends of the jaws and rear wall of said head for reciprocatory movements and having a positive connection with all of said jaws, whereby upon advancing and retracting movements of said thrust-member the jaws will be concurrently advanced and retracted to close and open the same; and a thrust-member-actuator J in operative connection with said thrust-member and consisting, in the form shown in Figs. 2, 10 and 11, of a series of circumferentially disposed pins or projections 28 fixed to the rear end of the thrust-member and extending backward into longitudinal grooves 29 formed in the periphery of the body portion of the spindle, a plurality of cam-levers 30 fulcrumed at their forward ends as at 31 and each having a cam face 32 in bearing engagement with the rear end of a pin or projection 28; a fulcrum bearing 33 shown as a collar adjustably secured to the forward end of the tubular portion 23 of the spindle and having in the front face thereof an annular groove which forms a seat for the rounded fulcrum end of the cam-lever, a cam-lever-actuating collar 34 supported for reciprocatory movements on the body portion of the spindle in the rear of the head portion 24 and having an internal cam face 34″ operable, on retractive movements of said collar, for depressing the rearwardly and upwardly projecting arm of the cam-levers 30 whereby to impart to said levers a thrust-member-advancing movement, and a thrust-member-retracting device shown as a spring 35 disposed between the enlarged portion of the thrust-member and the rear ends of the abutment sleeve 25 and effective, on the forward movement of the collar 34, for imparting retractive jaw-releasing movements to said thrust-member 27. The thrust-member 27, which is shown somewhat in the nature of a collar, is diametrically reduced at its forward end and has at the extreme end of such reduced portion an annular flange 27′ of less diameter than the diameter of the main portion of said member, in which is formed, at proper relative circumferentially distances, a series of transverse guide-grooves or slots each of which is designated by 27″ and the work-grasping jaws have at their rear outer edges rearwardly and downwardly extending L-like projections 26′ which extend around the outer edge of the flange 27′ on the thrust-member and said jaws having vertical plane rear faces 26″ which bear against the end face of said thrust-member as will be readily understood by reference to Figs. 10, 11 and 13 of the drawings, whereby said jaws are held as against longitudinal movement with respect to said member.

As a convenient means for holding the jaws in their proper relation circumferentially, each jaw is shown provided with a radially disposed pin 26‴ which enters a groove 27″ in the flange 27′ of the thrust-member as clearly shown in Fig. 13. This construction and organization of jaws and thrust-member insures a positive longitudinal movement of said jaws with their work-grasping faces in parallel lines and prevents accidental displacement of said jaws circumferentially with relation to one another. Furthermore it will be noticed that as the jaws are substantially wholly located within the head 24, and as the head is supported the major portion of its length in the bearing 16 all the lateral impact or stress exerted by the tool in operating upon the work is concentrated within, and is resisted by, the bearing 16, which positively prevents lateral distortions or disalinement of the chuck-jaws as frequently occurs in well-known machines in which the chuck proper grasps the work considerably in ad-

vance of the spindle bearing. The cam-lever-actuating sleeve or collar 34 is circumferentially grooved and is shown operated by a shifting-lever 34′ pivotally supported on the work spindle carrier and having a strap at the inner end engaging in said groove.

