No. 780,972. PATENTED JAN. 31, 1905.

D. R. BOWEN.

GRINDING MACHINE.

APPLICATION FILED APR. 28, 1904.

3 SHEETS—SHEET 1.

Fig. 1.

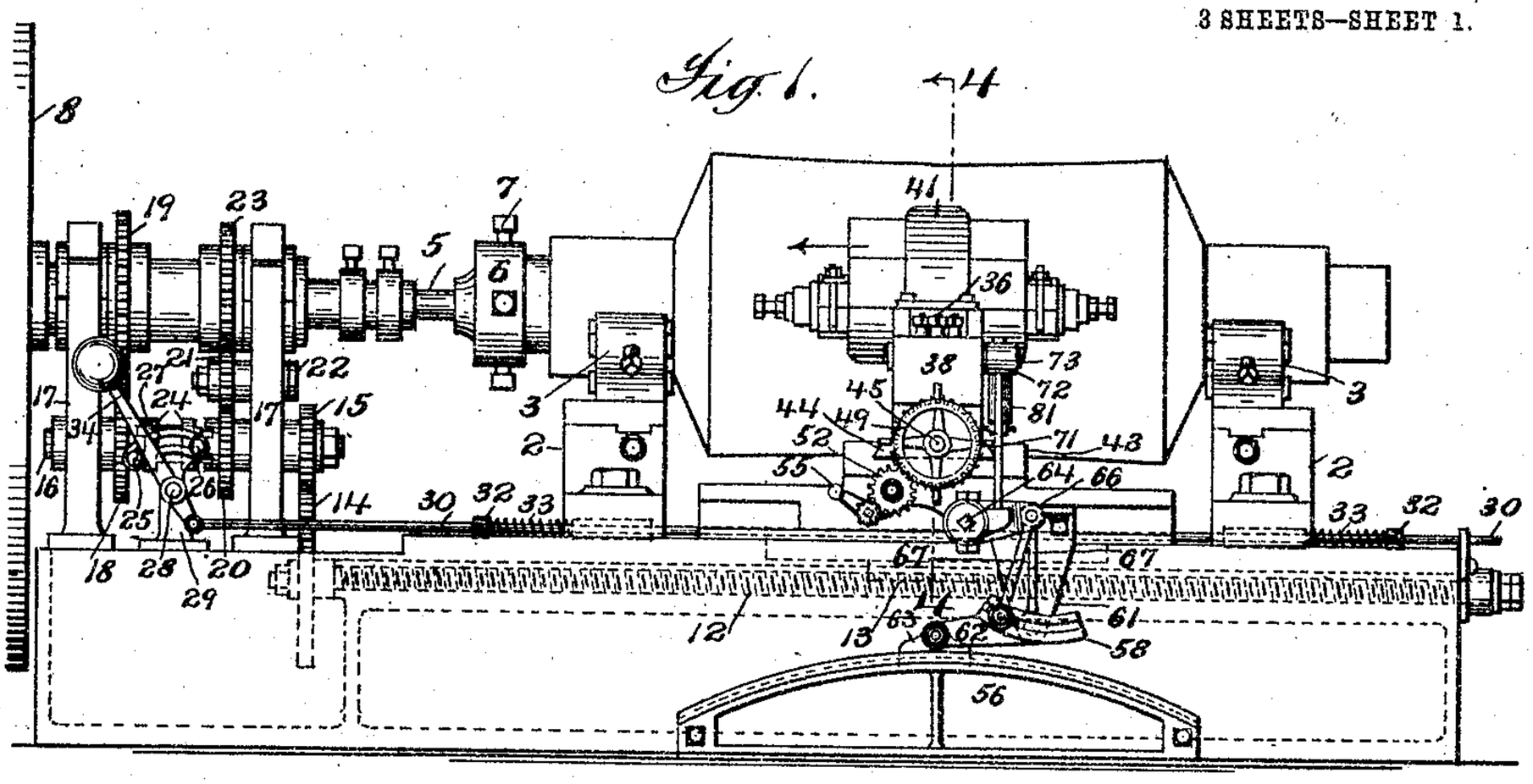
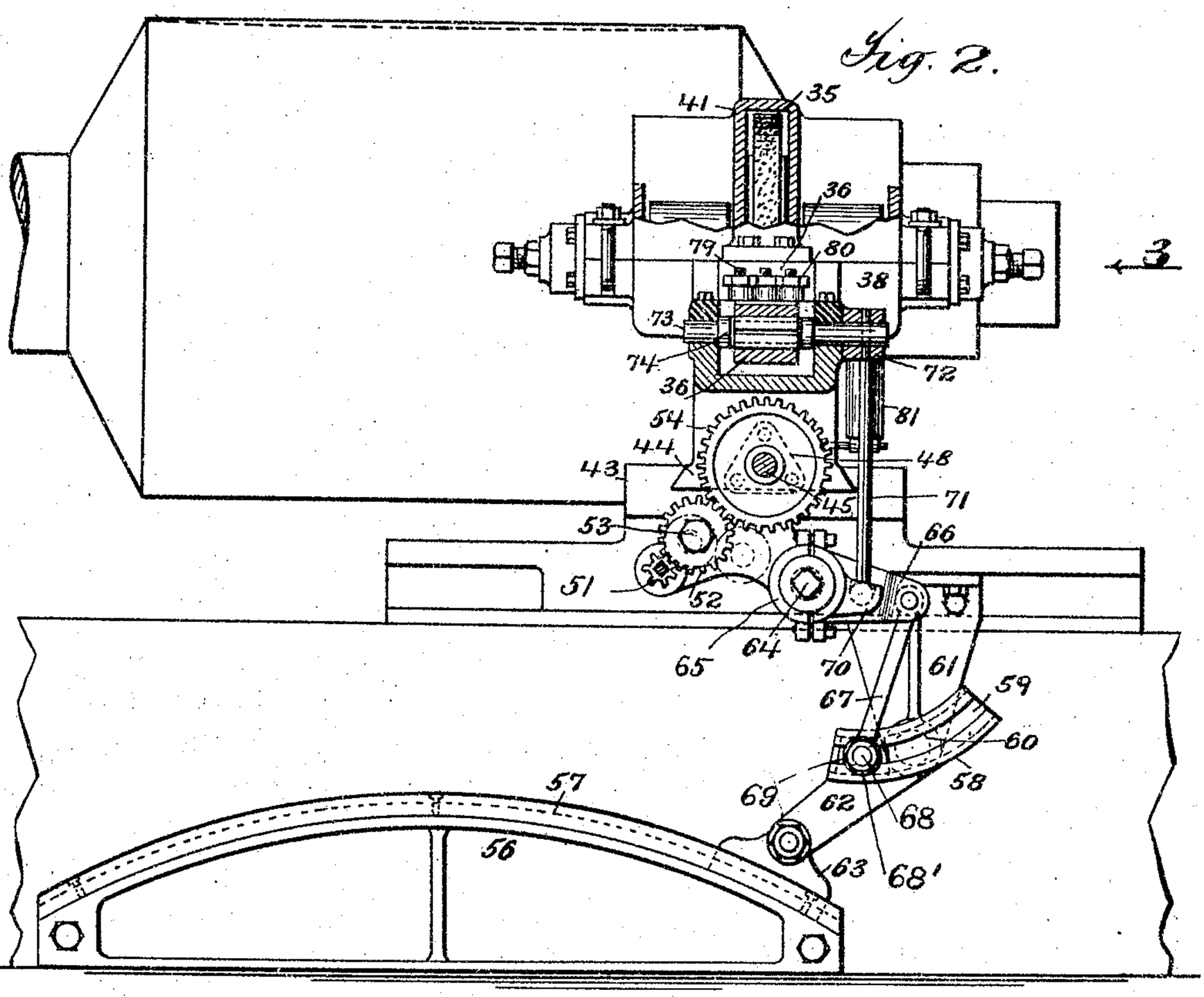



