S. A. ELY.

APPARATUS FOR GRINDING INTERNAL AND EXTERNAL SURFACES TO FIT.

APPLICATION FILED JULY 26, 1918.

1,332,437.

Patented Mar. 2, 1920.

4 SHEETS—SHEET 1.

Fig. 1.

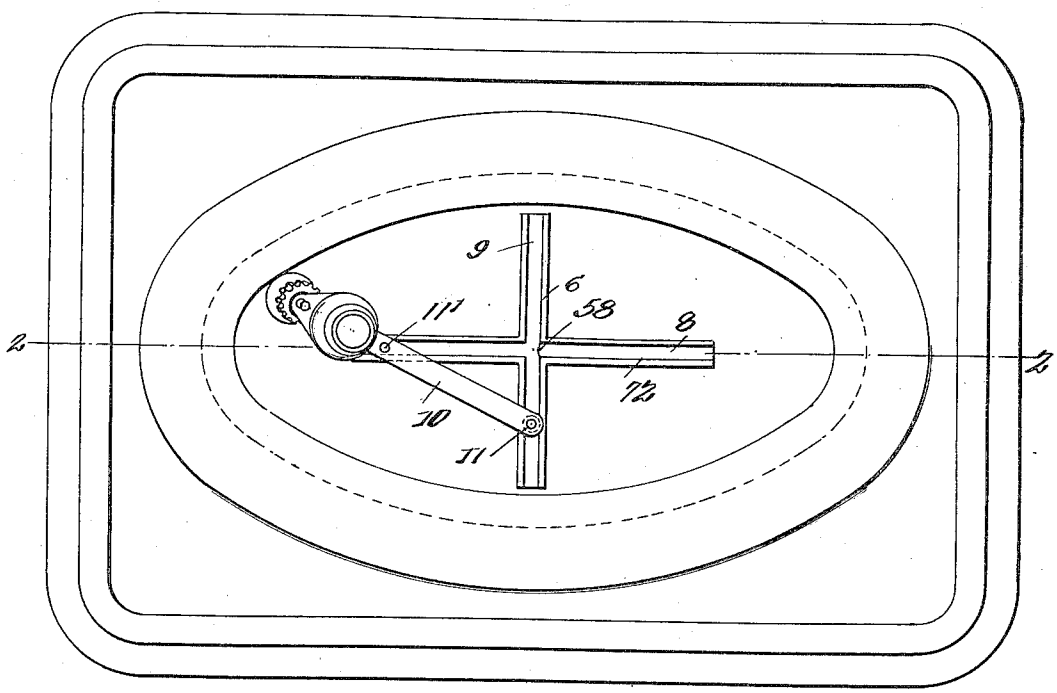
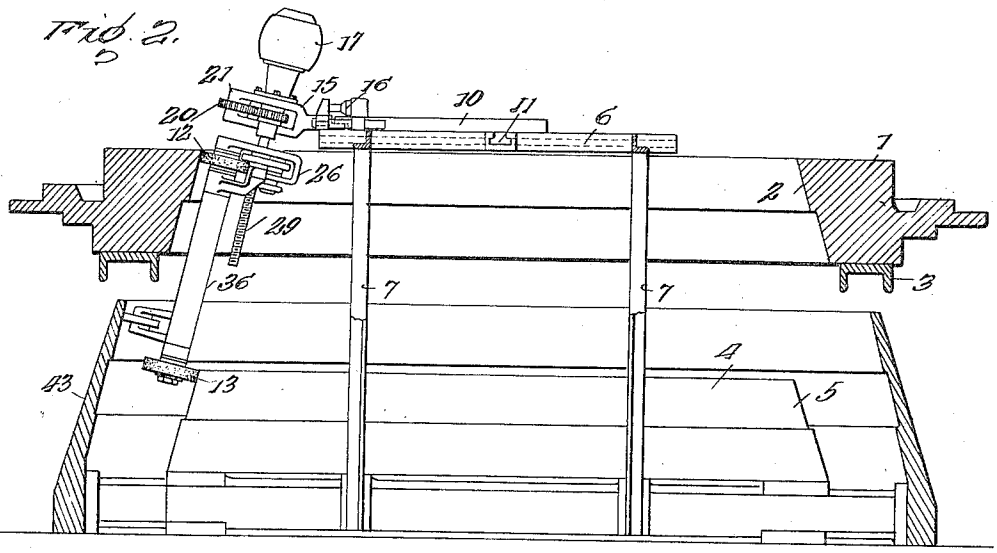


Fig. 2.



Witnesses

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4 SHEETS—SHEET 2.

Fig. 3.