The work-spindle rotating mechanism, which in the preferred form thereof shown most clearly in Figs. 1 to 5 inclusive, embodies instrumentalities for varying the speed of the spindle and which may hereinafter be referred to either as the "differential-speed spindle-actuating mechanism" or "spindle-actuating mechanism", comprises two worm-wheels 36 and 37, respectively, of different pitches, rotatably mounted upon the spindle D between the bearings 15 and 16 and which practically constitute loose clutch-members, each having clutch elements on the inner face thereof; a shiftable pin-clutch or clutch-member 38 splined to the spindle for reciprocatory movements between the two loose clutch-members or worm-wheels; an actuating lever 39 pivotally supported on the carrier and having means in operative engagement with the shiftable clutch-member; two worms 40 and 41 of different pitches meshing, respectively, with the worm-wheels 36 and 37 and having their shafts journaled in horizontal bearings on the carrier; two band-wheels or sheaves 42 and 43 fixed to the shafts of the worms 40 and 41, respectively; an idle band-wheel 44 pivotally supported on the carrier below and intermediate the band-wheels 42 and 43 (shown in dotted lines in Fig. 2); a counter-shaft 45 journaled in transverse bearings in the base A within the chamber 4 and having a band-wheel or sheave 46 and a cone pulley 47 fixed thereto; a band 48 extending around the sheave 46 on the counter-shaft, over sheave 42, under the idle band-wheel 44 and over the sheave 43; an oscillatory tension device (designated in a general way by K) in operative connection with said band 48 and effective for retaining the same taut during the reciprocatory movements of the work-spindle carrier irrespective of variation in the distances between the sheaves on said carrier and the sheaves 46 on the counter-shaft and which tension device preferably includes a weight 49 pivotally supported at 49′ on the side wall of the base and having at the free end thereof two idle-wheels 50 and 50′ in bearing engagement with the two runs respectively, of the band 48, as will be readily understood by reference to Fig. 2 of the drawings; a driven shaft 51 journaled in transverse bearings on the base preferably in the same horizontal plane as the shaft 45 and having a cone pulley 52 the larger end of which is opposite the smaller end of the cone pulley 47; a belt 53 extending from the cone pulley 52 around the cone pulley 47; and a driven pulley 54 fixed to one end of the shaft 51 and which may be driven from any suitable source of power.

It will be obvious that the differential-speed spindle-actuating mechanism may be variously modified within the purview of this invention, and that the tension device K, practically constituting an element of said actuating mechanism, is also subject to some modification without departing from this invention.

The turret or work-holder F is supported for rotative movements on the turret bearing 9, and, in the preferred form thereof shown in Figs. 1 and 2 of the drawings has a conical inner face fitting the external conical face of said bearing, and has the outer end thereof closed by a wall 55. The contour of the tool-holding face of the turret is in the nature of an equilateral polygon, the outer face of said turret being composed of a plural number of plane work-holding faces (each designated by 57) disposed tangent to a common arc concentric to the axis of said turret, and each having one or more longitudinal T-grooves 58 formed therein whereby tools, such as T, may be secured thereto. This turret F is located with its tool-holding faces wholly below the axis of the work-spindle and has its axis in parallelism with, and in the same vertical plane as, said spindle axis, whereby on successive rotative movements of the turret the work-holding faces will be brought successively into tangential relation with an arc which is concentric to the axis of said work-spindle. As a means for holding the turret upon, and against movement longitudinally of, the turret bearing there is provided a turret-holding spindle 59 which extends the entire length of the bed B, is journaled at its rear end in a bearing in the rear wall of the bed, and extends at its forward end through adjacent end walls of the turret bearing and turret, it being in the organization shown in Fig. 2, provided at this end with a nut which bears against the outer face of the end wall of the turret, and is shouldered at a point in the rear of said end wall, as at 60, to bear against a T-bushing or collar 61 interposed between the wear-plate or ring 14 and the reduced end of the spindle. The turret-rotating means, in the form shown in the accompanying drawings, comprises a worm-wheel 56 preferably formed integral with the front end wall of the turret; a worm 62 meshing with said worm-wheel and having a shaft 62′ journaled for a portion of its length in an elongated bearing 63 having at the inner end thereof an internally channeled ring 64 surrounding and covering the periphery of the worm-wheel 56, and which shaft 62′ is supported at its outer end in a bearing 65 on the front wall of the chamber 5 of the framework and is also provided with a hand-wheel 66 whereby the

same may be rotated to impart rotative movements to the turret.

The multiplex stop-device (designated in a general way by G) which controls successive advancing movements of the work-spindle carrier with respect to the turret comprises, generically, a plurality of stops each of which is designated by *s*, and all of which are disposed substantially concentric about the axis of the turret and are connected to said turret for movement concurrently therewith in a circular path intersecting the path of the abutment 18 on the work-spindle carrier, and each of said stops is constructed and organized for independent adjustment in a line parallel to the axis of the turret spindle 59. In the specific form shown in Figs. 1, 2 and 7, the multiplex stop-device consists of a stop carrier 67 fixed to the turret spindle 59 near the rear end of the machine and below the work-spindle carrier, and having a plurality of longitudinal stop-guiding grooves 68 formed in, and substantially equidistant about, the periphery thereof; a plurality of stops *s* having projections fitting said groove and supported for longitudinal movements therein; and independent adjustable means for each stop consisting of an adjusting screw or screw-rod 69 journaled for rotation in a bearing formed in a flange at the rear end of said stop-carrier and having a screw-threaded bearing in the stop, said screw having at the outer end thereof a head and which adjusting screws are normally held against rotative movement by means of a clamping device consisting of a clamp-plate 70 bearing against the heads of said screws, and a clamping collar 711 screwed upon the outer end of the spindle and bearing against said clamp-plate, as will be readily understood by reference to Fig. 2 of the drawings. In the specific form thereof shown in Fig. 5 of the drawing the mutiplex stop device G is shown as a plurality of stops *s'* having screw-threaded shanks bearing in screw-threaded openings in the outer end wall of the turret and disposed in an arc substantially concentric to the axis of the turret for orbital movements in a path intersecting the stop abutment on the work-spindle carrier, which stop abutment in this instance is shown as a rod or bar 18' extending forward beyond the front end of the carrier and adapted to enter the inner end of the turret and coöperate successively with the successive stops *s'* which limit successive advancing movements of said carrier.