Fig. 2.

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3 SHEETS—SHEET 2.

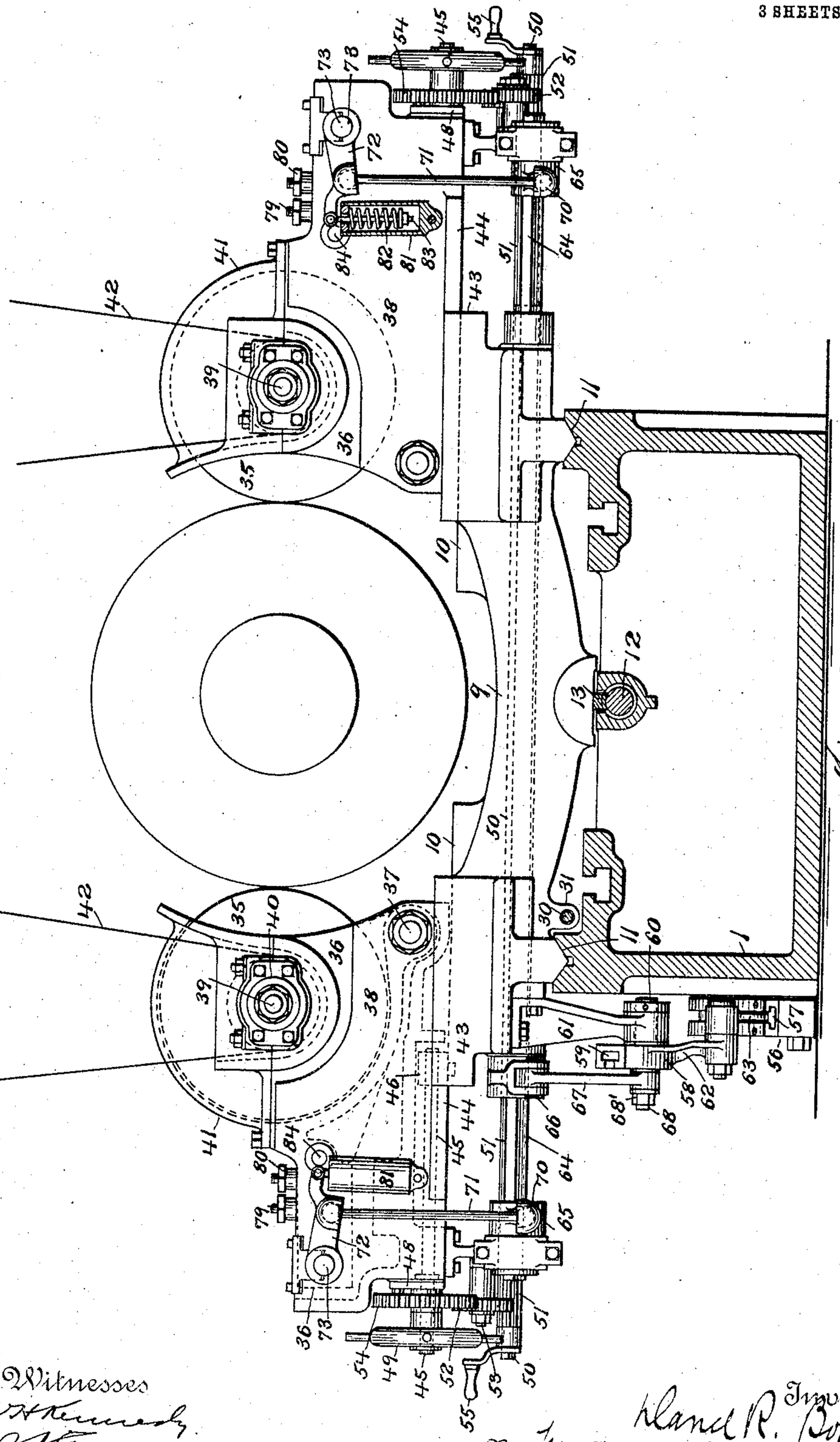


Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 4.