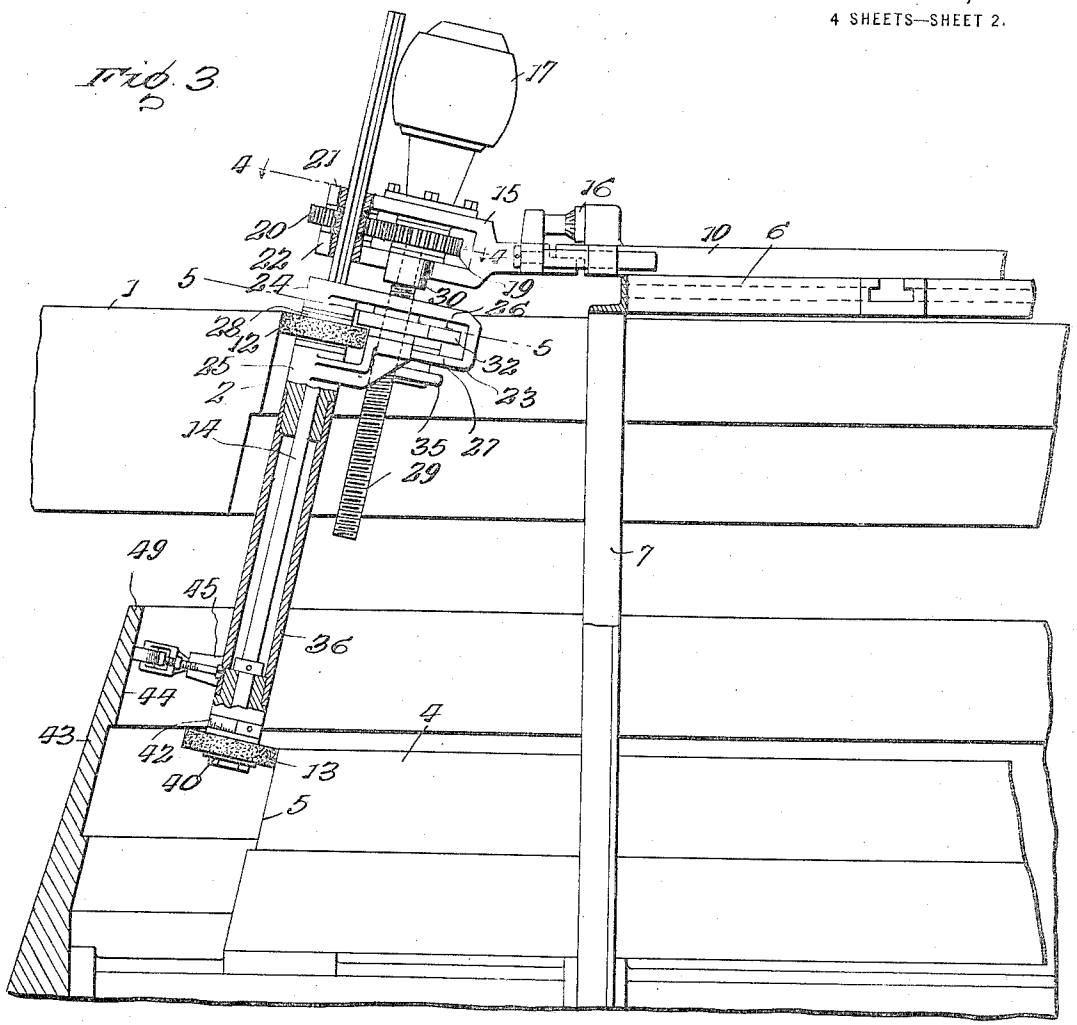


Fig. 4.

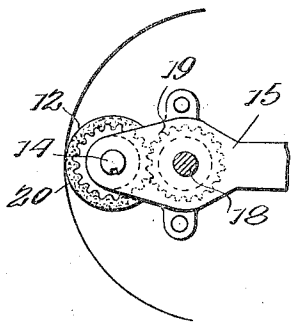
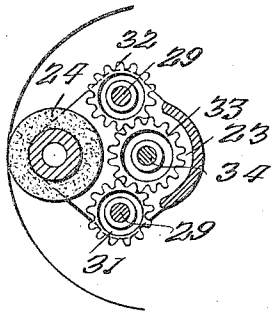


Fig. 5.



Witnesses

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4 SHEETS—SHEET 3.

Fig. 6.

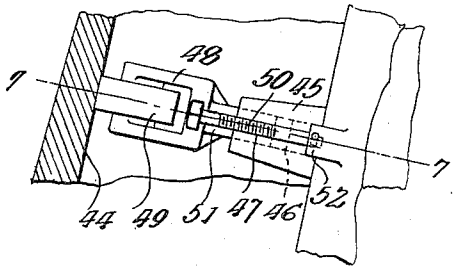


Fig. 7.

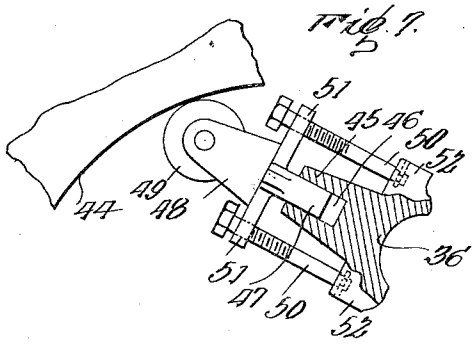


Fig. 8.

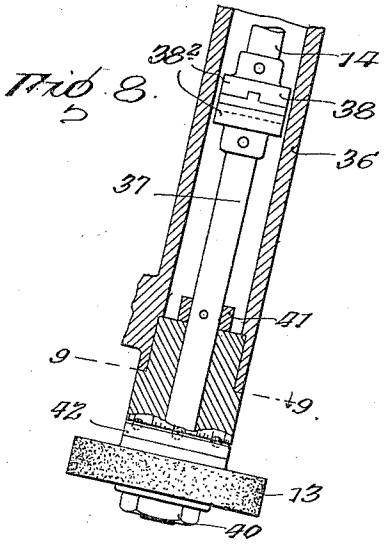


Fig. 9.