It is desired to state in the above connection that the invention is not limted to the specific construction and organization of stop device shown in the drawings for determining the limit of successive advancing movements of the work-spindle carrier, as these may be modified within the purview of this invention so long as the coöperative relations between the stopping instrumentalities and the turret or turret-spindle are not departed from.

The stops *s* and *s'* are so disposed relatively to each other about the axis of the turret to have a fixed relation, circumferentially with the work-holding faces of the turret, the number of stops corresponding to the numbers of work-holding faces, whereby each stop will determine the advancing movement of the work-spindle with respect to a particular tool or to a particular work-holding face on the turret; and it will be understood by a comparison of the figures of the drawings that orbital movements are imparted to the stops concurrently with rotative movements of the turret and by the turret rotating means.

The turret-positioning and tool-stroke-limiting means, which is designated in a general way by H, comprises a plural number of positioning-members or stops 71 disposed substantially in the arc of a circle concentric to the axis of the turret and are connected to have orbital movements concurrent with the rotative movements of said turret and each positioning-member having a stop face 72 disposed in a plane substantially radial to the axis of the turret; and a coöperative bolt or stop-abutment 73 supported for reciprocatory movements in a fixture on the machine and shiftable into the path of the positioning-members; and independent means for actuating the bolt or stop-abutment.

In the preferred specific construction and organization thereof shown in Fig. 5 the turret-positioning and tool-stroke-limiting means consists of a disk or carrier 74 fixed to the rear end of the turret spindle and having in the periphery thereof a T-groove 75; a plurality of positioning-members 71 disposed about the periphery of the carrier for adjustment in a common arc with relation to each other and each having a stop face 72 as before stated; adjusting and holding means 76 shown as bolts in connection with each stop member and disk; a bolt or stop-abutment 73 supported for reciprocatory movements in a bearing on the bed B of the machine in parallelism to the axis of the turret spindle; a spring 78 for advancing the bolt and normally retaining the same with its working end in the path of the stop faces on the positioning-members; and a treadle mechanism for imparting retractive movements to said bolt and consisting of a treadle 79 and an actuating connector 80 between said treadle and bolt. The stops 71 are made adjustable in order that they may be located with precision and also shifted slightly to compensate for wear. As the faces of the bolts *s'* of the turret and the long screw-bolt 18' on the work-carriage are quite wide they permit each stopping point of the turret in the direction of its rotation to be varied slightly,

these variations being controlled by corresponding adjustments of the stops 71.

In the form thereof shown in Figs. 2 and 4 of the drawings the positioning-members are carried directly by the turret and equidistantly disposed about the axis thereof with their stop faces extending into the interior of said turret, and the stop bolt is supported for reciprocatory movement in the turret bearing with its top face normally located in position to coöperate with the stop face of the positioning-member, the bolt in this instance being retracted by a treadle through the medium of connecting instrumentalities, parts of which are located within the turret bearing. In these figures the turret-positioning and tool-stroke limiting means is designated by H′, the stops by 71′ and the bolt or stop-abutment by 73′. The stops 71′ are not adjustable about the turret axis.

The cutting tool T, which may be of any desired or suitable kind, according to the work it is to perform, and which may be secured to the tool-holding face of the turret F in the manner illustrated, for instance, in Fig. 8, and as indicated in the graphical diagram Fig. 9 has a working stroke; in the arc of a circle the cutting point thereof describing throughout the working stroke thereof an arc which is preferably concentric to the axis of the turret or holder and substantially intersects the axis of the work on which said tool is operating.

