(Model.) 5 Sheets—Sheet 1.

C. M. BROWN.

GRINDING LATHE.

No. 370,003. Patented Sept. 13, 1887.

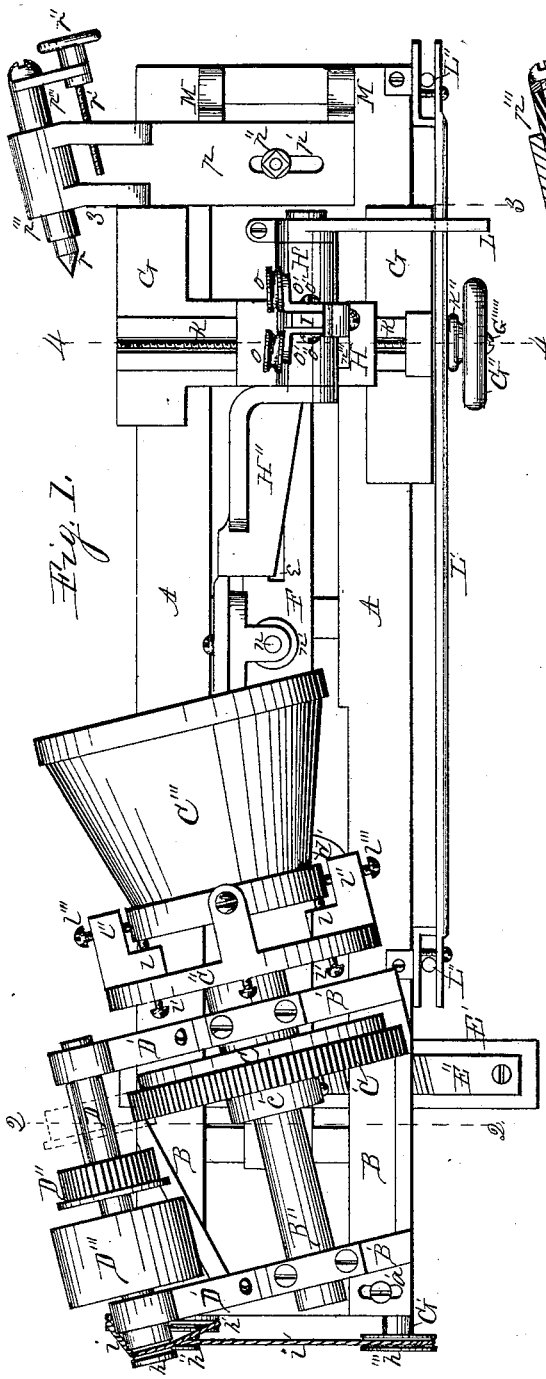


Fig. 1.

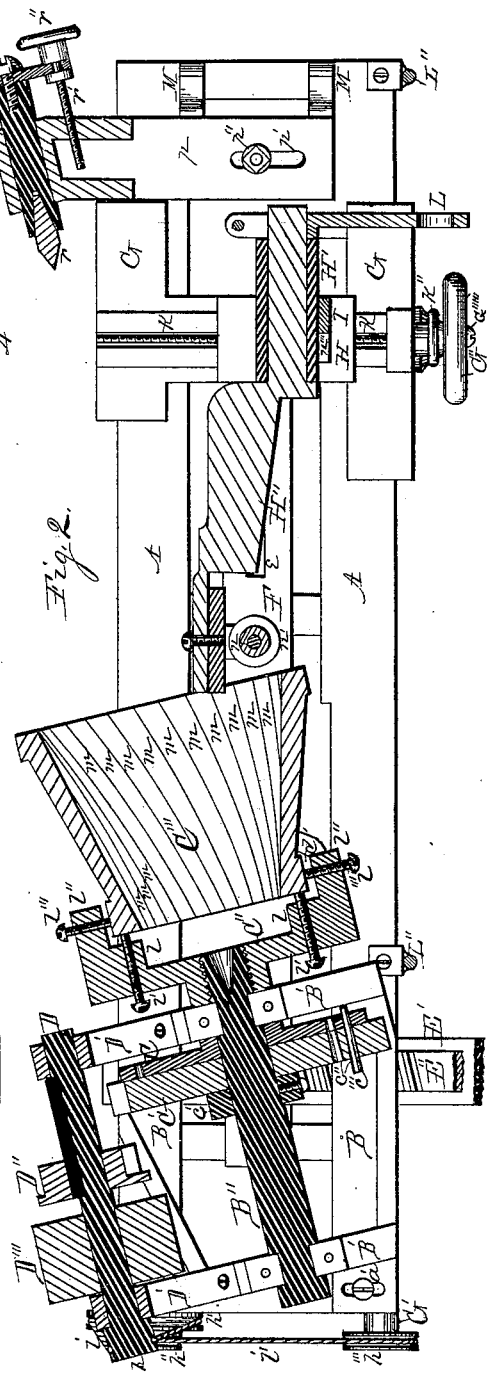


Fig. 2.

Witnesses.
C. F. Briggs.
A. D. Behel.

Inventor.
Charles M. Brown.
Per Jacob Behel
Atty.

(Model.)

5 Sheets—Sheet 2.

C. M. BROWN.

GRINDING LATHE.

No. 370,003. Patented Sept. 13, 1887.

