March 2, 1926. 1,575,558

S. EINSTEIN ET AL

CENTERLESS GRINDING MACHINE

Filed Jan. 18, 1924 2 Sheets-Sheet 1

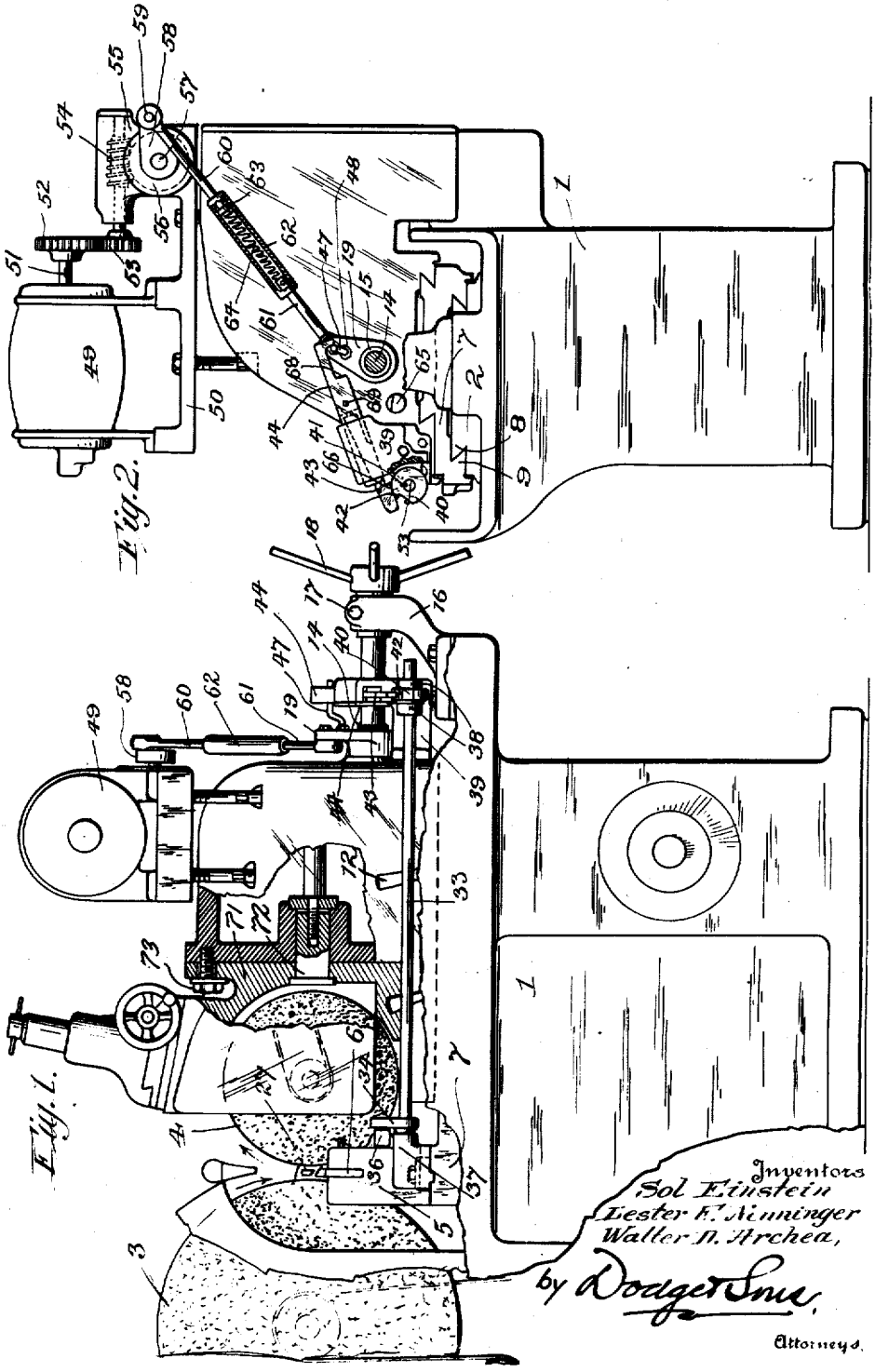


Fig. 2.

Fig. 1.

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Fig. 3.

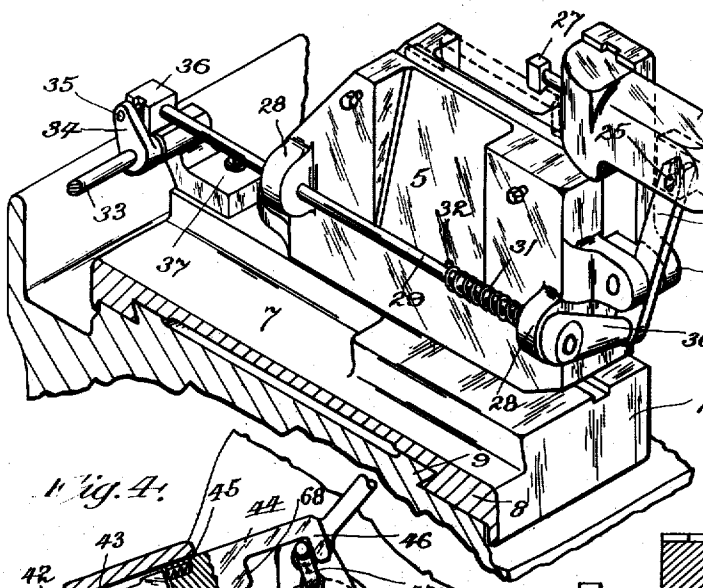
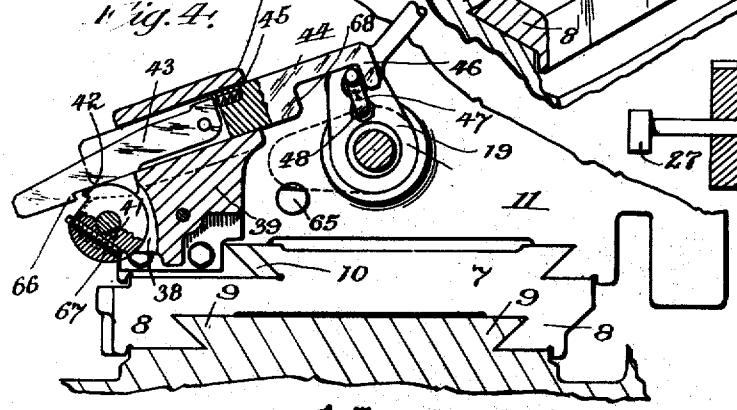