The graphical diagram Fig. 9 fully illustrates the relative movements of the turret F; tool T; and turret-positioning and tool-stroke-limiting means. In this figure the path described by the cutting edge of the tool is indicated by the upper curved line *h*—*h* which intersects the axis *f* of the work represented at W; the tool is represented at T with its point at its starting position indicated at *a*, or in juxtaposition to the periphery to the work W the successive cutting positions of the tool being indicated at *b*, *c*, *d*, *e*, and *f* respectively, the length of that portion of the arc *h*—*h* between the positions indicated at *a* and *f* being the total distance through which the cutting edge of the tool travels in cutting off the piece of work W. The spaces between successive radial dotted lines extending from the turret axis indicated at 59, to the several points *a*, *b*, *c*, *d*, *e*, and *f*, respectively, on the curved line *h*—*h* indicate the distance through which successive parts of the turret and tool between said axis and the arc *h*—*h* travel while the cutting point of the tool advances from *a* to *f* in its working stroke. The curved line *i*—*i* indicates the path of the stop face 72 of one positioning-member 71 of the turret-positioning and tool-stroke-limiting means, and the little circles *a*′, *b*′, *c*′, *d*′, *e*′, and *f*′ indicate successive positions of said stop-face with relation to the stop bolt 73, corresponding to the successive positions *a*, *b*, *c*, *d*, *e*, and *f*, of the cutting point of the tool.

One of the tool-holding faces 57 of the turret F is shown in full lines in the graphical diagram Fig. 9 in the position it occupies when the cutting point of the tool T is in its initial cutting position indicated at *a* and an advanced position of the turret face 57 is further indicated by dotted lines (a position it occupies when the tool is at the end of its working stroke) at which time said face is tangent to the two arcs represented by the dotted lines *j*—*j* and *k*—*k* respectively, the former of which is concentric to the axis of the turret indicated at *g* and the latter of which is concentric to the axis *f* of the work W as will be readily understood by reference to this figure.

When it is desired to change the length of the cutting stroke of the tool; for instance if it is to travel only through that portion of the arc *h*—*h* located between the points *a* and *c* the positioning-member 71 will be set with its stop face 72 intersecting the point *d*′ so that when the cutting point of the tool has arrived at *c* in its working stroke the stop face 72 will have arrived at *f*′ and be arrested in its further movement by the coöperating face of the bolt or stop-abutment 73.

1. In a metal-working machine, the combination with a work-spindle supported for rotative and reciprocatory movements and having a point of support shiftable to a position over and in the plane of the turret, of means for actuating said spindle; and a rotative turret supported in advance of and adjacent to the spindle with its axis in parallelism to, and below, the axis of said spindle and held as against straight-line movements and having a plurality of tool-holding faces disposed in planes tangent to a common arc concentric to the axis of said turret.

2. In a metal working machine, the combination with a rotary work-holder and a rotary multiplex tool-holder having substantially parallel axes, and with means for reciprocating one holder relatively to the other, of a multiplex stopping device comprising a plurality of equidistant independently-adjustable stops concentric with the axis of said multiplex holder and rigid means of connection between said stopping device and multiplex holder; means for simultaneously moving the multiplex holder and its stops in concentric arcs; and a stop abutment on the other holder in position to coöperate with said stops.

3. A metal-working machine including two parallel spindles disposed with their axes in a common vertical plane and one of which spindles is fixed longitudinally and the other of which is supported for longitudinal movement; a turret fixed to one spindle and wholly supported below the axis of the other spindle and having a plurality of plane tool-

holding faces disposed to be brought successively into tangential relation to an arc concentric to the axis of the other spindle; means for rotating the turret and fixed spindle; means for actuating the other spindle; and means, including a lock-bolt, and a series of positioning members coöperative with said lock-bolt and adjustable in a common arc concentric to the axis of the fixed spindle, for limiting successive rotative movements of said spindle.

4. In a metal-working machine, the combination with two parallel spindles having their axis in a common vertical plane and one of which spindles is fixed longitudinally and other of which is supported for longitudinal movement; of a turret fixed to one spindle and wholly supported below the axis of the other spindle adjacent to the work-holding end of the latter and having a plurality of plane tool-holding faces in position to be brought successively into tangential relation to an arc concentric to the axis of the other spindle; means for rotating the turret and fixed spindle; means for actuating the other spindle; a plurality of stops corresponding in number to the number of tool-holding faces carried by and disposed in substantially concentric relation to the turret spindle; and a fixture carried with the other spindle arranged to coöperate with said stops for limiting the longitudinal movements of one spindle with respect to the other.

