No. 720,912. PATENTED FEB. 17, 1903.

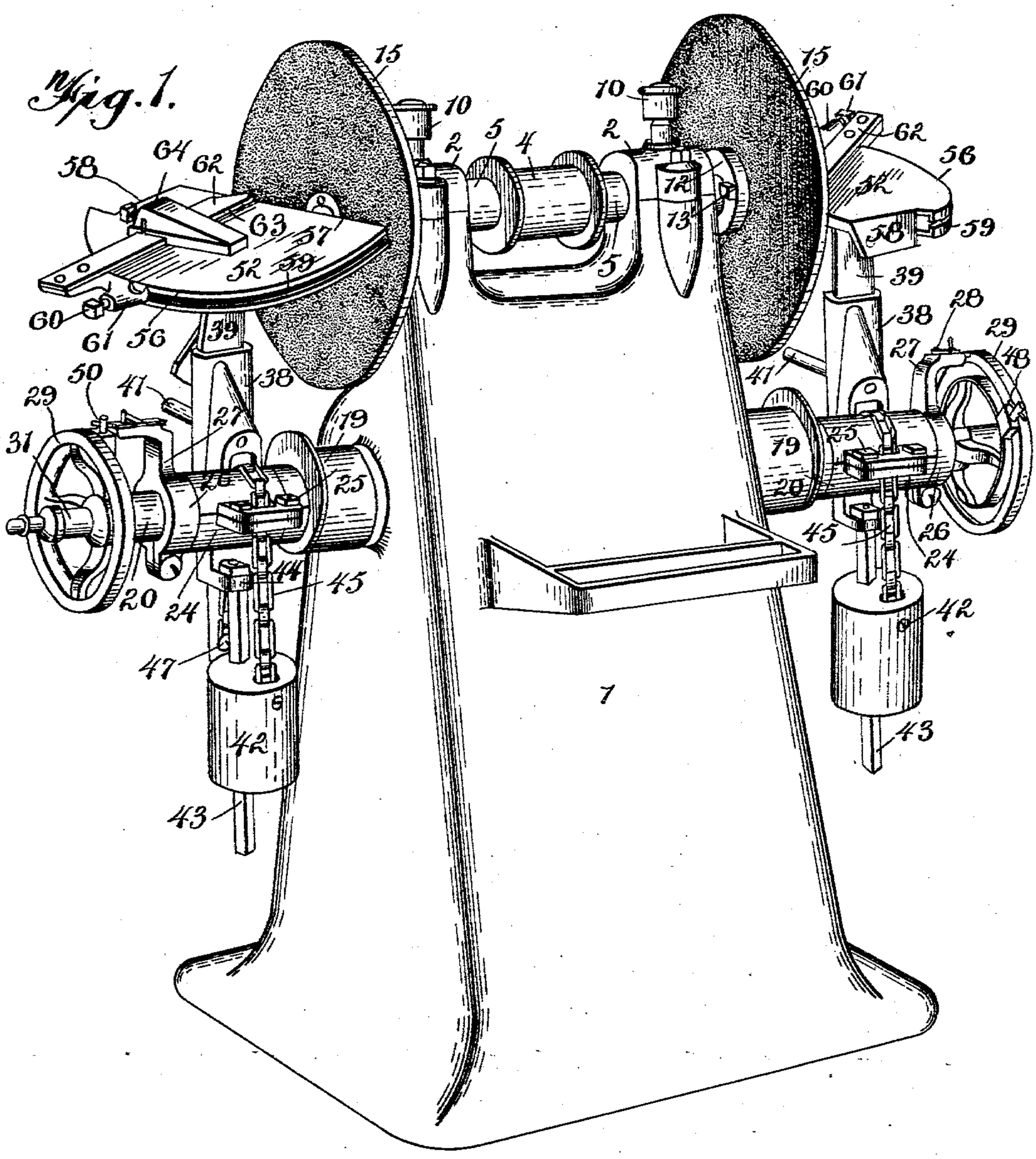
G. GORTON.

FLAT SURFACE GRINDING MACHINE.

APPLICATION FILED MAR. 27, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2.

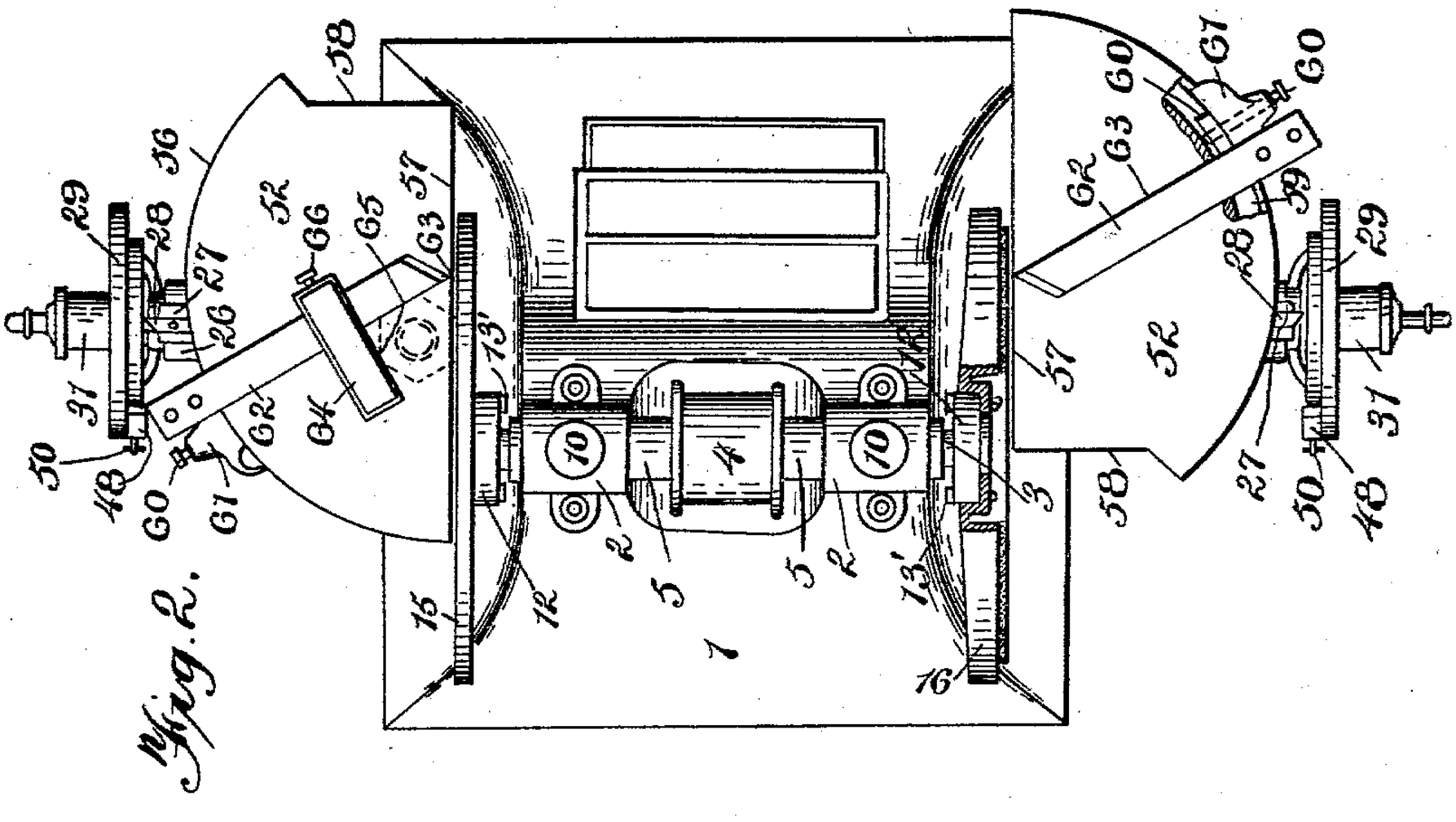
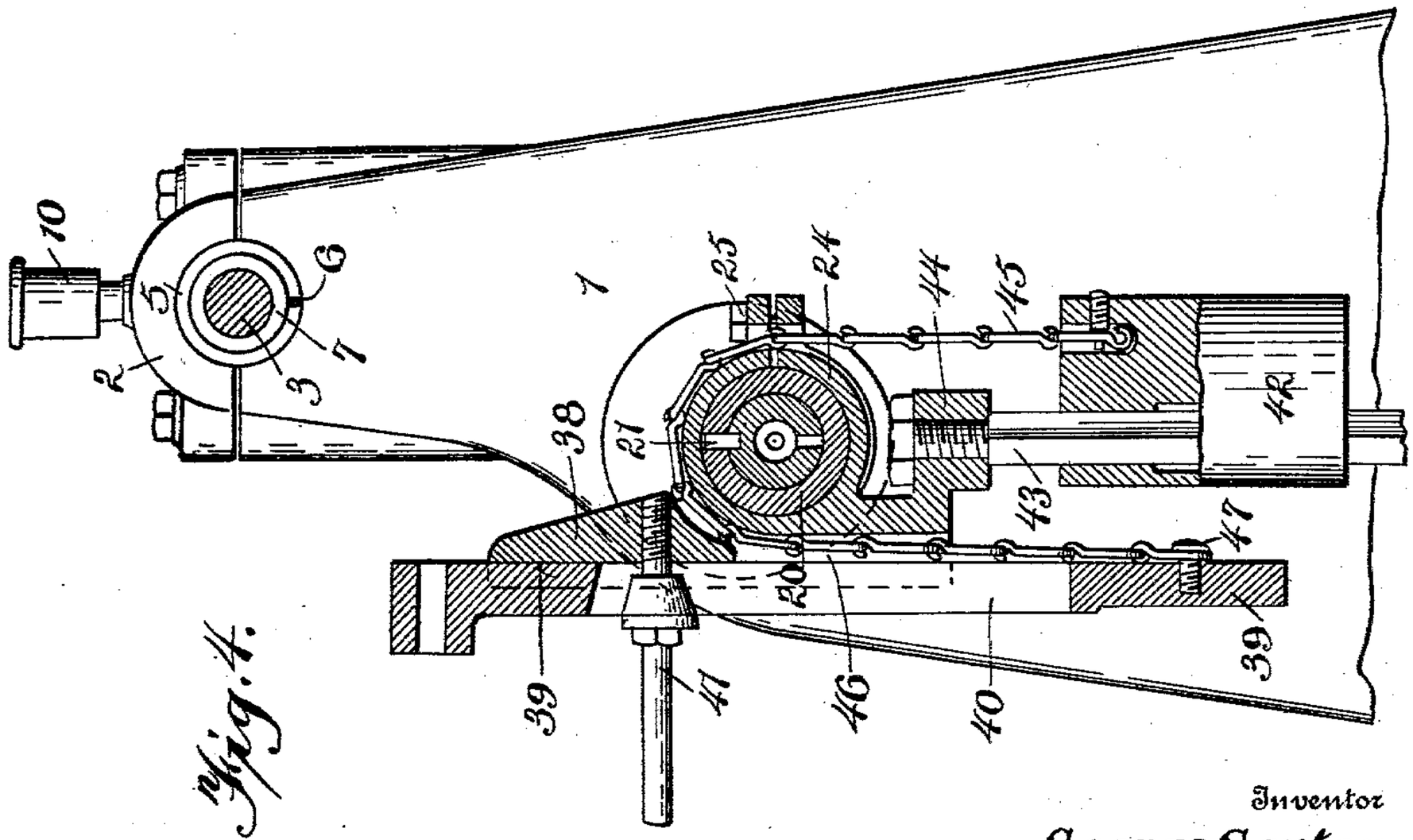


