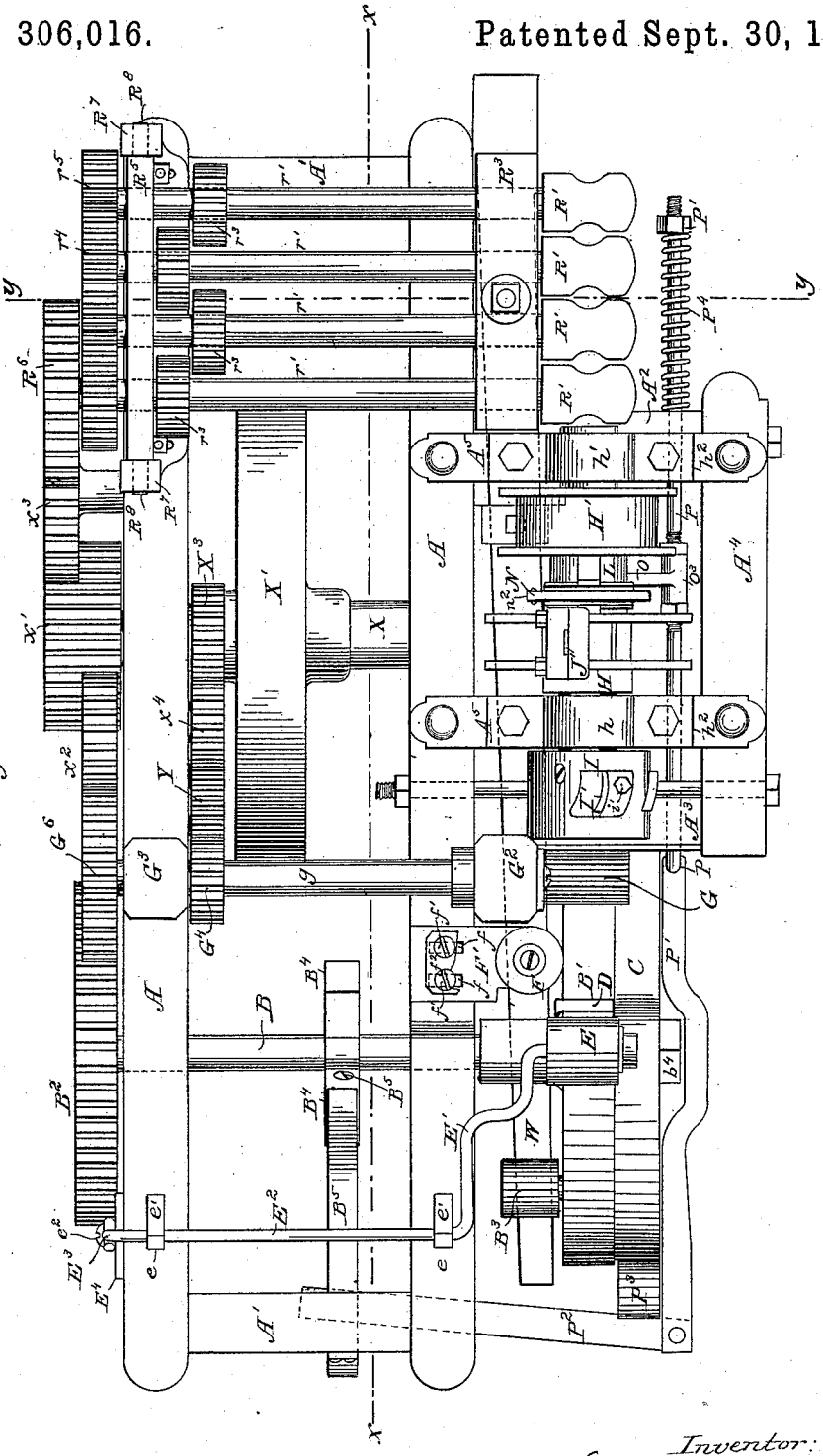
(No Model.) 7 Sheets—Sheet 1.

E. H. HUDSON.

WOOD TURNING LATHE.

No. 306,016. Patented Sept. 30, 1884.

Fig. 1.



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per W. E. Baxter
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(No Model.) 7 Sheets—Sheet 2.

E. H. HUDSON.

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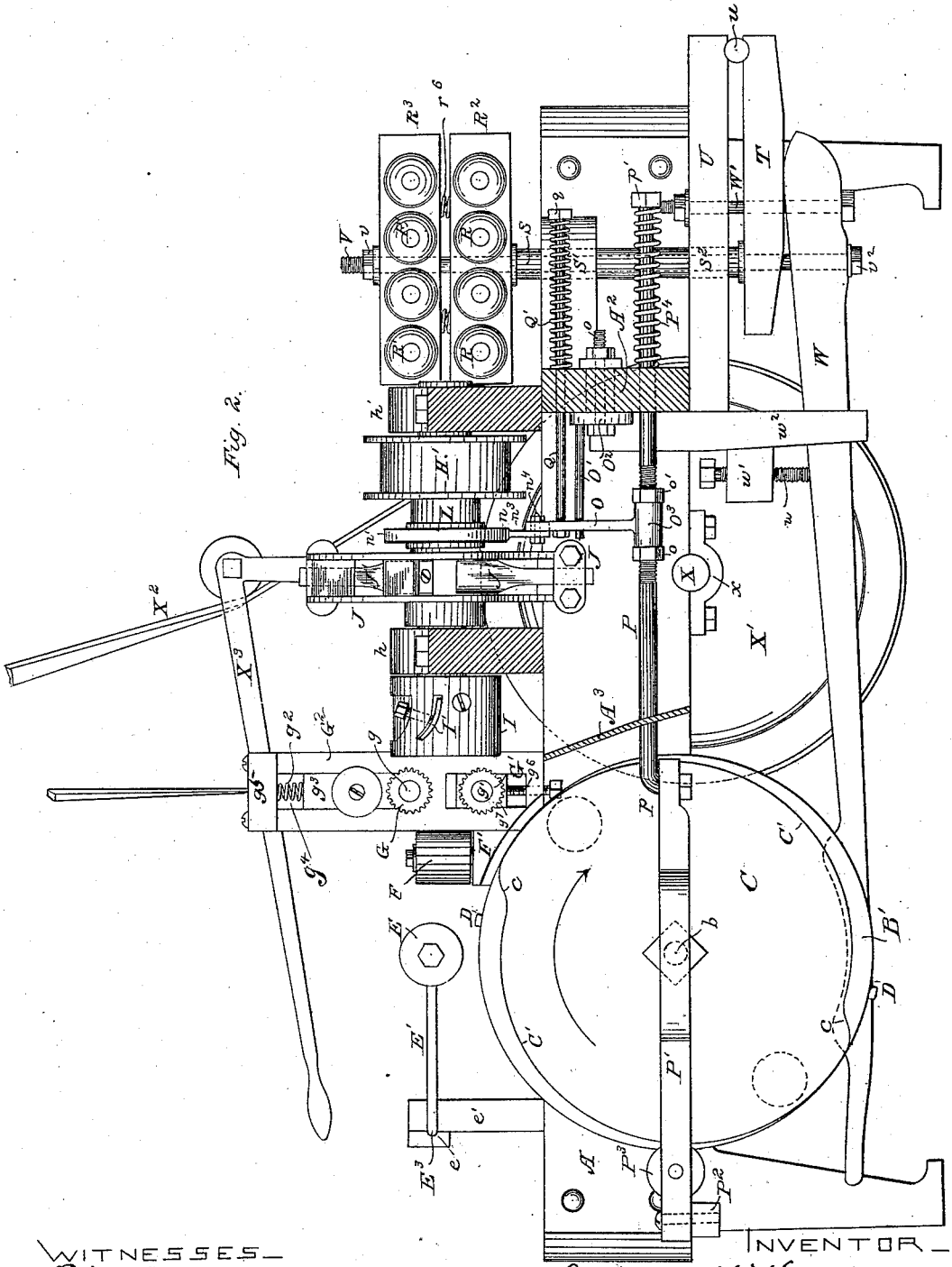
No. 306,016. Patented Sept. 30, 1884.