5. In a metal-working machine, the combination with a rotative work-holder supported for longitudinal movements and a rotative tool-holder, the latter of which has a plurality of working faces and is held as against longitudinal movement, and with means for retracting and advancing the work-holder, of a plurality of independently-adjustable stops disposed equidistantly in a common arc about the axis of the tool-holder; a stop abutment disposed on the work-holder in position to coöperate with said stops successively, whereby to limit the advancing movements of said holder; means for adjusting said stops longitudinally of the axis of the tool-holder; and actuating means in connection with the tool-holder and effective for imparting corresponding rotative movements in concentric arcs to said holder and stops concurrently, whereby to bring said stops successively into coöperative relation with said stop abutment.

6. A metal-working machine including a turret having means for securing thereto a plurality of tools and having a plurality of independently-adjustable stops one for each tool disposed about the axis of, and fixedly connected with, said turret; means for imparting concurrent rotative movements to said turret and stops; a work-spindle carrier supported for reciprocatory movements with relation to the turret and having a stop abutment coöperative with the stops successively whereby to limit the movement of said carrier with respect to the turret; means for reciprocating said carrier; a work-spindle mounted for rotation in said carrier; means for rotating said spindle; and means for locking the turret at rest intermediate to intermittent rotations thereof and during the advancing movement of the work-spindle.

7. The combination with a work-spindle carrier supported for reciprocatory movements and having a stop abutment, and with means for reciprocating said carrier, of a turret having a plurality of tools, a plurality of stops corresponding in number to the number of tools disposed about the axis of, and rotatable with, said turret and located in a common arc intersecting the path of the stop abutment; means for adjusting the stops independently in the direction of travel of the work-spindle carrier, and rotating means in connection with the turret.

8. The combination with a work-spindle carrier supported for reciprocatory movements and having a stop abutment, and with actuating means therefor, of a turret, a multiplex stop device supported for rotative movements below said carrier with its axis in parallelism with that of the work-spindle and having a plurality of stops connected with said turret and disposed to be brought independently into the path of said stop abutment, and also having means for adjusting each stop independently in the direction of movement of said carrier, whereby the limit of the working strokes of the carrier may be arbitrarily varied.

9. In a metal-working machine, the combination with the framework, of a bed having longitudinal slideways; a horizontal externally-tapered bearing formed integral with said bed in advance of said slideways and having an axially recessed outer end wall; an externally threaded annular wear-plate screwed into the recess of the end wall of the bearing and having its outer face disposed slightly in advance of the outer face of said end wall; an internally-tapered turret surrounding and fitting said bearing and having the inner face of its end wall in bearing engagement with the outer face of the wear-plate; a flanged bearing collar coöperative with the wear-plate and end wall of the turret; a shouldered spindle extending through the collar and end wall of the turret and having a nut at the outer end whereby to draw the shoulder of said spindle in engagement with the inner face of the collar and hold the turret against displacement longitudinally of the axis of said bearing; and rotating means in connection with said turret.

10. In a metal-working machine, the combination with a bed having a slideway, of a horizontally disposed conical bearing formed integral with said bed and extending beyond

the end of said slideway and also having a centrally recessed outer end wall at the smaller end of the cone; a centrally recessed turret mounted for rotation on the turret bearing and having its inner face beveled to fit said bearing and also having an end wall in juxtaposition with the end wall of said bearing; a wear-plate disposed between the end walls of the bearing and turret; and means for rotating said turret.

11. In a metal-working machine, the combination with a bed, of a work-spindle carrier supported for reciprocatory movements on said bed; means for reciprocating said carrier; a work-spindle journaled in bearings on said carrier; and differential-speed actuating mechanism in operative connection with the work-spindle and embodying means whereby the rotative velocity of said spindle may be arbitrarily changed, and also involving a plurality of band-connected sheaves and an oscillatory weighted tension device in operative connection with the band and effective for holding the same taut irrespective of the changes in position of the work-spindle carrier.