Fig. 4.



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NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.

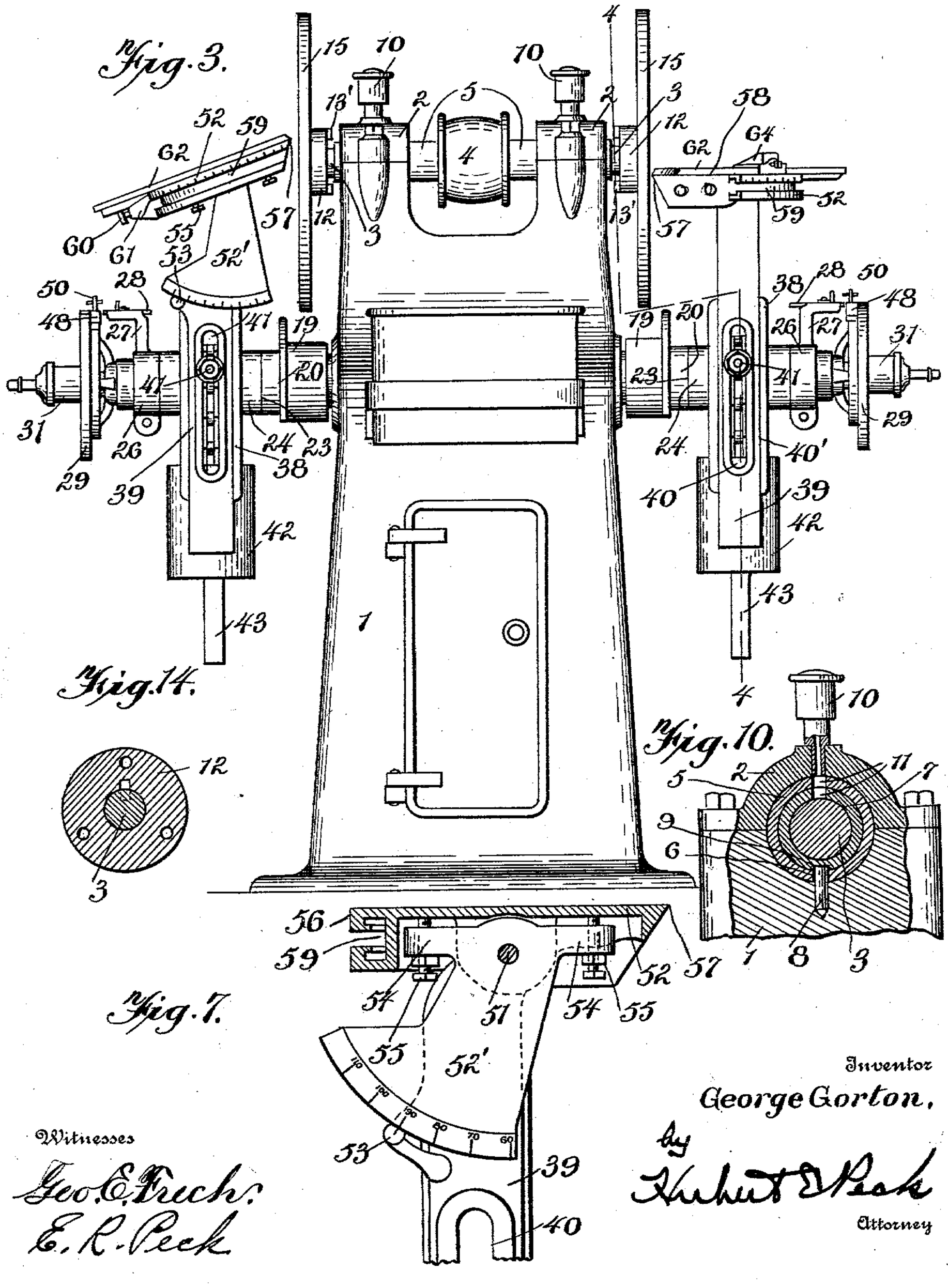

Fig. 14.

Fig. 10.

Fig. 7.

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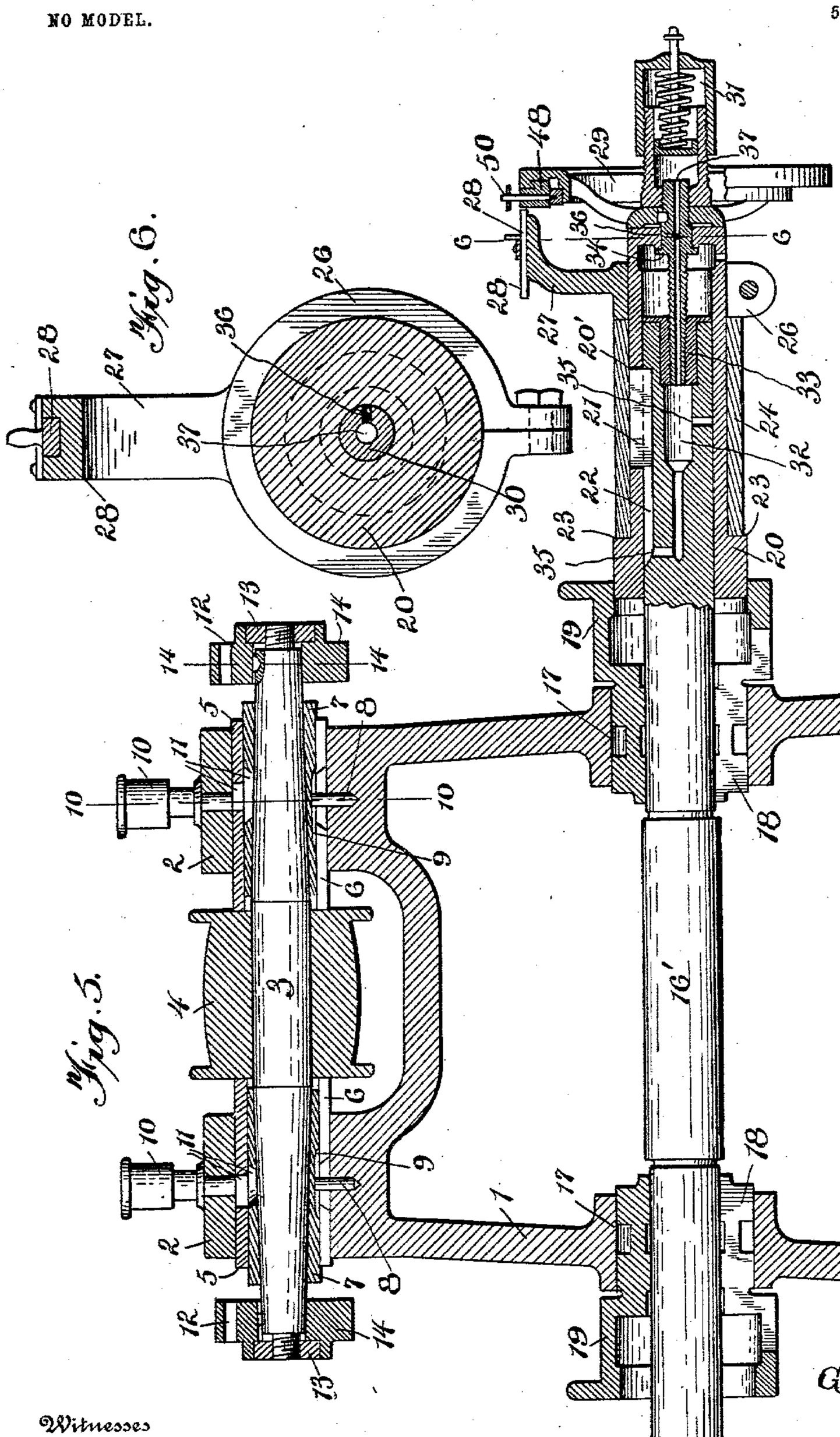
NO MODEL. 5 SHEETS—SHEET 4.



