A. B. LANDIS.

GRINDING MACHINE.

APPLICATION FILED NOV. 27, 1906. RENEWED AUG. 31, 1909.

945,467. **Patented Jan. 4, 1910.**

3 SHEETS—SHEET 1.

Fig. 1.

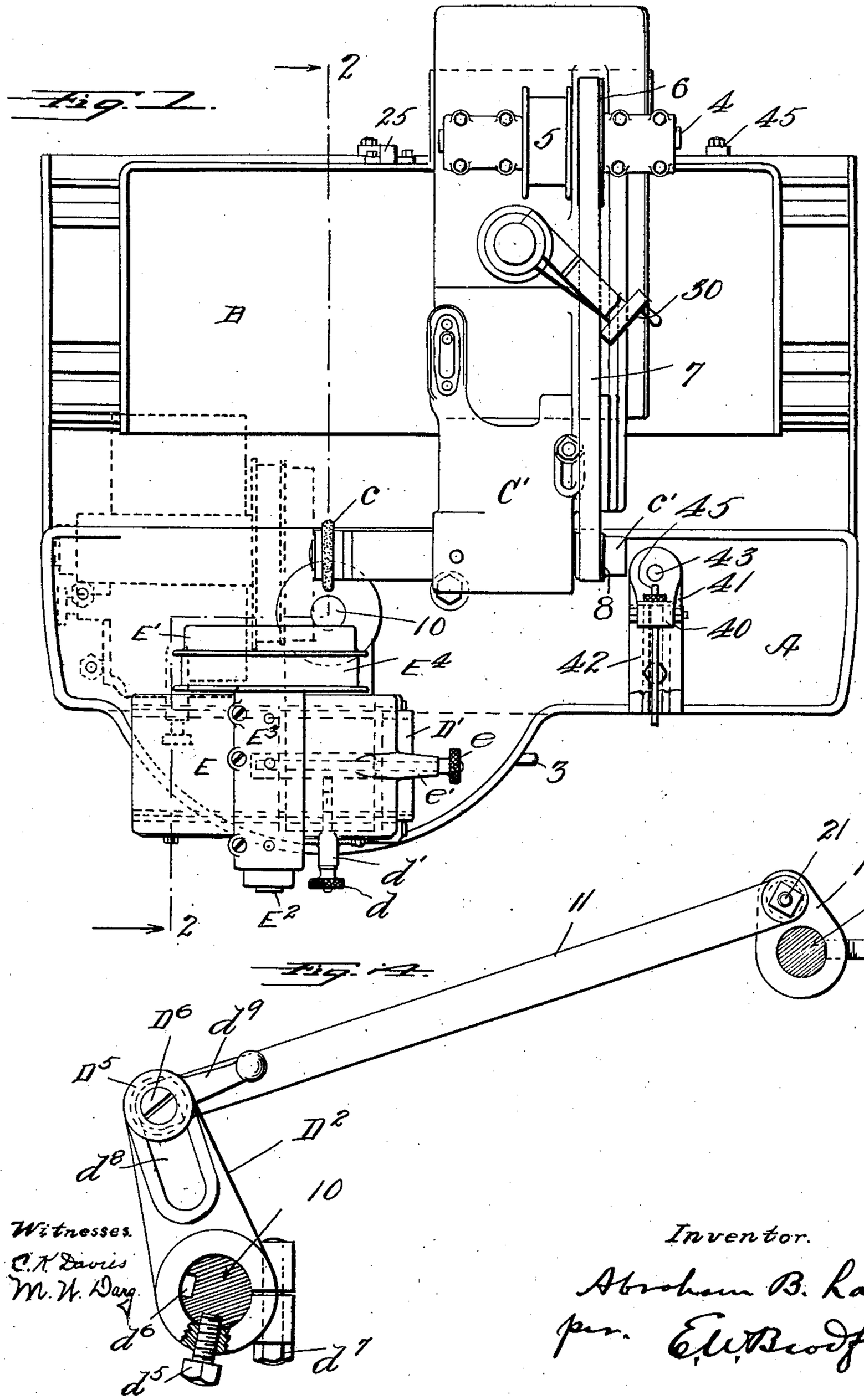

Fig. 2.

