May 25, 1926. 1,585,983

L. R. HEIM

ART AND APPARATUS FOR GRINDING

Filed August 4, 1922 4 Sheets-Sheet 1

Fig. 1.

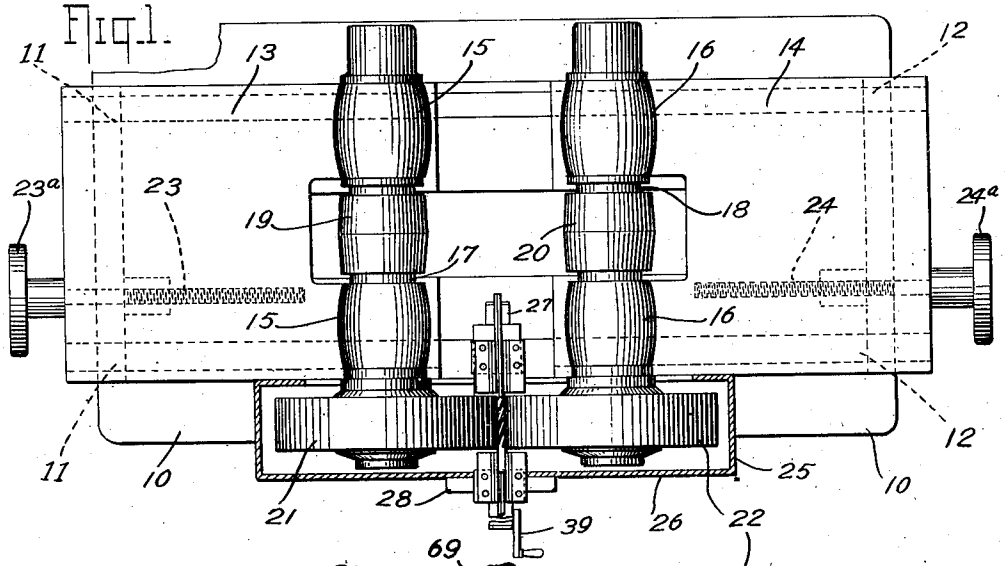
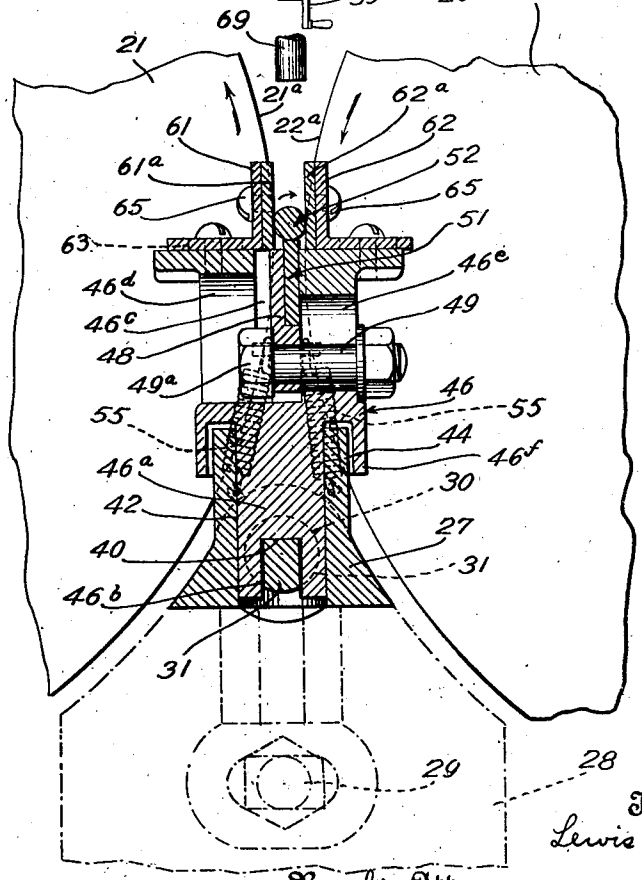


Fig. 2.



