No. 672,398.

Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.)

(Application filed Dec. 26, 1899.)

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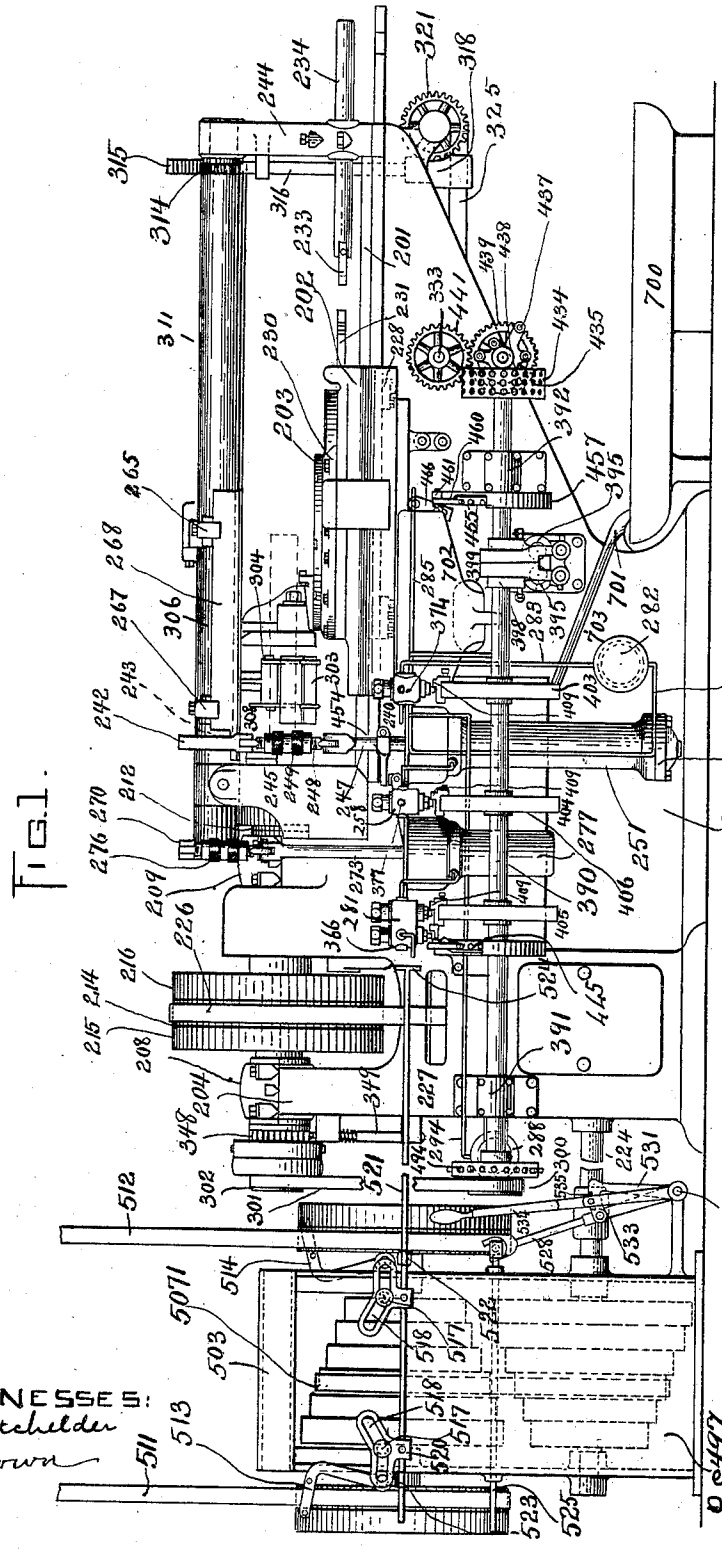


FIG. 1.

WITNESSES:
E. J. Batchelder
H. Brown

INVENTOR
James Hartness
by
Wright Brown & Quinby
his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

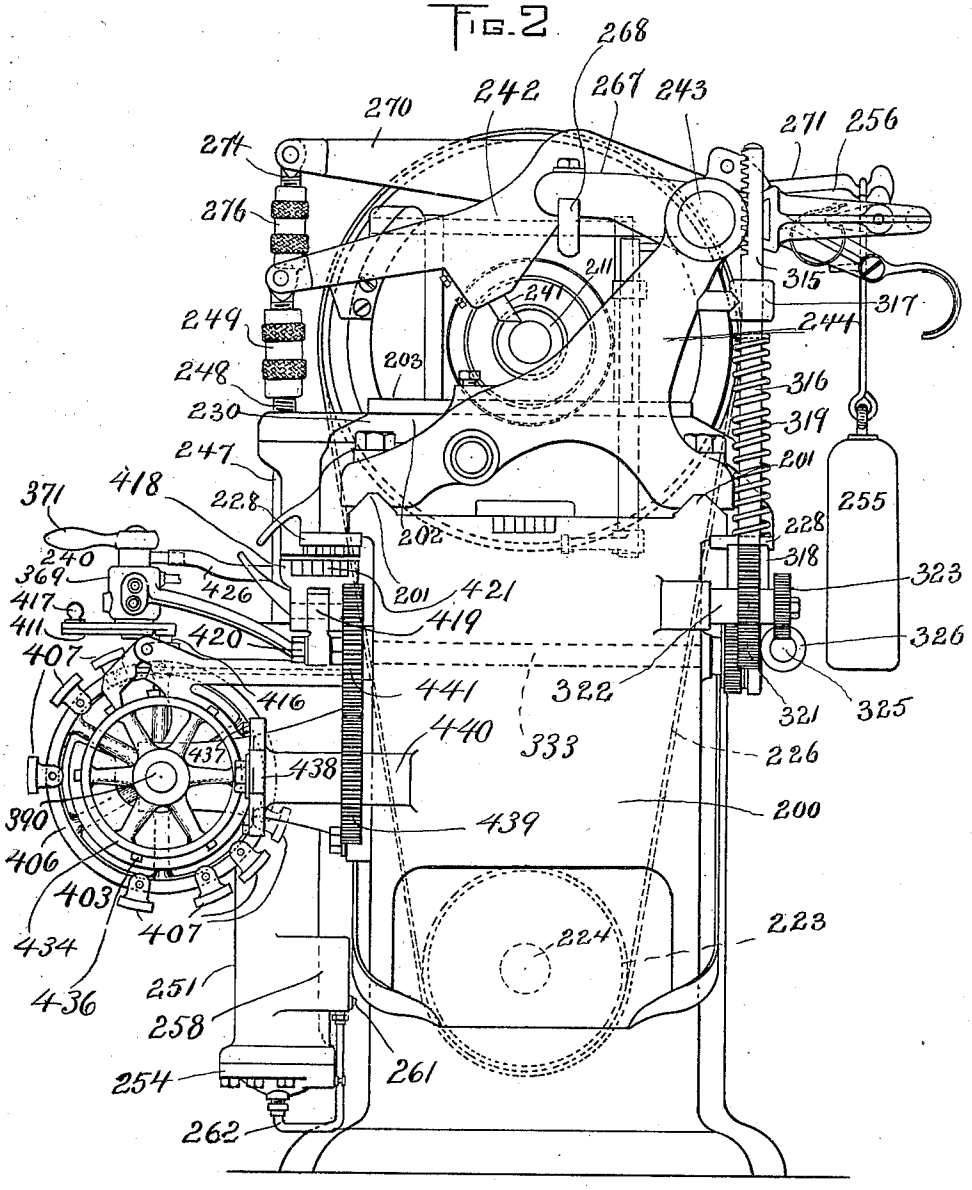
J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

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FIG. 2.



WITNESSES:
E. Batchelder
H. T. Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his attys

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No. 672,398. Patented Apr. 16, 1901.

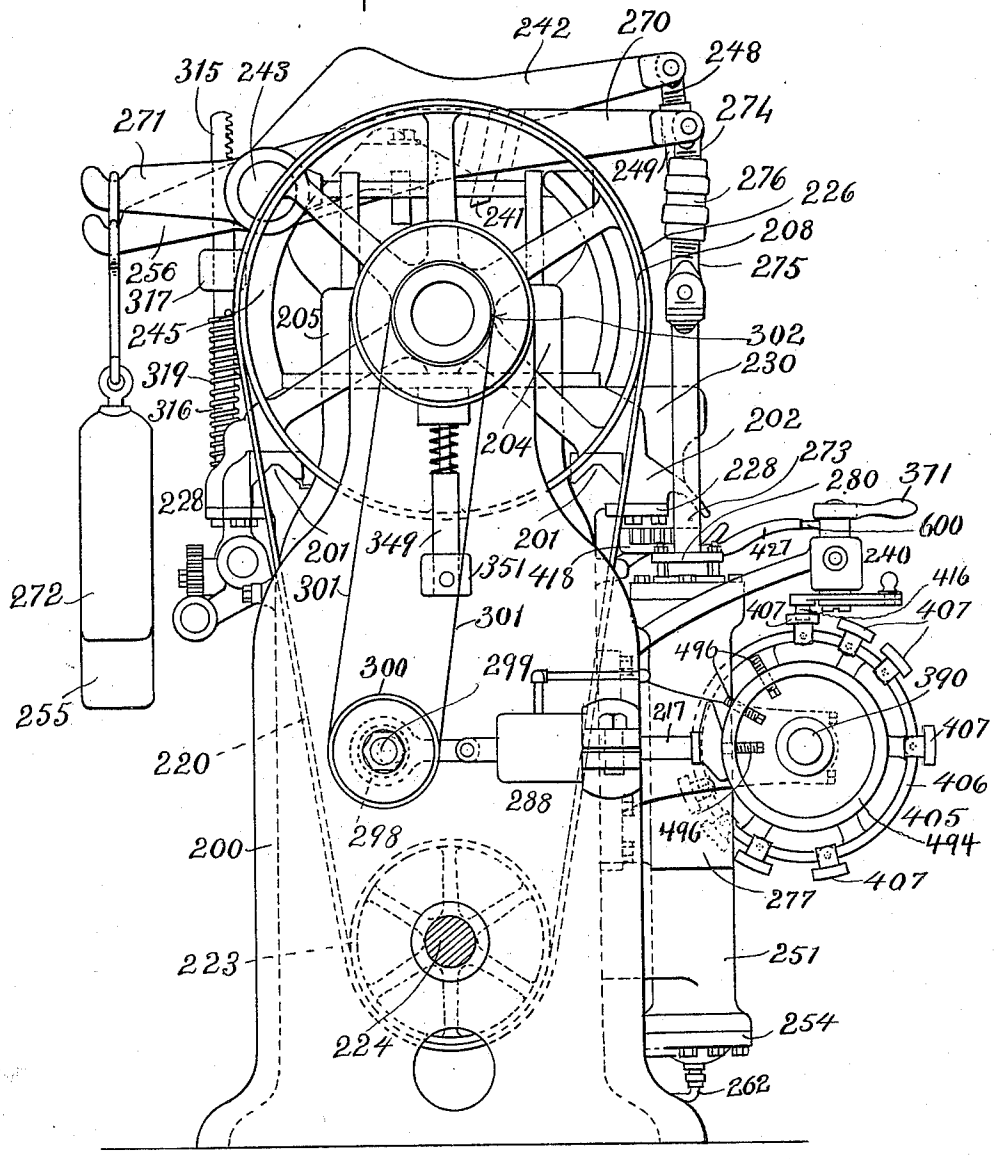
J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

(No Model.) 30 Sheets—Sheet 3.

FIG. 3.



WITNESSES:
E. Batchelder
A. Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his attys

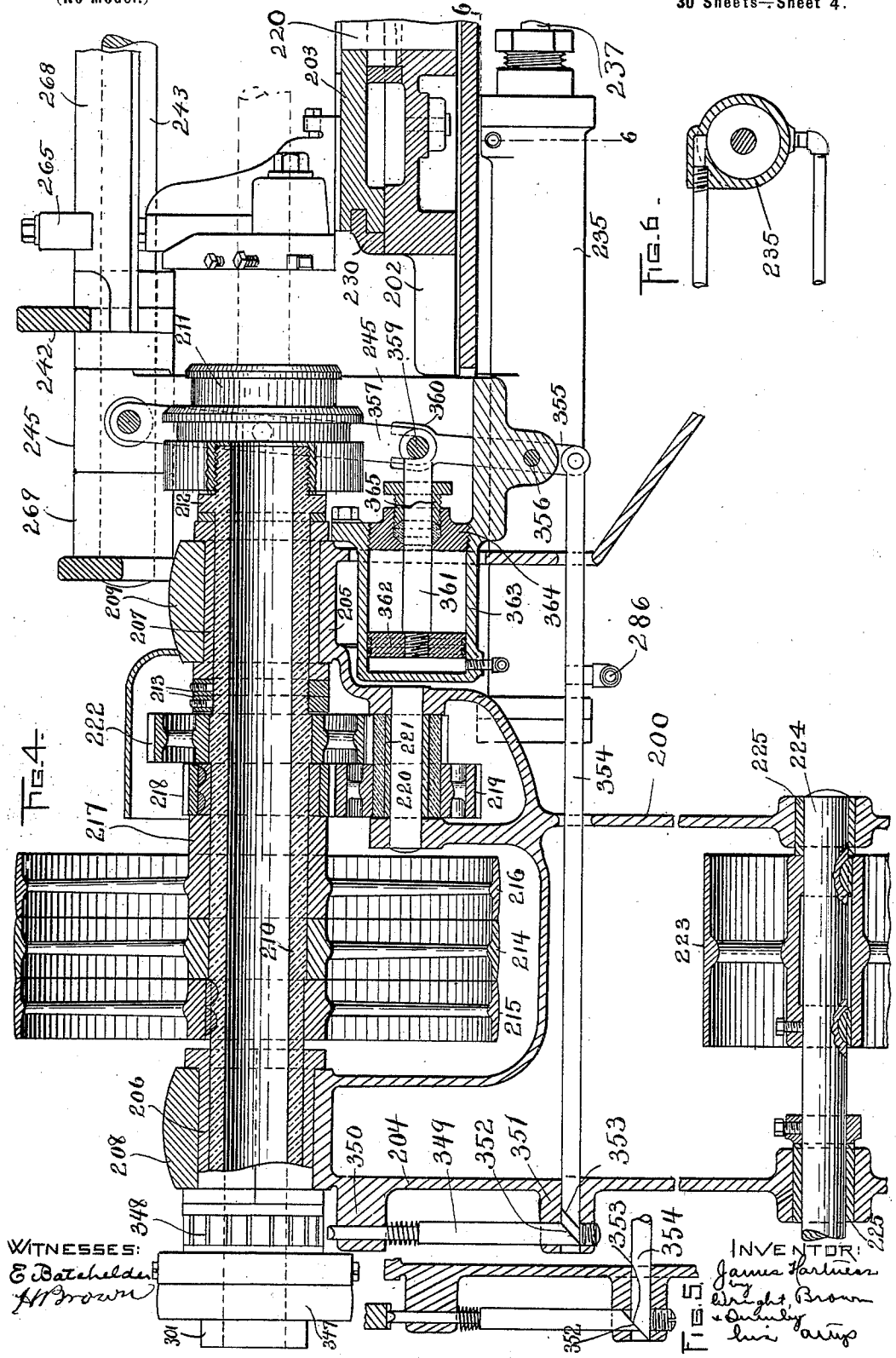
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

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J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

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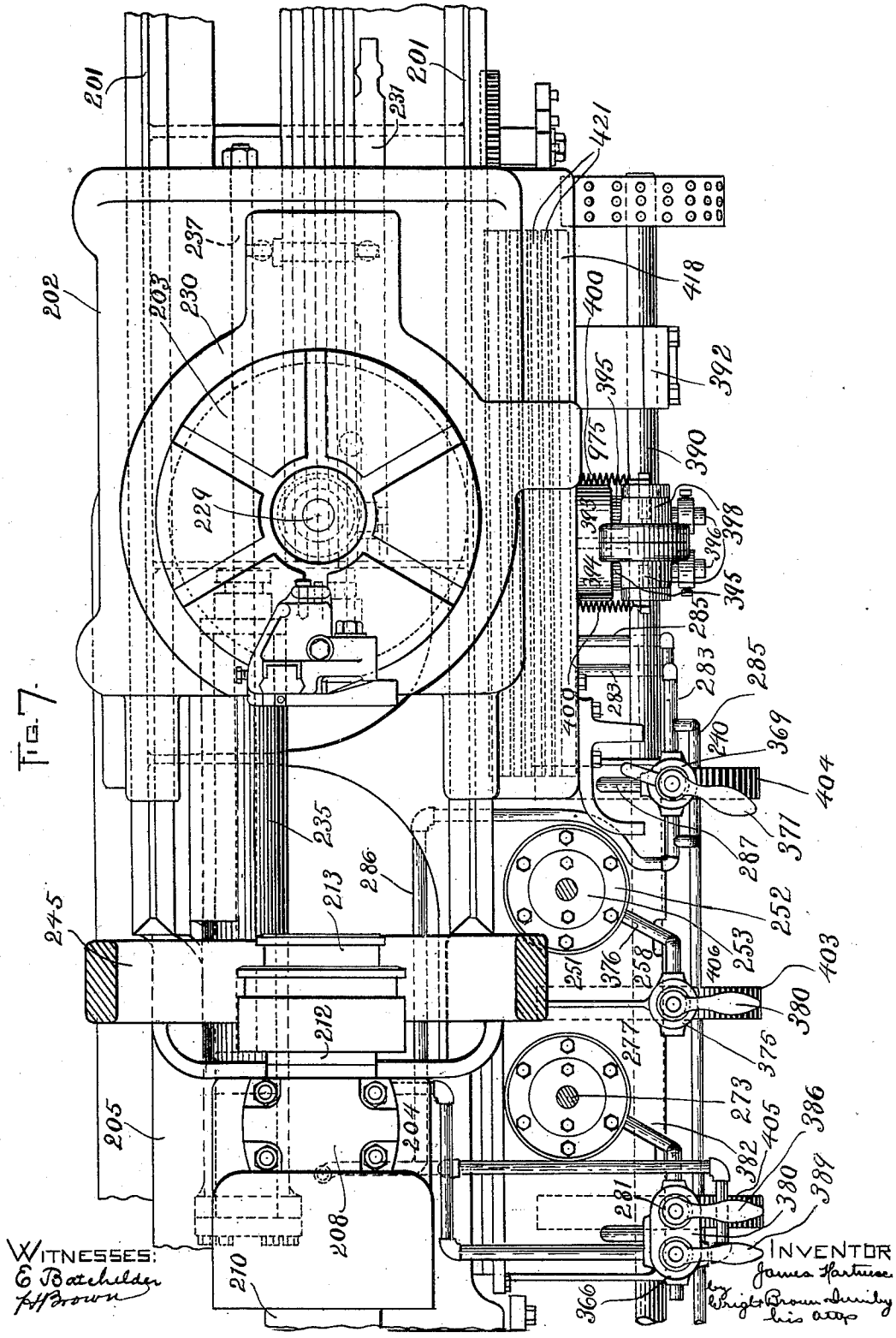


FIG. 7.

WITNESSES:
E. B. Batchelder
H. Brown

INVENTOR
James Hartness
by Wright Brown Quinby & Wright his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

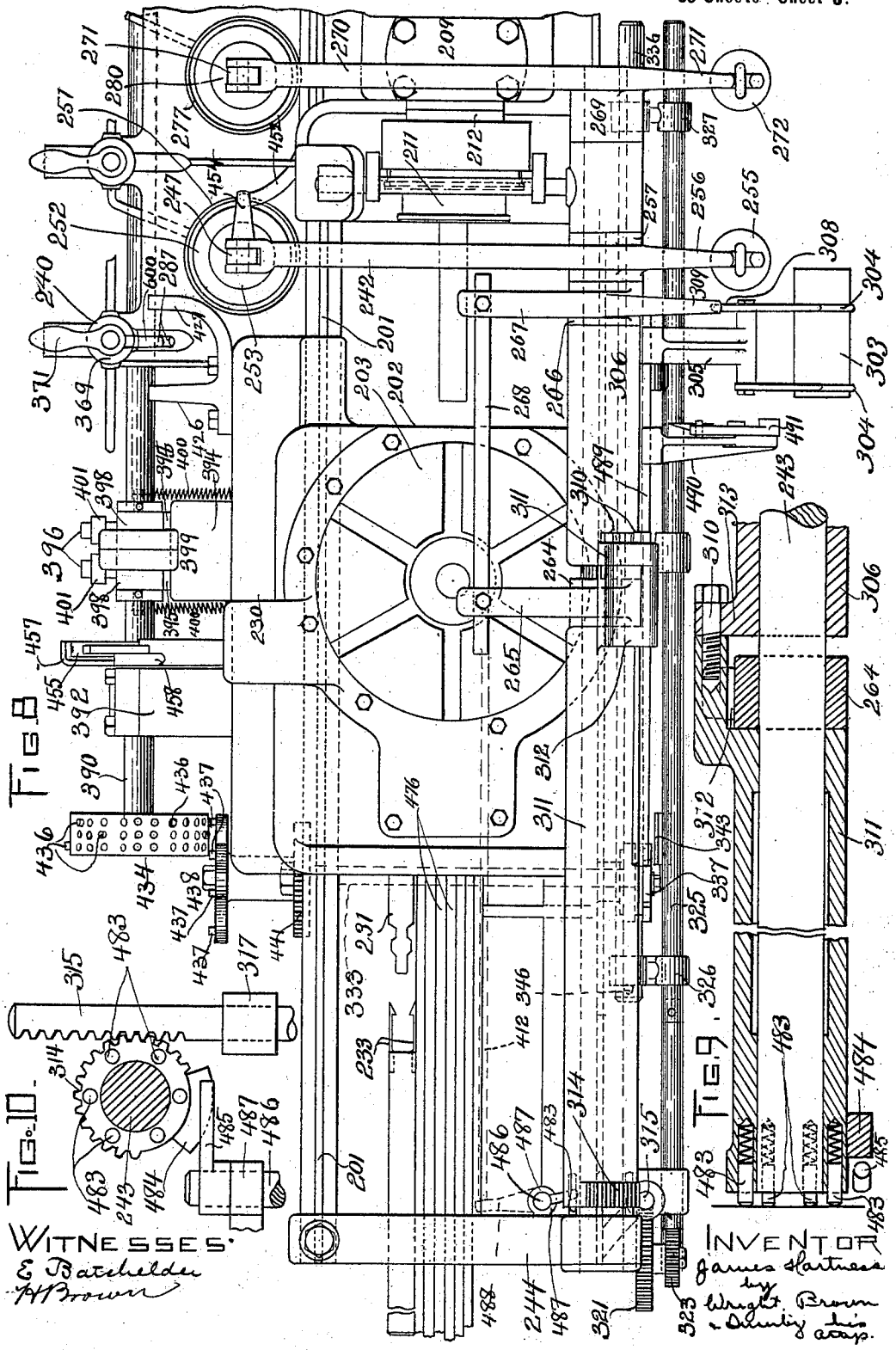
No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 6.



Witnesses:
E. Batchelder
H. H. Brown

Inventor:
James Hartness
by Wright, Brown & Quinby his attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

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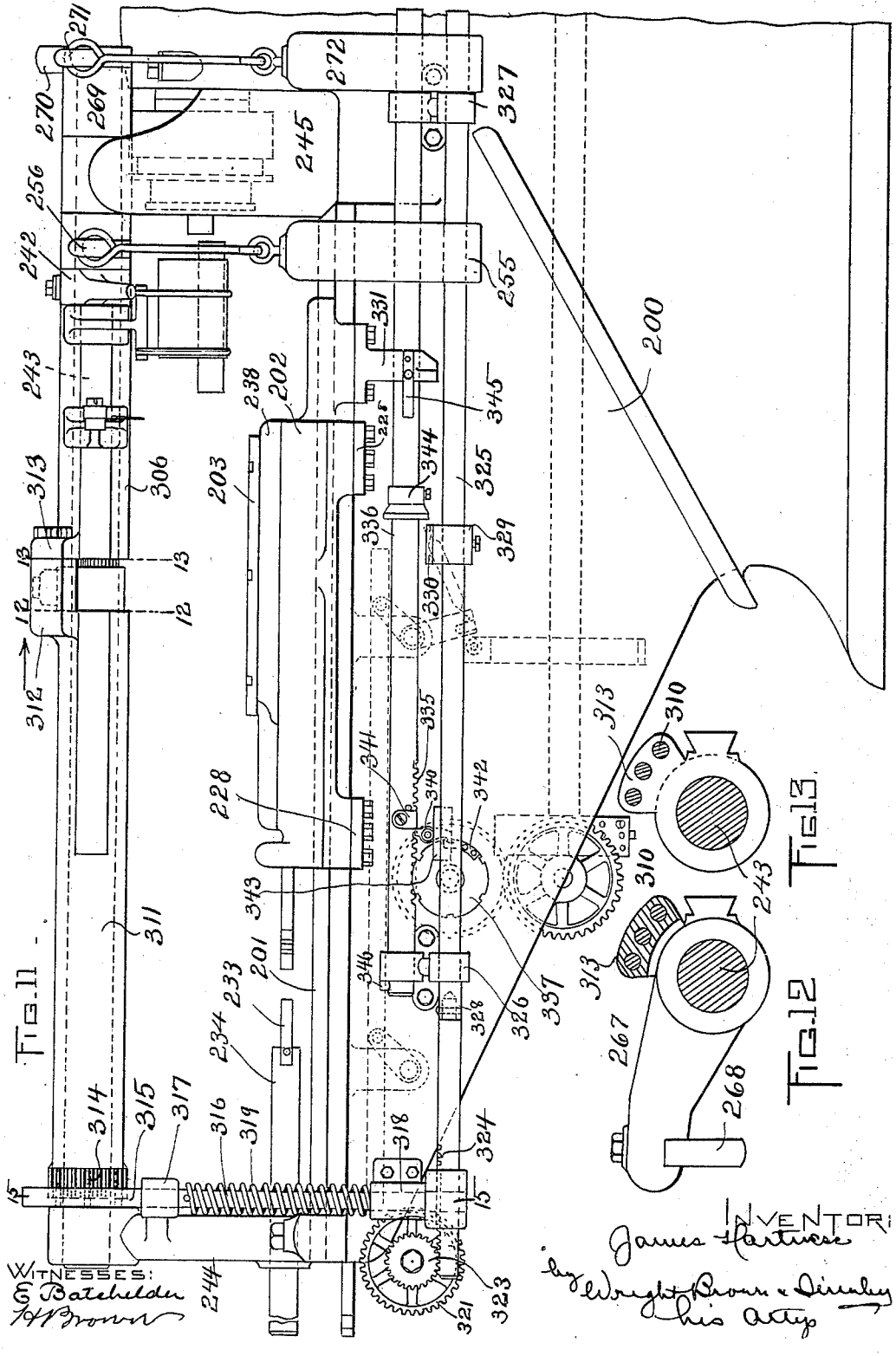


FIG. 11.