Witnesses.
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3 SHEETS—SHEET 2.

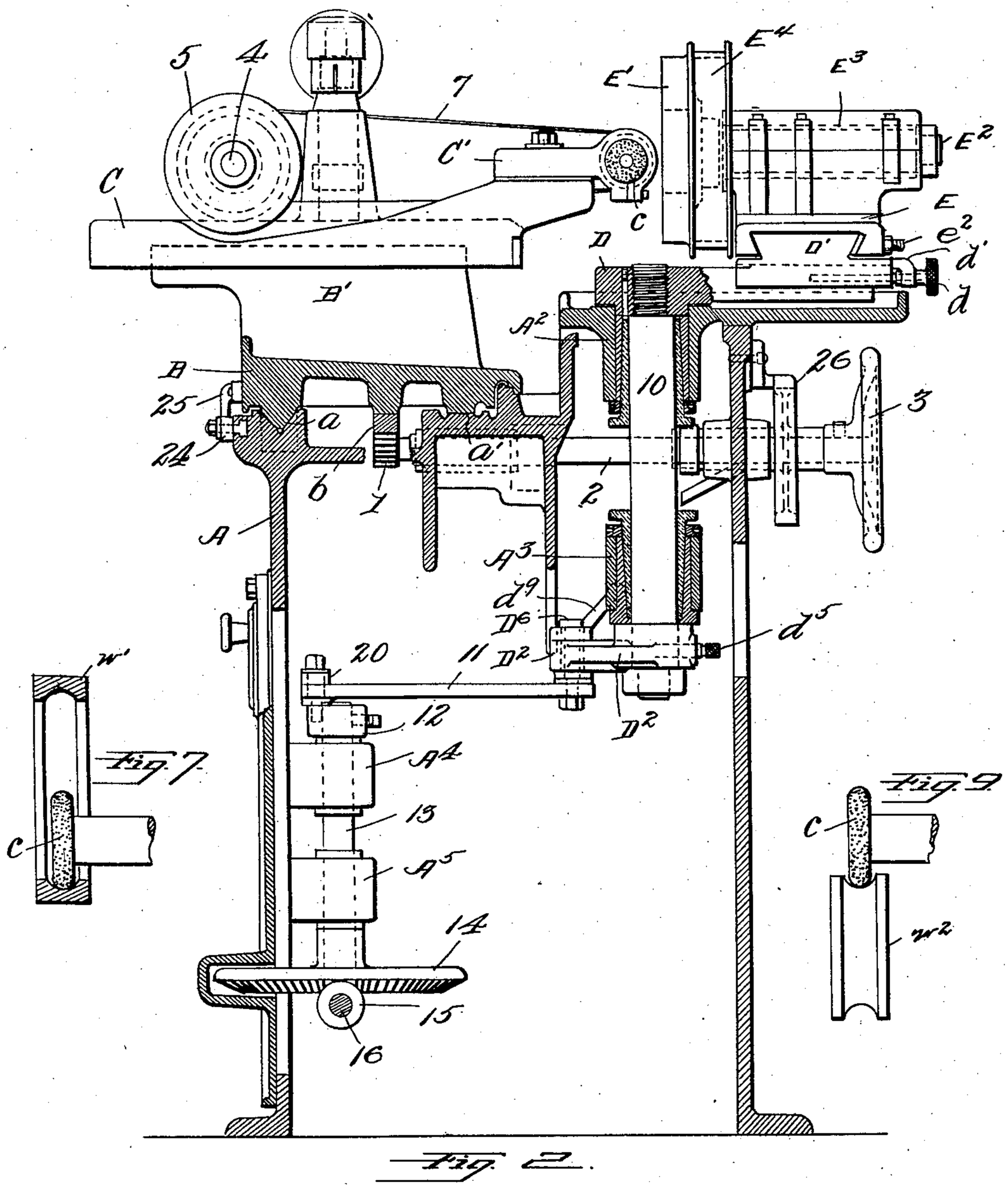

Fig. 2.

Fig. 7.

Fig. 9.

Fig. 8.

Witnesses.