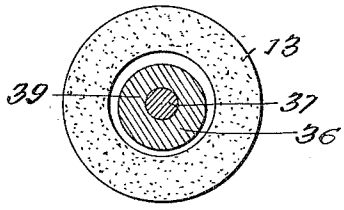
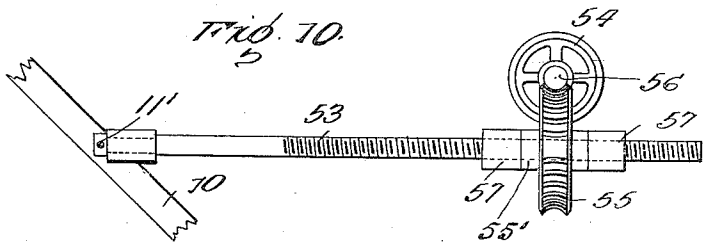


Fig. 10.



Witnesses

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4 SHEETS—SHEET 4.

FIG. 11.

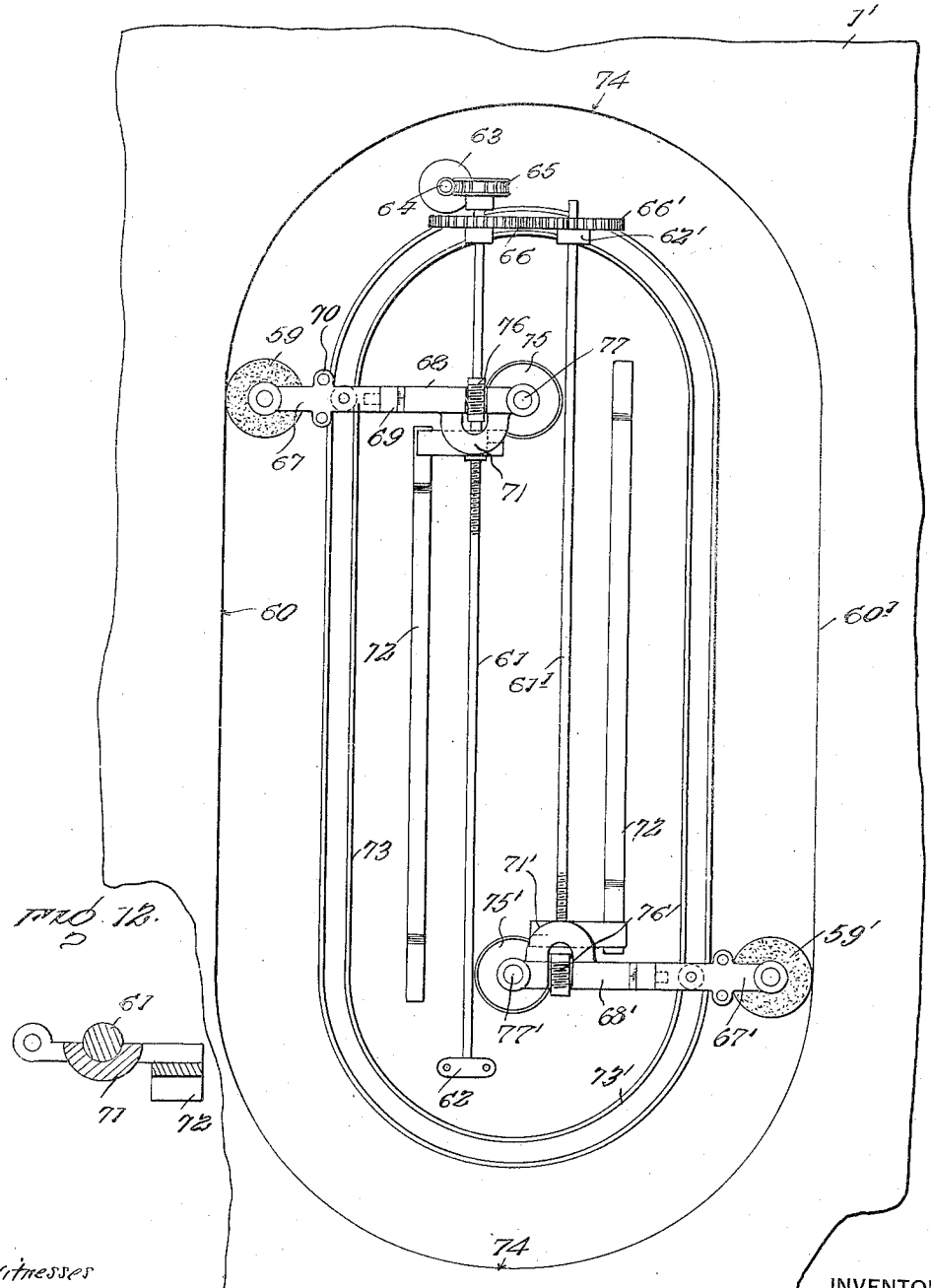


FIG. 12.