FIG. 12. FIG. 13.

Inventor:
James Hartness
by Wright Brown & Quinby
his Attys

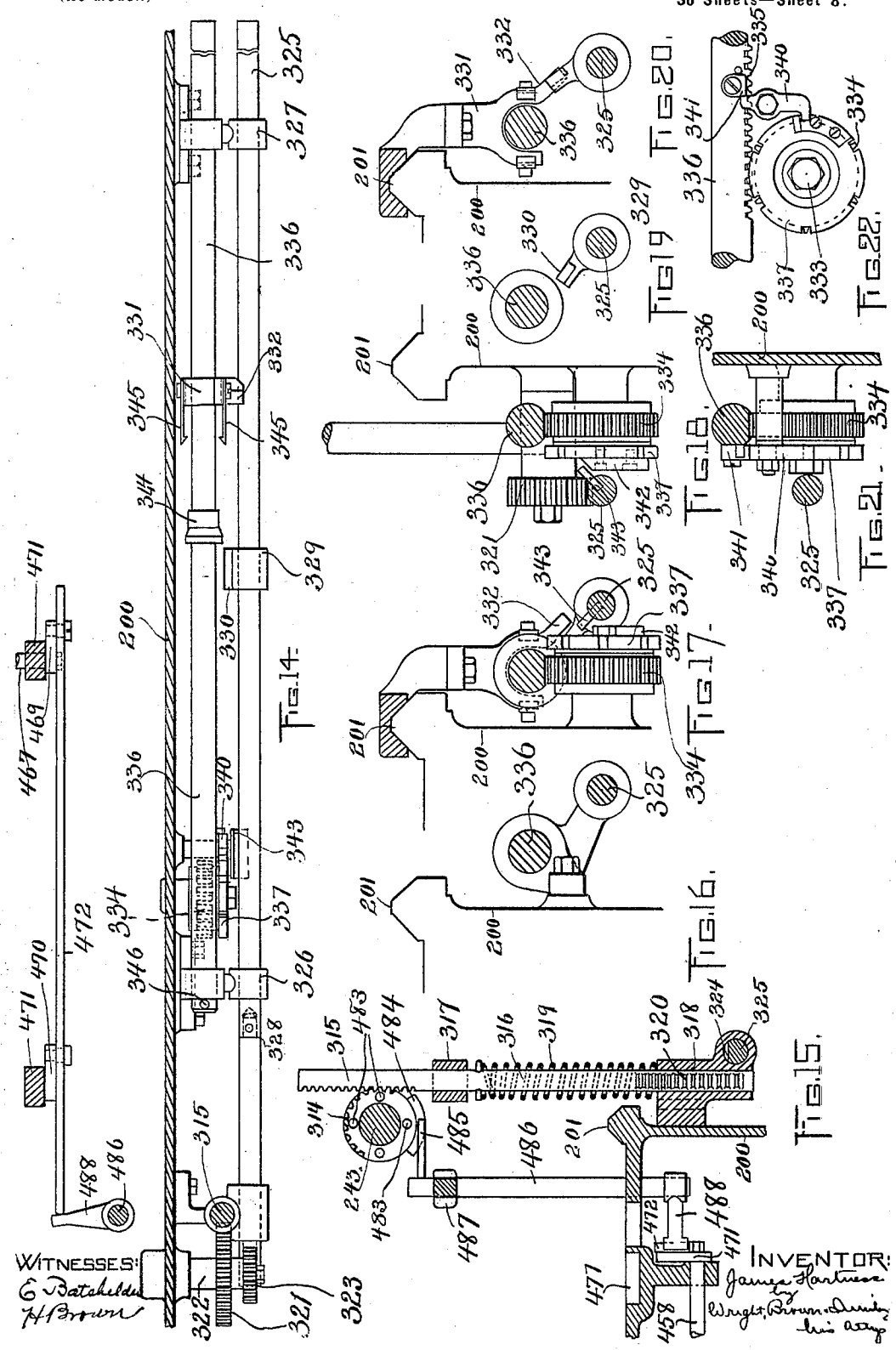
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

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J. HARTNESS.

LATHE.

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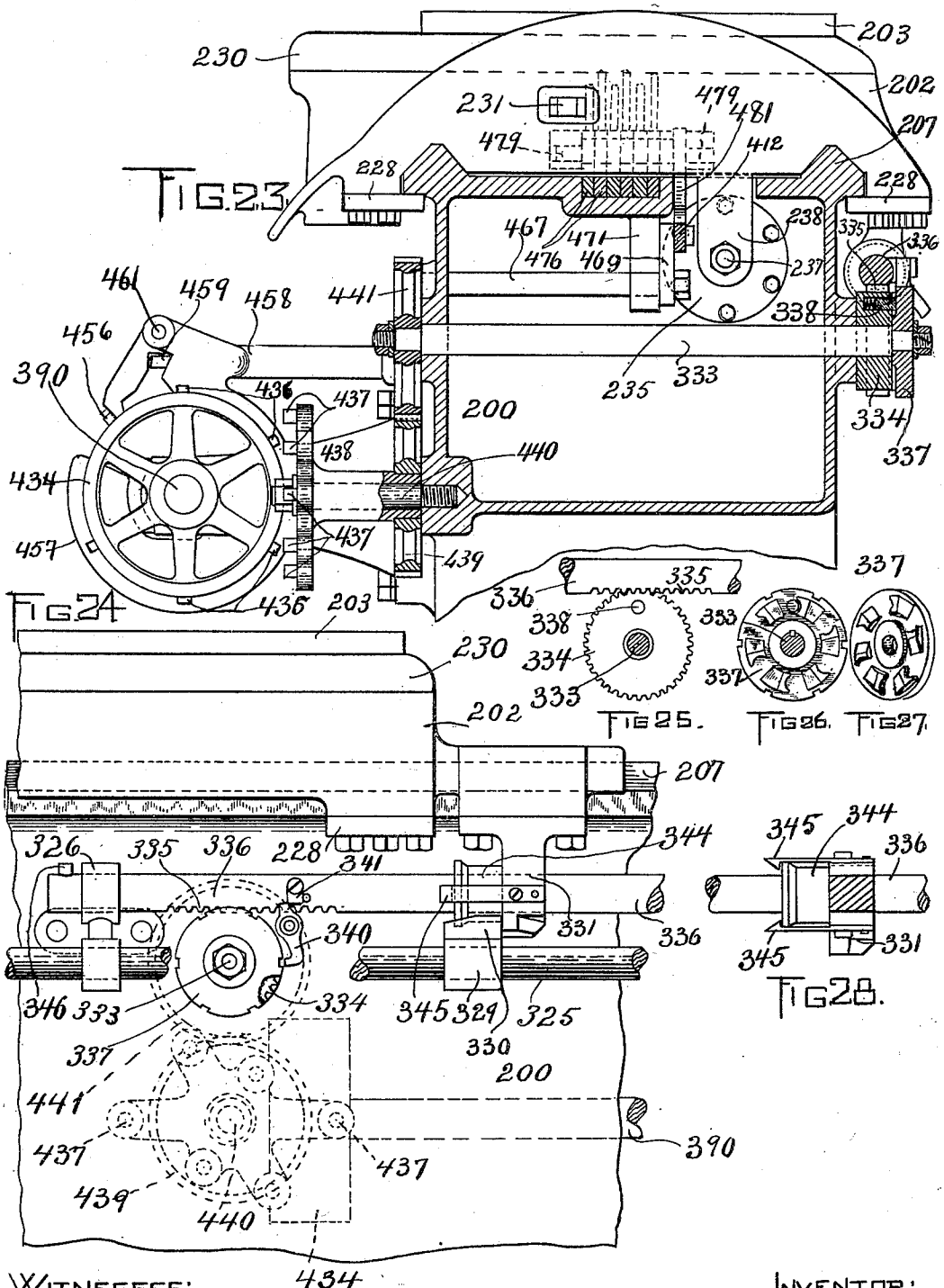


FIG 23.

FIG 24.

FIG 25.

FIG 26.

FIG 27.

FIG 28.

WITNESSES:
E Batchelder
H Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

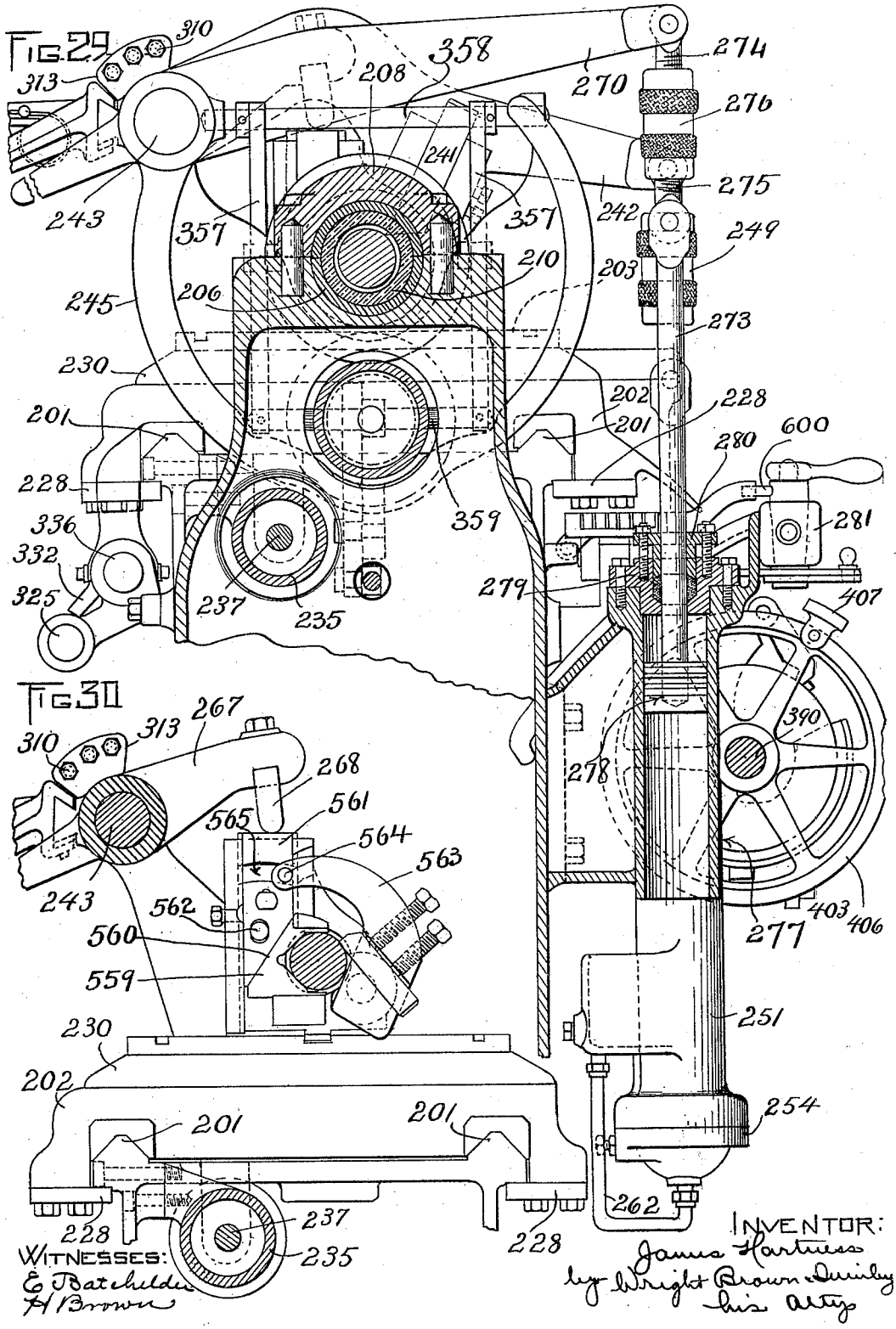
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LATHE.

(Application filed Dec. 26, 1899.)

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J. HARTNESS.

LATHE.

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Fig 31.

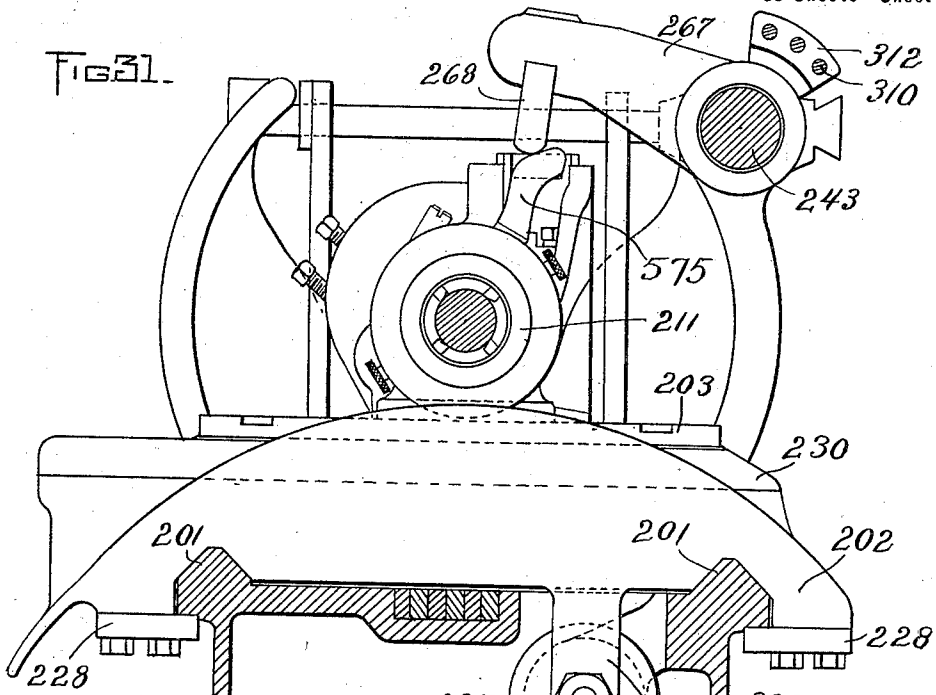
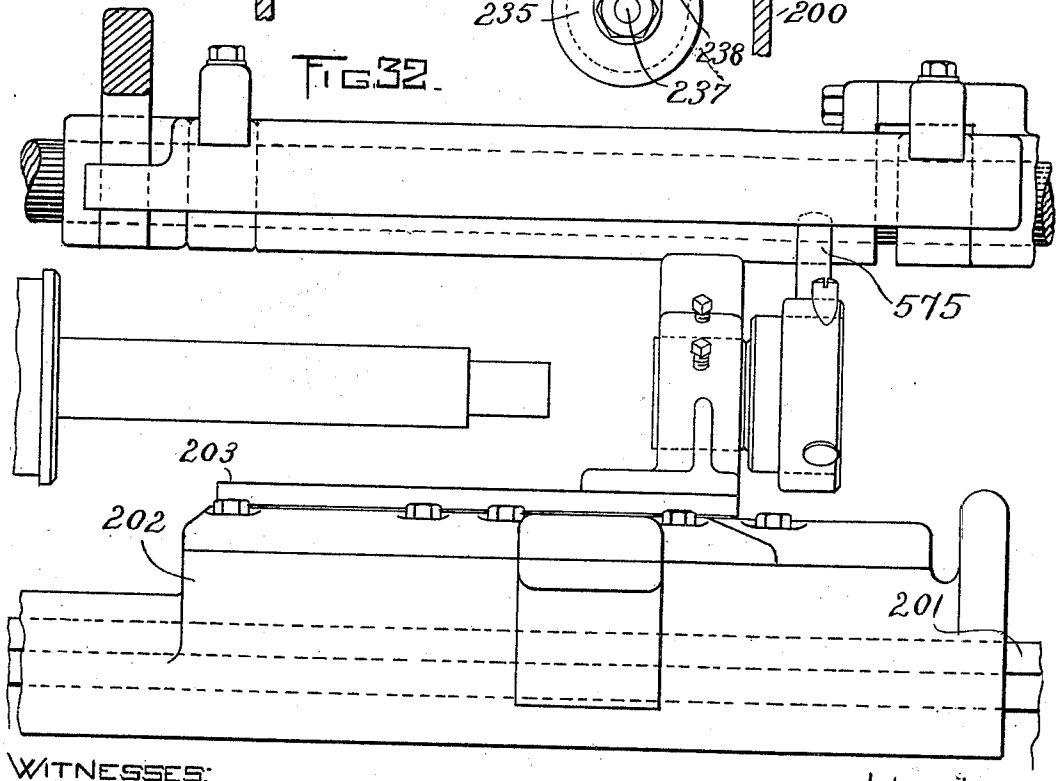


Fig 32.



WITNESSES:
E Batchelder
H H Brown

INVENTOR
James Hartness
by Wright Brown & Quinby
his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398.

Patented Apr. 16, 1901.

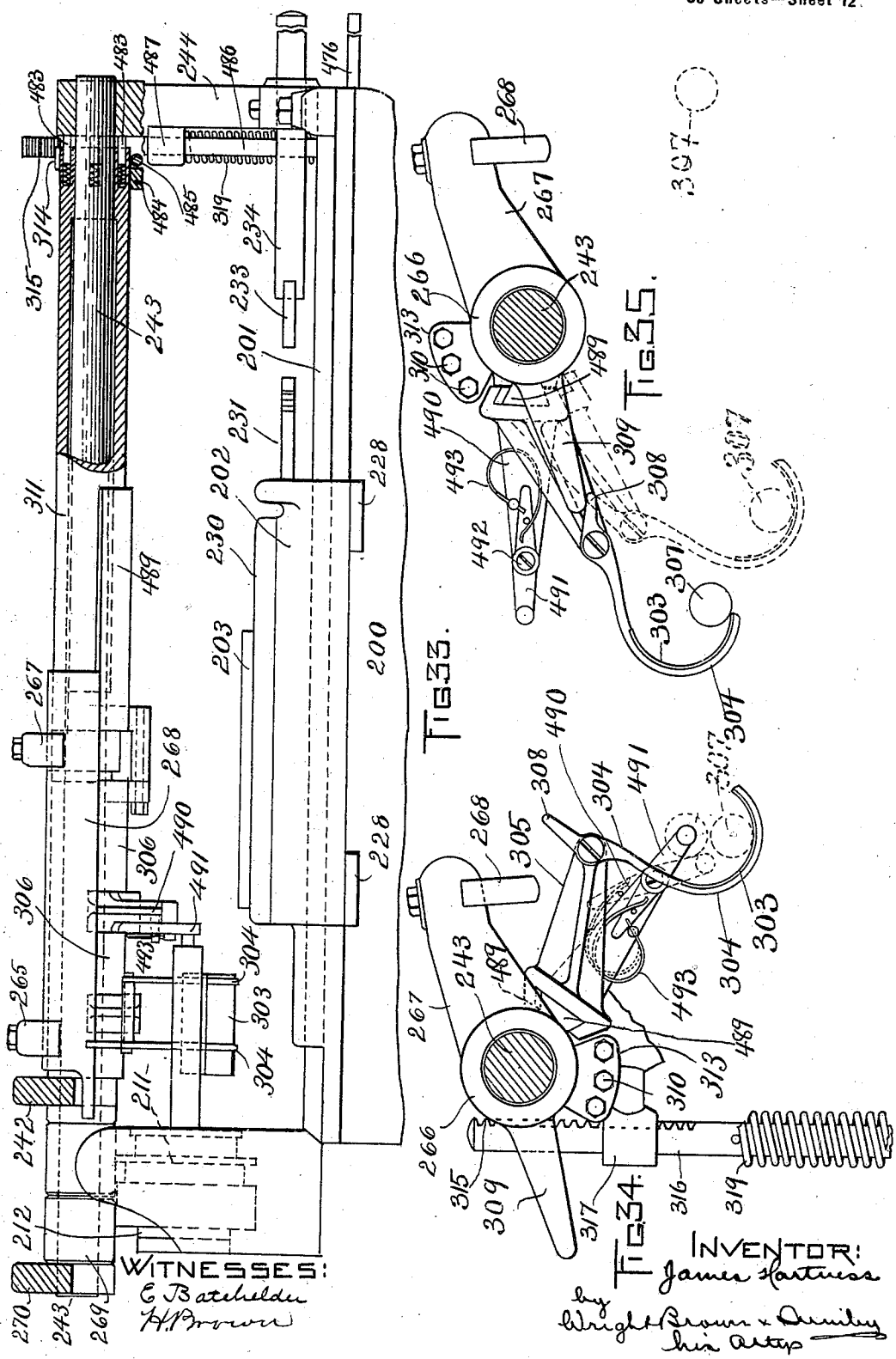
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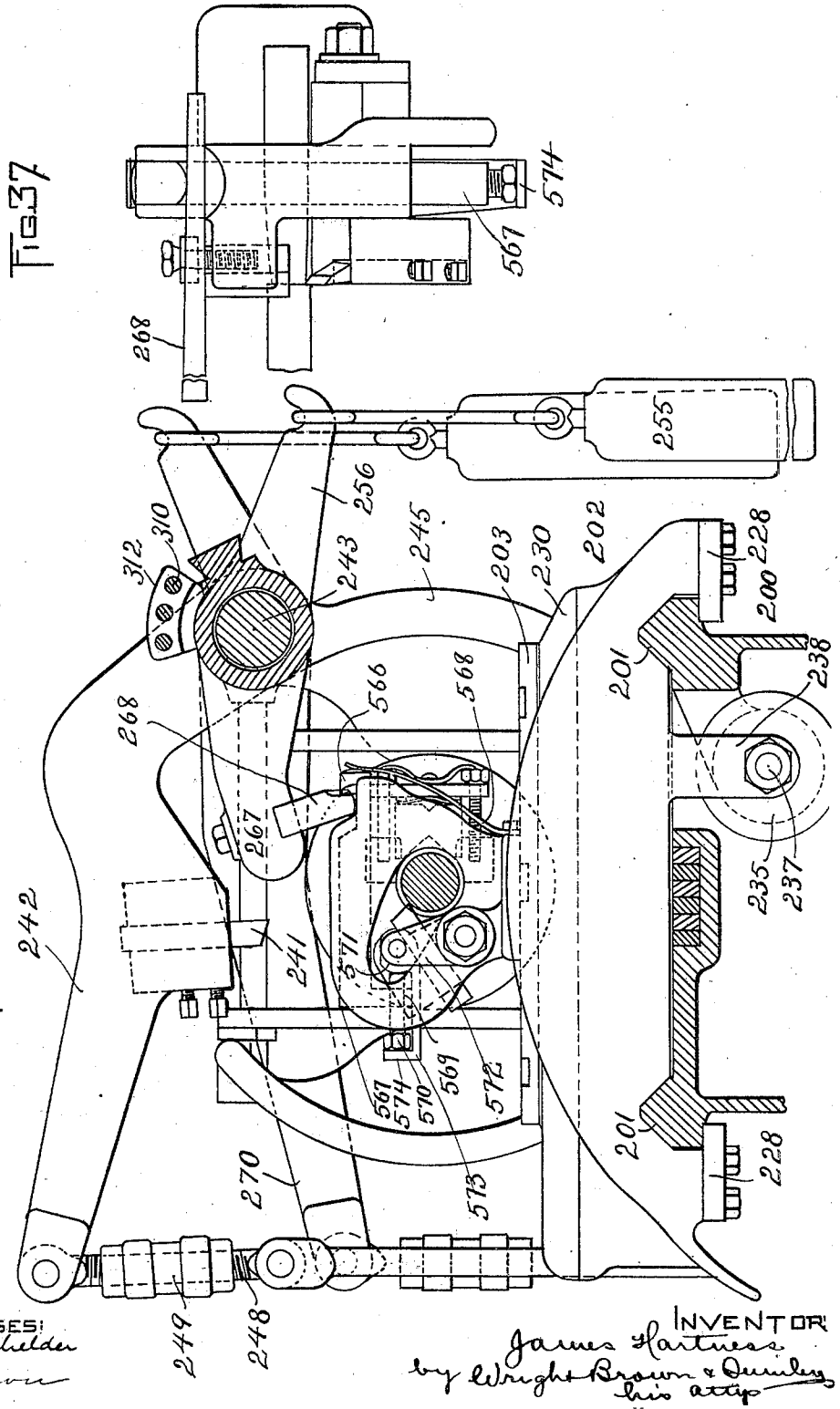
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J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

(No Model.) 30 Sheets—Sheet 13.



Witnesses:
E. Batchelder
H. Brown

Inventor:
James Hartness
by Wright Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398.

Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

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Fig. 38.

