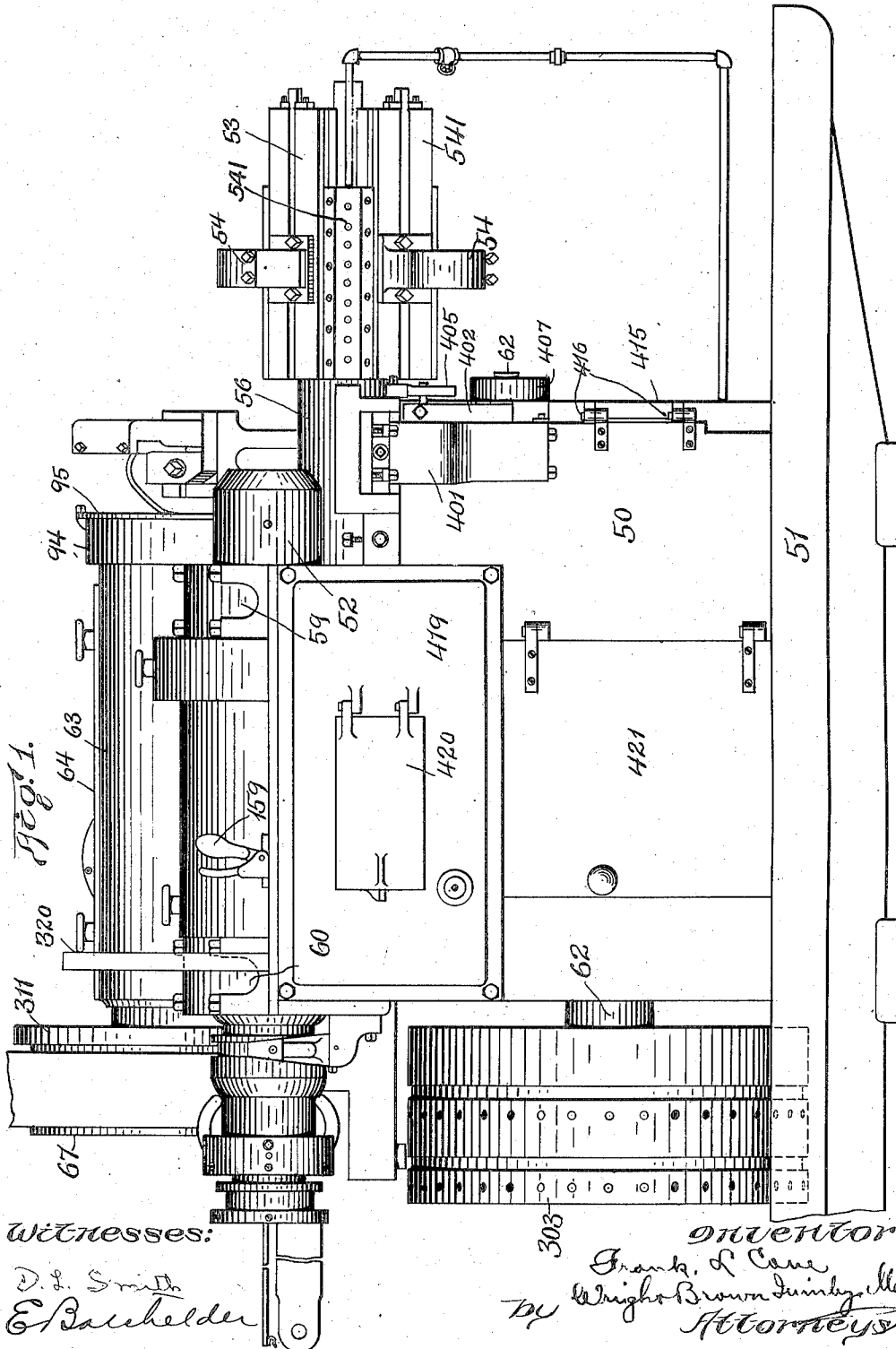


F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.

24 SHEETS—SHEET 1.



Witnesses:

D. L. Smith
E. Baeholder

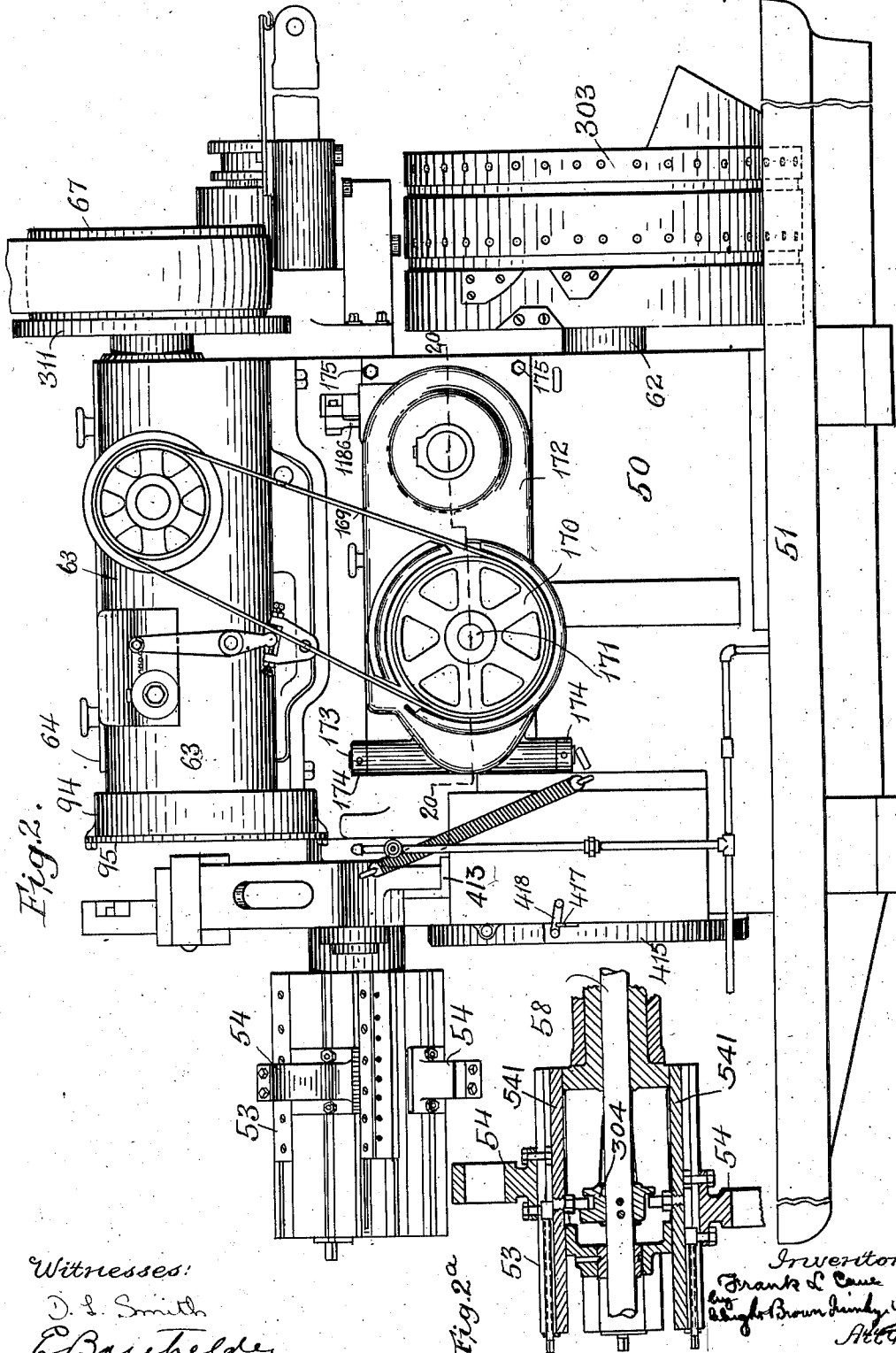
INVENTOR:

Frank L. Cone
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

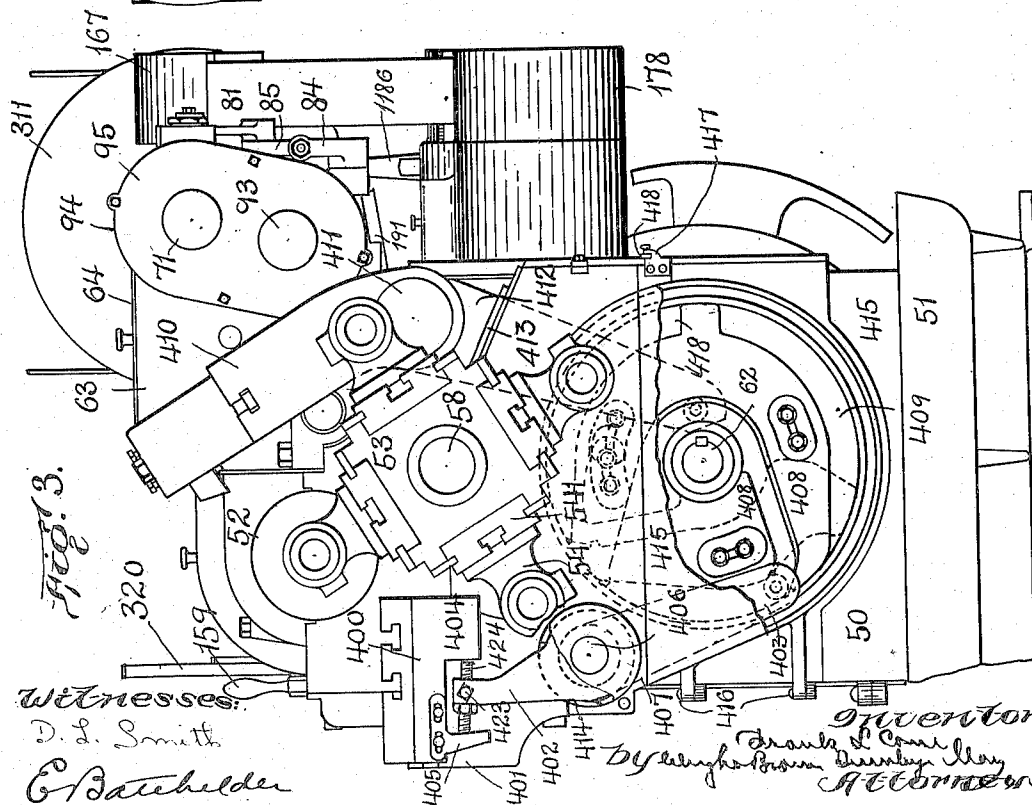
Patented May 6, 1919.
24 SHEETS—SHEET 2.



Witnesses:
J. S. Smith
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Inventor:
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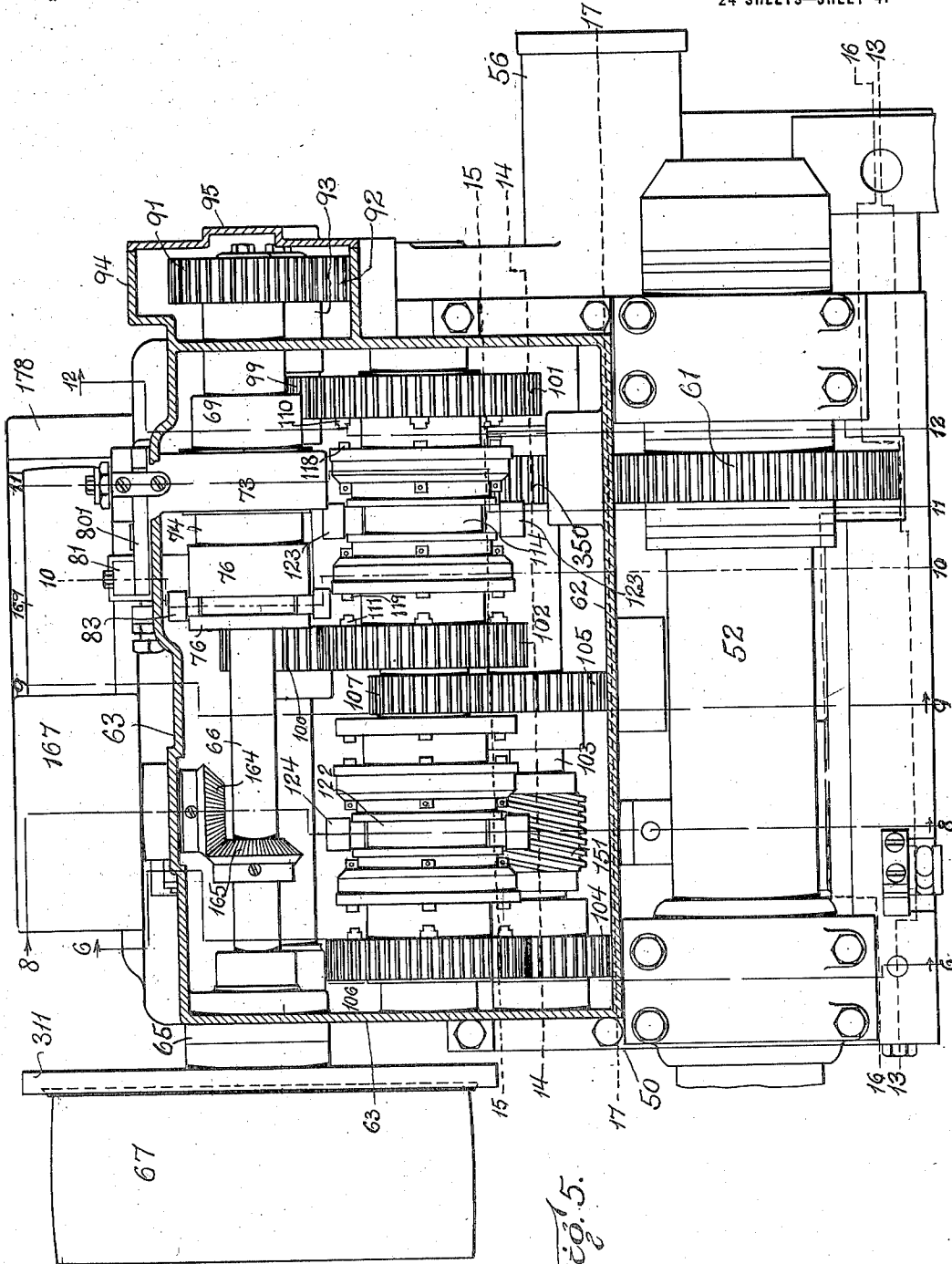
1,303,216.



F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 4.



Witnesses:

D. L. Smith

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Fig. 5.

Inventor:

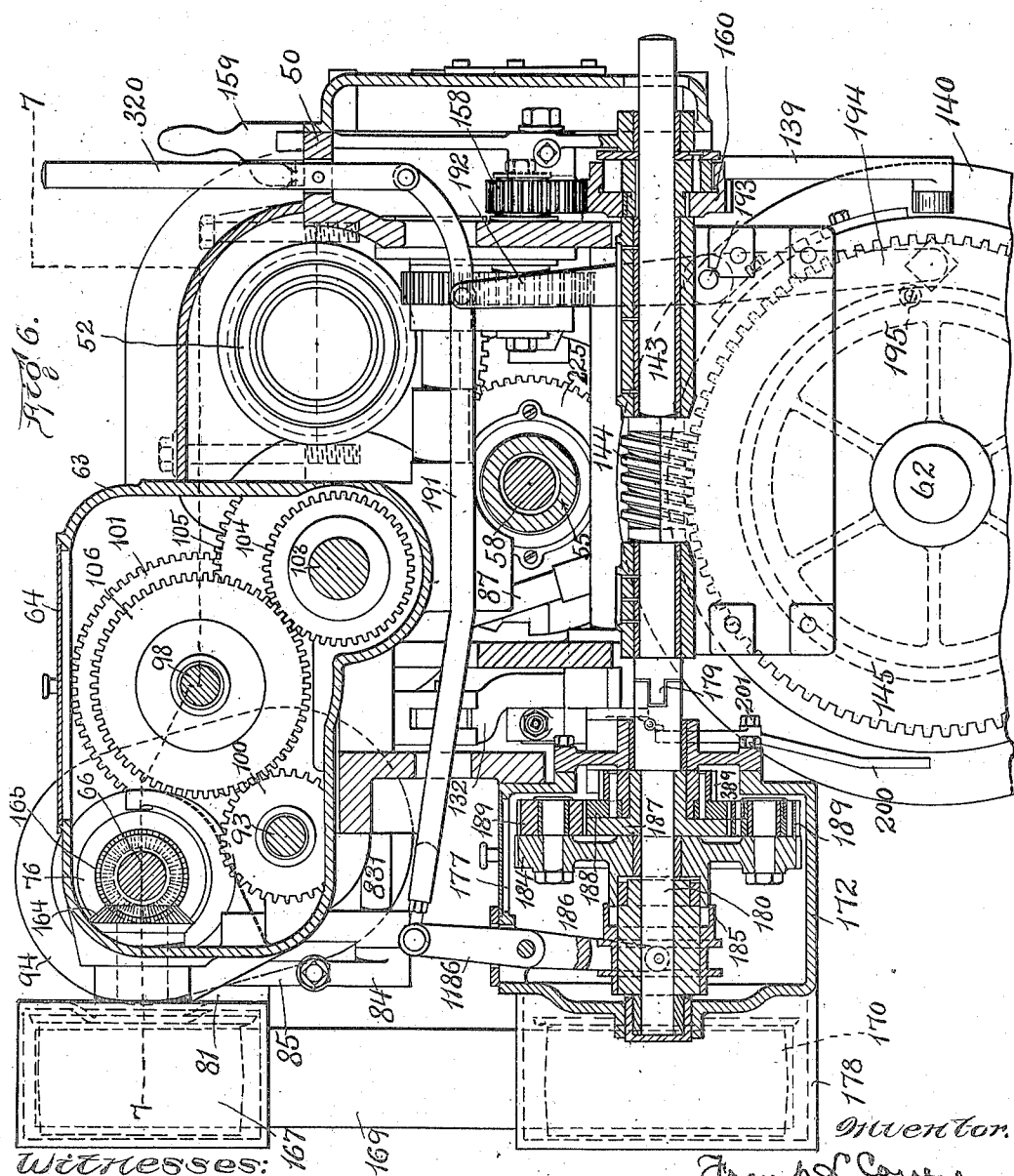
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
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1,303,216.

