No. 790,099. PATENTED MAY 16, 1905.

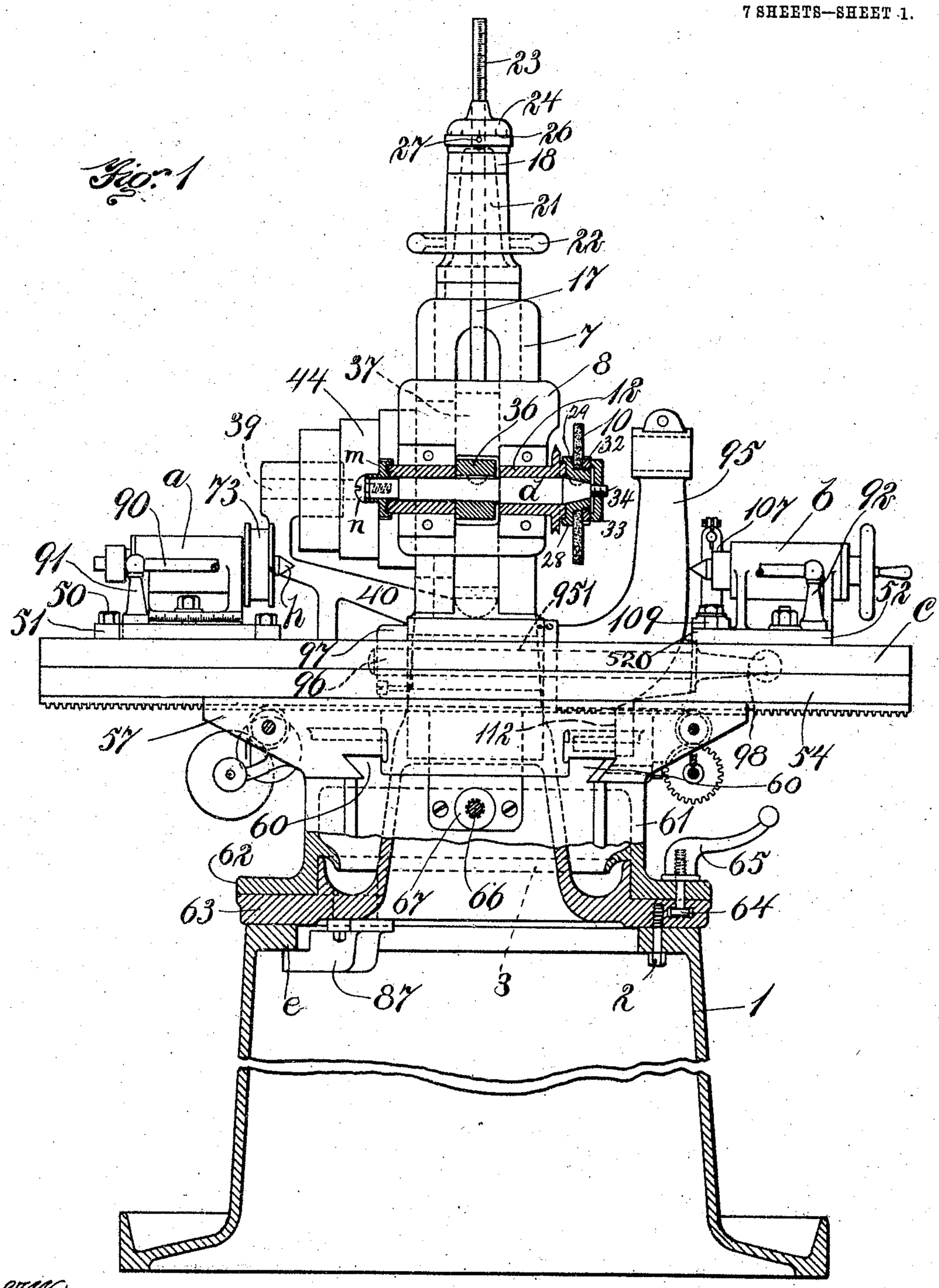
J. BATH.

GRINDING MACHINE.

APPLICATION FILED AUG. 24, 1904.

7 SHEETS—SHEET 1.

Fig. 1



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7 SHEETS—SHEET 2.