Witnesses

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APPARATUS FOR GRINDING INTERNAL AND EXTERNAL SURFACES TO FIT.

1,332,437. Specification of Letters Patent. Patented Mar. 2, 1920.

Application filed July 26, 1918. Serial No. 246,941.

To all whom it may concern:

Be it known that I, SUMNER A. ELY, a citizen of the United States, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Apparatus for Grinding Internal and External Surfaces to Fit, of which the following is a specification.

My invention relates to a grinding machine whereby internal and external surfaces, such as the seating surfaces of vaults and safes and the doors which are to seat therein, may be ground accurately and readily at a single operation in such a manner as to insure close fitting of the parts. It should also be noted that a feature of my invention is the grinding of parts, such as safe or vault doors and door seats, to an elliptical shape with great accuracy.

In grinding external and internal surfaces which are to fit accurately together, such as doors and the seating surfaces of the door jamb members, I arrange the members in concentric parallel relation, spaced apart one above the other, and provide a pair of grinding wheels one for the external surface and the other for the corresponding internal surface, which wheels are rotated together and are progressed around the peripheries of the parts to be ground, through substantially equal paths. In the grinding of surfaces which have an inclination from front to rear, such as the usual conical safe or vault doors and their seating surfaces, it is possible and preferable to arrange the grinding wheels on the same shaft (or a shaft and extension thereof) which extend adjacent to the surfaces to be ground and at the same angle as the said surfaces. The members having the surfaces to be ground are spaced apart a calculated distance, and the grinding wheels are of suitable diameter, so that one of the same will engage, with one portion of its periphery, one of the surfaces to be ground, and the other wheel will engage, with the opposite portion of its periphery, a similar point on the other surface to be ground. The members to be ground being arranged in concentric relation, similar points on the two surfaces to be ground will lie substantially in the same vertical planes, and, the grinding mechanism being progressed by a suitable guiding device through a path having the curvature or configuration of the surfaces to be ground, the active surfaces of the two grinding wheels will move through paths of identical curvature and substantially identical dimensions, so that the parts to be fitted together will be ground to a fit at the same operation, provision being made for the necessary slight clearance. In case the surfaces to be ground are not conical, other arrangements may be made than that suggested. When elliptical parts are to be ground, the peripheral motion of the grinders may be derived from a guiding device of the nature of the well-known ellipsograph.

The objects of my invention are to provide improved mechanism of the general character referred to above, as will appear more fully from the following specification and claims.

In order that a clearer understanding of my invention may be had, attention is hereby directed to the accompanying drawings forming part of this application and illustrating certain embodiments of my improved mechanisms, and the manner in which various forms of my improved methods may be carried out. In the drawings, Figure 1 represents a top plan view of mechanism for grinding an elliptical door casting and its seat at one operation, Fig. 2 is a vertical section taken on line 2—2 of Fig. 1, Fig. 3 is an enlarged vertical section illustrating the grinding mechanism shown in Fig. 2, Figs. 4 and 5 are horizontal sections taken, respectively, on lines 4—4 and 5—5 of Fig. 3, Fig. 6 is an enlarged elevation of the detail of construction shown in Fig. 3, Fig. 7 is a horizontal section taken on line 7—7 of Fig. 6, Fig. 8 is a vertical sectional detail showing the driving connections for the lower grinding wheel in Fig. 3, Fig. 9 is a section on line 9—9 of Fig. 8, Fig. 10 is a partial plan view of the mechanism shown in Fig. 1, illustrating a motor driven means for progressing the grinding wheels around the peripheries of the surfaces to be ground, Fig. 11 is a top plan view of a modified form of my invention, and Fig. 12 is a vertical section taken on line 12—12 of Fig. 11. The drawings are somewhat diagrammatic for the sake of clearance.

Figs. 1 to 10 of the drawings illustrate particularly the mechanism of arranging the parts when door and door jamb castings are to be ground to elliptical shape. Re-

ferring to the drawings, the door jamb casting 1, having a conical internal surface 2 against which the door is adapted to seat, is illustrated as mounted horizontally upon a table or support indicated by a channeled member 3. The door casting 4 having a conical exterior surface 5 is shown as supported at some distance below the door jamb member and concentrically therewith upon a lower horizontal surface. Members 1 and 4 may be adjusted in concentric position by manipulation of their supporting tables, so that similar points on the surfaces 2 and 5 will lie in nearly the same vertical planes. It is to be understood that the members 1 and 4 are cast to approximately the desired shapes and are to be ground to the desired accurate fit. Heretofore, safe or vault doors and their seats have been ground separately and as closely as possible to the desired dimensions, but, so far as I am aware, it has never been attempted to grind both members at the same time from a single guiding form. Also, so far as I am aware, no one has previously attempted to grind metal doors and their seats or the like to an elliptical shape by any means or method involving the automatic guidance of the grinder around the desired periphery.

