

June 12, 1923.

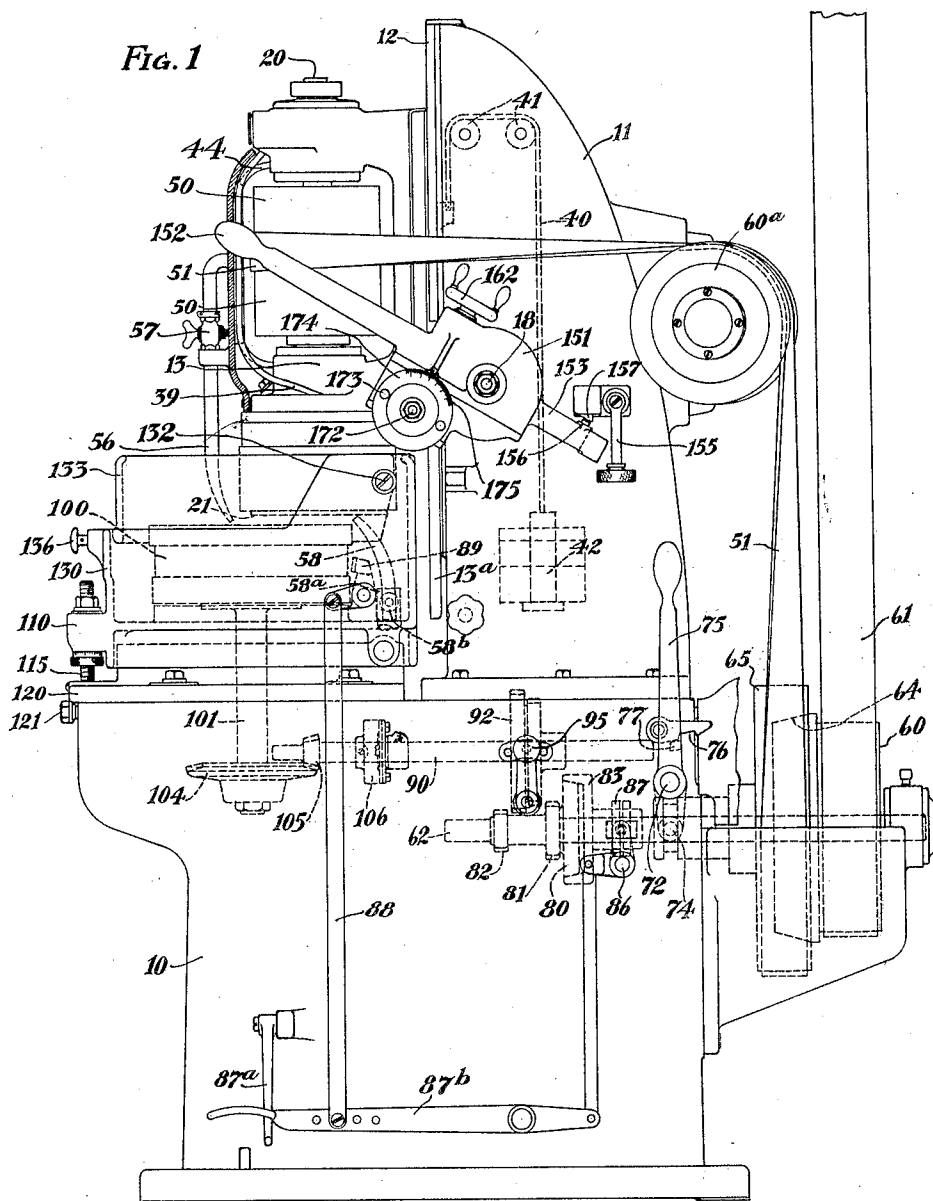
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C. KNOWLES

SURFACE GRINDING MACHINE

Filed June 16, 1920

5 Sheets-Sheet 1



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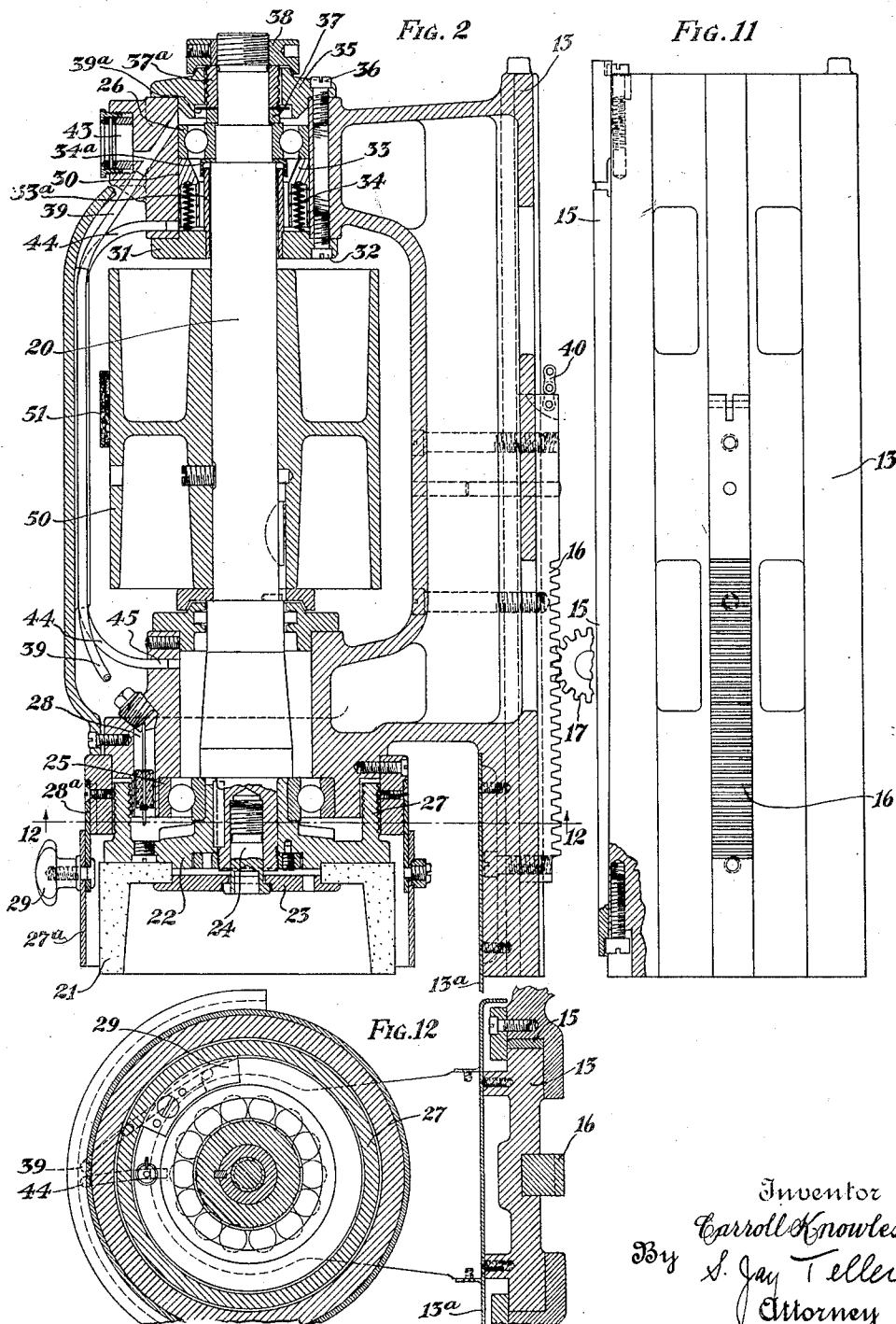
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5 Sheets-Sheet 2