Fig. 4.



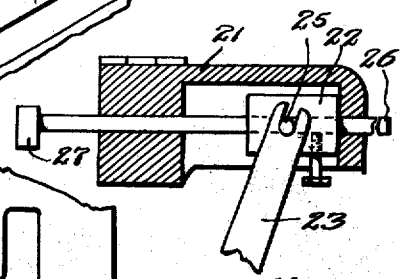
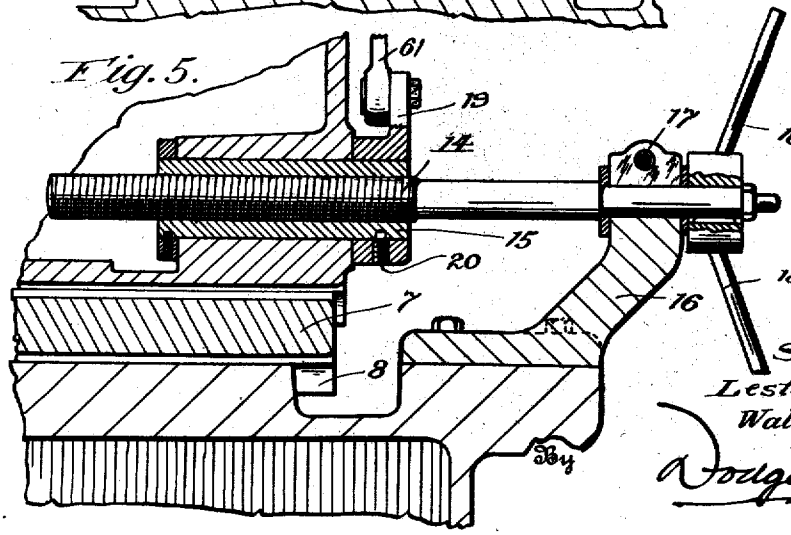


Fig. 6.

Fig. 5.



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Patented Mar. 2, 1926. 1,575,558

UNITED STATES PATENT OFFICE.

SOL EINSTEIN AND LESTER F. NENNINGER, OF CINCINNATI, AND WALTER D. ARCHEA, OF NORWOOD, OHIO, ASSIGNORS TO THE CINCINNATI MILLING MACHINE COMPANY, OF CINCINNATI, OHIO, A CORPORATION OF OHIO.

CENTERLESS GRINDING MACHINE.

Application filed January 18, 1924. Serial No. 687,063.

To all whom it may concern:

Be it known that we, SOL EINSTEIN, LESTER F. NENNINGER, and WALTER D. ARCHEA, citizens of the United States, residing respectively, at Cincinnati and at Norwood, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Centerless Grinding Machines, of which the following is a specification.

This invention pertains to centerless grinding machines for grinding articles of circular cross section, particularly such as are provided with a head, a shoulder or shoulders, or both. The machine may also do taper grinding, and the mechanism to which the invention is more specifically directed, that is to say, mechanism for automatically ejecting the work when ground to the desired extent, is capable of use in the grinding of the several classes of objects indicated.

The invention is illustrated in the accompanying drawings, in which:

Figure 1 is a side elevation of so much of the grinding machine as is necessary properly to illustrate the automatic work-ejecting mechanism in its relation to the grinding machine;

Fig. 2, an end elevation of the machine showing the automatic mechanism for actuating the ejector, the motor drive, etc., as viewed from the governing or control wheel end;

Fig. 3, a perspective view of the work-support, showing details of the ejector and its connection with the oscillating shaft which actuates it;

Fig. 4, a sectional elevation illustrating the construction of the latch through which the oscillating shaft is alternately engaged, turned in actuating direction, and released;

Fig. 5, a sectional view of a portion of the main bed of the grinding machine, showing the governing or control-wheel carrier and a slide interposed between the same and the machine bed.

Fig. 6 is a fragmentary view of the bunter stem and guide.

The grinding machine here indicated is of that type in which there is provided a suitable main frame or base 1 having a substantially horizontal bed or top-plate 2 carrying in suitable bearings a grinding wheel 3 and a governing or control-wheel 4 of like or similar material. The wheels 3 and 4 are mounted upon shafts or arbors, and independently rotated in the same direction about their respective axes and at appropriate speeds, said wheels, either or both, being adjustable to vary the distance between the two, and thus to gage or determine the diameter to which the work, or a portion or portions thereof, shall be ground. The office of the governing or control-wheel is to insure the rotation of such work or object at predetermined and uniform surface speed, while it is supported upon the work-rest and pressed or held against the effective surface of the grinding wheel.

In the machine illustrated the wheels are peripherally opposed, and a work-rest is interposed between their proximate peripheral faces, and serves to support the work or object being ground. This work-rest as best seen in Fig. 3, comprises a main base or member 5, and a specially designed work-support 6 in the form of a plate or blade, which latter is varied in form and dimensions to suit the particular work to be handled. In practice, a plurality of blades or direct work-supports is provided, the same being interchangeable to adapt the machine to the handling of objects of any particular form or dimensions.