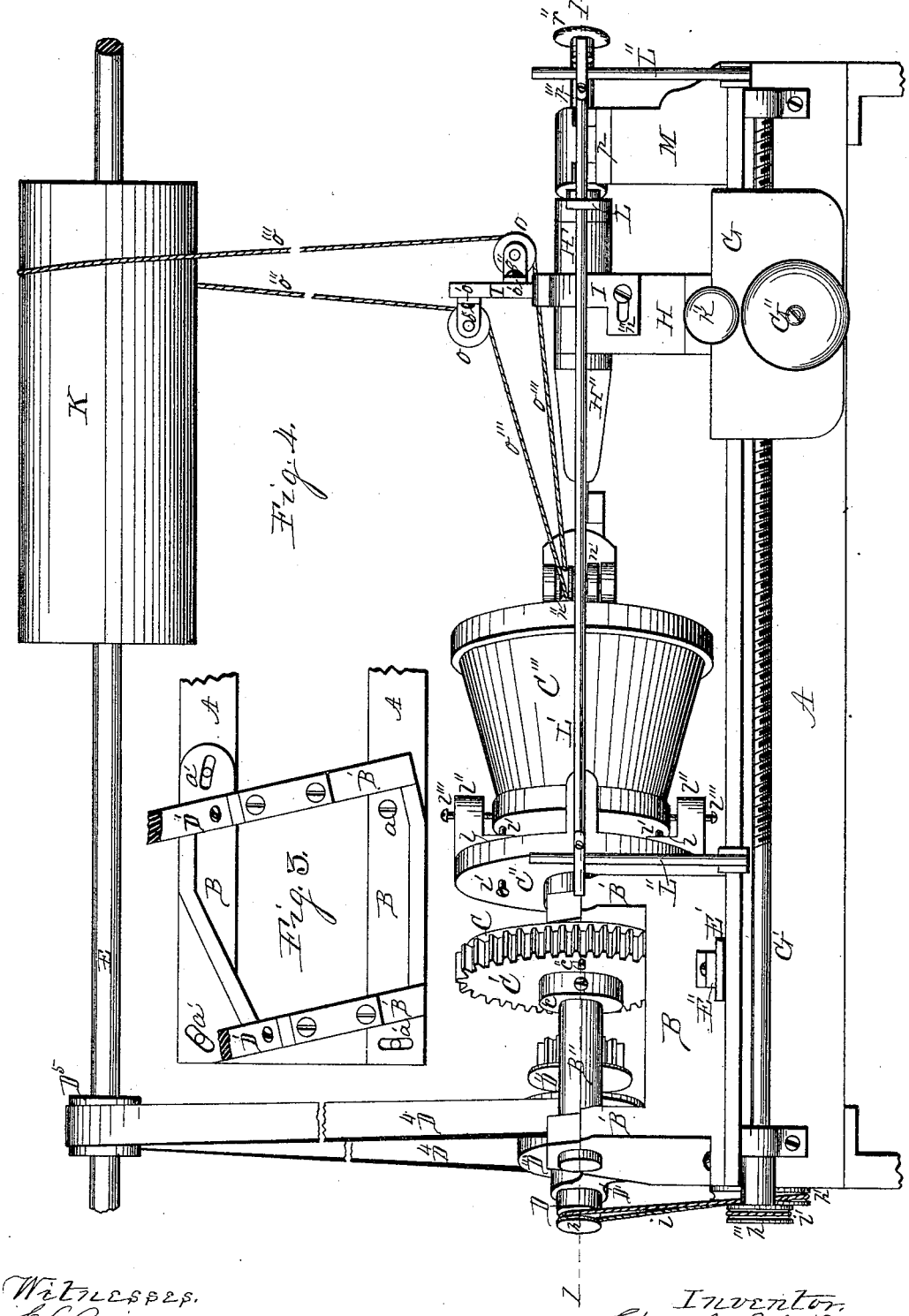


Fig. 4.

Fig. 5.

Witnesses,
C. F. Briggs
A. O. Bethel

Inventor,
Charles M. Brown,
Per Jacob Behrle Atty.

(Model.) 5 Sheets—Sheet 3.

C. M. BROWN.

GRINDING LATHE.

No. 370,003. Patented Sept. 13, 1887.

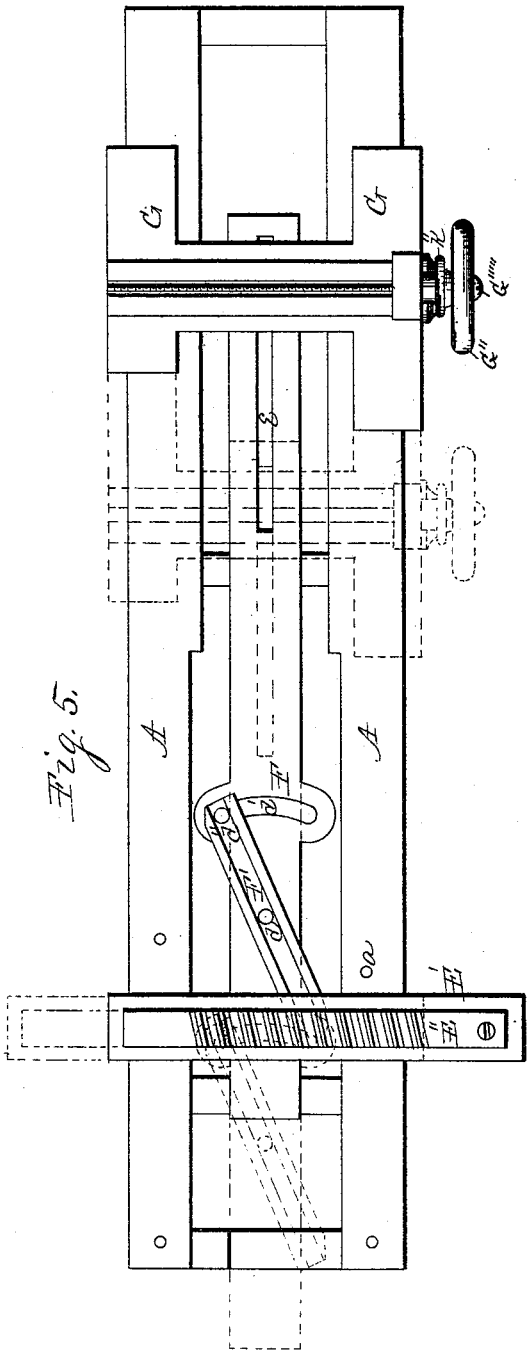


Fig. 5.

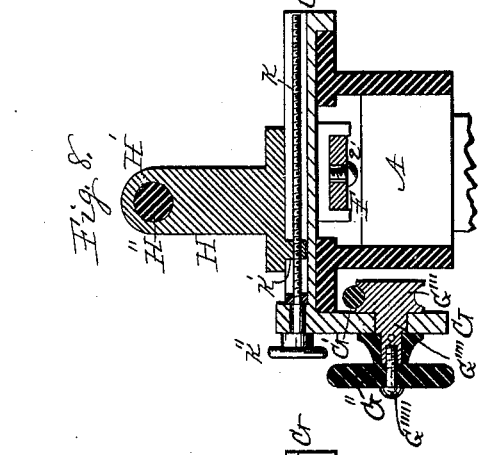


Fig. 8.

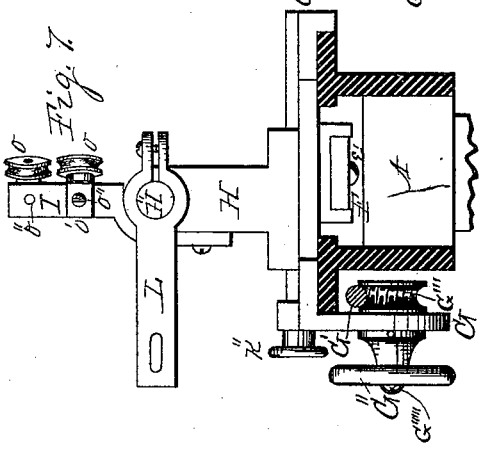


Fig. 7.