In grinding elliptical doors and their seats in accordance with my invention, a guiding device 6 is mounted above the central opening in the door jamb member 1, member 6 being illustrated as mounted upon vertical supports 7, 7. Member 6 is in the form of a cross comprising the guide 8 which extends along the major axis of the ellipse and the guide 9 which extends along the minor axis of the ellipse. An arm 10 travels over the guiding member 6 and is provided with downwardly extending flanged pins 11, 11′, which are guided in the transverse and longitudinal arms of the member 6, which latter is provided with upper flanges 12 for retaining the guided pins 11, 11′ in their straight line paths. The device described is similar to the well-known ellipsograph, and the end of the arm 10, opposite from that at which the pin 11 is located, describes an ellipse if pressure be applied to the arm 10 in suitable manner to cause the points 11 and 11′ to move forward and back in their guides 9 and 8. The proportions of the closed curve thus formed may readily be calculated, and the dimensions of the same are increased by increasing the effective length of the arm 10.

Referring particularly to Fig. 3, the grinding wheels 12 and 13 are preferably mounted on a single splined shaft 14 and an extension thereof, which extend within the surface 2 of member 1 and outside the surface 5 of member 4 and parallel to each. The members 1 and 4 are spaced apart such a distance and the grinding wheels 12 and 13 are of such diameters that diametrically opposite points on grinders 12 and 13 will engage similar points on surfaces 2 and 5.

A frame 15 is illustrated as extensibly connected to the guiding arm 10 of the device, so as to form an extension thereof, a vernier device 16 of any suitable character being illustrated diagrammatically and used for the purpose of extending the frame 15 to a greater or less distance. An electric motor 17 is carried by frame 15, the lower end of the motor shaft 18 being provided with a gear 19 which meshes with a gear 20 through which the shaft 14 extends. Shaft 14 is driven by gear 20 and has sliding connection therewith by virtue of the spline and splineway referred to. Frame 15 is preferably yoke-shaped, with upper and lower portions 21 and 22 between which gears 19 and 20 are suitably mounted.

A frame 23 is mounted below frame 15 and is provided with upper and lower cylindrical portions 24 and 25 which surround the splined shaft 14 and within which shaft 14 has rotative bearing. Frame 23 is yoke-shaped and is provided with upper and lower flanges 26 and 27 which are joined to the sleeve portions 24 and 25 of the frame. The grinding wheel 12 is secured to shaft 14 to rotate therewith and to move axially therewith, wheel 12 having hubs 28 which are confined between the portions 24 and 25 of frame 23.

A pair of screws 29, 29 are shown as extending through the flanges 26 and 27 of frame 23, frame 23 being parallel to frame 15 and the latter being at proper inclination to support shaft 14 at the desired angle. Screws 29, 29 are rotatably secured at their upper ends within bosses 30 on frame 15 and have threaded engagement with the frame 23, so that turning screws 29 results in upward or downward movement of frame 23 and the grinding wheel 12. Screws 29, 29 are provided with pinions 31, 32, which mesh with a pinion 33 on a stud 34 provided at its lower end with a knurled head or the like 35, so that rotation of member 35 results in feeding grinding wheel 12 transversely of the work upon which it is engaged.

The lower sleeve portion 25 of frame 23 has secured thereto a non-rotating sleeve 36 which surrounds the shaft 14 and extends downwardly to a point adjacent the lower end of the shaft. The lower grinding wheel 13 has been referred to as secured to the lower end of shaft 14, but it should be understood that grinding wheel 13 is secured in the preferred embodiment of my invention to a shaft 37 which forms a continuation of shaft 14, these shafts being connected by a flexible coupling 38 (see Fig. 8) of a character similar to the well-known Oldham coupling, so that provision may be made for movement of shaft 37 out of aline-

ment with shaft 14, shaft 37 being driven from shaft 14. The coupling referred to is not illustrated in detail as it is a well-known mechanism comprising a sliding disk 38′ mounted between a pair of members 38^2, 38^2, secured to shafts 14 and 37, respectively.

The features referred to are provided for the purpose of enabling the grinding wheel 13 to be moved transversely into the surface 5 on which it operates as the grinding wheel 12 is fed into the surface 2 on which it operates. This may be accomplished by providing an eccentric bushing 39, through which shaft 37 extends, this bushing being rotatably mounted within the sleeve 36. Shaft 37 extends through grinding wheel 13 and the wheel may be secured to the shaft by means of a nut 40 or the like. A collar 41 on shaft 37 serves to hold the eccentric bushing 39 in place. A ring 42 is integral with or secured to bushing 39 and serves to rotate the latter, ring 42 being provided with a vernier scale which may be adjusted in relation to a fixed gage on the exterior surface of sleeve 36 (not shown). By this means, grinding wheel 13 may be exactly adjusted to enable the same to be fed in the opposite direction from the grinding wheel 12, within the rather narrow limits which are required in grinding the castings 4 and 1 to the necessary finish.

A suitable bearing should be provided for sleeve 36 adjacent to grinding wheel 13. I may arrange for this, as is shown in the drawings, by providing a fixed frame member 43 surrounding the door casting 4 and extending outside of the sleeve 36. The inner surface 44 of member 43 is carefully finished into parallelism with the edge surface 5 of the door casting. The sleeve 36 may be provided with an outwardly extending lug 45 having a recess 46 therein, in which is slidably mounted a cylindrical stem 47 secured to or integral with a frame 48, which forms a bearing for a roller 49 adapted to engage against surface 44 of the fixed member 43. The position of roller 49 may be adjusted by means of bolts 50, 50, which extend through lugs 51, 51, on the member 48 and having screw-threaded engagement in suitable openings formed in lugs 52, 52 at the base of the projection 45. The bearing thus provided for the sleeve 36 is adjusted, so that the proper amount of pressure is exerted by the grinding wheel on surface 5, readjustment of screws 50, 50 being made whenever the vernier 42 is adjusted to feed the grinding wheel 13 into the work.