Fig. 2.



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E. H. HUDSON.

WOOD TURNING LATHE.

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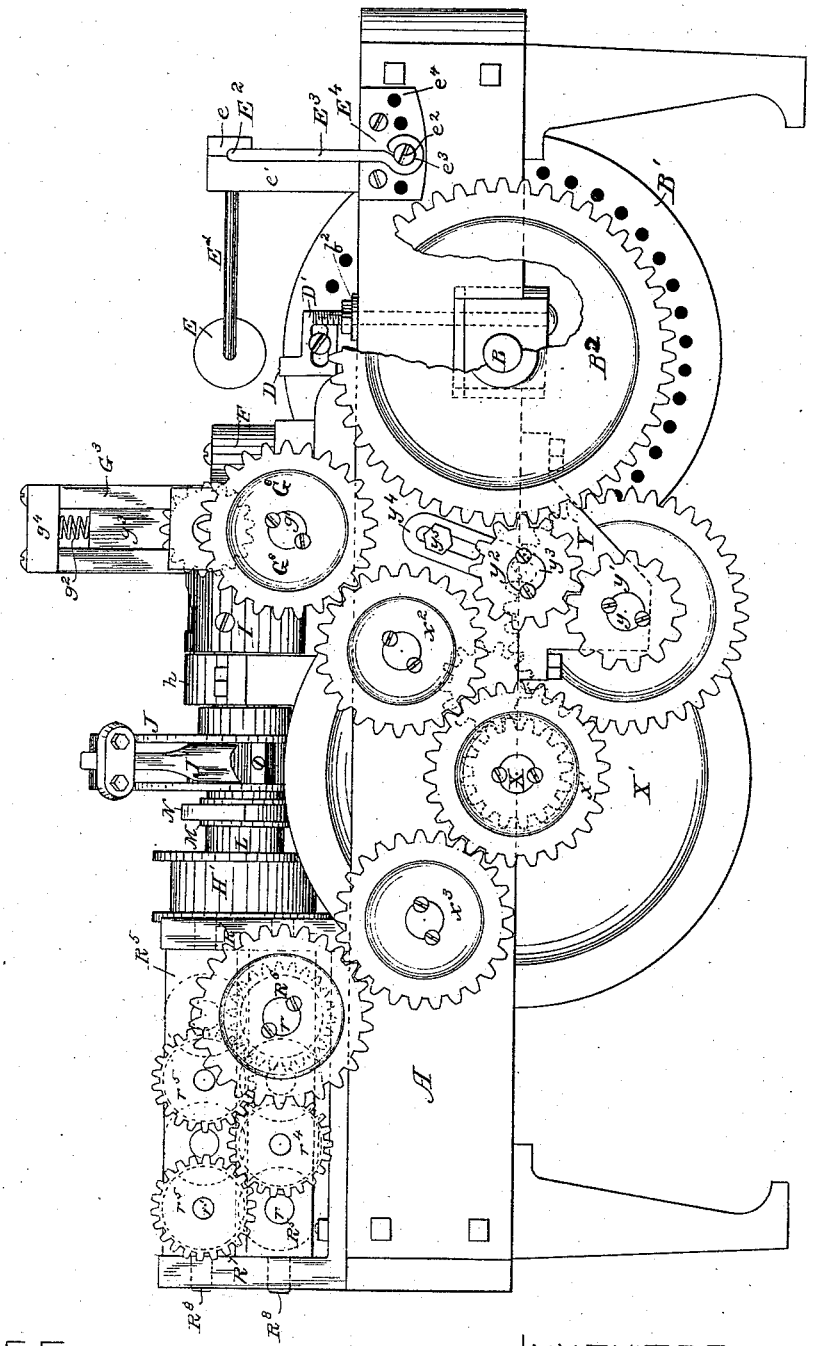

Fig. 3.

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(No Model.) 7 Sheets—Sheet 4.

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WOOD TURNING LATHE.

No. 306,016. Patented Sept. 30, 1884.

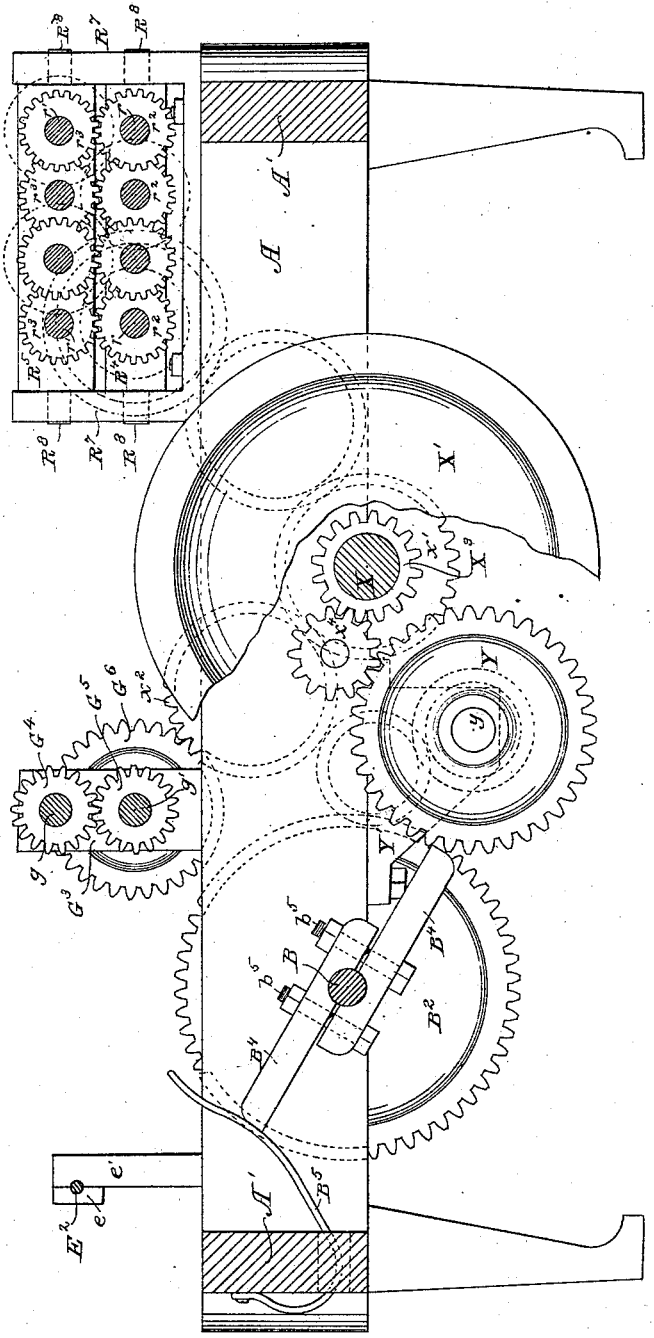

Fig. 4.

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(No Model.) 7 Sheets—Sheet 5.

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WOOD TURNING LATHE.

No. 306,016. Patented Sept. 30, 1884.

Fig. 5.

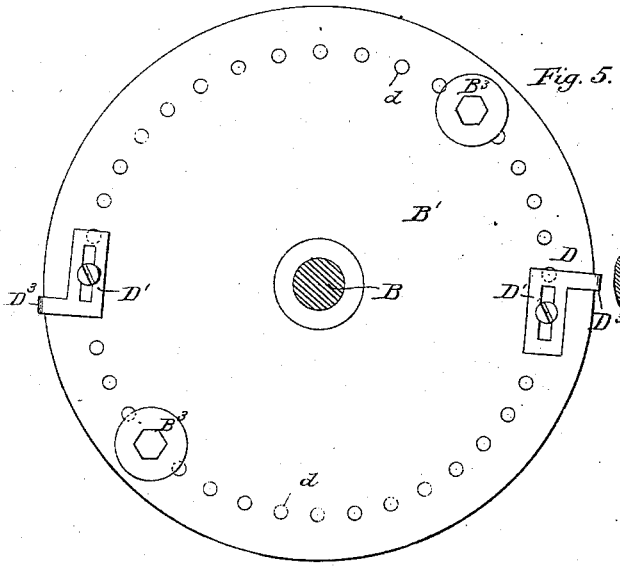


Fig. 6.