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3 SHEETS—SHEET 3.

Fig. 3.

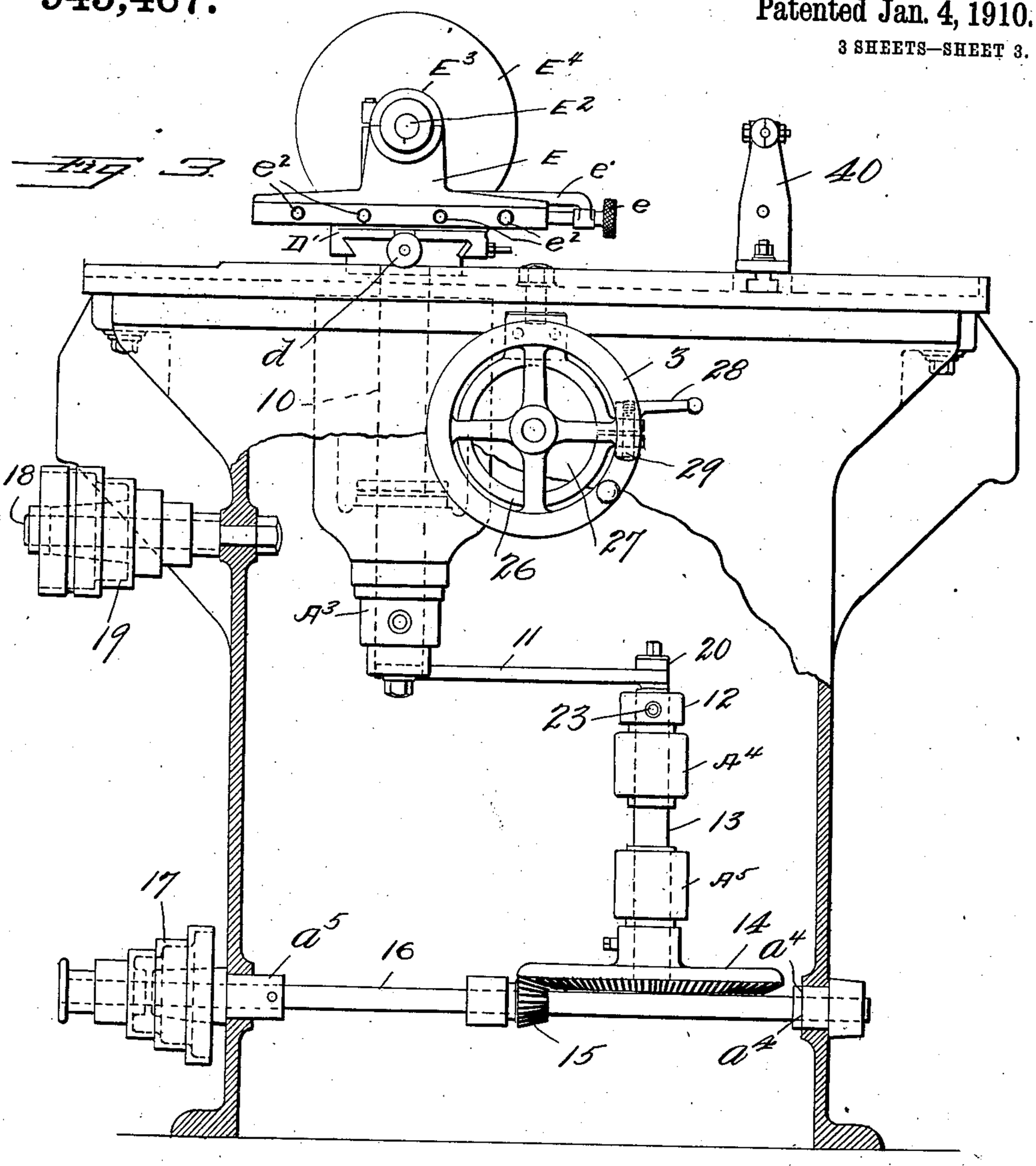


Fig. 5.