Fig. 2

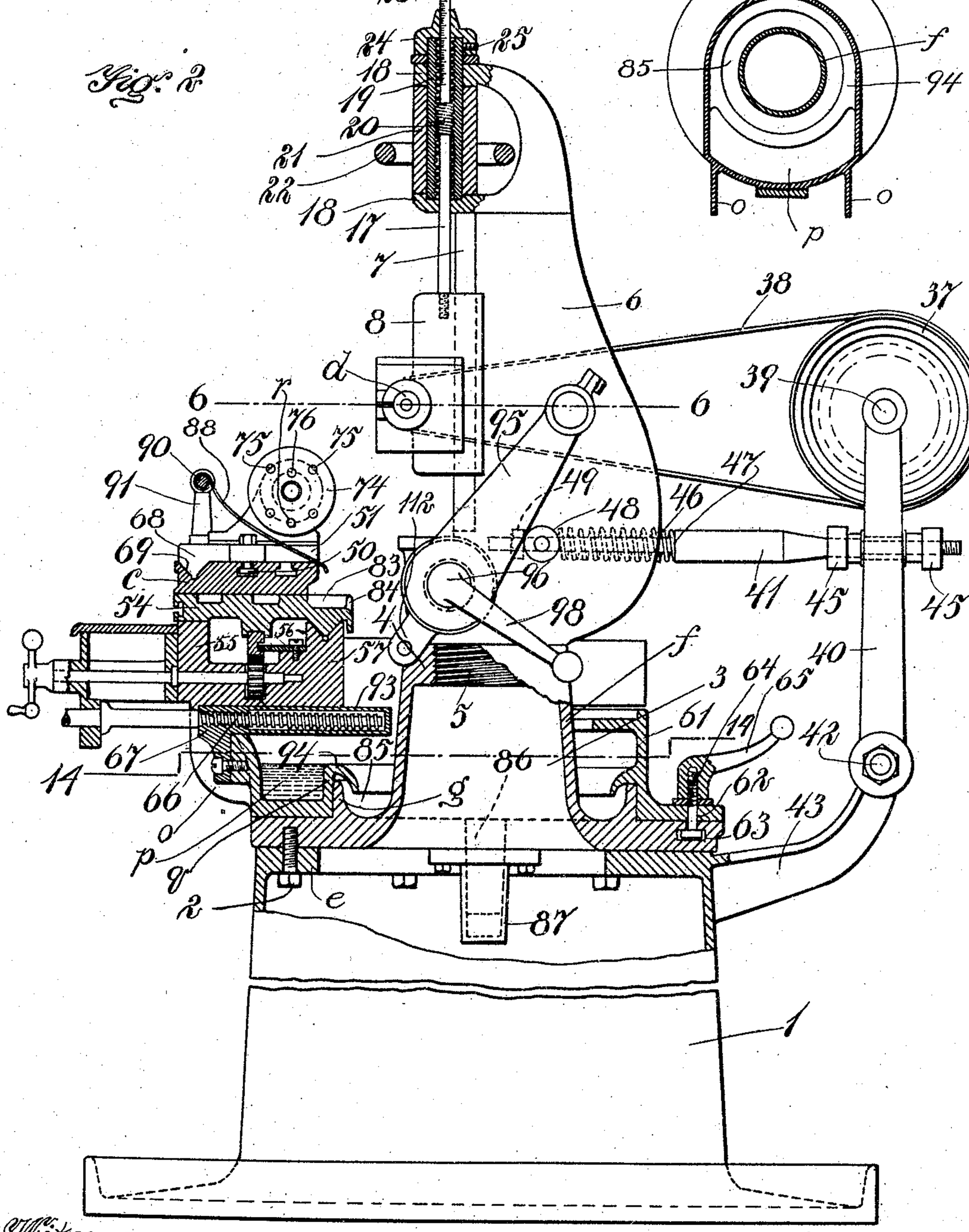

Fig. 14

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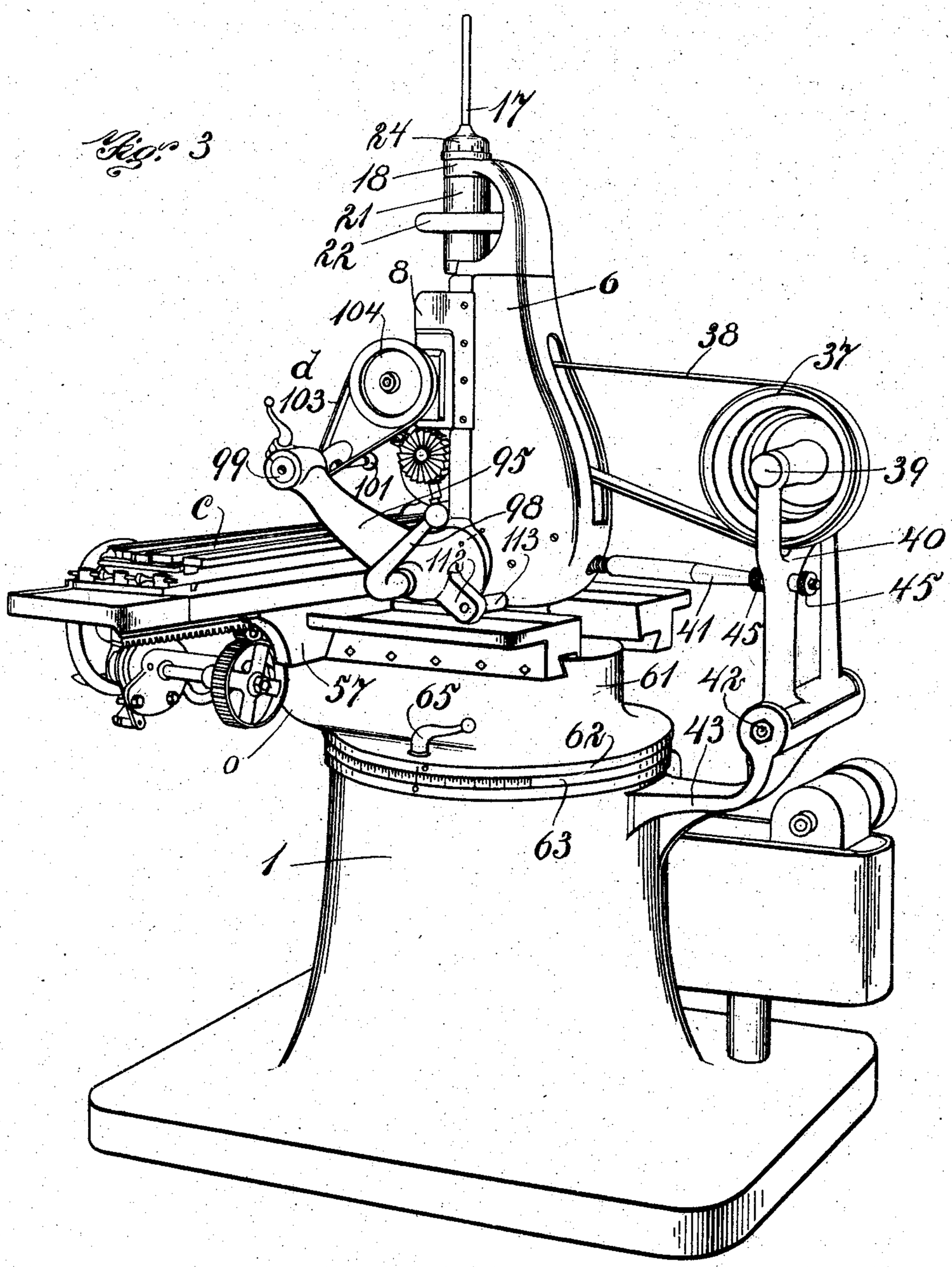
7 SHEETS—SHEET 3.

Fig. 3



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7 SHEETS—SHEET 4.

Fig. 4

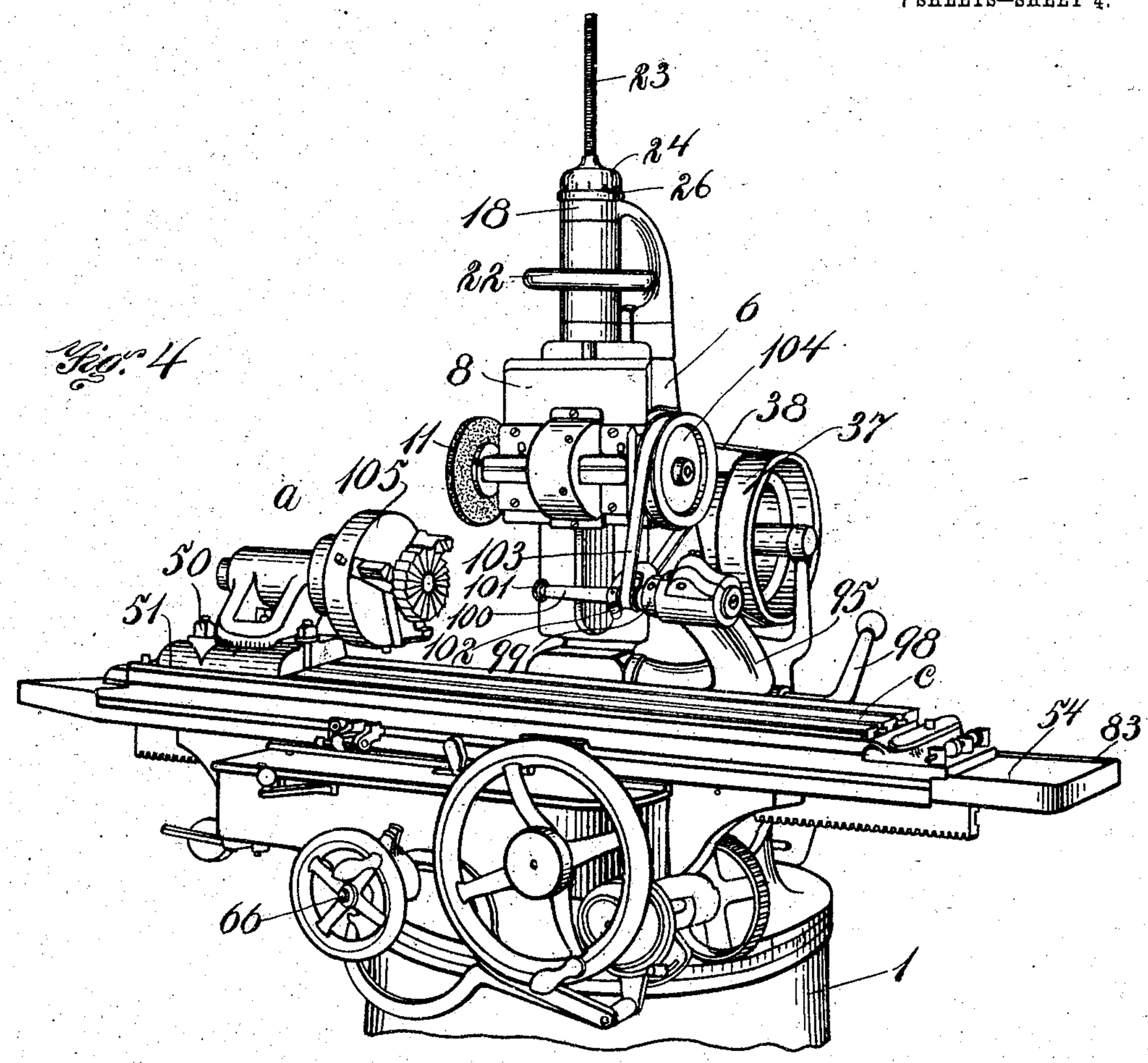
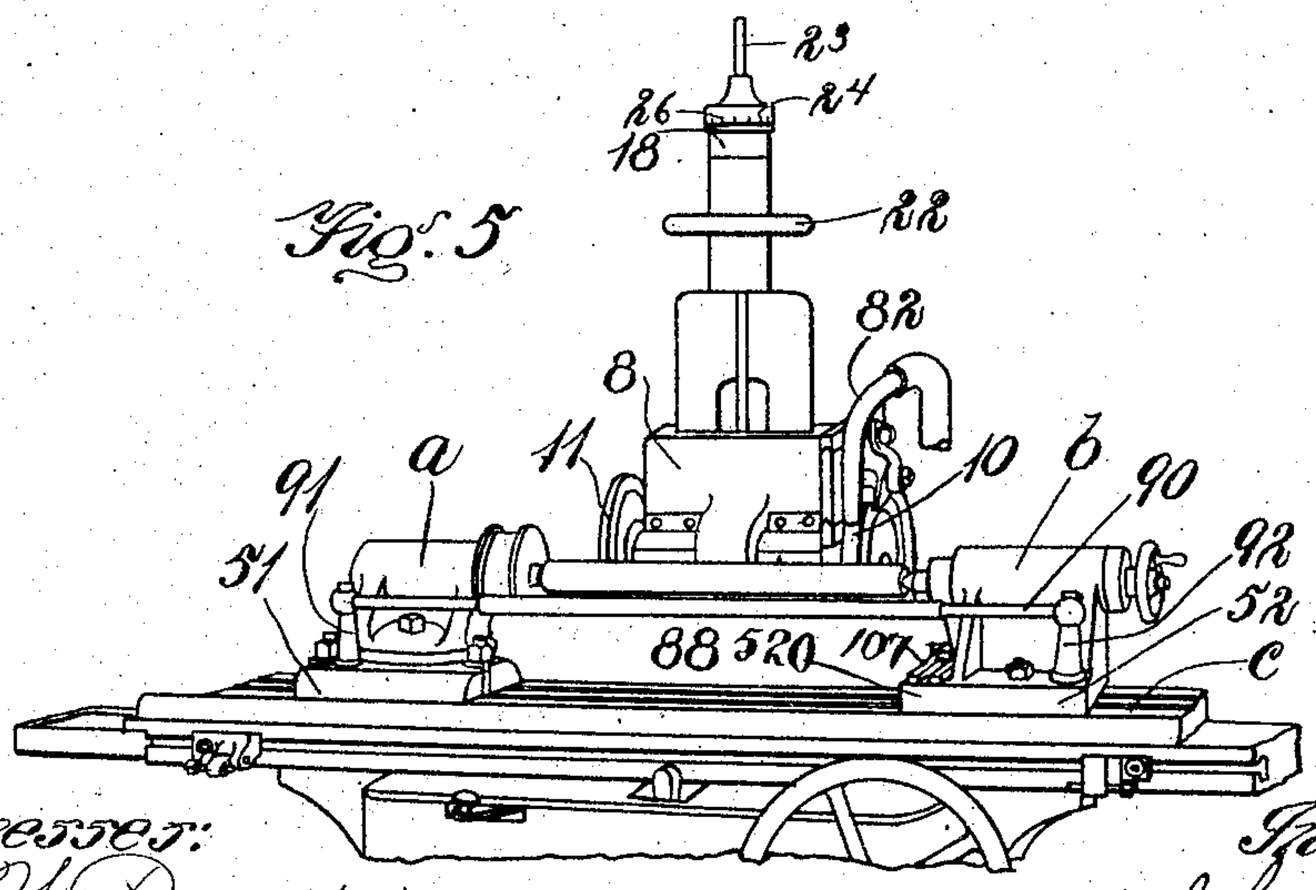