The arm 10 and the grinding apparatus carried thereby may be moved at the proper rate of speed to cause the progression of the grinders around their elliptical paths by any suitable means. This may be accomplished by the provision of a rod 53 having rotative engagement at one end with the pin 11′ by which a point on arm 10 is guided back and forth along the longitudinal track 8 of the guiding device 6. A motor indicated at 54 may be used to rotate the worm wheel 55 through the worm 56 on the motor shaft. The rod 53 is screw-threaded and is reciprocated by means of the nut 55′ through which the screw-threaded portion of link 53 extends, nut 55′ being secured to and rotated by worm wheel 55. Suitable bearings may be provided for rod 53, such as are indicated at 57, 57. Motor 54 is reversible and is operated to cause pin 11′ to advance and return along track 8, while pin 11 reciprocates along track 6 and the grinding wheels move through the desired elliptical paths. The dead center point, which occurs when the pin 11 is at the center of the guiding cross 6, may be overcome by the use of a suitable cam surface, such as is indicated at 58 in Fig. 1.

The operation of the device described and the method of grinding elliptical surfaces as described will be apparent from the above description. The grinding wheels 12 and 13 may be adjusted to grind surfaces 2 and 5 equally by means of the vernier 16, and by adjusting the concentric castings 1 and 4 to proper distances apart, the wheels 12 and 13 being of identical dimensions. Allowance for the slight clearance which the door will require in its seat may be made by means of the vernier 42, and the feed of the grinder 13 may be adjusted by vernier 42 exactly as the feed of wheel 12 is made by vernier 16, after the first complete grinding of the surfaces. Feed of both grinding wheels axially is accomplished, as stated, by means of the knurled head 35.

I believe that I am the first to provide a method and mechanism whereby elliptical doors and their seats may be accurately ground, or whereby any large metal objects may be ground accurately to elliptical shape, the use of a flexible grinder for this purpose having proved not only tedious and expensive, but lacking in accuracy. Elliptical doors are desirable features for many vault installations in that less material is employed than in a circular door required for the same size vault, and the architectural scheme of the installation may be rendered more effective.

A modification of my invention is shown in Figs. 11 and 12, whereby doors and seats or other desired surfaces of the character described may be ground to a combination of plane and curved surfaces as in the case of my so-called "paralipse" door, in which the sides of the door are straight with circular arcs at the top and bottom. For this purpose the guiding cross device 6 of Fig. 1 is supplanted by a different system of guiding.

The method and apparatus are indicated somewhat diagrammatically in Fig. 11, in which the grinding wheels 59, 59′ are adapted to grind the plane surfaces 60, 60′ of the door jamb member 1′, it being understood that similar grinding wheels are arranged below wheels 59 and 59′ to grind the external surface of the corresponding door member, the upper and lower wheels being arranged in the same manner as has already been described in connection with the first form of my invention. For feeding wheels 59, 59′ and the corresponding lower wheels along the plane surfaces 60, 60′, a pair of longitudinally extending screws 61, 61′ may be provided, these screws being rotatably mounted in suitable bearings, such as those shown at 62, 62′. Power for the rotation of the screws may be derived from a motor 63 through a worm and worm wheel 64 and 65, by which screw 61 is rotated, screw 61′ being rotated from screw 61 by a suitable connection indicated at 66, 66′ as a pair of gears. The grinding wheel 59 is intended to move downwardly (of Fig. 11) while the wheel 59′ moves upwardly and vice versa, motor 63 being reversible. Screws 61, 61′ may both be right-handed with the connection shown, or may be right- and left-handed, respectively, if a different form of connection, such as a chain and sprockets, is used between screws 61, 61′.

Grinding wheel 59 is carried by an arm 67, extensibly connected to an alined arm 68 by a device 69, which is calibrated and provides a vernier adjustment whereby wheel 59 may be fed into the work, in the same manner that frame 15 is connected to arm 10 by the connection provided with the vernier 16 shown in Fig. 3. Up and down adjustment of wheel 59 and its corresponding lower wheel may be accomplished by means similar to that described in connection with the first form of my device, this adjustment means being indicated diagrammatically at 70. A nut 71 is mounted on screw 61 and is pivotally secured to arm 68. The connections for grinding wheel 59′ and the lower wheel connected thereto are substantially the same as those just described, the nut 71′ being mounted on screw 61′ and connected to arms 68′, which is connected to arms 67′ by the adjusting means in the same manner as has just been described.

Nuts 71, 71′ are formed as half nuts only, so that they may be readily disengaged from screws 61, 61′, the construction being similar to that employed in the usual lathe construction in which reciprocation is given to a similar nut from a lead screw. The nuts 71, 71′ are slidably carried by plate cams, one of which, 72, is indicated in Fig. 12. Arms 67, 67′, 68, 68′, together with the grinding wheels carried thereby, are suitably guided and supported in their motion as by means of track 73 having parallel portions extending longitudinally and semi-circular end portions 73′.