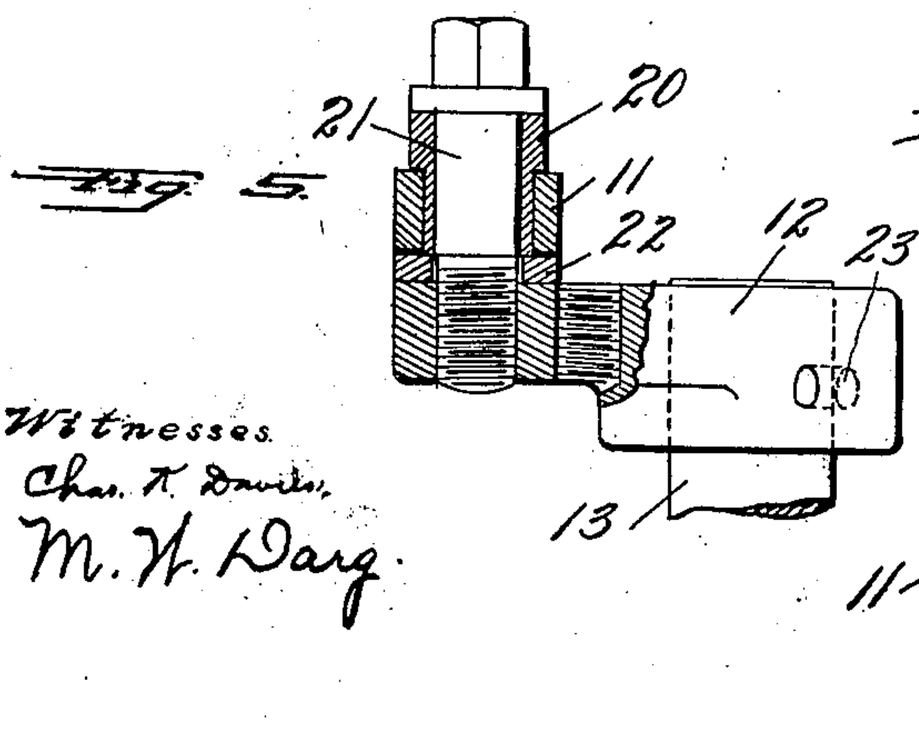
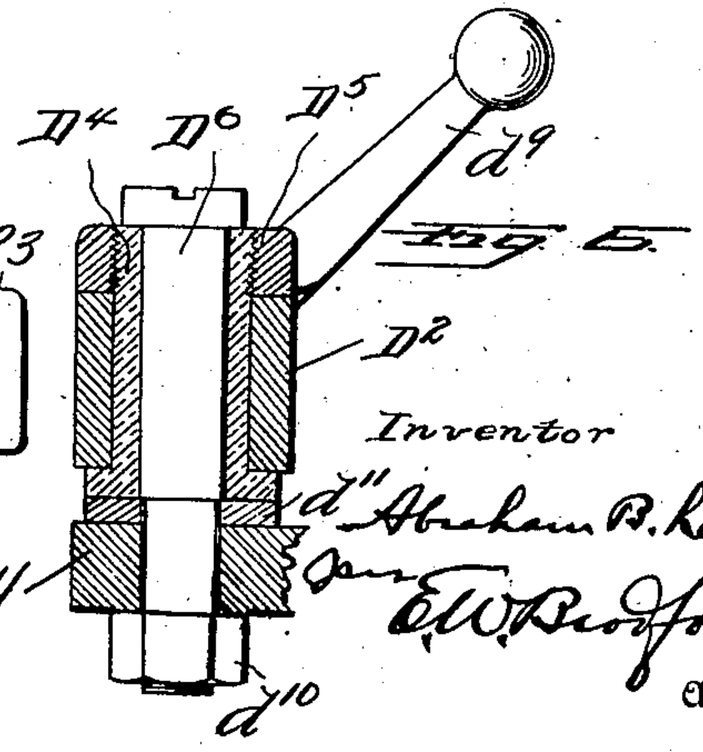


Fig. 6.



Witnesses.
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UNITED STATES PATENT OFFICE.

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GRINDING-MACHINE.

945,467. Specification of Letters Patent. Patented Jan. 4, 1910.

Application filed November 27, 1906, Serial No. 345,393. Renewed August 31, 1909. Serial No. 515,436.