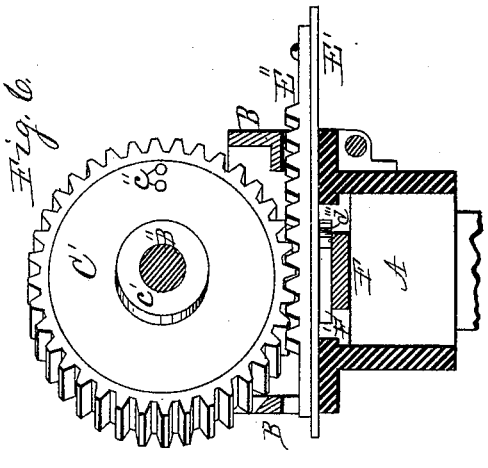


Fig. 6.

Witnesses.
C. F. Briggs
A. D. Shel

Inventor.
Charles M. Brown.
Per Jacob Behel
Atty.

(Model.)

5 Sheets—Sheet 4.

C. M. BROWN.

GRINDING LATHE.

No. 370,003. Patented Sept. 13, 1887.

Fig. 9.

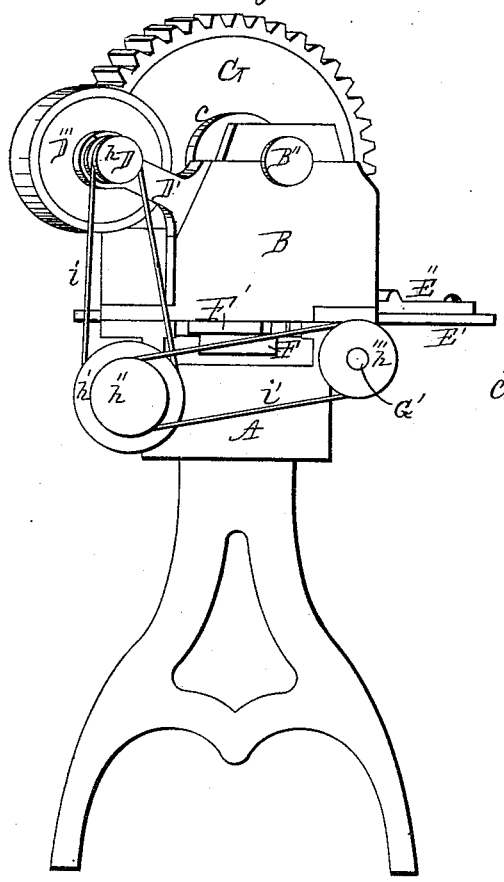


Fig. 10.

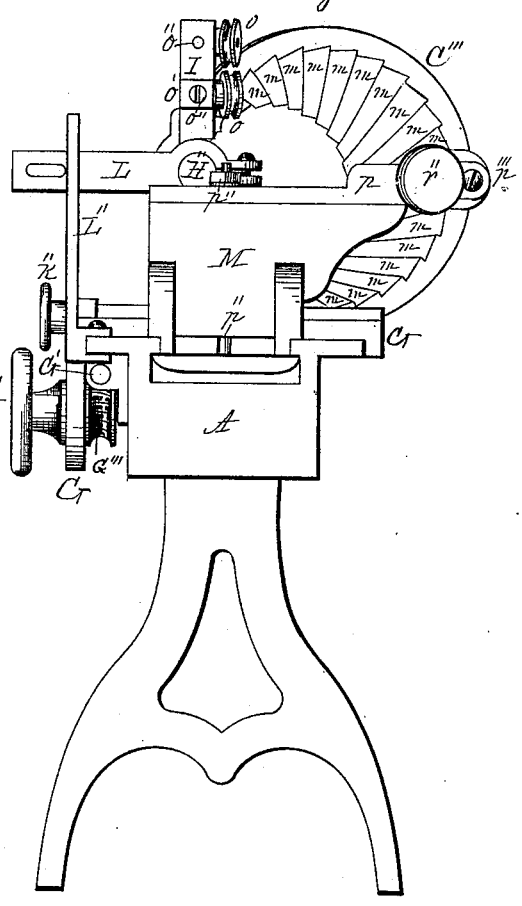


Fig. 13.

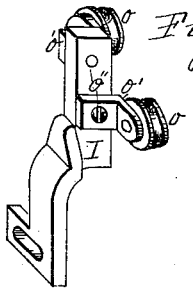


Fig. 11

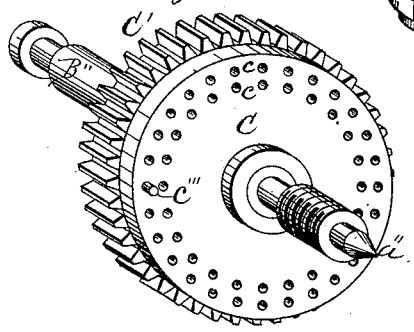
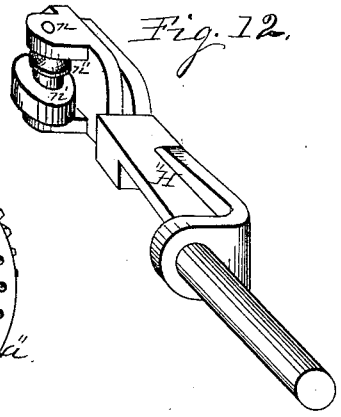


Fig. 12.