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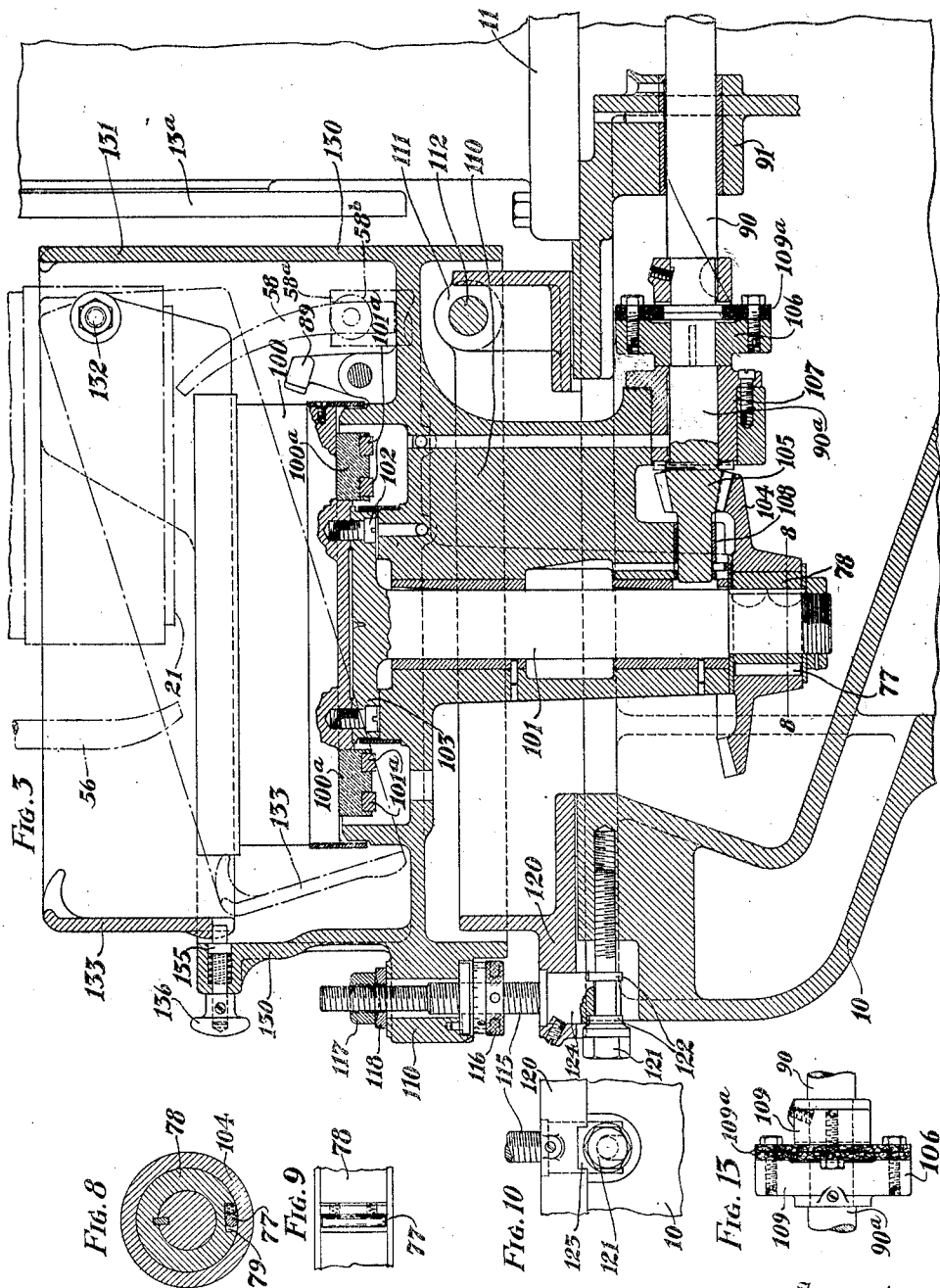
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5 Sheets-Sheet 3