To all whom it may concern:

Be it known that I, ABRAHAM B. LANDIS, a citizen of the United States, residing at Waynesboro, in the county of Franklin and State of Pennsylvania, have invented certain new and useful Improvements in Grinding-Machines, of which the following is a specification.

My said invention consists in certain improvements in grinding machines whereby such a machine is provided which is particularly adapted for grinding ball-races for bearings where balls are used, and such like circular grooves, all as will be hereinafter more fully described and claimed.

Referring to the accompanying drawings which are made a part hereof and on which similar reference characters indicate similar parts, Figure 1 is a top plan view of a grinding machine embodying my said invention, Fig. 2 a transverse vertical section through the same looking in the direction indicated by the arrows from the dotted line 2—2 in Fig. 1, Fig. 3 is a front elevation with a portion of the casing broken away to show the interior arrangement more clearly, and Figs. 4, 5, 6, 7, 8 and 9 detail views illustrating details of construction and operation more clearly.

In the drawings the portions marked A represent the main frame of the machine, B the grinding wheel carriage, C the slider, D the table carrying the work holding mechanism, and E the carriage carrying the work holding clutch.

The main frame A is a hollow casting of suitable form to support the several parts and provided with bearings for the several shafts as will be presently described. On one side it is formed with suitable ways *a a'* on which the carriage B is mounted and adapted to slide.

The carriage B is of suitable form to support the grinding wheel mechanism upon the ways *a a'* on the bed A and is provided on its underside with a rack bar *b*, with which a pinion 1 on a transverse shaft 2 engages. Said shaft 2 is mounted in suitable bearings in the bed A and has a hand wheel 3 on its outer end by which it may be turned to traverse the carriage back and forth upon the bed A to bring the grinding wheel to the desired positions.

The slider C is mounted in the usual or any approved manner upon a traverse slide B' provided on the carriage B and has a base C' secured to its forward end in which bearings are provided for the spindle *c'* of the grinding wheel *c*. A driving shaft 4 is mounted in suitable bearings on the top of the slider C and provided with a belt pulley 5 by which it may be geared to any suitable power shaft. Said shaft 4 is also provided with another pulley 6 connected by a belt 7 with a pulley 8 on the grinding wheel spindle *c'*, for driving said grinding wheel. The mechanism for moving said slider back and forth on the slide B' to carry the grinding wheel to and from the work is operated by the hand wheel 30 and may be similar to that shown in several of my former patents, such as shown in Figs. 3 and 4 of Patent 640,699, for example, and is not particularly illustrated herein, being well understood by those familiar with the art.

The work supporting table D is mounted rigidly upon the top end of a vertical shaft 10, which is journaled in suitable bearings A^2 and A^3 rigidly connected with the bed or frame A. Said table D extends to one side of the axis of said shaft 10 and has a slide D' adjustably mounted thereon by means of a screw *d* which is held in a bracket *d'* on the side of said part D' and engages a screw-threaded perforation in part D. The top of said part D' has transverse ways on which the carriage E is mounted. The lower end of shaft 10 has a crank-arm D^2 rigidly secured thereto and connected by a pitman 11 with a crank-arm 12 on the top of a shaft 13, which is journaled in bearings A^4 and A^5 on the opposite side of the bed A. A gear wheel 14 is mounted on the lower end of said shaft 13 which is adapted to mesh with a gear 15 on a shaft 16 which is mounted in suitable bearings a^4 and a^5 in opposite sides of the bed A and has a cone pulley 17 on its outer end by which it may be geared by a belt (not shown) to suitable driving power, preferably through a counter-shaft 18 mounted near the top of the frame having a similar cone-pulley 19 thereon.

The work-holding carriage E is mounted and adapted to slide upon the slide D' on the table D and may be held in adjusted position by means of transverse set-screws e^2 mounted in screw-threaded perforations in one of the flanges and adapted to impinge against one side of the way on said slide D'. A screw *e* held in a bracket *e'* on the end of

carriage E engages with a nut carried by slide D′ and thus serves as a means for adjusting said carriage back and forth.