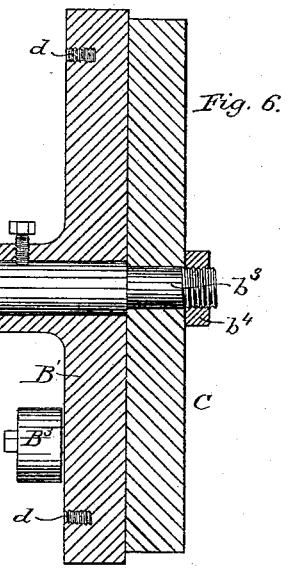
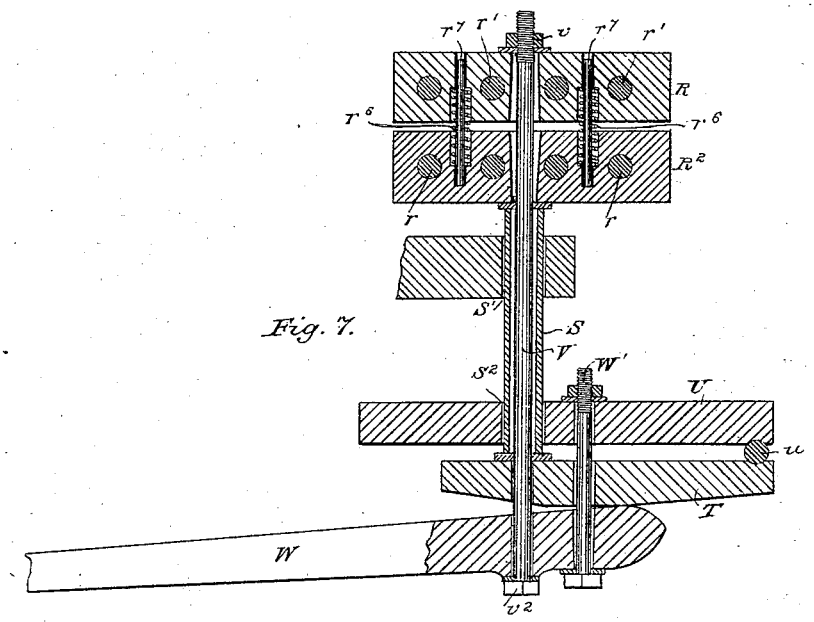


Fig. 7.



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(No Model.) 7 Sheets—Sheet 6.

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Fig. 8.

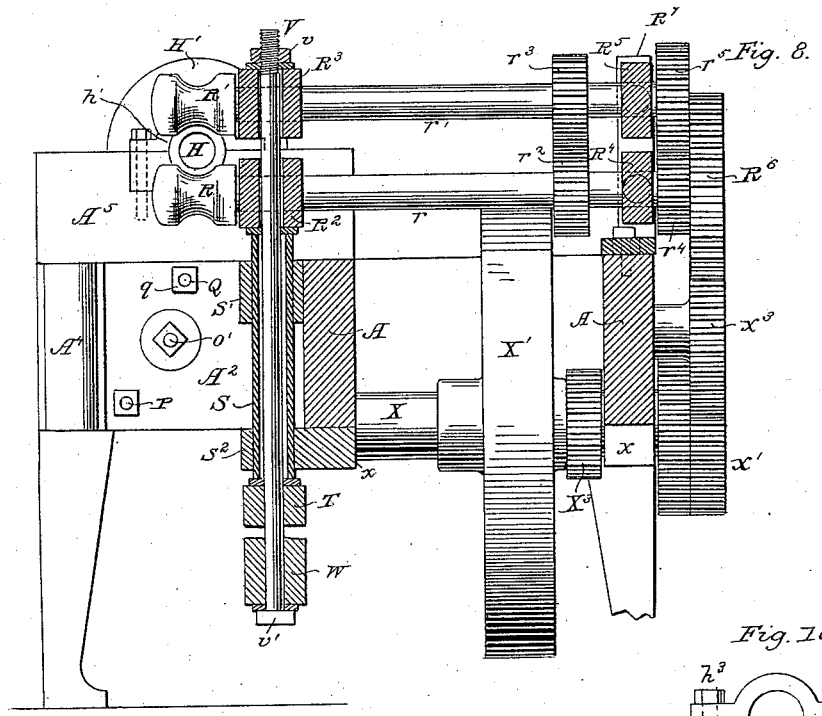


Fig. 10.

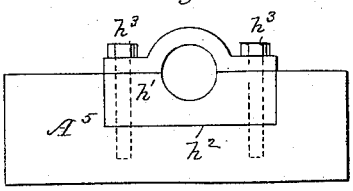
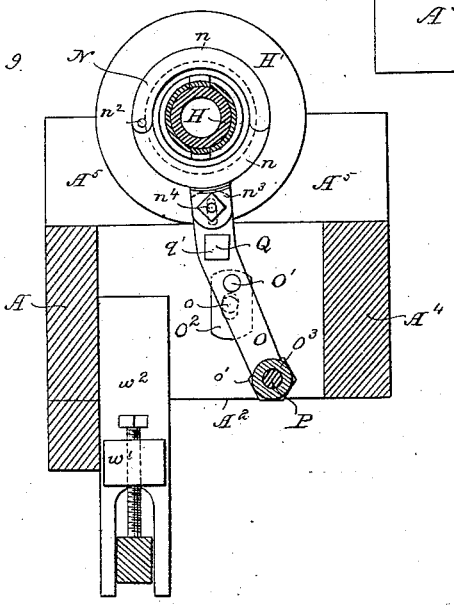


Fig. 9.



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(No Model.) 7 Sheets—Sheet 7.

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WOOD TURNING LATHE.

No. 306,016. Patented Sept. 30, 1884.

Fig. 12.

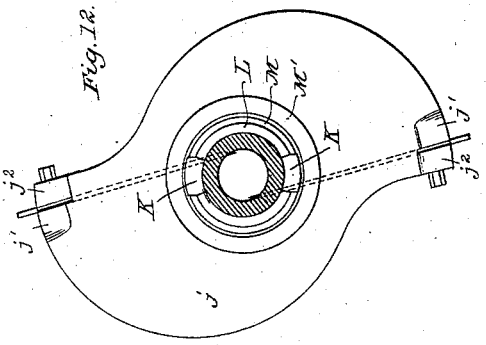


Fig. 16.

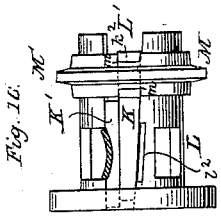


Fig. 11.

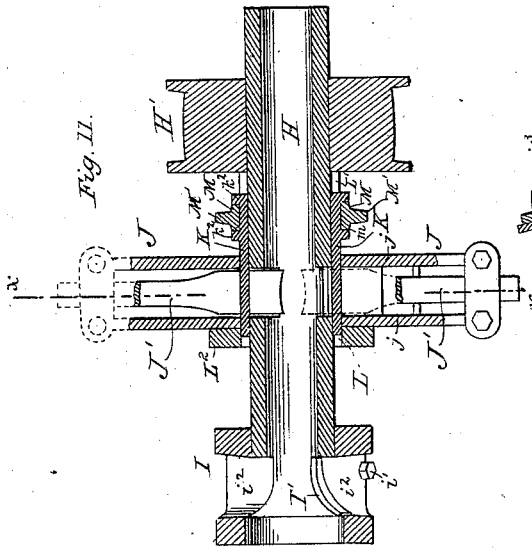


Fig. 13.

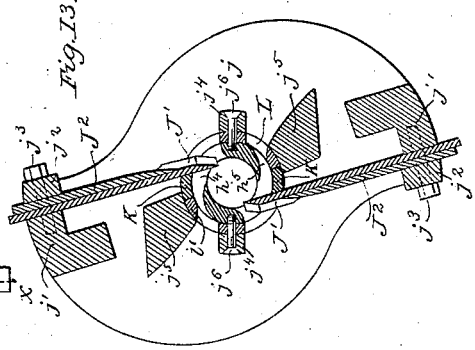


Fig. 14.