When the mechanism is put in operation, grinding wheels 59, 59′ move in opposite directions and at the same rate along the surfaces 60, 60′ until the ends of the straight portions of the surfaces to be ground are reached, at which points the plate cams 72 are provided with suitable drops, so that the half nuts 71, 71′ will drop out of contact with screws 61, 61′, the reciprocating movement of the grinders being accordingly finished. Connection is then made between arms 68, 68′ and other motive means for progressing the grinding wheels around the semi-circular curved end surfaces 74, 74 which are to be ground.

This may be accomplished in the manner indicated in the drawings, in which worm wheels 75, 75′ are shown meshing with worms 76, 76′, which are integral with or secured to screws 61, 61′ to obtain rotation therefrom. Worm wheels 75, 75′ may be disconnected from their shafts 77, 77′ during the time the grinding wheels are operating on the plane surfaces 60, 60′, but are adapted to be coupled to their shafts when the grinding wheels reach the curved surfaces 74, 74. When the grinding wheels reach these points and the half nuts 71, 71′ drop out of contact with their traversing screws 61, 61′, arms 68, 68′ are coupled to the vertical shafts 77, 77′, which are at the same moment coupled to the worm wheels 75, 75′. These connections may be made automatically or manually, the details of the couplings not being shown in the drawings in order to avoid complexity. Thus, the half nuts 71, 71′ may be caused to engage levers, for example, at the ends of the traversing movements of the nuts, which levers serve to clutch worm wheels 75, 75′ into driving engagement with their shafts, and at the same time couple members 68, 68′ to shaft 77, 77′. Means for producing these results, or arrangements by which the members 68, 68′ may be manually connected at their ends to the shafts 77, 77′, will be obvious. The connections having been made, shafts 77, 77′ will be rotated from motor 63, and members 68, 68′, together with the grinding wheels carried thereby, will be rotated about the axes of shafts 77, 77′ as centers, causing the grinding of the semi-circular surfaces 74, 74. When these curved surfaces have been traversed by the grinding wheels, motor 63 may be reversed and the grinding operations reversed, half nuts 71, 71′ moving up the slopes of the plate cams 72 into engagement with screws 61, 61′ at the moment when members 68, 68′ are uncoupled from shafts 77, 77′.

The grinding wheels may be rotated by motors which may be arranged in the same

relation to the shafts of the grinding wheels as is motor 17 to the shafts of grinding wheels 12 and 13 described in connection with Fig. 3 of the drawings.

It is obvious that one of the pairs of grinding wheels described may be omitted if desired and the remaining pair of grinding wheels, such as wheel 59 and the wheel below the same, caused to travel continuously about the periphery of the surfaces to be ground, or both pairs of wheels may thus travel continuously, and that various modifications of the apparatus described may readily be made within the spirit of my invention. It is also obvious that surfaces having other peripheral shapes from those referred to in the foregoing specification may readily be acted upon by the use of the apparatus described above with necessary modifications, and also that various changes may be made in the details of the apparatus described as will be obvious to those skilled in the art. My invention is not intended to be limited to the exact details of construction described, these being considered as illustrative. The door and jamb member or other parts having external or internal surfaces to be ground should, of course, as a preliminary step, be carefully adjusted into symmetrical positions. In the claims I refer to these members as being mounted concentrically in parallel relation, by which term I mean to designate the mounting of members of whatever shape in such relation as to properly position the similar points on the internal and external surfaces which are to be simultaneously ground by the upper and lower grinding wheels.

It should be noted that when reference is made in the claims to directions as vertical or horizontal, etc., the same should be understood as relative and not necessarily limiting. Referring to the form of my invention shown in Figs. 11 and 12, it should be understood that the connections between the upper grinding wheels shown and the lower grinding wheels not shown may be the same as those already described in connection with Fig. 3. That is, the members 67, 67′, connected extensibly with arms 68, 68′ through adjustment means, such as 70, may be similar to frame 15 connected to arm 10 through adjustment means 16; the upper and lower grinding wheels may be arranged on shafts and extensions similar to 14 and 37, and sleeves similar to 36, bearings similar to that at the lower end of sleeve 36, and adjustments for the lower grinding wheels similar to that shown in Fig. 3, may be used.

What I claim is:—

1. Grinding apparatus, comprising a pair of parallel grinding wheels, driving and supporting connections between them, a frame, a motor carried thereby, a traveling arm connected to and supporting said frame, and means for supporting said connections from said frame and driving the same from said motor.

2. Grinding apparatus, comprising a frame, a motor carried thereby, a shaft extending through said frame, connections for rotating said shaft from said motor, an upper grinding wheel on said shaft, a lower grinding wheel driven by said shaft, a traveling arm, means for supporting said frame as an extension thereof, and means for adjusting at will the distance said frame extends beyond said arm.

3. Grinding apparatus, comprising a frame, a splined shaft extending therethrough, a gear carried by said frame, through which said shaft extends, to be rotated thereby, a grinding wheel on said shaft, below said frame, a frame having sleeve portions surrounding said shaft above and below said grinding wheel, screw means for adjusting the vertical position of said second frame with relation to said first frame, a traveling arm, and means for supporting said first frame as an extension thereof, and for adjusting the distance said frame extends beyond said arm.