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5 Sheets-Sheet 4

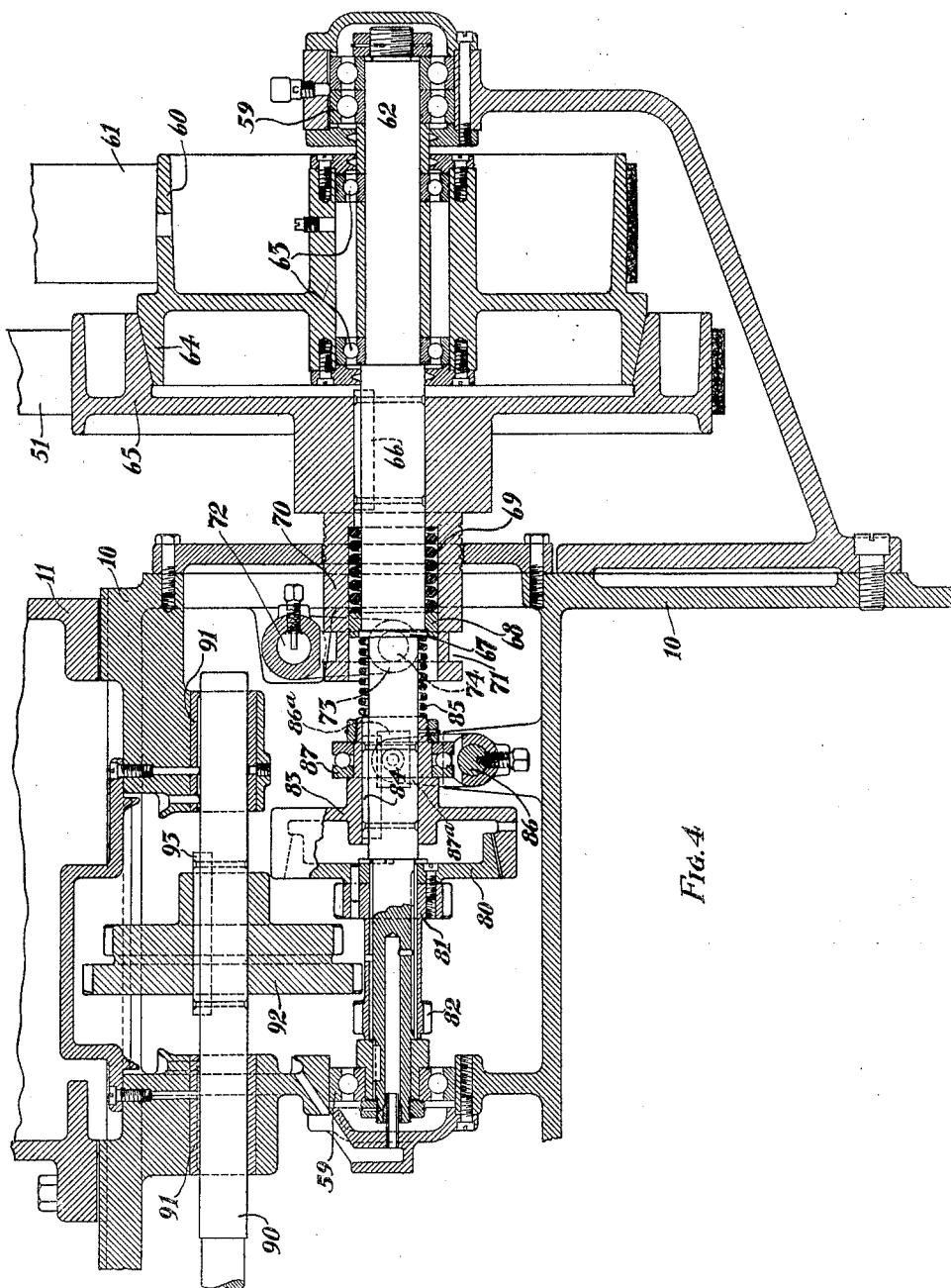


Fig. 4

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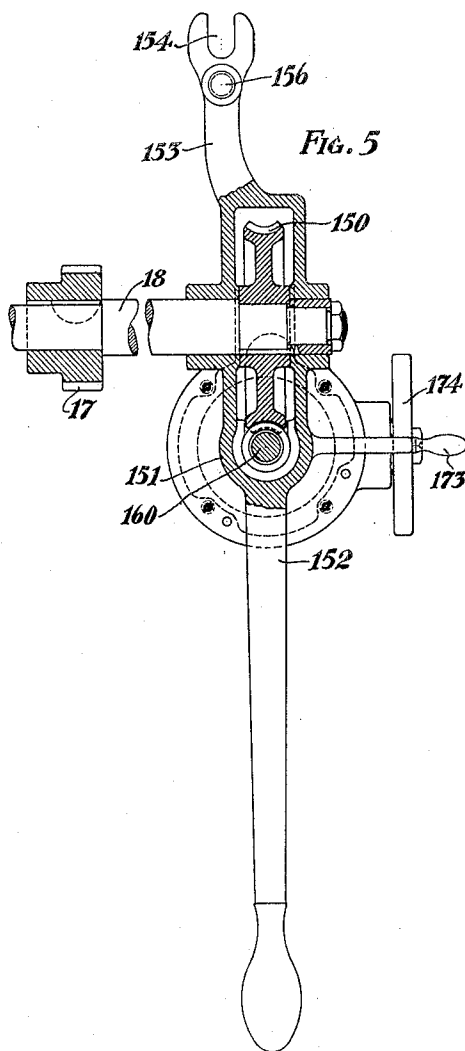
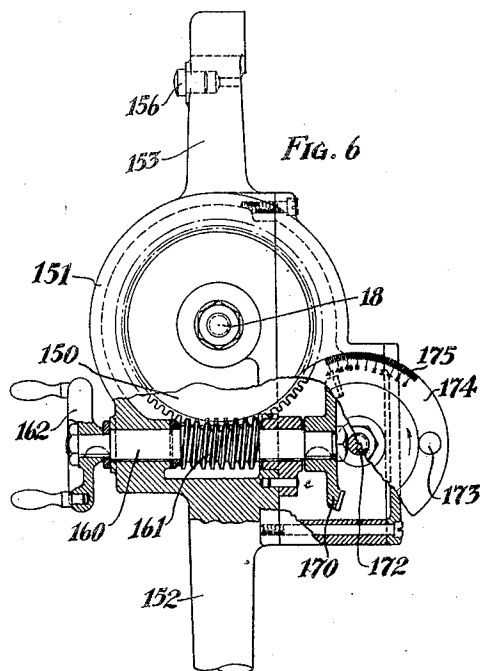
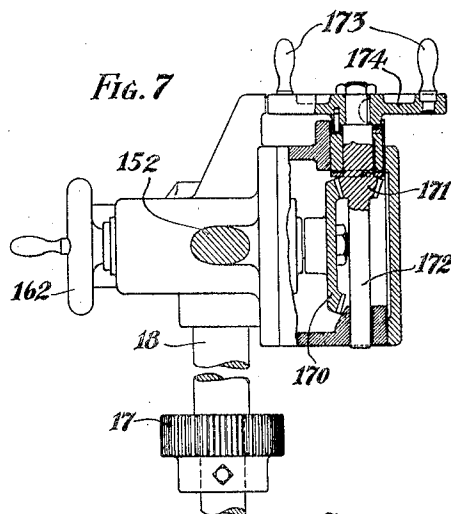
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SURFACE GRINDING MACHINE