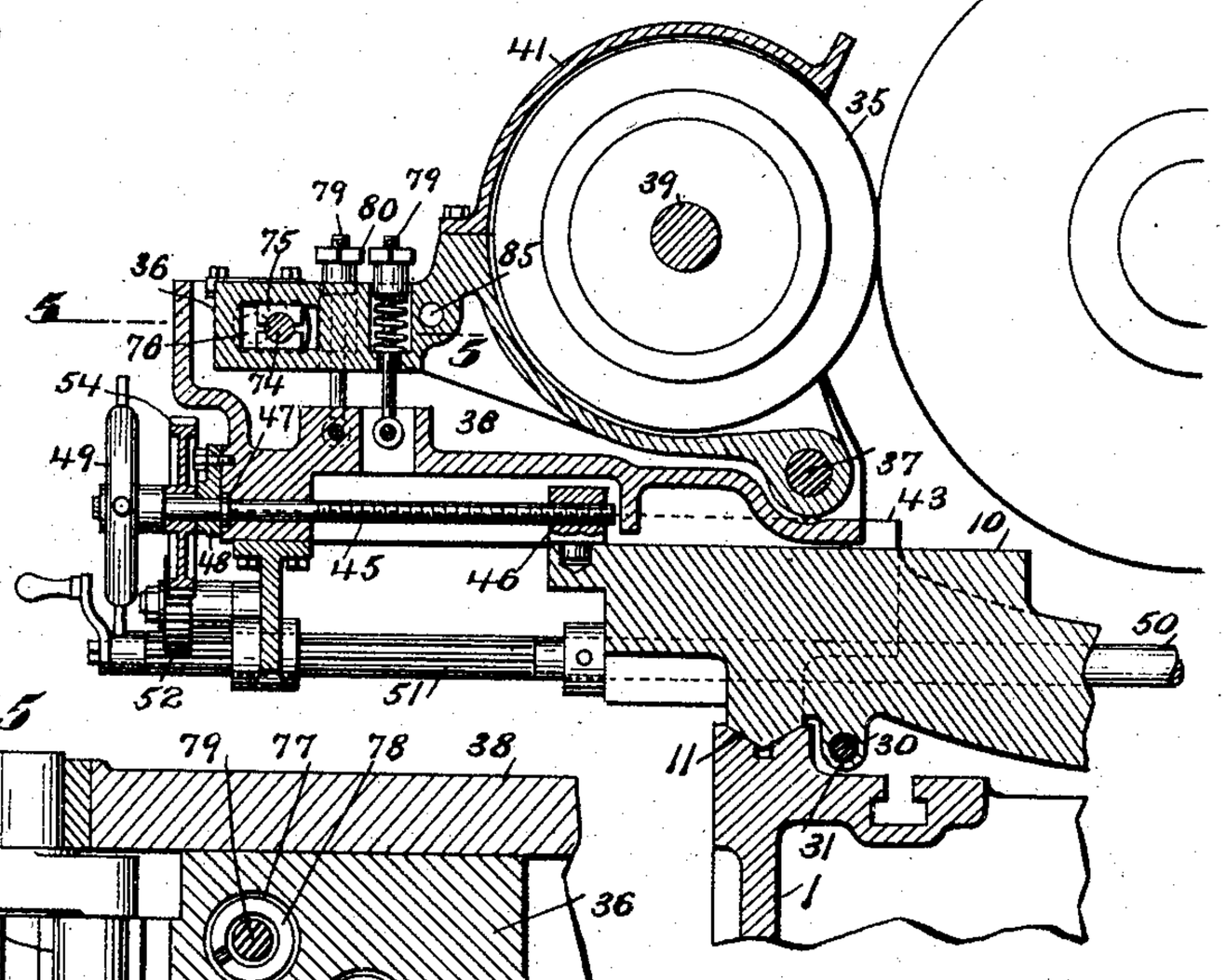



Fig. 5

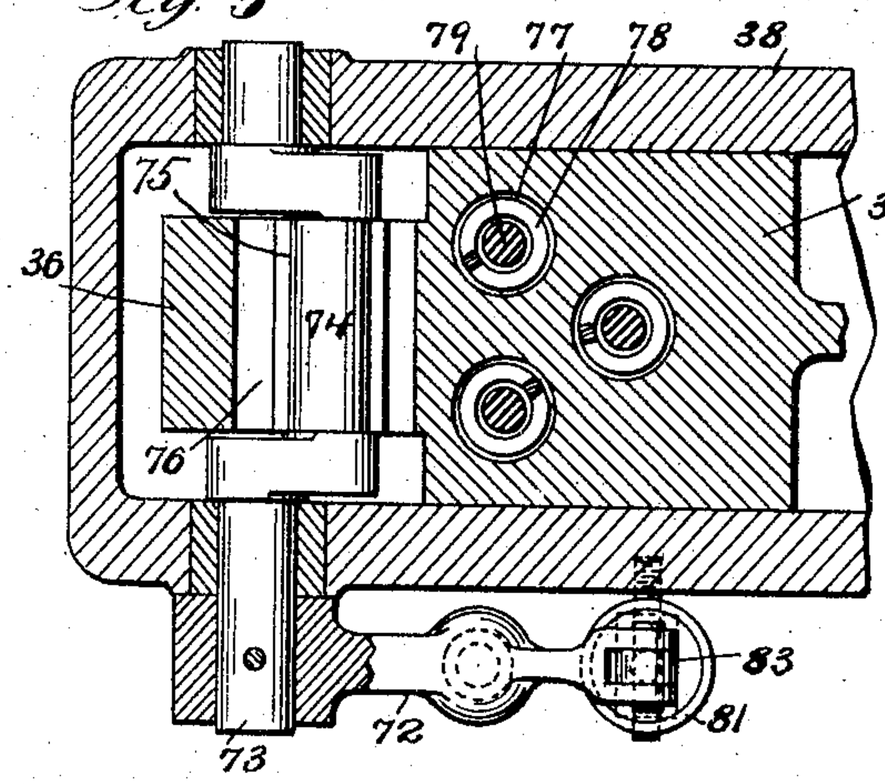
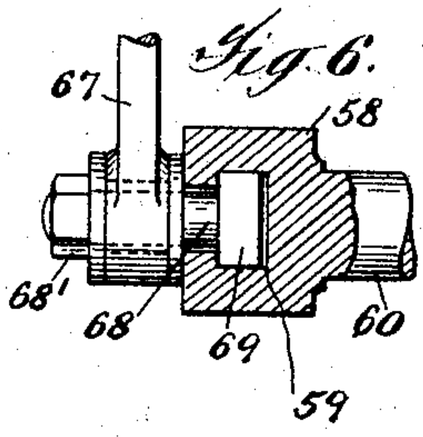



Fig. 6.