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NO MODEL. 5 SHEETS—SHEET 5.

Fig. 8.

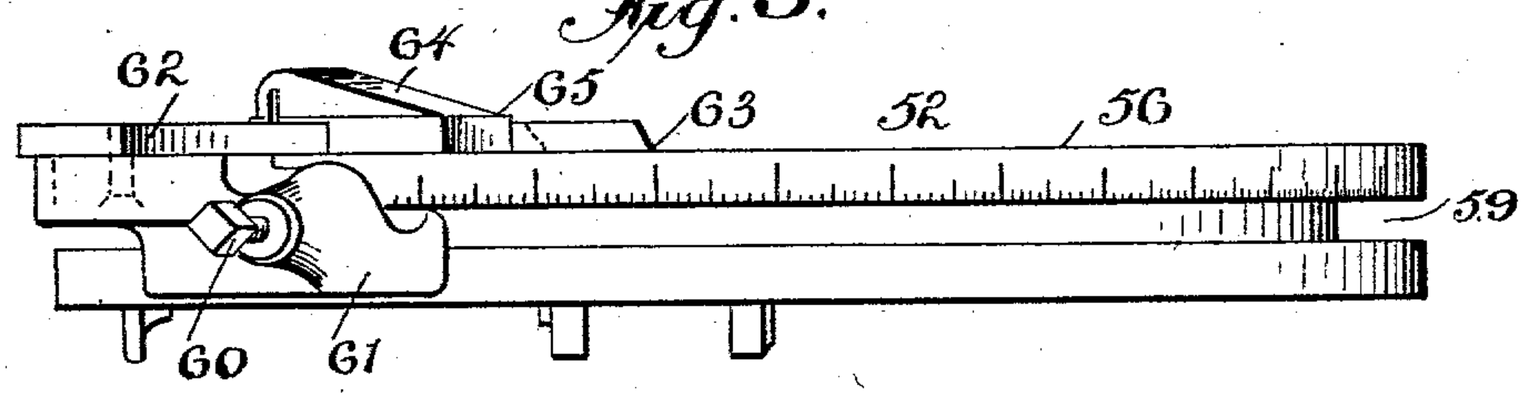


Fig. 9.

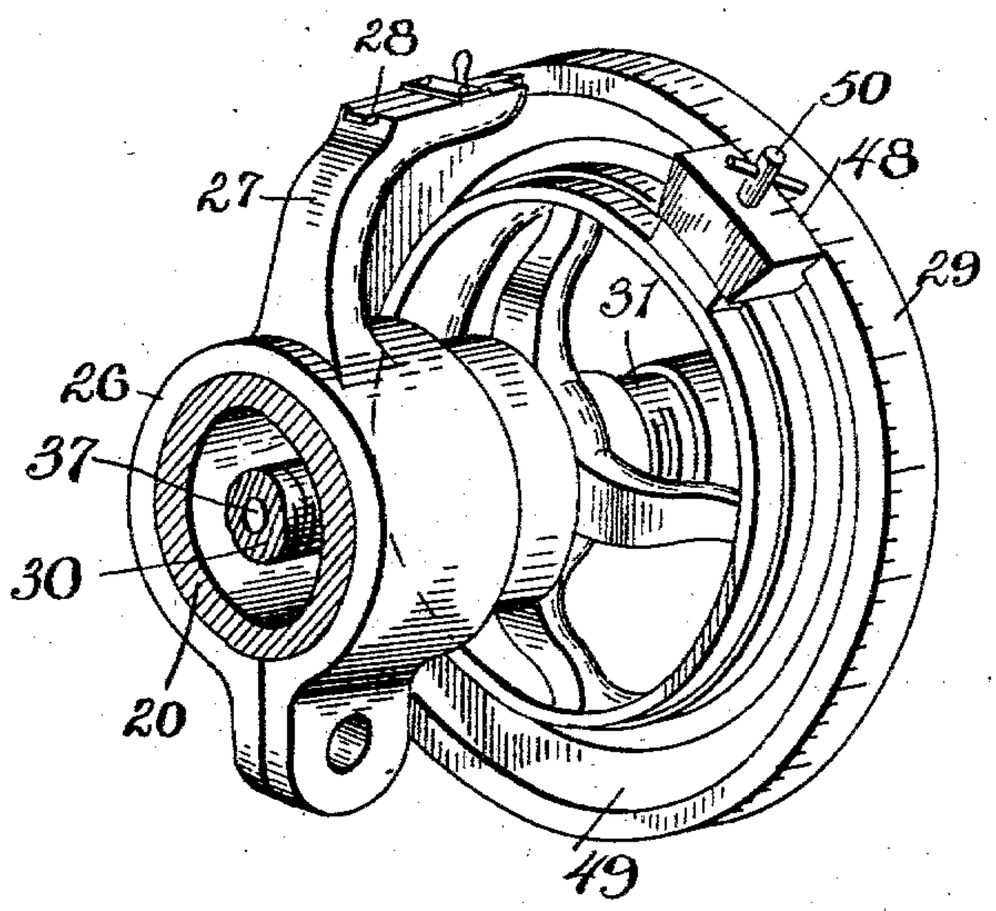


Fig. 11.

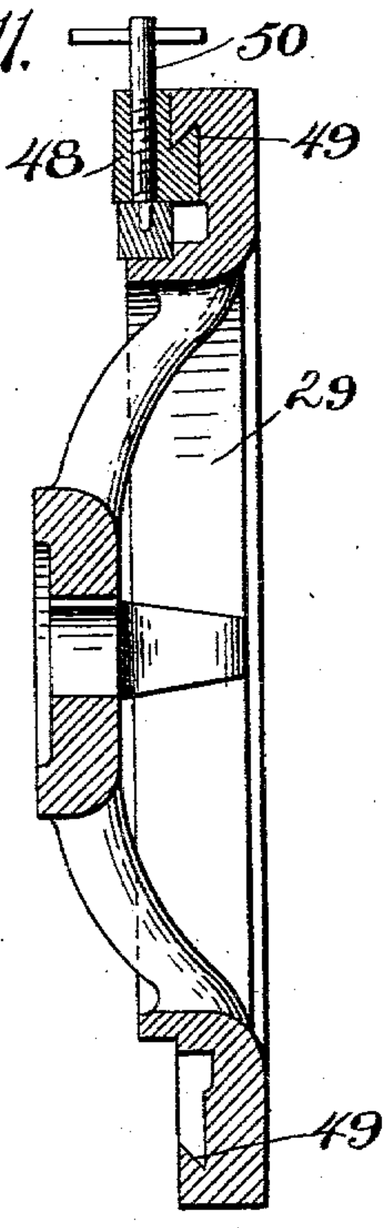


Fig. 12.