Fig. 5



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7 SHEETS—SHEET 5.

Fig. 8

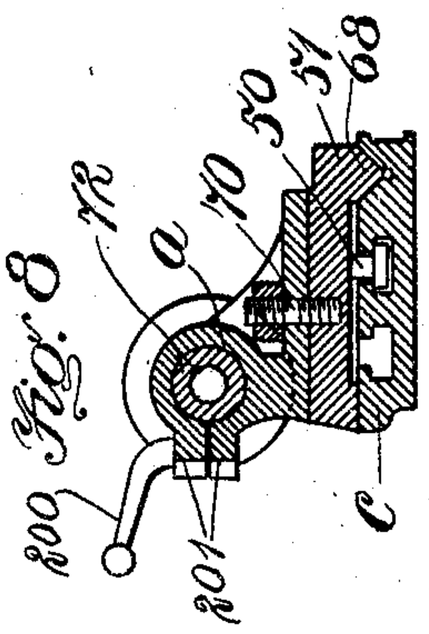

Fig. 6

Fig. 7

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7 SHEETS—SHEET 6.

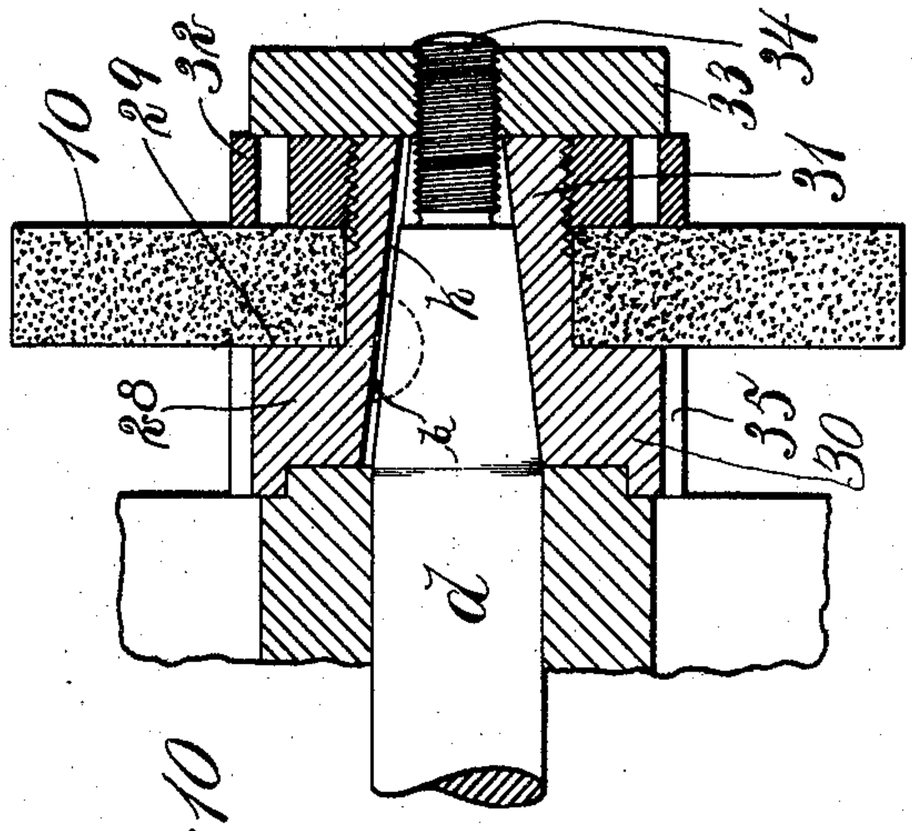

Fig. 10.

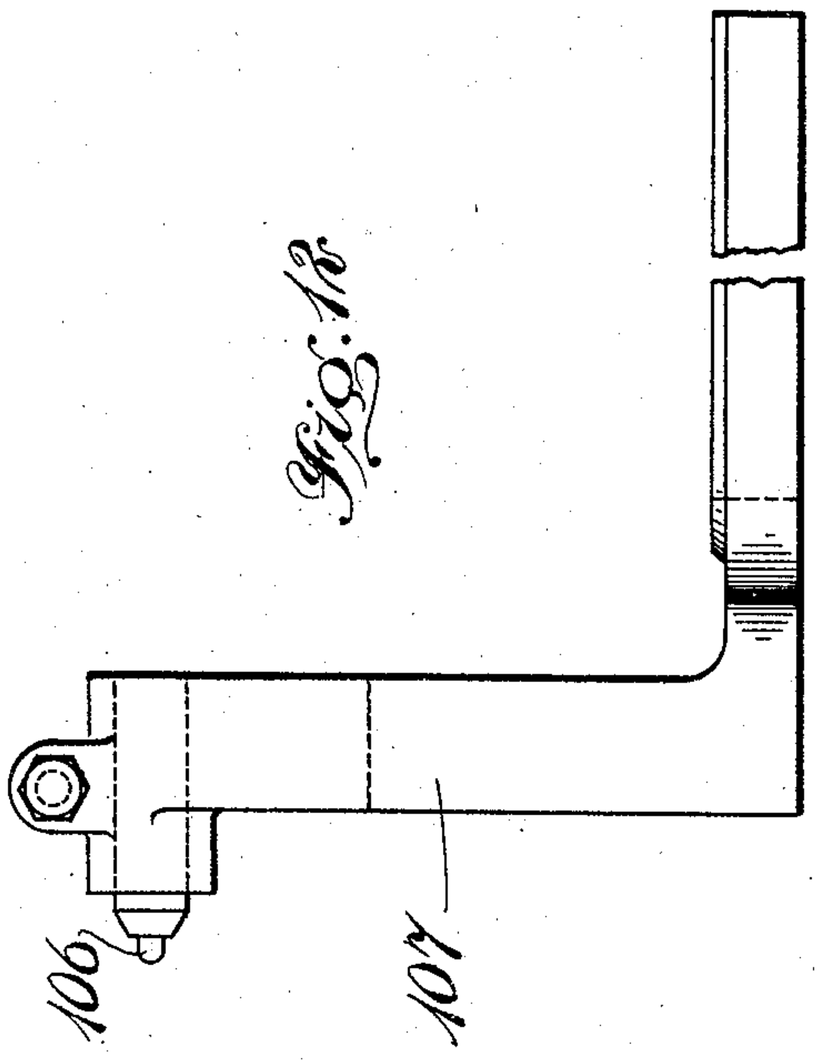

Fig. 12.