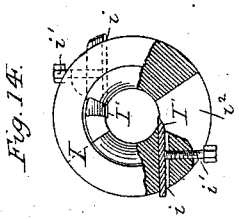


Fig. 15.

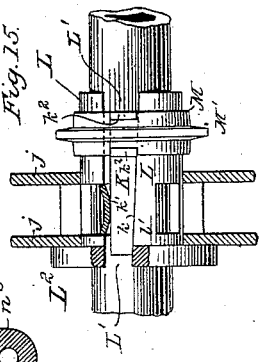
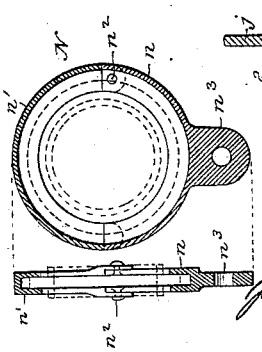


Fig. 17.



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UNITED STATES PATENT OFFICE.

ELISHA H. HUDSON, OF POTTERVILLE, MICHIGAN.

WOOD-TURNING LATHE.

SPECIFICATION forming part of Letters Patent No. 306,016, dated September 30, 1884.

Application filed November 24, 1882. (No model.)

To all whom it may concern:

Be it known that I, ELISHA H. HUDSON, of Potterville, in the county of Eaton and State of Michigan, have invented certain new and useful Improvements in Wood-Turning Lathes; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to that class of wood-turning machines for turning cylindrical or round and tapering bodies in which a hollow mandrel is employed for carrying the cutters, through which mandrel the article passes in the act of being turned.

The invention relates more particularly to features of construction in the mandrel with reference to the knives supported thereby; to devices for supporting and controlling the movable finishing-cutters; to devices for feeding the blank to the cutters at the proper time, with reference to the movement of the form-wheel, by which the movable cutters are controlled; to devices for seizing the article being turned in that portion thereof which has passed through the mandrel and feeding it forward, and to devices for varying the speed of the form-wheel with respect to the feed-motion.

The general object of the invention is to very greatly increase the capacity and efficiency of this class of machines, and at the same time to lessen the amount of hand labor required in running them.

The invention consists in the several features of construction and combinations of parts hereinafter set forth, and pointed out in the appended claims. First, referring briefly to the general features of construction in the machine as here illustrated and as preferably arranged, the main frame is of rectangular form in or upon the longitudinal parallel beams or parts of which the several transverse shafts and axes of the rotating parts are mounted. At one side, and external to this main frame, is a short transverse extension, which supports the hollow mandrel in a properly-elevated position, and with its axis parallel with the longitudinal beams of the main frame, or at right angles with the axis of the form-wheel and the transverse shafts and other rotating parts of the machine. The form-wheel is applied to its shaft externally to the main frame and adjacent to the mandrel. The mandrel contains shaping-cutters, and also finishing-cutters, the latter being in the nature of long spring-steel knives sharpened at their inner ends, and supported by their outer ends from arms projecting from the mandrel, and adapted to be moved at their inner ends, so as to vary the diameter of the article being turned, in order to give the required taper or other formation thereto. This variation of the cutting position of the knives is effected by means of sliding wedges arranged beneath the knives, as near as practicable to their cutting ends, said wedges being sustained and guided by suitable devices for the purpose, and automatically controlled by a connection arranged to bear upon the irregular or cam-shaped form-wheel. The mandrel is constructed of a separate piece from the arms, which latter are two in number, cast to form a unitary structure, and centrally secured to the mandrel, so as to practically balance each other, and thereby permit a high rate of rotary speed on the part of the mandrel. The wedge-guides are formed in a separate and detachable sleeve fitted to the mandrel, and also fitted to the outer knife-arm structure, so that the wedge-seats may be very simply and accurately formed, as will be hereinafter more clearly made apparent. In order that the ends of the blanks to be turned as they are fed into the machine may be presented to the cutters at the proper time in reference to the cam-shaped form-wheel, so that the irregularity or taper in the finished article shall come in the proper place in reference to its ends, a gage-wheel is provided which is attached to the form-wheel and revolves with it, which gage-wheel is provided with stops upon its periphery, against which the end of the blank is placed as it is fed into the machine over the said gage-wheel. For the purpose of seizing the turned end of the article being shaped a series of self-adjusting feed-rollers are arranged at the exit end of the mandrel, said rollers being mounted externally to the main frame, and in line

with the mandrel on vertically-movable ends of shafts, which, at the opposite side of the machine, are geared together to give the desired direction of motion. Feed-rollers are also similarly mounted and arranged at the entrance end of the mandrel for holding and carrying in the square stuff or blank to be turned. Gear-wheels mounted externally to the opposite side of the frame on the shafts of the form-wheel and feed-rollers are connected by intermediate gears, certain of which are changeable, so as to vary the speed of the form-wheel with reference to the feeding devices. It is intended that several mandrels of different sizes shall be employed for turning articles of materially greater or less diameter, and a corresponding number of removable bearing-boxes are provided, all of uniform external dimensions, fitted to suitable seats in the arms which support the mandrel. The annular slide on the mandrel, which operates the wedges by which the position of the knives is controlled, is provided with an arm and collar adapted to be detachably connected with a slide in the frame, provided with a roller-pin that rides the cam or form-wheel, in order that one mandrel may be substituted for another with little delay and inconvenience.

To more particularly describe the various features of construction in the machine and their operation, reference is made to the accompanying drawings, in which—

Figure 1 is a plan view of the machine. Fig. 2 is a front elevation with a portion of the frame removed. Fig. 3 is a rear elevation. Fig. 4 is a vertical longitudinal section on line *x x* of Fig. 1. Figs. 5 and 6 are detail views of the gage-wheel and form-wheel. Fig. 7 is a vertical section of the devices for operating the gripping-rollers. Fig. 8 is a transverse section of the machine on line *y y* of Fig. 1. Fig. 9 is a partial transverse section through the mandrel, showing the arm and collar for moving the sliding ring thereon. Fig. 10 is a detail view of one of the removable bearing-boxes. Fig. 11 is a transverse section through the hollow mandrel and through the oppositely-arranged knife-carrying arms secured to the mandrel. Fig. 12 is a side view of the knife-carrying arm structure. Fig. 13 is a section of the same on line *x x* of Fig. 11, or between its two parallel plates. Fig. 14 is an end view, partially in section, of the shaping cutter-head. Fig. 15 is a detail view showing one of the sliding knife-moving wedges. Fig. 16 is a view of a modification of the arrangement of the parts shown in Fig. 15. Fig. 17 is a detail of the grooved collar for moving the sliding ring, which actuates the wedges by which the knives are controlled.

The main frame or bed of this machine is composed of two side pieces, A A, and end pieces, A′ A′.

From the central portion of the front side of the main frame projects a rectangular extension consisting of transverse arms A^2 A^3, and a longitudinal piece, A^4. The arms A^2 A^3 support the bearing-boxes of the hollow cutter-carrying mandrel H, arranged horizontally and longitudinally of the machine, as shown.