Inventor
Lewis R. Heim

By his Attorney
Robert S. Blair

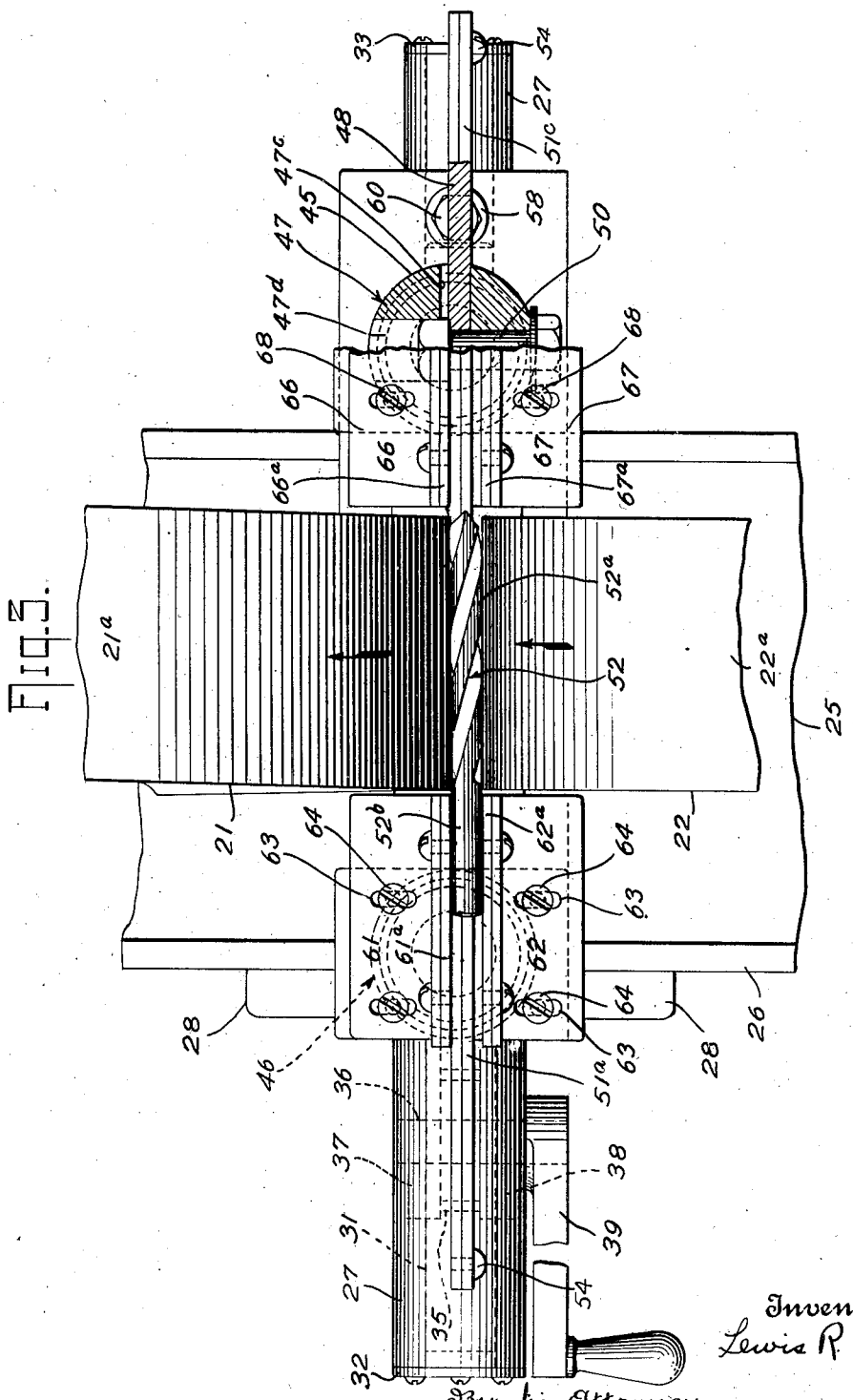
May 25, 1926. 1,585,983

L. R. HEIM

ART AND APPARATUS FOR GRINDING

Filed August 4, 1922 4 Sheets-Sheet 2

Fig. 2.



Inventor
Lewis R. Heim

By his Attorney
Robert S. Blair

May 25, 1926. 1,585,983

L. R. HEIM

ART AND APPARATUS FOR GRINDING

Filed August 4, 1922 4 Sheets-Sheet 3

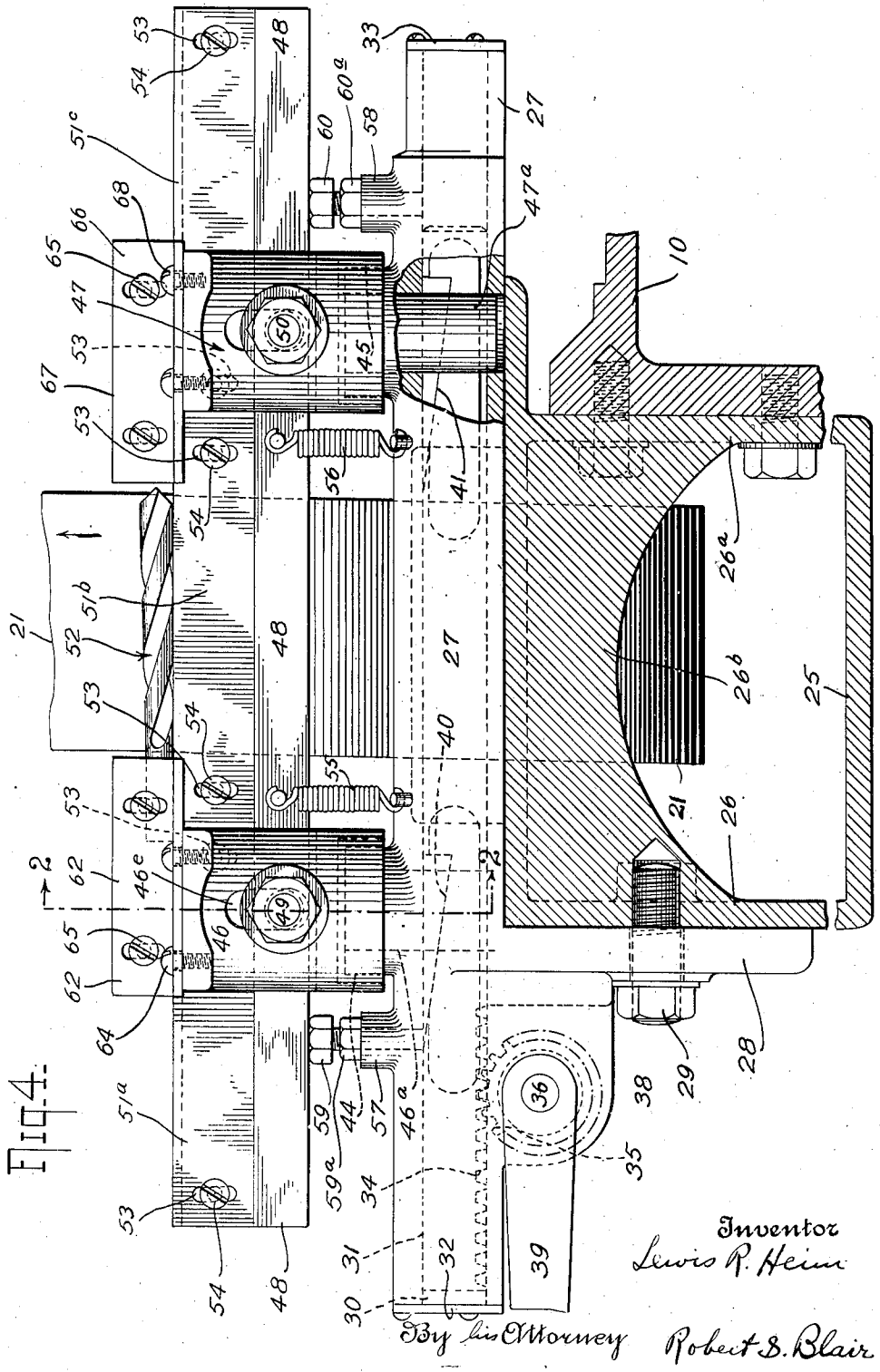


Fig 4.

Inventor
Lewis R. Heim

By his Attorney Robert S. Blair

May 25, 1926. 1,585,983

L. R. HEIM

ART AND APPARATUS FOR GRINDING

Filed August 4, 1922 4 Sheets-Sheet 4

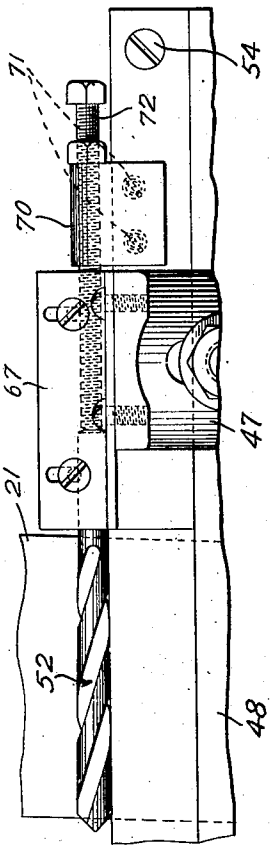


Fig. 6.