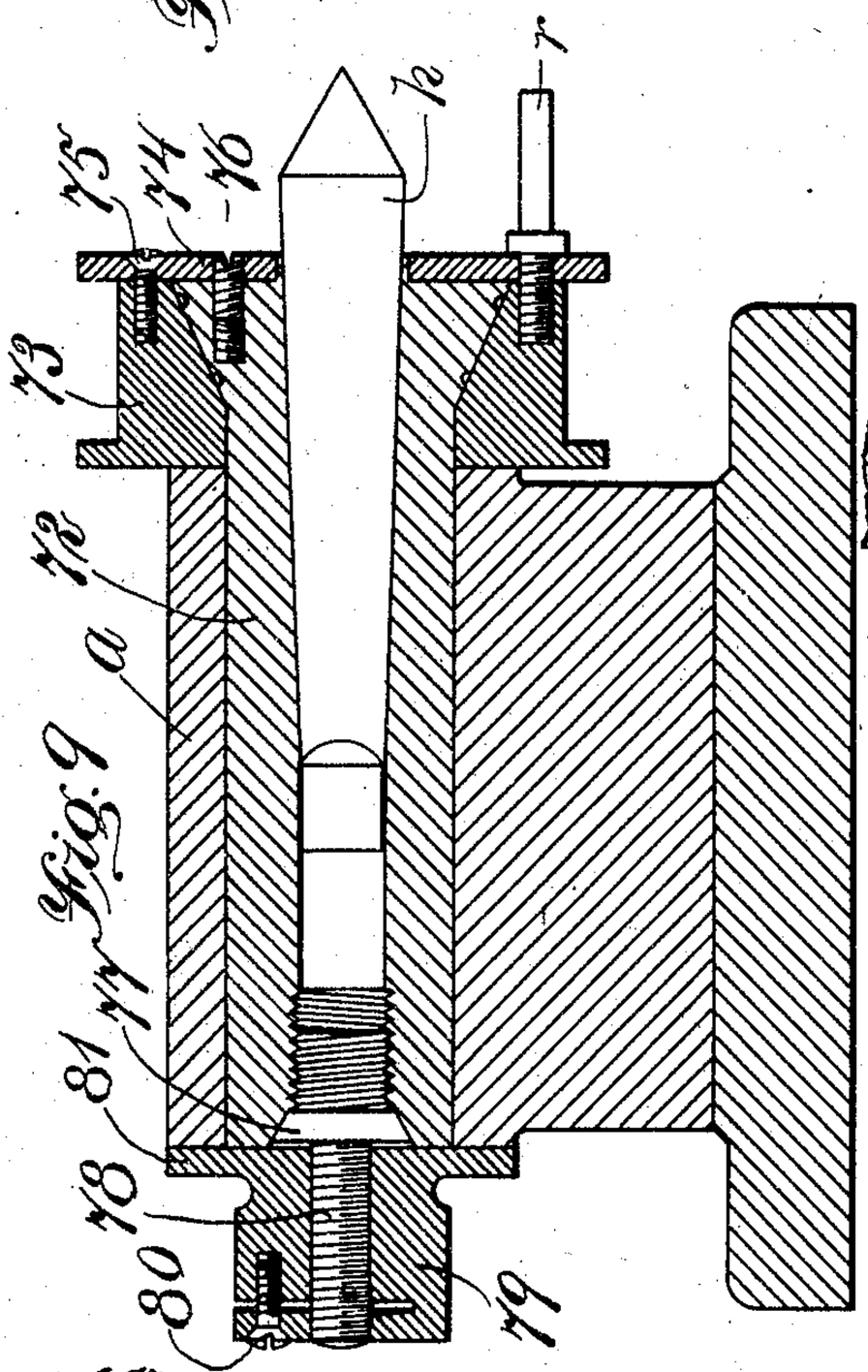

Fig. 9.

Fig. 11.

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7 SHEETS—SHEET 7.

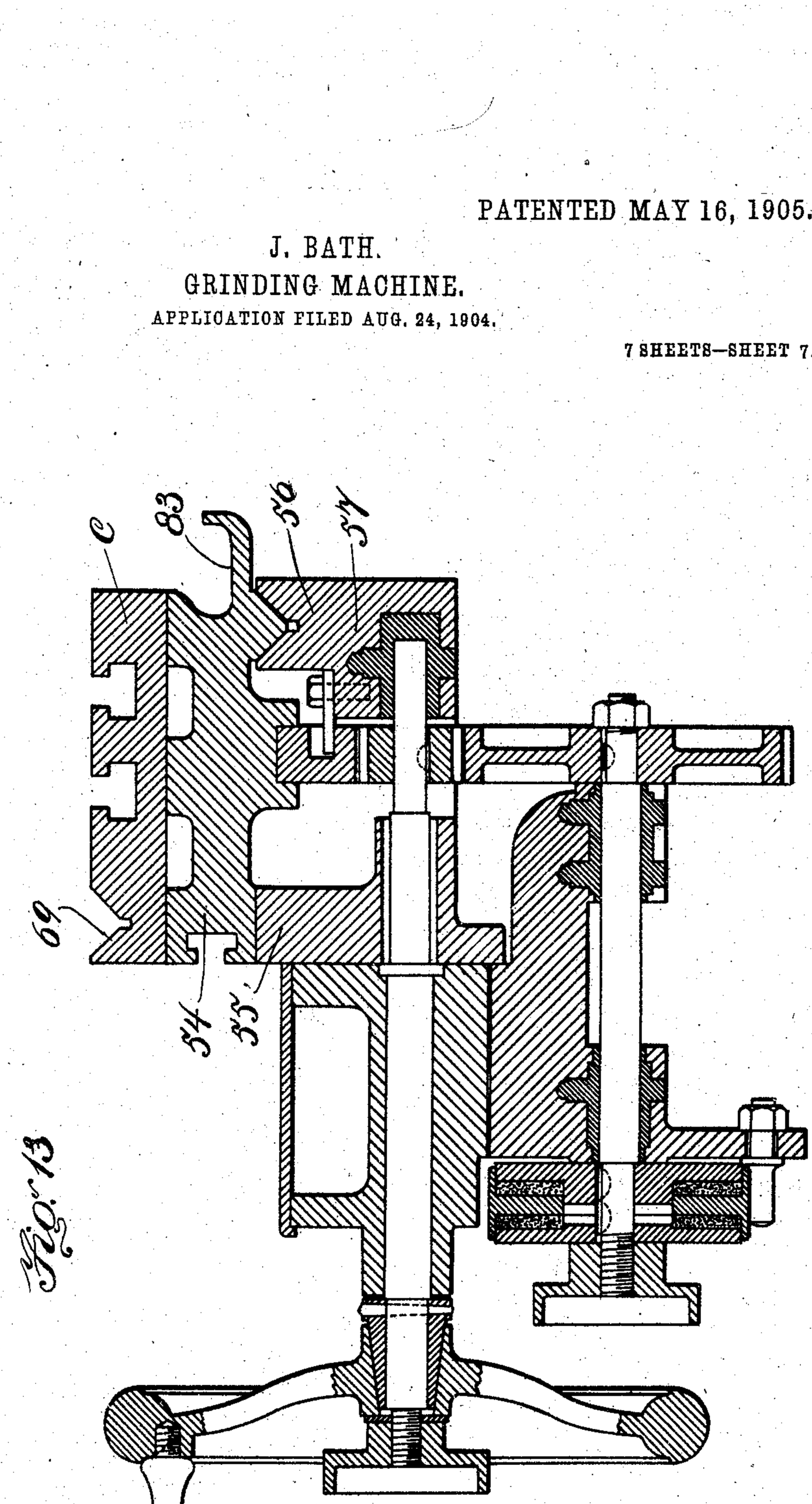

Fig. 13

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No. 790,099. Patented May 16, 1905.

UNITED STATES PATENT OFFICE.