Witnesses,
C. F. Briggs
A. D. Bichel

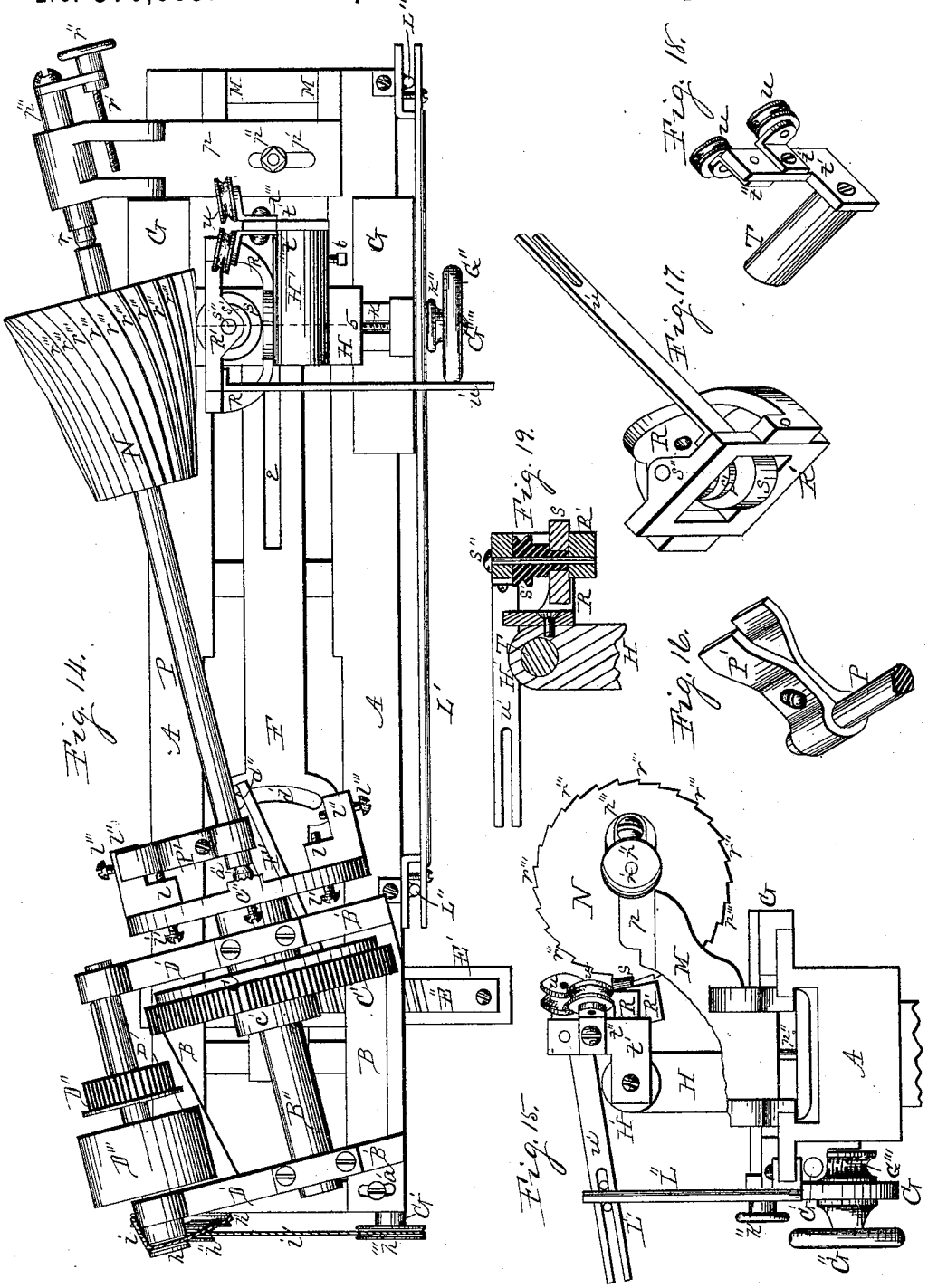
Inventor
Charles M. Brown.
Per Jacob Behel
Atty.

(Model.) 5 Sheets—Sheet 5.

C. M. BROWN.

GRINDING LATHE.

No. 370,003. Patented Sept. 13, 1887.



Witnesses.
C. F. Briggs
A. O. Bethel.

Inventor
Charles M. Brown
Per Jacob Behel
Atty.

UNITED STATES PATENT OFFICE.

CHARLES M. BROWN, OF ROCKFORD, ILLINOIS, ASSIGNOR TO THE KNOWLTON MANUFACTURING COMPANY, OF SAME PLACE.

GRINDING-LATHE.

SPECIFICATION forming part of Letters Patent No. 370,003, dated September 13, 1887.

Application filed September 19, 1883. Serial No. 106,774. (Model.)

To all whom it may concern:

Be it known that I, CHARLES M. BROWN, a citizen of the United States, residing in the city of Rockford, in the county of Winnebago and State of Illinois, have invented a new and useful Grinding-Lathe, of which the following is a specification.

This invention relates to grinding-lathes in which revolving grinding-wheels are employed.

The object of this invention is to produce a lathe capable of use in grinding the exterior or interior surfaces of tapering or conic cylinders having plain or grooved surfaces, spiral, or otherwise. To this end I have designed and constructed the lathe represented in the accompanying drawings, in which—

Figure 1 is a plan view of a lathe embodying my invention. Fig. 2 is a horizontal section cut upon dotted line 1 on Fig. 4 through the lathe-centers, in which the guide-bar L′ is omitted, being fully shown in other figures. Fig. 3 is a plan view of the head-end portion of the lathe-bed and a portion of the head-stock in place thereon, showing its construction for the purpose of adjustment on the bed. Fig. 4 is a side elevation. Fig. 5 is a plan view with head and tail stocks omitted. Fig. 6 is a vertical transverse section on dotted line 2 on Fig. 1, as seen from the head end of the lathe, shaft D being omitted. Fig. 7 is a vertical transverse section on dotted line 3 on Fig. 1 as seen from the tail end of the lathe. Fig. 8 is a vertical transverse section on dotted line 4 on Fig. 1 as seen from the tail end of the lathe, the part L′ being omitted. Fig. 9 is an elevation of the head end of the lathe. Fig. 10 is an elevation of the tail end of the lathe. Fig. 11 is an isometrical representation of the gear-wheel of the head-stock. Fig. 12 is an isometrical representation of the grinding-wheel and its arm-support employed in grinding the internal conic surfaces. Fig. 13 is an isometrical representation of belt-guides or idle-pulleys employed in connection with the grinder, Fig. 12. Fig. 14 is a plan view of the lathe adjusted to grind the external surfaces of the conic cylinder. Fig. 15 is a tail-end elevation of Fig. 14. Fig. 16 is an isometrical representation of the dog to hold the shaft of the cylinder. Fig. 17 is an isometrical representation of the grinding-wheel and its support employed in grinding the external surface of the cylinder. Fig. 18 is an isometrical representation of the belt-guides employed in connection with the grinder, Fig. 17; and Fig. 19 is a vertical transverse section of a portion of the tool-post and grinding-wheel and its support on dotted line 5 on Fig. 14.

In the figures of the accompanying drawings, A represents a lathe-bed of the usual construction mounted in the usual manner on suitable supports.

At B is represented a head-stock mounted upon the head end of the bed, having a pivotal connection therewith at the point *a* in its front forward corner and slotted openings *a′* in its other corners, through which screw-bolts are passed, having a screw-thread connection with the bed in such a manner as to serve to fix the head-block in position on the bed and, by means of the slotted openings, permit a limited adjustment of the head-stock upon the bed to vary the angle of its spindle relatively with the lengthwise axis thereof. The vertical end walls, B′, of this head-stock are oblique to the lengthwise axis of the bed, and in these end walls a spindle, B″, is supported to revolve in suitable bearings, having its lengthwise axis at right angles to the end walls, and consequently oblique to the lengthwise axis of the bed. This spindle is provided in the usual manner with a conic center, *a″*, made removable.

At C is represented an index-plate of disk form fixed to the spindle to revolve therewith. This disk is perforated at proper intervals in concentric circles or rings *c*, to correspond with the intervals of the divisions of the work to be operated upon in the lathe.