12. In a metal-working machine, the combination with a work-spindle carrier supported for reciprocatory movements and with carrier-reciprocating means, of a work-spindle rotatably supported in said carrier; two loose clutch members journaled on said spindle for rotation with respect thereto and including respectively, a high-speed and a low-speed worm-wheel; a fast clutch member splined to the spindle between said loose clutch members; means for shifting the fast clutch member into operative engagement with one or the other loose clutch members arbitrarily; two worms meshing, respectively, with the worm-wheels of the loose clutch members and journaled in bearings on the spindle-carrier; and continuously operative worm-rotating means including a plurality of band-connected sheaves, and a weighted tension device in operative connection with the band and effective for holding the same taut irrespective of changes in position of the work-spindle carrier.

13. In a metal-working machine, the combination with a work-spindle carrier supported for reciprocatory movements, and with a work-spindle supported for rotation by said carrier, of differential-speed spindle-actuating mechanism in operative connection with said spindle and consisting of a worm-wheel on said spindle; a worm meshing with said worm-wheel and journaled in bearings on the carrier and having a sheave or band-wheel fixed thereto; means for actuating said counter shaft; a band extending around both band-wheels; and one or more idlers engaging said band intermediate the two band-wheels and adapted for holding the band taut irrespective of the position of one band-wheel with respect to the other, as determined by changes in positions of the work-spindle carrier.

14. In a metal-working machine, the combination with a reciprocatory carrier and with actuating means therefor, of a rotative work-spindle supported in said carrier; and continuously operative rotating means in connection with said spindle and including two rotative sheaves one mounted on the carrier and one mounted on the framework; a band connecting said sheaves; and a shiftable tension device in connection with said band.

15. In a metal-working machine, the combination with a work-spindle carrier and with means for reciprocating said carrier; of a work-spindle rotatably mounted in said carrier; and rotating mechanism for said work-spindle consisting of a worm-wheel in connection with said spindle; a worm meshing with said worm-wheel and having its shaft journaled in bearings on the carrier and having a sheave fixed thereto; a counter shaft journaled in the framework and having a sheave; means for driving the counter shaft; a band extending around and operatively connecting the two sheaves; an oscillatory weight pivotally supported at one end on the frame and having at the free end thereof two idle wheels in engagement, respectively, with the two runs of the band, said weight and idlers constituting a tension device for the band and holding the same taut during reciprocatory movements of the carrier.

16. In a metal-working machine, the combination with a rotative turret, and with actuating means therefor, of a work-spindle carrier supported for movements towards and away from said turret; means for reciprocating said carrier; a work-spindle rotatably mounted in said carrier; and continuously effective rotating means in operative connection with said work-spindle and embodying a plurality of band-connected sheaves, and an oscillatory weighted tension device having one or more idle-wheels in connection with the band and effective for holding the same taut irrespective of changes in positions of the work-spindle carrier.

17. In a metal-working machine, the combination with a reciprocatory work-spindle carrier and with actuating means therefor, of a work-spindle supported for rotation in said carrier; two worm-wheels of different pitches loosely mounted for rotation upon said spindle and having adjacent clutch faces; a clutch splined to said spindle between the two clutch faces of the worm-wheels; means for reciprocating said clutch whereby to clutch one or the other worm-wheel to the spindle; two worms of different pitches meshing, respectively, with said worm-wheels and having their shafts journaled in bearings on the carrier; a sheave or band-wheel fixed to each worm-wheel shaft; an idle sheave rota-

tably supported on the carrier intermediate the other sheaves; a counter shaft journaled in the framework below the carrier and having a sheave fixed thereto; a band extending around the counter shaft-sheave and over and under successive sheaves on the carrier; a shiftable tension device in connection with the runs of the band and effective for retaining the same taut irrespective of changes in positions of the carrier; and means for rotating the counter shaft.

18. In a metal-working machine, the combination with a turret having a plurality of tool-holding faces, of a plurality of lock-bolt receiving members corresponding in number to the number of the tool-holding faces, and adjustably supported for rotation with said turret; means for independently adjusting said members in a common arc concentric to the turret axis; a lock-bolt supported for reciprocatory movements in a fixed bearing on the machine in position for entering the receiving members successively on rotative movements of the turret; means for actuating the lock-bolt; and means for imparting rotative movement to said turret.