While the mechanism which constitutes the present invention is here shown and described in connection with this particular type of grinding machine, it is to be understood that it is designed for and capable of use with machines of other types, whether the grinding be done upon the periphery of the grinding wheel, or upon the side face as is commonly done with grinders of disk type, and whether a control-wheel or some other gaging and supporting device be used to hold the work properly against the grinding surface.

The general position and arrangement of the work-rest and its supporting blade will be seen upon referring to Fig. 1. In the present instance the base 5 of the work-rest is secured to a slide 7 having longitudinal guiding ribs 8 closely fitting similar ribs 9 formed upon the top or bed-plate of the base or main frame 1, as seen in the several figures. This dovetail guideway construction is common in machines of this class, and may include adjustable or replaceable filling or wear strips 10 such as shown in Fig. 3, between the slide 7 and the carrier 11 of the control-wheel 4, where the like dovetail construction is employed. The carrier 11 is in the form of a hollow shell or box, and is provided with clamping means of any approved or usual construction, operable by a hand-lever 12, at the infeeding side of the machine, and serving to lock said carrier firmly and rigidly to the slide 7, or to release said carrier when it is desired to adjust it relatively to slide 7, or to adjust slide 7 relatively to the carrier. Similarly, slide 7 is provided with like clamping means operable by a hand-lever 13 for rigidly clamping said slide to its ways on the bed or top-plate 2 of the main frame 1. These may be simple cams or wedges.

Adjustment of slide 7 is made when necessary, to position the work-rest 5—6 properly between the opposed grinding and governing or control-wheels 3 and 4, the base 5 of the work-rest being rigidly secured to the inner end of said slide. The adjustment of the carrier 11 relatively to the slide is to accurately gauge the width of the space between the grinding and governing wheels to insure the grinding of the object to the precise diameter desired. When, therefore, it is necessary to position the work-rest initially for a given piece of work, the carrier 11 is run slightly backward or away from the grinding wheel 3 and clamped to the slide 7, which together with the carrier is then moved inward or outward as required, to position the work-rest base 5 and the work-supporting and guiding blade or bar 6. The slide 7 is then clamped firmly to the bed-plate or top 2 of the machine. Carrier 11 is next disengaged or unclamped from slide 7, and is moved to effect the proper positioning of the governing or control-wheel 4 relatively to grinding wheel 3.

These movements of the slide 7 and carrier 11 jointly, or of the carrier 11 alone, are effected by a screw 14 passing through and threaded into sleeve 15 swiveled in the shell or carrier 11 in any convenient way, the stem or shank of the screw being in turn swiveled in an arm or bracket 16 rising from the main frame or base of the machine, and having the arm in which said stem is swiveled, split and capable of being drawn into gripping or binding contact with the stem by a pinch-screw or bolt 17. The outer extremity of the screw stem is provided with a hand wheel or spoke-wheel 18 by which to rotate the screw and advance or recede the carrier 11, the sleeve 15 being at such time held in any convenient way against rotating with the screw. Under this arrangement it is possible to advance and recede the carrier, with or without the slide 7, manually, by turning the screw 14 through the medium of wheel 18, the pinch-screw 17 being at such times backed to free the stem of the screw, and it is further possible upon tightening said pinch-screw and thus binding the stem of screw 14, to advance or recede the carrier, with or without the slide 7, by rotating the sleeve 15, for which purpose said sleeve is provided with a radial arm 19, here shown as formed with a hub or collar encircling the sleeve and secured thereon by a set-screw 20.

The automatic ejecting device is brought into action only after the work has been ground to the predetermined extent, and after the governing or control-wheel 4 has been receded sufficiently to completely free the ground object. This is effected by bringing the objects to the ground to the machine with the latter adjusted to remove a definite quantity or thickness or metal, or to grind to a certain depth, and continuing the grinding until the object frees itself in the space between the grinding and governing or control-wheel, as is well understood in the art. It is desirable, however, that the automatic mechanism for separating the grinding and control-wheels be so constructed, arranged, and adjusted as to permit the grinding to continue a period of time adequate for completing the predetermined amount of grinding with, advisably, a slight margin or excess of time, to guard against premature actuation of the ejecting devices, which will now be described in detail.

As shown in Fig. 3, this ejecting device comprises a horizontal arm 21 secured upon or made integral with the base 5 of the work-rest, and having an internal longitudinal guideway to receive and permit reciprocation of a block 22 of polygonal cross section, and also to permit oscillation of a lever 23 fulcrumed between ears or lugs 24 projecting from one end of the base 5 of the work-rest. The arm or lever 23 is slotted or forked at its upper end to receive a horizontally-projecting pin or stud 25 carried by the sliding block 22. Said block 22 is secured upon a rod or stem 26 which projects through openings in the ends of arm 21, its inner end being provided with a head or bunter 27 movable lengthwise over and just above the beveled upper edge of the work-supporting blade or bar 6 in position to con-

tact with the leading end of the inserted work, and to push the finished work outward.

Carried in ears or guides 28 projecting from the base 5 of the work-rest is a rod 29 which carries at one end a radial arm 30, the outer end of which is preferably reduced and is carried through an elongated opening in the lower end of lever 23, so that if the rod 29 be longitudinally reciprocated it shall swing the lever 23 about its fulcrum, and move rod 26 and bunter 27 inward over the work-supporting plate or bar 6, causing the bunter to eject the work lying thereon and between the grinding and the governing wheels 3 and 4. A spring 31, here shown as of helical form and encircling rod 29, bears at one end against the ear 28 nearest the radial arm 30, and at its opposite end against a screw or stud 32, or other abutment on rod 29, and serves to return said rod and the arm 30 to the normal position in which they are shown in Fig. 3, this action in turn serving to retract or move outward rod 26 and bunter 27, thus leaving the work-supporting bar 6 clear and ready to receive a new article to be ground.