JOHN BATH, OF FITCHBURG, MASSACHUSETTS.

GRINDING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 790,099, dated May 16, 1905.

Application filed August 24, 1904. Serial No. 222,000.

To all whom it may concern:

Be it known that I, JOHN BATH, of Fitchburg, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Grinding-Machines, of which the following is a specification.

This invention relates to machines for grinding and finishing to exact size metal tools and parts of machinery, and comprises the new and useful improvements in such machines hereinafter described and claimed.

In the drawings forming a part of this application, Figure 1 represents a front elevation, partly in section, of a machine embodying the improvements constituting the subject-matter of my invention. Fig. 2 is a side elevation, partly in section, of the machine as seen from the right of Fig. 1. Fig. 3 is a perspective rear view of the machine. Fig. 4 is a perspective front view of the upper part of the machine, showing the auxiliary internal grinding-wheel hereinafter described in position. Fig. 5 is a view similar to that shown in Fig. 4, but showing a different tool in position for operation. Fig. 6 shows a horizontal section taken on the line 6 6 of Fig. 2. Fig. 7 is a detail plan view of the head-stock of the machine, and Fig. 8 a cross-sectional view taken on the line 8 8 of Fig. 7. Fig. 9 is a longitudinal sectional view, on an enlarged scale, of the same. Fig. 10 is an enlarged detail view, in longitudinal section, of one end of the tool-supporting spindle or arbor with a grinding-tool in position thereon. Fig. 11 is an enlarged side elevation of the spindle-carrying head, showing the manner in which the spindle-bearing blocks are secured to the head. Fig. 12 is a side elevation of a device for truing the grinding-tool. Fig. 13 is a cross-section of the bed or platen. Fig. 14 shows a horizontal section, on a reduced scale, of the machine-support, taken on the line 14 14 of Fig. 2.

The machine consists of a wide low base 1 of generally cylindrical shape, slightly tapered from bottom to top, the top being formed with an inwardly-directed flange *e*, having a flat upper surface to which is detachably secured in any suitable manner, as by screws 2, an upright support 3. The support 3 is formed with a wide circular flange 63 of substantially the same diameter as the upper surface of the base 1, constituting the base portion of the support, into which the holding-screws 2 are threaded, and a short central column *f*, which tapers inwardly from bottom to top and has a central aperture extending its entire length. At its upper end the column is provided with an internally-threaded portion 4, into which is screwed a correspondingly-threaded projection 5, extending from the bottom of a standard 6. The standard may be removed from the support by unscrewing the projection 5 from the threaded portion 4, and thereby access is given through the opening in the support 3 to the bolts which connect the support and base together. An upright annular rib *g*, surrounding the column, is formed on the upper surface of the flange 63, and between the column and the rib is a groove 85, for a purpose to be described. The outer surface of the rib *g* and the upper surface of the flange 63 beyond the rib are finished off to form a bearing for an annular swivel-knee 61, which supports the carriage and table for holding the work and which will be furthermore fully described.

The forward side of the standard 6 is provided with a vertical guideway 7, upon which is adjustably mounted a spindle-carrying head 8, having bearings for a spindle *d*, which carries the grinding-tools 10 11. The spindle-bearings consist of split boxes 12, having bolt-receiving flanges 13, through which they are securely fastened in recesses in the head 8 by means of bolts 15, and having flanges 14, through which pass bolts 16, whereby the bearings may be adjusted to fit the spindle *d*. The spindle-carrying head is adjusted vertically along the guideway 7 by means of a rod 17, attached to the upper end of the head and passing upward therefrom through the forwardly-extending ears 18 18 of the head 6, and a long nut 19, which engages with an enlarged screw-threaded portion 20 of the rod 17. The nut 19 is snugly fitted into a sleeve 21, held between the ears 18, which carries a hand-wheel 22, and is secured therein, so that when the sleeve is rotated by the hand-wheel

the nut is also rotated, thus causing the rod 17 and head 8 to be raised or lowered, according to the direction in which the hand-wheel is turned.

In order to gage the position of the spindle-carrying head, the rod 17 is provided with a graduated scale 23, readings from which indicate the distance of the head above the work-support. To the upper end of the nut 19 a cap 24 is secured, by means of a set-screw 25, so that it rotates with the nut, but has no motion longitudinally thereof. The upper surface of the cap constitutes the fixed reading-line for the scale on the rod, and on the lower edge of the outer surface of this cap are graduations 26, which by reference to a mark 27 on a stationary part of the machine-frame indicate fractions of a revolution of the cap 24 and nut 19. The cap thus constitutes a dial by which fractions of the divisions of the scale 23 may be measured. By means of this double system of graduations the position of the head may be determined with great accuracy and a possibility of fine adjustment thereby obtained.

The grinder-carrying spindle (see Figs. 1, 6, and 10) is formed with reduced end portions, of which one is tapered, while the other is straight, and thereon are mounted wheel-bushings for supporting the emery-wheels which constitute the grinding-tools. The construction of the spindle, bushings, and wheels may be readily understood from an inspection of Fig. 10, which shows the right-hand end of the spindle *d*. The wheel-bushing 28 is formed with an internal tapered bore to fit the taper of the spindle and with a shoulder 29 and reduced portion 31 to receive the emery-wheel 10. The emery-wheel is clamped against the shoulder 29 by a nut 32, screwed on the threaded outer end of the reduced part of the bushing, and the latter is secured to the spindle by a nut 33, threaded upon a reduced extension 34 of the spindle *d*. Slipping of the bushing upon the spindle may be prevented by means of a suitable feather-and-slot connection, consisting of a feather *i*, secured to the spindle, and a slot *k* in the bushing, into which the feather projects. Wide flanges 30 are formed on the bushings, which flanges are provided with slots 35 for the reception of a spanner-wrench, by which the bushings and spindle may be held stationary while a tool is being secured in position or removed. The bushing *m* on the other end of the spindle, which holds the wheel 11, is similarly constructed, except that the bore is not tapered. By means of a spanner engaged in a slot of either bushing the spindle may be held to allow the other bushing to be rotated for removal from it. By constructing the flanges on the bushing with considerable width I am enabled to make the bore with the greatest possible diameter, thereby obtaining a large area of contact with the spindle, while at the same time being able to make the reduced portion 31 with a very small external diameter, and also strengthen the bushing and provide room for the spanner to engage the flange. The bushing *m* is held in place by a screw *n*, threaded into the end of the spindle, by means of which wear may be taken up and the bushings held against the ends of the spindle-bearings to prevent end play of the spindle.

The spindle and tools are rotated by a belt 38 passing over a pulley 36 on the spindle *d*, driven by a pulley 37, secured to a shaft 39, mounted rotatably on an arm 40, which is pivoted at 42 to a bracket 43 on the base of the machine. The pulley 37, and thereby the spindle *d*, is driven at any desired speed by a stepped pulley 44, secured to the pulley 37, which receives motion from a suitable source of power. An important feature of my invention is an automatic device for keeping the belt 38 at a uniform tension for all positions of adjustment of the spindle-head. As the spindle moves up and down it would be farther away from the shaft 39 at some times than at others if the shaft 39 were held in stationary bearings, making the belt sometimes tight, sometimes loose, and it is therefore necessary to maintain the distance between the spindle and shaft nearly uniform. To this end the bearing for the shaft is made movable and a device for moving the bearing is provided. Said device consists of a bar 41, one end of which extends through the arm 40 and is held in adjusted position relatively thereto by collars 45, threaded on the bar on opposite sides of the arm, and which is constantly pressed away from the spindle-head by a spring 46, surrounding the bar and bearing at one end against a shoulder 47 on the bar and at the other end against an abutment 48, mounted in the standard 6 of the machine. The pivotal connection of the arm 40 with its support permits the arm to swing freely toward and away from the standard, its outward movement being limited by a nut 49 on the inner end of the bar, which contacts with the abutment 48 on the opposite side from that against which the spring 46 bears. The collars 45 can be adjusted on the bar 41 to move the arm 40 relatively to the bar and vary the tension of the belt and spring.