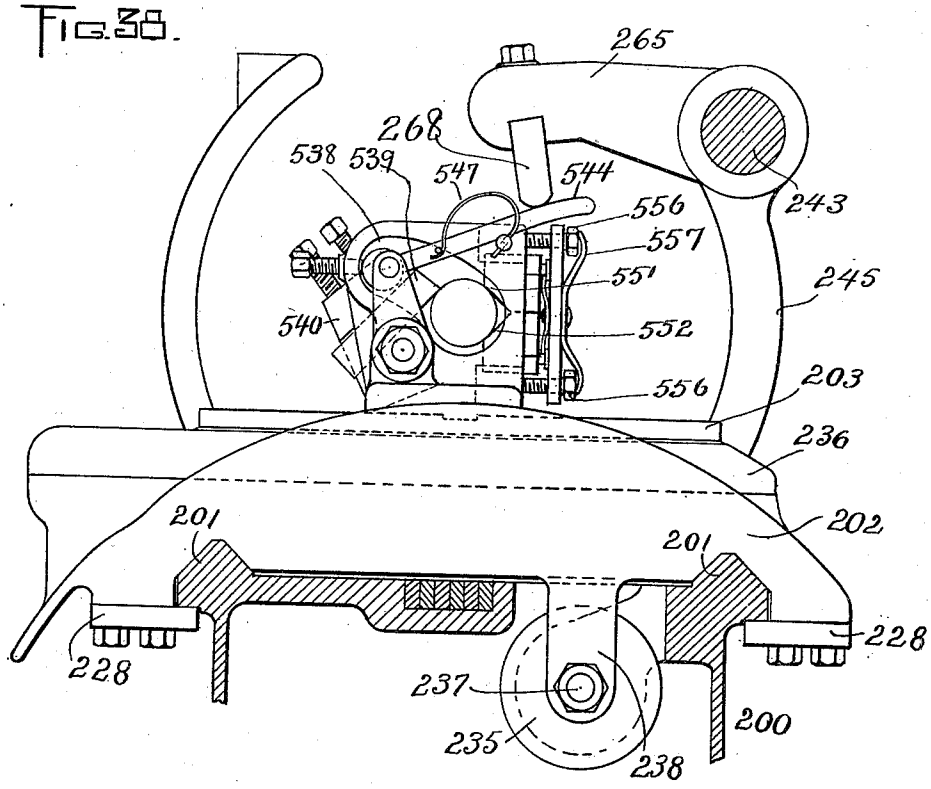
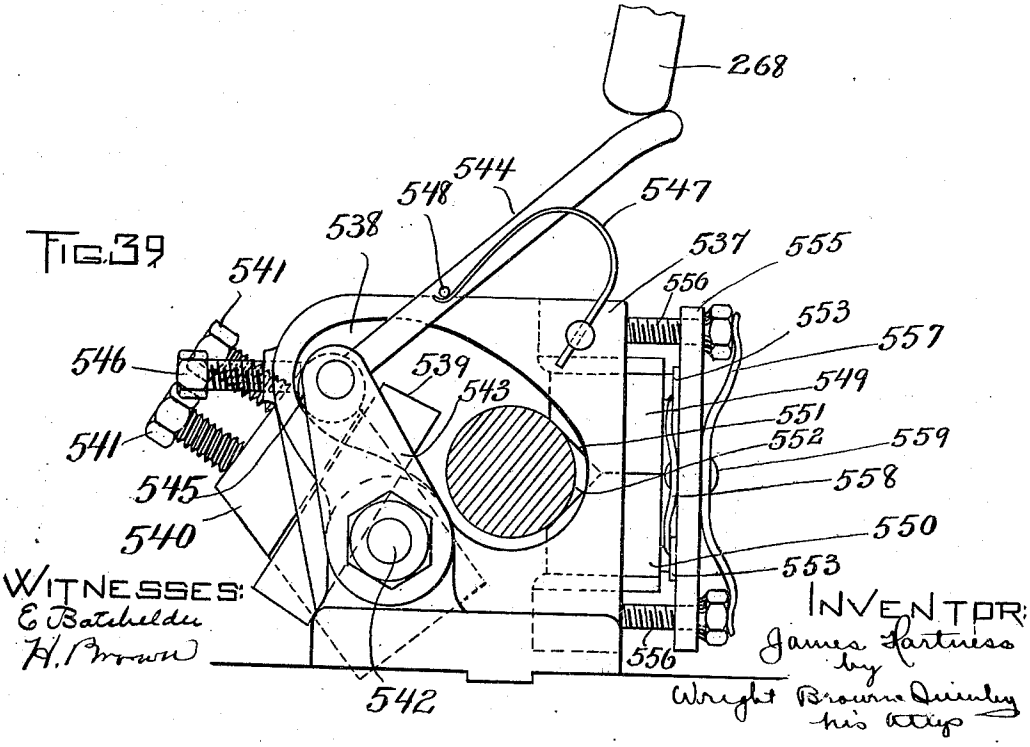


Fig. 39.



WITNESSES:
E. Batchelder
H. Brown

INVENTOR:
James Hartness
by
Wright Brown Quinby
his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

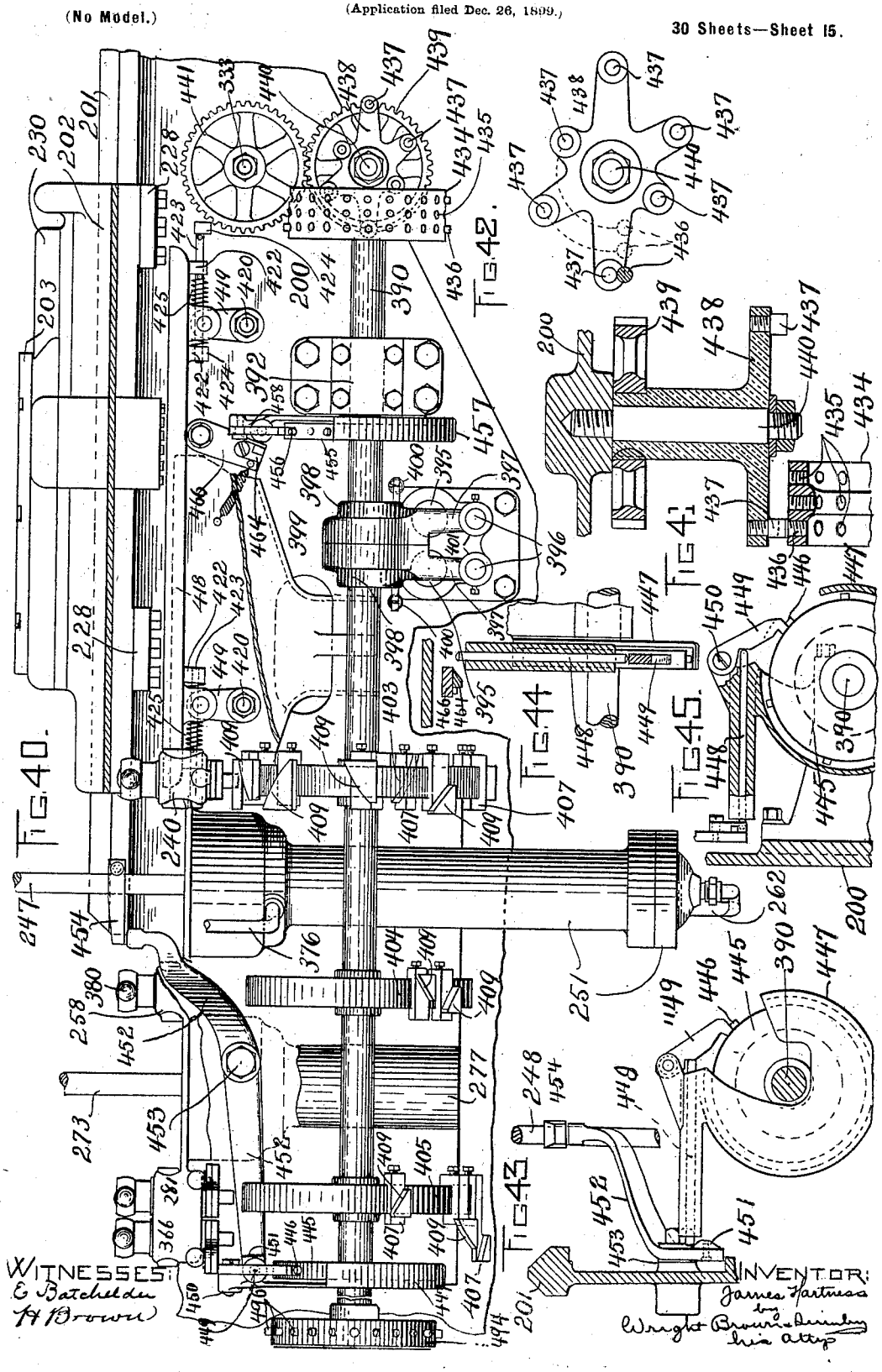
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J. HARTNESS.

LATHE.

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No. 672,398.

J. HARTNESS.

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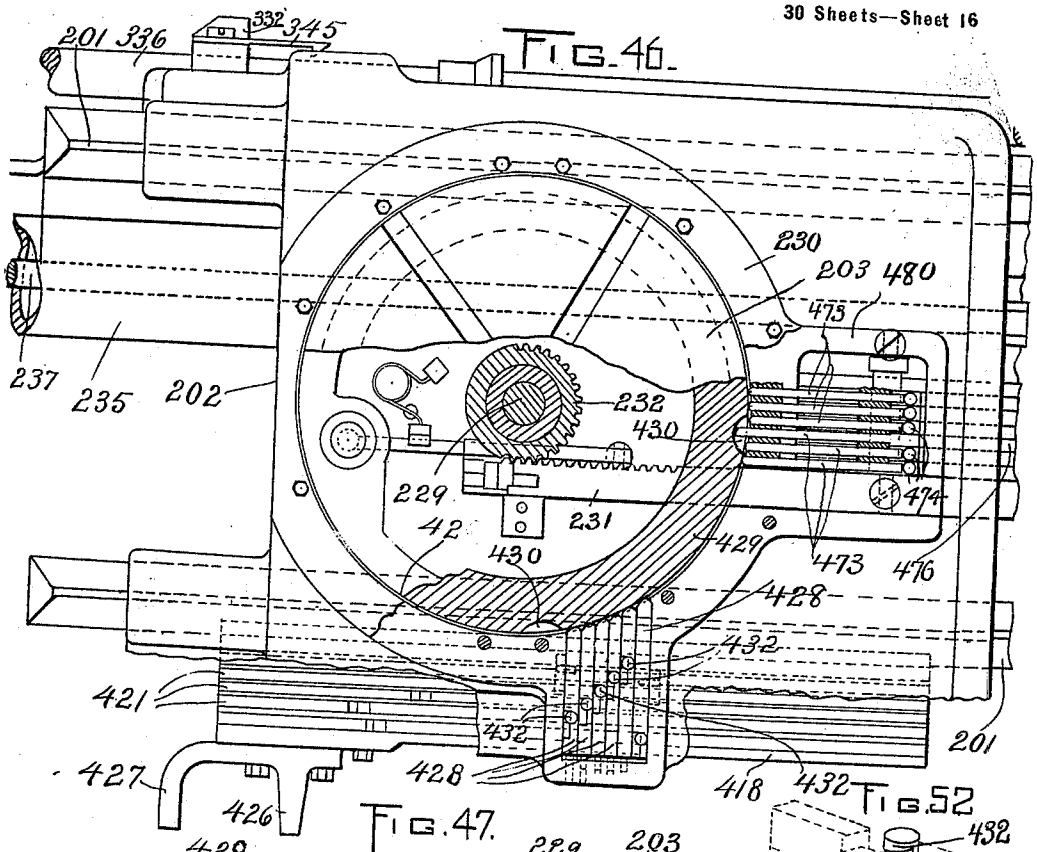


FIG. 46.

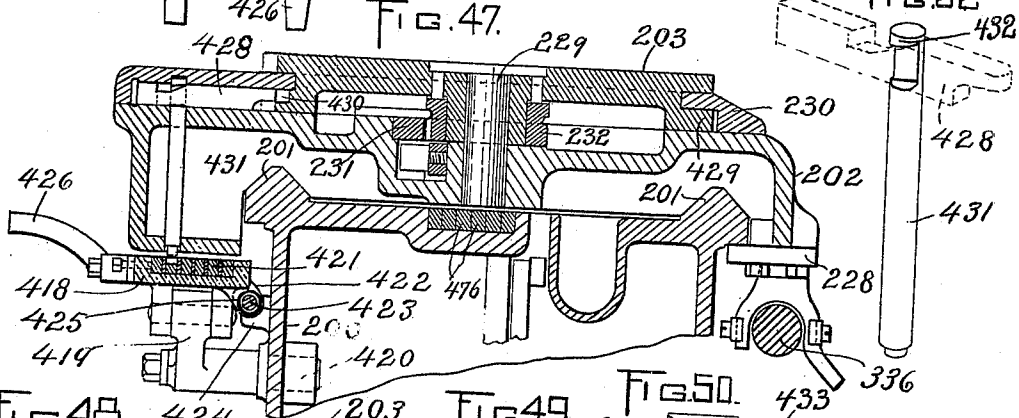


FIG. 47.

FIG. 52.

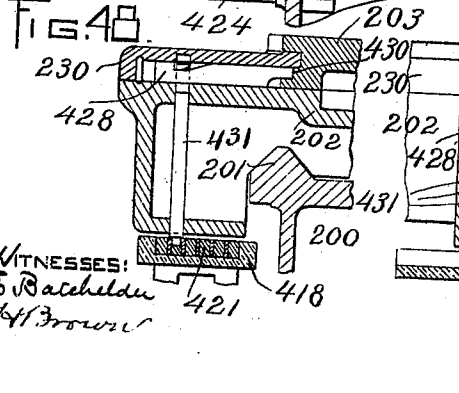


FIG. 48.

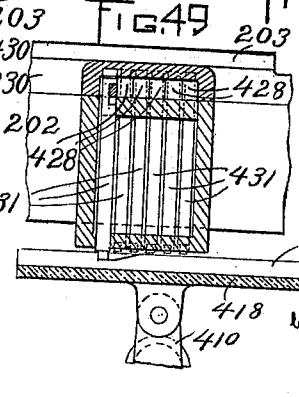


FIG. 49.

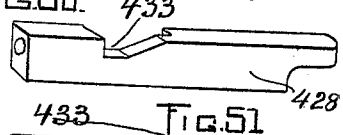


FIG. 50.

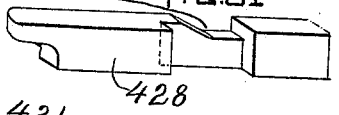


FIG. 51.

Witnesses:
E. Batchelder
T. H. Brown

James Hartness
Inventor:
by Wright Brown & Quinby
his attys.

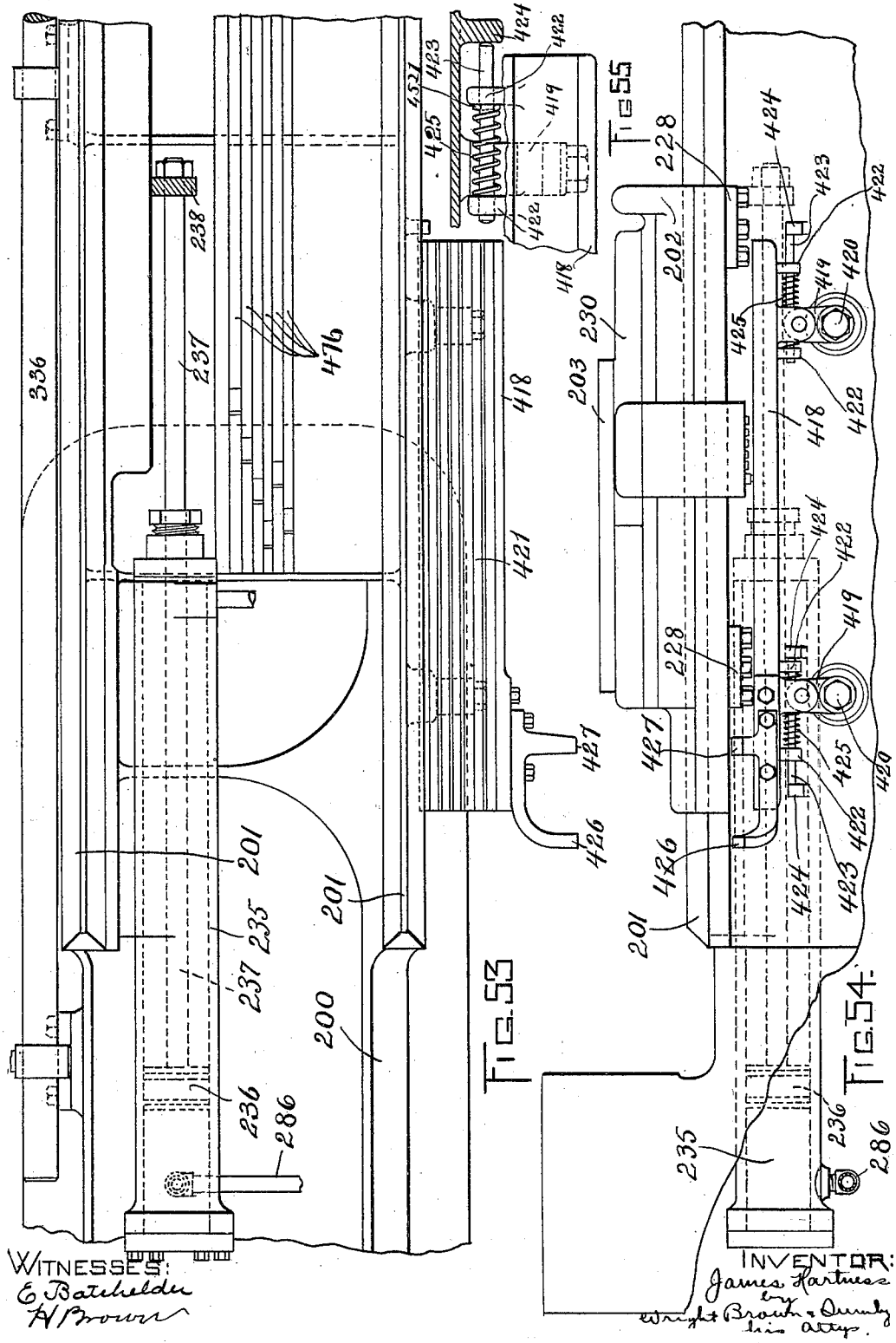
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

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WITNESSES:
E. Batchelder
H. Brown

INVENTOR:
James Hartness
by
Wright Brown & Quinby
his Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

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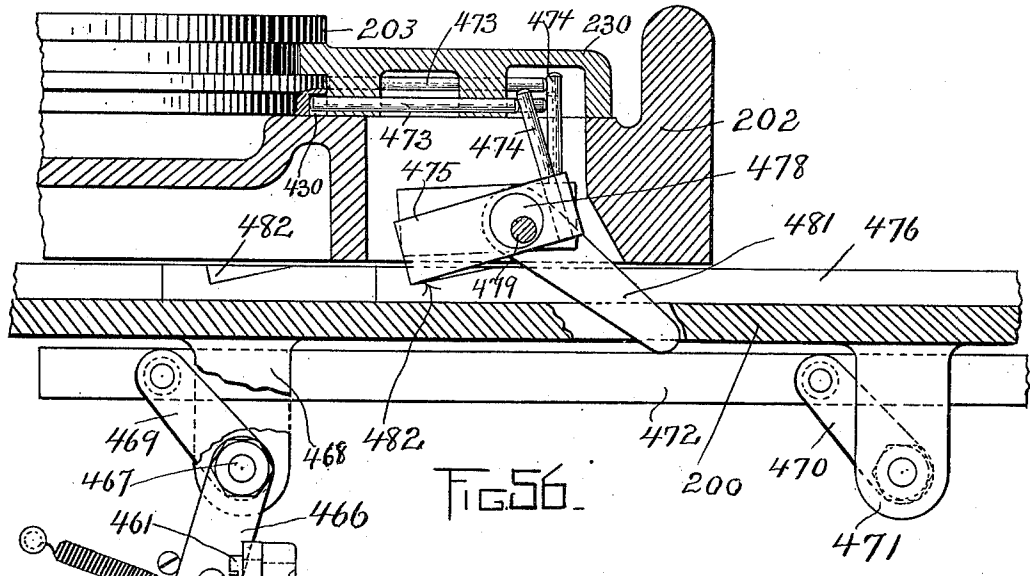


FIG. 56.

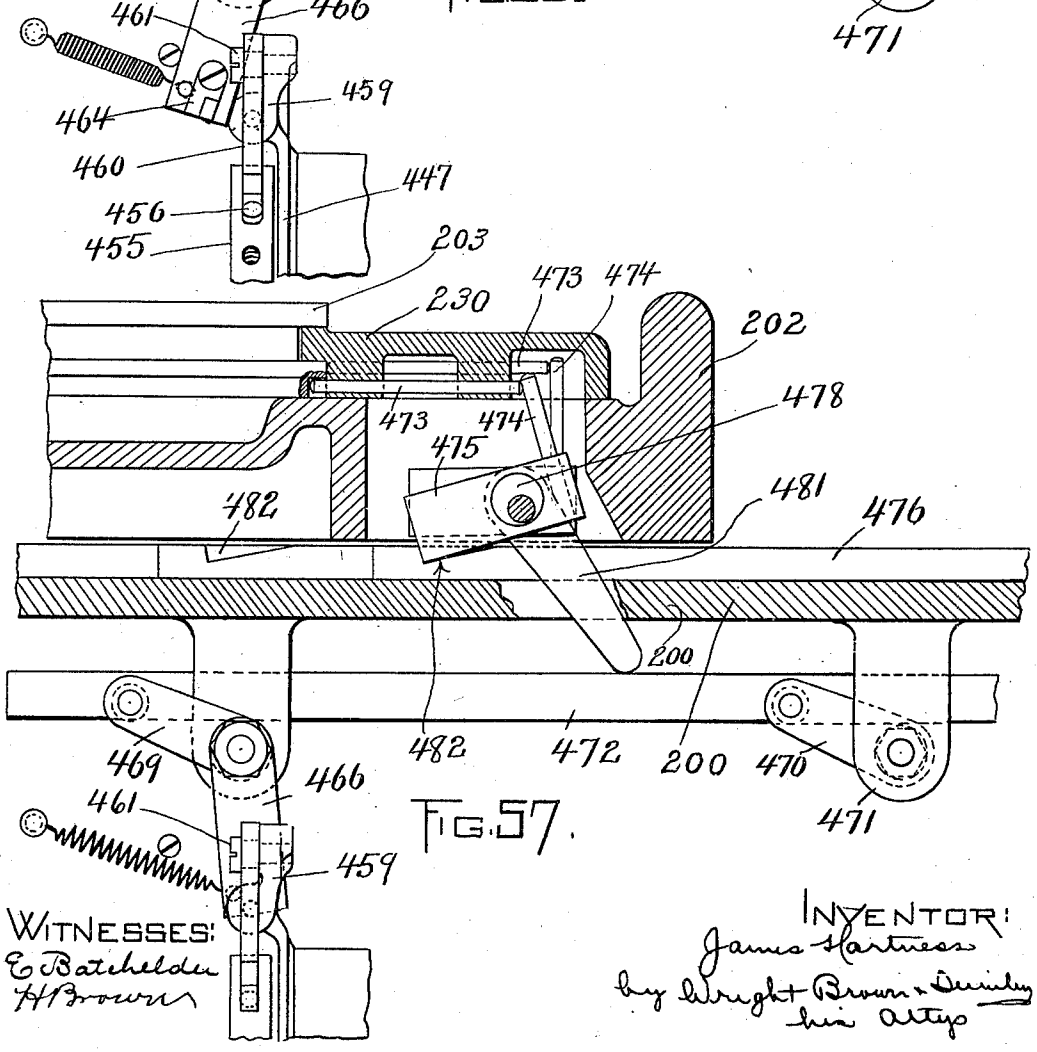


FIG. 57.

WITNESSES:
E. Batchelder
H. Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

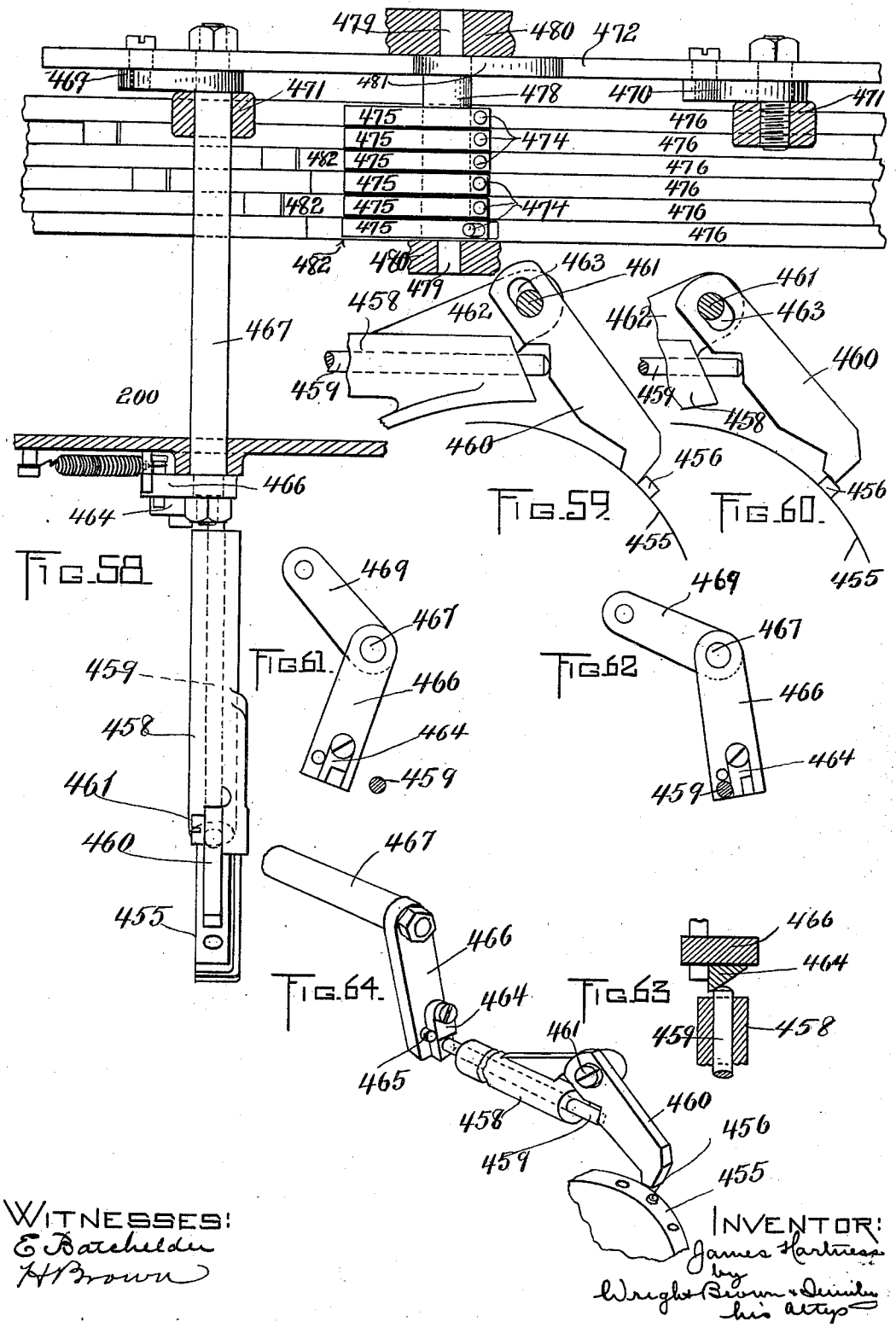
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J. HARTNESS.