Patented May 6, 1919.
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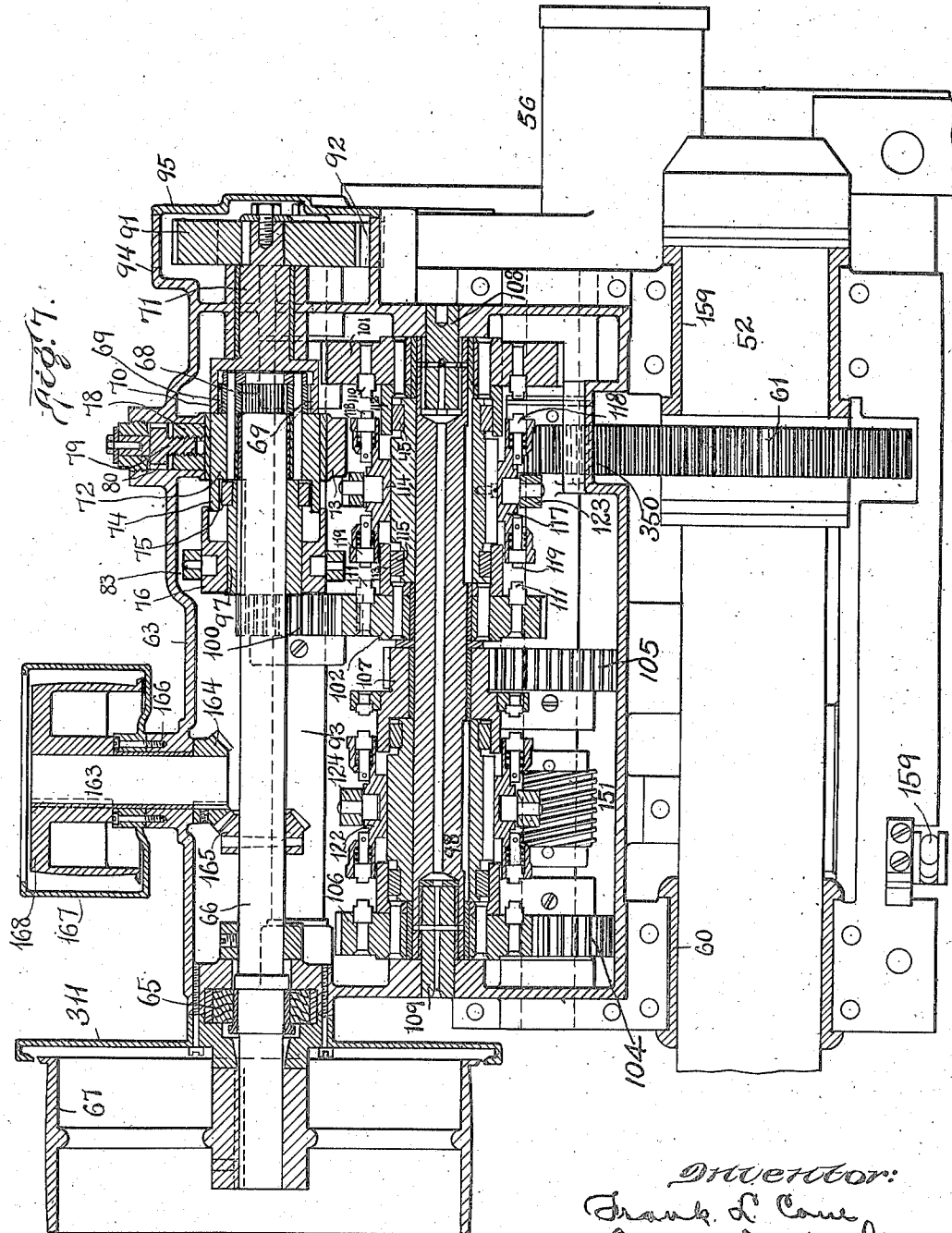
Witnesses:
D. L. Smith
E. Batchelder

Inventor:
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
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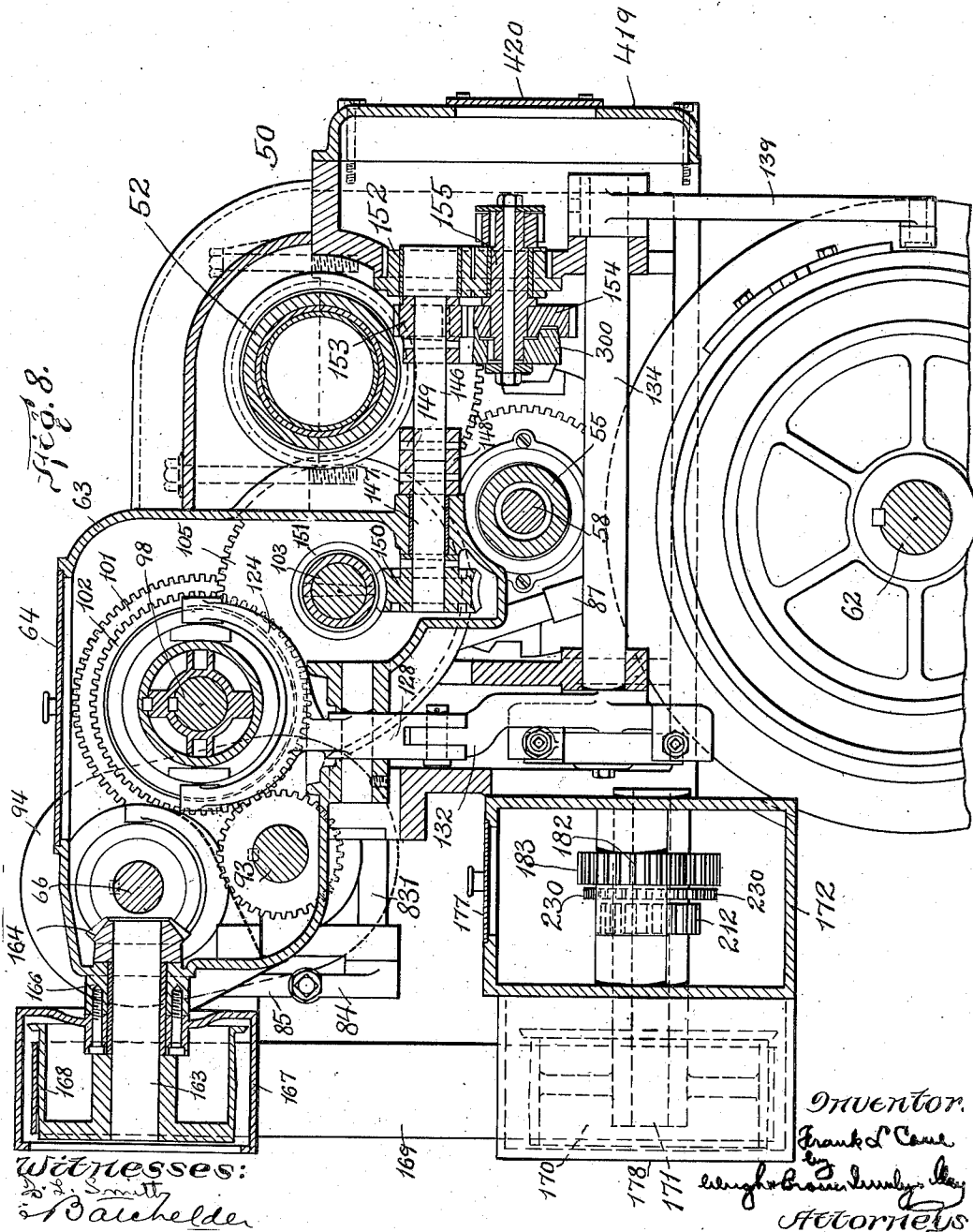
Witnesses:
D. L. Smith
E. B. Schelder

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Attorney

F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 7.



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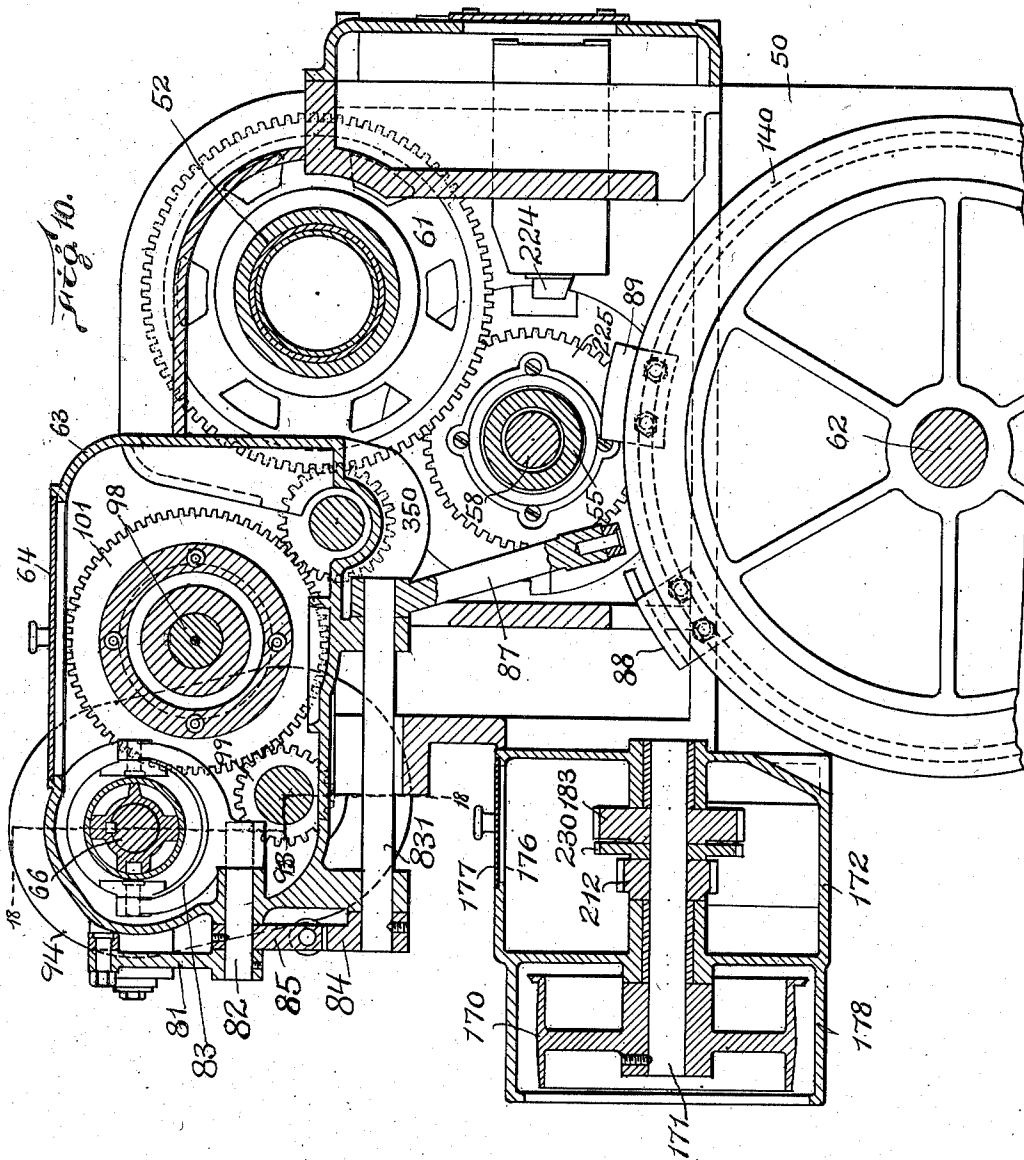
D. L. Smith
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
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1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 9.



Witnesses:

D. S. Smith
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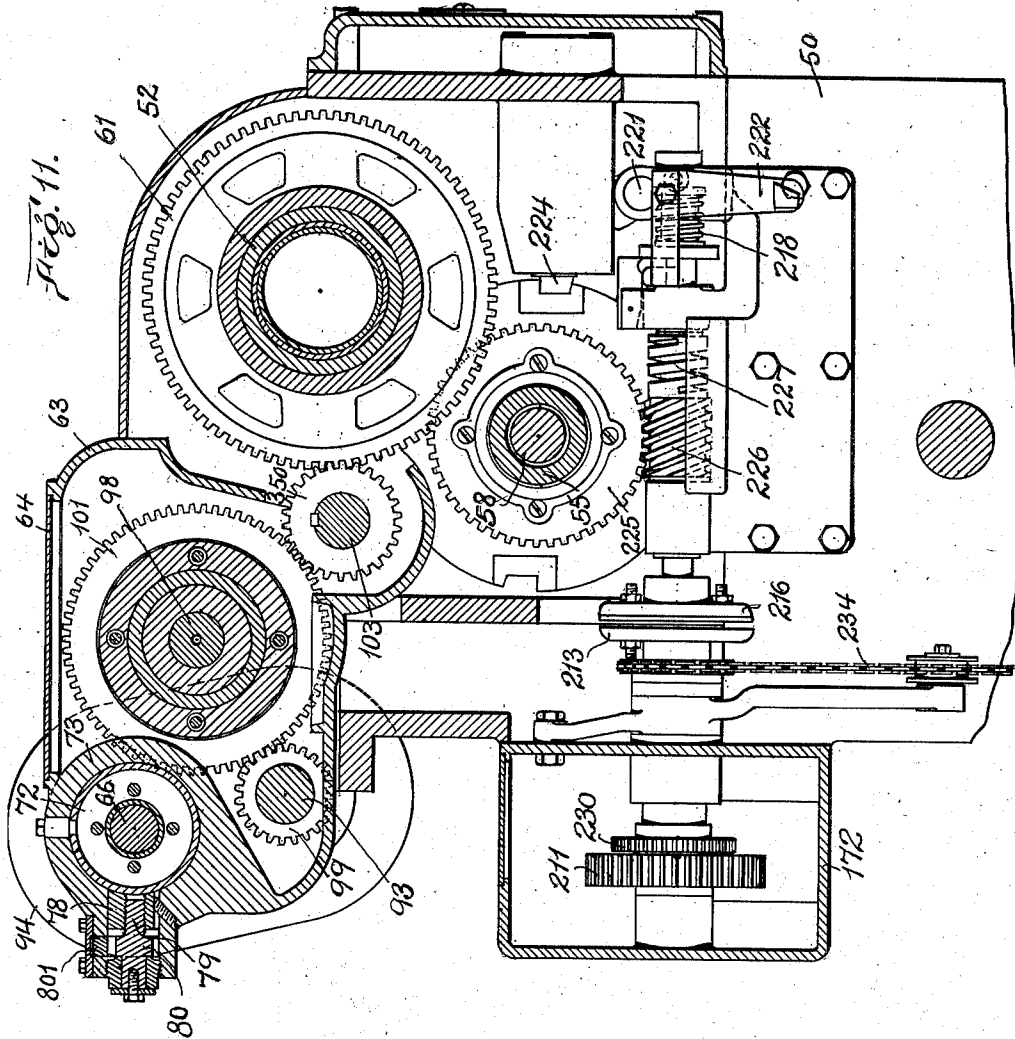
Inventor:

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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 10.