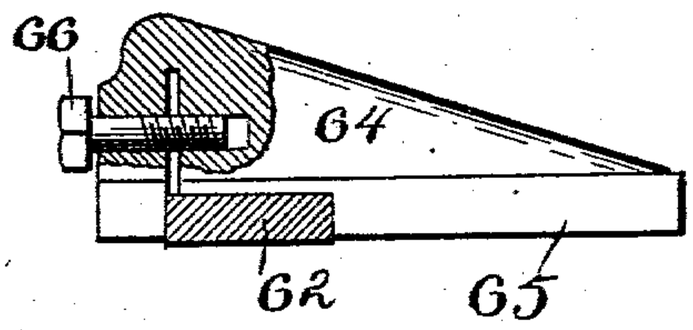
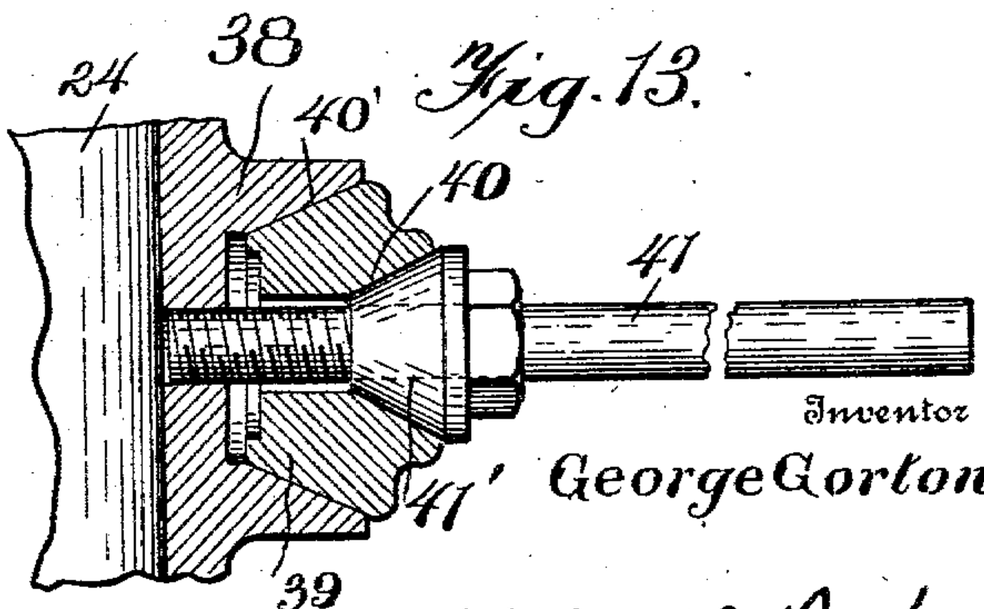


Fig. 13.



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UNITED STATES PATENT OFFICE.

GEORGE GORTON, OF RACINE, WISCONSIN.

FLAT-SURFACE GRINDING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 720,912, dated February 17, 1903.

Application filed March 27, 1902. Serial No. 100,275. (No model.)

To all whom it may concern:

Be it known that I, GEORGE GORTON, a citizen of the United States, residing at Racine, Racine county, State of Wisconsin, have invented certain new and useful Improvements in Flat-Surface Grinding-Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to certain improvements in grinding or polishing machines, and relates more particularly to flat-surface grinders or what are generally known in the trade as "disk" grinders.

An object of the invention is to provide certain improvements in bearings or mountings for the arbor of a flat or circular surface grinding-machine wherein the arbor carries one or more vertically or otherwise disposed grinding-surfaces, usually circular disks or chucks rigidly secured to both outer ends of the arbor and carrying the abrading or grinding surfaces, the work being applied to the abrading-surfaces at the outer faces of said disks or chucks, a table or other fixture or support being provided for each abrading disk or surface to hold the work.

Another object of the invention is to provide an improved flat or curved surface grinding-machine having an improved, durable, comparatively dust-proof, and perfectly lubricated feed device for the work-table or other support carrying the work and forcing the same to the rapidly-rotating abrading-surface.

Another object of the invention is to provide improved means in a flat or curved surface grinder for maintaining an oscillating and vertically-adjustable work-table automatically balanced, whatever the vertical or lateral adjustment thereof.

Another object of the invention is to provide a flat or curved surface grinder having a vertically-adjustable work-table with an improved automatic counterbalancing mechanism which will uphold the work-table, even though the supporting and adjusting parts are loosened to permit vertical adjustment.

Another object of the invention is to provide a flat or curved surface grinder with improved, simple, and very efficient and accurate swinging vertical and angular adjusting mechanisms for a work table or support.

Another object of the invention is to provide a flat or curved surface or disk grinder with an improved segmental work-table and holding devices, whereby most accurate angular adjustments can be attained where careful accurate work is required or surfaces must be finished at accurate angles.

A further object of the invention is to provide certain improvements in parts and details with the end in view of producing an accurate, highly-efficient, flat or curved surface or disk grinder with perfection of oiling arrangements and practically dust-proof working bearings and parts.

The invention consists in certain novel features in construction, in combinations, and in arrangements of parts and details, as more fully and particularly pointed out and specified hereinafter.

Referring to the accompanying drawings, which show merely for purposes of illustration and explanation certain constructions as examples from among other arrangements within the spirit and scope of my invention, Figure 1 is a perspective view of a flat or curved surface grinder embodying various features of my invention, the work-table opposite one grinding-surface being shown arranged horizontally and at right angles to the plane of the abrading or grinding surface, the table opposite the other abrading-surface being shown tilted with respect thereto. Fig. 2 is a top plan view of the machine, showing both work-tables in the horizontal position and provided with protractors, the protractor of one table having a square head clamped thereto, dotted lines indicating a hexagonal nut held in proper position by the protractor and its square head for accurate finishing by the abrading-surface, the other table being partially broken away, one grinding-head being partially broken away to show a grinding-ring clamped therein, while the other grinding-head is composed of a steel or other metal disk having a flat abrading sheet or surface applied thereto. Fig. 3 is a front elevation of the machine of Fig. 1 looking at the opposite side from that appearing in Fig. 1. Fig. 4 is a vertical section on the line 4 4, Fig. 3, showing the counterweight and mech-

anism for permitting oscillation and vertical adjustment of the table. Fig. 5 is a vertical detail section taken longitudinally of the counter-shaft or disk arbor and also longitudinally of the stud and feed mechanism, one end of the stud being broken away, the tables and counterweight mechanism not being shown. Fig. 6 is a detail vertical section on the line 6 6, Fig. 5. Fig. 7 is a detail sectional elevation showing the table, its quadrant, and a portion of the upright or slider carrying the table. Fig. 8 is a detail edge elevation of the table, showing the protractor-head and the protractor square head clamped thereon. Fig. 9 is a detail perspective view bringing out the details of the hand feed-wheel and the stop mechanism therefor. Fig. 10 is a cross-section on the line 10 10, Fig. 5, through an arbor-bearing and journal-box. Fig. 11 is a detail diametrical section through the hand feed-wheel. Fig. 12 is a detail section through a protractor-blade, showing a square head clamped thereon and partially broken away. Fig. 13 is a detail cross-sectional view through the cross or hub head and the vertical plate carrying a work-table, showing the clamping means. Fig. 14 is a cross-section on the line 14 14, Fig. 5.

In the drawings, 1 is a suitable pedestal having a head-stock. The pedestal and head-stock can be cast in one piece, the pedestal being hollow, substantially as shown. The head-stock is provided with journal-boxes 2 2, receiving the horizontal rotary arbor 3, said arbor at its opposite ends, carrying the vertically-disposed grinding-disks. Two separated journal-boxes are shown, so that the central portion of the arbor between said boxes can rigidly receive the belt-pulley 4, to which the driving-belt is applied. However, I do not wish to limit my invention to any particular means for applying the driving power to the arbor, as various arrangements other than the pulley shown can be employed for this purpose. For instance, the journal-boxes might be separated sufficiently and the head-stock be so formed as to receive an electric or other motor, so that the power will be directly applied to the arbor. In the example shown each journal-box has a removable top cap or section, as usual, secured down on the rigid portion of the head-stock, forming the under section of the box, or by two bolts or machine-screws. However, I do not wish to limit my invention to either a split or non-split journal-box, but clamping or holding means for the bearing-sleeves should be provided. The journal or bearing portions of the arbor are tapered from the central portion thereof, carrying the pulley to the outer ends—that is, the end portions of the arbor taper in opposite directions to form conical bearings, while the opening through each journal-box is cylindrical. The two bearing and journal portions of and for the arbor are similar, so that a description of one will apply to the other, and it will here be stated that so far as I am at present advised I do not wish to limit my invention to the double type of machine—that is, an arbor carrying two oppositely-arranged grinding-disks and work-tables and supporting devices opposite said grinding-surfaces.

5 is a split adjustable end-thrust bearing-bushing fitting the inner surface of the journal-box and extending longitudinally through and beyond the same. The inner end of this bushing preferably abuts against the end face of the pulley 4 or collars provided for that purpose. This bushing 5 is usually cylindrical exteriorly and internally and snugly fits the inner surface of the journal-box, with the longitudinal split 6 throughout the length of the bushing arranged at the bottom thereof or otherwise. The internal diameter of this bushing is greater than the greatest external diameter of the conical journal of the arbor.