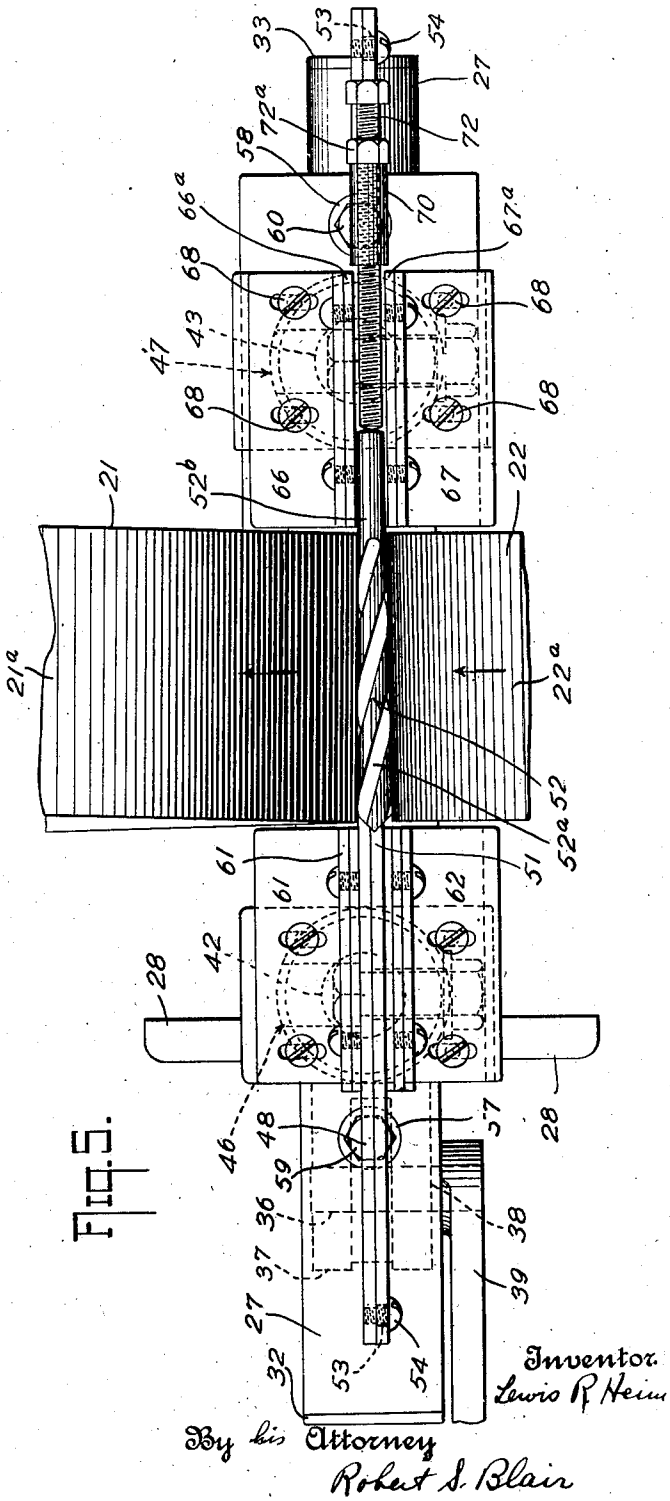


Fig. 5.

Inventor.
Lewis R Heim

By his Attorney
Robert S. Blair

Patented May 25, 1926. 1,585,983

UNITED STATES PATENT OFFICE.

LEWIS H. HEIM, OF DANBURY, CONNECTICUT, ASSIGNOR TO THE HEIM GRINDER COMPANY, OF DANBURY, CONNECTICUT, A CORPORATION OF CONNECTICUT.

ART AND APPARATUS FOR GRINDING.

Application filed August 4, 1922. Serial No. 579,566.

This invention relates to grinding and, more particularly, to an art and apparatus for grinding articles or bodies having a circular cross section.

One of the objects of this invention is to provide practical apparatus of efficient and reliable action for grinding articles or bodies of circular cross section and capable of grinding such articles in various forms. Another object is to provide apparatus of the above nature in which convenience and simplicity of manipulation are combined with ruggedness and durability of construction. Another object is to provide apparatus of the above nature readily adaptable to meet various conditions of use. Another object also is to provide a simple and practical art of grinding articles which may be readily and inexpensively carried on and with accurate and dependable results. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combination of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of various possible embodiments of the mechanical features of this invention,

Figure 1 is a plan view of the grinding apparatus, certain parts being broken away;

Figure 2 is a sectional view taken on the line 2—2 of Fig. 4;

Figure 3 is a plan view on an enlarged scale of certain parts of the apparatus shown in Fig. 1, certain parts being broken away and shown in section to illustrate more clearly certain features of construction;

Figure 4 is a side elevation, partly in section and with certain parts broken away to show the construction more clearly, as viewed from the bottom of Fig. 3;

Figure 5 is a view in plan substantially similar to that of Fig. 3, but shows a modified form of apparatus; and

Figure 6 is a partial side elevation as viewed from the bottom of Fig. 5.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings and more particularly to Fig. 1, there is shown a main supporting frame 10 provided at its top portion with suitable pairs of ways 11 and 12 extending longitudinally of the main frame 10 and adapted to slidably support thereon the carriages 13 and 14 respectively. At the adjacent ends of the carriages 13 and 14 are provided pairs of bearings 15 and 16 respectively adapted to rotatably support the shafts 17 and 18 respectively. The shaft 17 is provided with a pulley 19 intermediate the bearings 15 and has mounted upon an overhanging end thereof what will be herein termed a regulating wheel 21. The shaft 18 is provided with a pulley 20 and upon its overhanging end is mounted to rotate therewith what will be termed a grinding wheel 22.

The regulating wheel 21 and the grinding wheel 22 may conveniently be made of suitable abrasive material and, as will be seen in Fig. 2, the wheels 21 and 22 are adapted to present operative surfaces, indicated at 21^a and 22^a respectively, approaching each other. The wheels 21 and 22 are rotated by means of their respective pulleys at speeds which are respectively low and high, the grinding wheel 22 being driven at a suitable grinding speed. Moreover, the wheels are rotated in such directions, as indicated by the arrows in Fig. 2, as to present the operative surfaces 21^a and 22^a traveling in opposite directions.

As will be seen in Fig. 1, the carriages 13 and 14 with their respective wheels 21 and 22 may be moved in their respective ways toward or away from each other, suitable screws 23 and 24 operated by the hand wheels 23^a and 24^a being provided for bringing about this adjustment.

As shown in Fig. 1, the wheels 21 and 22 operate within a housing 25, shown broken away in this figure, the housing 25 being suitably secured to the front of the main

frame 10 of the machine. Turning now to Fig. 4 of the drawings, part of this housing construction is more clearly shown in section and it will be noted that the housing 25 is provided with a front wall 26 and a rear wall 26ª bridged by the rib 26ᵇ between the wheels to form a horizontal supporting surface. Upon the latter rests a casing 27 in general of a cylindrical shape but plane-faced on its under side to rest upon the bridging rib 26ᵇ and adapted to extend rearwardly between the wheels 21 and 22. The casing 27 has adjacent its forward end a downwardly extending lug or plate 28 preferably integrally formed therewith by means of which the casing 27 is secured in position to the front wall 26, a suitable screw 29 serving to make the connection therebetween.

The casing 27 is bored out throughout substantially its entire extent, as indicated at 30 (see Fig. 2), to provide a cylindrical bearing or guiding surface, and within the casing 27 is housed for slidable movement therein a substantially cylindrical bar 31. Suitable caps 32 and 33 are mounted upon the respective ends of the casing 27 thereby to effectually enclose and protect the relatively sliding surfaces of the parts therein.