LATHE.

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30 Sheets—Sheet 19.



Witnesses:
E Batchelder
H H Brown

Inventor:
James Hartness
by
Wright Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398.

Patented Apr. 16, 1901.

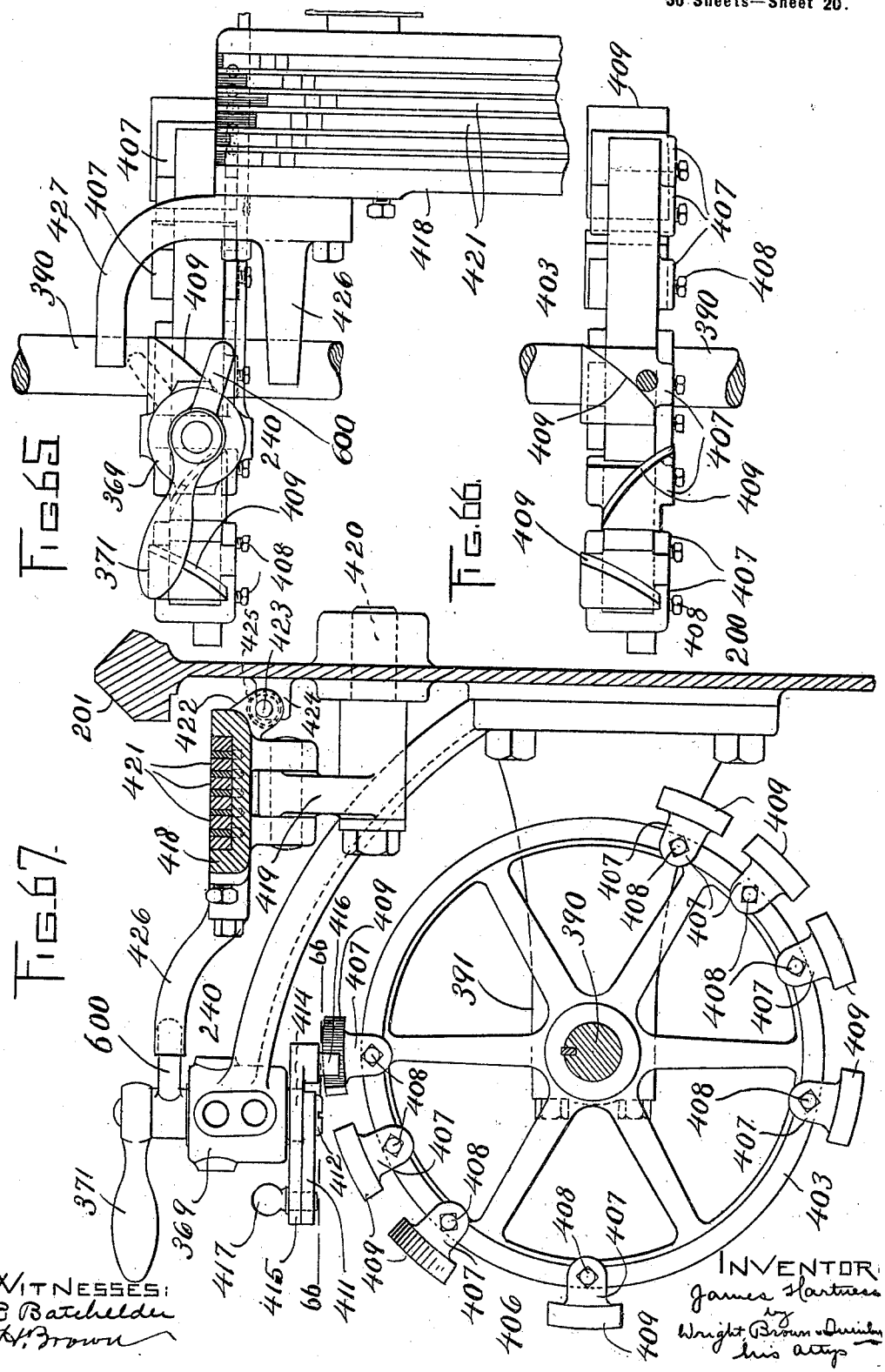
J. HARTNESS.

LATHE.

(No Model.)

(Application filed Dec. 26, 1899.)

30 Sheets—Sheet 20.



WITNESSES:
E. Batchelder
A. Brown

INVENTOR:
James Hartness
by Wright, Brown & Quinby
his attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 21.

FIG. 68.

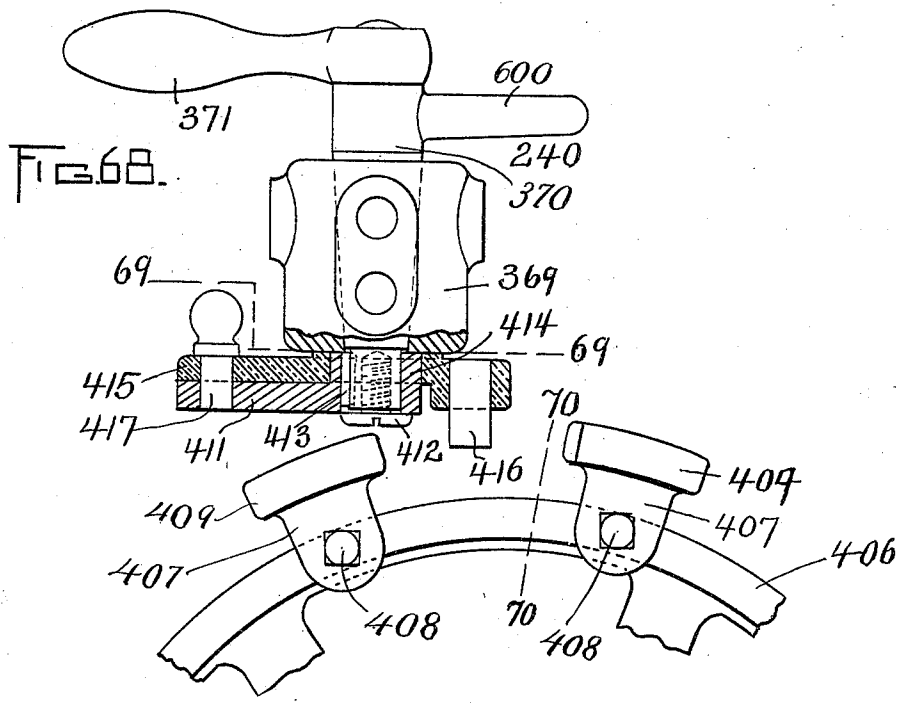


FIG. 69.

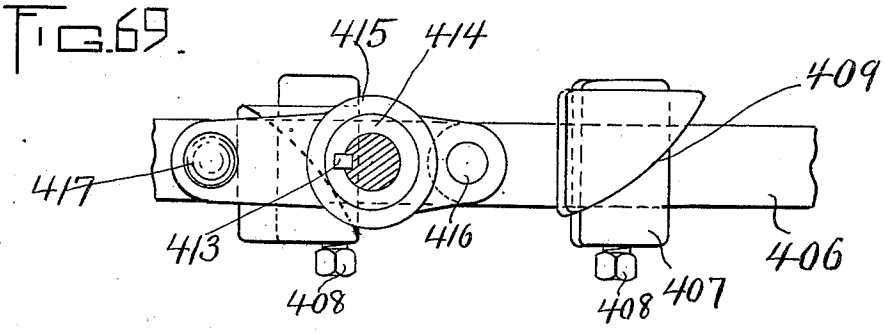
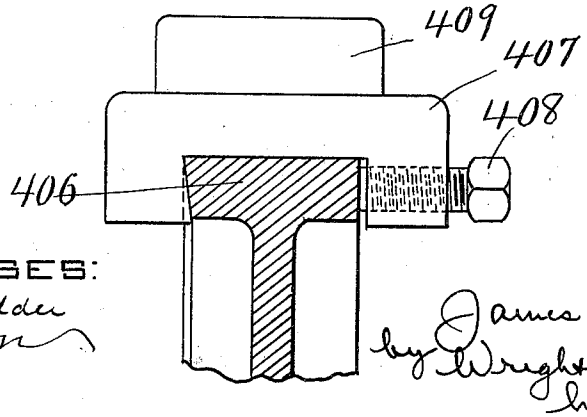


FIG. 70.



WITNESSES:
E. Bartschelder
H. Brown

INVENTOR
James Hartness
by Wright Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 22.

FIG. 71.

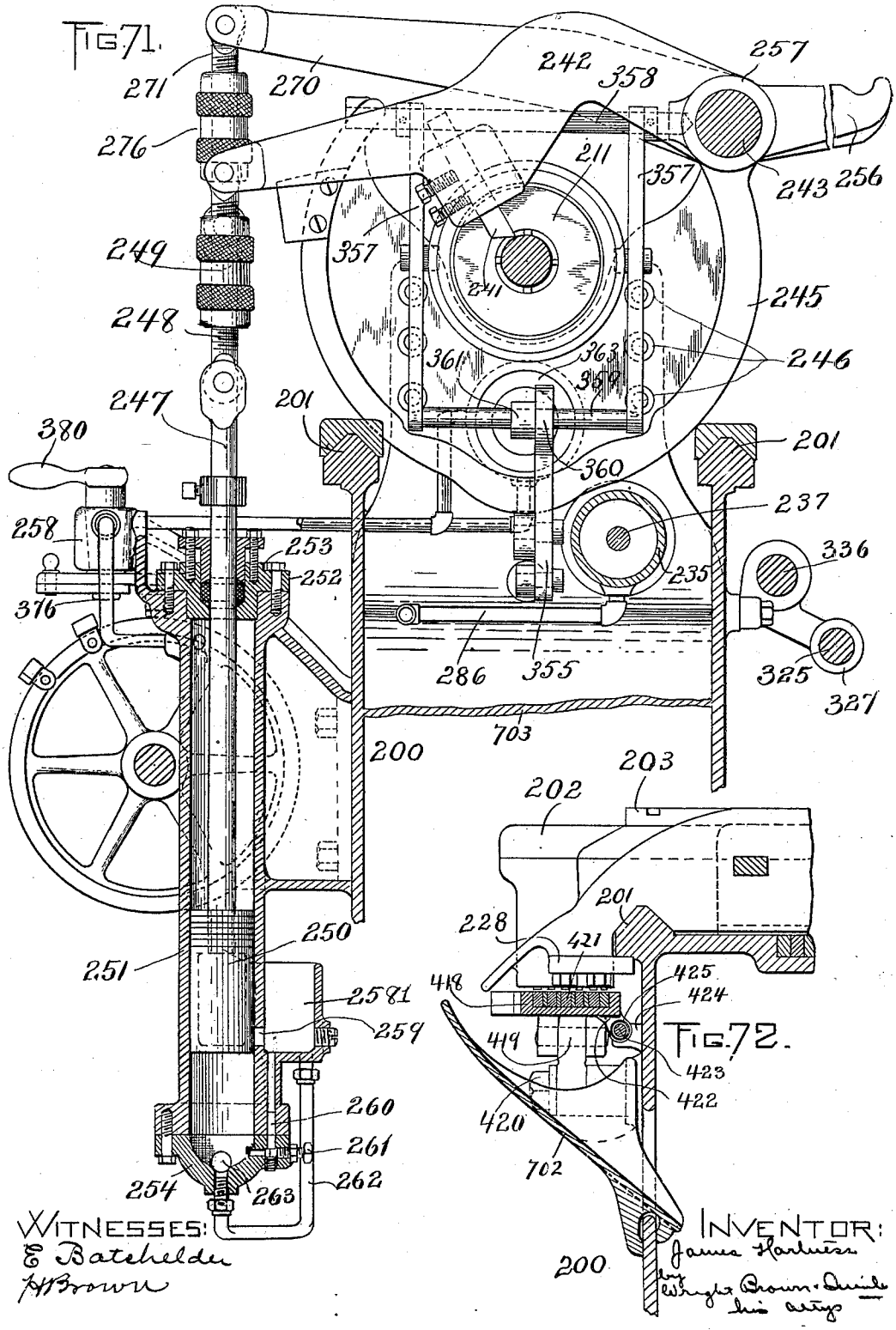


FIG. 72.

WITNESSES:
E Batchelder
H Brown

INVENTOR:
James Hartness
by Wright Brown Quinby & Co
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

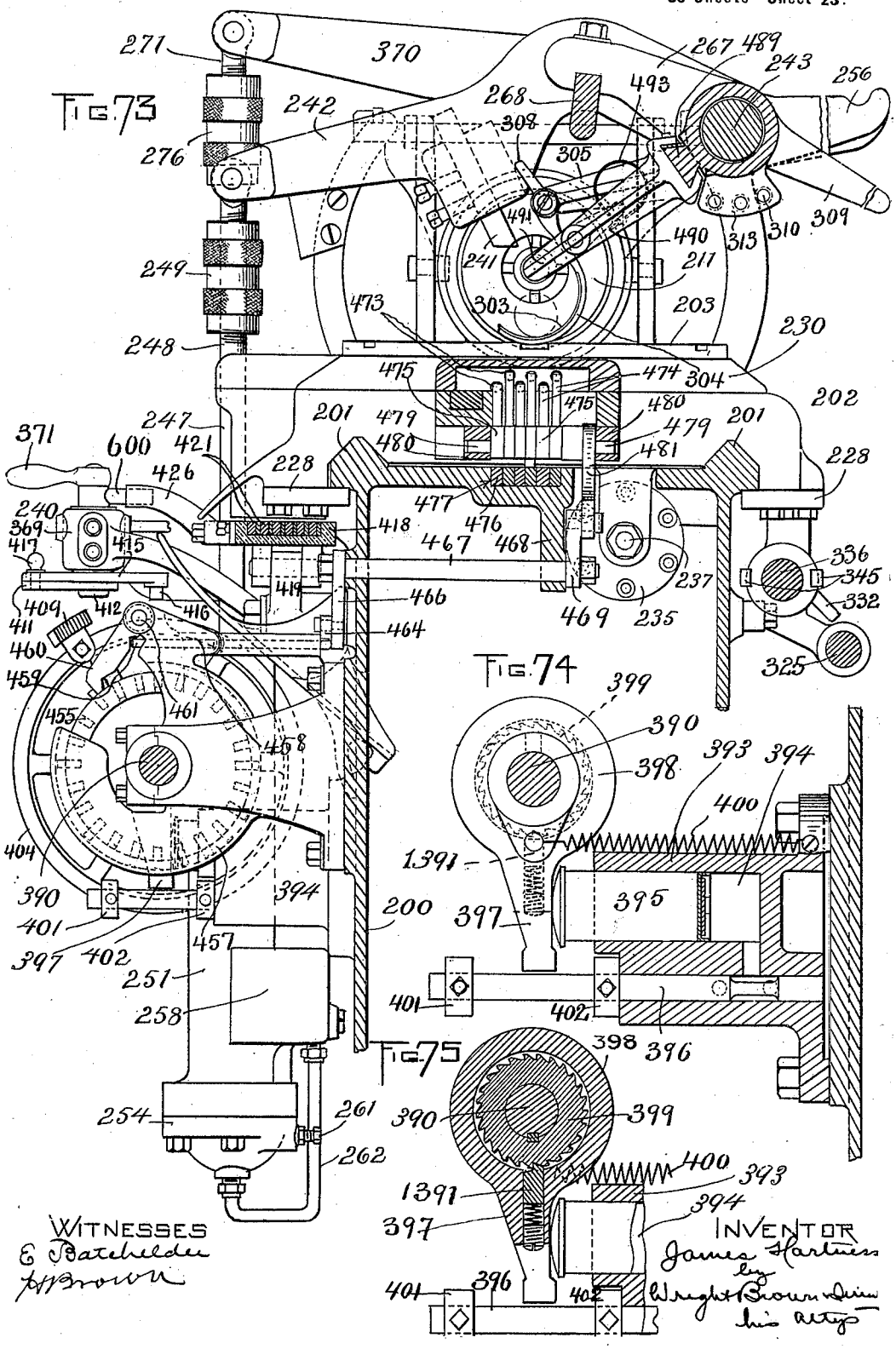
No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

(no Model.) 30 Sheets—Sheet 23.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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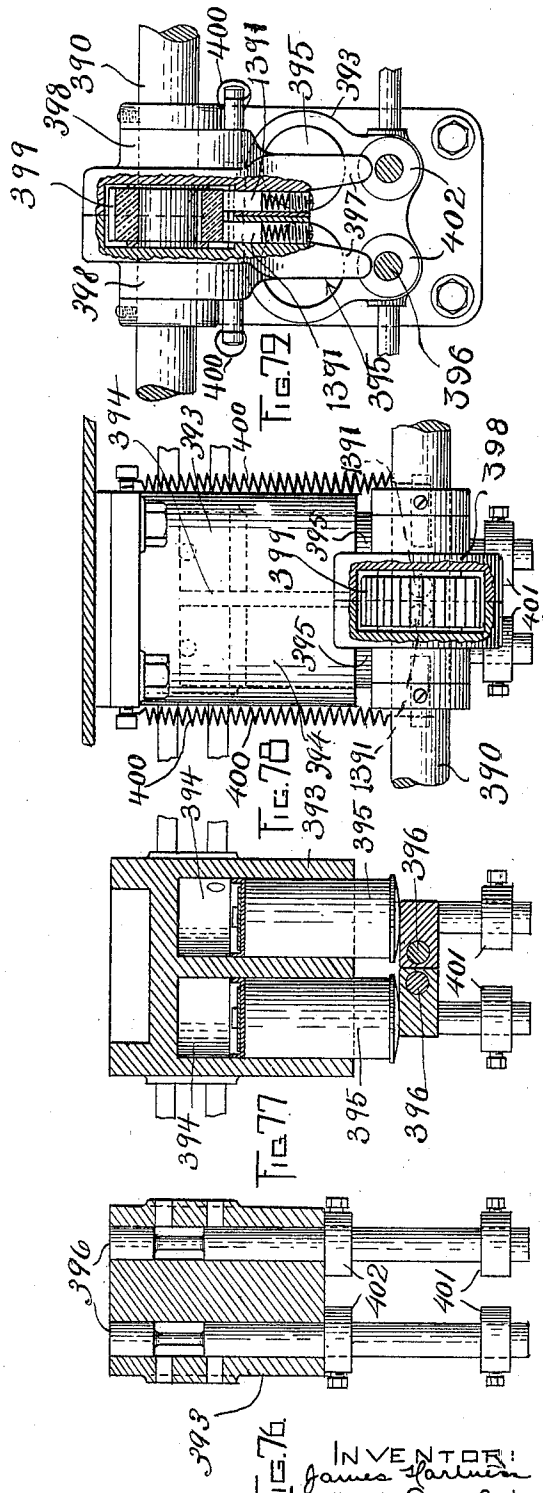
J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

(No Model.)

30 Sheets—Sheet 24.



Witnesses:
E. Batchelder
H. Brown

Inventor:
James Hartness
by Wright, Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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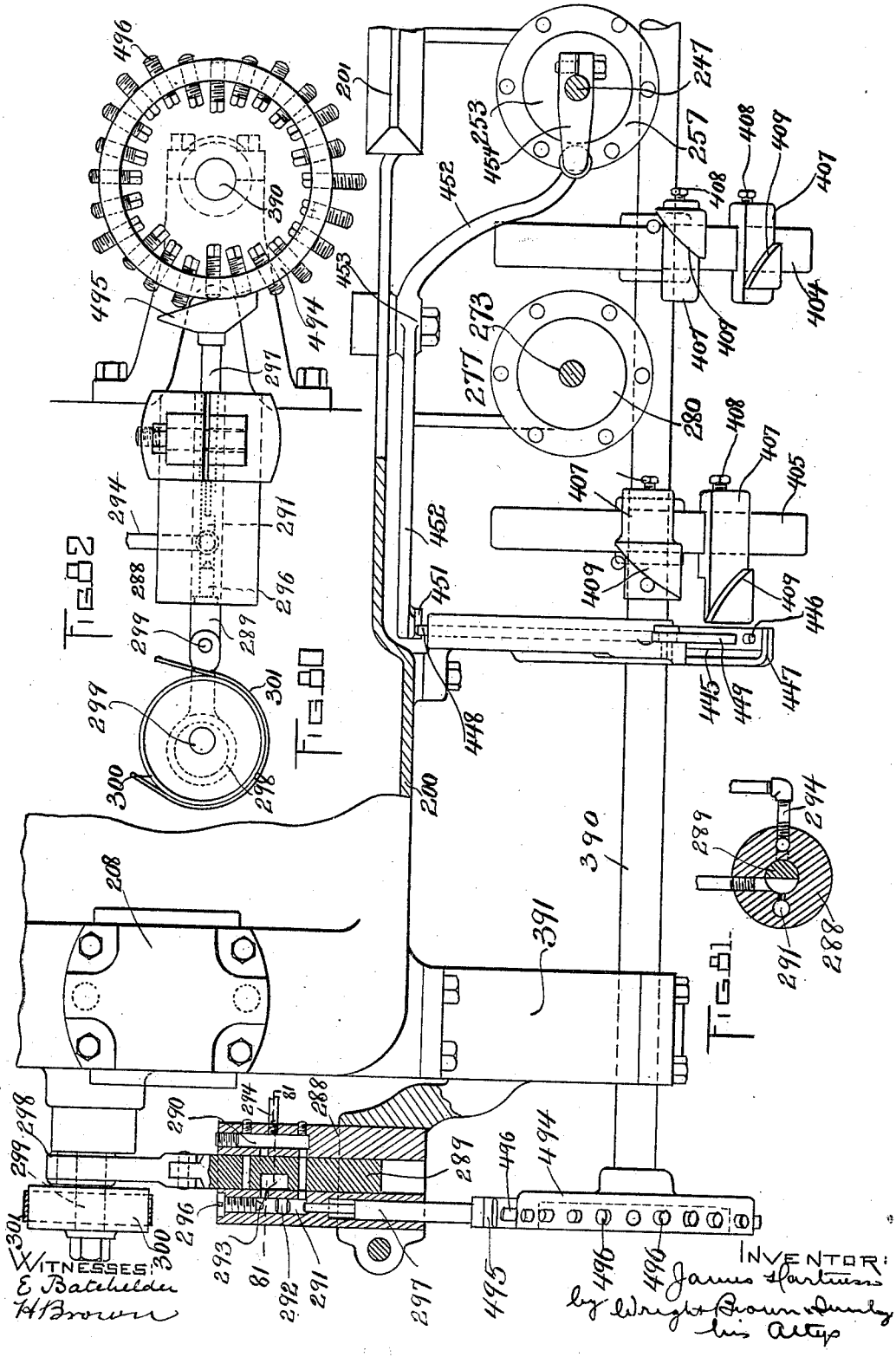
J. HARTNESS.

LATHE.

(No Model.)

(Application filed Dec. 26, 1899.)