19. In a metal-working machine, the combination with a rotative turret, of a plurality of turret-positioning members revoluble with the turret in a common arc concentric to the axis thereof, and each having a lock-notch and also embodying means whereby the same may be adjusted in said arc with respect to the other members; a turret locking-bolt supported for reciprocatory movements parallel to the axis of the turret and in position to successively engage in the lock-notches of the positioning members; and means for imparting rotative movements to said turret to bring the lock-notches of the positioning members successively into register with the lock-bolt.

20. In a metal-working machine, the combination with a rotative turret, of a spring-advanced bolt supported for reciprocatory movements parallel to the axis of said turret; a plurality of positioning-members revoluble in a common arc concentric to the axis of said turret and each having a locking face coöperative with the lock-bolt; means for independently adjusting the positioning-members with respect to one another in said common arc; means for rotating said turret to bring the locking faces of the positioning-members successively into coöperative relation with the lock-bolt; and retracting means for the lock bolt.

21. In a metal-working machine, the combination with a rotative turret, of a spring-advanced lock-bolt supported for reciprocatory movements parallel to the axis of the turret; a plurality of positioning-members revoluble with said turret in a common arc concentric to the axis thereof and each having a locking face coöperative with the lock-bolt; independent means for adjusting each positioning member with respect to the others in said common arc; means for rotating said turret to bring the locking faces of the positioning-members successively into coöperative relation with the lock-bolt; retracting means for the lock-bolt; a plurality of stops disposed to revolve about the common axis of, and with, the turret and turret-positioning members; independent means for adjusting each stop longitudinally of said axis; a work-spindle carrier supported for reciprocatory movements and having a stop abutment coöperative with said stops; and means for reciprocating said carrier.

22. In a metal-working machine, the combination with the bed thereof, of a work-spindle carrier supported on said bed for reciprocatory movements and having a centrally disposed rack on the under side thereof and also having a stop abutment; a plurality of stops disposed substantially equi-distantly about a common axis and located in a common arc intersecting the path of the stop abutment; means for revolving the stops about their common axis to bring them successively into coöperative relation with the stop abutment on the carrier; a transversely disposed shaft having bearings in the bed and having a pinion meshing with the rack; and means for rotating the pinion-shaft to advance and retract the carrier.

23. In a metal-working machine, the combination with the bed thereof, of a reciprocatory work-spindle carrier mounted on said bed and having a stop abutment and also having means for rotating a work-spindle; reciprocating means for said carrier; a spindle supported for rotative movements below, and extending longitudinally of, said carrier and held against longitudinal movement; a plurality of independently-adjustable stops supported substantially equi-distantly about the axis of the spindle and orbitally movable in a path intersecting the path of the stop abutment; and means for rotating said spindle to bring said stops successively into the path of the stop abutment and limit the successive advancing movements of the carrier.

24. The combination with work-holding and rotating means, of a rotative turret; a tool mounted on said turret for movement in the arc of the circle intersecting the arc of the work; means for advancing the turret and tool in the arc of a circle to bring the tool to an approximate working position and for subsequently advancing the tool in the arc of a circle throughout its working stroke; and adjustable means in connection with the turret for limiting the working stroke of the tool.

25. The combination with a longitudinally movable rotative work-holder, of a bed

having a fixed turret-bearing embodied therein and located under said work-holder, a turret supported by said turret-bearing and held against endwise movement, and means for turning said turret.

26. The combination with a work-spindle and its carrier the latter of which has a stop, of means for reciprocating said carrier, a turret having its axis parallel with that of the work-spindle, means for turning said turret, and a plurality of stops movable in unison with said turret and coöperative separately with said stop on the work-spindle carrier.

27. The combination with a work-spindle and its carrier the latter of which has a stop, of means for reciprocating said carrier, a turret having its axis parallel with that of the work-spindle, means for turning said turret, and a plurality of stops movable in unison with said turret and independently adjustable longitudinally of the axis of the turret and coöperative separately with said stop on the work-spindle carrier.

28. The combination with a work-spindle and with means for rotating the same, of a turret having its axis parallel to that of the work-spindle, means for turning said turret, a stop controlling the extent of rotation of said turret, and a plurality of stops movable in unison with said turret and located in the path of said first-mentioned stop and adjustable to different positions in said path.

Signed by me at Hartford, Conn. this 2nd day of April, 1900.

LOUIS H. BLOOD.

Witnesses:
M. H. FLYNN,
E. C. WHITNEY.