Filed June 16, 1920

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

CARROLL KNOWLES, OF HARTFORD, CONNECTICUT, ASSIGNOR TO PRATT & WHITNEY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

SURFACE-GRINDING MACHINE.

Application filed June 16, 1920. Serial No. 389,431.

To all whom it may concern:

Be it known that I, CARROLL KNOWLES, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Surface-Grinding Machines, of which the following is a specification.

This invention relates to grinding machines of the surface type in which a wheel of abrading material is rapidly revolved, preferably about a vertical axis, and brought down into contact with the work to be ground mounted on a slowly revolving work table.

More particularly the invention relates to surface grinders in which an abrasive wheel of annular form engages the work to be ground against one of its flat end surfaces.

The objects of the present invention are to improve the construction of a surface grinding machine of the above type and in particular to improve the details of construction of the work table and operating means therefor.

More particularly, it is an object of the invention to mount a rotatable work table about a normally vertical axis which may be inclined or tilted slightly as, for instance, about a horizontal axis so that the grinding machine may be utilized to grind a slightly concave or convex surface.

Another object is to so mount this table in combination with its driving means that the table may be revolved in one direction ahead of, or independently of, the driving mechanism so that while the table is being loaded with work preparation for the grinding operation, it may be easily rotated by hand to place the pieces or work to be ground in position on the work table.

Another object of the invention is to provide an improved guard surrounding and enclosing the wheel and work table so that the water used in connection with the abrasive wheel will not be thrown off, but will be confined to a channel and returned to a storage tank conveniently provided on or near the machine.

This guard surrounding the wheel and the work table is preferably made in two pieces one of which is pivoted to the other so that a portion, as for instance the front portion, of the guard may be moved to an inoperative or lowered position to facilitate access to the work table to load and unload the pieces on the table.

A portion of the guard is preferably provided as an integral part of the carriage in which the work table is mounted, the rear portion of this guard being made considerably higher than its forward portion. To the rear portion of this guard is pivoted the movable portion of the guard. Normally the movable guard portion is held up in its operative position by a latch. When it is desired to place pieces to be ground on the table or to remove them after having been ground it is only necessary to operate the latch which causes the movable portion of the guard to fall from its operative position to a position low enough to permit ready access to the work table by the operator.

Also it is an object of the invention to provide an improved adjusting or controlling means for varying the pressure of the wheel against the work and to adjust and feed the wheel down toward the work, this means also providing a convenient means for quickly lowering and raising the wheel into and out of contact with the work.

In the accompanying drawings, I have shown an embodiment of the invention which I now deem preferable but it is to be understood that changes and modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

In the drawings annexed hereto and forming a part herewith:

Figure 1 shows a side elevation of the complete machine, the outline of some of the principal parts being shown in dotted lines.

Fig. 2 is an enlarged elevational view, shown in cross section, of the abrasive wheel, wheel slide and spindle.

Fig. 3 is a cross sectional view in eleva-

tion of the work table and driving connections therefor.

Fig. 4 is an elevation in section of the main driving means and speed change mechanism for driving the table.

Fig. 5 is a view of the wheel slide adjusting and feeding means, parts of the same being shown in section.

Fig. 6 is a side view of the same.

Fig. 7 is another view showing the means for this regulating device.

Fig. 8 is a cross sectional view taken on line 8—8 of Fig. 3.

Fig. 9 is a view of the clutch shown in Fig. 8.

Fig. 10 is a detail view of the work table adjusting means.

Fig. 11 is a rear view of the wheel slide.

Fig. 12 is a sectional view of the wheel slide taken on line 12—12 of Fig. 2.

Fig. 13 is an outside view of a flexible joint provided in the table driving means.

The invention in its entirety comprises the following principal elements; namely, first, a base or frame for the machine; second, a vertically slidable carriage having mounted at its lower end a grinding or abrasive wheel adapted to be rapidly rotated about a vertical axis; third, a rotatable work table adapted to be rotated at different speeds much slower than the abrasive wheel and also mounted so that its axis of rotation, which is normally vertical, may be tilted through a small angle out of parallelism with the axis of the grinding wheel; fourth, a device for controlling the vertical movements of the grinding wheel and slide so that the wheel may be rapidly raised or lowered from or to the work, or very gradually lowered and fed toward the work; and fifth, a suitable enclosure or guard for the grinding wheel and table adapted to be quickly moved into and out of operative position to facilitate loading and unloading of the work table with articles to be ground.

Referring more particularly to the figures of the drawings, 10 refers to the base or frame of the surface grinding machine provided with a column 11 resting on the upper surface of the base 10. Preferably the column 11 is rigidly secured to the base 10, the securing means holding the column permanently in position perpendicularly to the upper surface of the base. The forward vertical surface of the column 11 is provided with vertical ways 12 by which a wheel slide 13 is accurately guided in its movements toward and away from the work table 14 and held in sliding engagement with and in position against the column 11.