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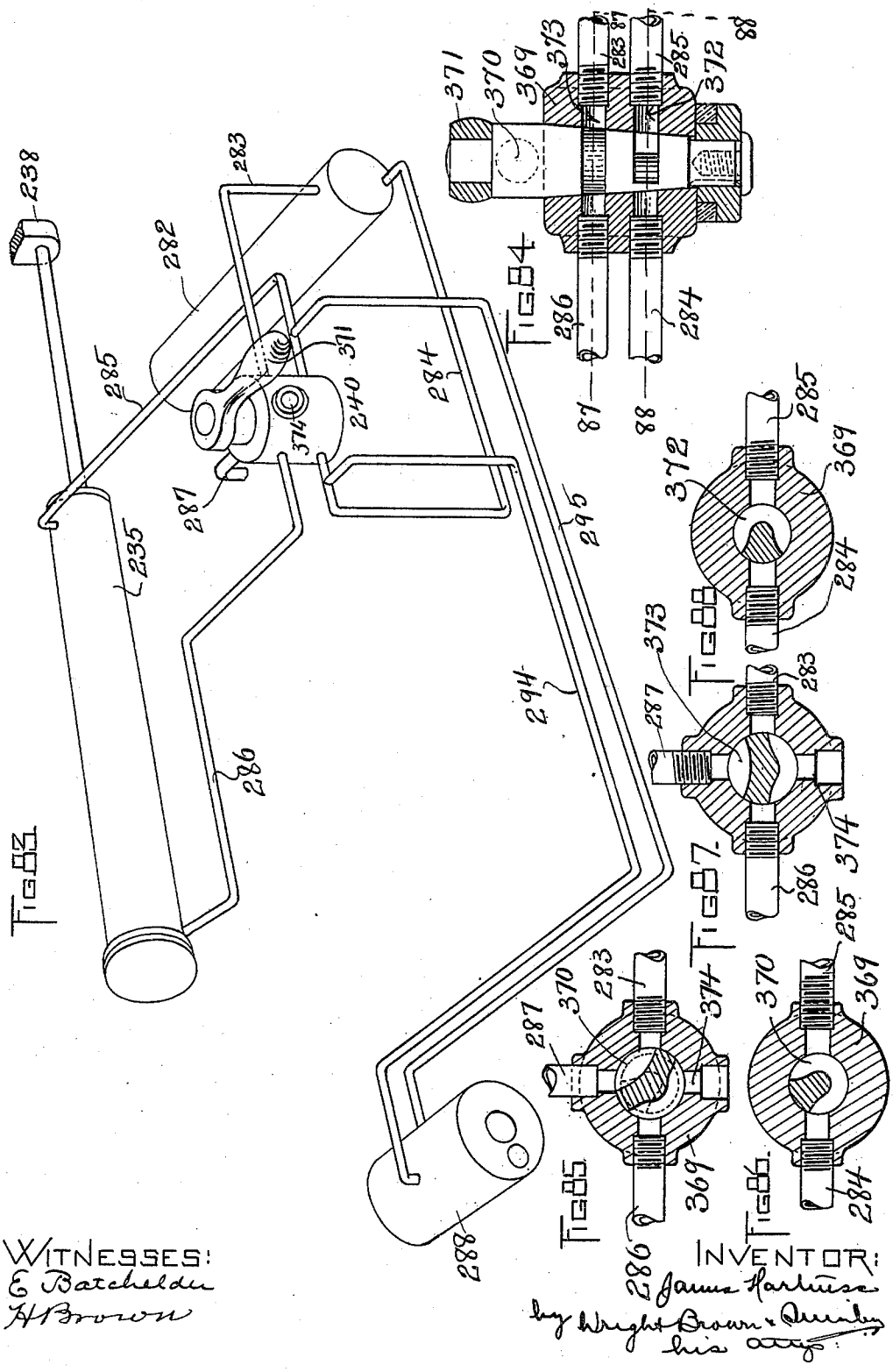
No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 26.



WITNESSES:
E Batchelder
H Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(Application filed Dec. 26, 1899.)

(No Model.) 30 Sheets—Sheet 27.

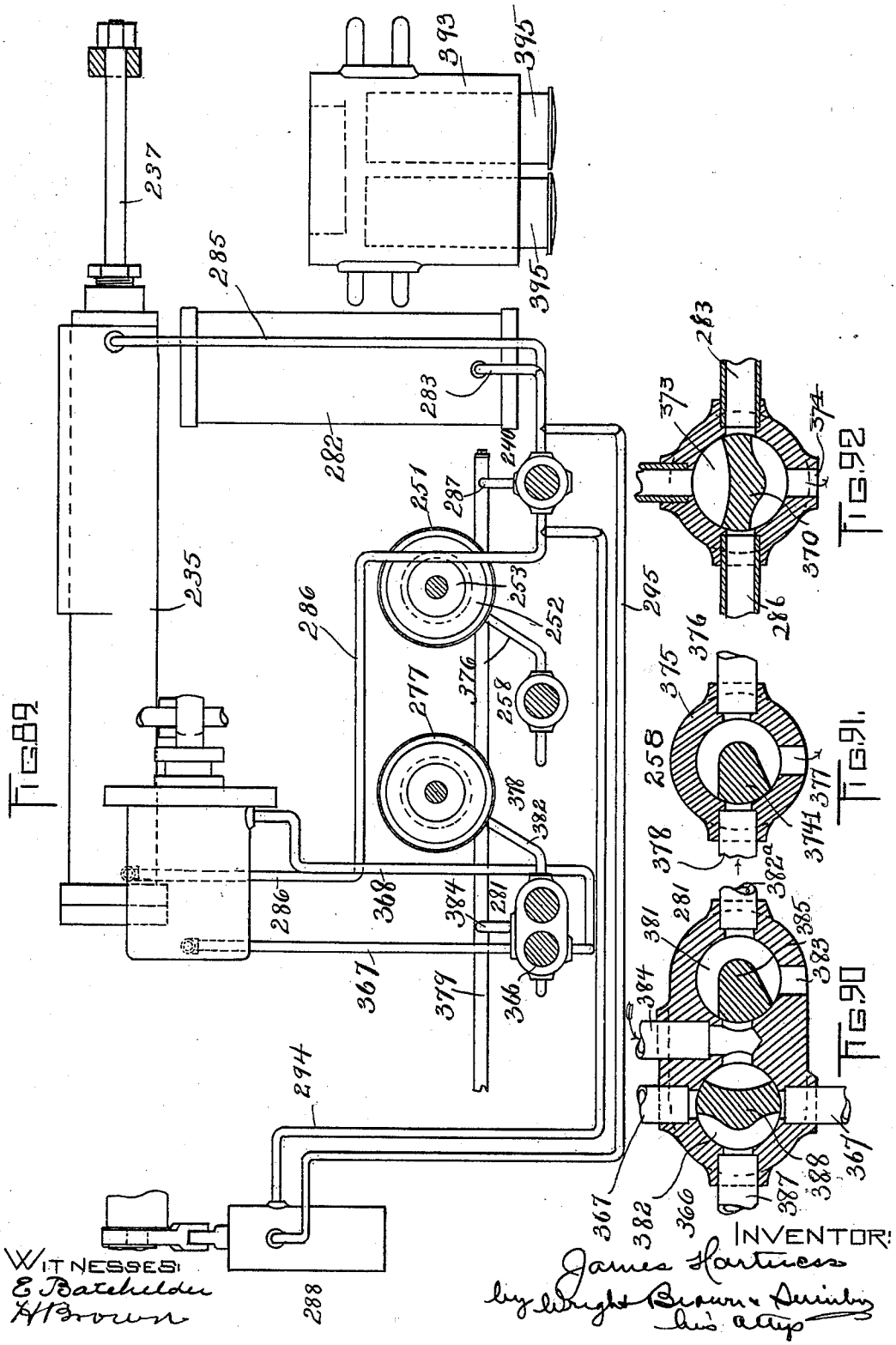


FIG. 89

FIG. 92

FIG. 91.

FIG. 90

WITNESSES:
E. Batchelder
H. Brown

INVENTOR:
James Hartness
by Wright Brown & Quinby
his attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 28.

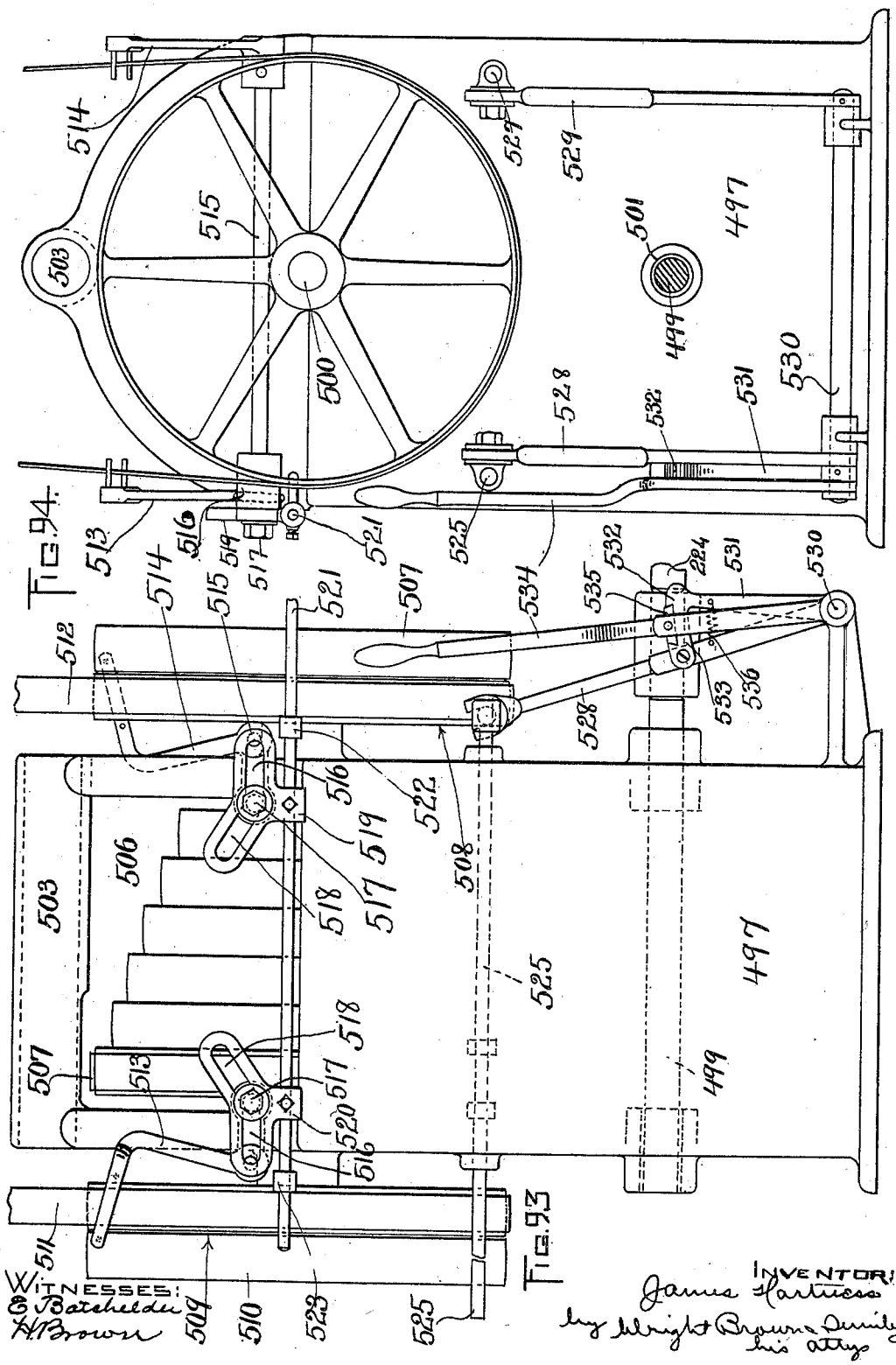


Fig. 94.

Fig. 93.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 672,398. Patented Apr. 16, 1901.

J. HARTNESS.

LATHE.

(No Model.) (Application filed Dec. 26, 1899.)

30 Sheets—Sheet 29.

FIG. 95.

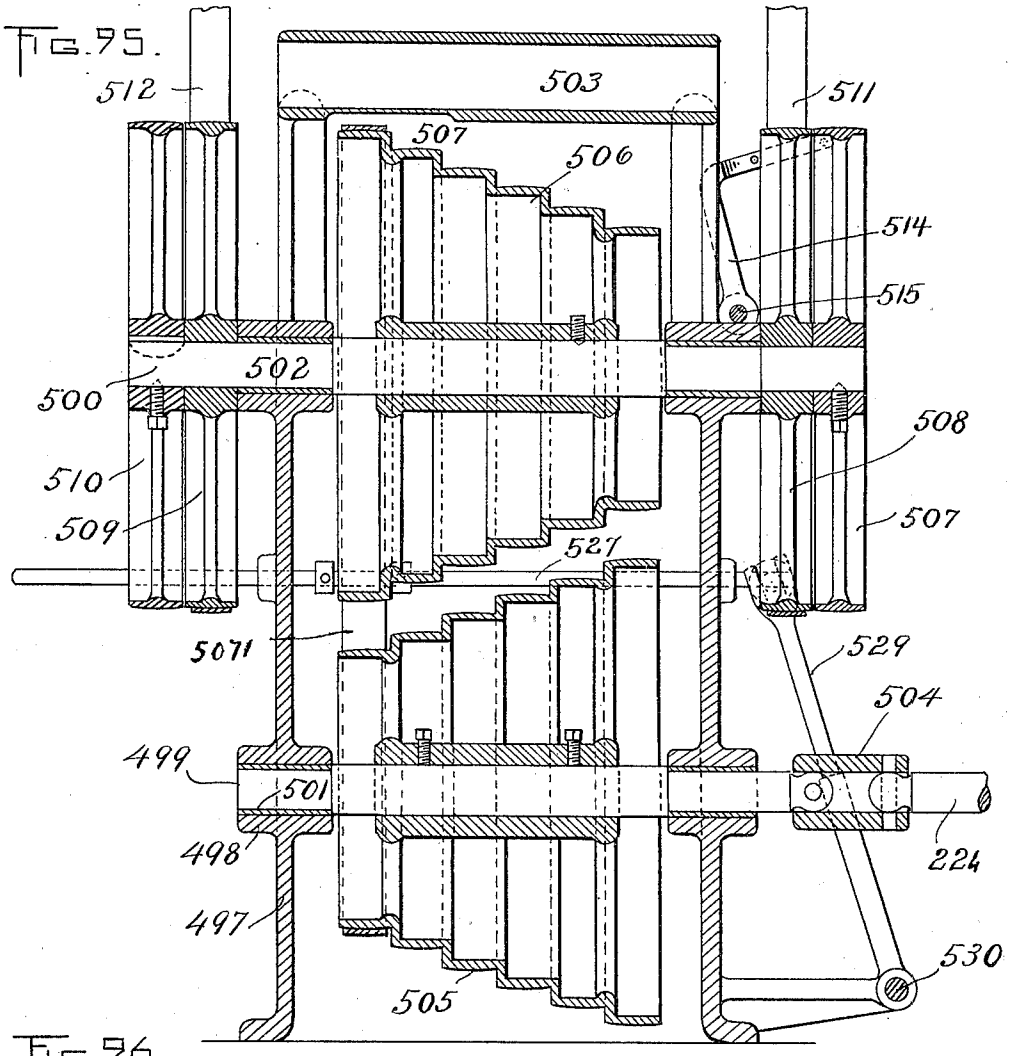
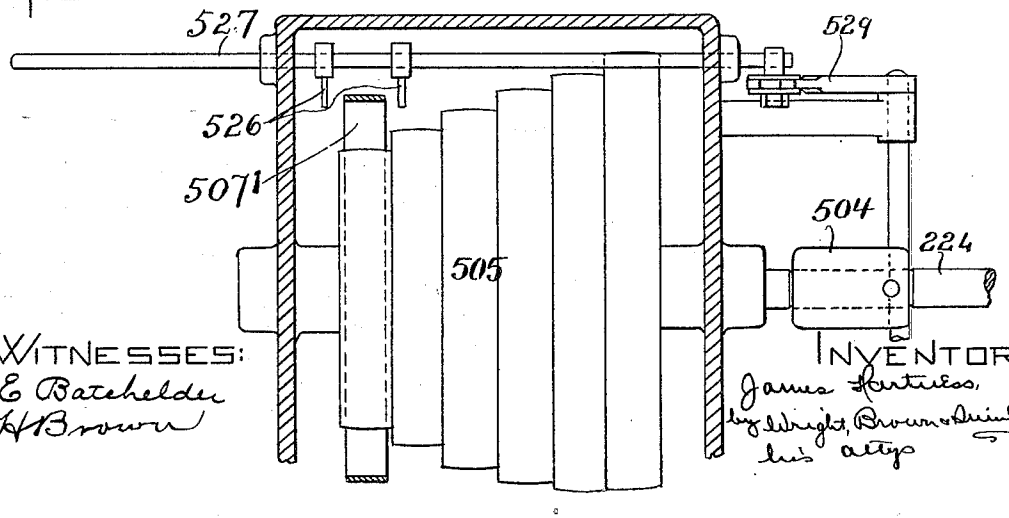


FIG. 96.



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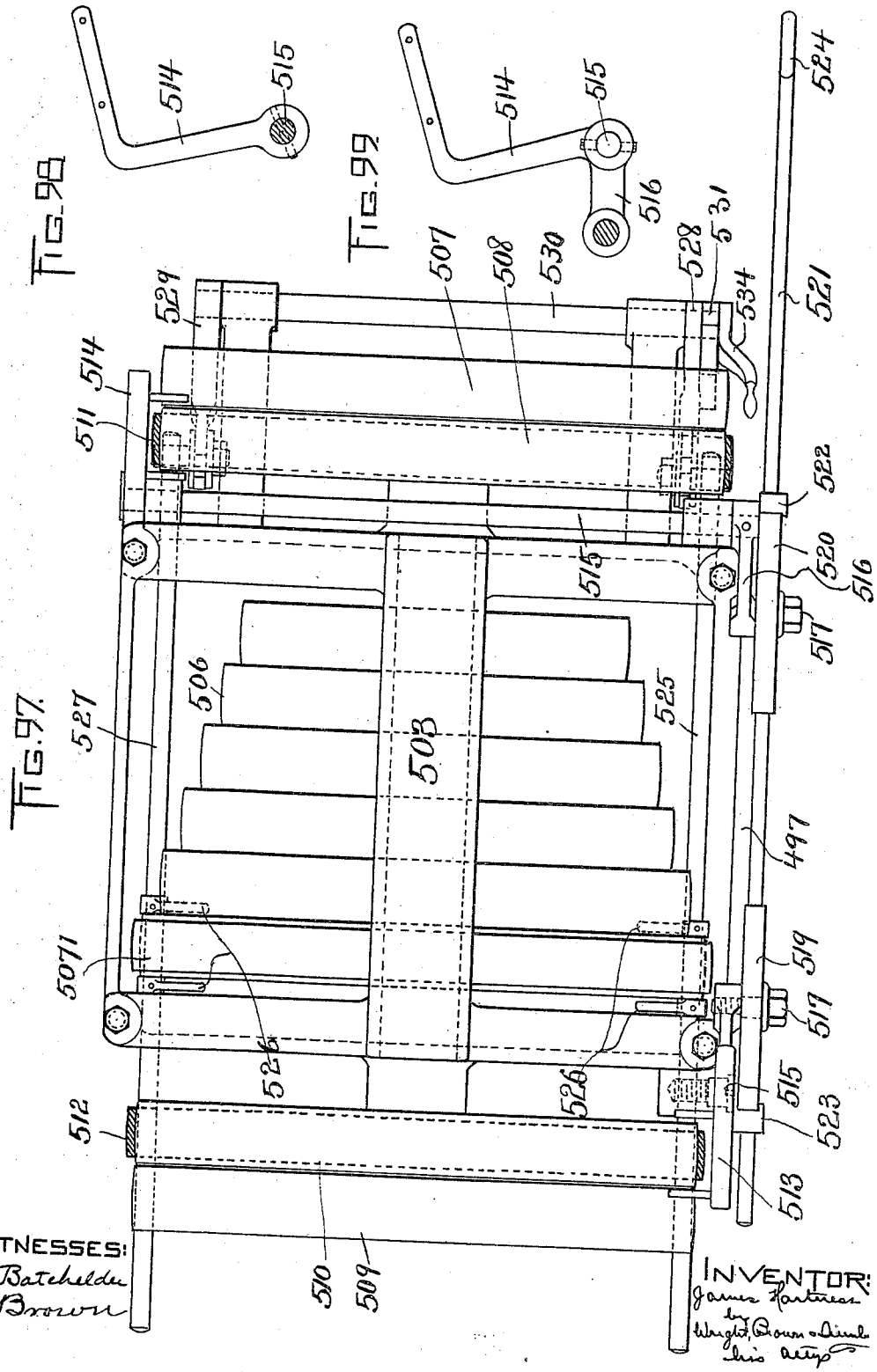
Patented Apr. 16, 1901.

LATHE.

(No Model.)

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30 Sheets—Sheet 30.



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UNITED STATES PATENT OFFICE.

JAMES HARTNESS, OF SPRINGFIELD, VERMONT.

LATHE.

SPECIFICATION forming part of Letters Patent No. 672,398, dated April 16, 1901.

Application filed December 26, 1899. Serial No. 741,615. (No model.)

To all whom it may concern:

Be it known that I, JAMES HARTNESS, of Springfield, in the county of Windsor and State of Vermont, have invented certain new and useful Improvements in Lathes, of which the following is a specification.

This invention has relation to lathes, and particularly to that class in which the tools operate upon a bar of metal, although so far as many of the features of the invention are concerned they may be employed on a lathe for "chucking" or facework.

The primary object of the invention is to provide a lathe by means of which a greater number of operations may be accurately performed. It is highly desirable in such lathes that they shall be capable of being operated either automatically, semi-automatically, or else be controlled entirely by hand, according to the work which is to be accomplished, and consequently another object of the invention is to provide a lathe with mechanism whereby it can be readily converted from an automatic or semi-automatic machine to one that is controlled entirely manually.

To these ends my invention comprises a machine provided with controlling devices located in convenient position for an operator, whereby they may be manipulated manually, and mechanism whereby the said devices may be actuated automatically or else semi-automatically. The mechanism which I have contemplated employing permits a great range of work being done by the machine and provides for a maximum of adjustments to suit the machine for all kinds of turning-work.

The machine, as subsequently described, is so constructed as to possess great rigidity, whereby the work is performed with the greatest accuracy, since the parts are capable of resisting the numerous and varied strains occurring during the several operations performed by the tools, and, moreover, it is provided with means for the careful handling and removal of the finished product.

When the machine is controlled manually, the construction and arrangement of the controlling devices are such that all the various operations of the machine are regulated and controlled with a minimum muscular effort on the part of the operator, the operating-devices being under instant control, whereby they respond immediately to the said controlling devices.

With the exception of the chuck-spindle all of the movable parts of the machine are actuated by (preferably though not necessarily elastic) fluid-pressure, the fluid acting either directly or through the medium of a liquid upon a piston arranged in a conveniently-located cylinder. In this way the speed of the movable parts may be graded to suit any particular requirement.

Where the speed of movement of the actuating part is immaterial, the elastic fluid may act directly upon the piston, but where it must be certain or regular it is controlled by devices which throttle the flow of a liquid which is placed either between the fluid and the piston or on the opposite side of the piston, the liquid being employed, since it is substantially non-compressible, and its flow may be regulated by the size of the aperture through which it is forced. Of course in this connection it will be understood that the invention contemplates the employment of any suitable device for controlling the flow of liquid and that the invention is therefore dependent upon no particular one.

The valve mechanisms for governing the fluid-operated device are preferably located upon one side of the machine, and when the machine is controlled automatically they are actuated by a single cam-shaft, which during one rotation causes a complete cycle of operations of various parts of the machine. The cam-shaft is controlled in its rotation by various devices, which I term "escapements" for lack of a better word, whereby one operation or combination of operations succeeds another at any predetermined time.

As will be ascertained from the following description, the machine possesses numerous other advantageous and novel features of construction and relative arrangement of parts, as will be pointed out in detail, among them being means (controlled automatically, if desired) for "closing" a tool or bringing it into operative relation to the bar or the work upon which it is to operate.

Referring to the drawings forming a part of this specification, and upon which similar reference-numerals indicate similar parts or

features, as the case may be, wherever they occur, Figure 1 represents a front side elevation of a turret-lathe embodying my invention. Fig. 2 represents a rear end elevation of the same. Fig. 3 represents a front end elevation of the turret-lathe. (In this connection I desire to state that I have called the head end of the machine the "front" end for obvious reasons.) Fig. 4 represents a longitudinal section through the work-carrying spindle and illustrates in detail the fluid-actuated device for opening and closing the chuck. Fig. 5 is a detailed section illustrating the controller for the roller-feed, by means of which the work is advanced through the work-carrying spindle. Fig. 6 represents a vertical section through the cylinder which forms a part of the carriage-moving mechanism. Fig. 7 illustrates a plan view of the main portion of the lathe with the upper structure removed. This figure shows the piping connected with the various fluid-cylinders. Fig. 8 represents a plan view of the same as it appears to a person standing in the rear of the machine, and it shows the mechanism for operating the cutting-off tools and the tool-closing devices. Fig. 9 is a detail view of the top shaft and the two-part sleeve thereon. Fig. 10 represents a detail view of the rack and pinion for rotating the said shaft. Fig. 11 represents an elevation of the rear end of the machine looking from behind. Figs. 12 and 13 represent sections on the lines 12 12 and 13 13, respectively, of Fig. 11. Fig. 14 represents two slide-bars mounted upon the rear side of the bed or lathe, one of them forming a portion of the device for removing the finished product. Fig. 15 represents a transverse section on the line 15 15 of Fig. 11. Fig. 16 represents the brackets in which the two slide-bars are journaled. Figs. 17, 18, 19, 20, and 21 represent detailed views of portions of the mechanism by means of which the motion is transmitted from the tool slide or carriage to the devices for removing the finished product. Fig. 22 represents in detail the mechanism for transmitting the movement of the said slide to one of the escapement mechanisms located upon the front side of the machine, and it likewise shows the locking-pawl for the same. Fig. 23 is a transverse section through the rear end of the machine and shows the additional mechanism for transferring motion to the escapement. Figs. 24, 25, 26, 27, and 28 show the same in detail. Fig. 29 represents a transverse section through the lathe and represents the fluid-operated mechanism for actuating the tool-closing device. Fig. 30 represents one form of tool-closer adapted to be operated by the last-mentioned device. Fig. 31 represents a partial section through the lathe looking from the head end thereof and illustrates the tool-closing device. Fig. 32 represents a rear elevation of the same. Fig. 33 represents a rear elevation of the same, parts being shown in section. Figs. 34 and 35 represent the device for removing the finished product. Fig. 36 represents a section looking toward the head end of the machine and represents the device for closing a threading-die. Fig. 37 represents the tool in detail. Figs. 38 and 39 represent another form of turning-tool with which the closing device may be employed. Fig. 40 represents a front elevation of a portion of the lathe and illustrates in detail a cam-shaft which controls the various valves, together with the escapement mechanisms for said shaft. Figs. 41 and 42 represent the escapement, which is actuated by mechanism which moves in unison with the rotation of the turret. Figs. 43, 44, and 45 represent in detail the escapement mechanism for the cam-shaft governed by the device which actuates the cutting-off tool. Fig. 46 represents a plan view, partially in section, of the slide and the turret thereon. Fig. 47 represents a transverse section through the same. Figs. 48, 49, 50, 51, and 52 represent adjustable stops for governing the action of the valve by means of which the flow of fluid into the slide-actuating cylinder is regulated. Fig. 53 represents a plan view of the bed with the carriage removed. Fig. 54 represents a front elevation of the bed with the mechanism for actuating the valve last referred to. Fig. 55 represents a detail portion of the mechanism shown in Fig. 54. Figs. 56 and 57 represent mechanism controlled by rotation of the turret for governing the escapement for the cam-shaft. Figs. 58, 59, 60, 61, 62, 63, and 64 represent the last-mentioned escapement in detail. Figs. 65 and 66 represent the device last referred to for governing the valve and also a cam which likewise acts upon said valve. Fig. 67 is an elevation, looking toward the head of the machine, of the cam, the valve, and the adjacent parts. Fig. 68 shows the device whereby the valve may be actuated automatically or manually. Figs. 69 and 70 illustrate the cams shown in Fig. 68. Fig. 71 illustrates the mechanism for actuating the cut-off tool, the same including fluid-actuated and liquid-regulated mechanism. Fig. 72 illustrates the means for disposing of the cuttings. Fig. 73 represents a section through the rear end of the lathe looking toward the head end. Figs. 74, 75, 76, 77, 78, and 79 represent the motor for the cam-shaft. Fig. 80 represents in partial plan the cam-shaft and the motor for the liquid which is used in governing the feed of the turret slide or carriage. Fig. 81 represents a section on the line 81 81 of Fig. 80. Fig. 82 represents the automatic mechanism for varying the amount of fluid passed through the meter. Fig. 83 represents a perspective view of the fluid-actuated device for causing the actuation of the turret-slide. Fig. 84 represents a sectional view of the valve mechanism. Figs. 85, 86, 87, and 88 represent sections through the valve, Figs. 85 and 87 representing the valve for controlling the passage of the air and Figs. 86 and 88 representing the by-pass valve or valve for the fluid. Fig. 89 repre-

sents diagrammatically in plan view all of the various fluid-cylinders, with the valves therefor. Figs. 90, 91, and 92 represent transverse sections of the valves for the chuck-opener and tool-closer, the cut-off, and the turret-slide mechanism, respectively. Figs. 93, 94, 95, 96, 97, 98, and 99 represent belt-shifting mechanism for controlling the direction and speed of rotation of the work-carrying spindle.