Transversely upon the main frame, and at the feed end of the machine, is journaled a shaft, B′, one end of which projects through the front longitudinal frame piece of the machine, and has upon it a disk or gage-wheel, B′, over which the blanks are fed into the machine, and also a cam or form wheel, C, which is attached to the outside face of said gage-wheel and revolves with it. The shaft B has bearings in boxes *b b*, placed in recesses in the under side of the side piece of the frame, and held in place by bolts *b′ b′*, which pass upward through the frame, and are secured by nuts b^2 b^2 upon their threaded ends. The rear end of the shaft B has upon it, outside of the rear longitudinal frame-piece, a spur-wheel, B^2, which is driven by means of appropriate intermediate gearing from the main driving-shaft of the machine, as hereinafter described. The gage-wheel B′ is keyed on the shaft B, and is arranged in line with the orifice of the hollow cutter-carrying mandrel, and has upon its periphery one or more adjustable gage-stops, D. The form-wheel C is placed upon a short pin or extension, b^3, upon the end of the shaft B, and is clamped against the face of the guide-wheel B′ by a nut, b^4, upon the threaded end of the pin b^3. The stops D are each composed of a slotted plate, D′, secured to the inner face of the gage-wheel by a screw passing through the slot of the plate and into a threaded aperture in the face of the wheel, and a short arm, D^2, which is bent at right angles to the plate D′, and extends transversely across the cylindrical face of the wheel. These stops or gages D may be placed at any point upon the periphery of the gage-wheel B′ by inserting the screws which hold them into any one of a series of apertures, *d*, arranged at equal intervals near the edge of said wheel. A yielding guide-roller, E, is placed immediately over the gage-wheel B′, and is mounted on the end of the bent spring-arm E′ upon the end of the cross-shaft E^2, which is located in bearings *e e* upon standards *e′ e′*, placed upon the sides A A of the main frame. This guide-roller is for the purpose of causing the gage-wheel to grip the end of the blank when it is placed thereon with its end against one of the stops D, so that the blank shall be carried forward into and through the mandrel by the revolution of the gage-wheel until its emerging end is gripped by the feed-rollers.

Upon the rear end of the cross-shaft E^2 is an arm or lever, E^3, the lower end of which is adapted to be adjustably fastened to the rear of the machine by means of a pin, e^2, which passes through an eye, e^3, in the end of the arm E^3, and through one of the series of apertures e^4 in the plate E^4, attached to the said frame. The object of this adjustment is to

partially rotate the shaft E^2, and thereby raise and lower the roller E, in order to accommodate said roller to the different-sized blanks that it may be desired to feed into the machine.

The cam or form wheel C, which operates and controls the devices for producing the taper or other form in the finished article, is attached, as stated, to the gage-wheel B′, and revolves with it, and the object of the stops D upon the said gage-wheel is to determine the time at which the end of the blank enters the mandrel with reference to the cam-surfaces upon the form-wheel, and therefore to determine the position of the tapers or other irregularities on the finished article.

In the operation of feeding the blank into the mandrel the end of the blank is placed against a stop and moved or pushed along with it until the guide-roller E is reached, which thereupon seizes and holds the blank to the periphery of the gage-wheel, and causes the latter in its rotation to carry the blank forward into the mandrel.

G G′ are rollers which feed the blank into the cutting-mandrel H, and which are placed a short distance forward of and in line with the guide-wheel B′. These feed-rollers G G′ are attached upon the outer end of shafts $g\,g'$, arranged transversely upon the main frame, which have bearings at their forward ends in a standard, G^2, attached to the front side of the frame, and at their rear ends in a standard, G^3, upon the rear longitudinal frame-piece. The upper feed-roller, G, is automatically adjustable with reference to the lower one, so as to allow for variations in the thickness and irregularities in the form of the blanks, and is held in working opposition to it by a compressed coiled spring, g^2, in the slotted standard G^2. The front end of the feed-roller shaft g has a bearing in a sliding box, g^3, Fig. 2, that is free to move in the vertical slot g^4 of the standard G^2, and is held in its normal position by the spring g^2, before mentioned. This spring is compressed between the upper surface of the said box and a cross-piece, g^5, upon the top of the upright G^2, which closes the upper end of the slot therein. The lower feed-roller, G′, is adjustable by means of a screw, g^6, which supports its bearing-box g^7. The feed-roller shafts g and g' are connected at their rear ends by two gear-wheels, G^4 G^5, which transmit motion to the shaft g from the shaft g', the end of which projects through the standard G^3 and has upon it a gear-wheel, G^6. Said gear-wheel G^6 is actuated through the medium of an idler from a spur-wheel on the rear end of the main driving-shaft. The feed-rollers G G′ are corrugated, as shown, in order to more effectually grip the blank.

Between the gage-wheel B and the feed-rollers is a vertical guide-roller, F, against which the rear side of the blank runs in passing over the guide-wheel and through the said feed-rollers. This guide-roller is mounted on a block, F′, which is adjustable in a horizontal plane, so as to allow the roller F to be moved laterally in reference to the path of the blank. The block F′ is provided with slots $f\,f$, and is attached to the main frame by screws $f'\,f'$, which pass through said slots and are tapped into the top of the frame A. A broad washer, f^2, is placed upon the block F′, through which both screws pass, and which covers the slots $f\,f$, so as to prevent dust or cuttings from entering them. The axes of the feed-rollers G are inclined slightly in a horizontal plane—that is to say, the front end is slightly more advanced than the rear end—so as to cause the blank to bear against the roller F.

H is the hollow cutter-carrying mandrel, journaled in bearings $h\,h'$ upon the transverse blocks A^5 A^5, resting upon the lateral extension A^2 A^3 A^4 of the main frame, and having its axis located at right angles to the other rotating shafts of the machine and in line with the feed-rollers and the top of the guide-wheel B′. The mandrel H at the feed end projects beyond its bearings h, and has upon such projecting end a cutter-head, I, which carries the shaping-cutters I′ I′. Upon the central portion of the hollow mandrel, between its bearings $h\,h'$, are the oppositely-projecting cutter-carrying arms J J, which support the finishing knives or cutters J′. The mandrel is driven by a belt which passes over a pulley, H′, upon the said mandrel, and which obtains its motion from a driving-pulley, which is preferably not connected with the other operative parts of the machine.

In order that mandrels of different sizes may be placed in the machine for the purpose of turning articles of materially greater or less diameter, removable bearing-boxes $h\,h'$ are provided, adapted to the different-sized mandrels, but which are of uniform external dimensions and fitted to suitable seats, h^2, in the transverse pieces A^5 A^5, and are held in position by tap-nuts h^3 h^3. The shaping-cutters I′ I′ are arranged in the usual manner, being placed in slots $i\,i$ in the head I, and adjustably fastened therein by means of abutting-screws $i'\,i'$, tapped into the head at right angles to their cutters. The cutter-head I has the usual flared opening, and the cutters have curved cutting-edges shaped to correspond with the shape of the orifice of the cutter-head, as shown in Fig. 11 of the drawings. The said cutter-head I is also provided with the usual radial orifices i^2 i^2, for the escape of cuttings or shavings. The inner ends of the curved shaping-cutters I′ I′ approach each other sufficiently to reduce the square stuff or blank to a cylindrical shape with a diameter slightly greater than the largest portion of the finished article, and just large enough to pass freely through and to be guided by the cylindrical bore of the mandrel in that portion which intervenes between the shaping and finishing cutters. The finishing-cutters

J′ J′ are curved or bent transversely near their cutting-edges, and are arranged tangentially in reference to the orifice of the mandrel and extended outwardly in long spring-steel shanks, the ends of which are clamped at the extremities of the oppositely-projecting supporting-arms J J. The arms J J are composed of two parallel plates, *j j*, connected with each other by one pair of outer cross-bars, *j′*, and two pairs of inner cross-bars, j^4 and j^5, preferably cast in the same piece with the plates. The plates *j* have a central aperture fitted to receive the sleeve L, which in turn is fitted closely to the cylindrical surface of the mandrel. The plates or arms are secured to the mandrel by any suitable means—as, for example, by screws j^6, Fig. 13, which pass through the cross-bars j^4 and through the subjacent parts of the sleeve into the mandrel. Additional pins or bolts may be employed to secure the sleeve L to the mandrel, and the arms J may be further fastened to the sleeve by screws or pins inserted through the sleeve-flange L^2, and into the adjacent plate of the said arms. The knives or cutters J′ J′ are located between the arm-plates *j*, and are held by clamps j^2 and bolts j^3, which bind their outer ends to the cross-bars *j′*. The inner or cutting ends of the knives extend through suitable openings in the sleeve L and mandrel H, and are adjustably supported upon wedges K, arranged longitudinally against the outer surface of the mandrel in corresponding slots in the sleeve L, and longitudinally movable to raise and lower the knives, and thereby vary the diameter of the article being turned. Said wedges are seen in side elevation in Figs. 15 and 16, in cross-section in Fig. 13, and in longitudinal section in Fig. 11. The sleeve L and the wedges K project at one side of the arms J, and in said projecting portion both are surrounded by a loose ring, M, engaged with the wedges by lugs k^2 on the latter, one on each side of the ring, so that the wedges may be slid longitudinally in their seats by a sliding movement of the ring upon the sleeve. Said ring is shown to be provided with a central annular flange by which it may be engaged with a suitable mechanism for sliding the ring and the wedges. Such a mechanism will be hereinafter described. The wedges are held in the slots of the sleeve by the adjacent and surrounding part of the arm structure J, and, to give more reliable support thereto, the cross-pieces j^5 are placed in position to give backing to said wedges. The latter are of course made slightly thinner than the sleeve, in order to move freely within their guiding and confining parts.