7 is a preferably, although not necessarily, unsplit metal bearing-sleeve tightly fitted longitudinally within the bushing 5 and usually projecting beyond the outer end thereof. This bearing-sleeve is exteriorly cylindrical to conform to the interior of the bushing, while the interior of the sleeve is longitudinally tapered to conform to the tapered journal of the arbor, which rotates in said sleeve. The bushing and sleeve are held against axial movement by any suitable means. For instance, I show a pin 8 inserted in the bottom of the journal-box and projecting upwardly at the central portion of the box radially of the arbor and through the bottom split of the bushing and into a shallow longitudinal groove 9 in the exterior bottom face of the bearing-sleeve. The groove 9 is elongated to permit the longitudinal adjustment of the tapered sleeve in the box and on the taper of the arbor to take up wear and secure the desired adjustment of the bearing. The inner end of the sleeve 7 preferably does not extend inwardly to the pulley, but terminates a distance back within the bushing.

10 is a lubricant-cup screwed into the top of the journal-box, which has a duct for the lubricant coinciding with registering longitudinal slots 11 11, opening radially through the bushing and sleeve to the taper of the arbor to freely supply the necessary lubricant to the bearing. The openings 11 11 are in the form of longitudinal slots to permit the longitudinal adjustment of the bushing and sleeve.

The bushing 5, abutting against the side face of the pulley or a collar or other stop on the arbor, takes up the end thrust, and the sleeve and bushing can be adjusted independently and longitudinally by loosening the screws contracting the journal-box or other bearing clamping means. When the journal-box screws are tightened, the split bushing is thereby contracted around the tapered bearing-sleeve and rigidly clamps the same in the desired position. The end of the arbor projecting outwardly beyond said bearing-sleeve

receives the collar 12, to which the grinding or abrading surface carrier is secured. The collar slips on the tapered projecting arbor end and is held to revolve therewith by suitable means, such as a key, fixed to one part and entering a longitudinal groove in the other part. The collar is retained on the arbor end by suitable means—for instance, by a nut 13, screwed on the projecting reduced threaded end of the arbor and entering a recess in the outer end or face of the collar. The outer end of the collar is annularly rabbeted to receive the center of the disk or chuck carrying the abrading-surface and to form the annular shoulder 14, on which the annular edge of the bore of the chuck or disk rests. The collar is shown formed with longitudinal holes to receive the screws or bolts clamping or securing the grinding disk or chuck on the collar. Flat circular sheet-metal disks 15, having their flat faces covered or coated with grinding or abrading material, can be removably secured on said collars, or other grinding-surface carriers or supports can be secured on said collars. For instance, large chucks or disks 16, carrying emery or other abrading-rings, can be employed. However, my present invention does not relate to the construction of the vertically or otherwise disposed rotary grinding or abrading head carried by the arbor, and I do not wish to limit myself to any particular construction in this respect. Suitable work carriers or tables are arranged at the outer or abrading faces of the vertically-disposed rotary grinding-heads, so that the work can be held to the abrading-surfaces, and these tables are preferably carried by adjustable devices and supports. In the example shown the supports at one side of the machine for one table are similar to those at the opposite side of the machine for the other table, so that the explanation of the supports for one table will apply to those for the other table, except that the right-hand table of Figs. 1 and 3 is not provided with the quadrant and is not intended for angular adjustment or tilting on its vertical plate or slider.

16′ is a strong rigid horizontal usually cylindrical stud or shaft extending transversely through and beyond the side faces of the pedestal at a distance below the arbor ends. The central portion of the stud between the side walls of the pedestal is usually enlarged or provided with shoulders just within the pedestal. The vertical walls of the pedestal where the stud passes therethrough are formed with enlarged alined openings 17. These holes are preferably formed cylindrical and elongated by surrounding flanges or hubs. The internal diameter of each hole 17 is larger than the exterior diameter of the portion of the stud within the hole, and the stud is rigidly fixed to the pedestal and within these holes against axial and longitudinal movement by the dust caps or shields having the longitudinally-split inner or bushing ends 18 and the enlarged outwardly-projecting ends 19. One dust-shield is provided for each hole 17, and the portion 18 of the cap fits tightly around the stud and is driven into the hole 17, with the split at the bottom, and is thereby contracted and clamped around the stud, most rigidly securing the same in the pedestal, with the enlarged cylindrical cap portion 19 projecting outwardly along the stud and having an internal diameter greater than the external diameter of the stud to the extent and for the purpose hereinafter appearing.

20 is a bearing and feed sleeve embracing and longitudinally movable on the projecting outer end of the stud and extending beyond the extremity thereof with its outer end closed. The inner end of this sleeve 20 is surrounded by the enlarged outer end 19 of the dust-shield, and the sleeve moves longitudinally of and within said rigid cap from its limit of outward movement to its limit of inward movement, and the cap snugly embraces the sleeve to prevent the entrance of grit and fine dust to the sleeve and onto the surface of the stud. Suitable means are provided to hold the sleeve against axial movement of the stud. For instance, the sleeve at its top portion and between its ends is shown formed with a radial slot therethrough and extending longitudinally thereof to receive the flat elongated sliding key 21, extending inwardly into an elongated longitudinal groove 22 in the top of the stud. The outer end of this groove 22 forms a stop against which the key abuts to limit the outward movement of the sleeve on the stud, and the groove extends inwardly of the stud and permits the full inward movement of the key and sleeve. The outer surface of the sleeve is reduced to form a cylindrical bearing and an annular stop-shoulder 23 at the inner end of the bearing. This bearing portion of the sleeve is embraced by a cross-head hub 24. This hub is so formed as to freely move axially on the sleeve or to be clamped rigidly to the sleeve against axial movement. These functions can be accomplished in various ways. For instance, I show the hub split and provided with laterally-extending separated ears connected by clamping bolt or bolts 25, so that the hub can be tightened and clamped on the sleeve or the bolts can be loosened sufficiently to permit the hub to turn axially on the sleeve. The inner end of the hub abuts against the shoulder 23 of the sleeve, while the hub is confined on the sleeve by the split collar 26, rigidly clamped on the projecting outer end of the sleeve. This collar 26 carries a rigid upwardly-projecting arm or bracket 27 at its upper end, carrying a sliding stop 28, arranged to be moved into or out of the path of a part of or member carried by the feed-wheel 29. This stop can be in the form of a block or plate confined in a slideway or groove transversely across the upper end of the arm 27, and the stop is shown provided with an upwardly-projecting handle by which the

stop can be moved. The feed-wheel is formed with a hub abutting against the outer end of the feed-sleeve 20 and slipped onto the projecting outer end of a feed-screw 30 and confined to turn therewith by a key usually rigid with said screw and projecting into a longitudinal groove in the wheel-bore. Suitable means are provided to secure the wheel on the feed-screw. As a means which can be employed for this purpose I show a lubricant-cup 31, preferably of the compression type, screwed on the outer end of the screw 30 and up against the feed-wheel hub. The feed-screw extends loosely through the outer otherwise closed end of the feed-sleeve and longitudinally of the sleeve and centrally and longitudinally into the outer end of the supporting-stud. The stud is formed with a central longitudinal passage or bore 32 to receive the screw and with a nut 33, fixed in the outer end of said bore and through which the screw works. The screw is provided with an annular stop or flange 34, abutting against the inner face of the end of the sleeve. Hence it is obvious that rotation of the hand-wheel revolves the screw and slides the feed-sleeve longitudinally of the supporting-stud inwardly and outwardly as the hand-wheel is turned to the right or left. In order to maintain perfect lubrication of the moving parts—viz., the sleeve on the supporting-stud and the cross-head hub on the sleeve—I can form the feed-screw with a longitudinal lubricant-supply duct 37 from the lubricant-cup 31 through the inner end of the screw and discharging into the passage or bore 32 within the stud. The stud is formed with radial lubricant-ducts 35 through the outer surface of the stud to lubricate the engaging surfaces of the stud and sleeve. One of the ducts 35 is shown discharging into the key-groove 22 to supply lubricant for the sliding key and also to supply lubricant through the slot in the feed-sleeve receiving the key 21 to the inner surface of the cross-head hub engaging the exterior of the feed-sleeve. The feed-screw is also provided with a small radial lubricant, opening 36 from the longitudinal duct 37 to the smooth-faced portion of the feed-screw forming the journal or bearing of the screw in the outer end of the feed-sleeve, and from which surfaces the lubricant will find its way to lubricate the engaging surfaces of the feed-wheel hub and outer surface of the feed-sleeve.