The work-holding chuck E′ is or may be of any suitable or approved form for holding the character of work for which the machine is intended and is mounted upon a shaft E^2 in suitable bearings E^3 provided on the carriage E. A belt pulley E^4 is provided on shaft E^2 adjacent to said chuck by which it may be driven by a belt gear from any suitable power.

In Figs. 7, 8 and 9 I have illustrated different forms of work which this machine is intended to do. In Fig. 8 the grinding wheel *c* is shown as operating in an annular grcove in the face of a plate *w*. The parts of the machine adjusted as shown by whole lines in Fig. 1 are in the position required to do this particular work. In Fig. 7 I show the grinding wheel *c* as operating in a groove in the inside edge of a ring *w′*. The position of the work-holding table for doing this character of work is illustrated by dotted lines in Fig. 1. The work consisting of the ring *w′* being held by the work-holding chuck E′, as will be readily understood. In Fig. 9 the grinding wheel *c* is shown as operating in a groove in the circumference of a disk w^2. The work-holding carriage will be in the same relative adjustment for this work as shown by dotted lines in Fig. 1 except that the carriage E must be adjusted on the slide D′ to bring the center of the work directly over the axis of the shaft 10 carrying the work-holding carriage.

In the operation of the machine the work, whether it be of the form shown in Figs. 7, 8 or 9, is mounted in the work-holding chuck E′ in the usual and well known manner and the carriage E and work-holding table D are adjusted to bring the center of the circle describing the curve of the groove to be ground directly over the center of the axis of the upright shaft 10 which carries said work-holding table. These adjustments are secured by swinging the work-holding table D to either the position shown by whole lines or that shown by dotted lines in Fig. 1, according to whether the ball-race or groove is to be ground in the face of the work, as shown in Fig. 8, or in the edge of the work as shown in Fig. 7 or 9. This adjustment is secured by backing the locking screw d^5 (which is mounted in a screw-threaded perforation in the end of the arm D^2) out of engagement with a notch d^6, two of which are formed at right angles to each other in the sides of the shaft 10 where it extends into said arm D^2. The clamping screw d^7, which extends through ears on opposite sides of a slot in one side of the eye in arm D′ which receives said shaft 10, is also loosened, which thus permits said shaft 10 to turn freely in said arm D^2. Said shaft and the table carried upon its upper end is then swung from one position to the other as may be required by the work which is to be done by the machine and the set-screw d^5 is turned to engage with the other one of the notches d^6 and the set-screw d^7 is turned up tightly, which thus locks arm D^2 rigidly in this position on the lower end of said shaft 10. Said arm D^2 being connected by the pitman 11 to the crank-arm 12 on the shaft 13 and said shaft 13 being driven through the gears 14 and 15 from the driving shaft 16, the upright shaft 10 is given a rocking or vibratory movement as will be readily understood, and the work *w w′* or w^2, being held with its center directly above the axis of said shaft 10, is given a true vibratory movement around the operating face of the grinding wheel *c*, which being at the same time in rapid rotary motion grinds the groove with a face of a true curve in cross section as well as of a true circle in form. The length of the vibratory or rocking movement of shaft 10 may be regulated by adjusting the operating length of the arm D^2 by means of an adjustable connection with pitman 11 which is most clearly illustrated in Figs. 4 and 6. Said arm D^2 is formed with a slot d^8 in which is mounted a bearing D^4 having an annular flange around its lower end adapted to engage with the lower edge of said arm D^2 and formed screw-threaded at its upper end and provided with a nut D^5 having a handle d^9 by which it may be turned and thus firmly clamp said bearing D^4 in any desired adjustment in said slot d^8. The pitman 11 is journaled on the lower end of a bolt D^6 mounted in bearing D^4 and having a nut d^{10} on its lower end between which and a washer d^{11}, said pitman 11 is held and adapted to pivot. Thus by backing the nut d^5 by means of handle d^9 the bearing D^4 is loosened and may be slid back and forth in the slot D^8 to secure the length of throw or sweep of the arm D^2 desired, and when the proper adjustment is secured the parts may be locked in this position by turning said nut by means of said handle to clamp said bearing securely to the top and the lower edges of said arm. The opposite end of pitman 11 is pivoted to the crank-arm 12 in a similar manner as shown most clearly in Fig. 5. The pitman 11 has a sleeve 20 mounted in a perforation therein through which a bolt 21 is inserted, the lower end of said bolt 21 being screw-threaded and adapted to screw into a screw-threaded perforation in said arm 12. A washer 22 is interposed between the face of said arm 12 and the lower end of said sleeve 20 so that the pitman 11 is left free to pivot on said sleeve between said washer and a shoulder near the upper end thereof. Said crank-arm 12 is secured to the upper end of a shaft 13 by means of a set-screw 23. It will thus be seen that the throw of the crank-arm D^2 may be accurately adjusted