C″ represents a chuck produced in face-plate form provided at proper intervals with chuck-arms projecting from its face side. These arms consist, first, of a shoulder portion, *l*, fitted with adjusting-screws *l′*, screw-threaded therein parallel with the axis of the chuck to receive the end of the work placed therein. These arms also consist of the projecting arm portions *l″*, fitted with clamping-screws *l‴*, screw-threaded into the arms in radial lines to engage the periphery of the work to center and hold it in the chuck. This chuck is screw-

threaded onto the projecting end of the spindle in the usual manner. In this instance, to illustrate the practical working of my improved lathe, I have employed and fixed in the chuck a conic cylinder, C‴, substantially such as used in the Gratiot Mill patent, No. 260,750, July 11, 1882, having its inner surface provided with spiral grooves *m*, of saw-tooth form in section, and their number in equal divisions correspond to the number of perforations in one of the concentric rings *c* in the index-disk.

At C′ is represented a toothed gear-wheel mounted loosely upon the spindle in position to engage the index-disk on its head end, and it is held in place thereon by means of a collar, *c*′, fixed in place on the spindle by means of a set-screw. This gear-wheel is provided with holes *c*″, one of which at least will coincide with the holes in each ring of holes in the index-disk in such a manner that a pin, *c*‴, passed through one of the holes in the gear-wheel, will, when turned to the proper position, enter a hole in one of the annular rings of holes in the disk and serve to connect the gear-wheel and index-disk at any point within the limits of the device to adjust them relatively with each other and to cause them to revolve together.

At D is represented a shaft placed parallel with the spindle in the head-stock, and supported to revolve in bearings in rearward-projecting arms D′ of the vertical end walls, B′.

At D″ is represented a toothed gear-pinion mounted upon the shaft D, having a feather-connection therewith in such a manner as to permit it to be moved endwise thereon into or out of connection with the gear-wheel C′ on the head-spindle. This shaft D is also fitted with a belt-pulley, D‴, which receives a belt, D^4, from a pulley, D^5, on a counter-shaft, E, which may be connected with a prime mover in any suitable manner. From this arrangement it will be seen that when the gear-pinion engages the gear-wheel motion imparted to the pinion will be transmitted to the gear-wheel, causing it to revolve on its shaft-support, and when it is connected to the index-plate the spindle will be made to revolve with the gear-wheel.

At E′ is represented a transverse slide-bar capable of a reciprocating endwise sliding movement under the gear-wheel at right angles to the lengthwise axis of the bed in guides formed in the under face of the head-stock. On this slide-bar is removably fixed a gear-toothed rack-bar, E″, having its gear-teeth engage the gear-teeth of the gear-wheel in such a manner that the endwise back-and-forth movement of the slide bar with the gear-toothed rack fixed thereto will impart an oscillatory movement to the gear-wheel.

At F is represented a slide-bar capable of a reciprocating endwise sliding movement in the lengthwise axis of the lathe-bed in suitable guides.

At F′ is represented a grooved shifting bar having a central pivotal connection at *d* with the lengthwise slide-bar F, and by means of a segment-slot, *d*′, in the lengthwise slide-bar, concentric with the pivotal center of the shifting bar, and a clamping-screw, *d*″, passed through the segment-slot into the end portion of the shifting bar, it is made adjustable to vary its inclination relatively with the slide-bar. This shifting bar F′ is connected with the transverse slide-bar E′ by means of a stud, *d*‴, depending from the under face of said bar and entering the groove in the pivotal shifting bar F′ in such a manner that the endwise movement of the slide-bar F will impart an endwise movement to the transverse slide-bar E′, and, by means of the rack-bar, will impart an oscillatory movement to the gear-wheel. Instead of the stud *d*‴, to slide in the grooved way in the pivoted bar F′, a suitable block may be provided to receive the stud, and adapted to slide in the grooved way of the pivoted bar.

At G is represented a tool-carriage, which, in the main, is of the usual form of such parts, and is fitted to slide lengthwise on ways on the lathe-bed. This carriage is connected with a feed-screw gear, G^3, supported under the projecting edge of the bed to revolve in suitable bearings fixed thereto. The connection of the carriage with the feed-screw through the medium of screw-gear G^3 is such as to cause the carriage to move back and forth on the ways as the feed-screw is made to revolve in one or the other direction. It is also capable of a back-and-forth movement on the ways independent of the rotary movement of the feed-screw. To accomplish these movements of the carriage I have in this instance employed a screw-gear, G‴, placed in working contact with the feed-screw, having its shaft G^4 supported to revolve in a bearing in the vertical face-plate of the carriage and extending through the hub of the hand-wheel G″, having its projecting end fitted with a screw-nut, G^5, by means of which the screw-gear can be clamped and held to the inner face of the face-plate to receive the action of the feed-screw to operate the carriage. The hand-wheel G″ is fixed in a free manner to the shaft of a screw-gear by means of a pin passed through the hub thereof and through a slotted opening in the shaft, to cause them to revolve in unison when released from frictional contact with the face-plate, and when thus relieved the hand-wheel, in its connection with the feed-screw, serves as a means by which an attendant may be able to move the carriage in either direction on the ways by turning the wheel in the proper direction.

The tail-end portion of the lengthwise slide-bar F is provided with a lengthwise vertical slot, *e*, and a clamping-screw, *e*′, passed through the slot and screw-threaded into the under face of the carriage, serves to fix the parts to each other in such a manner as to cause the slide to conform to the movements of the carriage. This slotted and screw-clamp connection of the slide with the tool-carriage furnishes the

means of adjustment by which the slide may be connected with the carriage at any point within the limits of the slot. The head end of the lathe is provided with a train of belt-sheaves consisting of a sheave, *h*, on the projecting head end of the counter-shaft D in the head-stock, a pair of differential or speed sheaves, *h'* and *h''*, supported to revolve on a stud-journal projecting from the rear corner of head end of the bed, and a sheave, *h'''*, on the projecting head end of the feed-screw. The sheave *h* on the counter-shaft and the larger sheave, *h'*, of the differential sheaves are connected by a belt, *i*, and the smaller sheave, *h''*, of the differential sheaves is connected with the sheave *h'''* on the feed-screw by a belt, *i'*, from which it will be seen that motion imparted to the counter-shaft of the head-stock will be transmitted through the sheave-train to the feed-screw, and thence to the carriage.