Witnesses:

D. I. Smith
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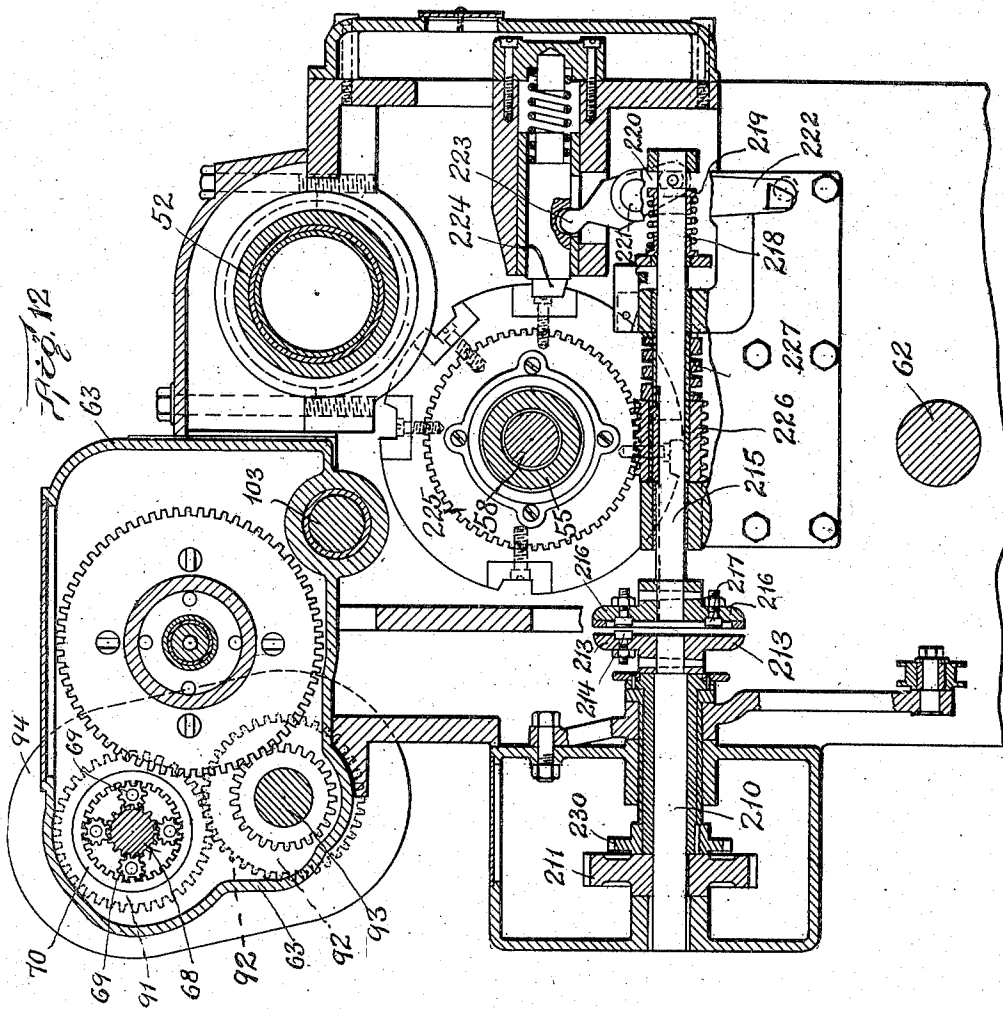
Inventor:

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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 11.



Witnesses:

D. I. Smith
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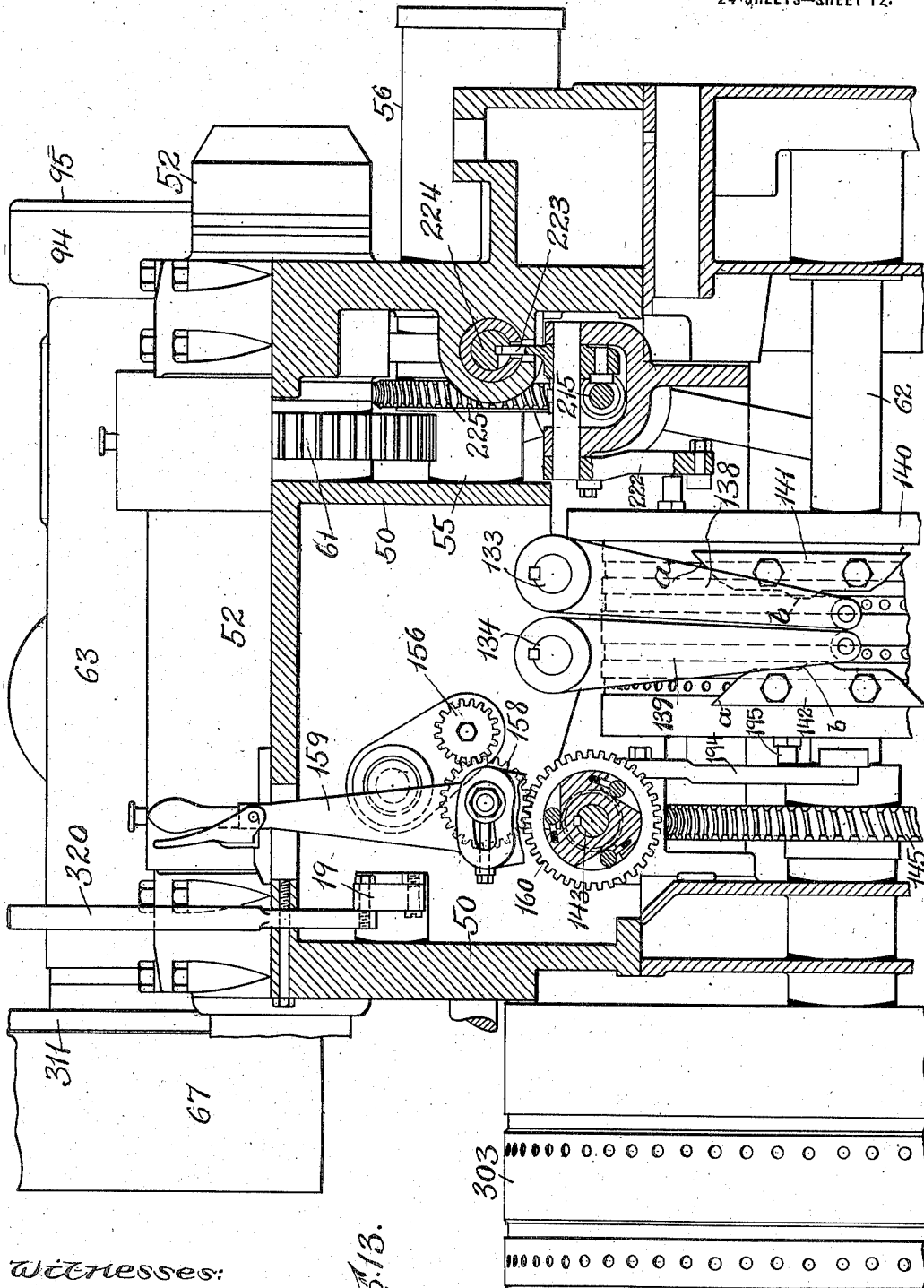
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 12.



Witnesses:
D. L. Smith
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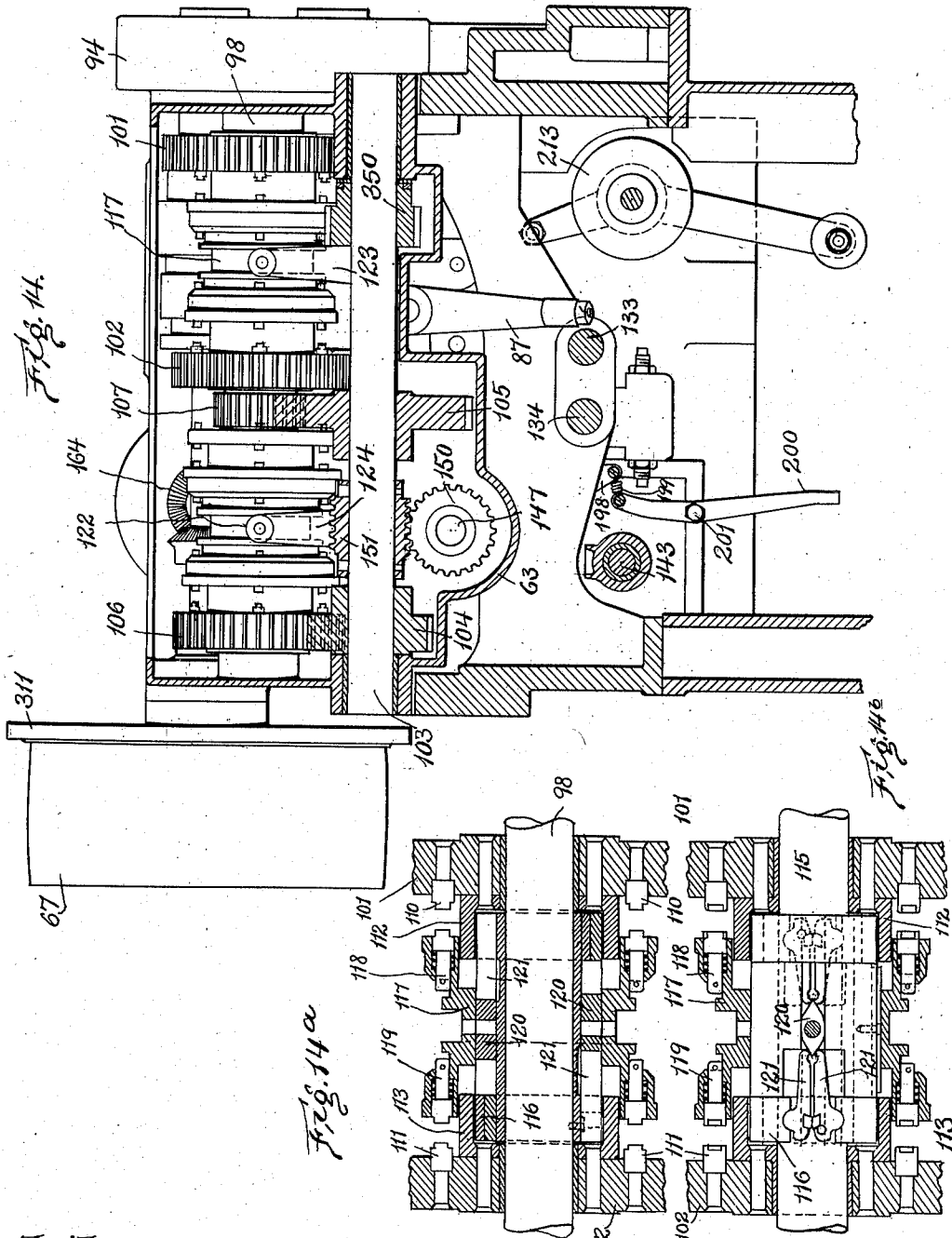
1100.13.

Inventor:
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 13.



Witnesses:

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1,303,216.

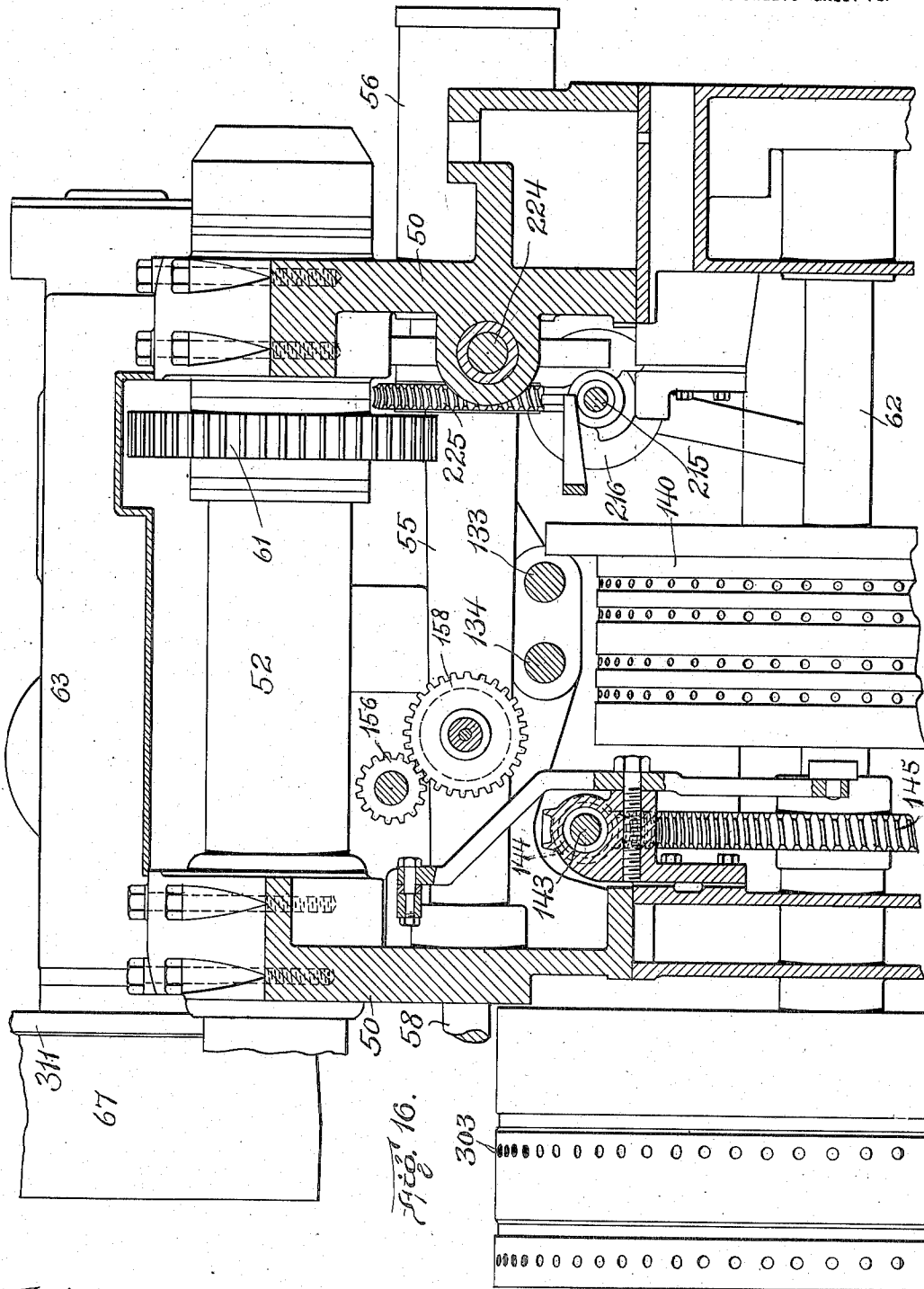
51.025

Inventor:
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 15.



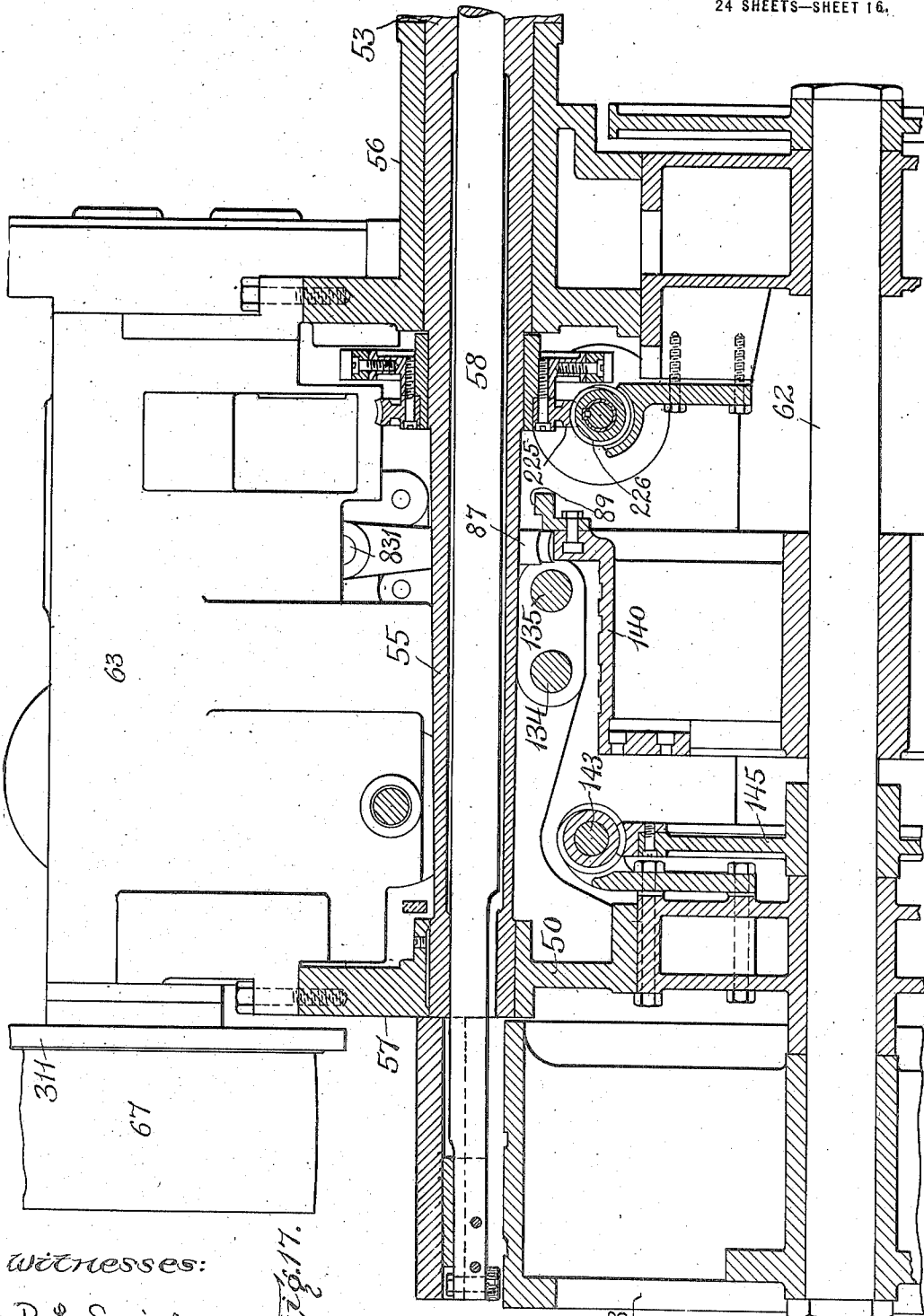
Witnesses:
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 16.