For the purpose of actuating the ejector and placing spring 31 under compression sufficient to restore the actuating devices to normal position, there is employed an oscillating shaft or rod 33 provided with a radial or crank-arm 34 having at its outer end a pin 35 which enters a vertical slot in the side of a block 36 secured upon the end of rod 29 opposite that which carries the arm 30. Shaft or rod 33 is carried at one end in a supporting arm or bracket 37, shown in Figs. 1 and 3, secured to slide 7, its opposite end passing through openings in ears 38 of a bracket 39 carried by the shell or carrier 11, and through the central opening of a disk or hub 40 placed between the ears 38.

The shaft 33 is longitudinally grooved to receive a key, rib or stud 41 seated in the wall of the central opening of disk 40, to permit relative axial movement of said disk and shaft. This provision is made in order that the carrier 11 and connected parts may be moved forward and backward upon the slide 7, or that the slide 7 may be moved forward and backward relatively to carrier 11, without disturbing the effective relation of shaft 33 and disk or hub 40. As seen in Figs. 2 and 4, the circumference of the disk or hub 40 is cut away at one point to leave a shoulder or abutment 42 for engagement by an overlying latch or dog 43 pivoted to swing vertically in a slot formed in a sliding bar 44 longitudinally movable in a guideway formed in the bracket 39, as best seen in Fig. 4.

To insure the prompt fall of the free end of latch 43 when it moves outward over the hub or disk 40, and its engagement with the shoulder or abutment 42 on the return movement, a spring 45 is advisably arranged to bear against the inner end of the latch above its pivot. The under side of bar 44 is cut away at the inner end of said bar, leaving an elongated recess, the outer wall of which forms a tooth 46 which is engaged by a bent rod or arm 47, Figs. 1 and 4, one end of which is threaded and screwed into a tapped hole in the oscillating arm 19, the threaded portion being provided with a jam-nut 48 to prevent the unscrewing or loosening and turning of the rod 47. This construction and arrangement of the rod 47 makes it possible to swing it about the threaded end as a pivot, and thus to vary the time of its engagement with the tooth 46 when the arm 19 swings toward said tooth.

To effect oscillation of arm 19 and consequent engagement of rod 47 with tooth 46 for moving bar 44 in a direction to turn hub or disk 40, and also for the purpose of oscillating the sleeve 15, there is provided the mechanism illustrated in Figs. 1 and 2. This comprises a motor 49, the base 50 of which is made fast to the top of carrier or shell 11, the armature shaft 51 being provided with a gear 52 which meshes with a pinion 53 on the shaft of a worm 54 journaled in a supporting standard 55, and meshing with a worm-wheel 56 carried by a shaft 57 journaled in bearings in the base of the supporting standard 55. Any suitable gear ratio may be employed between the motor shaft and worm-shaft, and the motor may if desired be provided with a rheostat or other usual means for varying and determining the speed of rotation of its armature and shaft, and consequently the speed of shaft 57. Shaft 57 will be caused to make one complete rotation for a predetermined number of rotations of the governing or control-wheel 4, which in turn will effect or permit a predetermined number of rotations of the work being ground, and this latter number will be such as shall insure the requisite and predetermined depth of grinding of the object treated.

Shaft 57 carries a crank-arm 58, the crank-pin 59 of which passes through an eye of one member 60 of a divided or two-part pitman, the second member 61 of which is similarly connected with a pin carried by the swinging end of oscillating arm 19, the two parts of the pitman being connected by a tubular sleeve 62, see Figs. 1 and 2. The pitman-section 60 fit and is movable through an opening in the upper end or head of sleeve 62, and carries within said sleeve a head or piston 63, while the section 61 is made fast in or to the lower end of said sleeve. Within the sleeve and abutting at its upper end against the piston or head 63 is a helical spring 64 which tends to hold

pitman section 60 at its outer limit relatively to the sleeve. The purpose and effect of this construction is to insure a dwell after full or complete movement of the oscillating arm 19 in its swing toward the bracket 38, or toward a fixed stop 65 placed in its path and serving to limit the throw of arm 19 in that direction. Its movement in the opposite direction is limited and determined by the length or radius of crank-arm 58, which should be slightly less than the radius of the arm 19, to the end that this arm and the pitman may never be completely alined, and that its proper oscillation shall be assured without any tendency to swing past a point at which the pitman will, at the proper time, reverse the swing of said arm 19.

As the arm 19 swings to the right (Figs. 2 and 3), the end of rod 47 engages the tooth 46 and moves the bar 44 longitudinally in an upward direction, or to the right as the parts are shown in Fig. 4. With the dog 43 in the position shown in said figure, with its shoulder or tooth 46 opposite the abutment 42 of disk 40, it will, soon after commencement of such movement, engage the latter, and as the movement continues cause a partial rotation of said disk and consequently of the shaft 33. This in turn will cause a swinging movement of the arm 34 near the opposite end of said shaft 33, and its pin 35, engaging a wall of the slot in block 36, will effect a longitudinal movement of rod 29, which through the arm 30 and lever 23 will effect a longitudinal movement of rod 26 and its bunter 27, causing the finished work to be ejected from its position on the work-supporting blade 6. As the movement of bar 44 continues, the flattened portion extending from the abutment 42 to the circumference of the disk 40, or a projection thereon, rising beneath the latch 43, will lift the same and effect a disengagement of the two teeth or abutments 42 and 66, whereupon spring 31, acting upon rod 29, will restore the ejector and its actuating devices to their normal positions, the normal position of the ejector being that indicated in Fig. 3. During the right-hand swing of arm 19, which effects the turning of disk 40 and shaft 33, sleeve 15 is turned about the then clamped or fixed screw 14, which is threaded in a direction to cause, on such turning, an outward movement of the carrier 11 and control-wheel 4, thus effecting a complete freeing of the finished object and permitting ejection thereof without resistance.