At H is represented a tool-post supported upon the carriage in a manner to permit it to move laterally thereon relatively with the lathe-bed in suitable guideways formed on the central bar of the carriage, extending crosswise of the lathe-bed. This carriage is provided with a tool-post-shifting screw, *k*, extending crosswise of the lathe-bed in a groove prepared for its reception through the central portion of the carriage, in which it is supported to revolve in suitable end bearings. The screw-threaded portion of this shifting-screw has a screw-thread connection with an arm, *k'*, depending from the under face of the tool-post. The projecting end of this shifting-screw is provided with a hand-wheel, *k''*, by means of which to turn the shifting-screw in either direction to move the tool-post back and forth on the carriage. The upper end portion of this tool-post at H' is produced in tubular-bearing form, having its axis parallel with the lengthwise axis of the lathe-bed.

At H'' is represented a tool-supporting arm having its tail-end portions produced in journal form to enter the tubular bearing in the tool-post, from which it extends toward the head end of the lathe. The head end of this tool-supporting arm is provided with a shaft, *u*, transverse to said arm and supported to revolve in bearings in the free-end portion thereof. The shaft *n* of the grinding-wheel and sheave is journaled in studs projecting from a plate adjustably secured to the tool-arm by means of a screw which passes through the arm into the plate, as shown in the drawings. Upon loosening the screw the plate can be adjusted in a vertical plane or about the axis of the screw, and then secured in a desired position by tightening said screw. On the lower end portion of this shaft *n* is mounted a grinding-wheel, *n'*, which may be any of the known varieties suitable for the work—such as the emery or corundum wheel or wheels prepared from suitable stone. On the upper end portion of this shaft *n* is fixed a belt-sheave, *n''*, to receive a belt to impart motion to the grinding-wheel.

At I is represented a vertical bracket fixed to the tool-post and made adjustable thereon by means of its slotted foot portion *n'''* and a clamping-screw passing through the slot and screw-threaded into the tool-post.

At *o* are represented idle belt-sheaves supported to revolve on stud-journals of brackets *o'*, which are supported on the portion of the bracket I which rises above the tool-post, to which they are adjustably fixed by means of clamping-screws *o''*, passed through the parts, an elongated slot of customary form being provided in the bracket. These idlers receive and serve to change the direction of the belt *o'''* in its passage round the sheave *n''* in the free end of the tool-supporting arm and over the driving-drum K on the overhead counter-shaft E, which is of sufficient length to permit the travel of the belt in the movement of the carriage on the ways of the lathe-bed.

At L is represented a lever-arm having a screw-clamp connection with the tail end of the journal of the tool-supporting arm H'', from which it extends in a horizontal lateral position toward the front side of the lathe. The outer or free end portion of this lever-arm is slotted lengthwise horizontally to receive a guide-bar, L', to slide thereon freely. This guide-bar L' is supported in a vertical plane parallel with the lathe-bed on vertical supports L'', fixed to the bed, from which they rise and receive the end portions of the guide-bar, which are fixed to the supports by means of screw-clamps in a manner to permit of a ready adjustment thereon vertically. This guide-bar, by means of its connections with its vertical supports, is capable of any inclination within the limits of the device relatively with the horizontal plane of the lathe-bed, and when inclined to the plane of the lathe-bed will cause the tool-supporting arm to oscillate on its journal-bearing in the tool-post when the carriage is moved back and forth on the bed.

In the use of my improved lathe for grinding the internal surfaces of a conic cylinder, substantially such as shown and hereinbefore described, the lathe is adjusted for the purpose by removing the gear-toothed rack-bar E'' and placing the gear-toothed pinion D'' in working contact with the gear-wheel C' on the head-spindle. The conic cylinder C''' is then placed in the chuck, properly centered, and securely fixed therein by means of the radial clamping-screws *l'''*. The cylinder is then properly aligned with the ways of the lathe-bed by adjusting the head-block on the bed by the means provided for the purpose. The tool-supporting arm H'', with the grinding-wheel *n'* in place thereon, is then adjusted to bring the grinding-wheel in working position to the inner face of the cylinder, which is accomplished by the vertical adjustment of the guide-bar L' by means of the screw-clamp connection of its ends with the vertical supports, and the lateral adjustment of the tool-post by means of the tool-post-shifting screw *k*. With these several parts properly adjusted,

substantially as stated, motion imparted to the lathe through its belt-connection with the overhead counter-shaft will be transmitted to the cylinder, causing it to revolve, and through the feed-screw to the carriage, causing it to traverse the ways of the lathe-bed, carrying the grinding-wheel through the cylinder lengthwise, and in this movement the grinding-wheel will be made to revolve in contact with the inner surface of the grooved cylinder by means of its belt-connection with the drum on the overhead counter-shaft, and in the combination of movements will operate to grind the inner projecting edge portions of the grooved inner surface of the cylinder or hollow cone to a uniform taper in every portion concentric with its axis. After the inner surface of the cylinder is reduced to the proper size and form by grinding, the gear-pinion is disengaged from the gear-wheel on the spindle and the gear-toothed rack-bar E″ is replaced and fixed in position to engage the teeth of gear-wheel C′. The lengthwise slide-bar F is then properly adjusted and fixed to the carriage by means of the clamping-screw *e′*. The shifting bar F′ is then adjusted on its pivotal connection with the lengthwise slide-bar at such an angle relatively with the slide-bar, and fixed in position thereon by means of the clamping-screw, that the endwise movement of the slide-bar, by means of its connection with the carriage, will cause the cylinder to oscillate in such a manner that the movement of the grinding-wheel shall accurately trace the spiral grooves in the cylinder. In this instance it is required that the grooves shall be of a uniform depth throughout their length, and inasmuch as the number of the grooves is the same at both the large and small ends of the cylinder they are consequently of greater width at the large end than at the small end thereof. This difference of width in the grooves, in connection with their uniform depth, requires that the working-faces of the grinding-wheel during its lengthwise movement through the cylinder shall have an oscillatory movement upon the axis of its supporting-arm substantially uniform during its lengthwise movement through the cylinder to adjust the grinding-faces of the wheel to the radial and inclined faces of the grooves therein. This I accomplish in this instance by the connection of the tool-supporting arm H″, by means of the lever-arm L, with the guide-bar L′, having its ends made independently adjustable on its vertical supports, to vary its inclination with the lathe-bed to regulate the oscillatory movement of the tool-supporting arm carrying the grinding-wheel. This oscillating movement of the grinding-wheel properly adjusted within the capabilities of the devices employed for the purpose, in connection with the oscillating movements of cylinder properly adjusted within the capabilities of the devices employed for its adjustment, will, in their combined movements, cause the grinding-wheel in its lengthwise movements through the cylinder to trace the radial and inclined surfaces accurately throughout their entire length.