The work is carried by a head-stock *a* and foot-stock *b*, mounted adjustably on a bed or platen *c* by means of headed bolts 50, seated in undercut slots in the platen, which extend through the base-plates 51 52 of the head and foot stocks and clamp them in position by means of nuts threaded thereon. The platen *c* is swivelly mounted by a pivot 53 on a table 54, which latter is supported so as to be longitudinally movable on supporting and guiding wings 55 56 of a carriage 57, said wings being located under opposite sides of the table, whereby great rigidity and stabil-

ity is given the table. Feeding mechanism is provided by which to move the table 54 and the work carried thereon past the grinder; but such mechanism forms no part of my present invention and need not, therefore, be here described. By means of the swivel connection between the platen *c* and table 54 the work may be set at an angle relatively to the line of feed and clamped in position by means of bolts 58, with nuts thereon, held by the table and extending through slots 59 in the platen, whereby a taper may be cut on the work.

The carriage 57 is mounted on guide-ribs 60, formed on the annular member or swivel-knee 61, before referred to, which surrounds the support 3 and is formed with a lateral flange 62, resting on the lateral flange 63, formed on the base of the support in such manner as to be capable of sliding thereon rotatively about the axis of the support, and is held in any desired position of adjustment by a clamp consisting of a bolt 64, the head of which extends into an undercut slot extending circumferentially about a portion of the flange 63, while its shank passes through the flange 62 and is fitted with a clamping-nut 65. As may be readily understood, a turn of the nut 65 in the proper direction will draw the head of the bolt 64 upward and bind the two flanges together. Graduation-marks forming a scale of any desired character are made on one of the flanges and a single mark on the other, by which the angle through which the member is turned may be determined. As the carriage, table, and work are all carried by the swivel-knee 61, this adjustment constitutes an additional instrumentality by which the work may be inclined, and this connection with the adjustment of the platen above described makes it possible to grind the work on any desired angle. The guide-ribs 60 project forward beyond the front wall of the swivel-knee in order to give provision for sufficient travel of the carriage, and they are supported by wings or brackets *o*, which are connected to the under sides of the ribs and to the front wall of the knee. These wings are an important feature of my invention, as they give rigidity to the guides 60 and enable the carriage and work to be held unyieldingly, thereby insuring accuracy of operation. If the carriage were permitted to yield, the work would spring away from and toward the grinder, causing chattering and loss of accuracy. A cross-feed for moving the work toward and from the grinding-tools is provided, consisting of the screw 66, threaded into a nut 67, secured to the knee 61 and held by the carriage 57 in such a manner that it may rotate freely therein, but is held from longitudinal motion relatively thereto, as is clearly shown in Fig. 2. The swivel-knee 61 is provided with an internal annular bearing-surface, which by engaging with the outer surface of the rib *g* retains the knee, preventing any side motion of the knee except rotation about the axis of the support. As the forward wall of the knee is extended beyond the circumference of the rib *g*, as shown in Fig. 2, the bearing at this side of the knee is formed by a curved upstanding rib *q*, which conforms to the curvature of the rib *g* and is joined with the side walls of the knee. A lateral inwardly and downwardly extending flange or gooseneck 94 is formed on the rib *q* and extends over the top of the rib *g*, protecting the bearing between the support and knee from the water and grit which fall from the work. Between the rib *q* and the front wall of the knee is a depression *p*, which forms a puddle-pan for catching the water dripping from the table, the function of which is later more fully described.

The construction of the head-stock, which is an important feature of my invention, will now be described. The base 51, as before stated, is secured to the platen *c* by means of bolts 50, and in addition is guided and held in correct alinement thereon by a rib 68, which projects into a longitudinal groove 69 in the platen. The base of the foot-stock also has a similar construction. It will be observed that by reason of this construction the necessity of providing a projecting rib on the platen or bed *c* for alining the head and foot stocks, which is an objectionable feature in the machines heretofore constructed, is avoided, and I am enabled to remove the head and foot stocks and place work with which they cannot be used upon the platen, clamping it in any desired position. This cannot be done with any of the grinding-machines known to me, for in all such machines there is a rib extending along the platen which restricts within narrow limits the sizes and positions of the pieces which can be clamped on the platen. The groove 69 also acts as a trough to conduct away water which may fall on the bed.

Another feature of the head-stock is the construction which permits it to be turned so that the center *h* carried by it may be presented to the grinding-wheel and ground true. The head-stock is not formed integrally with its base-plate 5, but consists of a separate casting, which is connected to the base-plate by a single pivot 70, about which it may be turned and which is provided with a nut by means of which the head-stock casting may be clamped in any desired position. A flange 71, curved on the arc of a circle whose center is the pivot, is formed on the head-stock casting, resting on the base-plate, and the outer edge of the flange is provided with a graduated scale by which the angle to which the head-stock is turned is indicated. Thus the center may be presented to the grinding-wheel and its point ground down to any desired angle, as shown in Fig. 7, the angle being measured by the scale on the flange 71. The center *h* is held friction-

ally in the tapered bore of a quill 72, rotatably mounted in a bearing in the head-stock casting, and may be turned by a pulley 73, mounted on the quill and driven by a belt from a suitable counter-shaft or other source of power. The pulley loosely surrounds the quill and may be fastened to it by a face-plate 74, which is secured to one side of the pulley by set-screws 75 and forms one of the flanges of the pulley and extends over the end of the quill, to which it may be attached by a set-screw 76. The set-screw 76 is normally seated with its entire length in a tapped hole in the quill, and when it is desired to connect the quill to the pulley the set-screw is screwed out until its outer end projects through a hole in the face-plate and engages the latter. Normally, however, the face-plate and quill are disconnected and the quill is held stationary in its bearing in the head-stock by a screw-clamp 200, (shown in Fig. 8,) which may be turned to draw the ears 201 of the bearing together and cause the bearing to bind on the quill. The only time the quill and center are rotated is when the center is being ground. At all other times the center is stationary and the work turns on it, being rotated by a pin *r*, attached to the pulley, which engages a dog clamped to the work. The quill 72 is held in position with the pulley 73 seated against one end of the bearing by a screw-stud 77, threaded into the end of the quill and having a tapered head seated in a countersunk seat in the end of the quill, and a threaded extension 78, which is surrounded by a nut 79, having a flange 81, which rests against the other end of the bearing and is clamped in position by a set-screw 80, the nut 79 being partially divided by a deep transverse slot and the set-screw being extended through both sections and when tightened causing them to be sprung together and tightly grip the threads of the stud. The nut is adjusted to take up the wear between the ends of the bearing and the pulley and nut.

An important feature of the invention is the shape and arrangement of the outer surface of the quill, which forms the bearing for the pulley 73. As shown in Fig. 9, the end of the quill on which the pulley is mounted is tapered outwardly, and the bore of the pulley is similarly tapered. The side of the pulley is flush with the end of the quill and both are covered by the face-plate 74. This structure serves both to exclude grit from the bearing and afford a provision by which the pulley may be caused to seat always snugly on its bearing and run perfectly true, for when the bearing gets worn the face of the pulley needs only to be scraped off a little and the screws 75 tightened to make the pulley as snug as before. This cannot be done with a cylindrical bearing, and with a cylindrical bearing also grit is liable to work in, which is impossible with my construction, where even if grit should work in between the face-plate and quill it could not possibly get between the quill and the pulley, as the centrifugal force prevents it moving along the inclined surface toward the axis of the quill, and there is this further advantage that with this construction there is no possibility of the pulley running off the end of the bearing.

A cooling liquid, such as water, is delivered to the grinding-wheel 10 from a pipe 82, and from the wheel the waste water drops into a trough 83, formed on one side of the table 54 and having an outlet 84 near its middle portion, through which the water runs into the puddle-pan *p* in the knee 61, from which it overflows into the annular groove 85, formed in the base of the support 3, which constitutes a water-receptacle connected to the support, from which an opening 86 leads to a pipe 87, fastened to the bottom of the support and extending downward, then laterally outward through one side of the base 1. Through the channel thus formed the water is conducted away from the machine to a tank or other receptacle, from which it may be returned to the pipe 82 by a suitable pump. When work of small size is being ground, the carriage is in near enough to the support for the outlet 84 to be over the groove 85, and in such case the water drops directly into the groove; but usually the water falls first into the puddle-pan, which is wide enough, as shown in Fig. 14, to catch the drip from the trough in nearly all positions of the table. When the puddle-pan becomes full, the water runs over the gooseneck 94, which acts as a shield to prevent the water and grit working into the bearing between the knee and support, into the groove 85, and thence through opening 86 and pipe 87 to the tank. A large proportion of the grit is deposited by sedimentation in the puddle-pan, so that only a small amount passes with the water to the pump. To protect the platen *c* from the water and grit thrown off from the grinding-wheel, there is provided a shield 88, attached to a bar 90, supported in standards 91 92, carried by the bases of the head-stock and foot-stock, respectively, the base of the head-stock being extended so that the location of the standard 91 thereon is far enough away from the head-stock to permit free rotary adjustment of the latter. The shield 88 extends rearwardly downward over the edge of the platen *c*, so that all the water which would otherwise fall on the platen is caught by the shield and caused to run off into the trough 83. Similar protection is afforded the cross-feed screw 66 by a shield 93, which is attached to the nut 67 and surrounds the screw.