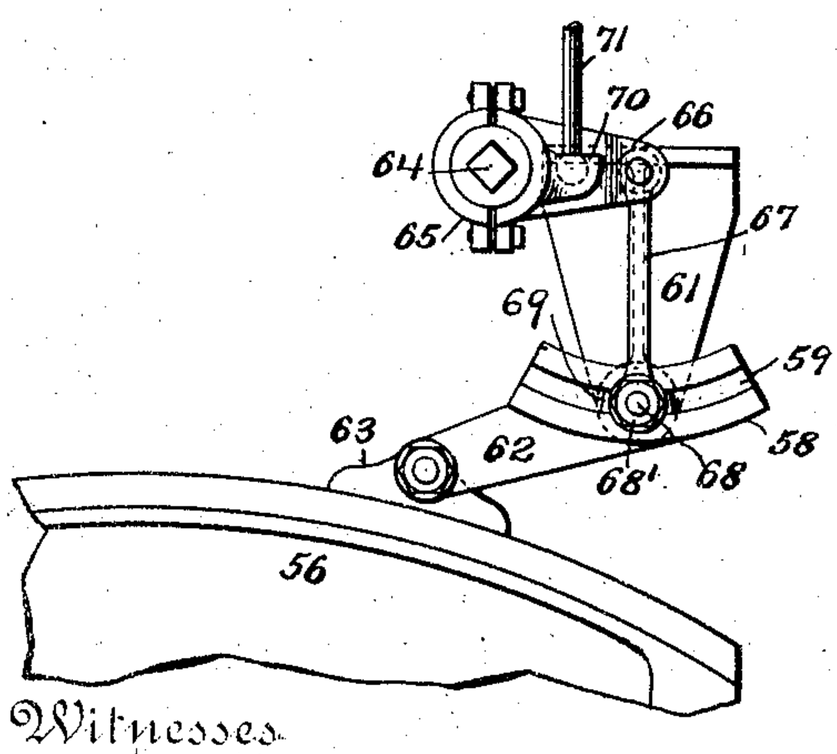




Fig. 7.

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No. 780,972. Patented January 31, 1905.

# UNITED STATES PATENT OFFICE.

DAVID R. BOWEN, OF ANSONIA, CONNECTICUT, ASSIGNOR TO FARREL FOUNDRY & MACHINE COMPANY, OF ANSONIA, CONNECTICUT, A CORPORATION OF CONNECTICUT.

## GRINDING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 780,972, dated January 31, 1905.

Application filed April 28, 1904. Serial No. 205,272.

*To all whom it may concern:*

Be it known that I, DAVID R. BOWEN, a citizen of the United States, residing at Ansonia, county of New Haven, and State of Connecticut, have invented certain new and useful Improvements in Grinding-Machines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to certain improvements in grinding mechanism, and more particularly to that class of grinding mechanism which is employed in grinding long and heavy rolls—such, for instance, as the rolls employed in paper-calendering machines—though the mechanism may be employed for grinding other kinds of heavy work. In grinding these heavy rolls it is frequently desirable to grind them so that the surfaces will be either concave or convex, and it is desirable that the grinding-machine be so constructed as to produce not only a convex or a concave surface when desired, but also to produce, when desired, a roll having a true cylindrical surface.

It has been proposed to grind rolls of the class described by a machine which employed two grinding-wheels, one on each side of the work-support, the grinding-wheels being given a movement to increase and decrease their grinding action, this movement being effected by means of a controller and there being between the controller and the grinding-wheel supports an adjustable connection by which the amount of movement given the grinding-wheels might be somewhat varied. In these machines, however, the pivots for the grinding-wheel supports were located behind the grinding-wheels, the means for effecting the movement of the supports being connected to the supports at points between the pivots and the work. The result of this construction was that the grinding-wheels moved in an arc substantially tangent to the cylindrical surface of the rolls to be ground, and any considerable movement of the supports caused the wheels to move away from the work. It was impossible, therefore, with these machines to cause the grinding-machines to give the cylinder a strong cut, and, furthermore, since in this class of machines the grinding-wheels are driven from an overhead shaft, to which the wheels are belted, any considerable movement of the wheels, such as would be necessary to produce a strong cut, would slacken the belts and stop the wheels. Furthermore, in the machine referred to it was not possible to operate the grinding-wheels so as to produce a convex surface. Machines have also been proposed employing a stationary grinding-wheel and a pivoted support in which the work was mounted, the work by means of a suitable controller being moved toward and away from the center of the grinding-wheels. These machines, however, were adapted only for the grinding of small work—such, for instance, as the grinding and polishing of the spindle-blades used in the textile art. These machines, furthermore, were adapted only to produce work having convex surfaces. Grinding-machines employing grinding-wheels on each side of the work as heretofore constructed have been provided with adjusting devices by which the position of the grinding devices with respect to the work has been controlled. The adjusting devices, however, for each grinding-wheel have been located on the same side of the machine with the grinding-wheel and the adjusting devices on opposite sides have been independent of each other, so that the attendant, if it became necessary to adjust the grinding devices of any particular machine, had to go around the machine in order to adjust the mechanisms on both sides.

It is one of the objects of this invention to produce an improved grinding mechanism for grinding rolls or similar heavy work, in which a work-support is employed and in which the grinder is mounted on a support which is capacitated to be moved toward and away from the center of the work in the work-support during the grinding operation, a fresh surface of the work being continually presented to the grinder by effecting a relative

movement between the grinder and the work-support.

A further object of the invention is to produce a machine employing grinders located on each side of the work-support, the grinders being provided with a suitable adjusting mechanism which is operable from both sides of the machine.

A further object of the invention is to provide an improved grinding-machine employing a grinding-wheel support and a work-support, between which a relative movement is effected, and a suitable controller, there being between the grinding-wheel support and the controller adjustable connections of such a character that the controller may give to the grinding-wheel support the movements necessary to produce a ground surface which is convex, concave, or straight.

A further object of the invention is to improve the details of the construction of grinding-machines adapted to grind heavy work.

With these and other objects in view the invention consists in certain parts, improvements, and combinations, as will be hereinafter described and then pointed out in the claims hereunto appended.

In the accompanying drawings, which illustrate a preferred embodiment of the invention, and in which like characters of reference indicate the same parts, Figure 1 represents in side elevation a grinding-machine embodying the invention. Fig. 2 is an elevation, partly in section, on an enlarged scale, of a portion of the mechanism illustrated in Fig. 1. Fig. 3 is an end view of the construction illustrated in Fig. 2 of certain parts of the machine being shown in section. Fig. 4 is a sectional elevation of one of the grinding devices and certain of the mechanism which cooperates therewith. Fig. 5 is a sectional plan view on the line 5 5 of Fig. 4. Figs. 6 and 7 are detail views of certain parts of the construction by which the controller effects the movement of the grinding-wheel supports.