By the construction and arrangement of the disk-formed index-wheel fixed to the spindle supporting the chuck-head, in connection with the gear-wheel loosely mounted on the spindle, the chuck-head and the work supported therein are made adjustable relatively with the gear-wheel in either direction by means of the pin connecting the index-wheel with the gear-wheel, and in this instance the index-wheel is perforated to correspond with the number of grooves in the cylinder, from which it will be seen that each groove in the cylinder may be adjusted to the same position relatively with the gear-wheel, and consequently in the same relation to the adjusted grinding-wheel, by which the several grooves in the cylinder may be ground uniform.

The depth of the groove is determined by the relative position of the axis of the cylinder and the tool or tool-arm. This is constant in the direction of the depth of groove after adjustment of parts.

The width of the groove for any single adjustment is determined by the breadth of the grinding-face. To make the groove wider than this at the large end of the cylinder the latter may be adjusted to bring the part of the proposed groove that was not cut by the first operation because of the narrowness of the tool under the same by moving the latter to the right and revolving the index-wheel and spindle and securing the index and gear wheels together in the new position. The rotation of the cylinder can be made to correspond with the greater curvature of the required path of the tool in this new adjustment by means of the bar F′, in its combination with the longitudinal bar and the transverse rack-bar. No reason, however, exists why, ordinarily, the grinding-wheel may not be sufficiently wide on its working-face to cut the full width of the groove.

This lathe is also designed to grind the outer surface of conic cylinders, as represented in Figs. 14 to 18, inclusive, and for this purpose the lathe-bed is provided with a tail-stock, M, fitted to the ways and capable of a lengthwise adjustment thereon. The upper portion, *p*, of this tail-stock is of slide-form, fitted to move laterally relatively to the lathe-bed on the base portion M of the tail-block in guideways, and is slotted lengthwise, as at *p′*, to receive the clamping-bolt *p″*, employed to fix the tail-stock to the bed. The slide portion *p* of this tail-stock is fitted at its rear end with a tail-spindle, *p‴*, to move endwise in a suitable socket, having its axis in the same plane with the axis of the head-spindle. This tail-spindle is provided with a removable conic pointed center, *r*, and is also fitted with a spindle-shifting screw, *r′*, connected with the spindle and with its supporting-slide, so that the rotations of the screw will impart an endwise movement to the spindle. This shifting-screw is provided

with a hand-wheel, r'', by which to rotate the screw.

At N is represented a conic cylinder, substantially such as are employed in the patent to Gratiot hereinbefore referred to, having its peripheral surface produced in spiral grooves r''', of saw-toothed form in section, and by means of the adjustable head and tail stocks can be readily aligned with the line of movement of the carriage. This cylinder is mounted upon a shaft, P, supported in the lathe upon the conic centers of the spindles. The head end of this shaft is connected to one arm of the chuck by means of a lathe-dog, P', which embraces both the shaft and the clutch-arm snugly to cause it to move with the movements of the lathe in both directions.

At R is represented a bracket of yoke form adapted to connect with the rear face of the tool-post by means of a clamping-screw or otherwise in a manner to hold it in position thereon when adjusted.

At R' is represented a grinding-wheel supporting-frame, rectangular in outline form, and of proper dimensions to enter between the outward-projecting arms of the yoke-formed bracket R, and having a pivotal connection therewith on opposite sides to permit of an oscillatory movement of the frame within the yoke.

At s is represented a grinding-wheel of any suitable material and of proper dimensions, and the sleeve s''' of this grinding-wheel is provided with a belt-sheave, s', through which to impart motion to the grinding-wheel. This grinding-wheel and belt-sheave are preferably mounted upon an arbor, s'', supported to revolve in suitable bearings in the supporting-frame R'. To this pivoted supporting-frame of the grinding-wheel is fixed a lever-arm, u', substantially the same as the lever-arm L, hereinbefore described. This lever-arm u' extends laterally toward the front side of the lathe, having its free end portion slotted to receive the guide-bar L', which, when adjusted on its vertical supports, will control the oscillatory movements of the grinding-wheel in the back-and-forth movements of the carriage on the ways of the lathe-bed to cause the face of the grinding-wheel to trace the spiral grooves on the cylinder, substantially in the same manner and for the same purpose as hereinbefore described in connection with the grinder employed upon the internal surface of the hollow conic cylinder.

At T is represented a shaft fitted to enter the tubular bearing H' in the upper end portion of the tool-post, in which it is made adjustable, and when adjusted is fixed in position by means of a set-screw, t, or other known means. This shaft is provided with an angle-arm, t', rising from its end in a vertical position, and to its vertical portion on opposite sides thereof at proper intervals are fixed stud journal-brackets t'' by means of clamping-screws passed through the parts in such a manner as to permit an adjustment of the brackets on their supports, elongated slots being provided in the brackets or supports for this purpose.

At u are represented idle belt-sheaves employed to change the direction of the belt o''' on its passage round the sheave s' on the sleeve s''' of the grinding-wheel and over the drum K on the overhead counter-shaft. It will be seen that the endwise adjustment of the shaft T will operate to vary the tension of the belt o''', employed to impart motion to the grinding-wheel.

From the foregoing it will be seen that the lathe is capable of adjustments within the limits of the devices to vary the angle of the axis of motion relatively with the line of travel of the carriage to produce cones in which their peripheral lines form various angles with their axis or cones of various tapers. It will further be seen that by the removal of the tool-supporting arm H, with its attachments, and the bracket I, with its idle-sheaves, and substituting therefor the yoke-bracket R, with its grinding appliances, and the shaft T, with its idlers, in connection with the adjustments, substantially as hereinbefore described in connection with the conic cylinder C''', the lathe will be fitted to grind and finish the external surface or periphery of the cone N, with its spiral grooves, substantially in the same manner as hereinbefore described in connection with the grinding and finishing of the spiral grooves of the internal surface of the conic cylinder C'''.

In the foregoing I have confined the description of the operation of my improved lathe to the grinding and finishing of the internal and external surfaces of the spirally-grooved conic cylinders C''' and N; but it is evident that other forms of conic work, plain or grooved in other forms, may be ground and finished on my improved lathe.

I am aware that a rectangular head-stock had been pivoted to a lathe-bed near the transverse center thereof prior to my invention, and my claim in this respect is limited to the construction hereinafter particularly pointed out.

I am also aware that in a machine for cutting spiral grooves in grinding-rolls the spindle has been made to move the bed or carriage back and forth through the medium of a screw-gear on a transverse shaft and a fixed rack with intermediate gear-wheels. A pinion on the tail-stock has also been combined in a machine for grinding twist-drills with a rack and slide in such a manner that the spindle was rotated when moved longitudinally, power being transmitted through the spindle.

I am further aware that a spindle, gear-wheel, carriage, and feeding-screw have been so combined in a lathe that the rotation of the spindle moved the carriage. In my combination the spindle is not used as a medium for transmitting power while the cylinder is being ground, as in cases to which my attention has been called and which are above referred to. My tool-carriage is moved longitudinally

to its work by mechanism independent of the spindle, but may be returned by means of a gear-wheel on the spindle, and the means for producing these operations in the constructions herein claimed are unlike any known to me as existing prior to my invention.