to suit any conditions or requirements of the work.

The grinding wheel *c* when in operative position is always in the position shown in Fig. 1 the work being adjusted to the grinding wheel in this position directly on a line with the axis of the shaft 10. A stop 24 is mounted in a longitudinal groove on the back of the frame A in position to be contacted by a strike 25 secured on the back of carriage B which stop is adjusted to that position which will limit the movement of the carriage to bring the grinding wheel to the correct operative position. Said carriage B, after being adjusted through the medium of the shaft 2 with the pinion 1 thereon engaging with the rack *b*, may be locked in a proper adjustment by means of a band-brake 26 which is carried on the frame A and encircles a brake-wheel 27 rigidly mounted on said shaft 2. Said brake 26 is operated by a hand lever 28 having a nut on its end which engages with the upper end of a clamping bolt 29 which projects through perforations in the two adjacent ends of the brake as shown most clearly in Fig. 3.

In order to provide that the face of the grinding wheel *c* may be kept of a true curve and in condition for doing the work in a most advantageous manner, I have shown a "diamonding" tool mounted directly upon the machine in position to be readily used at any time for dressing off the face of said grinding wheel. Said tool consists of a standard 40 mounted on a base 41 which base is mounted to slide on a transverse way 42 on the top of bed A near the end opposite the shaft 10. Said standard is pivoted to the base 41 on a pivot 43 and adapted to be swiveled thereon by means of a handle 44. A stud 45 with a diamond on its front end is carried by said standard near its top in position to be opposite the axis of the shaft *c'* carrying the grinding wheel *c*. In operation the carriage B is run back upon the ways on the top of frame A until the arm 25 strikes another stop 46, which is also mounted in the groove near the top of said frame, as is the stop 24, and is adjusted to that position to limit the rearward movement of said carriage B to bring the center of the grinding wheel *c* opposite the axis of the pivot 43 of the diamonding tool. The carriage C is then moved forward by means of the hand wheel 30 until the face of the grinding wheel will contact with the diamond of the tool, which tool is swiveled on its pivot 43 by means of the handle 44 to travel back and forth across the face thereof. Said wheel being in rapid rotation the diamond operates to remove any imperfections and dress off said face to a true curve very quickly and put it in perfect operative condition and to conform with the circle to be ground as the radius of the swing of the tool may be adjusted to suit. It will thus be seen that the grinding wheel may be very conveniently kept in order, as at any time during the operation upon any piece of work when its condition becomes unsatisfactory the operator is enabled to quickly run the carriage B to the stop 45 and by a few vibrations of the diamonding tool across the face of said wheel correct any irregularity and put it in perfect form. By this means grooves of a true form for ball-races in different kinds of mechanism where such structures are used may be quickly and perfectly formed by grinding, as will be readily understood.

Having thus fully described my said invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A grinding machine, for grinding curved surfaces, comprising a frame, the grinding wheel carriage, means for adjusting said carriage, the grinding wheel base mounted thereon, said grinding wheel, means for driving the same, a work supporting table mounted on a pivot or shaft, means for adjustably holding the work on said table with the axis of the curve of the work in line with the axis of said pivot, and means for rocking said table on its pivot, substantially as set forth.

2. In a grinding machine, the combination of the frame, the grinding wheel carriage mounted thereon, the grinding wheel mounted on a spindle and journaled in suitable bearings in a base mounted on said carriage, the work holding table comprising a supporting arm mounted at one end upon a vertical shaft, work holding devices mounted upon its opposite end, and means for vibrating or rocking said shaft to carry the work in a curved path across the face of the grinding wheel, substantially as set forth.

3. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted and geared to be driven, a vertical shaft, a work supporting table mounted upon said vertical shaft, adjustable work holding devices mounted on said table, means for adjusting and securing the work at a point in line with the axis of said vertical shaft, means for adjusting and securing the grinding wheel at a point in line with the axis of said vertical shaft, and means for automatically rocking said vertical shaft, substantially as set forth.

4. In a grinding machine, the combination of the frame, the grinding wheel carriage mounted in suitable ways thereon, means for traversing said carriage back and forth, means for locking said carriage in any adjusted position, a slider mounted on a transverse way on the top of said carriage, means for adjusting said slider back and

forth, the grinding wheel base on said slider carrying the bearing for the grinding wheel spindle, the grinding wheel spindle mounted in said bearing. the grinding wheel on said spindle, means for driving said spindle, the work supporting table mounted on a vertical shaft, means for clamping the work on said table, and means for rocking said pivot or shaft to carry the work in a curved path across the face of said grinding wheel, substantially as set forth.

5. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted on one side thereof, means for adjusting and driving said grinding wheel, the work supporting table mounted upon the opposite side of the frame on a vertical shaft, gearing driven from the machine driving shaft for rocking said shaft to swing said table in the arc of a circle around its axis, the work holding devices on said table, and means for adjusting said work holding devices to bring the work in line with the axis of said shaft, substantially as set forth.

6. In a grinding machine, the combination of the frame, the grinding wheel carriage, the grinding wheel suitably mounted thereon, means for adjusting the parts carrying said grinding wheel, means for driving said grinding wheel, the work supporting table mounted on a vertical shaft, means for holding the work mounted on said table, means for adjusting the work holding devices to bring the work in line with the axis of said shaft, a crank-arm on the lower end of said shaft, a second vertical shaft on the opposite side of the machine geared to a power shaft and having a crank-arm on its upper end, and a pitman connecting the crank-arm to said second shaft, substantially as set forth.

7. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted thereon, means for driving said grinding wheel, the work supporting table mounted on a vertical shaft, means for holding the work adjustably mounted on said table, a crank-arm secured to the lower end of said shaft and provided with means for securing it to said shaft in different positions, and means connected with said crank-arm for rocking or vibrating said shaft, substantially as set forth.

8. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted thereon, means for driving said grinding wheel, the work supporting table mounted on a vertical shaft, the work holding devices adjustably mounted on said table, means for rocking said shaft, and means for swinging and securing said table to a normal position either to hold the face of the work parallel with the axis of the grinding wheel or at right angles thereto, substantially as set forth.

9. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted thereon, means for driving said grinding wheel, the work supporting table mounted on a vertical shaft, a crank-arm secured to the lower end of said shaft by means which may be secured to said shaft in different positions to secure the normal position of the table in different relative positions to the grinding wheel, and means connected therewith for imparting a vibratory motion to said shaft, substantially as set forth.

10. In a grinding machine, the combination of the frame, the grinding wheel suitably mounted thereon, means for driving said grinding wheel, the work supporting table mounted on a vertical shaft, means for holding the work adjustably mounted on said table, a crank-arm secured to the lower end of said shaft, a pitman one end of which is adjustably secured in a slot in said crank-arm and its other end secured to a crank-arm mounted on another shaft, and means for driving said other shaft whereby a vibratory or rocking movement is imparted to the shaft carrying said work supporting table, substantially as set forth.

11. In a grinding machine, the combination of the frame, the grinding wheel supporting and operating mechanism, the work-holding and supporting mechanism mounted on a pivot at right angles to the axis of the grinding wheel, means for vibrating said pivot, and means for adjusting the length of the vibratory movement, substantially as set forth.

In witness whereof, I, have hereunto set my hand and seal at Waynesboro, Pennsylvania this 23d day of November, A. D. nineteen hundred and six.

ABRAHAM B. LANDIS. [L. S.]

Witnesses:
JESSE R. MANHETZ,
ALF. N. RUSSELL.