In the specific example shown the cross-head hub is integral with a vertically-disposed head 38, located to one side of the vertical plane of the stud and extending above and below the horizontal plane of the hub. The outer face of this head can be longitudinally grooved to form a guide or slide way to receive the slider-plate or supporting-leg 39, depending from and carrying the work-table. The said slide-plate has longitudinal slot 40 therethrough and in length equal to the extent of vertical adjustment of the work-table. Said slot is closed at its ends, and a clamping bolt or screw 41 passes through the slot and into the cross-head 38 to clamp the slide-plate and its table in the desired vertical adjustment. This screw 41 is extended outwardly to form a handle by which the cross-head can be rocked on the feed-sleeve when the cross-head hub is loosened to carry the work-table back and forth across the abrading-surface. If desired, the longitudinal slide or guide way of the cross-head 38 can be tapered or contracted inwardly by having its side walls transversely beveled. (See Fig. 13.) The longitudinal edges 40′ of the slider or table-carrying plate 39 are correspondingly beveled, and the arrangement can be such that the inner face of the slider 39 is located a distance from the floor of the groove or guideway of cross-head 38. (See Fig. 13.) When the bolt 41 or the nut thereof is tightened, the slider 39 is wedged into the tapered guideway and most firmly and rigidly locked in position. The beveled or inclined edges take up wear and are not seriously interfered with in performing their functions by the grit and fine dust thrown off during the grinding operations. To prevent the longitudinal walls of the slider yielding or springing toward each other, I show a tapered washer 41′ on the bolt and pressed into the slider-slot by the clamping-nut. This washer will support the side walls of the slider and press them outwardly against the parallel walls of the cross-head guideway. However, I do not wish to limit other features of my invention to this specific joint and clamping arrangement between the slider and cross-head.

A suitable counterbalancing device is employed to uphold or balance the slide-plate and its table when the screw 41 is loosened and also to automatically maintain a swinging balance whatever the vertical adjustment of the work-table and slide-plate. As a means which might be employed for this purpose I show a vertically-sliding counterweight 42, confined against lateral movement and guided in its vertical movement by a rigid depending elongated bar 43, usually angular in cross-section and passing through a correspondingly-formed hole extending longitudinally through the counterweight. This bar at its upper end is preferably, although not necessarily, detachably fastened to the cross-head by passing through a laterally-extending lug 44, rigid with the lower end of the cross-head and located a distance below the hub of said cross-head. The upper threaded end of the guide-bar 43 passes through said lug 44 and is secured by a nut on the upper end of the bar and located between the lug and hub.

45 is a flexible connection, such as a chain, at one end secured in or to the upper end of the counterweight and from thence passing upwardly and loosely through openings in the separated ears of the cross-head hub and from thence over the rounded top surface of

said hub and down at the opposite side thereof through a central vertical slot 46 in the cross-head and opening through the floor of the guideway therein. The lower end of the chain is detachably or otherwise secured at 47 to the lower end of the slide-plate 39, carrying the work-table. If desired, the chain can be readily released from the slide-plate and the weight thus allowed to drop from the guide-bar 43 with the chain, and the guide-bar can also be readily removed by unscrewing its securing-nut. The weight will approximately balance the slide-plate and table and uphold the same when the clamping-screw 41 is loosened. Also as the slide-plate is raised or lowered the counterweight automatically moves in an opposite direction, down or up, the chain sliding over the top face of the hub, and hence the parts are automatically balanced to swing on the feed-sleeve, and the parts can be easily and conveniently swung to carry the work-table back and forth across the abrading-face of the rotary grinder or head.

The hand feed-wheel 29, which is turned to move the work-table to or from the face of the rotary abrading-surface, is preferably formed with a graduated scale around its rim to indicate the feed. This scale reads in connection with a stop mechanism coöperating with the sliding stop 28, carried by a part rigid with the feed-sleeve. This stop mechanism comprises a sliding block 48, arranged at and projecting inwardly beyond the inner face of the rim of the hand-wheel and provided with a dovetailed base fitted in an annular dovetailed or undercut groove 49 in the inner side of said rim of the hand-wheel and extending completely around the said rim, so that said block when released can slide completely around the rim at the inner face thereof. The outer face or edge of said block usually has a mark to register with any one of the indicating-marks of the scale on the wheel-rim, so that the block can be moved to any mark indicating the distance it is desired to feed the work and can then be clamped to the rim. The block projects inwardly, so that when the sliding stop 28 is moved outwardly it will project into the path of said block and engage the same and stop the rotation of the feed-wheel when the work-table has been fed the desired distance. The block 48 can be provided with any desired clamping device, such as a hand-screw 50, passing through the same and provided with a head to clamp against the bottom wall of the groove receiving said block. The feed can be adjusted to a nicety by this device and is very effective where accurate work is required and in effect constitutes a micrometer-feed.

The upper end of the sliding plate 39, carrying the work-table, is provided with a transverse bolt-hole to receive the transverse clamping-bolt 51, securing the work-table 52 to said plate or bar. The upper end of the slide-plate 39 is located approximately under the center of the work-table and is secured thereto by said bolt 51, passing through transverse holes in a pair of ears or flanges depending from the under side of the table and preferably integral therewith. The arrangement is preferably such that said clamping-bolt 51 is parallel with the abrading-surface, so that when said bolt is loosened the straight edge of the table adjacent to and parallel with the abrading-surface can move vertically and maintain its parallelism with said surface as the flat top face of the table varies its angle with respect to said abrading-surface. If desired, a depending quadrant 52′ can be mounted on said pivot and clamping bolt 51 and depend beside the slide-plate 39, with its lower sector-shaped edge provided with a graduated scale, as shown, reading from the side of the quadrant by means of an indicator on a lug 53, rigid or integral with the slide-plate and which, if desired, can also serve as a guide for the lower curved edge of the quadrant. The scale of the quadrant is for the purpose of accurately setting the flat upper face of the work-table to any desired angle with respect to the vertical plane of the rotating abrading-surface. If desired, the clamping-bolt 51 can pass loosely through the upper end or hub of the quadrant 52′, and the said hub can be formed with laterally or horizontally extending arms 54 54, extending oppositely on diametrically opposite sides of the clamping-bolt and beneath the table. Screw-threaded openings extend vertically through the free ends of the arms and receive vertical adjusting or set screws 55 55, at their upper ends abutting against the under face of the table. By means of these screws the position of the quadrant with respect to the table can be most accurately set and adjusted. After the position of the quadrant has been accurately set the quadrant can, if desired, be clamped to the table and slide-arm by the clamping-screw, and the set-screws will maintain the quadrant and table in their proper relative positions when the clamping-screw is loosened to adjust the table to any particular angle. The work-table shown has a flat plain top face and a straight inner edge 57, maintained parallel with the abrading-surface, and the table is usually beveled from the under side to form a comparatively sharp inner edge to permit the table to move close up to the abrading-surface when tilted up to an abrupt angle. The outer edge 56 of the table is formed on the arc of a circle, preferably from one end of the straight inner edge around almost completely to the opposite end of said straight inner edge, although a straight edge 58, usually at right angles with the inner edge 57, can be provided, if desired, extending from one end of the edge 57 to one end of the curved edge 56. The table can be formed with a depending flange at said outwardly-extending straight edge 58 for the application of any special fixtures which an opera-

tor may desire to attach to the table to receive or hold special or peculiar work. The center of the circle in which the curved edge 56 is included is preferably located at an intermediate point in the length of the straight inner edge 57. A horizontally-disposed T slot or undercut or dovetailed groove or channel 59 is formed in and throughout the length of the curved edge of the table and opening outwardly through the vertical edge thereof below the flat top face of the table. This channel is formed to receive the shank and head or nut of a clamping-bolt 60, passing through a protractor head or block 61 and accessible from the exterior thereof, so that the bolt can be tightened to rigidly clamp the block at any particular point in the length of the slot or loosened, so that the block can be moved to any point within the length of the curved edge. This protractor-head has an outwardly and upwardly extending portion on which the outer end of the flat straight protractor-blade 62 is rigidly secured. This blade is usually rectangular in cross-section, with flat upper and lower faces, and rests on the flat upper face of the table and extends inwardly along said face to the inner edge thereof. If desired, the inner end of the protractor-blade can be beveled off laterally from its rear side edge to a point, so that the front work-engaging edge 63 of the blade is straight up to the inner straight edge 57 of the table, and the protractor is usually so arranged that its said inner end is approximately located at the center of a circle which includes said curved edge 56. The vertical front curved edge 56 is preferably provided with degree graduations, and the protractor-head 61 can have an indicator mark or point to coincide with any one of said degree-marks. The straight work-receiving edge of the protractor usually constitutes a radius of the arc of the curved edge 56, and the degree graduations indicate the angle of the said edge of the protractor with respect to the vertical plane of the abrading-surface. Hence the protractor can be accurately adjusted to any angle possible within the length of the curved edge and clamped rigidly in the desired position. This feature is of great practical utility where it is desired to accurately finish off work with flat faces at certain accurate angles with each other or other parts. The work is placed on the table and held against the straight edge of the protractor to give the angle and is then pressed to the abrading-face or held in position while the table-feed, hereinbefore described, is utilized to move the work to the abrading-face or to accurately gage and determine the depth of surface ground off, as will be readily understood by those skilled in the art. If desired, a removable square head 64 can be provided for the protractor-blade. This head 64 consists of a strong metal block with a flat under face to rest on the flat table-top. Near one end, on its under side, this block is formed with a transverse seat or groove to receive and fit down on the protractor-blade, so that the inner straight work-receiving edge 65 of the head extends accurately at right angles from the working edge 63 of the protractor-blade. The head 64 can be moved longitudinally of the protractor-blade, and is provided with means for detachably clamping to and at any position along said blade. For instance, a clamping-screw 66 can be provided for this purpose. The drawings show the application of the protractor square head in connection with finishing or grinding a hexagonal nut, and those skilled in the art will readily appreciate the operation and advantages of this feature of my invention. When this protractor square head is employed, the table-feed mechanism is utilized to force the work to the abrading-surface. However, I do not wish to limit all features of my invention to the employment of a table-feed, as with certain kinds of work the article to be polished or ground can be by hand moved over the surface of the table and against the abrading-surface, as desired. Also I do not wish to limit all features of my invention to the employment of the segmental table, as for certain kinds of work a plain or rectangular table or some other form or arrangement of work-support can be provided. Also I do not wish to limit all features of my invention to the employment of the protractor either with or without the square head. Also I do not wish to limit all features of my invention to the angular adjustment of the work-table nor to the protractor in combination with the segmental table, as the protractor might be provided with an angle adjusting mechanism in connection with other forms of work-table. Furthermore, I do not wish to limit all features of my invention to the particular lubricating arrangements nor to the particular arbor-bearings described.