In order to more firmly hold the knives down to their work, re-enforcing plates J^2 may be clamped upon the knives, as shown in Fig. 13. The openings in the sleeve L and mandrel H, which admit the cutting ends of the knives J′, are arranged to extend both in front and at the rear of the knives, so as to allow the necessary movement thereof, as described, and also to permit escape of the shavings at both these points.

The purpose of the construction described in the devices for securing the knife-carrying arms J upon the hollow mandrel H is to provide a cheap and simple means for forming the seats for the wedges K, and at the same time for accurately fitting the said arms upon the mandrel. The sleeve L is formed to fit upon the exterior of the mandrel and the central aperture in the knife bored out to the proper diameter to fit closely upon the said sleeve. The sleeve is readily slotted to receive the wedges K as described, and the difficult and expensive operation of forming the necessary seats for said wedges either in the exterior surface of the mandrel or in the knife-carrying arm structure is thereby avoided. A bearing strip or shoe, K′, is preferably introduced between the wedge K and the knife, as shown in Fig. 16, the edge of which is curved to fit the curve of the knife in its central portion where it comes in contact therewith, in order to give a firmer bearing over the entire width of the curved end of the knife. It is found in practice that the heat generated by the high speed at which the cutters are driven tends to evaporate the lubricant upon the wedge K adjacent to the knife. In order to avoid this effect the wedge-seat will be cut away at its central portion, opposite the knife, so that the wedge will have a bearing at its ends only, as shown in Fig. 16.

As a means for sliding the ring M and the wedges K, the ring-flange M′ is embraced by a grooved collar, N, Fig. 17, and is free to revolve therein. The said collar is made in two sections, *n* and *n′*, hinged together at n^2, so that the collar can be readily placed upon or removed from the sliding ring. The lower section, *n*, of the collar N has upon it a short arm, n^3, by which the said collar is attached to an arm, O, upon a longitudinally-reciprocating rod, P, arranged below and parallel to the axis of the hollow mandrel, as seen in Fig. 2. The rod P has bearings in the transverse portions A^2 A^3 of the frame, and is attached by a hinged joint, *p*, to the connecting-rod P′, which extends across the face of the cam-wheel C, and a short distance beyond its opposite side is connected to the end of a swinging arm, P^2, pivoted to the under side of the end piece, A′, of the main frame.

Upon the side of the rod P′, and bearing against the periphery of the "form" or cam-wheel C, is a friction-roller, P^3. The opposite end of the rod P is extended beyond its bearings in the frame A^2, and has a nut, *p′*, upon its end, between which nut and the side of the frame is a compressed coiled spring, P^4. The object of this spring is to keep the roller P^3 against the periphery of the cam-wheel, causing it to follow its irregularities, so that as the cam-wheel is revolved the wedges K receive a corresponding movement through the me-

dium of the sliding ring M, to which they are attached, and the collar and arm connecting the same with the rod P.

In order to guide and support the arm O in its proper place with reference to the sliding ring M, so that the weight of the grooved collar N shall be supported independently of the ring M, and so that the flange M′ shall run freely in said collar, a guide-pin, O′, is provided, which is adjustably attached in the side of the frame A^2, and is parallel with the sliding rod P. This rod O′ is attached to a plate, O^2, clamped to the inner face of the frame A^2 by means of a bolt, *o*, which passes through a vertical slot in the said frame, and is secured by a nut and washer upon its outer end. The arm O and the collar N, which it supports, can thus be adjusted with exactness in reference to the ring M. The arm O is connected to the rod P, so as to be adjustable longitudinally upon it, by means of a sleeve, O^3, upon the lower end of the arm, which is slipped over the rod, and secured in proper position by two nuts, *o′ o′*, upon a threaded section in the rod, and between which the sleeve O^3 is clamped.

Near the upper end of the arm O is attached an auxiliary rod, Q, which is parallel with the rod P. This rod Q passes through an aperture in the frame A, and has between a nut, *q*, on its outer end, and the face of the frame A a compressed coiled spring, Q′, and its inner end passes through an aperture in the arm O, and is provided with a head, *q′*. The object of this spring-rod Q is to act in conjunction with the spring upon the rod mentioned, to keep the arm O and collar N constantly strained in the direction of the delivery end of the machine, and to take up all lost motion therein.

In order to allow the collar N to be detached from the arm O when it is desired to change the mandrels for the purpose of turning articles of different sizes, the said collar is secured to the arm by a bolt, n^4, which passes through the arm n^5 on the collar, and a slot in the end of the arm O. By means of the slot mentioned the position of the collar N upon the arm O can be adjusted accurately, and provision is thus also made for the difference in the sizes of the collars upon the different mandrels.

R R′, Figs. 1, 2, 4, 7, and 8, are a series of pairs of opposing and self-adjusting gripping-rollers arranged immediately at the delivery end of the mandrel and in line therewith. The object of this series of rollers is to seize the finished end of the article being turned immediately before or at the moment it passes from the feed-rollers G, in order to carry the article through the mandrel and prevent its revolving therewith after it has passed the said feed-rollers.

The rollers R R′, of which their are four pairs shown, although a greater or less number may be used, as found desirable, are grooved upon their faces in line with the aperture in the mandrel, so as to approximately fit a portion of the cylindrical or tapered surface of the finished article. These rollers are attached to the outer end of the series of shafts *r r′*, Fig. 1, which have bearings at their front ends in two adjustable bearing-blocks, R^2 and R^3, (seen best in Figs. 2, 7, and 8,) and at their rear ends in two pivoted bearing-pieces, R^4 and R^5, Figs. 1 and 8. The shafts of each pair of opposing rollers are connected at their rear ends by cog-wheels r^2 r^3 of equal size, and one of each pair of shafts extends through one of the pivoted bearing-blocks, R^4 or R^5, and has upon its rear end a spur-gear, r^4 or r^5, connected to a corresponding gear either above or below it, as the case may require, on one of the shafts of the next pair of rollers. The shafts *r r′* are all actuated by a gear-wheel, R^6, upon the extreme end of the lower shaft, *r*, of the pair of rollers nearest the mandrel, which is driven by appropriate intermediate gearing from the driving-shaft X. Motion is transmitted from the lower shaft, *r*, just mentioned, by the gear r^4 thereon to the gear r^5 upon the adjacent upper shaft, *r′*. This gear r^5 meshes in turn with the gear r^4 on the lower shaft of the next pair, and that in turn with the gear r^5 on the upper shaft of the last pair. The object of this arrangement is to enable the shaft and rollers to be placed close together horizontally, and the vertically-arranged connecting-gears r^2 r^3 on each pair of shafts are placed alternately forward on their shafts, so as to lap each other for the same purpose as shown in the plan view, Fig. 1. The rear bearing-blocks, R^4 and R^5, are pivoted at their ends by journals R^8 in vertical standards R^7, attached to the rear longitudinal side piece, A, of the main frame, so as to allow a requisite movement of the gripping-rollers R R′.