The turret-lathe, which is illustrated upon the accompanying drawings, to which reference may now be had for a detailed description, comprises the usual bed, turret, turret slide or carriage, and work-carrying spindle, these parts being so arranged with reference to one another that the tools mounted upon the turret are brought into proximity to the rotating work to perform their functions in any desired sequence.

The bed is indicated as a whole by 200, being what is commonly known as a "cabinet-bed"—that is to say, it is hollow for the purpose of receiving internal spindle-driving mechanism, and it is provided with parallel ways or shears 201, upon which the slide or carriage 202 is mounted.

The turret or tool-holder is indicated at 203 and is adapted to be rotated to bring the tools secured thereon successively into operative position with relation to the work. So far as many of the features of the invention are concerned the bed may be formed in any suitable way, provided it have sufficient strength to receive and support the various operative parts which must be carried thereby. Its rear end is overhanging, while its front or head end is constructed for the purpose of receiving and carrying the spindle.

Referring to Fig. 4, in connection with Fig. 3, it will be seen that the head end of the bed is formed with two upwardly-projecting hollow standards 204 205, adapted to receive journal-boxes 206 207, held in place by caps 208 209, respectively. In these journal-boxes is mounted a work-carrying hollow spindle 210, which projects toward the rear end of the machine to receive a chuck 211, adapted to be opened and closed. Any suitable form of chuck may be employed, so that I have not illustrated any particular one in detail.

The spindle is formed with a radial flange 212 at its inner end and is provided with collars 213, whereby it is held against longitudinal movement, said flange and collars lying at the ends of the journal box or bushing 207. Power is transmitted to the said spindle to rotate it at different speeds by suitable belt mechanism, comprising a loose pulley 214, a fast pulley 215, and a third pulley 216, connected to the spindle by speed-reducing mechanism. The last-mentioned pulley is formed with a sleeve-like hub 217, carrying a pinion 218, intermeshing with and driving a gear 219, loose upon a shaft 220, secured in the head of the bed. The gear 219 is connected with the pinion 221, intermeshing with and driving a gear 222, fast upon the spindle. A belt 226 connects either one of the pulleys 214, 215, or 216 with a driving-pulley 223, fast upon a shaft 224, journaled in bushings 225, secured in the lower part of the bed. The belt 226 may be shifted from one pulley to another by any suitable means, and the shifting may be accomplished by automatically or manually controlled devices; but inasmuch as such devices are well known I have not undertaken to illustrate them. As the driving-pulley 223 is located inside the hollow bed, there are apertures 227 in the sides of the bed to permit the passage of the belt, as shown in Fig. 1.

It is evident that the prime power-shaft 224 may be driven by a motor or may receive its power from a transmitter or other shaft. I have shown one form of mechanism which I employ for rotating said shaft in either direction at any desired speed; but I shall reserve the description of the said mechanism until I have completed the description of the other parts of the machine.

I shall first describe the machine in its simplest form, wherein its various operations are controlled manually, and shall then describe the mechanism for controlling those operations automatically. The turret-slide, which is adapted to reciprocate upon the ways or shears 201, is held in place by gibs 228, secured to the overhanging portions thereof and extending under the said ways, as shown in Fig. 23. The turret is substantially flat or plate-shaped, so as to pass under the work, and provided in its top with means for receiving a plurality of tools which may be presented successively to the work. In Figs. 46 and 47 said turret is shown as having a center pin or post 229, which takes bearing in the turret-slide and serves as a pivot. The turret is also provided with a circumferential groove to receive a continuous gib 230, which is bolted upon the top of the turret-slide. Mechanism is provided for imparting a rotatory movement to the turret as the slide completes its reverse movement backward or away from the work. I shall not describe the said mechanism, it sufficing to state that it includes a longitudinally-movable rack-bar 231, intermeshing with a pinion 232, (see Fig. 46,) which when turned in one direction carries with it the turret. The said bar is formed on its end with an arrow-head to engage and be held temporarily by spring-latches 233 on the end of a bar 234, mounted on a superstructure above the bed. The mechanism for advancing and withdrawing the slide comprises fluid-operated mechanism including a piston and cylinder and suitable valve mechanism.

Referring to Figs. 4, 23, 83, and 89, the cylinder is indicated at 235, and it is secured to the bed, being arranged in the hollow interior thereof. The piston 236 (see Fig. 53) is connected by the piston-rod 237 with a lug 238, depending from the rear end of the carriage. A valve is employed for regulating the ad-

mission of the fluid into and its discharge from the cylinder. This valve mechanism 240 is located on the front side of the machine, where it is convenient of access to the operator, and it likewise controls the admission of a liquid into the cylinder for the more accurate regulation of speed of the carriage. This liquid is normally contained in a tank 282, extending from the front side toward the rear side of the bed in the lower portion thereof, said tank being connected with the valve mechanism by a pipe 283, projecting from the upper side thereof. At its lower portion the tank is provided with a second pipe 284, by which liquid is conducted to the valve mechanism. From thence it can flow by a pipe 285 to the cylinder 235, being admitted at the upper side thereof, as best shown in Fig. 83. The valve mechanism 240 is connected with the opposite end of the cylinder 235 by a pipe 286, which enters the lower portion thereof. Air being admitted to the valve mechanism from a suitable source of supply to a pipe 287, either a gaseous fluid or a liquid may be admitted to this cylinder to force the piston in one direction or the other. For the purpose of regulating the flow of the liquid I employ a regulator or meter, (indicated as a whole at 288.) It is sufficient here to state that said regulator or meter consists of a casing provided with a reciprocating valve 289, (see Fig. 80,) which admits fluid from the inlet-port 290 to a cylinder or chamber 291, in which there is a loose piston 292. This piston measures the amount of liquid which escapes through the exhaust-port 293, the inlet-chamber and the inlet-port 290 being connected by a pipe 294 with the pipe 284 leading from the valve mechanism 240 to the tank 282, and the exhaust-port 293 being connected by a pipe 295 with the piping 285, which leads from the valve mechanism 240 to the cylinder 235. The amount of liquid passing through the meter is controlled by limiting the movement of the loose piston 292, there being for this purpose a screw 296 at one end of the cylinder 291 and an adjustable pin 297 on the other end of said chamber or cylinder. The reciprocating valve 289 is operated by an eccentric 298 on a stud-shaft 299 on the head end of the lathe, said shank being rotated by a pulley 300, driven by a belt 301 from a pulley 302, formed on the roller-feed. From this description it will be seen that by suitable manipulation of the valve mechanism 240 the tool-carrying slide may be advanced rapidly toward and withdrawn rapidly from the work, and that when the slide has reached its proper position for the tool to operate upon the work the slide will be advanced slowly and regulated during the time that the tool is operating, it being possible to permit the liquid to pass freely from the tank to the cylinder during the rapid movement of the slide and to then cause it to pass through the meter for effecting the slow and regular movement.

The various tools which operate upon the work are, with the exception of the cutting-off tool, mounted upon the turret, and by means of mechanism which I shall subsequently describe they are opened and closed quickly in accordance with a predetermined arrangement or gradually opened and closed during operation for producing work having tapering or irregular dimensions. The cutting-off tool, however, is supported entirely independently of the turret and is moved into and out of operation by independent mechanism which includes a separate carrier and fluid-operated mechanism governed by a suitably-located valve. The tool is indicated at 241, while the carrier therefor is indicated at 242. Said carrier consists of an arm which is loose upon a shaft 243, located in a plane above the bed and journaled at its ends in the standards or brackets 244 245, secured upon the bed, as shown in Figs. 1 and 2. The bracket 245 is in the nature of a hood, and it is secured to the head of the bed by any suitable means. The shaft 243 is located above the rear side of the bed, and it extends throughout the entire length of the ways or shears, as shown in Fig. 1, and supports other mechanism which shall be hereinafter described. The end of the carrier or cutting-off tool is connected to a piston-rod 247 by an adjustable connecting-rod 248, as shown in Fig. 71. Said adjustable rod consists of oppositely-threaded sections connected by a turn-buckle 249, said sections being pivotally connected to the carrier 242 and the piston-rod 247. The piston 250, to which the rod 247 is connected, is arranged in a vertical cylinder 251, forming a portion of a casting which is secured to the front of the bed. The upper end of the cylinder is closed by a head 252, provided with a stuffing-box 253, through which the piston-rod passes, while the lower end of said cylinder is closed by a head 254, bolted in place.

The carrier for the cutting-off tool is normally elevated to its upper extreme of movement, being held in that position by a weight 255, suspended from an arm 256, projecting rearwardly from the hub 257 of the carrier 242. Consequently upon admitting fluid to the upper end of the cylinder 251 the piston 250 is forced downwardly to bring the cutting-off tool into position to operate upon the work. I have provided for a rapid movement of the tool toward and from operative position and for accurately regulating its movements slowly after it has approached the work.

The construction which I employ permits of the use of a gaseous or elastic fluid for effecting the rapid movement of the tool-carrier and of a supplemental fluid, which is liquid in form, for regulating the slower movement of the tool-carrier after the tool has approached the work. The gaseous fluid which I prefer to employ is air, and its passage into and out of the cylinder 251 is regulated by a valve mechanism 258, which I shall subsequently describe in detail, said mechanism

being located in proximity to the valve mechanism 240, whereby the operator is enabled to put his hand upon either of them as occasion requires.

The fluid for accurately regulating the slow movement of the tool-carrier 242 is contained in the lower end of the cylinder 251, and it will be observed that on the side of the casing there is a cup or receptacle 2581, which communicates with the cylinder by an aperture 259 and a supplemental duct 260, adapted to be more or less closed by a throttling-valve 261. The duct 260 leads from the lower end of the cylinder to the cup 2581, while the duct 259 is at some little distance from the said end, as clearly shown. There is likewise a large conduit 262, which leads from the cup 2581 to the lower extremity of the cylinder and is normally closed by a check-valve 263. A suitable liquid, such as oil, is placed in the cylinder when the piston is raised, the level of the oil being substantially even with the lower portion of the aperture 259. Hence when air is admitted into the cylinder the piston is forced down rapidly, the air on the under side thereof being discharged through the duct 259. As soon, however, as the piston engages the oil in the cylinder its downward movement is checked and is regulated by the flow of the oil through the ducts 260 into the receptacle or cup 2581. This flow of oil is controlled and regulated by the throttling-valve 261, so that the cutting-off tool may be moved at the proper speed. When the pressure of air is cut off from the upper side of the piston the weight 255 is sufficient to elevate the piston, this being permitted since the oil can flow freely from the receptacle 2581 into the lower portion of the cylinder through the large duct 262.

Reference may now be had to Figs. 2, 3, 9, 10, and 11 to 28. Upon the rock-shaft 243 are rigidly secured the hubs 264 266 of two forwardly-projecting arms 265 267, respectively. To the under side of these arms, at their front ends, is secured an elongated bar 268, which is substantially parallel with the longitudinal lines of the slide and is arranged a little to the rear thereof, as best shown in Fig. 8. This bar is held normally at its upper extreme of movement, but is adapted to be depressed to close the tools or bring them into position to operate upon the work, the bar being long enough to engage the tools at any point during the travel of the slide. For the purpose of operating the said tool-closer fluid-operated devices are employed, they being controlled by a valve mechanism located in proximity to the two valve mechanisms which I have previously described. Upon the said rock-shaft 243 is rigidly secured the hub 269 of a long arm 270, which is projected rearwardly at 271 to receive the weight 272, by which the longer arm 270 is held at its upper extreme of movement. The forward end of the arm 270 is connected by an adjustable rod with the piston-rod 273, as shown in Fig. 29, the connecting-rod consisting of two sections 274 275, connected by a turnbuckle 276. The sections are at their ends pivotally connected to the arm 270 and the piston-rod 273. The cylinder 277 for the piston 278 is cast in one piece with the cylinder 251, previously referred to, and is therefore located on the front side of the bed. The lower end of the cylinder is open, while the upper end is closed by a cylinder-head 279, securely bolted in place and provided with a stuffing-box 280, through which the piston-rod 273 passes. When fluid is admitted to the upper end of the cylinder from a valve mechanism 281, which I shall subsequently describe, the piston is forced downward, carrying with it the arm 270 and the bar 268, and said parts remain in the position to which they are moved until the valve mechanism is shifted to permit the escape of the fluid, whereupon the weight 272 restores the parts to their normal positions. In addition to these features I provide means for receiving and removing the finished product, this being accomplished automatically. Referring now to Figs. 33, 34, and 35, in connection with Figs. 8 and 9, it will be seen that this mechanism includes a receiver for the finished product, consisting of a semicylindrical trough-like plate 303, supported by two curved arms 304, pivotally supported upon arms or brackets 305, projecting forward from a sleeve 306 upon the rock-shaft 243. Normally the receiver 303 lies in the position shown in full lines in Fig. 35; but by rotating the sleeve 306 around the shaft 243 the receiver may be brought to the position shown in Fig. 34—that is, directly under the work—so that after the severing or cutting-off tool has been operated the product will drop into the receiver and can be carried forward to the position shown in dotted lines in Fig. 35 and subsequently dropped into a suitable receptacle. To cause the receiver to drop the finished product, as indicated at 307, one of the arms 304 is provided with a projecting finger 308, which when the sleeve 306 is rotated and the arms 305 are swung rearwardly comes into contact with a projection 309 on the hub 266 of the arm 267, and the continued movement of the arms 305 causes the receiver to drop the article or product, as shown in Fig. 35.

For the purpose of rocking the sleeve 306 I employ the following devices: The sleeve 306 is made in two sections, bolted together by one or more bolts 310, as shown in Fig. 9. This formation of the sleeve in two parts is to permit the placing of one of the tool-closing arms upon the middle portion of the shaft 243, and by examining the last-mentioned figure it will be seen that the sections of the sleeve are far enough apart to permit them to move slightly longitudinally of the said shaft. The section of the sleeve at the rear end of the machine is indicated at 311 and is provided with the extension 312, registering with the lug 313, through which the bolts 310 are passed. (See

Figs. 11, 12, and 13.) On its end the section 311 of the sleeve is provided with a pinion 314, intermeshing with a rack 315 on the end of the vertical bar 316, slidingly mounted in bearings or guides 317 318, secured to the bracket 244 and the bed, as shown in Fig. 11. A strong helical spring 319 surrounds the bar and holds it normally at the upper extreme of its movement. At its lower end said bar is formed with rack-teeth 320, (see Fig. 15,) intermeshing with a gear 321 on a stud-shaft 322, projecting rearwardly from the rear side of the bed. On the said shaft there is also a pinion 323, intermeshing with rack-teeth 324 on a slide-bar 325, slidingly mounted in brackets 326 327, secured to the rear side of the bed, as shown in Figs. 11, 14, and 16. From this construction it will be seen that when the slide-bar 325 is moved longitudinally rearward the vertical bar 316 is depressed and the sleeve 306 311 is rotated to swing the receiver under the finished article, ready to receive it as soon as it is severed from the bar or unfinished work. In order, however, to swing the receiver at the proper time, special mechanism must be employed. The slide-bar 325 is formed in two parts, as shown in Fig. 11, which are swiveled together, as at 328, whereby the main portion of the bar may be rotated or rocked, and upon the rocking portion is rigidly secured a collar 329, having a beveled finger 330, and depending from the tool-slide at the rear side thereof is a yoke 331, having a beveled projection 332, adapted to engage the finger 330 when the latter is raised to proper position. The projection and the finger are so beveled that when the finger is raised and the tool-slide is moved toward the head of the lathe it slides under the finger, the latter rising to permit its passage; but when the slide or carriage moves rearwardly the projection 332 engages the finger 330 and moves it along, the bar 325 sliding therewith to operate the mechanism for rocking the sleeve 306 311, as previously described.

Normally the finger 330 lies in an inoperative position out of the path of the projection 332, and it remains in this position during the time that the various tools are operating upon the work, since it is necessary to raise the receiver only when the last tool (not counting the cutting-off tool) is operating upon the work. Mechanism is provided for raising the finger 330 to an operative position during the time that the last tool is being carried forward toward the work.

On a shaft 333, passing through the bed from front to rear, as shown in Fig. 23, is loosely placed a pinion 334, intermeshing with rack-teeth 335 on a slide-bar 336, mounted to slide in the guides or brackets 326 327, previously referred to, and rigidly secured to the said shaft 333 is a ratchet 337, having as many teeth as there are provisions for tools upon the turret. As there are places for six tools upon the turret, there are six teeth in the ratchet 337. Between the pinion 334 and the ratchet 337 is placed one or more spring-pressed pawls 338, adapted to engage sockets on the ratchet 337, whereby the pinion will carry the ratchet with it when moved in one direction, but is free to move relatively thereto when moved in the opposite direction, the sockets in the ratchet being equal in number to the teeth therein. Now it will be observed that each time the slide-bar 336 is reciprocated once the ratchet 337 will be advanced one step. The locking-pawl 340 engages the teeth on the ratchet, but is moved out of engagement by a latch 341 on the slide-bar 336 each time the slide-bar is moved rearwardly, whereby the ratchet is permitted to rotate, being at other times held securely against rotation. On the outer face of the ratchet is secured a clip or cam 342, which when the turret is being rotated for the sixth or last time engages a projecting key 343 on the bar 325, and hence when the ratchet is about to complete one revolution the key 343 is raised to rock the shaft and bring the finger 330 into alinement with the projection 332 on the yoke 331. The slide-bar 336 is reciprocated each time the carriage or slide for the tools is reciprocated and the turret is rotated, and hence the position of the ratchet 337 corresponds exactly to that of the turret. The movement of the bar 336 is accomplished by placing upon it a beveled sleeve or collar 344 and by attaching to the yoke 331 spring-latches 345. (See Fig. 14.) When the carriage moves rearwardly or away from the work, the yoke 331 engages the collar 344 and slides the bar 336 lengthwise to the rear to cause the rotation of the pinion and the consequent rotation of the ratchet, this movement of the bar occurring only as the tool-slide reaches the extreme of its movement and being simultaneous and coincident with the rotation of the turret. Then when the carriage or slide is advanced toward the work the spring-latches draw the bar forward until it is stopped by a pin 346 on the end of the bar engaging the bracket 326, after which the latches release the collar as the tool-slide continues its movement. From this description it is now apparent that when the last tool upon the turret has completed its work and the tool-slide is moved rearwardly the receiver is moved into position to catch the finished product as it is severed by the cutting-off tool, said receiver being held in this position by the continued engagement of the projection 332 with the finger 330 on the cam or collar 329. As soon, however, as the tool-slide begins its next forward movement the spring 319 returns the parts to their normal positions. After the work is severed and removed the unfinished bar is fed forward through the work-carrying spindle to present a fresh length upon which the tool may operate.

To permit the feeding of the bar, the chuck must of course be opened, this, together with the actuation of the roller-feed, being caused

by fluid-operated devices governed by a valve. The roller-feed is indicated at 347, and as its particular construction is of no moment so far as this invention is concerned I have not illustrated it in detail. It includes a ratchet 348, which when engaged and held stationary causes the feeding of the bar through the spindle. For the purpose of engaging this ratchet a spring-pressed catch 349 is arranged vertically in guides 350 351 on the head of the lathe, and at its lower ends the catch is beveled, as at 352, to be engaged and raised by the beveled end 353 of a rod 354, pivoted to a lever 355, fulcrumed at 356 in the bracket or hood 245, previously described as being U-shaped. (See Figs. 4 and 29.)

The chuck opener and closer consists of two arms 357, fulcrumed at their upper ends upon a cross-shaft 358, secured in the upper portions of the curved arms of the bracket 245, (see said last-mentioned figures,) the lower ends of said arms being connected by a cross-bar 359, which is engaged by the yoke 360 on the end of the arm 355. The cross-bar 359 is pivoted to the piston-rod 361, to which is secured the piston 362 in the cylinder 363, cast of one piece with the bracket 245. One end of the cylinder is closed by a head cast integrally therewith, while the other end is closed by a cylinder-head 364, having a stuffing-box 365, through which the piston-rod passes. Air is admitted to either end of the cylinder to open or close the chuck and to engage or release the ratchet 348. Upon reference to Fig. 89 it will be seen that the cylinder is connected with a valve mechanism 366 by pipes 367 368, leading to opposite ends of said cylinder. The valve mechanisms 281 and 366 are inclosed in one casing, as will be subsequently described, for the purpose of simplicity and facility of construction; but the two mechanisms are independent, as will be presently explained, and from the description given it will be seen that whenever it is desired so to do the operator may open the chuck and simultaneously therewith cause the feeding of the bar through the work-spindle. When the bar has been fed to the proper extent, the valve mechanism is changed to force the piston back to its normal operative position to close the chuck and disengage the catch 349 from the ratchet 348.

The four valve mechanisms to which I have referred—to wit, 240, 258, 281, and 366—are all located in a line on the front side of the bed of the lathe, as shown in Figs. 7 and 89.

Referring first to the valve mechanism indicated at 240, as shown in Figs. 84 to 88, inclusive, and Fig. 92, it will be seen that it consists of a casing 369, having a valve 370, with a handle 371. The valve contains two different chambers, (indicated at 372 and 373.) The pipes 285 and 284 lead into the chamber 372 and form a by-pass for the liquid from the tank to the cylinder, and the pipes 283 and 286 lead into the chamber 373. Into the chamber 373 there also leads a pipe 287 from the source of air-supply. That part of the valve 370 in the chamber 372 is shaped as shown in Fig. 88 and serves merely as a by-pass valve, while in the chamber 373 it is so formed (see Fig. 87) as to deflect the air into either of the pipes 283 or 286, there being an exhaust 374 for the air in either of the last-mentioned pipes. The positions assumed by the valve in the two chambers are shown by Figs. 86 and 88 and 85 and 87. In Figs. 86 and 88 the lower part of the valve corresponds in position to the upper part in Figs. 85 and 87. Thus it is apparent that the valve mechanism for operating the turret-slide is double, the neutral position of the valve being when its handle points forward. A slight movement of the handle in either direction causes the turret-slide to move slowly in a corresponding direction, and when the handle points to the extreme right or left the turret-slide moves quickly in that direction. The upper part of the valve mechanism controls the admission and exhaust of the elastic fluid, while the lower part serves as a liquid by-pass, the opening of which permits the passage of the liquid from the tank to the cylinder, or vice versa, an extreme movement of the valve being necessary to open the by-pass and a slight movement being sufficient to permit the passage of the elastic fluid.

In Fig. 91 the valve mechanism 258 is shown as provided with a valve 3741, arranged in a casing 375, said casing being connected with a cylinder 251 by a pipe 376. (See Figs. 71 and 89.) There is an exhaust-aperture 377 and also an inlet connected by a pipe 378 with an air-main 379, to which the pipe 287 is likewise connected. To the valve 3741 is connected a handle 380, by means of which it may be manipulated.

The valve mechanisms 281 and 366 are contained in a single casing having two separate chambers 381 and 382. The chamber 381 is connected to the cylinder 277 by a pipe 382 and is provided with the exhaust-port 383. The inlet-pipe 384, which is connected to the main 379, has ducts leading into both the chambers 381 and 382, as shown in Fig. 90, the duct leading into 381 being adapted to be closed by the valve 385, having the handle 386. The chamber 382 is connected with the chuck-operating cylinder by the pipes 367 and 368, previously referred to, and the exhaust-port is indicated at 387. The valve in the chamber 382 is indicated at 388 and is provided with a handle 389. The four handles 371, 380, 386, and 389 are all close together, so that the operator can easily place his hand upon any one of them, and very little muscular exertion is required to move them, all of the work being done by the elastic fluid.