The wheel slide is clearly shown in Figs. 2, 11 and 12 and will now be described in detail. This wheel mounting or slide is

in the form of a carriage 13 vertically slidable along suitable ways 12 provided on the column 11 as above stated. On the slide 13 is a suitable adjustable gib 15 fitting the ways 12 on the column 11 to constrain the slide to move vertically. Preferably, I secure a depending cover strip 13^a to the lower edge of the slide 13 adjacent the ways 12. This is shown in Figs. 1 and 3 and serves to protect the ways 12 from exposure to the water used in connection with the grinding machine. Suitably fastened longitudinally to the rear of the slide 13 is a rack 16 adapted to engage a pinion 17 on a wheel adjusting shaft 18. Shaft 18 is rotatively mounted horizontally in the column 11. Centrally mounted in the slide 13 in an axis parallel to the ways 12 is the wheel spindle 20. This spindle or shaft 20 at its lower end has an abrasive wheel 21 detachably attached by means of a flange member 22 suitably keyed or otherwise fastened to the lower end of shaft 20, the abrasive wheel 21 being locked in place by a locking plate 23. Between this flange member 22 and locking plate 23 the wheel 21 is clamped or fastened by means of a cap screw 24 threaded into the lower end of spindle 20.

Directly surrounding the abrasive wheel 21 is a protective guard 27^a depending from a ring 28^a suitably fastened to the lower portion of the slide 13. Preferably the guard 27^a can be adjusted relative to the ring 28^a and be held firmly in adjusted position by a screw clamping means 29.

In order to permit rotation of this shaft 20 and the wheel 21 with a minimum of resistance, I preferably mount it in suitable anti-friction bearings, one of which, as shown at 25, is in the form of a ball-bearing near the lower end of the spindle 20 and the other similar bearing 26 placed near the upper end of spindle 20.

The thrust of the spindle 20 while in operation is taken principally by the anti-friction bearing 25. I preferably support the spindle 20 in such a way, presently to be described, that it is forced upward by suitable springs 34. When it is brought down into contact with the work there will be no lost motion between the spindle 20 and slide 13 and consequently there will be no tendency for the wheel to press against the work after downward feeding movement has been stopped.

The rotative speed of the spindle 20 is so high that its bearings must be kept well lubricated and for this purpose I have provided an improved lubricating system in which a large amount of lubricant may be constantly circulated.

For this purpose I provide an oil receptacle formed around the spindle 20. On the

clamping plate 22 is formed an annular flange 27 so that between this flange 27 and the lower end of slide 13 an annular chamber is provided which may be supplied with lubricant through an opening 28. The outer wall of the receptacle formed by the flange rotates with the spindle 20 so that the oil is rapidly rotated and, due to the centrifugal force of the rotating oil, is forced against the flange 27 at a high pressure. To aid in retaining the lubricant in its receptacle and to prevent its flowing over the flange 27, this flange 27 is circumferentially or helically grooved as shown.

Depending from the lower surface of the slide 13 is a scoop-shaped member 29 dipping into the oil receptacle above described. The scoop member 29 is connected with a tube 39 extending vertically upward past a sight aperture 43 and connecting with a bore in the slide 13 extending to a point just above the anti-friction bearing 26.

Oil is driven into pipe 39 from the receptacle within the flange 27 by the momentum of the rotating oil and rises in tube 39 where it flows from tube 39 and passes through the ball bearing 26, thus lubricating it. Another tube 44 extends from below the anti-friction bearing 26 down to a point 45 adjacent the spindle 20 and above the anti-friction bearing 25. The oil after passing through bearing 26 and tube 44 may then flow through bearing 25 and back into the receptacle within flange 27.

The supporting means for the wheel spindle 20 comprises the following construction which is designed to force the spindle upward against the thrust bearing portions of the anti-friction or ball bearing 25.

The upper portion of the wheel slide 11 is suitably bored out, as shown at 30, the lower end of this bore being closed by a flange 31 also bored to permit the passage of the wheel spindle 20 therethrough. The flange 31 is fastened to the lower end of the bored out section 30 by cap screws 32. Sliding within the bored out section 30 is a member 33 containing a plurality of helical springs 34, their lower ends resting against the flange or ring 31 and each being partly countersunk into the member or block 33. The outer ring of the ball-bearing 26 rests on the upper surface of this member 33 and is so fitted that it may slide easily within the bored out section 30. At the top of the slide 11 is a cover plate 35 suitably fastened to the slide by cap screws 36. Preferably the members 35 and 38 are provided with overlapping parts, as shown, to prevent dust from entering bearing 26.

On the slide 20 the inner ring of the ball-bearing 26 is held in place by suitable washers 37, 37^a and a locking nut 38 forcing this ring against a shoulder provided on spindle

20. Secured to the spindle 20, preferably between washers 37 and 37^a, I place a shedder or baffle 39^a to aid in preventing the lubricant from escaping past the washer or sleeve 37^a and out of the slide 13. Preferably the washer or sleeve 37^a is grooved circumferentially or helically, also to aid in retaining the lubricant in place. It will be seen from the above construction that the weight of the spindle and the pressure of springs 34 are taken up by the ball-bearing 26 when the wheel is out of contact with the work but that as soon as it is pressed against the work the thrust is taken up by the lower ball-bearing 25 which is made larger and stronger to take up this upward pressure. The springs 34, previously mentioned, are of sufficient resiliency to balance the weight of the spindle 20 and rotating parts so that they are always held in their uppermost position, and when the abrasive wheel 21 is brought into contact with the work there is no lost motion to be taken up by the adjusting or feeding means for the wheel. Preferably the entire slide 11 and the rotating parts of the spindle 20 are suitably counterweighted in the usual manner. This may conveniently be done by providing a chain 40 attached to slide 13 and passing over wheel 41 to a counterweight 42 provided at the opposite end of the chain 40 and enclosed within the column 11.

To rotate the spindle 20 and wheel 21 a drum pulley 50 is provided of sufficient width to permit engagement with the driving belt 51 when the slide 13 is in any position to which it may be adjusted.