Witnesses:

D. S. Smith

E. Batchelder

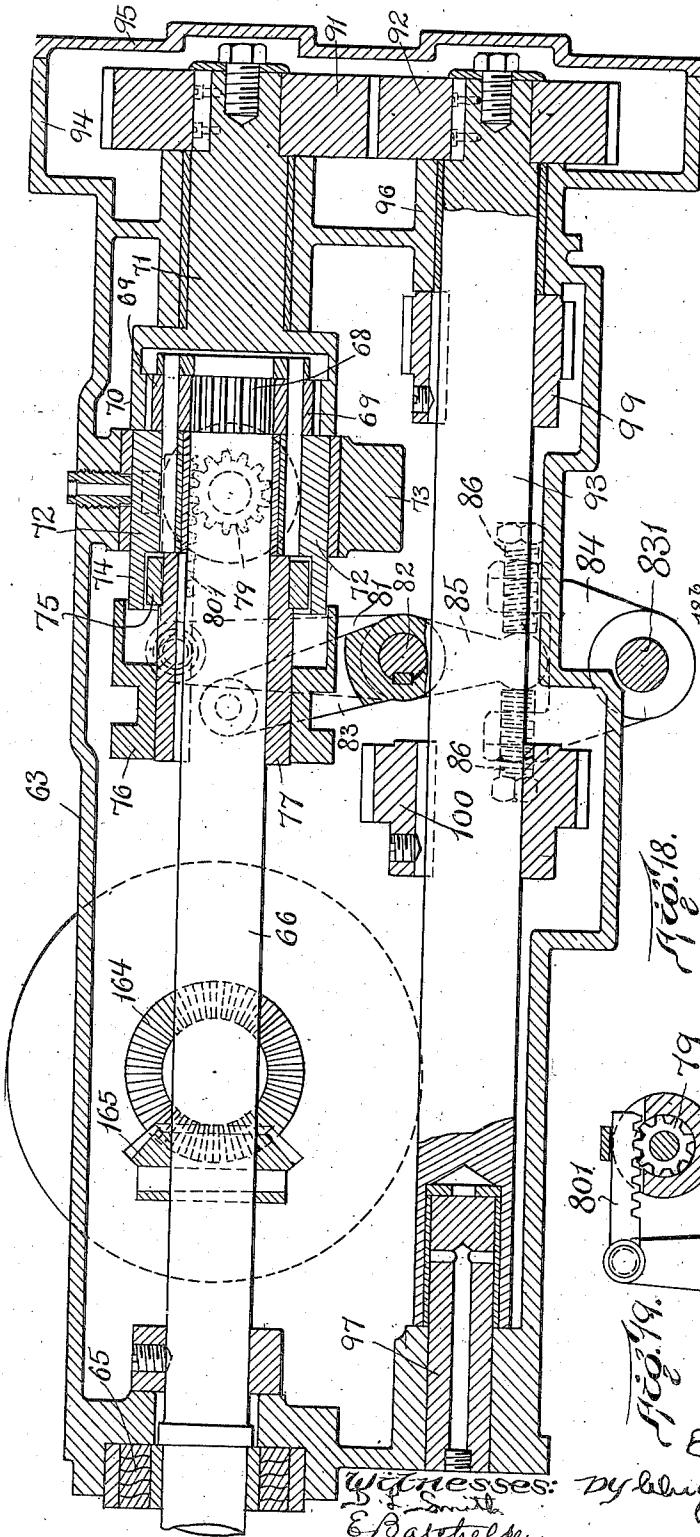
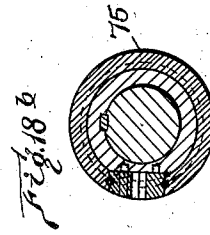
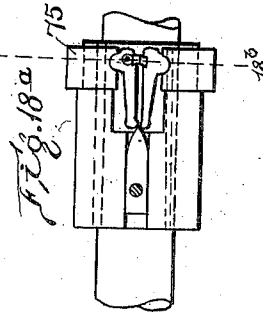
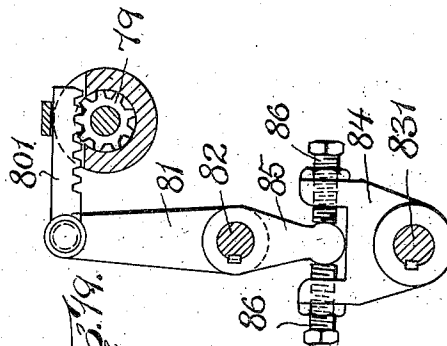
Fig. 17.

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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 17.



Witnesses:
J. Smith
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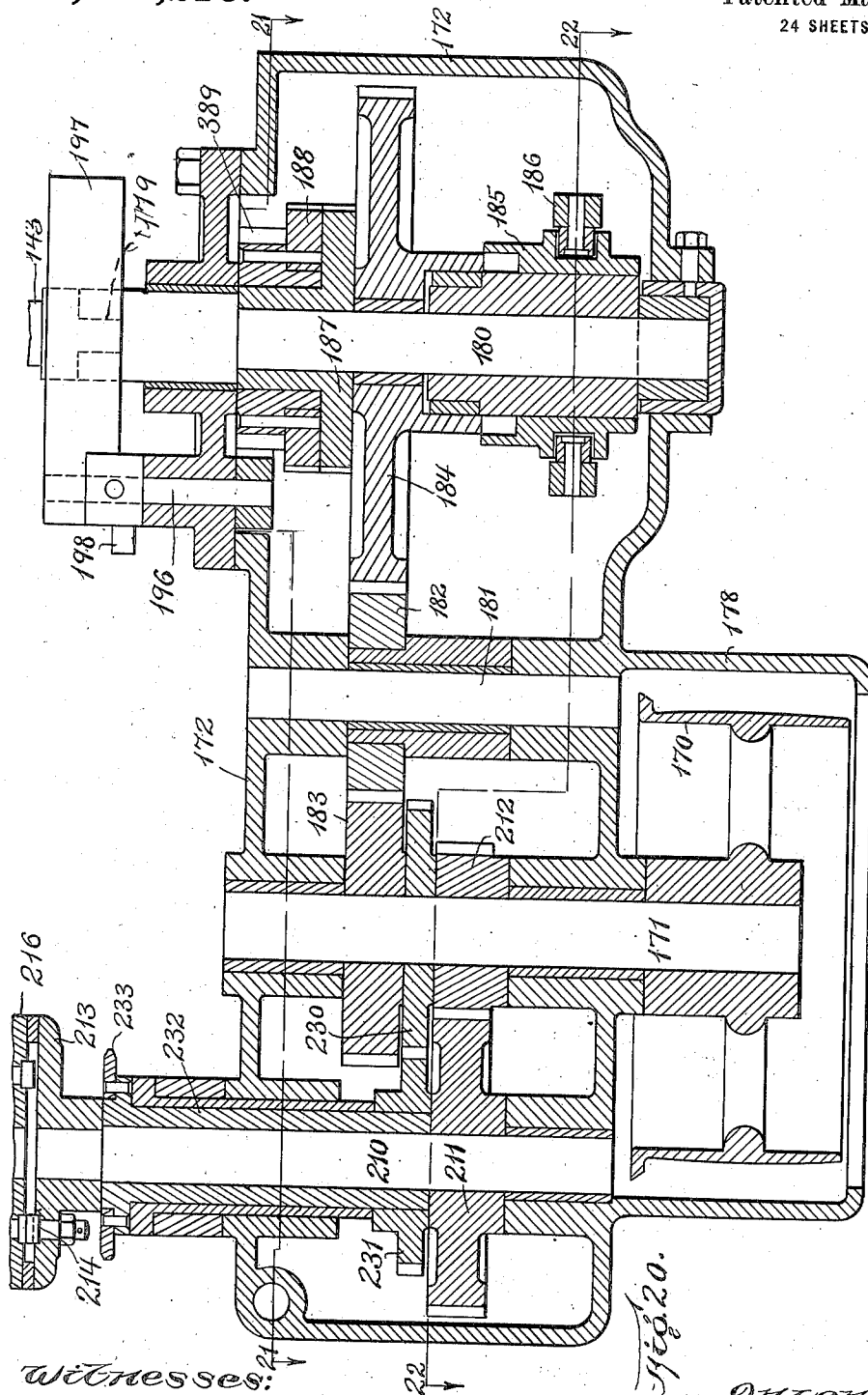
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.

24 SHEETS—SHEET 18,



Witnesses:

D. L. Smith
E. Batchelder

Fig. 20.

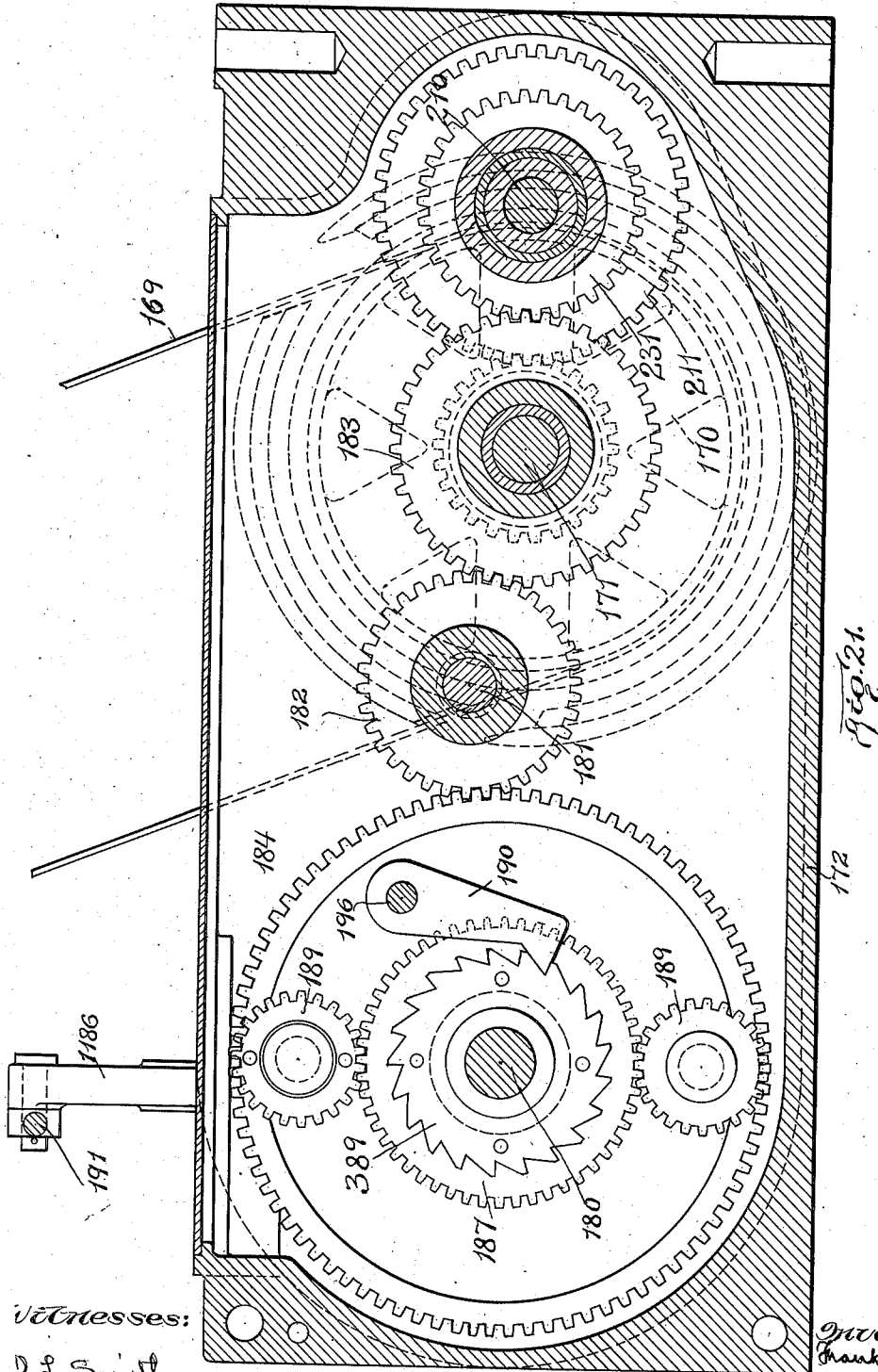
Inventor:

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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 19.



Witnesses:

D. L. Smith

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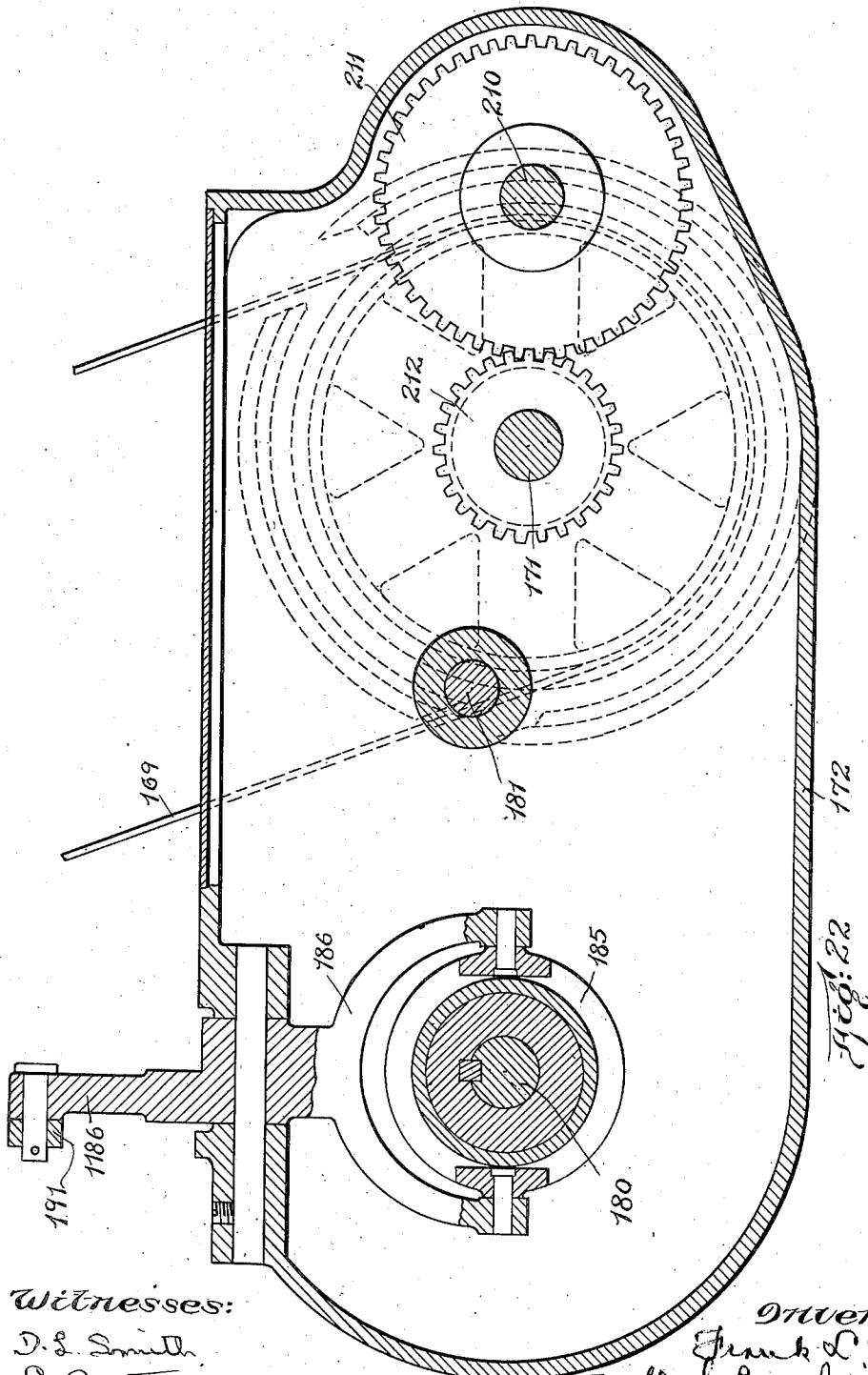
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.