4. Grinding apparatus, comprising a frame, a shaft extending therethrough, a grinding wheel on said shaft, below said frame, a traveling arm carrying said frame, said wheel being adapted to grind work positioned on the outer side of said wheel, in reference to said arm, a second grinding wheel below the first, connected for operation from said shaft, adapted to grind work positioned on the inner side of said wheel, a sleeve surrounding said shaft, between said wheels, and an abutment engaging the outer side of said sleeve, adjacent to said second wheel.

5. Grinding apparatus, comprising a frame, a shaft extending therethrough, a grinding wheel on said shaft, a second shaft extending beyond the first and parallel thereto, a flexible coupling joining said shafts, permitting movement of said second shaft out of alinement with the first, a grinding wheel secured to said second shaft, a sleeve surrounding said shafts, and means for adjusting the axial position of said second shaft and wheel in relation to that of said first shaft and wheel.

6. Grinding apparatus, comprising a frame, means for progressing the same horizontally through a desired peripheral path, a shaft extending through said frame at an angle parallel to the transverse directions of two surfaces to be ground, upper and lower grinding wheels positioned to be rotated from said shaft and having their axes parallel thereto, means for rotating said shaft in all positions of said frame, means for feeding said wheels axially, and bearing means

for said shaft adapted to hold said wheels pressed against surfaces to be ground by opposite sides, respectively, of said wheels.

7. Grinding apparatus, comprising a horizontal traveling arm, a frame extensibly secured thereto, a micrometer device for adjusting the distance said frame extends beyond said arm, a shaft extending in a vertical direction through said frame, a grinding wheel rotated thereby, a second grinding wheel parallel to the first, connections for rotating said second wheel from said shaft in axial alinement or slightly out of axial alinement with said shaft, and a micrometer device for adjusting the axial position of said second wheel in relation to said shaft.

8. Grinding apparatus, comprising a horizontal arm, a frame extensibly secured thereto, a micrometer device for adjusting the distance said frame extends beyond said arm, a shaft extending in a vertical plane through said frame, at an angle parallel to the transverse directions of two surfaces to be ground to fit one within the other, a grinding wheel on said shaft, an extension of said shaft, parallel thereto, means for adjusting said extension into or slightly out of alinement with said shaft, and a grinding wheel on said extension.

9. Grinding apparatus, comprising a horizontally extending frame, a shaft extending through the same at an angle parallel to the transverse directions of two surfaces to be ground, a grinding wheel on said shaft adapted to engage a surface on the side distant from said frame, an extension for said shaft, a grinding wheel thereon, adapted to engage a surface on the side toward said frame, means for adjusting said extension and second wheel toward and away from said surface, a bearing for said extension and the adjacent portion of said shaft, to take the reaction of said second wheel against said surface, and means for adjusting the position of said bearing as the position of said second wheel toward and away from said surface is adjusted.

10. Grinding apparatus, comprising a track having crossing arms extending along the axes of an ellipse, an arm having projections at spaced points thereon guided to travel along the said crossing arms, respectively, a frame extensibly secured to the outer end portion of said traveling arm, a micrometer device for adjusting the distance said frame extends beyond said arm, a grinding wheel carried by said frame, and means for rotating said wheel.

11. Grinding apparatus, comprising a traveling arm, a grinding wheel carried by the outer end thereof, a horizontal screw, a nut secured to said arm, adapted to engage said screw to move said wheel along a path parallel to said screw, means for disengaging said nut from said screw at a fixed point, and means for thereafter rotating said arm about a fixed center.

12. Grinding apparatus, comprising a pair of horizontal traveling arms, grinding wheels carried by the outer ends of each, means for progressing said arms in opposite directions along paths at a right angle to said arms, to cause said wheels to engage opposite plane surfaces, and means for thereafter causing said arms to swing about fixed centers to jointly complete the periphery of a figure bounded by straight sides and similar curved ends.

13. In an apparatus for simultaneously grinding a safe door and jamb to fit, means for supporting the door and jamb in substantial concentric relation, a plurality of grinding elements to engage the door and jamb, and means for directing travel of the grinding elements to describe a path corresponding to the desired contour of the door and jamb.

14. In an apparatus for simultaneously grinding a safe door and jamb to fit, means for supporting the door and jamb in substantial concentric relation and in different planes, a grinding element to engage the door, a grinding element to engage the jamb, means for directing travel of both elements to describe a path corresponding to the desired contour of the door and jamb, and a guide shaped to conform to the desired contour of the door to guide the first element in its path.

15. In an apparatus for simultaneously grinding an elliptical safe door and jamb to fit, means for supporting the door and jamb in substantial concentric relation and in different planes, a grinding element to engage the door, a grinding element to engage the jamb, means for operating both elements, means for directing travel of both elements in an elliptical path corresponding in contour and dimensions to the desired contour and dimensions of the finished jamb, and an elliptical guide member corresponding in contour but of larger dimensions than the door, to retain the first element in engagement with the door and insure the proper contour of said door.

This specification signed and witnessed this 7th day of June, 1918.

SUMNER A. ELY.

Witnesses:
DYER SMITH,
I. MCINTOSH.