At the forward end of the bar 31 and upon the under side thereof, as is more clearly shown in Fig. 4, there is formed a rack 34 adapted to mesh with a spur gear 35 fixedly mounted upon the stud shaft 36 which is rotatably supported between the spaced lugs 37 and 38 (see Fig. 3) integrally formed with the casing 27, the latter being suitably slotted or apertured to permit the gear 35 to extend into the casing 27 for engagement with the rack 34. Upon the outer end of the stud shaft 36 is mounted a handle 39 by means of which the spur gear 35 may be manually operated. Thus, referring to Fig. 4, a clockwise continuous movement of the gear 35 moves the bar 31 inwardly within the casing 27, and upon a counter-clockwise movement of the handle 39 and gear 35 a reverse movement of the bar 31 takes place, it being noted that the movement of the bar 31 throughout its range is brought about by a substantially continuous movement of the gear 35 with its associated operating handle 39.

At two spaced points in the upper surface of the bar 31, preferably one on each side of the wheels 21 and 22, are provided inclined surfaces 40 and 41; and at two substantially similarly spaced points in the casing 27 the latter is provided with vertically extending cylindrical openings 42 and 43 extending preferably entirely through the casing 27. The casing 27, moreover, has formed around the openings 42 and 43 and extending upwardly, as viewed in Fig. 4, sleeves 44 and 45 respectively. A pair of posts extending in a general upward direction and indicated generally at 46 and 47 are associated with the inclined surfaces 40 and 41 respectively of the bar 31 and it will be seen that the posts 46 and 47 have integrally formed therewith the downwardly extending, substantially cylindrically shaped portions 46ª and 47ª respectively, slidably mounted within the vertically extending guiding sleeves 44 and 45 respectively. Each of the portions 46ª and 47ª of the vertically extending posts 46 and 47 is slotted at the lowermost end thereof in order to straddle the bar 31 which is cut away upon the lateral sides adjacent the inclined surface portions 40 and 41, as is more clearly shown in Fig. 2 in connection with the post 46. Thus, as shown in Fig. 2, the lowermost end of the portion 46ª of the post 46 is slotted as at 46ᵇ, and in this figure is also clearly shown the manner in which the slotted portion straddles and overlaps on each side the cut-away portion of the bar 31. The latter is thus held against rotation about its axis and the constant engagement of the gear 35 with the rack 34 is thus assured.

It will thus be seen that upon movement of the bar 31 in the manner hereinbefore described and in a direction to the right as viewed in Fig. 4, the inclined surfaces 40 and 41 are operative upon the downwardly extending portions 46ª and 47ª of the supporting posts 46 and 47 respectively to give the latter a continuous upward movement as viewed in Fig. 4. Similarly, movement of the bar 31 to the left permits a retrograde movement of the posts 46 and 47 to take place. As conducive to greater clarity of expression, the upward movement of the posts 46 and 47 with associated parts to be hereinafter described will be hereinafter termed an outward movment, and the retrograde movement will be hereinafter termed an inward movement, reference being had more particularly to Fig. 2 of the drawings, wherein such movements will be seen to be respectively outward and inward with respect to the approaching operative surfaces 21ª and 22ª of the wheels 21 and 22 respectively.

The posts 46 and 47 are in general of a substantially cylindrical shape and are slotted along substantially the axis thereof as at 46ᶜ (Fig. 2) and 47ᶜ (Fig. 3). Within the slots 46ᶜ and 47ᶜ is positioned a work-supporting member 48 of sufficient extent or length to extend between the operative surfaces of the wheels 21 and 22. The work support 48 is secured to the post 46 by means of the bolt 49, the head 49ª of which extends through a slot 46ᵈ in one-half of the post 46 to hold the bolt 49 against turning, the body portion of the bolt 49 extending through a slot 46ᵉ in the other half of the post 46 and extending vertically with re-

spect thereto. By this construction it will be seen that the one end of the work support 48 may be rigidly secured to the post 46 and vertically adjusted with respect thereto. A substantially similar construction is employed for securing the other end of the work support 48 within the post 47, this construction being more clearly shown in section in Fig. 3 wherein the slot 47[a] in one half of the post 47 for holding the head of the bolt 50 against rotation is clearly shown. It will thus be noted that the work support 48 is thus rigidly supported at two spaced points, one at each side of the wheels 21 and 22, and that each end of the work support 48 is independently adjustable vertically with respect to the supporting posts 46 and 47.

Referring now to Fig. 2 of the drawings, it will be noted that the work support 48 is milled or cut away at its upper lateral portion and throughout substantially its entire extent to provide a recess for accommodating a suitable wear strip to be exposed to the work supported by the work support 48. As shown in this figure, the wear strip 51 is accommodated within the recessed portion of the work support 48 and its upper end face is exposed to the work, generally indicated at 52, for contact therewith. The wear strip 51 is preferably made of a suitable metal, such as steel, and is preferably hardened so as to effectively resist wear. Turning now to Fig. 4 of the drawings, it will be seen that I prefer to make the strip in a plurality of sections, as indicated for example at 51[a], 51[b] and 51[c]. Each of the sections is slotted preferably at its respective ends, as at 53, the slots 53 extending in a vertical direction and each adapted to have passed therethrough a screw 54 extending into the work support 48. The wear strips 51[a], 51[b] and 51[c], thus associated in endwise relation, may be independently adjusted with respect to the work support 48 in order that their upper end faces exposed for contact with the work 52 may be placed in alignment with each other.

As will be more clearly understood hereinafter, the maximum wear on the wear strips occurs in those parts thereof substantially immediately between the operative surfaces of the wheels 21 and 22 and by providing a wear strip of a plurality of sections as above described it will be seen that those sections or parts of the wear strip subjected to greatest wear may be readily readjusted for alignment with the remaining parts or, moreover, may be readily removed for regrinding, for example, or retruing and then replaced and aligned with the other sections. Moreover, the detrimental effects usually resulting by reason of warping due to hardening where a continuous wear strip is employed are effectively avoided and greater accuracy and uniformity of product attained.

It will thus be noted that upon movement in a vertical direction of the posts 46 and 47 as viewed in Fig. 4, the work support 48 will partake of a substantially similar movement, namely, inwardly or outwardly between the operative surfaces 21[a] and 22[a] as viewed in Fig. 2 of the drawings, and it will moreover be noted that such continuous movement of the work support 48 is positively controlled at two spaced points therein, thus assuring the maintenance at all times of the proper alignment and relation of the several parts.

As shown in Fig. 4, pairs of tension springs 55 and 56 are in engagement at their respective ends with the work support 48 and the casing 27 and tend normally to hold the slotted parts of the extensions 46[a] and 47[a] of the posts 46 and 47 in snug contact with the inclined surfaces 40 and 41 respectively, and thus insure a positive control of the inward or outward movement of the work support 48 in response to the actuating mechanisms hereinbefore described.