24 SHEETS—SHEET 20.



Witnesses:
D. L. Smith
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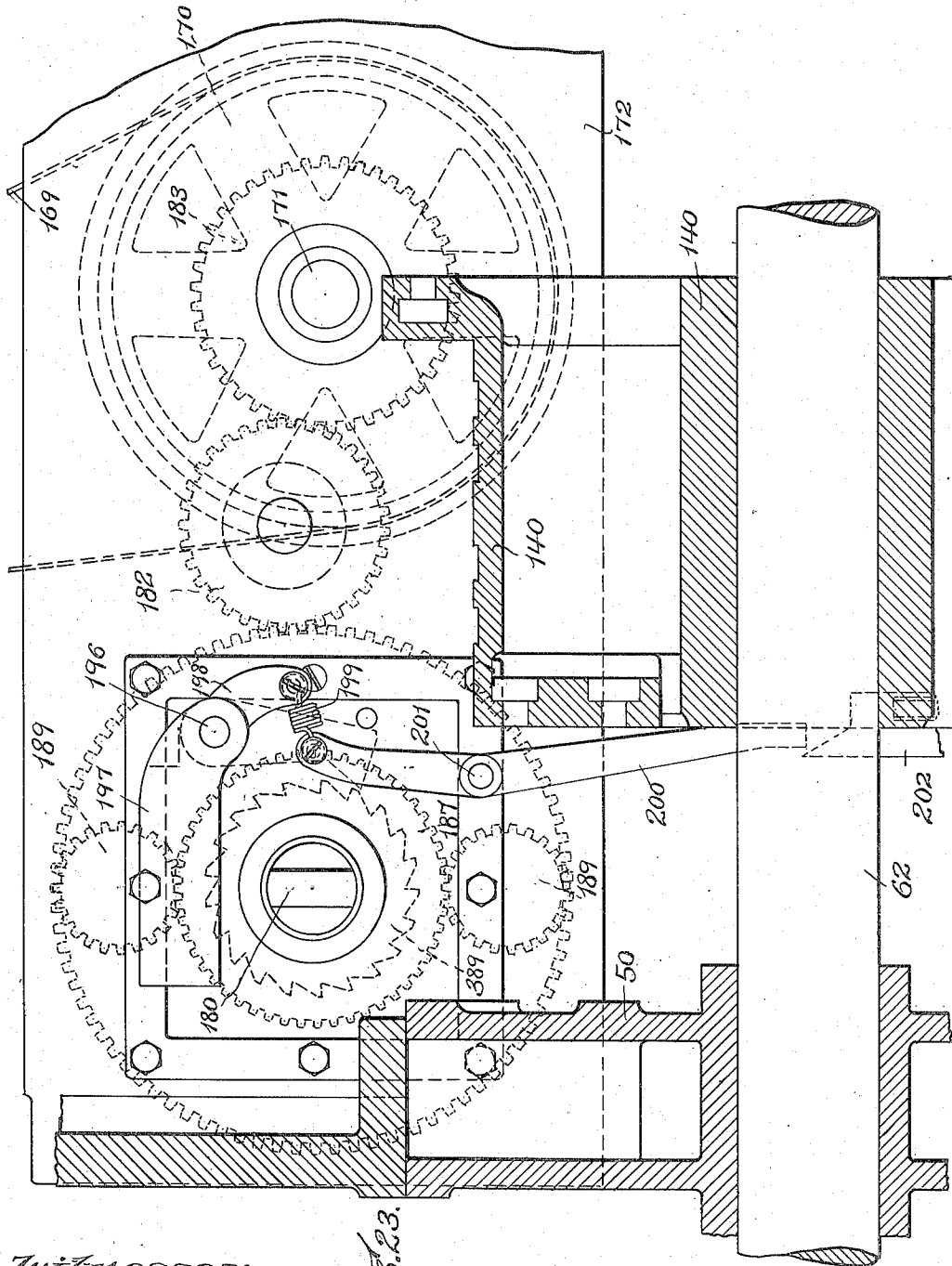
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.

24 SHEETS—SHEET 21.



Witnesses:

D. L. Smith
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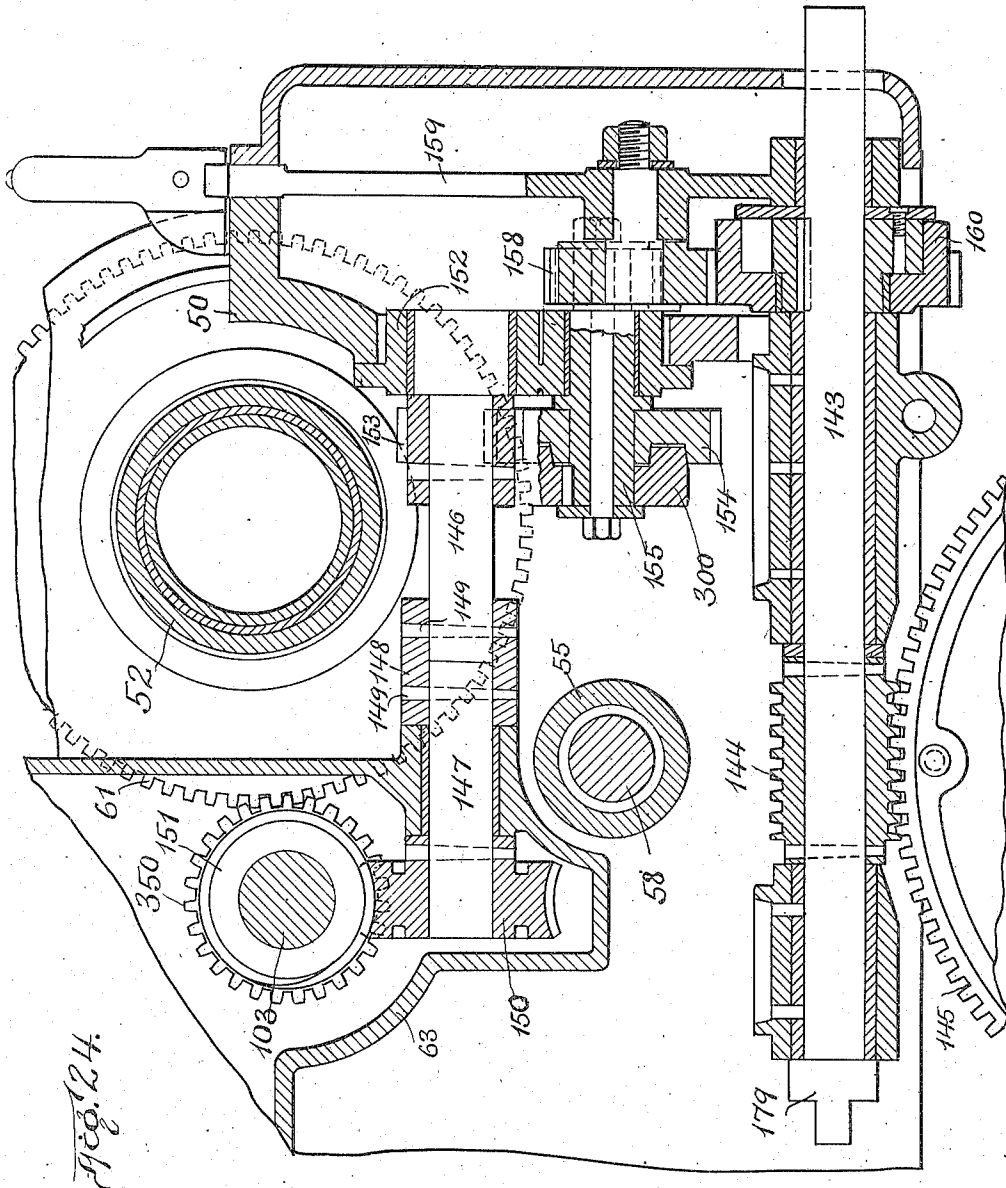
Fig. 23.

Inventor:
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F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 22.



Witnesses:

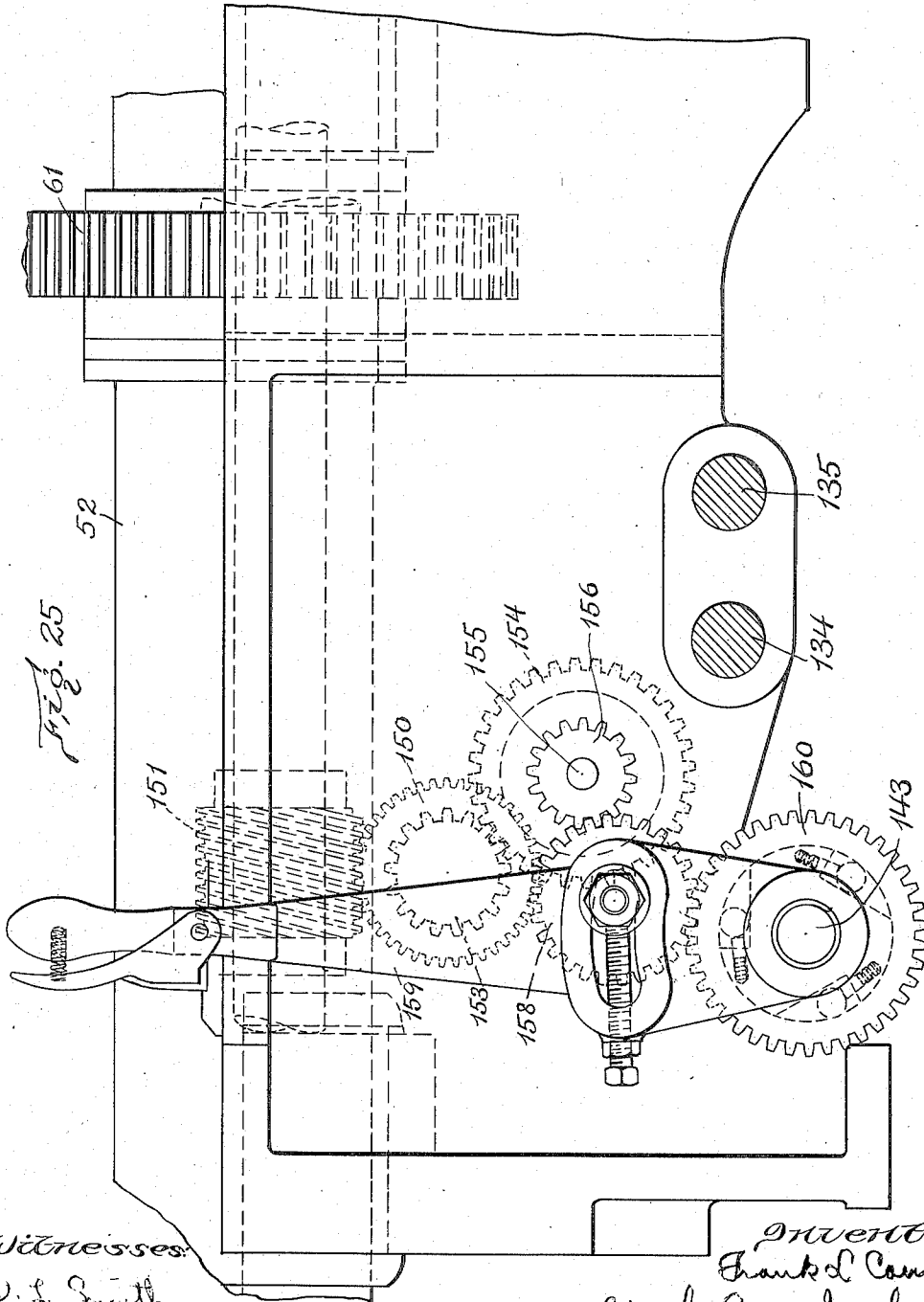
D. S. Smith
E. Batchelder

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by *Wright, Brown & Smith, Attorneys*

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SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 23.



Witnesses:
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Inventor:
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ATTORNEYS

F. L. CONE.
SINGLE DRIVE METAL WORKING MACHINE.
APPLICATION FILED FEB. 8, 1915.

1,303,216.

Patented May 6, 1919.
24 SHEETS—SHEET 24.

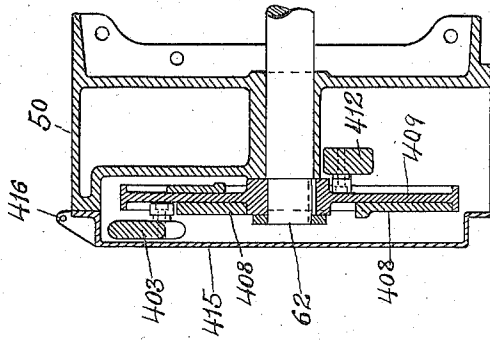


Fig. 25.

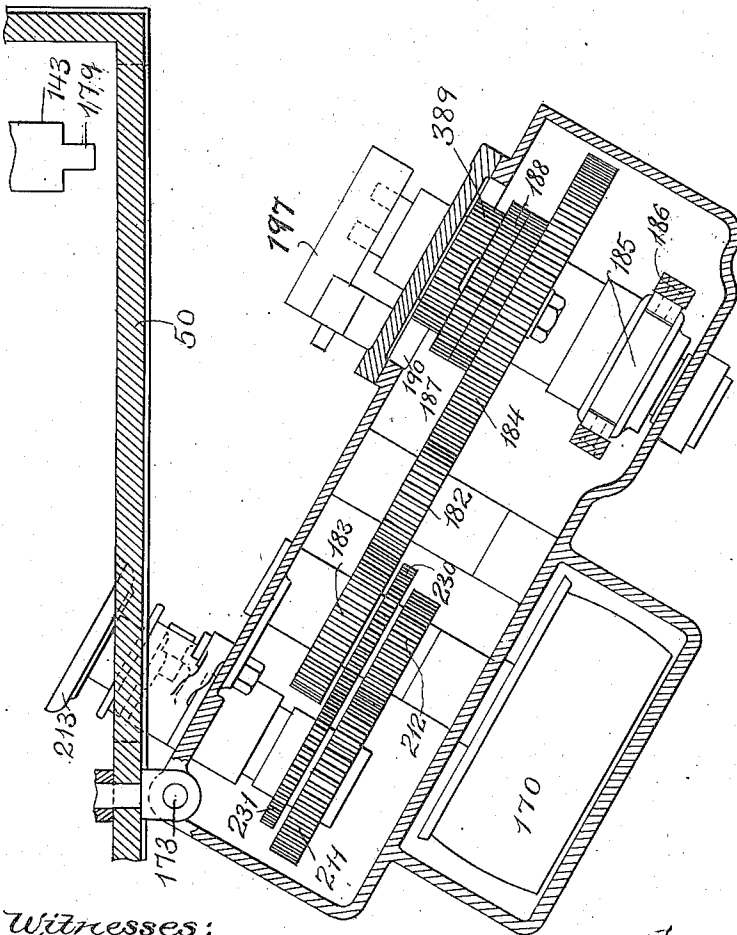


Fig. 26.

Witnesses:
D. L. Smith
E. Batchelder

Inventor.
Frank L. Cone
by
Wm. B. Brambley & Co.,
Attorney

UNITED STATES PATENT OFFICE.

FRANK L. CONE, OF WINDSOR, VERMONT, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE NATIONAL-ACME COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

SINGLE-DRIVE METAL-WORKING MACHINE.

1,303,216.

Specification of Letters Patent.

Patented May 6, 1919.

Application filed February 8, 1915. Serial No. 6,879.

To all whom it may concern:

Be it known that I, FRANK L. CONE, a citizen of the United States, and resident of Windsor, in the county of Windsor and State of Vermont, have invented certain new and useful Improvements in Single-Drive Metal-Working Machines, of which the following is a specification.

This invention has relation to what are termed in the art single-spindle automatic metal-working machines, wherein the work upon which the various operations are to be performed is held in a rotatable work spindle and is operated upon by tools supported and held by a rotatable turret so mounted and indexed as to advance the tools successively into potential working relation, and fed and withdrawn by a drum or feed shaft.

One of the objects of the invention is to provide a machine of this character with improved power-transmitting mechanisms by means of which the work spindle may be driven at a variety of different speeds, and in which the speed of the feed or drum shaft and the other automatic features of the machine may be correlated to the speed of the spindle so as to increase materially the output of the machine.

Still another object of the invention is to provide improvements in metal-working machines so that the variable-speed power-transmitting mechanism may be collected and so mounted as to be movable as a unit into and out of operative relation to the remainder of the machine, in consequence of which it may be, as it were, withdrawn from the machine for observation and repair and reinserted without any material expenditure of time or labor.

Another object of the invention is to provide an improved driving or power-transmitting mechanism for machines of this character, for preventing the shock due to sudden starting and stopping of some of the driven parts, as the result of which the machine may be driven at high speed, without danger of breakage, while at the same time preserving the characteristics of a positive drive.

Another object of the invention is to provide mechanism by which the direction of rotation of the spindle may be changed without affecting the direction of rotation of the feed shaft and the other parts which may be operated thereby, at the same time preserv-

ing the proper correlation of speed of the feed shaft and the spindle.

A further object of the invention is to provide a differential power-transmitting mechanism for the spindle, which will serve for machines of different sizes, and which may be attached to and removed from the machine as a unit.

Still another object of the invention is to provide numerous other improvements all of which will be explained in detail in the following specification and pointed out in the appended claims.

Referring to the accompanying drawings, which illustrate one embodiment of the invention:

Figure 1 represents a front elevation of a single-spindle automatic metal-working machine.

Fig. 2 represents a rear elevation of the same.

Fig. 2^a represents a longitudinal section through the turret.

Fig. 3 represents an end view, looking toward the end of the turret or tool carrier.

Fig. 4 represents a view of the other end of the machine.

Fig. 5 represents a horizontal plan view, partly in section, of the differential speed mechanism for driving the spindle.

Fig. 6 is a vertical transverse section on the line 6—6 of Fig. 5.

Fig. 7 represents a horizontal section on the line 7—7 of Fig. 6.

Fig. 8 represents a section on the line 8—8 of Fig. 5.

Fig. 9 represents a like section but on the line 9—9 of Fig. 5.