The driving connections for the spindle 20 and also for the work table comprise a main driving pulley 60 driven from any suitable source of power by a belt 61. Preferably the pulley 60 is rotatably mounted on the main driving shaft 62 by ball-bearings 63 and is provided with an integral flange 64. The outer surface of flange 64 is in the form of a cone and is adapted to fit in driving contact with a corresponding conical surface formed on a pulley 65. It is by this pulley 65 that belt 51 is driven. Between pulley 60 and the drum pulley 50 to belt 51 passes over idler pulleys 60^a conveniently mounted at the rear of column 11 to properly guide the belt 51. Pulley 65 is suitably splined to the shaft 62 by key 66 set into shaft 62, the pulley 65 being slidable along shaft 62 over this key.

The shaft 62 which is preferably mounted in ball-bearings 59 is provided with a shoulder 67 against which a collar 68 is adapted to be retained. Adjacent the collar 68 is a helical spring 69 surrounding the shaft 62 which at its opposite end presses against a shoulder formed in the bore of pulley 65. Preferably the spring 69 is en-

tirely enclosed within an extension 70 of the pulley 65. At the outer end of the pulley extension 70 is a circumferential groove 71.

A short shaft 72 mounted adjacent the groove 71 in pulley 65 is provided with a yoke member, one part of which is shown at 73 having suitable pins 74 engaging within the groove 71 provided in extension 70. Normally the parts are held by spring 69 in the position shown in Fig. 4 but oscillation of shaft 72 by means of a suitable lever 75 serves to compress spring 69 and thus moves the pulley 65 out of contact with the driving pulley 60 and thus stops its rotation. To hold the lever 75 in its inoperative position a latch 75^a is provided having a notch 76 into which the lug 77 on lever 75 may fit.

To rotate the table 100 the following mechanism is provided which is preferably operated from the shaft 62 which is used also for rotating the spindle 20. A clutch member 80 is rotatively mounted on the shaft 62 and coupled therewith are gears 81 and 82 preferably of different diameters. These three parts may conveniently be rigidly secured together as shown. Adjacent the clutch member 80 is a corresponding clutch member 83 splined to the shaft 62 by key 84 set rigidly in the shaft 62, the clutch member 83 being slidable along shaft 62 over this key 84. Normally the clutch member 83 is held in contact with the clutch member 80 by means of a coil spring 85 surrounding the shaft 62 and at one end bearing against the shoulder 67 provided on this shaft. The opposite end of spring 85 presses against an extension to the clutch member 83. Normally the parts are held in the position shown in Fig. 4, in which position the gears 81 and 82 are rotated with the shaft 62. A short shaft 86 is provided having yokes 86^a at the ends of arms 87^a (but one being shown) engaging a ball-bearing 87 mounted in a depression formed in the clutch member 83. Oscillation of the shaft 86 by means of the treadle 87^b moves the clutch member 83 out of contact with clutch member 80 and therefore stops the rotation of these gears 81 and 82, one of which during the operation of the machine is in engagement with its mating gear. To hold the treadle 87^b in its downward position a suitable latch 87^a is provided.

Lying parallel with the shaft 62 and adjacent thereto is a shaft 90 rotatable within suitable bearings 91 provided in the frame 10. This shaft carries gears 92 preferably made integral with each other and of different diameters, and adapted to mate with 81 and 82 respectively when the gears 92 are in either extreme position on shaft 90. Gear member 92 is slidable along shaft 90 over a key 93 set into this shaft. The position shown in Fig. 4 is the neutral position for

gear member 92 in which the shaft 90 is not rotated, rotation of the shaft 90 at different speeds being accomplished by sliding the gear member 92 to engagement with either gear 81 or gear 82. In order to vary the position of this gear member 92 it is only necessary to oscillate the lever 95 which is attached to a short shaft in engagement with the sliding gear 92 by an appropriate yoke enclosing gears 92 (not shown).

In Fig. 3 is shown a vertical central section of the rotating work table, the driving means for this table being shown in this figure and Fig. 4. At 100 is shown a chuck preferably of the magnetic type carried at the upper end of the shaft 101, this chuck forming the rotating table. This shaft 101 comprises the driving means for the work table and is preferably bolted securely to the lower surface of the work table or chuck 100 by screws 102 passing through a flanged portion 103 provided at the upper end of shaft 101.

The chuck 100 shown in Fig. 3 on its lower surface is provided with an insulating ring 100^a in which are embedded the slip rings 101^a adapted to be connected to the electric circuit within the body of the chuck itself. Contact brushes (not shown) mounted directly below the rings 101^a and connected to a source of electric current are adapted to contact with the outer exposed faces of the rings 101^a.

As is usual in this class of machines the chuck and work to be ground are flooded with water to prevent them from becoming overheated. This water may be supplied through conduits to a position on the chuck outside the abrasive wheel or to a point on the chuck within the abraiding ring of the wheel. In Figs. 1 and 3 I show both conduits, one or both of which may be used simultaneously. At 56 is shown a conduit in which is provided a controlling valve 57 extending to a point on the chuck outside the wheel 21 and at 58 another conduit extending upward through the frame of the machine to a point on the chuck within the periphery of the wheel. Preferably the conduit 58 is made vertically adjustable as shown. The conduit 58 fits within a supply pipe 58^a and may be fastened therein in any adjusted position by clamping screw 58^b.

It is to be understood that any form of a chuck may be utilized in connection with this machine but I prefer to use a magnetic chuck as shown which provides a convenient means for holding the piece or pieces to be ground in place and permits rapid removal and replacement of these articles.

For convenience in promptly stopping the rotation of the chuck 100 when it is desired to measure or remove the articles being ground a friction brake is provided as shown in Fig. 1. This may conveniently be oper-

ated by means of the treadle 87^b. At the time the treadle 87^b is depressed to throw out the clutch 83 a reach arm 88 attached at one end to the treadle arm 87^b is also depressed forcing a short arm 89, acting as a brake shoe, against the periphery of the chuck 100.