In some classes of work it is necessary to grind out an internal opening, and in such cases the auxiliary wheel shown in Fig. 4 is used. At one side of the standard 6 is an arm 95, having a stud 951 formed on it, which is

seated in a bore in the standard 6 and forms a pivot for the arm. A pin 96 passes through the arm and standard and screws into a nut 97, fastened to the standard on the other side. The pin is formed with a shoulder bearing against the arm and with a handle 98, by which the pin may be turned, so as to force its threaded end farther into the nut and press the shoulder against the arm, clamping it in position for operation, as shown in Figs. 3 and 4, or in the inoperative position. (Shown in Fig. 2.) The free end of the arm 95 has an opening in which may be clamped a sleeve 99, carrying journaled therein a spindle 100, which is provided with an internal grinding-wheel 101. The spindle 100 is driven at a high rate of speed from a pulley 104, substituted on the spindle *d* in place of the grinding-wheel 10 when this tool 101 is used, through a belt 103 passing over the said pulley and a pulley 102 on the spindle 100. When work of this character is being performed, the center *h* of the head-stock is removed and a chuck 105, capable of holding the work, substituted therefor. Other tools as well as the wheel may be used. For instance, a stud may be inserted in the arm and a cutter which is to be ground mounted on the stud. The cutter is turned on the stud to bring each tooth in succession to the grinder and moved from side to side to grind off the whole width of the tooth.

A lug 112 is formed on the hub portion of the arm 95, extending in the opposite direction beyond the pivot, and to the lug is secured a stud 113, which acts as a holder on which a guide for holding a twist-drill while being ground may be mounted.

It will be seen that the base 52 of the foot-stock is formed with a lateral ledge or lip 520, which extends horizontally toward the head-stock, being located in line with the head and foot stocks. This ledge is adapted to receive an auxiliary tool-holder 107, which normally rests on the ledge and is secured thereto by a bolt 108, passing through a slot 109 in the base of the holder and engaged in a tapped hole in the ledge. By loosening the bolt the tool-holder may be adjusted, and by removing the bolt the holder may be entirely disconnected from the foot-stock; but as a general thing the holder is allowed to remain on the ledge 520. This holder is adapted to support one of a variety of auxiliary tools, such as a pawl or stop for engaging and holding such work as a cutter while its teeth are being ground, or various kinds of work, such as edged tools, which cannot be supported between the head and foot stocks or carried by the head-stock alone, may be mounted upon the holder. A further use for which the holder is adapted is to support a diamond 106 for truing off the working face of the grinding-wheel. When it is necessary to true or square off the face of the grinding-wheel, the holder 107 is adjusted so that the diamond is in position to engage the face of the wheel, the latter is set in motion, and the foot-stock is moved past the wheel. When tapered work is to be ground, the face of the wheel may be trued on the same angle as the line of feed. So far as I am aware I am the first person to provide the foot-stock of a grinding-machine with means by which auxiliary tools may be carried by the foot-stock and also the first to provide a means on the foot-stock for holding work independently of any other support.

It will be seen that by the construction described I have provided a very strong and rigid machine. The base 1 being wide and comparatively low affords a firm foundation, and the support 3, having the wide base 63 securely fastened to the base-piece 1 and short tapered column and the standard 6, tightly screwed into the support, constitute an exceptionally rigid superstructure. The standard 6 is made with considerable thickness at its lower part the better to resist stresses tending to spring it rearward. The parts just enumerated form a machine-frame which is stationary at all times and never affected by any adjustments of the tool and work holders, as the holders are adjustably mounted on guides rigidly connected to the frame instead of being rigid with adjustable parts of the frame, as is the case with all the machines now known. The working parts are therefore just as unyielding when in their extreme outward positions as when at their inner limits of adjustment and work can be done as accurately in one position as in the other. This is not the case in any other machine. Hitherto it has never been possible to grind the teeth of large reamers without removing them from the holder and grinding them separately or to grind large taps, snap-dies, &c., of over two feet in diameter with any considerable accuracy on account of the distortion to which the supporting parts of the machines now in use are liable when at their extreme limits of adjustment; but with this machine I can work as accurately on large pieces as on small ones—that is, within one ten-thousandth of an inch of the required size.

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

1. In a machine of the character specified, an adjustable spindle-head, a tool-spindle carried thereby, a belt passing over said spindle, means for actuating said belt, and means tending to separate the tool-spindle and actuating means for producing tension in said belt.

2. In a machine of the character specified, a standard, a spindle-head adjustably mounted on said standard, a tool-spindle rotatably mounted in said spindle-head, a shaft movably

supported with respect to said standard, a belt passing about said spindle and shaft, and automatic means for forcing said shaft away from said spindle to produce tension in said belt.

3. In a machine of the character specified, a standard, a spindle-head adjustably mounted on said standard, a rotatable spindle carried by said spindle-head, an arm pivotally connected with said standard, a pulley mounted on said arm and arranged to swing about the pivotal connection of the arm toward and away from said spindle, a belt passing about said spindle and pulley, and spring-pressed means arranged to move said pulley away from the spindle, whereby tension is produced in said belt.

4. In a machine of the character specified, a standard, a spindle-head adjustably mounted on said standard, a rotatable spindle carried by said spindle-head, an arm pivotally connected with said standard, a pulley mounted on said arm, a belt passing about said pulley and spindle, a bar connected with said arm, and a spring carried by said bar and arranged to press against the standard and move the arm about its pivotal connection away from said spindle.

5. In a machine of the character specified, a standard, a spindle-head adjustably mounted on said standard, a rotatable spindle carried by said spindle-head, an arm pivotally connected with said standard, a pulley mounted on said arm, a belt passing about said pulley and spindle, a bar connected with said arm, a spring carried by said bar and arranged to press against the standard and move the arm about its pivotal connection away from said spindle, and means for adjusting the bar relatively to the arm.

6. In a machine of the character specified, a standard, a spindle-head mounted adjustably on said standard, means for adjusting said spindle-head, comprising a screw-threaded rod and a nut surrounding said rod, one of said last-named parts being connected to the spindle-head and the other to the standard, and means for indicating the adjusted position of the spindle-head, comprising a graduated scale connected with the rod, and a second scale surrounding the rod connected with the nut and constructed to measure fractions of the divisions of said first scale.

7. In a machine of the character specified, a standard, a spindle-head adjustably mounted thereon, a rod connected to the spindle-head and provided with a screw-threaded portion, a nut supported by the standard and arranged to engage the threaded portion of the rod, whereby the spindle-head may be adjusted on the standard, a scale formed on the rod for indicating the adjusted position of the spindle-head, and a second scale secured to the nut, surrounding the rod, and provided with divisions arranged to indicate fractions of the divisions of said first scale.

8. In a grinding-machine, a tool-spindle having a tapered portion, a grinding-wheel, a wheel-bushing constructed to carry the grinding-wheel and formed with a tapered bore to engage the tapered portion of the spindle and provided with flanges having slots, and a key mounted in said tapered portion projecting into a slot in the bore of said bushing.

9. In a machine of the character specified, a base, a one-piece support having an integral extended flange secured directly to said base and a central tapered column, a standard rigidly connected to said column, and a grinding-wheel adjustably mounted on said standard.

10. In a machine of the character specified, a base member having a flat upper surface, a support comprising a wide base portion and a short tapered column having a threaded portion mounted on the upper surface of the base member and rigidly secured thereto, a standard having a threaded lower part engaged with the threaded portion of the support, a guideway secured to said standard, and a spindle-head mounted on said guideway.

11. A grinding-machine comprising a base, a support provided with a longitudinal aperture resting upon said base, means for securing said support to said base, and a standard detachably connected to the support, so constructed and arranged that removal of the standard will give access through said aperture to said securing means.

12. In a machine of the character specified, a bed or platen having a plane top and a longitudinal V-shaped groove and a head-stock supported on the bed or platen and provided with a rib projecting into and bearing against the sides of said groove.

13. In a machine of the character specified, work-holding means comprising a head-stock, a base-plate, a support having a longitudinal V-shaped groove, a rib on the base-plate projecting into said groove and bearing against the sides thereof, and a pivotal connection between the head-stock and base-plate.