As thus far set forth the machine is semi-automatic so far as certain movements are concerned and manually controlled so far as other movements are concerned. The advance and withdrawal of the carriage are manually controlled, although the rotation of the turret is

accomplished automatically. The cutting-off tool is controlled manually, as well as the device for closing the tools upon the holder and turret; but the receiver and remover for the finished articles is operated automatically as soon as said articles are completed and severed. It is apparent, however, that all of the valves may be actuated automatically, and I shall now proceed to describe the means whereby this is accomplished. Journaled in brackets 391 and 392, bolted to the front face of the bed, is a cam-shaft 390, by means of which all of the valves are controlled. The shaft is rotated by an independent motor; but its rotation is intermittent, being dependent upon a plurality of escapements, which permit it to rotate only at predetermined times. The motor is shown in Figs. 74 to 79, inclusive. It comprises a casing 393, having twin cylinders 394 394, adapted to receive pistons 395 395, to which the admission of air from the main is controlled by valves 396. Each of the pistons and valves is independent of the other. Each piston on its outer end bears against an arm 397, depending from a hub 398, which is formed with a chamber, as shown in Fig. 78, the two chambers forming a large compartment to receive a ratchet 399, which is rigid upon the shaft 390. In each of the arms 397 is a spring-pressed dog or pawl 1391, adapted to engage the ratchet. The arms are held in a backward position yieldingly by springs 400, and on their lower ends the arms are formed to engage stops 401 402 on the valve-rod 396. From this construction it will be seen that as the pistons are reciprocated to oscillate the arms 397 (the valves being shifted by the arms 397 engaging the said stops) the shaft 390 will be rotated; but so long as the shaft is locked against movement the pressure of the air in the cylinders is inadequate to cause a breakage. The pistons reciprocate alternately in practical operation, although they are not shown in alternate positions. Upon the shaft are three cams 403, 404, and 405, the two former being adapted to actuate the valves in the valve mechanisms 240 and 258, while the cam at 405 is adapted to operate the valves of the two mechanisms at 281 and 366. These cams each consist of a wheel or disk 406, (see Figs. 65 to 70,) to which are securely clamped clips 407 by bolts 408. Each clip is provided with a cam-tooth 409, adapted to engage the valves and force them to one side or the other, and inasmuch as all of the valves are provided with the same device I shall describe only one of them, reference being had more particularly to Fig. 68, which shows the valve mechanism, generalized as a whole by 240. The valve 370 projects below the casing 369 to receive an arm 411, which is rigidly secured thereto by a screw 412 and a key 413, and on the hub 414 of said arm is loosely mounted a second arm 415, provided with a depending pin 416, adapted to be engaged by the cam-teeth 409. In order, therefore, to render the machine automatic, there is a removable locking-pin 417, which is passed through registering apertures in the arms 411 and 415, whereby the swinging of the arm 415 causes a similar movement of the arm 411, and therefore of the handle 371 and the valve 370. The cam-teeth of the various cams are arranged to operate the valves in their proper sequence, according to the work that is being performed, and inasmuch as all the cam-teeth are readily adjustable about their respective supports or wheels the variety of work which can be accomplished upon the machine is almost incalculable.

Where the machine is operated automatically, all of the movements of the valves are caused by the cam-shaft, with but one exception, and that is when the valve mechanism 240 is actuated to shut off the by-pass and retard the speed of the carriage when it is traveling toward the work, and I shall now proceed to describe the mechanism by which this is accomplished. In a trough-like bed 418, supported by arms 419, journaled upon studs 420, projecting forwardly from the bed, are adjustably clamped a plurality of stop-bars 421 equal in number to the projections on the turret for the tools. The bed is adapted to yield longitudinally in either direction, being provided with downwardly-projecting lugs 422 to loosely receive pins 423, which at their ends abut against lugs 424 on the bed. A spring 425 encircles each pin and bears at one end against a projection 4521 on the pin and at its other end against the inner lug 422. (See Fig. 55.) Consequently the bed, although moved in either direction, will be returned to normal position by the springs, it being noted that when the bed is so longitudinally moved it is likewise depressed. Now upon its forward end this bed is provided with projections 426 427 in position to engage a pin 600 on the valve-spindle of the valve mechanism 240. On the slide, in a substantially radial socket prepared to receive them, are a plurality of dogs 428 equal in number to the stop-bars 421 in the bed. The inner ends of these dogs, which are longitudinally movable under the tension of springs (not shown) pressing against their outer ends, bear upon the flange of the turret, over which the gib 230 takes, said gib itself being formed to receive said dogs. Around the said flange, which is indicated at 429, are a plurality of sockets or indentations 430, which are equal in number to the maximum number of tools to be placed upon the turret, or, in other words, six in the present case. Said notches are so located in different planes that each time a motion of rotation is imparted to the turret one will come opposite a particular dog to allow it to be projected thereinto, the ends of the dogs being in different horizontal planes. In the overhanging side of the carriage are placed pins 431, which are equal in number to the dogs 428, said pins and dogs being provided with notches, as shown in

Figs. 50, 51, and 52, to receive each other. Each pin has a head 432, which rests upon a dog and is adapted to drop into a depression 433 in said dog. When one of the dogs moves rearward into an indentation or socket 430, a pin which rests upon it is allowed to drop to rest upon one of the stop-bars 421 which is immediately therebeneath, it being understood that one of said pins 431 is over each one of the stop-bars. Said stop-bars are provided with notches or engaging edges, and hence when the turret reaches a certain point during its movement one of the notches or engaging edges in the stop-bars is engaged by one of the pins 431, and the whole bed is moved in the direction of movement of the turret to cause one of the projections 426 or 427 to engage the pin 600 of the valve mechanism 240 and slightly shift the valve to throw out the by-pass valve to cause the liquid to flow through the meter.

Referring once again to the cam-shaft 390, I shall now proceed to describe the escapements which permit its rotation at predetermined times to cause the actuation of the various valve mechanisms. One of the escapements is controlled by the movement of the turret and slide. Another is controlled by the "knock-off" mechanism and also by the stop which regulates the forward feed of the stock or bar, and the third by the cutting-off tool. These escapement devices, as I have said, control the time and degree of rotation of the cam-shaft, being so arranged and connected as to release the cam-shaft and permit its partial rotation instantly on the completion of a certain operation or a certain combination of operations, thus reducing to a minimum the time interval between operations and at the same time preventing conflicting operations taking place simultaneously. The first escapement consists of a wheel or disk 434, having a plurality of apertures 435, arranged in three rows or series, adapted to receive teeth or projections 436. These teeth are adapted to engage teeth 437, projecting forwardly from a spider 438, formed on or secured to a gear-wheel 439, journaled on a stud-shaft 440, projecting forwardly from the bed 200. The pin-apertures 435, of which there are two for each series of pins on the wheel 434, are arranged at different distances radially on the spider 438. There are six of these pins, their number being equal to the tools which are placed upon the turret, it being assumed that in each case the maximum of tools is employed. The gear 439 is engaged and driven by a gear 441 on the shaft 333, previously referred to and shown in Fig. 23. It has been previously explained that this shaft 333 is given a partial revolution for each reciprocation of the turret-slide, and hence it will be seen that each time the turret-carriage reaches its rear extreme of movement the spider 438 is rotated, so that, if the other escapements permit, the cam-shaft 390 will be rotated until it is stopped by another pin 437 on the spider or by a stop on some other escapement. The escapement which is controlled by the cutting-off tool includes a disk 445 upon the cam-shaft 390 and has a plurality of removable and adjustable teeth 446 dropped loosely into sockets in its periphery. These teeth are held from dropping out by a flanged hood 447, which partially encircles the disk, as shown in Fig. 43 in connection with Fig. 45. The hood is formed as a guide to receive a longitudinally-movable pin 448, which at its end bears against a pawl 449, pivoted at 450 to drop into engagement with the teeth 446 to prevent the rotation of the cam-shaft. The other end of the pin 448 projects beyond the guide, whereby it is adapted to be engaged by a cam projection 451 on the end of a bent lever 452, fulcrumed at 453 on the front of the bed. The other end of said lever is in the path of a dog 454, adjustably secured to the piston-rod 247, so that when said piston-rod reaches a certain point in its travel (probably its lower extreme of movement) the dog 454 engages the lever 452 and brings the cam projection 451 against the end of the pin 448 to move said pin longitudinally outward to lift the pawl 449 and permit a partial rotation of the cam-shaft to cut off the flow of fluid into the cylinder for the cutting-off tool. The third escapement, which is controlled by the knock-off mechanism and the stop for limiting the feed of the stock, consists of a disk 455, similar to that previously described and having a plurality of adjustable loose teeth 456, held in place by a hood 457, similar to that at 447. The said hood is provided with a guide 458 to receive a pin 459, bearing against a pawl 460, loosely pivoted upon a pin 461, passing into a bracket 462, secured to said guide 458. The pawl is slotted, as at 463, so that it may be thrown outward and at the same time dropped downward to rest upon the top of the teeth if the conditions are not yet proper for the rotation of the cam-shaft. The pin 459 is adapted to be thrust into operative position by a pivoted cam-latch 464, resting loosely against a pin 465 on an arm 466, attached to a rock-shaft 467. When the arm 466 swings to the right in Fig. 64, the pin 459 will be operated; but when the said arm swings to the left the cam 464 will yield as it passes the pin 459 and then drop into operative position. The shaft 467 extends part way through the bed from the front toward the rear, it being journaled in the front side thereof and also in a bracket 468, depending from the top thereof, as shown in Fig. 73. To the rear end of said rock-shaft 467 is attached an upwardly-extending arm 469, which, with the assistance of another arm 470, pivoted in a bracket 471, depending from the bed, supports a longitudinally-movable bar 472. (See Fig. 56.) The arms 469 and 470 are inclined forward from the vertical, so that by pressing downward upon the bar 472 or moving it forward by pressure against the end the arm 466 will be swung to actuate

the pin 459 and throw the pawl 460 into operative position. The knock-off mechanism, which is shown in my previous patent numbered 457,967, dated August 18, 1891, is modified somewhat, so as to operate upon this bar to permit the turning of the cam-shaft and the stoppage of the advance of the slide or carriage. Said knock-off mechanism includes a plurality of pins 473, arranged in the gib 230, as shown in Fig. 46, and at their forward ends they are adapted to enter the indentations or sockets 430 in the turret previously referred to. The said indentations are arranged in different horizontal planes, and as there are six consequently there are six pins 473. At their rear ends said pins bear against other pins 474, projecting upwardly from pawls 475, which are pivoted near one end to be depressed by gravity when their respective pins enter the depressions in the turret to permit them to engage notches in adjustable stop-bars 476, arranged in a groove 477 in the top of the bed, as shown in Fig. 73. The pawls 475 are placed upon a rock-shaft 478, which has at its ends eccentric studs 479, journaled in an offset 480 in the gib, as shown in Fig. 46, taken in connection with Figs. 56 and 73. This shaft 478 is provided with an arm 481, which bears upon the top of the bar 472, and consequently when one of the pawls 475 during the forward movement of the carriage engages one of the notches 482 in a stop-bar 476 the eccentric shaft 478 is rocked to throw the arm 481 downward and depress the bar 472 to actuate the escapement and (other things being in proper condition) permit the rotation of the cam-shaft. The next mechanism which controls this escapement is that connected with the device which stops the feed of the stock or bar fed forward by the roller-feed, and the said mechanism is indicated in Figs. 33, 8, 9, 10, 14, and 15. The sleeve 306 311 is longitudinally movable, as previously described, although it is held at its forward extreme of movement by spring-pressed pins 483, bearing against the bracket at the rear end of the lathe. The extreme rear end of the sleeve is provided with a lug or projection 484, which rests against an arm 485 upon a vertical rock-shaft 486, journaled in a bracket 487 in the end standard 244 on the bed. The lower end of the shaft extends through the bed and is provided with an arm 488, which bears against the longitudinally-movable bar 472 previously referred to, so that when said sleeve is moved longitudinally the bar 472 is actuated to operate the escapement and permit the cam-shaft to advance, if the other escapements are in position to permit it so to do. The sleeve 306 is formed with a tongue 489, upon which the arm 305 is secured, said arm being adjustable longitudinally of said sleeve, and also secured to said tongue is another arm 490, which is longitudinally adjustable thereon. On the end of this arm there is a centrally-pivoted stop or lever 491, fulcrumed at 492 and having a spring 493, by means of which it has a tendency to assume the positions shown in full lines in Figs. 34 and 35 with relation to the arm 490. When the receiver for the finished product is swung into the position shown in Fig. 34, the end of the stop-lever 491 engages the work which is being severed and is held in the position shown in dotted lines, the spring yielding to permit this. As soon, however, as the cutting-off knife completely severs the finished product from the bar the stop-lever 491 immediately springs into the position shown in full lines, so that it is in alinement with the axis of the work. Consequently when the roller-feed advances the bar or work the latter engages the stop-lever and moves it and the sleeve 306 311 longitudinally, and immediately thereupon the rock-shaft 486 is rocked to actuate the escapement, which permits the cam-shaft to rotate and admit air to the cylinder 363 to close the chuck and cut off the roller-feed.

From the foregoing explanation it is now apparent that the rotation of the cam-shaft is governed by the cut-off tool, the turret, the knock-off mechanism, and also the stop against which the stock is fed by the roller-feed, these various devices acting upon the three escapements which otherwise hold the cam-shaft against rotation.

It is essential that the speed at which the carriage is fed during the time that the tool is operating upon the work should be varied in accordance with the character of the work performed by the tool, and in order to accomplish the said variation in speed I employ devices operated by and coacting with the cam-shaft for varying the amount of fluid delivered by the meter to the carriage-operating cylinder. It consists of a wheel or disk 494, having a flanged rim, as shown in Figs. 80 and 82. This wheel is on the end of the cam-shaft 390 and is directly opposite the movable pin 297, which limits the throw of the loose piston 292 in the meter or regulator for the liquid. On the end of the pin is a cam-shaped head 495, adapted to be engaged by a variety of adjustable teeth 496 on the wheel 494. Said teeth consist of screws passed through the rim for the purpose of engaging the head 495, which is held outward by the pressure of the liquid in the chamber 291. The position of these teeth is determined by the character of the work performed by the tool to regulate the quantity or volume of the liquid passing through the meter. Any number of teeth may be employed provided they are adequate to cause the proper adjustment of the pin 297. I have stated that the shaft 224 may be driven by any suitable means, and I have shown in Figs. 93 to 99, inclusive, mechanism for determining the speed and the direction of rotation of the said shaft. Beyond the end of the lathe is a casing 497, having journal-bearings 498 for receiving two parallel shafts 499 and 500, which are journaled in bushings 501 and 502 therein. The top of the casing is

provided with an aperture 503 to receive the bar or stock which enters the hollow work-carrying spindle. The shaft 499 is connected to the shaft 224 by a gimbal or universal joint 504 (see Fig. 95) to impart motion thereto, and upon the said shafts 499 and 500 there are two oppositely-arranged cone-pulleys 505 and 506, connected by a belt 5071. On the ends of the shaft 500 are pulleys 507, 508, 509, and 510. Those at 507 and 510 are fast or rigidly secured to the shaft, and those at 508 and 509 are loose. There are likewise two belts 511 and 512, which travel in opposite directions, being driven from any suitable source of power. Mechanism is provided for moving said belts alternately to their respective fast wheels, and it consists of oppositely-arranged levers 513 514, each being adapted to engage a belt and move it from the fast to the loose pulley, or vice versa. The lever 513 is fulcrumed on a shaft 515 and has an arm 516, carrying a stud 517, the lever 514 being on the shaft 515, which is also provided with a short arm 516, having a stud 517. The two studs 517 extend into angular slots 518 in clips 519 and 520, adjustably secured to a longitudinally-movable rod 521, mounted in guides 522 and 523. The two clips 519 520 are oppositely arranged, so that the inclined portions of their slots 518 converge. The other portions of the slots are in alinement with each other. When the two belts 511 and 512 are on their respective loose pulleys, the clips 519 520 are in neutral position, as shown in Fig. 93, and by moving the rod 521 in one direction or the other one of the levers 513 or 514 will be actuated to move the belt engaged thereby to the fast pulley therefor—that is to say, if the rod 521 be moved to the left in Fig. 93 the lever 514 will remain stationary, as the stud 517 will be in the horizontal portion of the slot 518 in the clip 519, but the stud 517 of the lever 513 will be raised by reason of its entering the inclined portion of the slot 518 in the clip 520, and the lever 513 will be therefore swung about its fulcrum 515 to move the belt 511 onto the fast pulley 510. I have contemplated actuating the rod 521 by mechanism controlled by the cam-shaft 390; but I have shown it as being provided with a handle 524, by which it is manually operated. The means for shifting the belt 5071 along the cone-pulleys comprises two rods 525 and 527, passing through the casing 497 in parallelism with the shafts 499 and 500, and they are provided with projections 526 for engaging the opposite sides of the belt. Provision is made for moving said rods yieldingly in one direction and positively in the other direction, one of said rods having its yielding motion in a direction opposite to the yielding motion of the other—that is to say, this is done so as to shift the belt from the larger portion of one cone-pulley positively and yieldingly engage it with the larger portion of the other cone-pulley. For instance, if it is desired to move the belt 5071 to the right in Fig. 95 one of the rods will be moved positively to the right to slip the belt from the larger portion of the pulley 506, while the other part of the belt will be yieldingly drawn into engagement with the next larger portion of the cone-pulley 505. The devices for accomplishing this comprise two levers 528 and 529, both being mounted upon a rock-shaft 530, the lever 528 being loose thereon and the other being secured rigidly thereon. An arm 531 is also rigidly secured to said shaft 530, and it is provided with a segmental portion 532, which registers with a segmental clip or projection 533 on the lever 528. The hand-lever 534 is mounted loosely upon the shaft 530 and is provided with a dog 535, adapted to engage either the segment 532 or the segment 533. The arm 531 is connected to the lever 528 by a coiled spring 536. Consequently when the lever 534 is swung in one direction—say to the right in Fig. 93—the arm 531, and therefore the lever 529, will be moved positively to the right, while the lever 528 will be drawn in that direction yieldingly by the spring 536, and if the lever 534 be drawn to the left the lever 528 will be moved positively in that direction, while the arm 531 and the lever 529 will be drawn yieldingly thereafter. This permits the belt 5071 to be moved in either direction along the cones 506 and 507, so that it will be drawn positively to a lower step or on one below and will be engaged yieldingly with the larger step on the other pulley.

I have previously referred to the mechanism for closing the tool or bringing it into exact position to operate upon the work, and I shall now proceed to describe several forms of tool which may be employed in connection with the closer and opener.

The simplest form of tool is shown in Figs. 38 and 39. It consists of a support 537, adapted to be secured in any suitable way to the turret or tool-holder. It is formed with a segmental slot or aperture 538 to receive the end of the stock as the slide or carriage is moved toward the head. An ordinary turning-tool is shown at 539, and it is securely attached to an oscillatory holder 540 by set-screws 541. The holder is mounted upon a shaft 542, to which is secured an arm 543, projecting upwardly, as clearly illustrated. In the free end of the arm is pivoted a lever 544, having an eccentric boss 545, which bears against an adjustable screw 546, passed through the side of the holder or support 537. By rocking the arm downward the engagement of the eccentric with the end of the screw forces the holder and the cutter forward toward the work, as shown in Fig. 38, said lever being held normally in an inoperative position by a spring 547, secured to the support and having its free end bearing against a pin 548 on said lever. The said lever projects rearwardly far enough to be engaged by the longitudinal bar 268 on the closer, and consequently when said closer is operated by the fluid-

actuated device the lever 544 is forced downward and the tool is engaged with the work. For the purpose of resisting the thrust of the tool against the bar or work I provide the tool with a back-rest, which consists of two slides 549 550, having beveled edges 551 552, which form a V-shaped groove to receive the work. These slides are provided with headed studs 553, which bear against a bar 555, adjustably secured to the support by shoulder-screws 556. By adjusting said screws the position of the slides, which form a portion of the back-rest, may be varied. In order to prevent any vibration and to hold all of the contacting parts securely together, I provide two flat springs 557 and 558, secured to the bar 555 by a rivet 559, passed through their centers. The free ends of the spring 557 bear against the heads of the screws 556 and hold the bar 557 tightly against the shoulders thereon, while the free end of the spring 558 bears against the edges of the studs 553 and holds the bar 555 tightly thereagainst. I have provided means for simultaneously bringing the back-rest and the cutter into engagement with the work, as shown in Fig. 30. In this case the slide is formed in one piece, as indicated at 559, and is provided with the beveled edges, forming a V-shaped groove to engage the work. It slides in suitable guides and is provided with a beveled edge 560, against which a vertical sliding wedge 561 is engaged, said wedge being arranged in a groove in an upright portion of the support. The wedge is directly under the bar 268 of the closer, so that when the said bar is depressed the back-rest is brought into engagement with the work, its movement being limited by a pin 562, passed through an elongated slot in the wedge. A spring (not shown) raises the wedge when the pressure is removed from the end thereof. A cutter which is similar to that previously described and which is mounted in a swinging holder 563 is brought into engagement with the stock as the wedge descends. To accomplish this, the holder is provided with a curved arm having at its end a pin 564, entering a curved groove 565 in the wedge. Consequently as said wedge is depressed the holder is oscillated and the tool engages the stock. The tool may be engaged with the stock in other ways. For instance, its point may be brought gradually nearer or carried farther away from the center of the axis in case it is desired to taper the work. Mechanism for accomplishing this is shown in Fig. 36, in which case the bar 268 is tapered, as shown in Fig. 37. When it is depressed, its end is engaged with a beveled head 566 on a transversely-movable slide 567, mounted in the support, the said head and the slide being engaged by a spring 568. The outer end of the slide is bent downwardly at 569 to receive an adjusting-screw 570, which bears against a disk 571, pivoted to the end of the oscillating arm 572, which is connected with the tool-holder. The said disk is provided with an arm 573, which extends under the said screw and has a resilient end 574, which bears against the end of the screw 570. Consequently as the turret is advanced toward the work the head 566 slides along the beveled or inclined side of the bar 268 and is slid in its groove or guide to bring the cutting-point of the tool nearer and nearer the axis of the stock.

In Fig. 31 a threading-die is shown which may be of any suitable construction, being provided with an oscillatory arm 575, which when swung about its axis brings the cutters into engagement with the stock. As I have previously stated, I do not herein claim the construction of the tool and the back-rest, since they form the subject-matter of a copending application.

The operation of the machine when controlled manually will be understood without further description. I shall now proceed to set forth briefly the operation of the machine when controlled automatically. Assuming that six tools are secured upon the turret to operate successively upon the stock or work, and that the receiver for the finished product has been moved into position, and that the cutting-off tool is about to complete its downward movement, the following operations will take place: As the cutting-off tool and carrier complete their downward movement the lug or dog 454 engages the lever 452 and lifts the other end thereof to throw the pawl 449 out of engagement with the escapement-wheel 445. The cam-shaft as soon as it is released commences to rotate under the impulse of the fluid-operated motor, (shown in Figs. 74 to 79,) and the valve mechanism at 366 is actuated to admit air into the chuck-opening cylinder, whereby the chuck being open and the roller-feed being brought into operation the bar commences to advance through the work-carrying spindle. When the finished article drops from the bar after being severed, the stop-lever 491 is sprung into place, so that when the bar is fed forward far enough by the roller-feed to engage the said stop-lever the sleeve upon which the latter is mounted is moved forward and the rock-shaft 486 is rocked to move the bar 472 longitudinally to cause the disengagement of the pawl 460 of the escapement-wheel 455 to permit the cam-shaft to rotate another step and shift the valve mechanism last referred to to permit fluid to pass into the other end of the cylinder 363 for an instant to close the chuck and throw the roller-feed out of operation. Then a further turning of the cam-shaft shifts the valve to its neutral position, which relieves the spindle from the end thrust to which it is exposed during the operation of the chuck. At about the same time that the chuck is closed air is admitted to the tool-closing cylinder by a cam actuating the valve mechanism therefor, and the said valve mechanism remains in this condition until the tool completes its work upon the stock. At the same

time the valve mechanism for the carriage-feeding device is operated by the cam 403 to permit the full volume of fluid to pass into the carriage-feeding cylinder. The carriage moves forward quickly until one of the pins 431 engages one of the stop-bars 421 to move the bed 418 longitudinally to cause one of the projections 426 427 to engage a pin 600 on the valve mechanism 240 to shut off the by-pass through the cylinder and cause the liquid to pass from the tank 282 through the regulator or meter 288. The carriage now advances slowly and regularly until it reaches the end of its movement, at which time one of the pawls or dogs 475 engages one of the stop-bars 476 in the bed and operates the escapement to release the wheel 455, whereupon the cam-shaft rotates still further and reverses the valve mechanism at 240 to send the carriage back at full speed away from the work and at the same time releases the tool-closer. When the carriage gets back far enough for the yoke 331 at the rear side thereof to engage the collar 344 on the slide-bar 336, said bar is carried backward to rotate the shaft 333 and operate the escapement mechanism connected therewith to permit the cam-shaft to advance a step, whereupon the valve mechanism 240 is again actuated to start the carriage forward, the tool-closing mechanism being also operated practically simultaneously therewith. The carriage is brought forward five times to permit the tools to operate upon the stock, and as it is withdrawn upon the completion of the work performed by the fifth tool the turret is rotated to bring the sixth tool into position. At the same time the clip 342 on the ratchet 337 engages the web 343 on the bar 325 and lifts the finger 330 into position to be engaged by the projection 332 on the yoke 331. Then when the sixth tool has completed its work and the turret is moving rearwardly the projection 332 engages said finger 330 and slides the bar 325 rearwardly to rotate the sleeve 306 311 and bring the receiver 303 under the product, which is now finished, save for its being severed from the stock. The carriage remains stationary when it reaches the rearward end of its travel, the escapement being actuated when it reaches the said end to permit the shaft to rotate far enough for the cam 404 to act upon the valve mechanism 258, whereby air is admitted to the device which operates the cutting-off tool. The tool descends and severs the finished product, which drops into the receiver, and this completes one entire cycle of operations of the machine. When the next article is begun and the carriage slides forward to bring the first tool into engagement with the stock, the spring 319 returns the receiver or remover to its original position, and as it swings back the finger 308 engages the work 309 and the finished product is dropped onto a table or into some suitable receptacle.