Fig. 10 represents a section on the line 10—10 of Fig. 5.

Fig. 11 represents a section on the line 11—11 of Fig. 5, and shows a portion of the mechanism for indexing the turret.

Fig. 12 represents a section on the line 12—12 of Fig. 5, and illustrates the locking bolt for the turret.

Fig. 13 represents a vertical end section on the line 13—13 of Fig. 5.

Fig. 14 represents a vertical section through the back shaft on the line 14—14 of Fig. 5.

Figs. 14^a and 14^b represent sections through the clutch shaft, to show the construction of the combined friction and positive clutches.

Fig. 15 represents a section on the line

15—15 of Fig. 5, and illustrates the levers which operate the clutches on the main clutch shaft.

Fig. 16 represents a section on the line 16—16 of Fig. 5.

Fig. 17 represents a section on the line 17—17 of Fig. 5.

Fig. 18 represents a section on the line 18—18 of Fig. 10, and illustrates the main shaft and the constant-speed reversible intermediate shaft.

Figs. 18^a and 18^b show a part of the friction clutch on the constant speed shaft.

Fig. 19 is a detail illustrating the lever and the connections for controlling the direction of rotation of the intermediate shaft.

Fig. 20 represents a section on the line 20—20 of Fig. 2, and through the gear casing or gear box on the rear of the machine, which contains the variable-speed mechanism for rotating the drum or feed shaft at different speeds.

Figs. 21 and 22 represent respectively sections on the lines 21—21 and 22—22 of Fig. 20.

Fig. 23 is a sectional view and illustrates the cam-controlled mechanism for operating the pawl which forms a part of the variable-speed mechanism, and the gear box or casing.

Fig. 24 represents, in section, power-transmitting connections between the back shaft and the feed or drum shaft.

Fig. 25 illustrates the mechanism for disconnecting the drum shaft from the back shaft.

Fig. 26 shows the gear box which contains the power-transmitting mechanism driven from the prime power shaft as being moved to an inactive position or withdrawn from the shaft.

Fig. 27 represents a horizontal section through the bed of the machine to show the housing for the cam which actuates the supplemental tool slides.

The machine which I have selected for the purpose of illustrating one embodiment of the invention is designed for performing operations upon a bar which is fed automatically through the rotatable spindle or work carrier; but with little change it could be employed for chucking work. The machine is provided with a rotatable spindle which is mounted in the headstock and which may be driven at any one of a variety of speeds, according to the character of the operations to be performed on the work held thereby. The tools are mounted upon a turret whose axis is parallel to that of the work spindle, to which is imparted a step-by-step rotative movement to advance the tools successively into potential working relation to the work. The tools are mounted upon independent slides on the turret, and the reciprocatory movements of the tool slides are

effected through a cam drum mounted upon and driven by what I term a drum or feed shaft. This shaft is rotated at different speeds. During the feed of the tools its speed of rotation is correlated to that of the work spindle; but during the idle movements of the tools, as when they are being withdrawn, and the turret is being indexed, the drum shaft may be driven at two relatively higher speeds from the main or driving shaft. Mechanism is provided by means of which the direction of rotation of the spindle may be changed without affecting the direction of rotation of the drum shaft.

I employ an improved variable speed spindle-driving mechanism including a prime power shaft and differential speed power-transmitting mechanism operated thereby, all mounted in a separable casing or box which normally is secured to the main frame of the machine in operative relation to the spindle but which may as a unit be removed from the machine for inspection, repair, or replacement by another unit. This I regard as one of the valuable features of my invention, for the reason that it is customary to build machines of the character of that herein described in various sizes, according to the diameter of the stock upon which the tools are to operate; and hence by forming the differential speed power-transmitting mechanism for the spindle as a detachable unit, I am able to use the same power-transmitting mechanism for machines of different sizes, thereby greatly reducing the cost of manufacture.

In addition, I employ a variable speed power-transmitting mechanism for the drum shaft, which is mounted in a detachable or removable gear box normally held in operative relation to the drum shaft but removable from the machine and adapted to be employed in machines of different sizes. Preferably this power-transmitting mechanism to which I have referred is driven from the prime power shaft and is utilized in rotating the drum or feed shaft during the idle movements of the tools or at other times, as may be desired. This mechanism is in addition to the power-transmitting mechanism by means of which the drum or feed shaft is rotated at a speed correlated to that of the spindle.

Another feature of the machine to which I may at this time call attention is the provision of means for reducing shocks due to the sudden stopping or starting or change in the speed of movement of the several parts of the machine. In the power-transmitting mechanism for the spindle, as well as in that utilized for driving the drum shaft, I employ a combined friction and positive clutch so constructed and operated automatically that the driving and driven members are first clutched frictionally until the inertia of

the driven part is overcome, after which they are positively clutched to insure a positive transmission of power and prevention of slippage or lost motion.

5 Generally speaking, the machine as a whole is similar in some respects to that illustrated in Letters Patent to George Otis Gridley, No. 725,438, dated April 14, 1903, to which reference may be had for a detailed
10 explanation of parts which are herein but briefly referred to.

Before proceeding to a detailed description of the machine which is illustrated upon the drawings, I desire to have it understood that the invention is not limited to the particular embodiment which I shall describe; that the drawings are more or less conventional, some of the cams being omitted or shown conventionally; and that the
15 phraseology which I employ is for the purpose of description and not for limitation.

Referring now to the drawings,—the machine is provided with a main frame 50 which is substantially box-like in shape and
25 which is supported upon a base 51 of any suitable construction. The work spindle is indicated at 52, and the turret at 53. The tools 54 are mounted upon independent slides 541 in the sides of the turret, and on
30 the completion of the indexing of the turret the slide for the tool which then reaches potential working relation to the work is engaged with a reciprocatory actuator 304 on a slide bar 58 by which it is fed and retracted longitudinally of the axis of the
35 spindle and of the turret. This mechanism is all explained in said patent and need not be described in detail herein. The turret 53 is formed on the end of a hollow shaft 55 (see Fig. 17) which is mounted in the bosses 56, 57 and which has extending therethrough the reciprocatory slide bar 58. This bar is reciprocated by cams on the cam drum 303. When the turret is rotated, the tool slides
40 are engaged successively with the actuator 304.

The spindle 52 is journaled in suitable bearings 59 and 60 in the end walls of the main frame or headstock, and has formed
50 thereon or rigidly secured thereto a gear 61 by which it is driven. Suitable mechanism, which I need not now describe as it forms no special part of the present invention, may be utilized for automatically feeding the bar through the spindle after a piece of work
55 has been completed and severed from the end of the bar. The feed or drum shaft is indicated as a whole at 62, and it is provided with the various drums or cam carriers for controlling automatically the operation of the several instrumentalities which I shall
60 subsequently describe.

Variable speed power-transmitting mechanism for the spindle:—As previously indicated, this mechanism may be all formed

and assembled independently of the other parts of the machine and is removable as a unit from the machine. It comprises, generally speaking, a main or prime power shaft, a back gear shaft geared directly to the spindle, and two intermediate shafts
70 with trains of gear controlled by clutches operated by cams carried by the cam or feed shaft. This mechanism is contained within a separable gear box or casing which is indicated as a whole at 63, as shown in Figs. 2, 3, 6, 7 and 8. This casing is detachably bolted to the headstock or frame of the machine, beside and in the rear of the work spindle, and may be removed when desired. It is
75 provided at its top with a removable cover 64 through which access may be had to the interior thereof.

Journalled in a Hyatt roller bearing 65 at one end of the casing there is the prime
85 power shaft 66 to the projecting end of which is keyed the driving pulley 67. The said pulley has on its inner edge a peripheral marginal flange 310, which is beveled as shown, and in close proximity thereto is the
90 hood or guard 311, which receives any oil which is thrown by centrifugal action from the pulley, and delivers it to the bed of the machine.

The shaft 66 is driven at a constant speed
95 by a belt from a motor or countershaft. At its opposite end it is formed or provided with a pinion 68 which, as shown in Figs. 7, 12 and 18, intermeshes with planetary gears 69 intermeshing with an internal gear
100 70 on a shaft 71 placed in axial alinement with the shaft 66 and journaled in a bearing in the end of the casing 63. The gear 71 is driven in either direction from the shaft 66, either by causing it to rotate directly with the shaft 66 or by transmitting
105 power thereto from the planetary gears 69. The planetary gears are mounted upon the ends of pins which are journaled in a sleeve 72 in an annular bearing 73 and which is adapted to be either clutched to the shaft 66 or else held against rotation. To this end the sleeve 72 is formed with a friction cup 74 in its end which embraces a split
110 friction ring 75 which may be expanded thereagainst by the movement of the clutch sleeve 76 to the right in the position shown in Fig. 7. Normally the sleeve 72 is clutched to the shaft 66 through the friction ring 75 and a sleeve 77 on which it is mounted, the
115 last-mentioned sleeve being keyed to the said shaft. The means for locking the sleeve 72 against movement comprises a nut 78 which is moved to clamp the sleeve 72 by a screw 79, the latter being provided with a
120 pinion 80 by which it may be rotated. These parts are mounted in an annular boss formed in the wall of the casing 63. The pinion 79 is engaged by a rack 801 (see Fig. 19) pivoted to a lever 81 keyed to a shaft 130

82. Secured to this same shaft is a yoke 83 by which the clutch collar 76 is operated. When the clutch collar is moved in one direction to clutch the planetary-gear-carrying sleeve 72 to the shaft 66, the clamping nut 78 is withdrawn to release the said sleeve 72 so that the shaft 71 will be driven in the same direction as the shaft 66. When the clutch collar is moved in the opposite direction, however, the sleeve 72 is clamped against rotation and is released by the friction ring 75 so that the shaft 71 may be driven by the planetary gearing in a reverse direction. The yoke 76 and the rack 801 are, as I have described, operated from the rockshaft 82, and the latter in turn is rocked by shaft 831 through the medium of the two arms 84, 85, secured to the said shafts respectively, the arm 84 having the adjusting screws 86, 86 engaging the end of the arm 85 as shown in Fig. 19. The rockshaft 831, as shown in Fig. 10, is journaled in depending bosses from the bottom of the gear case 63 and is provided with a lever 87 which may be rocked in one direction or the other by cams 88, 89 on the cam wheel 140 arranged on the cam shaft 62. According to the character of the operation to be performed, as in tapping or threading, the direction of rotation of the shaft 71 may be changed or reversed.

The shaft 71 which extends through the end wall of the gear box is equipped with a change gear 91 which, as shown in Fig. 18, intermeshes with and drives a change gear 92 on an intermediate shaft 93. At the end of the gear box there is an extension or hood 94 which receives the movable change gears 91, 92 and which is equipped with a removable cover 95. The intermediate shaft 93 is journaled at one end in the bearing 96, and its other end is recessed and journaled on a removable trunnion 97 inserted in a boss in the end of the gear box 63. From the intermediate shaft 93 power is transmitted to a main clutch shaft 98 through two trains of gears, including the gears 99 and 100 on the shaft 93, and 101 and 102 on the shaft 98; and from the shaft 98 power is transmitted through two trains of gears to the back gear shaft 103, said trains including the gears 104, 105 on the back gear shaft, and 106, 107 on the main clutch shaft. (See Figs. 7 and 14). Thus the main clutch shaft may be driven at either of two speeds from the intermediate shaft in either direction, so that through the two trains of gears between the main clutch shaft and the back gear shaft, the latter may be driven in either direction at any one of four speeds. All the clutches which control the four trains of gears are placed upon the main clutch shaft and may be removed bodily therewith from the gear case. To this end it will be observed that in the end walls of

the gear case are the removable trunnions 108, 109 which extend into sockets in the main clutch shaft 98, the latter being equal in length to the distance between bosses on the end walls of the casing. By withdrawing the trunnions, the shaft 98 and parts mounted therein may be removed bodily through the aperture in the top of the casing.

I find, as I have previously indicated, that it is highly desirable that these clutches shall operate as friction clutches until the inertia of the driven parts is overcome, and that thereafter they should act positively so as to prevent slippage or lost motion; hence I provide clutches of this character between the shaft 98 and the gears 101, 102 and the gears 106, 107 and said shaft. Referring first to the gears 101, 102, it may be stated that they are loose upon the shaft and are provided with positive clutch pins or teeth 110, 111. The said gears are further provided with the friction cups 112, 113, which are pinned thereto. Between the two gears there is keyed upon the shaft a sleeve 114 provided with split friction rings 115, 116 respectively inclosed within the friction cups 112, 113. Upon the sleeve 114 there is splined a clutch collar 117, which, at its opposite ends, has yielding spring-tensioned teeth or pins 118, 119 for engagement with the clutch teeth 110, 111 respectively. This collar has oppositely projecting slides 120, the ends of which are pointed but which are adapted to move between the ring-expanding members 121 so as to expand the friction rings 115, 116 into engagement with their respective cups 112, 113. After the clutch collar has been moved in one direction so as to cause the slide 120 to expand the ring 115, for instance, so as frictionally to clutch gear 101 to the shaft 98, the shaft will be driven by friction so as gradually to overcome its inertia, after which the clutch sleeve may be moved still farther in the same direction to cause the clutch pins positively to engage the pins 110 and thereafter cause the driving of the gear positively. The same action will take place when the clutch collar is moved in the opposite direction so as to clutch gear 102 to said shaft. By providing the yielding pins or teeth 118, 119, I prevent the clutch from jamming or causing breakage, in case the ends of said pins engage the ends of pins or teeth 110, 111. Otherwise serious damage might result if both sets of pins were unyielding, since the clutch collars are moved positively by cam-actuated mechanism.

The gears 106 and 107 may be likewise clutched to the shaft by mechanism which is identical with that just described and which therefore needs no further description. The clutch collar in the last-mentioned case is

indicated at 122. The two clutch collars 114 and 122 are moved by the yokes 123, 124. (See Fig. 15.) Said yokes are secured to rockshafts 125, 126 respectively, the latter being
 5 provided with the arms 127, 128 connected by links 129, 130 to the levers 131, 132 which are loosely mounted upon the rockshafts 133, 134. The said shafts are provided with
 10 arms 136, 137, which lie between adjacent screws carried by the two levers 131, 132 respectively, so as to permit a relative adjustment of said levers with respect to the
 15 shafts. The rock shafts 133, 134, as shown in Fig. 13, are provided on their ends with depending arms 138, 139 adapted to be moved by cams mounted upon a drum 140 on the cam
 20 shaft 62. The said drum is provided with cams for moving each of the two arms 138, 139 first in one direction and then in the other, as occasion may require. Two of these cams
 25 are shown at 141, 142. It will be noted that each of these cams has a rise a to rock the shaft 133 far enough to throw in the friction mechanism of the clutch, and is provided
 30 with a further rise b to carry the clutch still farther to cause the engagement of the clutch pins and the positive actuation of the driven member. By means of the mechanism which I have thus described, it will
 35 be seen that at the proper point in the rotation of the feed shaft any one of the four clutches may be operated first to frictionally engage the driving and the driven parts and then after a short duration of time may be
 40 actuated to cause the driving and driven parts to be positively connected. In this way I am able to obviate any dangerous shock due to the stopping or starting of the several instrumentalities.

45 When the gear case is detached from the machine, it is merely necessary to disconnect the links 129, 130 from the arms 127, 128, and this may be done by the removal of
 50 cotter pins or other like devices which are used to maintain the connecting pintles in place. The gear 350 on the back gear shaft projects through a slot in the wall of the casing, and when the casing is secured in
 55 place it engages the gear 61 on the spindle shaft, as shown in Fig. 7.

I will now proceed to describe the mechanism for transmitting power to the feed or drum shaft 62. I have already stated that
 60 this shaft may be driven at different speeds either by the spindle-driving mechanism in the removable gear box so that its speed of rotation will be in a predetermined ratio to the speed of rotation of the spindle, or else
 65 that it may be driven directly from the constantly driven main driving shaft independently of the spindle so that it may be rotated at high speed during idle movements of the tools or at a slower or intermediate speed for other purposes. In either event, power
 70 is transmitted to the said shaft from a cross-

shaft 143 (see Fig. 6) which is provided with a worm 144 intermeshing with and driving a worm wheel 145 secured to the said shaft 62. Power from the spindle-driving mechanism is transmitted to said
 75 shaft through one end thereof, and power from the constantly-driven prime power shaft is transmitted to the other end thereof.

I will first explain the connections between the said cross-shaft 143 and the spindle-driving mechanism. Referring to Figs. 8 and 24, it will be seen that in parallelism with the shaft 143 but thereabove there is a
 80 shaft consisting of two sections, 146, 147, the ends of which are abutted and which are coupled together by sleeve 148 and removable taper pins 149. The section 147 of the shaft is journaled into the removable gear
 85 box 63, and on its end which projects into the interior of the box it is provided with a worm gear 150 which is meshed with a worm 151 on the back gear shaft 103. When the gear casing is to be removed, the section
 90 147 of the shaft is uncoupled from the section 146. The shaft section 146 is journaled in a suitable bearing 152, and it is provided with a gear 153 intermeshing with and driving a gear 154 secured upon a shaft
 95 155 by a safety coupling 300. See also Fig. 25.