Adjacent the ends of the casing 27 and upon the upper surface thereof (see Fig. 4) are provided the bosses 57 and 58 within which are threaded the cap screws 59 and 60 respectively. The bosses and their associated cap screws are positioned substantially within the path of inward movement of the work support 48 and act to limit the extent of such inward movement of the work support 48. The height of the abutting screws 59 and 60 may be readily varied and it will be noted that these adjustments may be made independently of each other so that the extent of inward movement of each end of the work support 48 may be predetermined at will. The limiting screws 59 and 60 are provided with lock nuts 59[a] and 60[a] respectively in order to lock the screws at the desired height of adjustment. Thus, upon movement of the bar 31 to the left or into the position as shown in Fig. 4, the work support 48 is positively moved inwardly between the operative surfaces 21[a] and 22[a] and the extent of such movement, it will be seen, is positively controlled or limited.

Considering now the operation of the apparatus, it will be first assumed that the work support 48 is adjusted within the posts 46 and 47 so that the upper end faces of the wear strips 51 present to the work 52 intended to be supported thereon a path of travel substantially horizontal. The wheels 21 and 22 are rotated as hereinbefore described, and at this point it may be noted that the axis of the regulating wheel 21 is slightly tilted in a vertical plane with respect to the axis of the grinding wheel 22, so that the operative surface 21[a] of the regu-

lating wheel 21 is given a path of travel which makes an angle with the path of travel of the work 52 determined by the work support 48. In Fig. 1 of the drawings this relative inclination of the axes of the two wheels is not shown in order to avoid complexity of illustration, but in Fig. 3 of the drawings the portions of the wheels 21 and 22 are clearly shown in the above relation. As hereinbefore noted, and as is more clearly shown in Fig. 2, the operative surfaces 21^a and 22^a of the two wheels approach each other and present on each side of the work support 48 and adjacent thereto oppositely disposed operative portions of these surfaces adapted to operate upon the work presented thereto. The operative surfaces of the wheels 21 and 22 are, moreover, so trued by suitable truing devices that the adjacent and opposed operative portions of the approaching surfaces 21^a and 22^a are more distant from each other at one end of the wheels in an axial direction than at the other. In Fig. 3 of the drawings, the opposed operative surfaces of the operative portions 21^a and 22^a of the two wheels are shown farther apart at the right-hand end thereof than at the left-hand end thereof, presenting to the work 52 lines of contact or operative portions of the surfaces which make an angle with each other as viewed in Fig. 3.

The actuating mechanism is first operated to move the bar 31 to the right, as viewed in Fig. 4, thus to move the work carrier 48 outwardly between the approaching operative surfaces of the two wheels, as viewed in Fig. 2. The work 52, herein shown as a twist drill, is thereupon placed upon the work support 48, the section 52^a which it is desired to grind larger at one end than at the other being positioned substantially above the approaching operative surfaces, and the section 52^b thereof or the shank of the drill being positioned exterior of the approaching operative surfaces and beyond the ends thereof which are of minimum separation. In order to maintain the work 52 upon the work support 48 when the latter is thus moved outwardly and held in outermost position there are mounted upon the respective halves of the post 46 L-shaped guides 61 and 62 each suitably slotted as at 63 and secured to the post 46 by means of the screws 64. The guides 61 and 62 may thus be independently adjusted toward or away from each other to accommodate therebetween work of different diameters and thus act to temporarily maintain the work 52 on the work support 48. The inner faces of the guide plates 61 and 62 I prefer to provide with wear plates 61^a and 62^a respectively, each detachably secured to its respective guide plate by means of screws 65, and each preferably composed of a suitably hardened metal.

The actuating mechanism is thereupon operated to move the bar 31 with associated inclined surfaces 40 and 41 to the left and into the position as shown in Fig. 4, thereby moving the work support 48 with the work 52 thereon inwardly, as viewed in Fig. 2, between the approaching operative surfaces 21^a and 22^a and to present the work 52 to the opposed operative portions of these surfaces related to each other as hereinbefore described. The regulating wheel 21^a acts to control the rotation of the work 52 upon the work support 48 during the action thereon by the grinding wheel 22 and the latter is effective to grind the right-hand end of the section 52^a of the work 52 larger than the left-hand end of this section, thus grinding this section in tapered form to an extent determined by the angular relation between the operative portions of the two surfaces.

The regulating wheel 21, however, in having the path of travel of its operative surface 21^a make an angle with the path of travel of the work 52^a as determined by the work support 48, is effective also to feed the work 52 along the work support and in a direction to the right, as viewed in Figs. 3 and 4.

As the work 52 is thus moved in a direction substantially along its axis, the right-hand end emerging from the opposed operative portions of the two wheels is received between two spaced L-shaped guide plates 66 and 67 adjustably mounted upon the two halves of the post 47 as by means of the screws 68. The construction of these guide plates 66 and 67 is preferably substantially similar to that of the guide plates 61 and 62 hereinbefore described, and it will be noted that the guide plates 66 and 67 are similarly provided with wear plates 66^a and 67^a respectively. The free end of the work 52 thus emerging from the more distant ends of the opposed operative portions of the wheels is guided by means of these guides 66 and 67 as the work is fed along the work support 48 by the regulating wheel, the other or less distant ends of the operative portions of the two surfaces being effective to grind the exteriorly positioned portion 52^b or shank of the drill substantially cylindrical. After the body operated upon has thus been passed or fed along the work support 48 and the grinding action thereon completed, the actuating mechanism is operated to move the work support outwardly between the approaching operative surfaces, whereupon the finished work is removed from the work support and replaced by the piece to be subsequently operated upon, whence the cycle hereinbefore described is repeated.

It will be noted that the work 52 placed

upon the work support 48 when in outermost position is held out of contact with the operative surfaces of the two wheels during the inward movement thereof and is presented to the opposed operative portions of the operative surfaces substantially when the limit of the inward movement of the work support is reached. Moreover, the inward movement of the work support is at each inward movement thereof halted at the same predetermined point so that the work is each time presented to the desired and intended operative portions of the surfaces related to each other in predetermined manner, as hereinbefore described. The attainment of accurate and uniform results is thus assured and it will be noted that the operation and manipulation of the apparatus is carried on in a simple, dependable and reliable manner. It will be understood that the action of the apparatus hereinbefore described has been set forth as taking place upon a drill, in which it is desired to grind the operative portion thereof in tapered form, only for convenience of illustration, and that the relation of the operative surfaces of the opposed operative portions thereof may be readily changed to meet varying conditions of use. Thus, for example, where it may be desired to grind a body of circular section to a form having a greater taper than that of the body above assumed for illustrative purposes, the operative portions of the two wheels may be made to include therebetween a greater angle than hereinbefore set forth; and that where such a greater taper is desired to be formed, it may be desirable to incline the work support 48 with respect to the horizontal. Such change may readily be made by independently adjusting the respective ends of the work support 48 vertically in the posts 46 and 47, and the limiting stops 59 and 60 may be correspondingly adjusted to differing elevations to properly limit the inward movement of the work support 48 thus inclined.