14. In a machine of the character specified, a frame, a work-holding carriage, a member mounted on the frame, having a guide for said carriage, and separated parallel webs or brackets formed on said member and connected to the guide for the carriage beneath the same.

15. In a machine of the character specified, a frame, a work-holding carriage, a member mounted on the frame, having a guide for said carriage, and separated parallel webs or brackets formed on said member projecting laterally to as great an extent as said guide and connected thereto beneath the same to support the guide and the carriage, the under edges of the webs being convexedly curved.

16. A grinding-machine comprising a frame, a member adjustably mounted thereon and provided with laterally-extending vertical webs or brackets separated by a space, guides mounted on and supported by said brackets,

a nut connected to said member in the space between the brackets, a work-holding carriage slidably mounted on said guides, and adjusting means carried by said carriage in engagement with said nut.

17. In a grinding-machine, a frame provided with an annular bearing, and an annular member mounted on said bearing for swiveling motion thereon and having laterally-extending vertical webs or brackets separated by a space, guides mounted on and supported by said brackets, a nut connected to said annular member in the space between the brackets, a work-holding carriage slidably mounted on said guides, and adjusting means carried by said carriage in engagement with said nut.

18. In a grinding-machine, a frame provided with adjacent annular flanges having extended horizontal and vertical bearing-surfaces, an annular member or swivel-knee provided with a complementary vertical bearing-face and a lateral flange having a horizontal bearing-surface mounted on the frame in engagement with said bearing-faces, whereby said member is enabled to be moved rotarily about said frame, and a guideway secured to said annular member for carrying the work-supporting slides of the machine.

19. In a grinding-machine, a frame provided with adjacent annular flanges having extended horizontal and vertical bearing-surfaces, an annular member or swivel-knee provided with a complementary vertical bearing-face and a lateral flange having a horizontal bearing-surface mounted on the frame in engagement with said bearing-faces whereby said member is enabled to be moved rotarily about said frame, clamping means engaged with said lateral flanges adapted to force said horizontal surfaces into frictional engagement to hold said annular member in adjusted position, and a guideway secured to said annular member for carrying the work-supporting slides of the machine.

20. In a grinding-machine, a frame provided with adjacent annular horizontal and vertical bearing-surfaces, an annular member or swivel-knee provided with complementary bearing-faces mounted on the frame in engagement with said bearing-faces, whereby said member is enabled to be moved rotarily about said frame, a guideway secured to said annular member for carrying the work-supporting slides of the machine, and webs or brackets connected to said annular member and said guideway for rigidly supporting the guideway and slides.

21. In a machine of the character specified, a head-stock provided with a bearing, a quill journaled in said bearing and having a central bore for holding a center, means for rotating the work, comprising a pulley mounted on the quill with provisions for detachable connection thereto, means having a threaded engagement with the bore of the quill adjacent its end for adjusting, and means for clamping said quill in the bearing.

22. In a machine of the character specified, a head-stock having a bearing, a quill journaled in said bearing and having provisions for holding a center, a pulley loosely mounted on said quill, and means for detachably securing said pulley to said quill, comprising a plate extending across the end of the quill and covering the junction between the pulley and quill detachably secured to the pulley and the quill.

23. In a machine of the character specified, a head-stock having a bearing, a quill or spindle rotatably mounted therein and provided with a conical external bearing portion at its end, the greatest diameter of said conical portion being at the end of the quill, a pulley having a complemental internal bearing-surface freely rotatable on said conical portion, and means connected to said pulley for taking up wear in the conical bearing.

24. In a machine of the character specified, a head-stock, a quill mounted in said head-stock, the outer surface of the quill being formed with a conical portion tapering inward from the end toward the center of the quill, forming a bearing, a pulley having a tapered bore mounted on the quill in engagement with the tapered portion thereof, and a face-plate secured to the pulley and extending over the end of the quill.

25. In a machine of the character specified, a head-stock, a quill mounted rotatably in said head-stock, the head-stock having provisions by which the quill may be held stationary, the external surface of the quill being formed with a cylindrical portion and a conical portion flaring outward toward the end of the quill, a pulley mounted on the conical portion of the quill for rotation thereon, a face-plate secured to one side of the pulley and extending over the end of the quill covering the line of division between the pulley and quill, means for detachably connecting the face-plate to the quill, and a center mounted in the quill and extending through an orifice in the face-plate.

26. In a machine of the character specified, a machine-support, a grinding-tool carried thereby, a work-holding table mounted for rotary adjustment about the support, means for supplying water to the tool, and provisions for receiving and leading away the waste water, comprising a trough connected to the table and having an outlet, a water-receptacle connected with the support surrounding the same and located to receive the water falling from the outlet of the trough, and a pipe connected with said water-receptacle.

27. In a machine of the character specified, a machine-support, a grinding-tool carried thereby, a work-holding table, a support for the table, comprising an annular member surrounding the machine-support and adjustably

carried thereby, whereby the table may be moved rotarily about the machine-support, means for supplying water to the tool, and provisions for receiving and leading away the waste water, comprising a trough connected to the table and having an outlet, an annular water-receptacle connected with the machine-support and located below the trough-outlet, and a pipe connected with said water-receptacle.

28. In a grinding-machine having a grinding-tool and a water-supply therefor, a machine-support having a central column and a vertical rib surrounding the column and forming between the rib and column an annular groove, an annular knee mounted swivelly on said support, and provided with a rib in engagement with the rib on the support, and a water-receptacle adjacent the rib, a work-holding table mounted on said knee and having a trough connected thereto and provided with an outlet located above said water-receptacle, and a pipe carried by the machine-support and connected to the water-receptacle of the support, the trough, water-receptacle, groove, and pipe constituting a water-lead for carrying away the waste water.

29. In a grinding-machine, a support having an extended base formed with an annular bearing on its upper surface, a central column, a grinding-wheel mounted on the column, means for supplying water to the wheel, an annular vertical rib formed on the base of the support adjacent the annular bearing and forming between itself and the column an annular groove, a pipe carried by the support and connected with the groove, an annular knee mounted swivelly on the bearing aforesaid and formed with a vertical rib in contact with the rib on the support, and a depression or puddle-pan adjacent the rib, a work-holding table carried by the knee, a trough connected to said table and formed with an outlet located above said puddle-pan, and a flange or gooseneck connected to the annular knee and extending over the rib and into the groove on the support, for excluding water and grit from the bearing between the support and knee, the trough, puddle-pan, groove, and pipe constituting provisions for receiving and leading waste water away from the machine.

30. In a machine of the character specified, a grinding-tool, a bed, head and foot stocks having base portions resting on said bed, the head-stock being separate from its base and pivoted for rotary adjustment thereon, supports held on the base portions of said head and foot stocks, respectively, the head-stock base portion being extended beyond the swivel head-stock and the support thereon placed free of the head-stock, whereby interference of the swivel head-stock with the support is avoided and free rotary movement of the head-stock permitted, a bar held in said supports, and a shield connected to said bar and extending downward over one edge of the bed.

31. In a machine of the character specified, a grinding-tool, a work-holding carriage, a feed-screw for said carriage, and a detachable shield projecting over said feed-screw to protect the screw from water and grit falling from the grinding-tool.

32. In a machine of the character specified, a standard having a bore, a nut fixed to said standard in line with the bore, an arm having a stud thereon mounted in the bore, and a screw extending through said arm, threaded into said nut and having a portion bearing on the arm for clamping said arm in position.

33. In a machine of the character specified, a standard, a nut secured thereto, an arm having a hub portion pivotally mounted on the standard, a screw extending through said hub portion, threaded into said nut and having a shoulder engaging the outer surface of the hub portion, a lug formed on the hub portion, and a stud carried by the lug for supporting work.

34. In a machine of the character specified having a bed and a head-stock supported thereon, a foot-stock adjustably mounted on the bed and consisting of a base portion and a standard, the base portion formed with a projection extending toward the head-stock, having provisions for holding an auxiliary tool.

35. In a machine of the character specified having a bed and a head-stock supported thereon, a foot-stock adjustably mounted on the bed having a base formed with a projecting ledge extending from the foot-stock in line with the head-stock, and a tool-holder detachably and adjustably mounted on said ledge, the tool-holder having provisions for carrying an auxiliary tool.

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

JOHN BATH.

Witnesses:
ALVAH M. LEVY,
ARTHUR L. GOODWIN.