Referring once more to the severing-tool, I desire to state that I have contemplated moving it in both directions by fluid-pressure, and in that event would dispense with the weight.

At the end of the machine there may be employed a drip-pan 700 to receive the oil and turnings, which are deflected into the interior of the bed by the deflectors 702, as shown in Fig. 72. In the interior of the bed there is an inclined plate 703, down which the turnings and oil flow to the drip-pan. On the outside of the bed there are also inclined troughs 703 below the deflectors to receive any oil which may flow down the outside of the bed, said troughs having their lower ends above the drip-pan 700.

Having thus explained the nature of my invention and described a way of constructing and using the same, though without attempting to set forth all the forms in which it may be made or all of the modes of its use, what I claim, and desire to secure by Letters Patent, is—

1. An interconvertible automatic and manually-controlled lathe, the same comprising controlling devices adapted to be actuated manually, in combination with automatic mechanism for actuating said controlling devices, and means for connecting said devices with and disconnecting them from said automatic mechanism.

2. An interconvertible automatic and manually-controlled lathe, the same comprising fluid-operated mechanism for operating the lathe, valve mechanism therefor adapted to be operatively controlled manually, automatic mechanism for controlling said valve mechanism, and means for connecting said automatic mechanism with said valve mechanism.

3. In a lathe, a cylinder and piston, a valve mechanism therefor, having a manually-operable handle, an automatic device normally disconnected from said valve mechanism, and means for connecting said device with said valve mechanism for operating the same automatically, said means being detachable whereby said mechanism may be operated either manually or automatically.

4. A lathe comprising a bed, a rotatable work-holder, a tool-holder movable on the bed toward and from the work-holder, a cutting-off tool mounted independently of the tool-holder, fluid-operated mechanism for actuating said tool, a manually-operable valve for said mechanism, and an automatic controller adapted to be connected to said valve.

5. A turret-lathe comprising a bed, a carriage or slide movable on ways on said bed, a turret supported rotatably by said carriage or slide and provided with means for receiving a plurality of tools, a supplemental tool-carrier supported independently of the turret, fluid-operated mechanism for actuating said tool-carrier, and an intermittently-rotated shaft for controlling the actuation of said fluid-operated mechanism.

6. A lathe comprising a bed, a rotatable

work-holder, a tool-holder movable toward and from the work-holder, a supplemental tool-carrier independent of the tool-holder, fluid-operated devices, one for actuating the tool-holder and the other for actuating the tool-carrier, and a shaft for mechanically controlling the actuation of said fluid-operated mechanism.

7. A lathe comprising a bed, a rotatable work-holder, a tool-holder movable on the bed toward and from the work-holder, a swinging arm independent of the tool-holder, and having provisions for receiving a tool, fluid-operated means for actuating said arm, and provisions whereby said means may be controlled automatically or manually as desired.

8. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, fluid-operated means for moving said tool-carrier rapidly toward and from the work and slowly when the tool is operating, and provisions whereby said means may be controlled automatically or manually as desired.

9. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, fluid-operated means for actuating said carrier including valve mechanism, and devices independent of the valve mechanism for regulating the speed of the carrier when the tool is operating on the work.

10. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, and means including valve mechanism for actuating said carrier by fluid-pressure, said means having provisions independent of said valve mechanism for retarding and regulating the movement of the carrier when the tool is moved to operative position.

11. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, fluid-operated means including valve mechanism for actuating the carrier, and devices supplemental to said valve mechanism for retarding the action of said means when the carrier reaches a predetermined point in its travel.

12. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, fluid-operated means including valve mechanism for actuating the carrier, and a liquid regulator or controller supplemental to said valve mechanism for said means.

13. A lathe comprising a bed, a tool-holder movable on said bed, a supplemental tool-carrier, a cylinder having a piston connected to said carrier, said piston being actuated by elastic fluid, and means in said cylinder for retarding the movement of the piston when it reaches a predetermined point in its travel.

14. A lathe comprising a bed, a tool-carrier, and means operated by elastic fluid-pressure for actuating said carrier, said means including a piston and upright cylinder, and a liquid-receptacle connected to said cylinder at its lower extremity.

15. A lathe comprising a turret-slide, a bed, a tool-carrier supplemental to the turret, and means operated by fluid-pressure for actuating said carrier, said means including a piston and upright cylinder, the latter being adapted to contain a liquid therein on one side of the piston, a receptacle having connections with the cylinder for receiving the liquid therefrom, and devices including a check-valve for throttling the liquid when passing from the cylinder to the receptacle, and permanently allowing its free passage from the receptacle to the cylinder.

16. A lathe comprising a bed, a tool-carrier, and means operated by elastic fluid-pressure for actuating said carrier, said means including a piston and cylinder, the latter being adapted to contain a liquid therein on one side of the piston, a receptacle communicating directly with and supported by the cylinder for receiving the liquid therefrom, and devices for throttling the liquid when passing from the cylinder to the receptacle, and allowing its free passage when passing from the receptacle to the cylinder.

17. A lathe comprising a bed, a tool-carrier, and means operated by fluid-pressure for actuating said carrier, said means including a piston and upright cylinder, and a liquid-receptacle connected to said cylinder at its lower end by two separate ducts, a throttle-valve for one of said ducts, and a check-valve for the other of said ducts.

18. A lathe comprising a bed, a tool-carrier, and means operated by elastic fluid-pressure for actuating said carrier, said means including a piston and upright cylinder, and a liquid-receptacle connected to said cylinder at its lower end by two separate ducts, a throttle-valve for one of said ducts, and a check-valve for the other of said ducts.

19. A lathe comprising a bed, a tool-carrier, and means operated by elastic pressure for actuating said carrier, said means including a piston and upright cylinder, a receptacle connected to the lower end of said cylinder whereby liquid will flow freely by gravity into the cylinder therefrom, and means for throttling the passage of the liquid from the cylinder to the receptacle.

20. A lathe comprising a bed, a tool-carrier, and means operated by elastic pressure for actuating said carrier, said means including a piston and upright cylinder, a receptacle connected to the lower end of said cylinder whereby liquid will flow freely by gravity into the cylinder therefrom, and means for throttling the passage of the liquid from the cylinder to the receptacle, said cylinder having an air-exhaust in its side above the normal level of the liquid.

21. A turret-lathe comprising a work-carrying spindle, a carriage or slide movable toward and from the work and carrying a rotatable work-holder or turret, fluid-operated means for automatically moving said carriage or slide, a supplemental tool-carrier independent of the tool-holder or turret, means for moving said carrier toward and from the

work, and automatic mechanism including valves, a shaft, and mechanical devices actuated by said shaft for operating said valves for controlling the two said means to cause the actuation of the carriage or slide, and the tool-carrier in predetermined order.

22. A lathe having a severing-tool, and a receiver adapted to be moved into position under the work to receive it when it is severed from the stock and drops by gravity.

23. A lathe having a severing-tool, a receiver adapted to receive the severed and finished work, and normally lying in an inoperative position, and means for moving said receiver to operative position under the work, whereby the latter may drop thereinto.

24. A lathe having a severing-tool, a receiver, adapted to receive the severed and finished work, and normally lying in an inoperative position, and means for automatically moving said receiver into operative position under the work, whereby the latter may drop thereinto.

25. A lathe having a severing-tool, a receiver for the finished work, means for moving said receiver into position under the work, whereby the latter may drop thereinto and means for causing said receiver to discharge the work.

26. A lathe comprising a reciprocatory tool-holder, a receiver mounted independently of the tool-holder to receive the finished and severed work and automatic devices controlled by said tool-holder for moving the receiver into operative position.

27. A lathe comprising a reciprocatory carriage, a turret thereon, a receiver for the finished work, and means controlled by the turret, and operated by the carriage for moving said receiver into operative position.

28. A lathe having a severing-tool, a finished-work receiver comprising a device to receive the work when severed, and a swinging arm for moving said receiving device into operative position under the work, that the latter may drop thereinto.

29. A lathe having a severing-tool, a receiver for the severed finished work, said receiver comprising a trough normally in an inoperative position, an arm to which said device is pivoted, and means for actuating said arm.

30. A lathe having a bed, a reciprocatory tool-holder, a receiver for the finished severed work, said receiver being supported on the bed, and means actuated by said holder for moving said receiver into operative position.

31. A turret-lathe having a bed, a reciprocatory turret, a receiver for the finished severed work, and means for moving said receiver to operative position at one or more predetermined points in the rotation of the turret.

32. A turret-lathe comprising a tool-slide, a receiver for the finished severed work, and means for moving said receiver into operative position, said means comprising suitable gearing, and devices actuated by the slide for operating said gearing.

33. A turret-lathe comprising a tool-slide, a receiver for the finished severed work, and means for moving said receiver into operative position, said means comprising a sliding bar, and devices for engaging said bar with the tool-slide.

34. A turret-lathe comprising a tool-slide, a receiver for the finished severed work, and means for moving said receiver into operative position, said means comprising a sliding bar, gearing between said bar and said receiver, and devices for engaging said bar with the tool-slide whereby it is actuated thereby.

35. A turret-lathe comprising a tool-slide, a receiver for the finished severed work, and means for moving said receiver into operative position, said means comprising a sliding bar, gearing between said bar and the receiver, and devices controlled by the movements of said tool-slide for engaging said slide with said bar.

36. A lathe comprising a rotary work-holder, means for feeding the stock through said holder, and mechanism having a portion in the path of and actuated by said stock for throwing said feeding means out of operation.

37. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, and mechanism including a stop adapted to be engaged by the stock for throwing the feeding means out of operation.

38. A lathe comprising a rotary work-holder having a chuck, means for feeding the stock therethrough, means for opening and closing said chuck, and mechanism governed by the movement of the stock for controlling said feeding means and said chuck opening and closing means.

39. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, fluid-operated devices for causing the operation of said means, and mechanism controlled by the said stock for governing said fluid-operated devices.

40. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, means for severing from the stock the finished work, and mechanism controlled by said severing means for causing the operation of the feeding means.

41. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, means for severing from the stock the finished work, and fluid-operated devices automatically controlled by the severing means for causing the operation of the stock-feeding means.

42. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, means for severing from the stock the finished work, fluid-operated devices for causing the operation of the stock-feeding means, and valve mechanism for said fluid-operated devices controlled automatically by the severing means.

43. A lathe comprising a rotary work-holder, means for feeding the stock therethrough,

means for severing from the stock the finished work, fluid-operated devices for causing the operation of said stock-feeding means, valve mechanism for said fluid-operated devices, a cam-shaft having a cam for actuating the valve mechanism, and an escapement for said cam-shaft controlled by said severing means.

44. A lathe comprising a rotary work-holder, means for feeding the stock therethrough, devices for causing the operation of the feeding means, a cam-shaft for controlling the said devices, and escapement mechanism for regulating the rotation of the cam-shaft.

45. A lathe comprising a rotary work-holder having a chuck, chuck opening and closing means, stock-feeding devices, and fluid-operated mechanism controlled by the stock for operating said chuck opening and closing means.

46. A lathe comprising a rotary work-holder having a chuck, chuck opening and closing means, stock-feeding devices, means for severing the finished work from the stock, and mechanism controlled by said severing means for actuating the chuck opening and closing means.

47. A lathe comprising a rotary work-holder, having a chuck, chuck opening and closing means, stock-feeding devices, means for severing the finished work from the stock, and fluid-operated mechanism controlled by said severing means for actuating the chuck opening and closing means.

48. A lathe comprising a rotary work-holder, having a chuck, chuck opening and closing means, stock-feeding devices, means for severing the finished work from the stock, fluid-operated devices for causing the operation of the chuck opening and closing means, and valve mechanism for said fluid-operated devices controlled by said severing means.

49. A lathe comprising a rotary work-holder having a chuck, chuck opening and closing means, stock-feeding devices, mechanism for actuating the chuck opening and closing means, an intermittently-actuated cam-shaft for controlling the said mechanism, and an escapement mechanism for said shaft.

50. A lathe comprising a rotary work-holder having a chuck, chuck opening and closing means, stock-feeding devices, fluid-operated devices for causing the operation of said chuck opening and closing means, valve mechanism for said devices, a cam-shaft for controlling said valve mechanism, and an escapement for said cam-shaft.

51. A lathe comprising a rotary work-holder having a chuck, chuck opening and closing means, stock-feeding devices, means for severing the finished work from the stock, and fluid-operated devices for causing the operation of the chuck opening and closing means, valve mechanism for said devices, a cam-shaft for controlling said valve mechanism and an escapement governed by the stock-severing means for regulating the rotation of the cam-shaft.

52. A turret-lathe having a tool opening and closing device automatically operable on each turret-tool after the latter is in working position.

53. A turret-lathe having mechanism independent of the tool and the turret for effecting the adjustment of a turret-tool relatively to the diameter of the work.

54. A turret-lathe having a sliding turret provided for the reception of tools, and a device for automatically closing a turret-tool when the latter is in working position, said device being operable at any point in the travel of the turret.

55. In a lathe, a turret tool-closer, a tool-carrying turret, and means independent of the turret for operating said tool-closer when the turret is not rotating.

56. In a lathe, a tool-closer, a tool-carrying turret, and means supported independently of the turret for operating said tool-closer.

57. In a turret-lathe, means for automatically effecting an adjustment of a tool on the turret, relatively to the work, and movable power devices independent of the turret for actuating said means.

58. A lathe having a tool-carriage and an automatic tool-closer operable independently of said carriage.

59. A lathe having a sliding turret, a plurality of tools thereon, and automatic mechanism independent of the turret for closing the tools successively independently of each other, at any point in the travel of the turret.

60. A lathe having a rotatable turret with one or more tools thereon, means for closing said tool or tools, and fluid-operated devices for operating said tool-closing means.

61. A lathe having a tool-slide movable toward and from the work, and means for closing the tool or tools on the slide at any point in its movement.

62. A lathe having a tool-slide, a tool-closer, fluid-operated devices for actuating the tool-closer, and a valve mechanism governing said fluid-operated devices.

63. A lathe having a movable tool-slide, and a tool-closer mounted and operated independently of the said slide.

64. A lathe having a tool-slide and a tool-closer including a movable bar substantially parallel to the path of movement of said slide.

65. A lathe having a tool-slide and a tool-closer including a bar substantially parallel to the path of movement of said slide, and means for moving said bar toward and from said slide.

66. A lathe having a tool-slide, a tool-closer, a cam-shaft, and fluid-operated devices controlled by said cam-shaft for actuating the tool-closer.

67. A lathe having a tool-slide, a tool-closer, means for actuating the tool-closer, including a yieldingly-driven intermittently-rotating cam-shaft, and means for regulating the rotation of said cam-shaft.

68. A lathe having a slide, movable toward

and from the work in lines longitudinal thereof, a tool-holder rigidly affixed to the slide, and having a member which is movable to close the tool on the work, and movable means independent of the slide for actuating said member.

69. A lathe having a slide, movable toward and from the work in lines longitudinal thereof, a tool-holder rigidly affixed to the slide, and having a member which is movable to close the tool on the work, and movable means for actuating said member at any point in the travel of the slide.

70. A lathe having a slide movable toward and from the work in lines longitudinal thereof, a tool-holder rigidly affixed to the slide and having a member which is movable to close the tool on the work, and movable means for actuating said member, said means being mounted independently of the slide.

71. A lathe having a slide movable toward and from the work in lines longitudinal thereof, a tool-holder rigidly affixed to the slide, and having a member which is movable to close the tool on the work, and movable means for actuating said member, said means consisting of a bar parallel to the lines of movement of the slide and movable toward the slide to engage the said member.

72. A lathe having a tool-slide movable longitudinally of the bed, said slide having tools rigidly fixed thereon; a tool-closer supported independently of the tool-slide, and consisting of a rock-shaft, arms on said rock-shaft and a bar adapted to engage any one of the tools; and means for actuating said tool-closer independently of the tool-slide.

73. A lathe having a tool-slide movable longitudinally of the bed, and provided with one or more tools fixed thereon and an automatic device for closing the tool gradually, independently of the slide.

74. A lathe having a tool-slide with one or more tools and an automatic device supported independently of the slide for closing the tool gradually, irrespective of the movement of the slide.

75. A turret-tool-closing device consisting of a bar held in position approximately parallel to the lines of travel of the turret-slide, said device having one or more faces to actuate the tools.

76. A turret-tool-operating device consisting of a bar held in position parallel to the travel of the turret-slide, and means for moving said bar to and from said slide, said bar having an inclined face for actuating a tapering or irregular turning-tool.

77. A lathe comprising a tool slide or carriage, means for reciprocating said tool slide or carriage, a yieldingly-driven cam-shaft for regulating the operation of the said means, and one or more escapements for controlling the rotation of said cam-shaft.

78. A lathe comprising a tool slide or carriage, means for reciprocating the said slide or carriage, a cam-shaft for regulating the operation of the said means, and an escapement for said shaft, controlled by the slide or carriage.

79. A lathe comprising a tool-slide, means for reciprocating said slide, and mechanism for controlling the operation of said means, said mechanism including a shaft, and an escapement for the shaft governed by the movement of the slide.

80. A lathe comprising a tool-slide, means for reciprocating said slide, and mechanism for controlling the operation of said means, said mechanism including a shaft, an escapement for the shaft governed by the movement of the slide, in one direction, and a second escapement for the shaft governed by the movement of the slide in the opposite direction.

81. A lathe having a tool-slide, fluid-operated devices for reciprocating said slide, valve mechanism for said devices, a cam-shaft for actuating said valve mechanism, and means controlled by said slide for governing the rotation of said cam-shaft.

82. A lathe having a tool-slide, fluid-operated devices for reciprocating said slide, valve mechanism for said devices, a yieldingly-driven cam-shaft for actuating said valve mechanism, and one or more escapements for governing the rotation of said cam-shaft.

83. A lathe having a tool-slide, fluid-operated devices for reciprocating said slide, valve mechanism for said devices, a cam-shaft for actuating said valve mechanism, an escapement for the shaft governed by the movement of the slide in one direction, and a second escapement for the shaft governed by the movement of the shaft in the opposite direction.

84. A lathe comprising a slide, a turret on said slide, means for reciprocating said slide, a yieldingly-driven shaft governed by the slide for regulating the operation of the said means, and supplemental devices controlled by the turret for regulating the operation of said means.

85. A lathe comprising a tool-slide, fluid-operated means for reciprocating the said slide, a valve for said fluid-operated means, a shaft for actuating said valve, and auxiliary means operable by the feeding movement of said tool-slide for actuating said valve.

86. A lathe comprising a tool-slide, fluid-operated means for reciprocating the said slide, a valve for said fluid-operated means, a shaft for actuating said valve, means for intermittently stopping the rotation of said shaft, and means auxiliary to said shaft for actuating the valve.

87. A lathe comprising a bed, a tool-slide thereon, means for reciprocating said slide, a shaft for controlling the said slide-reciprocating means, means for yieldingly rotating said shaft, and means for intermittently stopping said shaft during a single rotation.

88. A lathe comprising a bed, a tool-slide thereon, means for reciprocating said slide,

a shaft for controlling the said slide-reciprocating means, means for yieldingly rotating said shaft, and an escapement for said shaft governed by the said slide.

89. A lathe comprising a bed, a tool-slide, means for reciprocating the tool-slide, a work-carrying spindle having a chuck, chuck opening and closing means, a shaft for controlling the said slide-reciprocating means, and the said chuck opening and closing means, and escapements for said shaft governed by the said slide and the said chuck opening and closing means.

90. A lathe comprising a bed, a tool-slide, means for reciprocating the tool-slide, a work-carrying spindle, means for feeding the work therethrough, a shaft for controlling the slide-reciprocating means and the work-feeding means, and escapements for the said shaft, one governed by the feeding movement of the work and the other by the said tool-slide.

91. A lathe comprising a bed, a tool-slide, means for reciprocating the tool-slide, a work-carrying spindle, means for severing the finished work, a shaft for controlling the slide-reciprocating means and the work-severing means, and escapements for the said shaft, one controlled by the work-severing means, and the other controlled by the slide.

92. A lathe comprising a bed, a tool-slide, means for reciprocating the tool-slide, a work-carrying spindle, work-feeding means, work-severing means, a shaft controlling the slide-reciprocating means, the work-feeding means, and the work-severing means, and escapements for said shaft, one governed by the movement of the work, a second governed by the work-severing means, and a third governed by the slide.

93. A lathe having a yieldingly-driven intermittingly-rotated shaft, and an independent motor for said shaft, substantially as described.

94. A lathe having a yieldingly-driven shaft, one or more escapements for intermittently checking the rotation of said shaft, and an independent motor for said shaft.

95. A lathe comprising a bed, a slide having a turret, means for reciprocating the slide, and a knock-off mechanism including a plurality of stop-bars, a plurality of pawls cooperating with said bars, and an eccentrically-journaled shaft carrying said pawls.

96. A lathe comprising a bed, a slide having a turret, means for reciprocating the slide, auxiliary means for varying the movement of the said slide, and a knock-off mechanism for said auxiliary means, the same consisting of a plurality of stop-bars, adjustable stops carried by the slide to coact with said bars, and a longitudinally-movable bed or bracket in which said stop-bars are mounted.

97. A lathe comprising a bed, a slide having a turret, fluid-operated mechanism for reciprocating the said slide, auxiliary devices for varying the supply of fluid to said mechanism, and a knock-off mechanism for said devices, the same consisting of a plurality of stops coacting with the turret, stop-bars to coöperate with the stops, and a longitudinally-movable bed for said stop-bars, said bed being adapted to operate said auxiliary devices.

98. A lathe comprising a bed, a slide having a turret, fluid-operated mechanism for reciprocating said slide, a valve for said mechanism, a movable bracket adapted to actuate the valve, adjustable stop-bars on said bracket, and means on said slide for engaging said stop-bars.

99. An automatic turret-lathe having a rotary work-holder, a shaft for actuating said holder, a shaft for governing the action of one or more of the movable parts thereof, and a fluid-operated motor independent of said work-driving shaft for yieldingly rotating said shaft.

100. An automatic turret-lathe having a slide with a turret thereon, means for reciprocating the slide, means for rotating the turret, a shaft for governing the slide-reciprocating means, and an escapement for said shaft including a stop-carrier rotating in unison with the turret, and a carrier on said shaft having stops engaging those on the first-mentioned carrier.

101. A lathe having a tool-slide, means for reciprocating the slide, a shaft for governing the said means, an independent motor for said shaft, and an escapement for the said shaft, consisting of a stop-wheel on said shaft, and an automatically-operated pawl normally holding the stop-wheel against rotation.

102. An automatic lathe having a cam-shaft for governing the operation thereof, an escapement for said shaft, consisting of a stop-wheel on the shaft, and a pawl for engaging the same, and means for disengaging the pawl from one of the said stops to permit the shaft to rotate.

103. An automatic lathe having a cam-shaft for governing the operation thereof, an escapement for said shaft, consisting of a stop-wheel on the shaft, and a pawl for engaging the same, and a swinging arm for disengaging the pawl from a stop on the said wheel to permit the shaft to rotate.

104. An automatic lathe having a cam-shaft for governing the operation thereof, an escapement for said shaft, consisting of a stop-wheel on the shaft, and a pawl for engaging the same, and a swinging arm having a cam, and a pin adapted to be operated by said cam to throw the pawl out of engagement with the stop-wheel.

105. In a lathe, a tool-carriage, a piston and cylinder for moving said carriage, a valve mechanism having a valve with an arm or projection, and means for moving said arm or projection, said means including a wheel with a rim and adjustable cam-teeth clamped on said rim.

106. In a lathe, a tool-carriage, a piston and cylinder for moving said carriage, a valve mechanism having a valve with an arm or projection, and means for moving said arm or

projection, said means including a wheel with a rim, and with interchangeable adjustable cam-teeth clamped on said rim.

107. The combination in a lathe with the operative parts thereof, of a stop-wheel having a plurality of adjustable pins placed loosely therein, and a stationary shield for preventing the dropping of said pins as the wheel rotates.

108. A lathe comprising a tool-slide, fluid-operated mechanism for reciprocating the said slide, a liquid meter or regulator for regulating the movement of the said slide, and means for automatically varying the volume of the liquid passed through the said meter.

109. A lathe comprising a tool-slide, fluid-operated mechanism for reciprocating the said slide, auxiliary mechanism including a tank and a liquid meter or regulator for regulating the movement of the said slide, and means for automatically varying the volume of the liquid passed through the said meter.

110. A lathe comprising a tool-slide, fluid-operated mechanism for reciprocating the said slide, a liquid meter or regulator for regulating the movement of the said slide, and means for automatically varying the volume of the liquid passed through the said meter, said means consisting of a shaft, a cam thereon, and a regulating-pin actuated by said cam.

111. A lathe comprising a tool-slide, fluid-operated mechanism for reciprocating the said slide, auxiliary mechanism, including a tank, and a liquid meter or regulator for regulating the movement of the said slide, and means for automatically varying the volume of the liquid passed through the said meter, said means consisting of a shaft, a cam thereon, and a regulating-pin actuated by said cam.

112. A lathe comprising a bed, a slide movable thereon and carrying a turret, brackets supported on said bed beyond the limits of the travel of the slide, and a shaft supported by said brackets in combination with a work-severing device, and a finished-work-removing device both supported by the said shaft.

113. A lathe comprising a bed, a slide movable thereon and carrying a turret, brackets supported on said bed beyond the limits of the travel of the slide, and a shaft supported by said brackets, in combination with a work-carrying spindle, means for feeding the work through the spindle, and means having one member supported by the said shaft, for limiting the feed of the work.

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

JAMES HARTNESS.

Witnesses:

WILLIAM H. WHEELER,

ALICE M. WHEELER.