It will also be noted that, as shown in Fig. 1 of the drawings and as hereinbefore described, the wheels 21 and 22 may be readily adjusted toward and away from each other in order that their operative surfaces and the operative portions thereof may bear the desired relations with respect to the work support, this adjustment of the wheels being made use of particularly for adapting the apparatus for operation upon various sizes or diameters of work.

It might also be noted at this point that the extent of inward movement of the work support may be readily varied by changing the adjustment of the limiting screws 59 and 60 in accordance with different diameters of work that may be operated upon and so that, for example, when work of smaller diameter is intended to be operated upon the inward movement of the work support 48 may be made less in order that the work may be properly positioned to the lines of contact or operative portions of the surfaces of the two wheels. In reverse manner, when larger diameters of work are to be operated upon, it may be desirable to permit a greater inward movement of the work support 48 to take place in order that substantially the same lines of contact or operative portions of the surfaces of the two wheels are presented to the work.

It will be noted that during the grinding action of the apparatus as hereinbefore described a suitable cooling liquid is applied to the operative surfaces of the wheels and to the work, and in Fig. 2 is shown a pipe or conduit 69 for supplying fluid to the work. This fluid not only maintains the active parts of the apparatus cool, but also carries away with it the particles removed by the grinding action from the work. It will be seen that the casing 27 substantially entirely encases the actuating mechanisms therein housed and thus effectively protects these mechanisms from the destructive effects of the fluid and the particles carried thereby. Referring now to Figs. 2 and 4 of the drawings, it will be seen that the posts 46 and 47 are provided with downwardly extending skirts 46^f and 47^f respectively, each overlapping laterally the upwardly extending guiding sleeve formed in the upper part of the casing 27. The skirts 46^f and 47^f, moreover, are of sufficient extent to effectively overlap the guiding sleeves 44 and 45, respectively, throughout substantially the entire relative movement that takes place between the sleeves and their respective posts. The ingress of cooling fluid with its contained particles to the actuating mechanisms is thus effectively prevented.

In Figs. 5 and 6 of the drawings I have shown a modified form of certain of the features of my invention. It might be noted that parts of the apparatus shown in these two figures which are substantially similar to the constructions hereinbefore described are denoted by like reference characters and will not now in detail be again described. Referring more particularly to Fig. 5, note might be made, however, that the operative surfaces 21^a and 22^a of the regulating wheel 21 and the grinding wheel 22, respectively, have opposed operative portions which are more distant from each other at the left-hand end than at the right-hand end as viewed in this figure. It will be recalled that in Fig. 3 the opposed operative portions of the two wheels are related to each other in the reverse manner, that is, they are nearer to each other at the left-hand end than at the right. The work support 48 and wear strips 51^a, 51^b and 51^c are related

to each other and to the other mechanisms as already hereinbefore described. Similarly, also, in Fig. 5 are shown the guide plates 61 and 62 at the left-hand side of the two wheels, as also are the guide plates 66 and 67 at the right-hand side of the wheels.

Upon the work support 48, however, and preferably exterior of the guide plates 66 and 67, there is mounted an abutment 70 as by the screws 71, the abutment 70 being interiorly threaded to support therein an adjustable stop conveniently taking the form of a cap screw 72. The stop 72 has its one end extending between the guide plates 66 and 67, and reference to Figs. 5 and 6 will readily show that this end may be conveniently adjusted lengthwise of the guiding path formed between the guide plates 66 and 67, a lock nut 72^a serving conveniently to lock the stop in desired position.

In the operation of this apparatus the work support 48 is first moved outwardly between the approaching operative surfaces of the two wheels whereupon the work, herein again illustratively set forth as a drill 52, is placed upon the work support 48 with part of the operative section 52^a of the work 52 resting between the guide plates 61 and 62, the latter functioning thus to temporarily support the work on the work support 48. Preferably the shank 52^b of the work 52, which shank portion it is desired to grind cylindrically as distinguished from the tapered form desired to be given the section 52^a, is maintained in position on the work support 48 well within the range of the operative surfaces of the two wheels.

The work support 48 is thereupon moved inwardly between the approaching surfaces of the two wheels as hereinbefore described, thus presenting the work to the opposed operative portions of the surfaces which, as above noted, progressively approach each other in a direction from left to right as viewed in Fig. 5. The regulating wheel 21 thereupon controls the rotation of the work 52 during the action thereon of the grinding wheel 22, but the regulating wheel 21 also acts to feed the work 52 toward the right as viewed in Figs. 5 and 6. The right-hand end portions of the operative portions of the two surfaces are thus effective to grind the shank portion 52^b substantially cylindrically as it travels in the above-mentioned direction, the shank 52^b emerging from the ends of the operative portions nearest to each other. During this action it will be noted that the section 52^a of the work 52, which section it is desired to grind in tapered form, is gradually fed in the direction along its axis and into the angle formed by the operative portions of the surfaces. The section 52^a of the work is thus operated upon and ground into tapered form, the feeding action upon the work being halted or limited by the adjustable stop 72 against which the work 52 abuts when brought into the position shown in Figs. 5 and 6. Preferably the stop 72 is so adjusted that the feeding action is terminated when the left-hand end of the work 52 has been brought just within the opposed operative portions of the two surfaces, that section of the work 52 being thus held between these operative portions being ground to the desired tapered form.

The work support 48 is thereupon moved outwardly in the manner hereinbefore described to carry the work 52 out of operative relation from the opposed portions of the two surfaces, the guide plates 66 and 67 between which the shank 52^b of the work has been fed during the actions hereinbefore described acting to hold the work in position upon the work support 48 during this outward movement. The work is thereupon removed, whence the cycle of operation is repeated.

It may be noted that the desired angular relation between the opposed operative portions of the two surfaces, which relation acts materially to determine the degree of taper given the work, may be attained in any suitable manner, as for example by suitable truing devices known in the art, or any other convenient manner.

It will thus be seen that there has been provided in this invention an art and apparatus in which the several objects of the invention hereinbefore noted and many advantages are effectively achieved. It will be noted that the apparatus is of rugged and durable construction, is of convenient and simple manipulation, and is well adapted to meet the conditions of hard, practical use.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at relatively high speed, a regulating wheel rotatable at relatively low speed, said wheels being adapted to present approaching operative surfaces traveling in opposite directions and to present opposed operative portions for action upon work presented thereto, work supporting means adapted to be moved to position work supported thereon in or out of operative relation to the operative portions of said surfaces, the path of travel of the operative surface of said regulating wheel being inclined with respect to

the path of travel of work along said supporting means, means for preventing work on said work supporting means from contacting with said grinding wheel prior to movement of said supporting means inwardly to present the work to said operative portions of said two wheels, and guiding means associated with said supporting means and arranged to receive said work as it is fed out of operative relation to said two wheels by said regulating wheel.