In the drawings the bed of the machine, which may be of any suitable configuration, is marked 1. This bed serves to support the various mechanisms, which will be hereinafter referred to. The work-support employed may be of any suitable construction and will vary in construction according to the class of work upon which the machine is intended to operate. The machine which has been selected to illustrate the invention is a machine for grinding long and heavy rolls—such, for instance, as the calender-rolls hereinbefore referred to—and the work-support therefore is constructed so as to properly support such a roll and to permit it to be rotated. In the particular construction illustrated the work-support consists of a pair of standards 2, provided with bearings 3, in which the journals of the rolls are supported. The mechanism for rotating the work, when such mechanism is employed, may be of any suitable character. In the construction shown there is provided the shaft 5, said shaft carrying a coupling-head 6, which takes over the end of the roll, the coupling-head being secured to the end of the roll by means of bolts 7 or in any other suitable manner. This shaft 5 may be driven in any desired way—as, for instance, by means of a pulley 8.

Means will be provided whereby a relative traveling movement may be effected between the grinding mechanism, to be hereinafter described, and the work-support, and in the preferred construction this relative traveling movement will be effected by mounting the grinding mechanism on a carriage which will be reciprocated with respect to the work-support. While this carriage may be of any suitable construction, as shown it comprises a cross-web 9, having supporting-surfaces 10, on which the carriers hereinafter referred to rest. This carriage moves in ways 11 in the bed, which ways will preferably be grooved, as is usual in such constructions. The movement which is given the carriage will in the preferred construction be a reciprocating movement and may be effected by mechanism of any suitable character. As shown, the bed supports a feed-screw 12, which is engaged by a nut 13, mounted on the carriage. Means for driving the feed-screw may be of any desired character. As shown, this screw is provided with a gear-wheel 14, this gear being in mesh with a gear 15, mounted on a clutch-shaft 16, this shaft being supported in suitable standards 17, rising from the bed. The clutch-shaft is provided with a gear-wheel 18, loosely mounted thereon, which is in mesh with a gear-wheel 19, mounted on the shaft 5, before referred to. The clutch-shaft also has another gear-wheel, 20, loosely mounted thereon, this gear-wheel being in mesh with an intermediate 21, mounted on a stud 22 in one of the standards 17, before referred to. This intermediate is in mesh with a gear-wheel 23, mounted on the shaft 5, before referred to. The shaft 16 is also provided with a clutch-collar 24, this clutch-collar being secured to the shaft by a spline or in any other suitable manner as is common in such constructions and being provided with a pair of studs 25 26. These studs are operated by a slotted segment-lever 27, this lever being pivoted at 28 to a short standard 29, rising from the bed. As the segment-lever swings on its pivot its slotted portion forces the clutch-collar to engage with the hub of the gear 18 or the gear 20, as the case may be, and secures one or the other of these gears to the clutch-shaft, the gears 18 19 serving to drive the clutch-shaft in one direction and to move the carriage and the gears 20 23, and the intermediate 21 serving to drive the feed-screw in the opposite direction, and thus give the carriage an opposite movement. The reverse of the carriage

is preferably automatically effected, this being accomplished in any desired way. As shown, the bed supports a shifting rod 30, this shifting rod being pivoted to the end of the segment-lever 29. This shifting rod 30 passes through a pair of perforated ears 31 on the carriage and is provided with collars 32 secured thereto. Springs 33 are preferably located between the ears and the collars referred to, so as to cushion the stroke of the ears. As the carriage approaches the end of its movement, either in one direction or the other, one of the ears will, through the spring and collar at that end, shift the rod and throw the clutch. A ball-lever 34 is or may be provided to assist the shifting movement and to hold the parts of the clutch in engagement.

While the mechanism so far described is a convenient and effective mechanism for producing the results desired, mechanism of any other suitable form may be substituted therefor.

The grinding mechanism will preferably employ a grinding-wheel, and in the preferred construction two such wheels will be employed, one on each side of the work, although under some circumstances a single grinder might be used. The grinding device, or devices when two are employed, will be so mounted as to be capable of movement toward and away from the center of the work-support or the center of the work in the support during the grinding operation. While the construction by which the grinding device or devices is mounted may be varied, in the preferred construction and as shown these grinding devices, which consist of wheels 35, will be mounted in supports 36, these supports being pivoted at 37 in the carriers 38, which carriers will be hereinafter more specifically described. These grinding-wheels are mounted on shafts 39, which are supported in suitable bearings 40, secured to the support. They may, if desired, be protected by hoods 41 in the usual manner, and in the construction shown the shafts are driven by belts 42, these belts taken over suitable driving-pulleys on an overhead shaft. (Not shown.)

The grinding-wheel supports, as has been before pointed out, are mounted in carriers 38, these carriers being of a box-like form and resting on the supporting-surfaces 10 of the carriage. The carriage is preferably provided with ways 43, and the carriers have formed thereon ribs 44, which engage the ways and steady the movement. The carriers are given a sliding movement toward and away from the center of the work in order to bring the grinding-wheels into proper adjustment with respect to the work at the beginning of the grinding operation. The movement of the carriers may be produced by any desired mechanism. As shown, each of the carriers is provided with an adjusting-screw 45, these screws engaging nuts 46 on the carriage. In the construction shown these nuts are provided with short studs which engage in sockets on the carriage, this being a convenient form of attaching them. The adjusting-screws pass through perforations in the bottom of the carrier and are provided with collars 47, these collars being held snugly against the carrier by means of locking-pieces 48, secured to the carrier, so that the screws can have no longitudinal movement with respect to the carrier. The screws are provided with any suitable device for turning them—as, for instance, a hand-wheel 49.