In order that the precise point in the rotation of disk 40 at which the dog 43 shall disengage it, may be nicely adjusted and determined, a trip-screw 67 is provided, the forward end of which passes through the flattened face of disk 40 extending from tooth or abutment 42 to the circumference, and by varying the extent of its projection beyond said face, the point or time of tripping may be varied as desired. The recess in the under side of bar 44, one wall of which constitutes the tooth 46, has at the opposite end a wall or shoulder 68, with which the bent rod 47 will make contact when swinging to the left, in the event that said bar 44 fails to move back to normal position through gravity. In this way a positive re-positioning of bar 44 and latch 43 is insured, and proper engagement of the latch 43 and disk 40 is made certain.

It is obvious that any suitable connection between the motor 49 and arm 19 which will give the latter a proper timing, may be employed.

With the parts constructed, arranged, and operating as above described, the attendant, after properly adjusting the work-rest and the governing or control-wheel relatively one to another, sets the grinding and governing wheels in motion, the motor 49 is started and caused to run at appropriate speed, and the work or object to be ground is placed in position upon the supporting blade 6. Shaft 57 turns to the right, and the grinding operation begins at or about the time that the crank-pin 59 of crank arm 58 is at its greatest distance from the pin of oscillating arm 19, at which time the telescoping pitman is at its greatest extension. Further rotation of shaft 57 carries the crank-arm 58 downward, and swings arm 19 to the left, permitting the bar 44 and latch 43 to ride outward over the disk 40, so that the tooth of the latch shall pass beyond and drop to engaging position with reference to the tooth or abutment 42 of the disk 40.

During this movement of oscillating arm 19 to the left or toward its stop 46, sleeve 15 to which arm 19 is secured as above explained, is rotated in a direction to advance the carrier 11 and the governing or control-wheel 4 toward the work, causing said wheel to press the work into contact with the grinding wheel 3, and rotating the work, or permitting it to rotate, at a definite and predetermined surface speed. As the grinding proceeds and sleeve 15 continues to turn, the governing wheel is advanced very gradually toward the grinding wheel, and this advance continues until oscillating arm 19 makes contact with and is arrested by stop 65, at which time, owing to the continuing movement of crank-arm 58 while the sleeve 62 is prevented from moving longitudinally, section 60 of the pitman telescopes with or slides into sleeve 62, compressing the spring 64 therein. The grinding and governing wheels, however, continue to rotate, but without any further inward movement or advance of the governing or control-wheel, and the grinding, if not already completed, will be completed

during the gradual compression of said spring, thus insuring the complete grinding of the object.

When the crank-pin 59 passes the line extending from the center of shaft 57 through the crank-pin of oscillating arm 19, at such time occupying the dotted line position indicated in Fig. 4, said arm 19 will remain at rest, while spring 64 expands and follows the withdrawing section 60 of the pitman. This condition will continue until the head or piston 63 of pitman section 60 reaches the upper or outer end of the sleeve 62, whereupon the oscillating arm 19 will be raised and carried to the position shown in Fig. 4, where it will engage with the tooth 46, move bar 44, and effect rotation of disk 40 and shaft 33, bringing about the train of movements above described, and effecting longitudinal reciprocation of rod 26 and bunter 27, thereby ejecting the work from the work-rest. This action, owing to the disengagement of latch 43 by the trip-screw 67, will be promptly followed by release of disk 40, and the return of the parts of the ejecting mechanism to normal position through expansion of spring 31.

The actual time required for the completion of this cycle of operations is in reality short, but there is afforded in each cycle adequate time for placing in position upon the work-supporting blade the object to be ground, which being done, the governing or control-wheel advances, the rotation of the work and its grinding begin, the governing or control-wheel is steadily advanced until the work has been sufficiently ground, at which instant the advance of the governing wheel stops and later it is moved away from the grinding wheel to release the work, the ejector is then actuated and the work discharged, the parts are restored to normal position, and the cycle is repeated.

The telescoping action of the two-part pitman and compression of its enclosed spring causes the oscillating arm 19 to remain at rest on its stop 65, and the sleeve 15 to be likewise held at rest during the time of compression and expansion of spring 64, which is not completed until crank-arm 58 approaches its point of greatest distance from the crank-pin of arm 19, which in turn occurs just after the tripping of latch 43 and the ejection of the finished work. As the crank-arm 58 passes a straight line passing through the center of pin 59, the axis of shaft 57, and the center of the pin connecting the pitman with arm 19, said arm 19 begins its swing to the left, causing advance of the governing wheel, rotation of the work, continuing and gradual advance of the governing wheel, and return of arm 19 to the dotted line position of Fig. 4, with the results already described.

A stop-pin or other projection 69 serves to limit the outward movement of bar 44.