At the lower end of the shaft 101 is a bevel gear 104 suitably fastened by any convenient means to this shaft and meshing with another bevel gear 105 mounted on an extension shaft 90^a at the forward end of driving shaft 90 and normally in alignment therewith. The driving shaft 90 is provided with a bearing 91 in the base or frame of the grinding machine as above described and between the bearing 91 and the extension shaft 90^a it is provided with a flexible link or coupling 106 to enable the extension 90^a and the driving shaft 90 to be tilted slightly out of alignment with each other. Between the coupling 106 and the pinion 105 is a suitable bearing 107 for this extension shaft 90^a which is mounted on and may be tilted with a table mounting 110. Preferably an outer bearing 108 may be provided for the forward extension shaft 90^a of the driving shaft 90 just forward of the pinion 105, this bearing also provided in table mounting 110.

Any suitable flexible coupling may be provided between shaft 90 and extension shaft 90^a, the one shown comprising two identical members 109 in the form of short bars keyed respectively to shaft 90 and extension shaft 90^a. Bars 109 are set at right angles to each other and have fastened thereto a plurality of disks 109^a of flexible material such as leather. With shaft 90 and extension shaft 90^a slightly out of alignment rotation of these shafts may take place by slightly flexing the disks 109^a. Shaft 90 in its bearings 91 may slide forward to compensate for the tilting of the extension shaft 90^a.

During the operation of loading the chuck 100 with articles and especially when a large number of small articles are to be placed on the chuck to be ground simultaneously, it is convenient to rotate the chuck 100 in one direction independently of the shaft 90 and change speed gears 81 and 82 above described. This mechanism may comprise any form of clutch permitting operation of the driven member in one direction independently of its driving means but preferably I use a spring-pressed roller 77 retained in the body of bevel gear 104. The shaft 101 is provided with a bushing 78 keyed in any convenient manner to the lower end of this shaft 101. This bushing 78 is provided with a depression 79 for the roller 77 which is pressed in one direction by suitable springs at one side of the roller 77. The action of this roller 77 is to permit the shaft 101 to be

rotated in one direction when the shaft 90 is not rotating but will allow the shaft 90 when rotating to positively drive the shaft 101 and chuck 100.

The table mounting 110 above referred to is preferably mounted in bearings 111 to oscillate about the transverse shaft 112 and this mounting 110 and the table or chuck 100 may be adjusted in any oblique position about the axis of this shaft 112 within a small angle by means of adjusting screw 115 mounted rigidly in a carriage 120 presently to be more fully described in which the mounting 110 is carried. Preferably, I provide a suitable knurled and graduated nut 116 about this adjusting screw 115, the graduations indicating the degree to which the table 110 has been tilted. A suitable locking nut 117 and washer 118 are provided on the screw 115 to hold the table 110 in adjusted position. An additional adjustment of the table mounting is permitted in addition to the angular adjustment above described; this is to move the chuck 100 transversely toward or away from the spindle 20.

The table mounting 110 is mounted in a carriage 120 provided with a suitable groove engaging a tongue 123 upstanding on the upper surface of the frame 10 in order to permit forward and rearward sliding of the chuck 100 and mounting 110 in relation to the wheel 21 and the spindle 20. To hold the carriage 120 in adjusted position relative to the axis of the wheel spindle 21 a screw 121 is provided which may conveniently be provided, as shown in this figure, with a pair of collars 122 near its head end. These collars enclose between them a milled portion provided on the head 124 of the adjusting screw 115 as above described. The threaded end of screw 121 extends into the frame or bed of the machine.

From the above described construction it will be seen that the carriage 120 may be adjusted directly toward or away from the wheel 21 within a limited distance. In the usual position of the chuck or table 100 its center is in alignment with the outer periphery of the abrasive wheel, but the adjustment above described is provided so that the center of the table 100 may be varied to more or less overlap the periphery of the wheel. The tilting of the table 100 by adjustment of the nut 116 permits the abrasive wheel 20 to grind a slightly dished or convexed article.

The table or mounting 110 is provided with an annular flange 130 completely enclosing the work table 100 and at its rear end extending high enough, as shown at 131, to enclose the grinding wheel 20. Pivoted in this flange 130 by means of bolts or screws 132 is a guard 133 of substantially annular form which is shown in Fig. 3 in operative

position by full lines and in its inoperative position assumed when loading the machine by dotted lines. I preferably provide a spring-pressed catch or latch 135 which fits under and holds the movable guard 133 in its upper or operative position. It will be seen from this construction that by simply pulling the knob 136 of the catch 135 the guard 133 may be dropped at its outer or forward end by pivoting about the axis of bolts 132, thus permitting ready access to the chuck 100 for the purpose of removing and resetting the articles to be ground.

The device for controlling and adjusting the vertical position of the wheel 21 comprises, as above mentioned, a pinion 17 mounted on a short shaft 18 suitably mounted in the column 11 of the machine and which is in mesh with the rack 16 provided on the wheel slide 13. The shaft 18 extends outwardly at one side of the frame and is provided on its outer end with a worm gear 150 fastened thereto in any suitable way, as by a key as shown. Rotatively mounted on the end of shaft 18 and preferably enclosing gear 150 is a lever 151, one arm 152 of which is extended to form a handle and the arm 153 extending oppositely therefrom including a yoke 154 permitting the lever 151 to be definitely positioned relative to slide 13 and locked in this fixed position by means of a clamping bolt 155 mounted on the body or frame of the machine. Also mounted on this arm 153 of lever 151 is a contact button 156 which bears against a suitably hardened plate 157 adjacent the clamping bolt 155 on the column 11.

From this construction thus described it will be seen that the lever 151 can be securely locked in one position relative to the column 11. By rotating the worm wheel 150 and the pinion 17 the grinding wheel 21 may be very slowly raised or lowered in relation to the work table or chuck 100; also by loosening the clamping bolt 155 the lever 151 may be rotated about its axis thus rotating the gear 150 and pinion 17 so that the wheel 21 is rapidly raised or lowered.