While the carriers on each side of the machine may be independently adjusted, if desired, in the preferred construction and as shown suitable means will be provided so that the position of both carriers may be adjusted from both sides of the machine. The particular means employed to effect this result may be widely varied. As shown, the carriage has mounted therein a long shaft 50, which extends across the carriage and the machine. This long shaft 50 is provided at each end with a long pinion 51, these pinions being in engagement with gears 52, mounted on studs 53, secured to the frame. These intermediates 52 are in mesh with gears 54, mounted on the screws before referred to. It is apparent that when either screw 45 is turned the screw on the other side of the machine will be turned the same amount and in the same direction, so that the carriers on both sides of the machine are simultaneously adjusted. This feature is a great convenience in the operation of these machines, as an attendant standing between the two machines can adjust either or both of them without leaving his position. If desired, the shaft 50 may be provided with handles 55. When a quick adjustment of the carriers is to be effected, requiring a considerable movement of the carriers, the hand-wheels may be used, the finer adjustments being effected through the handles.

While the movement of the grinding-wheel supports, which occurs during the grinding operation, may be effected in any desired manner, it will preferably be effected through a controller the form, construction, and location of which may vary within wide limits. In the preferred construction this controller will consist of a convex block 56, located on one side of the machine, this block being provided with a groove 57. The connections by which the controller is enabled to produce the desired movements of the grinding-wheel supports may be also varied. As shown, this mechanism includes a rocker 58, having a groove 59 therein, this rocker having extending from it on the side opposite the groove a stud 60, this stud being supported in a bracket 61, depending from the under side of the carriage. (See Figs. 3 and 6.) Connected to this stud 60 is an arm 62, this arm carrying

a shoe 63, which runs in the groove 57 of the block 56. The movement of this rocker is transmitted through suitable mechanism to a lifter, which in turn operates the grinding-wheel support, and in the preferred construction this lifter will operate simultaneously the grinding-wheel supports on both sides of the machine. While the construction of this lifter may vary, as shown, it consists of a square shaft 64, mounted in the carriage, this shaft having secured to it on each side of the machine lifter-arms 65. The shaft also has secured to it at any suitable point a rock-arm 66, by which it is operated. This arm 66 has connected to it a link 67, this link being connected at the other end to a pin 68, this pin being secured to a slide-block 69, adjustable in the groove 59 of the rocker. The outer end of the pin 68 is threaded and is provided with a nut 68′, so that by loosening the nut the block 69 may be set at any desired point in the groove 59, after which by turning up the nut the block will be secured against any movement with respect to the rocker. It is apparent that if the block 69 be secured to the rocker at a point opposite the pivotal stud 60 the rocker may be moved through the arm 62 and the shoe 63; but no movement will be transmitted to the rock-shaft 64. It will be further seen that the movement of the shaft 64 will be varied according as the block 69 is secured to one side or the other of the center of movement of the rocker, and the amount of the movement will depend upon the distance the block is from the pivotal center of the rocker.

The particular means for transmitting the movement of the lifter to the grinding-wheel supports may be widely varied. As shown, the lifter-arms 65 are provided with sockets 70, and in these sockets are located lifter-rods 71. These lifter-rods at their other ends lie in sockets in arms 72, secured to a crank-shaft 73, mounted in suitable bearings in the carriers 38. On the crank 74 of this shaft 73 there is mounted a block 75, which slides in a way 76, formed in the rear end of grinding-wheel support 36. It will be readily understood that as the lifter-shaft is rocked and the arms moved the crank-shaft will impart a swinging movement to the support 36, this swinging movement taking place about the pivot 37. It will be further understood that as the carriage moves along the bed the shoe 63 moves over the convex surface of the controller-block, and if it be desired to grind a concave surface the connection of the link 67 to the rocker will be such that as the shoe travels up the incline of the controller the lifter-shaft is rocked, so that the lifter-arms 65 move upward. The grinding-rolls will through this mechanism be advanced steadily toward the center of the work until the shoe reaches the top of the incline of the controller. As the shoe passes down the other side of the incline the lifter-arms on the lifter-shaft will be moved downward, and the grinding-wheels will be gradually moved away from the work as the carriage continues its advancing movement. If it be desired to grind a convex surface, the point of connection of the link 67 with the rocker 58 will be such as to cause the movement of the lifter-arms on the lifter-shaft to be in the first instance downward. The grinding-wheel supports and the grinding-wheels will therefore move gradually away from the work and will continue this movement until the shoe reaches the top of the incline of the controller. At this time the movement will be reversed, and the wheels may be gradually advanced toward the work until the shoe reaches the end of the controller.

Attention is directed to the fact that the pivot 37, around which the grinding-wheel support swings, is located between the work and the point where the lifting connections are secured to the support. The result of this construction is that the grinding-wheels are moved in an arc which always tends to intersect the surface of the roll or other work to be ground, or, in other words, the grinding-wheels are advanced toward the center of the work-support or the work in the support. A further result of this construction is that the necessary movement to effect a very strong cut can be produced without in any wise slackening the driving-belts by which the grinding-wheels are driven. In the prior constructions the point of attachment of the lifting means was between the work and the pivots for the grinding-wheel supports. With these constructions the movement of the grinding-wheels was always away from the center of the work. Only a very slight movement of the grinding-wheels could therefore be effected without causing them to pass out of contact with the work, and, furthermore, the movement of the grinding-wheels being in a vertical arc instead of in a horizontal arc, as in the present construction, tended to slacken the driving-belts.

In order to overcome any tendency of the driving-wheels to chatter, which might result from looseness in the connections or from other causes, suitable steadying devices are preferably provided. While these steadying devices may be of any suitable description, in the construction shown the grinding-wheel support is provided with sockets 77, (see Figs. 4 and 5,) in which are located springs 78. These springs surround spring-rods 79, which are pivoted to the carriers 38 and extend upward through perforations in the bottoms of the sockets. These spring-rods are provided with adjusting-nuts 80, between which and the bottoms of the sockets the springs 78 lie. It will be understood that the lifting movement of the supports placed these springs under tension, so that any tendency of the support to jump or quiver will be obviated. If

desired, cushioning-springs may be employed in connection with the arms 72, which are fast on the crank-shaft 73. These springs when used may be arranged in any suitable manner. In the construction shown sockets 81 are pivoted to the sides of the carriers 38, and in these sockets are located springs 82, these springs surrounding spring-rods 83, which are pivoted to the arms 72. These spring-rods extend through perforations in the top of the sockets, and it will be readily seen that any upward movement of the arms will compress these springs.