We are aware that grinding machines in which the work is carried upon centers mounted upon a reciprocating slide or carriage, and receiving blanks automatically from a magazine or container, carrying them past a grinding wheel, and releasing them when ground, have heretofore been constructed and used. We are also aware that a similar construction except that the grinding wheel was caused to travel relatively to the work instead of the work travelling relatively to said wheel, has been employed. While machines of the character described are capable of turning out a considerable amount of well finished work in a given time, the machine here illustrated and described has far greater capacity, and grinds without the chattering which is difficult to avoid in grinding upon centers, particularly where such centers are, or either of them is, automatically advanced and receded relatively to the companion center, to clamp and release the work, and are necessarily required to move quite freely. Grinding the work while lying free upon a fixed rest or support between a grinding wheel on the one side and a governing or control wheel on the opposite side, and without axial movement of the work relatively to the grinder, or movement of the grinder longitudinally of the work, effects a more rapid removal of material, and better insures true circular form and uniformity of diameter throughout the grinding length, than is attainable by any other known construction.

While it is possible, and in some cases very desirable, to introduce the blanks or work and remove the finished objects, automatically, and such automatic in-feed as well as discharge is contemplated, it is not here shown or described in detail, but will probably be presented in an independent application. It is possible under the construction shown to introduce the work manually, and to advance and recede the governing or control-wheel manually, by detaching the pitman 60—61 from the oscillating arm 19 and swinging said arm by hand, the parts retained acting in the same manner as when actuated by power.

Various changes may be made in details of the structure here shown without departing from the spirit or scope of this invention. Thus a simple stud or pin may be substituted for the arm or bent rod 47, and set in one or another of a series of holes in arm 19. Other forms of trip mechanism may be employed instead of the disk 40, latch 43, and latch-bar 44, and the governing or control wheel carrier 11 may be moved by other well-known means instead of by the screw 14 and sleeve 15. The embodiment of our invention here set forth

is the best at present known to us and is found to operate satisfactorily, and to produce perfect work, but is illustrative only and subject to such modification as may be made by skillful designers and mechanicians, within their own calling and without invention.

In the structure here illustrated the grinding wheel moves downward toward the work and work-rest and the governing or control-wheel moves upward relatively thereto, the grinding wheel at high surface speed and the governing or control-wheel at relatively low surface speed. This is attained by any suitable ratios between the driving pulleys and the driven pulleys, as is well understood in the art. The governing wheel is journaled in a bearing or bearings in the shell or carrier 11, but preferably, as shown, in a separate extension 71 which is arranged to tip about a horizontal pivot bolt 72 to permit a slight tilting of the governing wheel axis relatively to that of the grinding wheel and of the object ground, so that the machine may, when desired, be used to feed objects axially during the grinding, as is now done in centerless grinding machines of this general type. The extension 71 is clamped in its adjusted positions, first by means of the bolt 72, and second, by means of a clamping bolt 73 which engages an arcuate slot in one of the clamped members. The details of this construction are not a part of the present invention and any equivalent structure might be substituted, it being common in the centerless grinding art to mount the governing wheel for such angular adjustment. The grinding wheel shaft or arbor is carried in a sleeve or bearing supported upon the main frame.

While there is shown and it is preferred to provide, a separate motor for moving the adjustable element of the grinding couple toward and from its companion, and for actuating the ejector, it is obvious that power may be taken from some continuously rotating member or element of the grinding machine for that purpose, and the claims are to be read with this understanding. In other words, the term "motor" as used in the claims comprehends and includes any continuously rotating element of the complete grinding machine, from which the requisite power may be taken and the necessary movements given, to actuate oscillating arm 19.

It is found advantageous with certain classes or forms of work to give a very slight inclination to the governing-wheel arbor, sufficient to maintain the leading or inner end of the object in contact with the bunter 27 so long as the grinding continues.

What we claim is:—

1. A centerless grinding machine comprising, in combination, a grinding wheel; a governing or control-wheel; in intermediate work-rest or support; means for progressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground.

2. A centerless grinding machine, comprising a grinding wheel; a governing or control-wheel peripherally opposed to the grinding wheel; a work-rest or support intermediate said wheels, said wheels having their axes parallel; means for rotating the grinding and governing wheels about their respective axes in one and the same direction, the grinding wheel at a relatively high speed and the governing wheel at a relatively low speed; means for varying the distance between the proximate peripheral faces of said wheels; and means for automatically removing the work from the work-rest between said wheels when the grinding is completed.

3. A centerless grinding machine, comprising a grinding wheel and a governing or control-wheel peripherally opposed, said wheels having their axes in common plane; means for rotating said wheels about their respective axes in one and the same direction, the grinding wheel at relatively high speed and the governing wheel at relatively low speed; a work-rest between the effective operating faces of said wheels, upon which rest the work lies without axial movement during the grinding; means for varying the distance between the opposed working faces of the wheels; and means for automatically removing the work from the work rest when the grinding is completed.

4. A grinding machine, comprising a grinding element; a governing or control element; an intermediate work-rest or support; means for driving the grinding and the governing elements, the grinding element moving downward toward the work-rest at relatively high speed, and the governing element moving upward toward the work-rest at relatively low speed; means for automatically and progressively advancing one of said elements toward the other gradually and to a predetermined extent, and thereafter separating said wheels to their original distance; and means for automatically ejecting the work after the wheels have approached to the predetermined minimum distance of separation, and after the movement of separation has begun.

5. A grinding machine, comprising a grinding element; a governing or control element; an intermediate work-rest or support; means for driving the grinding and the governing elements, the grinding element moving downward toward the work-rest at relatively high speed, and the govern-

ing element moving upward toward the work-rest at relatively low speed; means for automatically and progressively advancing one of said elements toward the other gradually and to a predetermined extent, and thereafter separating said wheels to their original distance; a motor connected with said advancing and receding means, and serving automatically to actuate and to reverse the same; and means for automatically removing the work from the work-rest during the separating movement.