It is evident that various changes and modifications might be resorted to in the forms, arrangements, and constructions of the parts described without departing from the spirit and scope of my invention. Hence I do not wish to limit myself to the constructions exactly as shown, but consider myself entitled to all such changes as fall within the spirit and scope of my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In combination, in a surface grinding-machine, a support, a rotary arbor mounted therein and having an end outwardly tapered with a reduced shouldered threaded extremity, a collar slipped on said tapered end, a key to hold the parts to rotate together and permitting removal of the collar, said collar having a reduced outwardly-extending hub around said extremity and having an end nut-recess, a clamping-nut screwed on said threaded extremity and located in said recess, a grinding-head fitted on said hub and against the outer face of the collar, and means for re-

movably clamping the head to the collar, substantially as described.

2. In combination, in a surface grinding-machine, a pedestal, a grinding-head, a rigid stud extending transversely through the pedestal, an outwardly-projecting dust-cap surrounding the stud and having a hub contracted in the opening in the pedestal and around and clamping said stud therein, a sleeve on the projecting portion of the stud having its inner end inclosed by said cap, and vertically-adjustable work-supporting means, substantially as described.

3. In combination, in a grinding-machine, a pedestal, a horizontal rotary abrading-head arbor mounted on the pedestal, said pedestal provided with alined transverse openings below said arbor, a transverse horizontal stud extending through said openings and projecting outwardly beyond the pedestal, split sleeves or hubs forced into said openings and around and rigidly clamping the stud therein, and work-table-supporting devices mounted on the projecting end of the stud.

4. In combination, a pedestal, a rotary grinder-head, a rigid stud projecting laterally from the pedestal, a longitudinally-adjustable sleeve inclosing the projecting stud, a rigid dust-cap exteriorly inclosing the inner end of the sleeve, means for moving the sleeve longitudinally of the stud, mechanism holding the sleeve against axial movement on the stud, and work-supporting devices carried by said sleeve, substantially as described.

5. In combination, in a grinding-machine, a pedestal, a rotary grinding-head carried thereby, a rigid stud projecting horizontally from the pedestal, a rigid dust-cap projecting from the pedestal outwardly around the inner portion of the stud, a sleeve-like member encircling and movable on said stud and having its inner end exteriorly and loosely inclosed by said cap, and work-supporting devices carried by said member, substantially as described.

6. In combination, in a grinding-machine, a pedestal, a rotary grinding-head, a stud rigid with and projecting from the pedestal, a sleeve inclosing and mounted to slide longitudinally on the projecting stud, said stud formed with a longitudinal groove, a key carried by the sleeve and sliding in said groove to hold the sleeve against axial movement, means to move the sleeve longitudinally of the stud, and work-supporting devices mounted on the sleeve, substantially as described.

7. In combination, a pedestal, a rotary grinding-head, a projecting stud having a longitudinal passage, and a nut located therein, and a work-table feed comprising a support or carrier longitudinally movable on said stud and provided with an outwardly-projecting longitudinal freely-turnable feed-screw passing longitudinally through said nut and into said passage, and at its outer end provided with a hand-wheel, said hand-wheel having a graduated scale and stop adjustable along the scale, and a coöperating stop carried by said longitudinally-movable support, substantially as described.

8. In combination, in a grinding-machine, a work-table-feed mechanism, comprising a rigid stud having a longitudinal passage with radial ducts therefrom to the exterior of the stud, a fixed nut in the passage, a sleeve longitudinally movable on the stud, a longitudinal feed-screw carried by and freely turnable in said sleeve and passing longitudinally within the stud and through said nut, hand turning means on the outer end of said screw, and a lubricant-cup secured on the outer end of said screw, said screw having a longitudinal duct from the cup and discharging into said passage, substantially as described.

9. In a grinding-machine, the combination of a pedestal, a rotary grinding-head, a supporting-stud, a longitudinally-movable work-table carrier on said stud and provided with a hollow feed-screw screwing longitudinally into the stud, a hand-wheel on the outer end of the screw, a lubricant-cup securing said wheel on the screw, the parts provided with lubricant-ducts communicating through said screw with the cup, substantially as described.

10. In a grinding-machine, in combination, a pedestal, a rotary grinding-head, a rigid stud, supporting-carriers for a work-table comprising a sleeve movable longitudinally on the stud and provided with a closed outer end beyond the stud, a feed-screw arranged longitudinally within the sleeve and screwing longitudinally into the stud and projecting loosely through said sleeve end and provided with a shoulder to draw the sleeve outwardly, a hand-wheel secured on the projecting outer end of the screw, a stop carried by and adjustable around the hand-wheel, and an adjustable coöperating stop carried by said sleeve and arranged for projection into the path of said wheel-stop, substantially as described.

11. In combination, in a grinding-machine work-table support and feed mechanism, a supporting-stud, a sleeve longitudinally movable thereon, a hub encircling the sleeve and adapted to move axially thereon, a longitudinal feed-screw having exterior hand turning means and confined loosely to the outer end of the sleeve to feed the same and screwing longitudinally into the stud, said screw having a lubricant-duct extending longitudinally therethrough and a lubricant-cup discharging into said duct, said stud and sleeve having lubricant-distributing ducts communicating with the inner end of said screw-duct and with the inner surfaces of said sleeve and said hub, substantially as described.

12. In combination, a pedestal having a rigid lateral support, a rotary grinding-head above the support, a sleeve confined to slide longitudinally on said support, a hub mounted on said sleeve and provided with work-ta-

ble supports, a collar on the sleeve confining said hub thereon, a feed-screw for moving the sleeve longitudinally on the support, a hand-wheel for turning the screw, said wheel provided with an annular slideway around the same, a block movable around the wheel in said slideway and provided with clamping means, and a stop carried by said collar and adapted to project into the path of said block to stop the feed at a predetermined point, substantially as described.

13. In a grinding-machine, the combination of a support, a movable member forming a part of the work-table carrier, a hand feed mechanism for moving said member and comprising a screw and a hand feed-wheel, said wheel having a graduated scale arranged circumferentially around its rim and an annular slideway in the vertical or side face of its rim, a slide confined in said way to move around the rim and having an indicating-mark along said scale, means to clamp said slide at any point around the rim, and a movable stop carried by said member and adapted to project into the path of the slide to stop the feed-wheel at a predetermined point, substantially as described.

14. In combination, a pedestal, a rotary grinding-head, a lateral supporting-stud, a longitudinally-movable sleeve mounted thereon and provided with feed mechanism, a cross-head provided with a hub encircling the sleeve and adapted to rock thereon, a vertical adjustable plate or bar carried by said cross-head, and a work-table opposite said grinding-head and carried by said plate, substantially as described.

15. In a grinding-machine, the combination of a pedestal, a lateral support, a cross-head comprising a vertically-disposed body having a vertical slideway and a clamping-hub on the opposite side of the body embracing said support and adapted to turn thereon or be clamped thereto, a vertical plate slidable on said way, a work-support mounted in the upper end of said plate, said plate formed with a longitudinal slot, and clamping means extending therethrough into said body and extended outwardly to form a handle, substantially as described.

16. In a grinding-machine, in combination, a support, a work-table carrier movable axially on the support and comprising a vertically-adjustable member, a work-table mounted on said member, means for locking said member and the table at the desired vertical adjustment, and a counterbalancing mechanism carried by said work-table carrier and maintaining the swinging balance thereof whatever the vertical adjustment of the member and table, substantially as described.

17. In a grinding-machine, in combination a pedestal, a lateral support, a cross-head mounted thereon and adapted to move axially thereon, vertically-adjustable work-table supports carried by said cross-head, and a counterbalancing mechanism comprising a weight and connections arranged to automatically move the weight up or down as said work-table supports move vertically in the opposite direction, substantially as described.