While the machine may be used, as has been before pointed out, to grind straight surfaces by setting the link 67 so that its lower end is opposite the center of the movement of the rocker 59, the same result may be effected by removing the lifter-rods 71 and by passing pins through perforations 84 in the carriers 38, the pins also passing through perforations 85 (see Fig. 4) in the grinding-wheel supports. These pins will lock the grinding-wheel supports to the carrier, so that no movement of the same can take place.

The operation of the machine will be clearly understood from the description hereinbefore given, and therefore no further detailed statement of the same is necessary. It will be seen that the machine provides for wide ranges of adjustments, this being true because the movement which is given the grinding-wheel supports during the grinding operation is toward and away from the center of the work in the supports. The grinding-wheels may therefore be set as far in or out as desired to give in the first instance as strong or as light a cut as is desired, and the inward or outward movement which takes place during the grinding operation may be controlled with great nicety by the adjustment of the connections between the rocker and the lifter.

Changes and variations may be made in the construction by which the invention is carried into effect, and it will also be understood that certain features of the invention may be used independent of other features and that such independent use is contemplated. The invention is not, therefore, to be limited to the specific construction herein described, and illustrated in the accompanying drawings.

What is claimed is—

1. In a grinding-machine, the combination with a work-support, of a grinding-wheel support, a grinding-wheel mounted thereon, means for producing a relative traveling movement between the supports, and means for moving the grinding-wheel toward and away from the center of the work in the work-support during the grinding operation, substantially as described.

2. In a grinding-machine, the combination with a work-support, of a grinding-wheel support, means for producing a relative traveling movement between the supports, a controller, connections between the controller and the grinding-wheel support for moving the grinding-wheel toward and away from the center of the work-support during the grinding operation, and means for varying the amount of movement, substantially as described.

3. In a grinding-machine the combination of a work-support, of a pivoted grinding-wheel support, means for producing a relative traveling movement between the supports, a controller, and connections between the controller and the grinding-wheel support for swinging the grinding-wheel on its pivot to cause it to move toward and away from the center of the work-support, substantially as described.

4. In a grinding-machine the combination of a work-support, of a pivoted grinding-wheel support, means for producing a relative traveling movement between the supports, a controller, connections between the controller and the grinding-wheel support for swinging the grinding-wheel on its pivot to cause it to move toward and away from the center of the work-support, and means for varying the amount of the swinging movement, substantially as described.

5. In a grinding-machine the combination with a work-support, of grinding-wheel supports on each side thereof, means for producing a relative traveling movement between the work-support and the wheel-supports and means whereby the position of the grinding-wheel supports on both sides of the machine may be controlled from either side, substantially as described.

6. The combination with a work-support, of grinding-wheel supports on each side thereof, means for simultaneously adjusting the supports toward and away from the work-support, said means being operable from either side of the machine, means for producing a traveling movement between the work-support and the wheel-supports, and means for moving the grinding-wheel supports toward and away from the center of the work-support during the grinding operation, substantially as described.

7. In a grinding-machine the combination of a work-support, of grinding-wheel supports located on both sides thereof, means whereby the grinding-wheel supports may be adjusted from either side of the machine, means for producing a traveling movement between the grinding-wheel supports and the work-support, a controller, and connections between the controller and the grinding-wheel supports for moving them toward and away from the center of the work-support during the grinding operation, substantially as described.

8. In a grinding-machine the combination of a work-support, of grinding-wheel supports located on both sides thereof, means whereby the grinding-wheel supports may be adjusted from either side of the machine, means for producing a traveling movement between the

wheel-supports and the work-support, a controller, connections between the grinding-wheel supports and the controller for moving the grinding-wheels toward and away from the center of the work in the support during the grinding operation, and means for varying the amount of the movement, substantially as described.

9. The combination with a work-support, of a carriage on which said support is mounted, means for reciprocating the carriage, a carrier mounted in the carriage, means for adjusting the carrier in the carriage with respect to the work-support, a grinding-wheel support pivoted in the carrier, and means for swinging the carrier on its pivot, the pivot of the grinding-wheel support being located between the work-support and the point of connection of the swinging means and carrier, substantially as described.

10. The combination with a work-support, of a carriage, means for reciprocating the carriage, a carrier, a grinding-wheel support pivoted in the carrier, a controller, connections between the controller and the carrier for swinging the grinding-wheel support on its pivot, the pivot of the grinding-wheel support being located between the work-support and the point where the controller connections are secured to the carrier, substantially as described.

11. The combination with a work-support, of a carriage, means for reciprocating the carriage, a carrier, a grinding-wheel support pivoted in the carrier, a controller, connections between the controller and the carrier for swinging the grinding-wheel support on its pivot, the pivot of the grinding-wheel support being located between the work and the point where the controller connections are secured to the carrier, and means for varying the amount of movement, substantially as described.

12. In a grinding-machine the combination with a work-support, of grinding-wheel supports in each side thereof, means for producing a relative traveling movement between the work-support and the grinding-wheel supports, devices whereby each grinding-wheel support may be adjusted with respect to the work-support, and connections whereby the adjustment of either grinding-wheel adjusts the other, substantially as described.

13. In a grinding-machine the combination with a work-support, of grinding-wheel supports on each side thereof, means for producing a relative traveling movement between the work-support and the grinding-wheel supports, carriers on both sides of the machine in which the wheel-supports are mounted, a screw for adjusting each carrier, and connections whereby the adjustment of either screw adjusts the other, substantially as described.

14. In a grinding-machine the combination with a work-support, of grinding-wheel supports on each side thereof, means for producing a relative traveling movement between the work-support and the wheel-supports, carriers, one for each wheel-support and in which the wheel-supports are pivoted, screws and suitable connections, one for each carrier, whereby each carrier may be adjusted with respect to the work-support, a shaft extending across the machine and gearing between the shaft and each of the adjusting-screws, substantially as described.

15. In a grinding-machine the combination with a work-support, of a grinding-wheel support, a grinding-wheel mounted therein, means for producing a relative traveling movement between the supports, means for moving the grinding-wheel toward and away from the center of the work in the work-support during the grinding operation, and steadying devices whereby chattering is prevented, substantially as described.

16. In a grinding-machine the combination with a work-support, of a pivoted grinding-wheel support, means for producing a relative traveling movement between the supports, means for swinging the grinding-wheel on its pivot toward and away from the center of the work in the support, and coöperating steadying devices, substantially as described.