6. In combination with a grinding and a governing element; means for rotating the same in proper direction and at suitable relative speeds; a work-rest intermediate the grinding and the governing elements and serving to support the work while being ground; a bunter movable over the work-rest in line with the axis of the work to be ground; an oscillatory shaft mounted in bearings, carrying a toothed disk, and connected with said bunter substantially as described, to effect a reciprocatory movement of the bunter over the work-rest; a motor; an oscillatory arm connected with and oscillated by said motor; a projecting stud carried by the oscillating arm; a sliding bar engageable by said stud; and a latch carried by said bar and provided with a tooth to engage the tooth of the disk, whereby said disk and shaft may be turned to actuate the bunter.

7. In combination with a grinding and a governing element; means for rotating the same in proper direction and at suitable relative speeds; a work-rest intermediate the grinding and the governing elements and serving to support the work while being ground; a bunter movable over the work-rest in line with the axis of the work to be ground; an oscillatory shaft mounted in bearings, carrying a toothed disk, and connected with said bunter substantially as described, to effect a reciprocatory movement of the bunter over the work-rest; a motor; an oscillatory arm connected with and oscillated by said motor; a projecting stud carried by the oscillating arm; a sliding bar engageable by said stud; a latch carried by said bar and provided with a tooth to engage the tooth of the disk, whereby said disk and shaft may be turned to actuate the bunter; and a stud or shoulder upon the disk serving at a given point in its rotation to release the latch from engagement with said disk.

8. In combination with a grinding and a governing element; means for rotating the same in proper direction and at suitable relative speeds; a work-rest intermediate the grinding and the governing elements and serving to support the work while being ground; a bunter movable over the work-rest in line with the axis of the work to be ground; an oscillatory shaft mounted in bearings, carrying a toothed disk, and connected with said bunter substantially as described, to effect a reciprocatory movement of the bunter over the work-rest; a motor; an oscillatory arm connected with and oscillated by said motor; a projecting stud carried by the oscillating arm; a sliding bar engageable by said stud; a latch carried by said bar and provided with a tooth to engage the tooth of the disk, whereby said disk and shaft may be turned to actuate the bunter; a stud or shoulder upon the disk serving at a given point in its rotation to release the latch from engagement with said bunter; and a spring for restoring the bunter and connected parts to their normal position.

9. In combination with a grinding and a governing element; means for rotating the same in proper direction and at suitable relative speeds; a work-rest intermediate the grinding and the governing elements serving to support the work while being ground; a bunter movable over the work-rest in line with the work to be ground; an oscillatory shaft mounted in bearings and connected with said bunter substantially as described, to effect a reciprocatory movement of the bunter over the work-rest; an oscillatory arm; a projecting stud carried by said arm; a sliding bar engageable by said stud; a latch carried by said bar and adapted alternately to engage, partially rotate, and release the oscillatory shaft; and a continuously rotating element connected with and serving to reciprocate the latch-carrying bar.

10. In combination with a suitable frame or base provided with a longitudinal guideway; a slide mounted and movable longitudinally upon said guideway and itself provided with a longitudinal guideway; means for clamping said slide upon and releasing it from the first-mentioned guideway; a shell or carrier mounted and movable longitudinally upon the second guideway, and provided with means for clamping it to and releasing it from said guideway; a governing or control-wheel journaled in said carrier and movable therewith toward and from a grinding wheel mounted upon a shaft or arbor carried in a bearing or bearings upon the main frame of the machine; a work-rest carried by the slide and located between the opposed faces of the grinding and the governing wheels; an internally threaded sleeve swiveled in said carrier and having its axis parallel with the guideways of the bed and slide; a screw threaded to fit the thread of said sleeve and extending into the same; a bracket carried by the main frame, in which the outer end of the screw stem is swiveled; means for rotating said screw stem; means for rotating the

sleeve; and means for securing at will the screw stem or the sleeve against rotative movement; whereby the carrier or the carrier and the slide upon which it is mounted may be moved forward or backward by rotation of the sleeve or the screw, as desired.

11. In combination with a suitable frame or base provided with a longitudinal guideway; a slide mounted and movable longitudinally upon said guideway and itself provided with a longitudinal guideway; means for clamping said slide upon and releasing it from the first-mentioned guideway; a shell or carrier mounted and movable longitudinally upon the second guideway and provided with means for clamping it to and releasing it from said guideway; a governing or control-wheel journaled in said carrier and movable therewith toward and from a grinding wheel mounted upon a shaft or arbor carried in a bearing or bearings upon the main frame of the machine; a work-rest carried by the slide and located between the opposed faces of the grinding and the governing wheels; an internally threaded sleeve swiveled in said carrier and having its axis parallel with the guideways of the bed and slide; a screw threaded to fit the thread of said sleeve and extending into the same; a bracket carried by the main frame in which the outer end of the screw stem is swiveled; means for rotating said screw stem; means for rotating the sleeve; means for securing at will the screw stem or the sleeve against rotative movement; a work-ejecting bunter movable over and in line with the work-rest; an actuating shaft for said bunter, journaled at one end in a bearing upon and movable with the slide, and at its opposite end extending through ears movable with the governing-wheel carrier; a disk encircling said shaft, located between said ears, and slidable upon but incapable of rotation independently of the oscillatory shaft; and automatic mechanism for alternately engaging, partially rotating, and releasing said disk to effect oscillation of the shaft in one direction after the grinding is completed and the carrier has begun its outward movement, and to permit the return of the shaft and connected parts to normal position when released by the latch.