I am aware that a dial-plate, disk, stud or pin, and gear-wheel fixed to a tubular shaft, said wheel being driven by the movement of the carriage through the medium of a fixed rack, pinion, shaft, and wheel, have been used for the same general purpose as contemplated by my machine; but my combination is much simpler, and is distinguished by the fact that the gear-wheel, being loosely mounted on the shaft and in immediate contact with the dial, is adapted to be directly connected thereto and in different positions circumferentially, and also by the fact that it gears with a pinion connected immediately with the source of power. The gear-wheel can therefore be rotated by such pinion so as to revolve the spindle and the object to be ground without the lengthwise movement of the tool-carriage when it is desired to grind the interior edge of a hollow cylinder or of a frustum of a cone, in which case the tool has after adjustment no movement lengthwise of the lathe. The pinion can also be disconnected from the gear-wheel, and the transverse movable rack being in place said wheel can be made to oscillate or rotate back and forth through the medium of the longitudinal bar and tool-carriage and its driver. During this latter operation the relative position of the dial or index-disk and the gear-wheel can be adjusted, as before described, by turning the dial and spindle, by which means the cylinder is turned and a new path for the grinding-wheel brought under the same.

I claim as my invention—

1. The head-stock pivoted at one corner to the lathe-frame, in combination with a tail-stock adjustable transversely to the frame and a tail-spindle located on the side of the lathe-frame opposite to the pivot of the head-stock, substantially as set forth.

2. The head-stock pivoted at one corner to the frame, and provided with obliquely-placed ends, in combination with the spindle and the tool-carriage ways, whereby the spindle is held normally oblique to the lathe-frame and carriage-way, and whereby its obliquity may be varied, substantially as set forth.

3. The combination of the head-stock pivoted at a front corner to the lathe-frame with a tail-stock located on the opposite side of the median line of the lathe and near the opposite side of the frame, substantially as set forth.

4. The combination, with the head-spindle and with an index-disk secured rigidly to said spindle, of a gear-wheel loosely mounted on the spindle and made adjustable in its connection with the index-disk, and a driver engaging the gear-wheel, all as set forth, whereby the cylinder to be ground can be adjusted circumferentially and then rotated, substantially as and for the purpose set forth.

5. The combination, with the gear-wheel mounted loosely upon the head-spindle, and the index rigidly fixed on the spindle, provided with means for rigidly connecting the same to the gear-wheel, of a gear-pinion to engage the gear-wheel, said pinion having a feather or spline connection with its counter-shaft support, substantially as and for the purpose set forth.

6. The combination, with the longitudinal slide-bar and the toothed rack-bar, of a shifting bar suitably connected with the slide-bar and having an oblique position relatively with the slide-bar and with the lathe-bed, and mechanism for giving the slide-bar a reciprocating movement in the lengthwise direction of the lathe-bed, substantially as and for the purpose set forth.

7. The combination, with the lengthwise slide-bar and means for giving it a reciprocating movement lengthwise of the lathe-bed, of a shifting bar having an adjustable connection with the lengthwise slide-bar, whereby it is made capable of an oblique position thereon relatively with its axis of motion, substantially as and for the purpose set forth.

8. The combination, with the carriage and means for giving it a reciprocating movement on the carriage-ways, of a gear-wheel and spindle, a slide rack-bar capable of a reciprocating movement transversely of the line of travel of the carriage in suitable guideways, and the slide-bar placed immediately below the carriage and lengthwise the lathe connecting the tool-carriage and the transversely-sliding rack-bar, substantially as and for the purpose set forth.

9. The combination of the tool-carriage and its driver and the carriage-ways with a head-spindle supported in a position oblique to the carriage-ways, substantially as set forth, whereby a cone can be ground by a movement of the tool-carriage lengthwise of the lathe-bed.

10. The combination, with a tool-post provided with a tubular bearing having its axis parallel with the line of travel of the carriage, of a tool-supporting arm journaled in the tubular bearing of the post and mechanism for giving oscillatory motion to said arm by the movement of the carriage, substantially as and for the purpose set forth.

11. The combination of a journaled tool or wheel and a journaled tool-arm, and a lever connecting the tool-arm with a guide, whereby the tool-arm is turned in its bearing, substantially as described.

12. The combination, with the lathe-bed and with the lever-arm of the tool-support and with the rotary tool-support, of a guide-bar supported in a vertical plane substantially parallel with the lathe-bed and made vertically adjustable on its supports, substantially as and for the purpose set forth.

13. The combination, with the slide of the

tail-stock made adjustable on the base portion thereof transversely relative with the lathe-bed, of a tail-spindle capable of an endwise movement in an end socket thereon, said spindle having its axis oblique to the line of movement of the carriage, substantially as and for the purpose set forth.

14. The combination, with the tail-spindle having its axis oblique to the line of travel of the carriage and capable of an endwise movement in its oblique support, of a shifting-screw having a suitable journal-connection with the spindle and a screw-thread connection with the slide, substantially as set forth.

15. The combination of a carriage, a tool-post, and journal-bearings for the axis of the tool or grinding wheel made adjustable on the arm, whereby the angle between the plane of rotation of the grinding-wheel and the tool-arm may be varied, substantially as set forth.

16. The combination, with the journaled tool-supporting arm, of a grinding-wheel whose axis is transverse to the longitudinal direction of the tool-arm, a belt-sheave supported to revolve on bearings in the free end of the arm, and mechanism for oscillating said arm in a direction transverse to the axis of the wheel, substantially as specified.

17. In combination, a tool-post made adjustable in a direction transverse to the carriage-ways, a journaled tool-arm adjustable on its horizontal axis, and a grinding-wheel adapted to revolve on an axis transverse to the length of the tool-arm.

18. The combination of the counter-shaft, pulleys and movable pinion supported thereon, the gear-wheel, spindle, and the removable rack connected by intermediate mechanism with the pulleys on the counter-shaft, all substantially as set forth, whereby the spindle can be revolved by means of the rack when grinding grooves in the exterior of a cylinder, and then, the rack being removed and the pinion adjusted, revolved by the latter while grinding smooth the interior of the cylinder.

19. The combination of the pinion movable on the counter-shaft, the gear-wheel, spindle and chuck, the tool-carriage, a transversely-adjustable tool-post, a circumferentially-adjustable tool-arm, and a grinding-wheel, all substantially as set forth, whereby the interior of a hollow cylinder or cone may be ground.

CHARLES M BROWN.

Witnesses:
DAVID N. STARR,
A. O. BEHEL.