18. In a grinding-machine, in combination, a pedestal, a support, a cross-head adapted to rock thereon, a vertically-adjustable member carried by the cross-head, a work-carrier on the upper end of said member, a guide depending from the cross-head, a weight confined and longitudinally movable on said guide, and a flexible supporting connection from the weight passing over a part of said head and downwardly and secured to said member, whereby the member and work-carrier are balanced by the weight and as the member is moved vertically the weight is moved vertically in the opposite direction to maintain a swinging balance of the parts, substantially as described.

19. In combination, in a grinding-machine, a lateral support, a cross-head between its ends having a clamping-hub mounted on said support and adapted to oscillate thereon or be clamped thereto, said head having a vertical slideway and a longitudinal slot opening through the floor thereof, a vertical plate adjustable longitudinally on said slideway and at its upper end adapted to receive the work holder or carrier, means to secure said plate in the desired vertical adjustment, a counterweight, a vertical guide therefor, and a flexible supporting connection secured to the weight and extending upwardly to and over said hub and downwardly through said slot and confined to said plate, substantially as described.

20. In a grinding-machine, in combination, a vertically-adjustable plate, a support therefor, a work-table mounted on the upper end of said support to tilt vertically, means to clamp the table to the support at the desired angle, a quadrant depending beside said plate and provided with a curved lower edge and graduated scale, the plate provided with a lateral lug at said edge having an indication along which said scale moves, the quadrant at its upper end mounted to swing with the table, substantially as described.

21. In a grinding-machine, in combination, a vertically-adjustable plate, supports therefor, a work-table, a clamping-bolt passed through the upper end of said plate and a part of the table to clamp the table at any desired angle, a quadrant depending beside the plate, said bolt passing through the upper end of the quadrant, the upper end of the quadrant having oppositely-projecting arms beneath the table, and vertical set-screws passing through said arms and abutting against the under face of the table, substantially as described.

22. In a grinding-machine, in combination, a work-table having a top face and a straight inner edge and a longitudinally-curved outer edge, the center of the curvature of which is located approximately at a point along the

inner edge, a carrier arranged at the vertical face of said curved edge and adjustable longitudinally thereof, securing devices therefor, and a work-rest secured to and adjusted by said carrier and extending radially over the table approximately to said center, substantially as described.

23. In combination, in a grinding-machine, a work-table having a top face and provided with a slideway arranged longitudinally of its outer edge and opening through the vertical outer face of said edge below the plane of the top face of the table, adjusting and securing means adjustable along said slideway, and a work-rest secured to said means, and adjustable thereby, and extending therefrom inwardly over the top face of the table approximately to the inner edge of the table, substantially as described.

24. A surface grinding-machine, having a work-table formed with a slideway in its outer vertical edge, a slide movable along said edge and provided with clamping means, and a protractor extending inwardly over the top face of the table approximately to the inner edge thereof and carried by said slide, substantially as described.

25. A surface grinding-machine having a work-table with a flat upper surface and a straight inner edge, in combination with a protractor-blade extending from the outer edge of the table inwardly thereof approximately to the straight inner edge, and a holder for the protractor adjustable along the outer edge of the table, substantially as described.

26. A surface grinding-machine having a work-table with a curved segmental outer edge, said edge being provided with a graduated scale, the vertical portion of said edge formed with a longitudinal channel or groove, a block movable along said groove and provided with means to clamp the same at any point along said edge, and a protractor-blade secured to said block and extending inwardly and radially along the top surface of the table, substantially as described.

27. A surface grinding-machine having the work-table with a flat top face, a straight inner edge and a curved segmental outer edge, the center of the circle in which said curved edge is included being located approximately at an intermediate point along said inner edge in combination with a protractor-blade, and adjusting and clamping devices, therefor, substantially as described.

28. A grinding-machine work-table in combination with a protractor-blade movable over the top face thereof and provided with adjusting and clamping means, and a removable square head fitted to the blade and resting on the top face of the table, substantially as described.

29. A grinding-machine work-table having the straight inner edge, and a curved segmental outer edge extending from one end of the inner edge, and an outwardly-extending straight edge from the opposite end of the curved edge to the opposite end of the inner edge and approximately at right angles with the inner edge, said table formed to receive fixtures at said outwardly-extending straight edge substantially as described.

30. In a grinding-machine, in combination, a cross-head having a vertical slideway with side walls, a vertically-adjustable plate adapted to receive the work-carrying device or holder and mounted to slide vertically in said way and formed with a longitudinal slot, a clamping-bolt passing through said slot into the head and provided with a nut and a tapered washer adapted to crowd into said slot and bear against the side walls thereof, substantially as described.

31. In a grinding-machine, in combination, a pedestal, a rotary grinding-head, a support parallel with the axis of the grinding-head, a work-table carrier carried by and movable axially and longitudinally of said support and comprising a vertically-adjustable member, a work holder or table mounted on said member, a hand feed mechanism for said carrier for carrying the work-holder to and from the grinding-head, and a counterbalancing mechanism balancing said member and the work-holder and maintaining said carrier in swinging balance irrespective of the vertical adjustment of the work-holder, substantially as described.

32. In a grinding-machine, in combination, a rotary grinding-head, a pedestal, a work holder or table arranged opposite said head, a carrier therefor mounted to swing and carry the said holder back and forth in front of said head and comprising an adjustable member to vary the vertical position of said holder, and a counterbalancing mechanism mounted on the carrier and connected with said member to maintain the swinging balance of said carrier irrespective of the vertical adjustment of said holder, substantially as described.

33. In a grinding-machine, in combination, a work holder or table, a carrier therefor comprising a vertically-adjustable member carrying said holder, and a counterweight mechanism carried by said carrier and comprising a weight and a flexible connection between the weight and said member whereby the weight rises and falls as said work-holder moves down and up, substantially as described.

34. In a grinding-machine, in combination, a work holder or table, a carrier therefor comprising a vertically-adjustable member carrying the work-holder, a balance-weight supported by the carrier and connected with said member, and a micrometer hand feed mechanism for said carrier, substantially as described.

35. In a grinding-machine, a swinging tool-holder carrier provided with means for vertically adjusting the tool-holder, and a counterbalancing mechanism carried by said carrier and maintaining the swinging balance thereof irrespective of the vertical position of the work-holder, substantially as described.

36. In a grinding-machine, in combination, a work table or holder, a movable carrier therefor comprising mechanism for vertically adjusting said holder, a counterweight mechanism for said holder mounted on and carried by said carrier and means for moving said carrier, substantially as described.

37. In a grinding-machine, the combination of a pedestal, a rigid stud projecting therefrom, a work table or holder carrier mounted on and adjustable longitudinally of said stud, and a hand feed mechanism for said carrier comprising a screw and turning means provided with a graduated scale and an adjustable stop, substantially as described.

38. In a grinding-machine, in combination, a support, a work holder or table carrier carried by said support and comprising a hub having a depending guide, and a vertically-adjustable member, the work-holder mounted on said member, means for clamping said member, a weight movable vertically along said guide, and a flexible supporting connection from the weight to said member, substantially as described.

39. In a grinding-machine, in combination, a pedestal, a stud carried thereby, a sleeve longitudinally movable on the stud, a work-holder carrier mounted on the sleeve and provided with a work-holder, and a hand feed mechanism for moving the sleeve on the stud comprising a screw and a hand-wheel arranged at the outer end of the sleeve and stud and moving with the sleeve, substantially as described.

40. In a grinding-machine, a work-table, in combination with a protractor movable over the face of the table, a square head over the face of the table and projecting from and confined to said protractor, and adjusting and securing means for said protractor secured to said table at and adjustable along the outer edge of said table, substantially as described.

41. In a grinding-machine, a work-table having a straight inner edge and a curved segmental outer edge, the center of the curvature of which is located approximately at a point intermediate the length of said straight inner edge, said table formed below the plane of its top face with a slideway longitudinally of and at the outer vertical face of said curved edge, substantially as described.

42. In a grinding-machine, in combination, a rotary grinding-head, a work-table having an inner edge adjacent to said head and a segmental curved slideway or slot, the center of the curvature of which is located approximately at a point intermediate the length of said inner edge, a carrier adjustable along said slot and provided with locking means, and a protractor extending over the face of the table approximately to said center and secured to and adjustable over the face of the table by said carrier, substantially as described.

43. A grinding-machine work-table having a segmental curved outer edge provided at its outer vertical face with a slideway, in combination with a head adjustable along the outer face of said edge and provided with clamping means, and work-engaging means secured to said head and extending over the top face of the table, substantially as described.

44. In combination, a work-table having a slideway, a slide adjustable longitudinally of said way, a protractor-arm extending over the face of the table approximately to the inner edge thereof and at one end secured to and adjusted by said slide over the face of the table, and securing means to secure the said arm at the desired angle, substantially as described.

45. A work-table in combination with a protractor-arm movable over the face of the table and provided with adjusting and securing means, and a square head over the face of the table and confined to and adjustable longitudinally of said arm and provided with securing means, substantially as described.

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

GEORGE GORTON.

Witnesses:
ALBERT L. ANDERSON,
JOHN P. BARRY.