On the same shaft with the gear 154 is a gear 156 with which may be meshed a gear 158 loosely journaled on a stud shaft carried by a hand lever 159 which appears in the
 100 front of the machine as shown in Fig. 1. The said lever 159 is loosely pivoted upon the shaft 143, and the gear 158 intermeshes with a gear 160 on said last-mentioned shaft. Preferably a spring-tensioned roll ratchet clutch mechanism, as shown in Fig. 25, is interposed between the gear 160 and the shaft
 105 143. This clutch mechanism permits the shaft 143 to be driven at a greater speed than the gear 160, as when power is being transmitted to said shaft from the continuously
 110 driven prime power shaft, and also permits the gear 160 to be driven in the reverse direction when the direction of rotation of the spindle is reversed without affecting the direction of rotation of said shaft 143. When
 115 is desired wholly to disconnect the drum or feed shaft from both driving mechanisms, at a time when the shaft is disconnected from the prime power shaft, it may be accomplished by moving the hand lever 159 to
 120 the left in Fig. 25 so as to move the gear 158 out of mesh with the gear 156. By the mechanism which I have thus described, the cross-shaft 143, and therefore the feed or drum shaft 62, may be driven with the spindle
 125 directly from the spindle-driving back gear shaft 103 at different speeds which bear a predetermined ratio to the speeds of rotation of the spindle.

I will now describe the mechanism for 130

transmitting power to the feed or drum shaft directly from the prime power shaft 66. Referring again to Figs. 7 and 8, it will be observed that projecting rearwardly from the casing 63 there is a shaft 163 which on its inner end has a bevel gear 164 intermeshing with and driven by a like gear 165 on the shaft 66. The shaft 163 is journaled in a bearing afforded by a boss 166 to which is secured a cylindrical hood or casing 167 which incloses a pulley 168 keyed upon the shaft 163. From this pulley a belt 169 transmits power to a pulley 170 keyed to a shaft 171 journaled in a box or casing 172 projecting rearwardly from the frame of the machine, as shown by Figs. 2, 10, and 22. The free end of the casing 172 may be secured to the frame by removable bolts 175. The gear box or case 172 may be swung bodily outwardly about the axis of the pin-
 20 tle 173 so as to expose the mechanism which is therein contained (see Fig. 26), and it is also provided in its top with an aperture 176 closed by a removable cover 177, as shown in Fig. 10. The box or casing is provided with a forwardly projecting flange or housing 178 which incloses the pulley 172, being of course provided with slots through which the belt 169 may pass.

I have provided for the transmission of power from the shaft 171 to the indexing mechanism for the turret and also to the cross-shaft 143 by which the feed shaft is driven. I will first describe the power-transmitting mechanism by which power is transmitted from the shaft 171 to the cross-shaft 143. At its rear end the shaft 143 is formed with a fin or coupling member 179 to engage a socket in a shaft 180 journaled in the case or box 172, said shaft 180 being parallel to that at 171. Between these two shafts there is an intermediate shaft 181 having a pinion 182 intermeshing with a gear 183 fast on the shaft 171 and with a gear 184 loose on the shaft 180. The last-mentioned gear may be clutched to the shaft 180 by a friction clutch mechanism, indicated at 185, including a sleeve which is operated by a yoke 186. The mechanism for moving this yoke I will subsequently explain.

The gear 184, as shown in Figs. 6 and 21, carries two planetary gears 189, 189 which intermesh with the gear 187 and also with a gear 188 which is loose on the hub of the gear 187. The hub of the gear 188 is provided with a ratchet wheel 389 with which may be engaged a pawl 190 to hold it against rotation. The gear 188 has one less tooth than the gear 187, so that when the ratchet 189 is held against rotation the shaft 180 will be driven forward at an intermediate slow speed, as for instance when the work spindle is being driven in a reverse direc-

tion, or at any other time, as when the spindle is being driven forward.

Referring again to the clutch-moving yoke 186, this is operated by a lever 1186 projecting upwardly through an aperture in the gear casing and connected by a link 191 with a two-armed lever 192, 194 pivoted at 193, the lower arm 194 of which is moved in one direction or the other by cams 195 projecting from the end of the cam drum 140. (See Fig. 13.) The link 191 is also connected to a hand lever 320 projecting through the top of the main frame at the front thereof so that the clutch lever 1186 may be shifted by hand in case of emergency. The pawl 190 which is used to lock the ratchet 189 against movement is mounted upon a rockshaft 196 which projects through the inner wall of the casing as shown in Fig. 15 and is provided with a weight 197 which tends to hold the pawl in inactive position. Connected to the rockshaft 196 is an arm 198 connected by a spring 199 with a lever 200 which is fulcrumed at 201. This lever may be rocked about its fulcrum by one or more cams 202 placed on the ends of the drum 140, as shown in Fig. 23. By the means which I have just described, the feed or drum shaft may be automatically driven either at high speed from the constantly driven prime power shaft, or else at an intermediate slow speed, by throwing in the pawl to engage the ratchet and cause the transmission of power through the planetary gearing. The mechanism for controlling the pawl is supported by the gear case, and is swung outwardly with the latter when the gear case is moved about its hinge.

I will now describe the mechanism for indexing the turret, which mechanism receives its power from the belt-driven shaft 171 in the gear case 172. Journaled in the said gear case there is a shaft 210 to which there is affixed a gear 211 intermeshing with and driven by a gear 212 on the shaft 171. The shaft 210 projects inwardly from the gear case and is provided on its end with a clutch disk 213 having pins or teeth 214. This shaft 210 is in alinement with a shaft 215 which is slidably journaled in bearings located within the main frame of the machine, as shown in Figs. 11 and 12. On the end of the shaft 215 there is a clutch disk 216 confronting that at 213 and equipped with clutch pins or teeth 217. Normally these clutch disks are disengaged as shown in Fig. 12, but upon moving the shaft 215 to the left they may be caused to engage so as to effect the transmission of power from the shaft 171 to the shaft 215. The shaft 215 is held normally to the right, however, by a spring 218 one end of which abuts against the bearing and the other end of

which abuts against a collar 219 loose on the shaft. The shaft may be moved to the left by a lever 220 on a rockshaft 221, said shaft being provided with a depending arm 222 with which a cam on the cam drum 140 will engage once during each rotation of the feed shaft so as to rock said lever 222 to the left and cause the engagement of the two clutch disks 213, 216. Incidentally, it may be remarked that the rockshaft 221 carries also an arm 223 engaging the locking bolt 224 which locks the turret at its several stations as it is rotated step by step. This will be referred to again subsequently.

The turret extension 55 is provided with a gear 225 as shown in Figs. 12 and 17, with which is engaged a worm 226 splined upon the shaft 215. A strong spring 227 engages one end of the worm and tends to hold the other end against the shaft bearing, as shown in Fig. 12. The parts are so arranged that when the cam on the cam carrier or drum swings the arm 222 to the left so as to withdraw the locking bolt 224, the shaft 215 is moved to the left to cause the toothed clutch disks to become engaged positively. Thereafter the engagement of the end of the locking pin with the cylindrical face of the turret holds the shaft in the position in which it was moved until the turret has advanced one step so that the locking bolt can spring into the next socket provided therefor. As this happens, the spring 218 moves the shaft to the right and releases the disk 216 from that at 213. This particular indexing and locking mechanism which I have described does not materially differ from that illustrated and described in said patent hereinbefore referred to.

While it forms no important part of the machine which I have described herein, yet I may call attention to the fact that from the shaft 171 is driven the usual oil pump which feeds oil to the bearings. This is accomplished by means of a gear 230 fast on the shaft 171 and intermeshing with a gear 231 fast on a sleeve 232 loose on the shaft 210. This last-mentioned sleeve has a sprocket wheel 233 by which power is transmitted through a chain 234 to the pump, not shown.

In addition to the foregoing instrumentalities, the machine illustrated is provided with supplemental tool carriers, operated by cams on the feed or drum shaft, for carrying forming and cutting-off tools. These carriers are so mounted, and the cam disk is so located, that the cams are protected from chips or cuttings. One of said tool carriers consists of a cross forming-slide 400, mounted on a guideway 401 formed on the main frame at the front of the machine. It is fed in and out by a lever having the two arms 402, 403,—the arm 402 carrying

an adjusting screw 424 engaging a solid abutment 404, and a screw 423 for engaging the adjustable abutment 405 on the tool slide. The hub of the lever is fulcrumed on a stud shaft 406, inside of a case or hood 407 which is affixed to the end of the main frame. The arm 403, engages path cams 408, on the outer end face of a cam disk 409 mounted on the end of the feed shaft 62. The cutting-off tool is mounted on the arm 410 of an elbow lever pivoted on a shaft 411, and the arm 412 passes downwardly through a slot in the top of the guard or hood and is operated by path cams on the inner face of the cam disk 409. Placed on the top of the hood is a slide 413, which fits closely on the arm 412 and covers the slot in the hood or case, so that no chips or cuttings can gain entrance to the interior of the case and become lodged on the path cams. In this connection it may be noted that the hub of the lever 402, 403 fits closely in a slot in the hood or case, the metal at the ends of the slot being bent inwardly as at 414 to engage the hub, and prevent chips or cuttings from passing through the slot. The hood or case is formed in two parts, of which the lower portion 415 is hinged by pintles 416 to the end of the main frame and has a hook 417 on its free end to be engaged by a latch 418 on the main frame. The cam disk 409 is inclosed within the guard or case, but access may be had thereto by opening the hinged portion of the case.

The main frame is provided, in its front, with a removable plate 419 having a hinged door 420, and with a lower door 421 through which access may be had to the interior mechanism in the frame.

One of the advantages of the improvements hereinbefore described is that the spindle may be driven in either direction at four speeds, so that a great variety of operations may be performed with the proper spindle speed therefor. This is particularly important in cutting either right or left hand threads, in threading or turning work of greatly different diameters, in forming, in cutting off, and in drilling small holes. Moreover, the feed shaft may be driven at any one of these four speeds in correlation to the spindle speed during the forward rotation of the spindle, or it may be driven at either of two different speeds (always, however, in the same direction) when the spindle is being driven in a reverse direction.

Having thus explained the nature of my said invention and described a way of constructing and using the same, although without attempting to set forth all the forms in which it may be made or all the modes of its use, what I claim is:

1. A metal-working machine comprising the combination with a work spindle, a tool carrier, a feed shaft for actuating the tool carrier, and a main frame by which said instrumentalities are supported, of a separable casing normally supported by the main frame, a constant speed drive shaft, and variable speed power-transmitting mechanism for the spindle, both supported by said casing and detachable therewith. 70
2. A metal-working machine comprising the combination with a main frame, and a work spindle journaled in the main frame, and having a gear thereon, of a separable unitary variable speed power-transmitting mechanism adapted to be operatively engaged with said spindle gear and comprising a constant speed drive shaft, a driven shaft, and intervening trains of clutch-controlled gearing, and a casing therefor detachably supported on said main frame, and bodily removable therefrom. 75
3. A metal-working machine comprising the combination with a main frame, and a work spindle journaled in the main frame, and having a gear thereon, of a separable casing or gear box detachably secured to said main frame in proximity to the spindle, a constant speed drive shaft and variable speed power-transmitting mechanism carried by said casing or gear box and removable bodily therewith from the main frame, said power-transmitting mechanism including a gear for meshing with said spindle gear. 80
4. A metal-working machine comprising a main frame, a work spindle and a feed shaft journaled therein, a unitary variable speed power-transmitting mechanism for driving the spindle but separable therefrom, a gear box or casing therefor detachably mounted on the main frame, and controlling means mounted on the main frame and actuated by said feed shaft, and detachably connected to said power-transmitting mechanism for automatically controlling the operation thereof. 85
5. In a metal-working machine, the combination with a main frame, and a work spindle and a feed shaft both journaled thereon, of a separable gear box or casing mounted on said frame, variable speed power-transmitting mechanism journaled in and removable with said gear box or casing and including a drive shaft, a back gear shaft, and trains of variable speed clutch-controlled gearing connecting said shafts; and mechanism actuated by said feed shaft for actuating the clutches of said power-transmitting mechanism but from which the latter are separable when said gear box or casing is removed from said main frame. 90
6. In a metal-working machine, the combination with a main frame, a work spindle and a feed shaft both journaled thereon, rockshafts journaled on said main frame, and cam mechanism on said feed shaft for rocking said rockshafts; of a separable gear box detachably mounted on said frame, a power shaft in said gear box, and variable speed power-transmitting mechanism in said gear box for rotating said spindle and including trains of gear, clutches therefor, and controllers for said clutches all removable bodily with said gear box; and means detachably connecting said rockshafts with said clutch controllers whereby the latter are automatically operated. 95
7. In a metal-working machine, the combination with a main frame, a tool slide, and a work spindle and a feed shaft for the tool slide both journaled on said frame, of a unitary variable speed power-transmitting mechanism, including a casing detachably supported on said main frame having a back shaft in driving relation to said spindle, a shaft journaled on said main frame for transmitting power to said feed shaft, and means for detachably coupling said variable speed power-transmitting mechanism to said power-transmitting shaft. 100
8. In a metal-working machine, the combination with a main frame, a work spindle, a feed shaft for the tools, a cross-shaft and power-transmitting connection between the cross-shaft and the feed shaft, all supported on the main frame, of a box or casing supported on the main frame and variable speed power-transmitting mechanism supported thereby and comprising a back gear shaft operatively but detachably geared to said spindle and said cross-shaft, a constant speed drive shaft, and clutch-controlled trains of gearing between said constant speed shaft and said back gear shaft. 105
9. In a metal-working machine, the combination with a main frame, a work spindle, a feed shaft for the tools, a cross-shaft and power-transmitting connections between the cross-shaft and the feed shaft, all supported on the main frame, of a box or casing supported on the main frame and the following mechanism all supported thereby, to wit:— a back gear shaft detachably geared to the spindle, a shaft driven thereby but alined with and detachably coupled to said cross-shaft, a constant speed driving shaft, and variable speed power-transmitting connections between said drive shaft and said back gear shaft. 110
10. In a metal-working machine, the combination with a main frame, and a work spindle, and a feed shaft for feeding and withdrawing the tools both journaled on the main frame, of a gear box or casing secured upon the main frame, a constant speed drive shaft and a back gear shaft journaled therein with the back gear shaft operatively but detachably connected to the spindle and the feed shaft, and variable speed power-transmitting mechanism in said box or casing 115

between said drive shaft and said back gear shaft and including a main clutch shaft, two trains of clutch-controlled gearing actuated by the drive shaft, and two trains of clutch-controlled gearing actuated by said clutch shaft, the clutches for said trains being all located on said main clutch shaft.

11. In a metal-working machine, the combination with a main frame, and a work spindle, and a feed shaft for feeding and withdrawing the tools both journaled on the main frame, of a gear box or casing secured upon the main frame, a constant speed drive shaft and a back gear shaft journaled therein with the back gear shaft operatively but detachably connected to the spindle and the feed shaft, variable speed power-transmitting mechanism in said box or casing between said drive shaft and said back gear shaft and including a main clutch shaft, two trains of clutch-controlled gearing actuated by the drive shaft, two trains of clutch controlled gearing actuated by said clutch shaft, the clutches for said trains being all located on said main clutch shaft, and means for detachably mounting said clutch shaft in said casing whereby it is removable bodily therefrom without detaching the clutches and gears carried thereby.

12. In a metal-working machine, the combination with a main frame and a work spindle and a feed shaft both journaled thereon, of a gear box or casing mounted on the main frame and containing a constant speed drive shaft and variable speed power-transmitting mechanism for driving said work spindle and said speed shaft together at different working speeds, a gear box or casing mounted on said frame and containing power-transmitting mechanism for driving said feed shaft independently of the spindle, and power-transmitting connections between the constant speed drive shaft in the first-mentioned casing and the power-transmitting mechanism in the second-mentioned casing.

13. In a metal-working machine, the combination of a work spindle, a feed shaft for advancing and withdrawing the work, a cross-shaft geared to said feed shaft, a constant speed driving shaft, variable speed power-transmitting mechanism operated by said driving shaft for driving the spindle at different working speeds, power-transmitting connections between said mechanism and one end of said cross-shaft whereby said cross-shaft may be rotated with the spindle, and power-transmitting mechanism operated by said constant speed driving shaft and operatively connected to the other end of said cross-shaft to drive it independently of said spindle.

14. In a single-drive metal-working machine, the combination with a main frame, a work spindle, a tool carrier, a feed shaft for actuating said tool carrier, and a second

shaft geared to said feed shaft, all mounted on the main frame, of a gear box detachably mounted on the main frame and having a shaft alined with and detachably coupled with said cross-shaft, and mechanism in said gear box for transmitting power to said shaft.

15. In a single-drive metal-working machine, the combination with a main frame, a work spindle, a tool carrier, a feed shaft for actuating said tool carrier, and a cross-shaft geared to said feed shaft, all mounted on the main frame, of a gear box detachably mounted on the main frame, a constantly driven shaft therein, a second shaft supported therein and alined with and detachably coupled to said cross shaft, and variable speed power-transmitting mechanism in said gear box and interposed between said constantly driven shaft and said second shaft.