In order to provide for longitudinal adjustment of the gripping-rollers R, so as to bring them in exact alignment horizontally with the orifice of the hollow mandrel, the rear bearing-supports, R^7, may be cast in one piece, so as to form a rigid structure, and provided with slots, and attached to the top of the main frame by screws or bolts, so that the said standards can be adjusted upon the frame and the gripping-rollers moved to any desired position. The front bearing-blocks, R^2 and R^3, are both vertically movable, so as to bring the upper and lower rows of the gripping-rollers closer to or farther from each other, in order that the opposing rollers may first be separated to allow the end of the turned article to pass between without touching them, until the rear end thereof is about to leave the feed-rollers, when they may be made to grip the finished end of the article, so as to thereafter carry it the remainder of the way through the cutters. The rollers R R′ are made to normally stand apart sufficiently by means of expanding coiled springs r^6, and they are caused to grip the article at the proper time in its passage between them by devices operated by a roller-

pin, B^3, Figs. 1, 5, and 6, attached in suitable position to the gage-wheel B′.

To control the gripping-rollers from the gage-wheel having the roller-pin B^3, the lower bearing-block, R^2, rests at its center upon the top of a vertical tube, S, Figs. 2, 7, and 8, which slides in fixed bearings S′ and S^2, attached to the sides of the main frame. The lower end of the tube S rests upon one end of a short lever, T, connected at its outer end by a flexible joint, *u*, with a fixed bar, U, attached to the said main frame, and through which passes the tube S before mentioned. The upper bearing-block, R′, is supported from the lower one by the two coiled springs r^6. A vertical headed rod, V, passes downward loosely through the bearing-blocks and through the tube S and lever T, and has upon its upper threaded end a nut, *v*, by which its length may be adjusted. This rod V is connected at its lower end to a long lever, W, which extends forward in position to engage with the roller-pin B^3. A bolt, W′, passes freely upward through the said lever and through the short lever T and arm U, and is secured by a nut upon the top of said arm, as shown. The lever W extends a short distance beyond the point of attachment of the bolt W′, and its upper side is curved or rounded off at the end and rests against the lower side of the short lever T. Depression of the lever W, therefore, operates to raise the lower rollers, R, and depress the upper rollers, R′, equally, and an opposite movement of the lever allows them to spread. The compound leverage obtained by the construction shown causes the rollers to grip the article being turned with great force. One or more rollers, B^3, may be employed, and said rollers are detachably secured to the face of the wheel B′ by means of screw-threaded center-pins run into either of the threaded holes *b* before mentioned, and may thus be set at any desired point on said wheel. Fixed guides w^2 retain the lever in due position to engage the roller-pin B^3, and a screw, *w*, threaded through a fixed block, *w′*, serves as an adjustable stop to limit the upward throw of the lever W and the spread of the gripping-rollers R R′.

The apertures in the bearing-blocks R^2 R^3, through which the rod V passes, are enlarged in a direction lengthwise of the blocks, so as to allow considerable vertical play to the ends of the blocks, for the purpose of permitting the upper and lower rows of rollers to assume an inclined position, in order that they may conform to the taper or other irregular shape of the article that passes between them. The apertures in the levers W and T, through which the rods V and W′ pass, are also enlarged to permit the necessary movement of these parts. The portion of the lever W upon which the roller-pins upon the gage-wheel act is preferably shaped to a curve coincident with the path of the rollers, as shown by dotted lines, Fig. 2, so that the said lever will be depressed and held down for a period sufficiently long to cause the gripping-rollers to draw the finished article completely out of the mandrel. The length of time during which the lever is depressed may be made to vary according to circumstances, (such as the length or shape of the object being turned,) so that the gripping-rollers will act for a longer or shorter period by placing additional rollers on the wheel B, and thereby holding the lever W down for a longer or shorter period, as the case requires.

Near the center of the main frame of the machine, and transverse to it, is placed the main driving-shaft X, and upon it is a large driving-pulley, X′, which is actuated by a belt, X^2, from a variable cone-pulley upon a countershaft, (not shown.) A tightener, X^3, is arranged to operate on the belt X^2, by which the feeding devices may be stopped and started, and which take up the slack when the belt is on one of the smaller pulleys of the cone. The driving-shaft X has bearings in boxes X X upon the lower side of the frame of the machine.

Upon the end of the shaft X, which projects outwardly beyond its bearing on the rear side of the frame, is a gear-wheel, *x′*, which, through the medium of an idler, x^2, transmits motion to the gear-wheel G^6 upon the feed-roller shaft *g′*, before described. Motion is also transmitted from the wheel *x′* through the idler x^3 to the spur-wheel R^6, which actuates the gripping-rollers R R′. The gearing connecting the driving-shaft and the feed-rollers and that connecting the same shaft with the gripping-rollers are made of the same diameter, in order that the shafts of the feed-rollers and the shafts of the gripping-rollers may be rotated at the same speed, so that after the gripping-rollers have been brought to bear on the article passing through the mandrel (which usually takes place before the end of the blank has left the feed-rollers) the said gripping-rollers may carry it forward without effecting the action of the feed-rollers or causing any slipping of either roller upon the article, which is thus moved at the same speed during its entire passage through the mandrel.

Upon the driving-shaft X, and adjacent to the inner face of the rear longitudinal piece A of the main frame, is a gear-wheel, X^3, which, by means of an idler, x^4, actuates another gear-wheel, Y, upon a short shaft, *y*, having its bearing in a pendent bracket, Y′, attached to the under side of the frame. On the opposite end of the shaft *y*, and outside of the frame, is a gear-wheel, *y′*, which, through the medium of an idler, y^2, actuates the spur-wheel B^2 upon the end of the gage-wheel shaft B.

In order to vary the speed of the form-wheel C upon the shaft B in relation to the speed of the feed-rollers, the intermediate gear-wheel, *y′*, is adapted to be removed and replaced by one of greater or less diameter.

To accomplish this it is necessary to shift the position of the idler y^2, which meshes with the wheel mentioned. This is done by mounting the journal-pin y^3 of the idler y^2 upon an adjustable plate, y^4, which is slotted, and is held upon the frame A by a bolt, y^5, passing through the slot, and an aperture in the frame and secured by a nut upon its inner threaded end.

In shaping a tapered or irregularly-curved article of a certain length the speed of the feed-rollers must be so adjusted in reference to the speed of the form-wheel that the article shall be fed through the cutter in the exact time that it takes the form-wheel to complete its revolution, or such portion thereof as is necessary to give the required movement to the finishing-cutters. In case, therefore, it is desired to give the same general form to an article of greater or less length, and by the use of the same form-wheel, it is necessary to increase or diminish the speed of the form-wheel so that the movement of the cutters controlled by it shall take place while the article, whatever its length, is passing through the cutters, and the adjustability of the relative speeds of the form-wheel and feed-rollers which is accomplished by introducing intermediate gears of different diameters between the driving-shaft and the form-wheel shaft, as has just been described, is for this purpose.

The mode of driving the feed-rollers, the gripping-rollers, and the form-wheel shaft B, which is shown in the drawings, is not essential to my invention, but any means of giving the required motion to these parts may be used.

It may be observed that the idlers x^2 x^3 x^4 are merely incidental to the machine shown as constructed, and that by changing the position of the driving-shaft so that the wheel X′ will mesh with the gear-wheels G^6 and R^6, and rotating it in an opposite direction, these idlers may be omitted, the shaft y being also moved in such case to a proper position with reference to the driving-shaft.