17. In a grinding-machine the combination with a work-support, of pivoted grinding-wheel supports located on each side thereof, means for producing a relative traveling movement between the work-supports and the grinding-wheel supports, a controller, connections between the controller and the grinding-wheel supports on each side of the machine whereby the controller swings the wheel-supports on their pivots to move the wheels toward and away from the work during the grinding operation, the pivots of the wheel-supports being located between the work and the point where the controller connections are secured to the support and coöperating steadying devices, substantially as described.

18. In a grinding-machine the combination with a work-support, a carriage, means for reciprocating the carriage, carriers mounted on the carriage one on each side of the work-support, grinding-wheel supports pivoted in the carriers, means for adjusting the carriers toward and away from the work-support, a controller, connections between the controller and the pivoted wheel-supports whereby the supports may be swung toward and away from the work during the grinding operation, the pivots of the wheel-supports being located between the work and the point where the controller connections are secured to the supports, and coöperating steadying means, substantially as described.

19. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, carriers mounted

in the carriage on each side of the work-support, grinding-wheel supports pivoted in the carriers, a controller, connections between the controller and the wheel-supports whereby the wheel-supports are swung on their pivots toward and away from the work, the pivots of the supports being located between the work and the point where the controller connections are secured to the supports, adjusting devices for each carrier whereby the carrier may be moved toward and away from the work, and connections whereby the adjustment of either carrier adjusts the other, substantially as described.

20. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, carriers mounted in the carriage on each side of the work-support, grinding-wheel supports pivoted in the carriers, a controller, connections between the controller and the wheel-supports whereby the wheel-supports are swung on their pivots toward and away from the work, the pivots of the supports being located between the work and the point where the controller connections are secured to the supports, coöperating steadying devices, adjusting devices for each carrier whereby the carrier may be moved toward and away from the work, and connections whereby the adjustment of either carrier adjusts the other, substantially as described.

21. In a grinding-machine the combination with a work-support, of a grinding-wheel support, a controller, connections between the grinding-wheel support and the controller, and means whereby said connections may be adjusted to produce a ground surface which is concave, convex or straight, substantially as described.

22. In a grinding-machine the combination with a work-support, of a grinding-wheel support, means for producing a relative traveling movement between the supports, a controller, a pivoted rocker operated from the controller, connections between the rocker and the pivoted support, and means for adjusting said connections with respect to the rocker so that they may be located opposite its center or on either side of the center, whereby a straight, convex or concave ground surface may be produced, substantially as described.

23. In a grinding-machine the combination with a work-support, of grinding-wheel supports located on each side thereof, means for producing a relative traveling movement between the work-support and the grinding-wheel supports, a controller, and connections between the controller and the grinding-wheel supports whereby a straight, convex or concave ground surface may be produced, substantially as described.

24. In a grinding-machine the combination with a work-support, of pivoted grinding-wheel supports on each side of the work-support, means for producing a relative traveling movement between the work-support and the grinding-wheel supports, a controller, a rocker operated from the controller, connections between the rocker and both the pivoted supports, means for adjusting said connections with respect to the rocker so that they may be located opposite its center or on either side thereof, whereby a straight, convex or concave ground surface may be produced, substantially as described.

25. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, a pair of carriers mounted in the carriage, one on each side of the work-support, grinding-wheel supports pivoted in the carriers, a lifter, connections from the lifter to both wheel-supports, the pivot of the wheel-supports being located between the point where the lifter connections are secured to the supports and the work, a controller, and connections between the controller and the lifter, substantially as described.

26. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, a pair of carriers mounted in the carriage, one on each side of the work-support, grinding-wheel supports pivoted in the carriers, a lifter, connections from the lifter to both wheel-supports, the pivot of the wheel-supports being located between the point where the lifter connections are secured to the supports and the work, a controller, connections between the controller and the lifter, and coöperating steadying devices, substantially as described.

27. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, a pair of carriers mounted in the carriage, one on each side of the work-support, grinding-wheel supports pivoted in the carriers, a lifter, connections from the lifter to both wheel-supports, the pivot of the wheel-supports being located between the point where the lifter connections are secured to the supports and the work, a controller, a rocker operated from the controller, connections from the rocker to the lifter, and means for adjusting said connections with respect to the rocker, substantially as described.

28. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage with respect to the support, pivoted grinding-wheel supports on each side of the machine, a rock-shaft extending across the machine and mounted in the carriage, connections from the rock-shaft to the pivoted work-support, the pivots of the work-support lying between the work and the point where these connections are secured to the wheel-supports, a controller, and connections whereby the controller operates the rock-shaft, substantially as described.

29. In a grinding-machine the combination

with a work-support, of a carriage, means for reciprocating the carriage with respect to the support, pivoted grinding-wheel supports on each side of the machine, a rock-shaft extending across the machine and mounted in the carriage, connections from the rock-shaft to the pivoted work-support, the pivots of the work-support lying between the work and the point where these connections are secured to the wheel-supports, a controller, and adjustable connections between the controller and the rock-shaft whereby the amount of movement of the rock-shaft may be varied, substantially as described.

30. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, carriers mounted in the carriage, one on each side of the work-support, adjusting devices for each carrier, operating means for each adjusting device, connections between the adjusting devices whereby the operation of either adjusting device operates the other, a grinding-wheel support on each side of the machine, said grinding-wheel supports being pivoted in the carriers, a lifter, connections between the lifter and the grinding-wheel supports, the pivots of the grinding-wheel supports being located between the work and the point where the lifter connections are secured to the supports, a controller, and adjustable connections between the controller and the lifter whereby the amount of movement of the lifter may be varied, substantially as described.

31. In a grinding-machine the combination with a work-support, of a carriage, means for reciprocating the carriage, carriers mounted in the carriage, one on each side of the work-support, adjusting devices for each carrier, operating means for each adjusting device, connections between the adjusting devices whereby the operation of either adjusting device operates the other, a grinding-wheel support on each side of the machine, said grinding-wheel supports being pivoted in the carriers, a lifter, connections between the lifter and the grinding-wheel supports, the pivots of the grinding-wheel supports being located between the work and the point where the lifter connections are secured to the supports, coöperating steadying devices, a controller, and adjustable connections between the controller and the lifter whereby the amount of movement of the lifter may be varied, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

DAVID R. BOWEN.

Witnesses:
GEORGE W. OSBORN,
NORMAN P. KNIGHT.