12. A grinding machine, comprising a grinding element and an opposed governing or control element, the latter mounted in a carrier movable toward and from the grinding element; a work-rest between the grinding and the governing elements; an ejector movable over and in proximity to the work-supporting face of said rest; an actuating shaft connected with and serving to move the ejector in one direction over the work-rest; means mounted upon and movable with the governing-wheel carrier for periodically imparting a partial rotation to said shaft in one direction; means for restoring said shaft and connected parts to their normal positions; and means for automatically advancing and receding the governing-wheel carrier periodically a predetermined distance, the connections between the oscillating shaft and its actuating mechanism being such as to permit movement of the actuating devices in the direction of said shaft without disturbing the operative relation of said shaft and its actuating devices.

13. In a grinding machine, a grinding element and an opposed governing or control element, one mounted for rotation in a carrier movable toward and from the other; a slide provided with guideways upon which said carrier is mounted and movable; guideways upon the main frame of the machine upon which said slide is guided and movable; a work-rest carried by said slide and extending into the space between the grinding and the governing elements; means for locking the carrier to the slide and for releasing it therefrom at will; means for locking the slide to the guideway on the frame and releasing it therefrom; and means for moving the carrier toward and from the work-rest, both with the slide when locked thereto, and independently of the slide when unlocked therefrom.

14. A centerless grinding machine comprising in combination, a grinding wheel; a governing or control-wheel; an intermediate work-rest or support; means for progressively advancing and receding one of said wheels toward and from the other; means for automatically removing the work from between said wheels after it is completely ground; and means for causing the work being ground to maintain contact with the bunter until ejected.

15. A centerless grinding machine comprising in combination, a grinding wheel; a governing or control-wheel; an intermediate work-rest or support; means for progressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground, the governing wheel being capable of having its axis tilted out of parallel relation to that of the grinding wheel, whereby the inner or leading end of the object ground will be maintained in contact with the ejecting bunter until ejection takes place.

16. A centerless grinding machine comprising, in combination, a grinding wheel; a governing or control-wheel; an intermediate work-rest or support; means for pro-

gressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground, the governing wheel having its axis tilted slightly out of parallel relation to that of the grinding wheel, and in a direction to cause the object ground to maintain contact with the ejecting bunter until ejection occurs.

In testimony whereof we have signed our names to this specification.

SOL EINSTEIN.
LESTER F. NENNINGER.
WALTER D. ARCHEA.

gressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground, the governing wheel having its axis tilted slightly out of parallel relation to that of the grinding wheel, and in a direction to cause the object ground to maintain contact with the ejecting bunter until ejection occurs.

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DISCLAIMER.

1,575,558.—*Sol Einstein* and *Lester F. Nenninger*, Cincinnati, Ohio, and *Walter D. Archea*, Norwood, Ohio. CENTERLESS GRINDING MACHINE. Patent dated March 2, 1926. Disclaimer filed March 8, 1929, by the patentees, the assignee by mesne assignments, *Cincinnati Grinders Incorporated*, assenting and concurring.

Hereby enter this disclaimer to the subject matter of claims 1, 2, and 3 in the said specification, which claims read as follows:

"1. A centerless grinding machine comprising, in combination, a grinding wheel; a governing or control-wheel; an intermediate work-rest or support; means for progressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground.

"2. A centerless grinding machine, comprising a grinding wheel; a governing or control-wheel peripherally opposed to the grinding wheel; a work-rest or support intermediate said wheels, said wheels having their axes parallel; means for rotating the grinding and governing wheels about their respective axes in one and the same direction, the grinding wheel at a relatively high speed and the governing wheel at a relatively low speed; means for varying the distance between the proximate peripheral faces of said wheels; and means for automatically removing the work from the work-rest between said wheels when the grinding is completed.

"3. A centerless grinding machine, comprising a grinding wheel and a governing or control-wheel peripherally opposed, said wheels having their axes in common plane; means for rotating said wheels about their respective axes in one and the same direction, the grinding wheel at relatively high speed and the governing wheel at relatively low speed; a work-rest between the respective operating faces of said wheels, upon which rest the work lies without axial movement during the grinding; means for varying the distance between the opposed working faces of the wheels; and means for automatically removing the work from the work-rest when the grinding is completed."

[*Official Gazette April 9, 1929.*]

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1,575,558.—*Sol Einstein* and *Lester F. Nenninger*, Cincinnati, Ohio, and *Walter D. Archea*, Norwood, Ohio. CENTERLESS GRINDING MACHINE. Patent dated March 2, 1926. Disclaimer filed March 8, 1929, by the patentees, the assignee by mesne assignments, *Cincinnati Grinders Incorporated*, assenting and concurring.

Hereby enter this disclaimer to the subject matter of claims 1, 2, and 3 in the said specification, which claims read as follows:

"1. A centerless grinding machine comprising, in combination, a grinding wheel; a governing or control-wheel; an intermediate work-rest or support; means for progressively advancing and receding one of said wheels toward and from the other; and means for automatically removing the work from between said wheels after it is completely ground.

"2. A centerless grinding machine, comprising a grinding wheel; a governing or control-wheel peripherally opposed to the grinding wheel; a work-rest or support intermediate said wheels, said wheels having their axes parallel; means for rotating the grinding and governing wheels about their respective axes in one and the same direction, the grinding wheel at a relatively high speed and the governing wheel at a relatively low speed; means for varying the distance between the proximate peripheral faces of said wheels; and means for automatically removing the work from the work-rest between said wheels when the grinding is completed.

"3. A centerless grinding machine, comprising a grinding wheel and a governing or control-wheel peripherally opposed, said wheels having their axes in common plane; means for rotating said wheels about their respective axes in one and the same direction, the grinding wheel at relatively high speed and the governing wheel at relatively low speed; a work-rest between the respective operating faces of said wheels, upon which rest the work lies without axial movement during the grinding; means for varying the distance between the opposed working faces of the wheels; and means for automatically removing the work from the work-rest when the grinding is completed."

[*Official Gazette April 9, 1929.*]