In the machine illustrated in the drawings the form-wheel is adapted to move the finishing-cutters, so as to form two articles with the same regular taper during each revolution of the wheel by having two cam-surfaces, C′, of regularly-increasing radius, as shown, each extending half-way around the circumference of the wheel. The change from one to the other of these cam-faces is made by the short incline c. It is found that, as the roller-pin P^3, which, as above described, is kept in contact with the periphery of the form-wheel C by the spring P^4 acting upon the rod P, traverses these more abrupt irregularities upon the said form-wheel, the said roller is liable to suddenly accelerate or retard the speed of the form-wheel, owing to the amount of lost motion in the gear-train, by which it is run. When such abrupt changes in the direction of the cam-faces occur otherwhere than at their termination, any unsteadiness in the motion of the form-wheel arising from their presence will produce a corresponding irregularity in the shape of the article being turned, and in any case the utmost regularity of the form-wheel is desirable. To produce the desired regularity, a friction device is provided which, as here shown, consists of the arms B^4, adjustably attached to the shaft B, and the spring B^5, attached to the end A′ of the frame, and arranged in position to bear against the arms while the roller-pin P^2 is passing the abrupt inclination of the form-wheel. If forms are being turned requiring several such inclinations, a continuous friction-wheel may be employed; but if the arms shown are used, they may be of any desired number and adjusted on the shaft B, so as to be set at the points required. The stops D are as many in number as there are cams on the form-wheel for separate articles to be turned. In the drawings there are two similar cams and stops, adapting the machine to turn two articles or spindles at one revolution of the gage and form-wheel. The gage-wheel is, as shown, perfectly circular, and is permanently attached to the shaft B, said shaft being vertically adjustable by means of movable bearings, as seen in dotted lines of Fig. 3, so that the blank may be fed with its axis in line with that of the mandrel, and the lower feed-roller, G′, is also adjustable for the same purpose, as before described. The form-wheel is changed in order that one may be substituted for another to produce the various forms of articles desired to be turned, and it is also adjustable in relation to the gage-wheel B′ by loosening the nut b^4 on the pin b^3, so that the cam-surfaces thereon may be readily changed in their relation to the stops D and rollers B upon the gage-wheel, thus rendering it unnecessary to change the position of the said stops and rollers when it is desired to change the position of the irregularity in the article being turned with reference to the ends thereof. The transverse piece A^3 of the frame, which is adjacent to the form-wheel and beneath the shaping-cutters, is preferably inclined, as shown in Fig. 2, so as to deflect the cuttings and shavings which fall from the shaping-cutters away from the gage and form wheel C.

The several mandrels of unequal size may be provided with wedge-shifting collars M′ of equal external dimensions, all fitted to run freely in a collar, N, in which case said collar may be permanently attached to the arm O of the shifting-bar P; or, if preferred, each mandrel may be provided with its own permanent collar N, detachably secured to the arm O, as described.

I am aware that interchangeable gears or other devices have been used in geometric lathes for changing the speed of a form-wheel for controlling the cutters with reference to the speed of a spindle for rotating the blank, and do not, therefore, claim such device broadly, but only when combined with the form-

wheel and feed-rollers of a hollow-mandrel lathe in which the blank is fed longitudinally through the mandrel.

I claim as my invention—

1. The combination, with the hollow rotating mandrel, and a movable cutter or cutters mounted therein, of a form-wheel, means for actuating the cutters from the form-wheel, feed-rollers constructed to feed the blank longitudinally through the hollow mandrel, and driving-connections between the feed-rollers and form-wheel, embracing change-speed devices constructed to permit the relative speeds of the said form-wheel and feed-roller to be varied, whereby the same form-wheel may be used in turning articles of different lengths, substantially as described.

2. The combination, with a hollow mandrel and cutter and a form-wheel, of vertically-movable feeding-rollers arranged at the exit end of the mandrel for gripping and drawing forward the article to be turned, and means operated from the form-wheel for controlling said rollers, substantially as described.

3. In combination with the mandrel and form-wheel, the double series of feed-rollers R R′, mounted on shafts r r', having vertically-movable bearings R^2 R^3 at the front ends of said shafts, means for separating said rollers, and means operated by the form-wheel for causing them to grip the article being turned, substantially as described.

4. In combination with the hollow cutter-carrying mandrel and form-wheel, the double series of gripping-rollers R R′, springs for holding them normally apart, a lever actuated by the form or gage wheel, and means connecting said lever with the gripping-rollers, substantially as and for the purpose set forth.

5. In combination with the hollow cutter-carrying mandrel, movable bearing-blocks sustaining opposing feed-rollers, separating-springs r^6 between said blocks, a tube, S, attached to the lower block, a rod, V, connected with the upper block and located within the tube, a lever, T, pivoted on the machine-frame and connected with the said tube, a lever, W, engaged with the lever T and the rod V, a fulcrum-support, W′, for said lever, and a form or gage wheel provided with devices for actuating the lever W intermittently, substantially as described.

6. The combination, with a hollow cutter-carrying mandrel and the gage-wheel B′, of the form-wheel C, mounted upon the same shaft with the gage-wheel, and circumferentially adjustable with reference thereto, substantially as and for the purpose set forth.

7. The combination, with a hollow cutter-carrying mandrel and the cam-surfaced form-wheel C, of the gage-wheel B′, having a stop or stops, D, upon its periphery, said stop or stops being independently adjustable in position with reference to the cam surface or surfaces of the form-wheel, substantially as described.

8. The combination, with a hollow cutter-carrying mandrel and the gage-wheel B′, having threaded apertures d in its face, of the stops D, and slotted plate D′, adapted to be attached to said gage-wheel by a screw passing through the slot in the plate D′, and into the apertures d, substantially as described.

9. In combination with the hollow mandrel and gage-wheel B′, the roller E, mounted on the end of an elastic pivoted arm, E′, and means for adjusting said arm, substantially as described.

10. The duplex cutter-arms consisting of two parallel and connected plates made separate from the mandrel proper and centrally poised thereon, in combination with the oppositely-arranged spring-cutters secured at their outer ends to the arms, and sliding wedges arranged and supported beneath the inner ends of the cutters, substantially as described.

11. In combination with the rotating hollow mandrel, the cutter-supporting arm structure made separate from the mandrel, and consisting of two parallel and rigidly-connected plates arranged transversely to the mandrel, centrally secured thereto, and provided with means for securing the cutters between the plates, substantially as described.

12. The combination, with the cutting-knives, sleeve L, and wedges K, of the hollow mandrel H, having apertures for the entrance of the cutting-knives, which apertures are cut away so as to afford a passage, h^5, extending beneath the said wedges to exit-apertures in said sleeve for the escape of shavings from beneath the cutting-edges of the knives, substantially as described.

13. The combination, with the hollow mandrel, spring-cutter, sliding wedges, and arm O, connected to said wedges, of the reciprocating rod P, the pivoted extension-piece P′, swinging lever P^2, and roller P^3, adapted to follow the periphery of the cam-wheel C, substantially as described.

14. The combination, with the hollow mandrel, spring-cutter, and wedge for moving the said cutter, of the slide-ring M, collar N, and the arm O, connected with the rod P, and adjustable longitudinally of said rod, substantially as described.

15. The combination, with the hollow mandrel, spring-cutters, and wedge for moving said cutters, of the sliding ring M, arm O, means for supporting and moving said arm, and the collar N, composed of two hinged sections, and adjustably secured to the said arm, substantially as and for the purpose described.

16. The combination, with the frame A of the machine, hollow mandrel, spring-cutters, and wedge for moving said cutters, and the sliding ring M, of the collar N, arm O, reciprocating rod P, and the guide-pin O′ for said arm, adjustably attached to the said frame, substantially as described.

17. The combination, with the hollow rotating mandrel, movable cutters mounted

therein, sliding wedges for actuating the cutters, and a reciprocating rod, P, for actuating the said wedges, of the arm O, attached at one end to the said rod so as to project laterally therefrom, and connected with the wedges, a sliding rod, Q, attached to said arm near its free end, and a spring, Q′, constructed to throw said rod toward one limit of its movement, substantially as and for the purpose set forth.

18. The combination, with the shaft B, the form-wheel C, secured thereon, and the spring-rod P, provided with a roller-pin constructed to bear upon said form-wheel, of one or more arms, B^4, secured upon the said shaft, and a spring, B^5, constructed to bear upon said arms during a portion of their rotation, substantially as described.

19. The combination, with the machine-frame and the hollow cutter-carrying mandrel, of feed-rollers R R′, vertically-movable bearing-blocks R^2 R^3, and pivoted bearing-blocks R^4 R^5 for said feed-rollers, and standards R^7, supporting the bearing-blocks R^4 R^5, and laterally adjustable upon the said frame, substantially as and for the purpose set forth.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

ELISHA H. HUDSON.

Witnesses:
M. E. DAYTON,
JESSE COX, JR.