16. In a single-drive metal-working machine, the combination with a main frame, a work spindle, a tool carrier, a feed shaft for actuating said tool carrier, and a cross-shaft geared to said feed shaft, all mounted on the main frame, of a gear box detachably mounted on the main frame, a constantly driven shaft therein, a second shaft supported therein and alined with and detachably coupled to said cross shaft, variable speed power-transmitting mechanism in said gear box and interposed between said constantly driven shaft and said second shaft, and means operated by said feed shaft for automatically controlling said variable speed power-transmitting mechanism.

17. In a single-drive metal-working machine, the combination with a main frame, a work spindle, a tool carrier, a feed shaft for actuating said tool carrier, and a shaft geared to said feed shaft, all mounted on the main frame, of a driven shaft normally alined with and detachably coupled to said second mentioned shaft, a driving shaft, power-transmitting mechanism between said driving and driven shafts, a gear box or casing supporting in permanent relation said driving and driven shafts and said power-transmitting mechanism, and means for hinging said gear box to said frame.

18. In a single-drive metal-working machine, the combination with a main frame, a work spindle, a tool carrier, a feed shaft for actuating said tool carrier, and a shaft geared to said feed shaft, all mounted on the main frame, of a driven shaft normally alined with said second mentioned shaft, a driving shaft, differential speed power-transmitting mechanism between said gears, a gear box or casing supporting said driving and driven shafts and said power-transmitting mechanism, means for hinging said box or casing to said frame, and separable mechanism supported by said frame and said gear box for controlling the operation

of said variable speed power-transmitting mechanism.

19. In a metal-working machine, a main frame, a work spindle, a rotary tool turret, mechanism for indexing the turret including a shaft having a clutch member thereon, a driven shaft alined therewith and having a complemental clutch member, a constant speed driving shaft, power-transmitting mechanism between said driving and driven shafts, and a gear box or casing attached to said main frame and supporting said driving and driven shafts and said power-transmitting mechanism in permanent relation.

20. In a metal-working machine, a main frame, a work spindle, a rotary tool turret, mechanism for indexing the turret including a shaft having a clutch member thereon, a driven shaft alined therewith and having a complemental clutch member, a constant speed drive shaft, power-transmitting mechanism between said driving and driven shafts, a gear box or casing supporting said driving and driven shafts and said power-transmitting mechanism in permanent relation, and means for hinging said gear box to said frame.

21. In a metal-working machine, a main frame, a work spindle, a rotary tool turret, a feed shaft for feeding the tools, mechanism for indexing the turret including a shaft having a clutch member thereon, a driven shaft alined therewith and having a clutch member for engagement by said first-mentioned clutch member, a driving shaft, power-transmitting connections between said driving and driven shafts, a gear box removably supported on said casing and supporting said driving and driven shafts and said power-transmitting mechanism in permanent relation, and mechanism automatically operated by said feed shaft for causing the engagement of said clutch members.

22. In a metal-working machine, a main frame, a work spindle, a rotary turret, a feed shaft for feeding the tools, a shaft for rotating the feed shaft, and turret-indexing mechanism including a shaft, said last two mentioned shafts having coupling members on the ends thereof, in combination with a gear box removably supported on the main frame, driven shafts on said box normally alined with said two shafts and having complemental coupling members for engaging the first-mentioned coupling members respectively, a driving shaft on said box, and power-transmitting mechanism on said box between said driving and said driven shafts.

23. In a metal-working machine, a main frame, a work spindle, a rotary turret, a feed shaft for feeding the tools, a cross-shaft for rotating the feed shaft, and turret-indexing mechanism including a cross-shaft, said cross-shafts having coupling members on the ends thereof, in combination with a

gear box, driven shafts on said box normally alined with said cross-shafts and having complemental coupling members for engaging the first-mentioned coupling members respectively, a driving shaft on said box, power-transmitting mechanism on said box between said driving and said driven shafts, and means for hinging said gear box on said frame.

24. In a metal-working machine, the combination with a work spindle, and a feed shaft for the tools adapted to rotate together at different predetermined ratios, of variable speed power-transmitting mechanism for driving the work spindle and feed shaft, said mechanism comprising a clutch having friction and positive members, and mechanism controlled by the feed shaft and timed to cause the friction members of said clutch first to be frictionally engaged until the inertia of the driven parts is overcome and then cause the positive members to be engaged, thereby to prevent subsequent slippage or lost motion.

25. In a metal-working machine, the combination with a work spindle and a feed shaft for the tools adapted to rotate together at different predetermined ratios, of variable speed power-transmitting mechanism for driving the work spindle and feed shaft, said mechanism comprising a shaft geared to the spindle and the feed shaft, a gear thereon, a friction clutch for frictionally clutching the gear and the shaft, a collar having means for operating the friction clutch on the initial movement of said collar, said gear and collar having cooperative positive clutch members, and mechanism operated by said feed shaft for moving said collar in one direction to cause the operation of the friction-ring clutch and thereafter moving said clutch collar still farther in the same direction to cause the engagement of said positive clutch members.

26. In a metal-working machine, the combination with a work spindle and a feed shaft for the tools, of variable speed power-transmitting mechanism for driving the work spindle and the feed shaft, said mechanism comprising a shaft geared to the spindle and the feed shaft, a gear thereon, a friction clutch for frictionally clutching the gear and the shaft, a collar having means for operating the friction clutch on the initial movement of said collar, said gear and collar having cooperative positive clutch members, mechanism operated by said feed shaft for moving said collar in one direction to cause the operation of the friction-ring clutch and thereafter moving said clutch collar still farther in the same direction to cause the engagement of said positive clutch members, and means for mounting the positive clutch members of one of said elements to yield longitudinally of the movement of

said collar to prevent damage in case said members abut end to end when said collar is shifted by said feed-shaft-operated mechanism.

5 27. A single-drive single-spindle automatic turret lathe, comprising a main frame, a turret having tool slides thereon, a feed shaft having a cam drum, an actuator operated by said cam drum for feeding the tool
10 slides, a separate gear case mounted on said frame, and containing a constant speed drive shaft, and variable clutch-controlled speed power-transmitting mechanism for driving said work spindle and feed shaft together at
15 different working speeds, a separate gear case mounted on said frame and containing variable speed clutch-controlled mechanism for driving said feed shaft independently of the spindle, and including a driving shaft
20 connected to and driven by said constant speed driving shaft, and means automatically operated by the feed shaft for controlling the operations of said variable speed mechanisms.

25 28. An automatic metal-working machine comprising a work spindle, a tool slide, a feed shaft having a cam drum for imparting movement to said tool slide, a cross-shaft geared to the feed shaft, and a train of
30 gears, including a ratchet clutch for transmitting power to said cross-shaft to rotate it in only one direction, a constant speed driving shaft, a reversible variable speed power-transmitting mechanism for driving
35 said spindle and said cross-shaft, through said train of gears, together forwardly at different working speeds and for driving said spindle in a reverse direction at said different working speeds, supplemental
40 power-transmitting mechanism operatively connected to said constant speed shaft for driving said cross-shaft forwardly at a different speed independently of the spindle, and mechanisms automatically operated by
45 said feed shaft for controlling the direction of rotation of the spindle, and the operations of said variable speed power-transmitting mechanism and said supplemental power-transmitting mechanism.

50 29. In a metal-working machine, a main frame, a work spindle, a tool-carrying turret, a feed shaft for reciprocating the tools, and turret-indexing mechanism, a gear box separable from the main frame but supported thereon, a drive shaft in said box,
55 and power-transmitting connections in said box, for driving said feed shaft and said turret-indexing mechanism.

30. In a metal-working machine, a main
60 frame, a work spindle, a tool-carrying turret, a feed shaft for reciprocating the tools, and turret-indexing mechanism, a gear box, a drive shaft in said box, power-transmitting connections in said box, for driving
65 said feed shaft and said turret-indexing

mechanism, and means for hinging said gear box on said frame.

31. In a metal-working machine, a main frame, a work spindle, a tool carrier, a feed shaft for reciprocating the tool carrier, a
70 gear box removably supported on the frame, a constant speed shaft in said gear box, power-transmitting mechanism driven thereby and arranged in said gear box to be removable therewith, and means for detachably
75 connecting said power-transmitting mechanism with said feed shaft.

32. In a metal-working machine, a main frame, a work spindle, a tool carrier, a feed shaft for reciprocating the tool carrier, a
80 gear box, a constant speed shaft in said gear box, power-transmitting mechanism driven thereby and arranged in said gear box, means for detachably connecting said power-transmitting mechanism with said feed
85 shaft, means for hinging said gear box to said main frame, and mechanism formed of separable parts, and automatically operated by said feed shaft for controlling the operation of said power-transmitting mechanism.
90

33. In a metal-working machine, a main frame, a work spindle, a tool carrier, a feed shaft for reciprocating the tool carrier, a
95 gear box, a driving shaft and a driven shaft in said gear box, clutch-controlled power-transmitting mechanism between said driving and driven shafts, means for detachably and operatively connecting said driven shaft to said feed shaft, mechanism formed in
100 separable parts and operated by said feed shaft for controlling the clutch, and means for removably supporting said gear box on said main frame.

34. A metal-working machine comprising a work spindle, a cam shaft, a drive shaft, a
105 reversible shaft alined with the drive shaft, for driving the work spindle, a gear on the drive shaft, an internal gear on the reversible shaft, a sleeve on the drive shaft having a planetary gear meshing with the two said
110 gears, a clamp for frictionally holding said sleeve against rotation, a friction clutch for clutching said sleeve to said shaft, and mechanism operated by said cam shaft for actuating said friction clamp to release said
115 sleeve and simultaneously actuating said clutch to clutch said sleeve to said drive shaft and vice versa.

35. A metal-working machine comprising a work spindle, a cam shaft, a drive shaft, a
120 reversible shaft alined with the drive shaft, for driving the work spindle, planetary gearing between said shafts, including a sleeve loose on said drive shaft, a friction clutch for clutching said sleeve to said shaft,
125 a clamp for clamping the sleeve against rotation, and means operated by the cam shaft for actuating said clutch and said clamp.

36. A metal-working machine comprising a work spindle, a cam shaft, a drive shaft, a
130

reversible shaft alined with the drive shaft, for driving the work spindle, planetary gearing between said shafts including a sleeve loose on the shaft, a friction clutch for
 5 clutching said sleeve to said shaft; a clamp comprising a nut, and an operating screw therefor having a gear, a rack for rotating the gear, and means operated by the cam shaft for operating said clutch and moving
 10 said rack.

37. A metal-working machine comprising a work spindle, a cam shaft, a drive shaft, a reversible shaft alined with the drive shaft, for driving the work spindle, planetary gear-
 15 ing between the shafts including a sleeve, and mechanism automatically operated by the cam shaft for clamping the sleeve against rotation and unclutching the sleeve from the drive shaft, and vice versa.

38. In a metal-working machine, a main
 20 frame, a work spindle, a main tool carrier, a cam shaft, a cam carrier thereon, a hood or casing inclosing said cam carrier, a supplemental tool carrier, means operated by the
 25 cam disk for operating the supplemental tool carrier, and extending through a slot in said hood or casing, and means for preventing the passage of chips through said slot.

39. In a metal-working machine, a main
 30 frame, a work spindle, a main tool carrier, a cam shaft, a cam carrier thereon, a hood or casing on the main frame inclosing the cam carrier, a supplemental tool carrier having an arm extending through a slot in the hood
 35 or casing, and a slide engaged and movable with said arm and covering the slot in the casing to prevent the passage of chips or cuttings therethrough.

40. In a metal-working machine, a main
 40 frame, a work spindle, a main tool carrier, a cam shaft, a cam carrier thereon arranged outside the end wall of said frame, a hood or casing on the end of said main frame and inclosing said cam carrier, a supple-
 45 mental cross-moving tool carrier having an operating member extending through a slot in said hood or casing, and means for closing said slot to prevent the entrance of chips or cuttings into said hood or casing.

41. In a metal-working machine, a main
 50 frame, a work spindle, a main tool carrier, a cam shaft, a cam carrier thereon arranged outside the end wall of said frame, a hood or casing on the end of said main frame and in-
 55 closing said cam carrier, a supplemental tool-holding cross-slide mounted on guides on the main frame, and a lever for actuating said slide and operated by the cam carrier, said lever having its hub located in a slot
 60 in said hood or casing, there being means at the ends of the slot engaging the periphery of the hub to prevent the passage of chips.

42. In a metal-working machine, a main
 65 frame, a work spindle, a main tool carrier, a cam shaft, a cam carrier thereon arranged

outside the end wall of said frame, a hood or casing on the end of said main frame and inclosing said cam carrier, supplemental tool carriers movable transversely of the tool
 spindle and having operating members ex- 70
 tending through slots in said hood or casing into operative relation to said cam carrier, and means for preventing the passage of chips through said slots.

43. In a metal-working machine, a main 75
 frame, a main tool carrier, a work spindle, a cam shaft for feeding the tools, one or more supplemental cross-moving tool carriers, a cam carrier on the end of the cam shaft out-
 side the end of the main frame for operating 80
 the supplemental tool carriers, and a hood or casing on the end of the main frame and inclosing said cam carrier, said hood or casing comprising a hinged door which may be
 opened to expose said cam carrier. 85

44. In a metal-working machine, a work
 spindle, a feed shaft for feeding the tools, a drive shaft, a power-transmitting mecha-
 nism operated by the drive shaft for rotating 90
 the spindle and the feed shaft comprising a friction clutch mechanism and a positive clutch mechanism, and means operated by
 the feed shaft for closing the friction clutch until the inertia of the spindle and feed
 shaft is overcome, and for subsequently clos- 95
 ing the positive clutch mechanism for driving the spindle and feed shaft positively.

45. A lathe comprising a main frame hav-
 ing a work holder and a tool holder, and cams for controlling the operation of said 100
 holders, and a detachable gear box containing change speed mechanism for the work holder and the cams.

46. A lathe comprising a main frame, a gear box, and means for connecting the same 105
 together; said main frame being provided with a work holder, a tool holder, and a cam carrier for operating the tool holder; said gear box being provided with a spindle-driving shaft, a cam-carrier driving shaft, and 110
 change speed mechanism including clutches for driving said shafts at different speeds; in combination with means for transmitting power from said shafts to the spindle and cam carrier respectively, and means operated 115
 by said cam carrier on the main frame for shifting said clutches in the gear box.

47. A lathe comprising a main frame provided with a work holder, a tool holder, and a cam carrier; a gear box provided with 120
 change speed mechanism, detachable connections for transmitting power from the change speed mechanism to the instrumentalities of the main frame, and means for detachably connecting the main frame and 125
 the gear box.

48. A lathe comprising a work spindle, a tool holder, a cam carrier, and a frame on which said instrumentalities are mounted, and a detachable gear box having speed- 130

changing mechanism for imparting movement to said instrumentalities on said frame.

49. A lathe comprising a frame, a spindle journaled thereon, a separable gear box having a constant speed drive shaft and variable speed power-transmitting mechanism for the spindle, means for detachably connecting the gear box and the frame in operative relation, and cam mechanism on the frame for controlling the operation of said variable speed mechanism.

50. In a lathe, the combination with a main frame, having a spindle and a cam shaft, of a gear box separable from the main frame and having a spindle-driving shaft and speed-changing mechanism including a clutch for driving said spindle-driving shaft at different speeds, and clutch-controlling mechanism operated by the cam shaft on the main frame.

51. In a lathe, the combination with a main frame, having a spindle and a cam shaft, of a gear box separable from the main frame and having a spindle-driving shaft and speed-changing mechanism including a clutch for driving said spindle-driving shaft at different speeds, and clutch-controlling mechanism operated by the cam shaft on the main frame and consisting of separable portions in consequence of which the gear box may be detached from the main frame.

52. In a lathe, the combination with a main frame having a work spindle, and a cam carrier, of a separate gear box having a spindle-driving shaft detachably connected to said spindle, speed changing mechanism including a clutch for driving said spindle-driving shaft at different speeds, and clutch-controlling means operated by said cam carrier on the main frame and consisting of separable portions whereby said gear box may be detached from the main frame.

53. A metal working machine comprising a main frame, a work spindle and a feed shaft journaled therein, a separable gear box or casing normally in fixed relation to the main frame, and having variable speed power-transmitting mechanism for driving the spindle but separable from the spindle, and controlling means actuated by the feed shaft for automatically controlling the operation of the power-transmitting mechanism.

54. A metal working machine comprising the combination with a tool slide, a work spindle, a feed shaft, and a main frame supporting said instrumentalities, of a variable speed power-transmitting mechanism including a spindle-driving shaft and a shaft for driving the feed shaft, and a separable gear box or casing supporting said power-transmitting mechanism.

55. In a lathe, the combination with a main frame having a work spindle, a tool holder, a cam carrier for operating the tool holder, and a cam shaft; of a separate gear box having a cam-driving shaft connected to the cam shaft, a main drive shaft, and change speed mechanism between said main drive shaft and said cam-driving shaft.

56. In a lathe, the combination with a main frame having a work spindle, a tool holder, a cam carrier for operating the tool holder, and a cam shaft; of a separate gear box having a cam-driving shaft connected to the cam shaft, speed-changing mechanism including a clutch for driving said cam driving shaft at different speeds, and clutch-controlling means operated by said cam carrier on the main frame.

In testimony whereof I have affixed my signature, in presence of two witnesses.

FRANK L. CONE.

Witnesses:

MARCUS B. MAY,
JOHN E. POVEY.