2. The herein described art which consists in placing a work piece of round section upon a movable work support which extends between the approaching operative surfaces of a grinding wheel and a regulating wheel, the path of travel of the operative surface of the regulating wheel being inclined to the path of travel of the work in a general axial direction, moving the work support in a direction substantially transverse of itself to carry the work piece into operative relation to the opposed operative portions of the two wheels, and then permitting the regulating wheel to feed the work piece in a general axial direction.

3. The herein described art which consists in placing a work piece of round section upon a movable work support extending between the approaching operative surfaces of a grinding wheel and a regulating wheel, the path of travel of the operative surface of the regulating wheel being inclined to the path of travel of the work piece in a general axial direction, and the two wheels having adjacent operative portions more distant from each other at one end thereof than at the other, moving the work support in a direction substantially transverse of itself to carry the work piece into operative relation to the opposed operative portions of the two wheels so that the latter act to reduce a portion of the work piece to substantially tapered form, and in permitting the regulating wheel to move the work piece in an axial direction so that the least distant parts of the opposed operative portions of the two wheels will reduce another portion of the work piece to substantially cylindrical form.

4. In apparatus of the general nature of that herein described, in combination, a pair of wheels one of which has an abrasive active surface, means mounting said wheels to present operative surfaces approaching each other in one plane, said wheels being adapted to present coacting operative portions in greater proximity to each other at one end than at the other in a plane making an angle with said other plane, a work support extending between said wheels arranged to support work thereon with a section of the work extending exteriorly of said opposed operative portions of said wheels and means for moving said work support inwardly between said approaching operative surfaces and to bring the work thereon into operative relation to said operative portions of said wheels with a section of said work extending exterior of and beyond the one end of said operative portions.

5. In apparatus of the general nature of that herein described, in combination, a grinding wheel adapted to be rotated at a relatively high speed, a regulating wheel adapted to be rotated at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions and said grinding wheel being adapted to present an operative portion of progressively increasing distance of separation from the operative portion of said regulating wheel, and means for supporting a substantially round body between said wheels and in operative relation to the operative portions thereof, the path of travel of the operative surface of said regulating wheel making an angle with the path of travel of said body along said supporting means, said regulating wheel acting to control the rotation of said body during action thereon by said grinding wheel and said operative portion of said grinding wheel acting to grind a section of said body greater in diameter at one end thereof than at the other and that portion of said grinding wheel of least distance from the operative portion of said regulating wheel acting to grind cylindrical another section of said body as said regulating wheel feeds said body along said supporting means.

6. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions and to present operative portions of said surfaces of progressively increasing distance of separation, means for supporting a substantially round body between said wheels with a section of said body in operative relation to said operative portions of said wheels and with another section of said body extending exteriorly of said operative portions and beyond the ends thereof of minimum separation, the path of travel of the operative surface of said regulating wheel making an angle with the path of travel of said body along said supporting means whereby said regulating wheel acts to feed said body along said supporting means and in a direction toward the ends of said operative portions of said surfaces of maximum separation.

7. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in

opposite directions and approaching each other in one direction and to present operative portions of said surfaces of progressively increasing distance of separation, and means for carrying a substantially round body between said approaching operative surfaces and for supporting said body with a section thereof in operative relation to said operative portions and with another section of said body extending exteriorly of said opposed operative portions and beyond the ends thereof of minimum separation, the path of travel of the operative surface of said regulating wheel making an angle with the path of travel of said path along said supporting means whereby said regulating wheel acts to feed said body along said carrier and in a direction toward the ends of said operative portions of maximum separation.

8. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and to present opposed operative portions thereof to work presented thereto, a work rest extending between said wheels, and means for giving said work rest a relatively rapid movement between said approaching operative surfaces and in a direction substantially transversely of itself, thereby to carry work positioned thereon into or out of operative relation to said opposed operative portions of said wheels, said means being arranged to maintain said work rest substantially parallel to itself throughout its movement.

9. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and to present opposed operative portions thereof more distant from each other at one end than at the other, means for carrying work inwardly between said approaching operative surfaces and for supporting said work in operative relation to said opposed operative portions of said wheels for operation thereon to grind said work larger at one end thereof than at the other, and means for limiting the inward movement of said supporting means.

10. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions and approaching each other and to present operative portions of said surfaces of progressively increasing distance of separation, and means for carrying a substantially round body inwardly in a direction substantially transverse of the axis of said body between said approaching operative surfaces of said wheels and for supporting said body in operative relation to said operative portions of said surfaces, said regulating wheel governing the rotation of said body on said supporting means while said grinding wheel acts to grind said body larger at one end than at the other.

11. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions and approaching each other and to present operative portions of said surfaces of progressively increasing distance of separation, means adapted to support a body having a circular section in operative relation to said wheels, and actuating means for giving said supporting means with said body thereon a relatively rapid movement inwardly between said approaching surfaces thereby to present said body to said operative portions of said surfaces, said regulating wheel governing the rotation of said body on said supporting means while said grinding wheel grinds said body larger at one end than at the other.

12. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions thereof for action upon work presented thereto, means extending substantially between said wheels for supporting work in operative relation to said wheels, actuating means for moving said supporting means inwardly between said approaching surfaces to present said work to said operative portions of said surfaces for operation thereon, and separate means each adapted to coact with one end of said supporting means for limiting the inward movement of said supporting means.

13. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, and actuating means in engagement substantially with the ends of said supporting means and substantially upon opposite sides of said wheels for moving said supporting means in a vertical direction between said approaching operative

surfaces of said wheels to position work supported on said supporting means in or out of operative relation to said operative portions of said surfaces.

14. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, means having an inclined surface adapted upon movement thereof to raise or lower said supporting means between said wheels to position work thereon into or out of operative relation to the operative portions of said surfaces, and means for giving said last-mentioned means a substantially rapid movement thereby to raise or lower said supporting means.

15. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, means having an inclined surface coacting with said supporting means adapted upon movement thereof to move said supporting means in substantially a vertical direction to position work thereon into or out of operative relation to the operative portions of said surfaces, a rack associated with said last-mentioned means, and a rotatable gear meshing with said rack for moving said last-mentioned means.

16. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, a pair of vertically movable posts one on each side of said wheels and each adapted to support one end of said supporting means, and means for simultaneously moving said posts thereby to position work on said supporting means into or out of operative relation with the operative portions of said surfaces.

17. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, a pair of vertically movable posts one on each side of said wheels and each adapted to support one end of said supporting means, means having two inclined surfaces each in engagement with one of said posts adapted upon movement thereof to move said posts and said supporting means to position work thereon into or out of operative relation to the operative portions of said surfaces, and means for moving said last-mentioned means.

18. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, a pair of vertically movable posts one on each side of said wheels, means for adjustably securing said supporting means to each of said posts, and means for simultaneously moving said posts in a vertical direction.

19. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, means for moving said supporting means substantially vertically in one direction between said operative surfaces of said wheels, and substantially continuously acting means tending to move said supporting means substantially vertically in the opposite direction.

20. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions of said surfaces for action upon work presented thereto, means extending between the operative surfaces of said wheels for supporting work thereon, positively acting means for moving said supporting means substantially vertically in one direction between the operative surfaces of said wheels, and yielding means for opposing the action of said last-mentioned means.

21. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching opera-

tive surfaces and opposed operative portions for action upon work positioned therebetween, work-supporting means adapted to be moved inwardly between said approaching surfaces to position work supported thereon to said operative portions, means for limiting the extent of inward movement of said supporting means, and continuously acting means operative upon said supporting means to insure movement of the latter to the extent determined by said limiting means.

22. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions for action upon work positioned therebetween, work-supporting means adapted to be moved inwardly between said approaching surfaces to position work supported thereon to said operative portions, movable means having an inclined surface coacting with said supporting means and adapted upon movement thereof in one direction to move said supporting means outwardly and between more distant parts of said approaching surfaces and upon movement in reverse direction to permit movement of said supporting means in reverse direction, and spring means coacting with said supporting means for insuring movement thereof in said reverse direction.

23. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions for action upon work positioned therebetween, work-supporting means adapted to be moved inwardly between said approaching surfaces to position work supported thereon to said operative portions, means adapted to permit inward movement of said supporting means between said approaching surfaces to take place, adjustable means for predetermining the extent of said inward movement, and spring means associated with said supporting means for insuring the full extent of movement thereof as predetermined by said adjustable means.

24. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and opposed operative portions for action upon work positioned therebetween, work-supporting means adapted to be moved inwardly between said approaching surfaces to position work supported thereon to said operative portions, movable means having an inclined surface coacting with said supporting means and adapted upon movement thereof in one direction to move said supporting means outwardly and between more distant parts of said approaching surfaces and upon movement in reverse direction to permit movement of said supporting means in reverse direction, means for limiting the movement of said supporting means in said reverse direction, and spring means for insuring said reverse movement to the extent determined by said limiting means.

25. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and to present opposed operative portions for action upon work presented thereto, means extending between said wheels for supporting work thereon adapted to be moved between said approaching operative surfaces to present said work to said operative portions of said surfaces, and means in engagement with said supporting means at two spaced points therein for moving said supporting means to position work thereon into or out of operative relation to the operative portions of said surfaces.

26. In apparatus of the general nature of that herein described, in combination, a grinding wheel adapted to be rotated at a relatively high speed, a work support for supporting a body in operative relation to said grinding wheel, said work support having a vertically extending post, a vertically extending sleeve-like member for receiving and guiding said post, means for moving said post in a vertical direction within said sleeve-like member, and protective means associated with said post and extending downwardly to substantially envelop the upper end of said sleeve-like member throughout the range of vertical movement of said post therein.

27. In apparatus of the general nature of that herein described, in combination, a grinding wheel, a work support adapted to support work in operative relation to said grinding wheel, a vertically movable post, means mounting said work support upon the upper end of said post, and a vertically extending sleeve-like member for receiving and guiding said post throughout its range of movement, said post being provided with a circumferentially extending skirt member adapted to overlap the upper end of said sleeve-like member throughout the range of movement of said post.

28. In apparatus of the general nature of that herein described, in combination, a grinding wheel adapted to be rotated at a relatively high speed, a regulating wheel adapted to be rotated at a relatively low speed, said wheels being adapted to present

operative surfaces traveling in opposite directions, a work support extending between said wheels for supporting work in operative relation to said wheels, said work support having associated with it a downwardly extending member, means for moving said supporting member in a vertical direction, a vertically extending way for guiding said downwardly extending member throughout the range of movement thereof, and protective means associated with said downwardly extending member for overlapping in a lateral direction said way.

29. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions, a work support extending between said wheels for supporting work in operative relation thereto, movable means having an inclined surface coacting with said work support adapted upon movement thereof to move said work support in a vertical direction, and means for substantially entirely encasing said movable means.

30. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions, a work support extending between said wheels for supporting work in operative relation thereto, a casing having a longitudinally extending guiding way, movable means having upon the upper portion thereof an inclined surface mounted within said guiding way, said casing having an opening therein for exposing said inclined surface, means connected with said work support and extending through said opening for engagement with said inclined surface whereby upon movement of the latter said work support is moved in a vertical direction, and laterally extending means associated with said last-mentioned means for overlapping said casing adjacent said opening.

31. In apparatus of the general nature of that herein described, in combination, a grinding wheel rotatable at a relatively high speed, a regulating wheel rotatable at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions, a work support extending between said wheels for supporting work in operative relation thereto, a casing having a longitudinally extending way, movable means having an inclined surface mounted within said casing and slidable within said way, said casing having an opening therein for exposing said inclined surface and having a vertically extending guiding sleeve surrounding said opening, a downwardly extending post associated with said work support contacting at its lower end with said inclined surface whereby upon movement of the latter said work support is moved vertically and said post is guided within said vertically extending sleeve, and protective means associated with said post for overlapping the upper end of said sleeve throughout substantially the range of movement of said post.

32. In apparatus of the general nature of that herein described, in combination, a grinding wheel adapted to be rotated at a relatively high speed, a regulating wheel adapted to be rotated at a relatively low speed, said wheels being adapted to present operative surfaces traveling in opposite directions, work-supporting means extending between said wheels for supporting work in operative relation to said wheels, a plurality of wear strips associated in endwise relation upon said supporting means, and means for independently vertically adjusting each of said wear strips with respect to said supporting means.

33. In apparatus of the general nature of that herein described, in combination, a pair of coacting wheels one of which has an abrasive active surface, said wheels being adapted to present approaching operative surfaces and to present opposed operative portions for action upon work presented thereto, work-supporting means extending between said wheels and adapted to be moved inwardly between said approaching operative surfaces to present work to said opposed operative portions of said surfaces, and guiding means associated with said supporting means for holding work on said supporting means when the latter is moved to hold said work out of operative relation to said operative portions of said surfaces during the movement thereof.

34. In apparatus of the general nature of that herein described, in combination, a grinding wheel adapted to be rotated at a relatively high speed, a regulating wheel adapted to be rotated at a relatively low speed, said wheels being adapted to present approaching operative surfaces traveling in opposite directions and to present opposed operative portions for action upon work presented thereto, work-supporting means adapted to be moved to position work supported thereon in or out of operative relation to the operative portions of said surfaces, the path of travel of the operative surface of said regulating wheel making an angle with the path of travel of work along said supporting means, guiding means associated with said supporting

means and upon one side of said wheels for holding work on said supporting means prior to moving of said supporting means inwardly to present said work to said operative portions of said wheels, and guiding means associated with said supporting means and upon the other side of said wheels for receiving said work as it is fed out of operative relation to said operative portions.

In testimony whereof, I have signed my name to this specification this 29th day of July, 1922.

LEWIS R. HEIM.