In order to slowly and gradually rotate the worm wheel 150 and pinion 17 in relation to the lever 151 the following mechanism is provided. Transversely mounted in the lever 151 near its axis is a short worm shaft 160 carrying a worm 161 preferably made integral with shaft 160 and in mesh with the worm wheel 150. At one end of this worm shaft 160 is provided a suitable hand wheel 162 by means of which the shaft 160 and the gear 161 may be rotated. This hand wheel 162 provides a convenient and readily accessible means for gradually moving the wheel slide 13 and wheel 21 vertically in relation to the worm while the lever 151 is locked in position.

At the opposite end of the worm shaft

160 is fastened a bevel gear 170 which is in mesh with a bevel pinion 171 mounted on or made integral with a short cross shaft 172 arranged at right angles to the worm shaft 160. This cross shaft 172 carries at its outer end a suitable pair of handles 173 which preferably are mounted on a plate 174. The ratio between the gears 170 and 171 is about three or four to one, so that by rotating the plate 174 a speed of rotation is given the gear 150 of about one fourth that of rotation of the handle 162. This latter mechanism may be conveniently used to adjust the spindle 20 to compensate for wearing away of the wheel 21 and for fine feed adjustments.

On the plate 174 I preferably provide a series of graduations as shown at 175. These are so calibrated that rotation of the plate 174 between adjacent graduations indicates a vertical movement of the wheel 21 of one thousandth of an inch.

From the above description the operation of the machine may be obvious but a short description will be given. With the wheel slide 13 elevated and the guard member 133 lowered to the position shown in dotted lines in Fig. 3 the chuck is ready to be loaded with the articles to be ground. As soon as this loading operation is completed the wheel slide 13 is lowered by means of the lever 151 which may be then locked in position by means of locking bolt 155. As soon as the movable guard 133 has been raised so that it may engage the latch 135 and the water supply turned on to flood the table 100 and the articles to be ground with water the grinding may be begun.

The wheel 21 may be advanced to grind the articles placed on chuck 100 by means of hand wheel 162, the distance advanced by the wheel 21 being indicated by the graduations 175 on plate 174. The machine may also be used and ordinarily would be used when a large number of identical articles are to be ground by operation of lever 151 to feed the wheel 21 against the articles to be ground. In this case the position of the lever 151 relative to the position of the slide 13 is adjusted or varied by means of the handle 173; this adjustment however would only have to be varied as the abrasive wheel 21 became more and more worn. In this case as soon as the lever 151 is brought to a position in which the button 156 is in contact with plate 157 the wheel is definitely positioned relative to the chuck 100.

The contact button 156 and the contact plate 157 have no tendency to wear or change their positions so that this stop arrangement permits the slide 13 to be repeatedly brought down toward the chuck 100 to the same position within a very minute variation and this may be accomplished by merely rotating the pinion shaft 18 by the arm 152 on lever 151. As soon as the lever 151 has

been rotated so that the contact button 156 and contact plate 157 touch each other continued pressure on the lever 151 can have no effect on the position of the slide 12. Any pressure applied to the lever 151 serves merely to slightly deflect the arm 153, the effect of which on the work is not appreciable.

It will thus be seen that a convenient, rapid and accurate method of control for the abrasive wheel has been provided which permits rapid and precise grinding of duplicate articles or which is adaptable to a wide range of sizes and types of articles to be ground.

As soon as the articles have been ground to the desired dimension the slide may be raised by means of lever 151 and the table 100 may be stopped by movement of clutch 83 operated by foot treadle 87. Simultaneously with the movement of clutch 83 the brake shoe 89 is applied against the periphery of chuck 100, thus bringing the chuck 100 promptly to rest. The guard 133 may then be lowered to its inoperative position by movement of the latch 135, thus permitting ready access to the table 100 by the operation to remove the articles ground and for placing other articles in position ready for grinding.

What I claim is:

1. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and means to vary the position of said lever relative to said slide.

2. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, means to definitely position said lever relative to said slide, and means to vary the position of said lever relative to said slide.

3. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and means mounted on said lever to vary the position of said lever relative to said slide.

4. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and means enclosed by said lever and adjacent its fulcrum to vary the position of said lever relative to said slide.

5. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and a worm and worm wheel to vary the position of said lever relative to said slide.

6. A wheel adjusting and feeding means for surface grinding machines comprising

in combination, a wheel slide, a lever for operating said slide, means to vary the position of said lever relative to said slide, and an indicator on said last mentioned means to indicate the position of said slide relative to said lever.

7. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and a worm mounted on said lever in engagement with a worm wheel to vary the position of said lever relative to said slide.

8. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, and a worm mounted on said lever and in engagement with a worm wheel, said worm and worm wheel being enclosed by said lever to vary the position of said lever relative to said slide.

9. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever for operating said slide, means to vary the position of said lever relative to the slide, and an indicator on said lever, the axis about which said indicator rotates being parallel to the axis about which said lever may rotate.

10. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, a lever rotatable about a horizontal axis for operating said slide, means to vary the position of said lever relative to the slide, and an indicator on said lever, the axis about which said indicator may rotate being parallel to the axis about which said lever may rotate.

11. A wheel adjusting and feeding means for surface grinders comprising in combination, a wheel slide, a lever for operating said slide, a worm and worm wheel mounted on said lever to vary the position of said lever relative to said slide, and an indicator connected with said worm.

12. A wheel adjusting and feeding means for surface grinders comprising in combination, a wheel slide, a lever for operating said slide, a worm and worm wheel mounted on said lever to vary the position of said lever relative to said slide, and supplemental means on said lever to rotate said worm.

13. A wheel adjusting and feeding means for surface grinders comprising in combination, a wheel slide, a lever for operating said slide, a worm and worm wheel mounted on said lever to vary the position of said lever relative to said slide, and motion reducing means on said lever to rotate said worm.

14. A wheel adjusting and feeding means for surface grinders comprising in combination, a wheel slide, a lever for operating

said slide, a worm and worm wheel mounted on said lever to vary the position of said lever relative to said slide, and a pair of bevel gears on said lever to rotate said worm.

15. A wheel adjusting and feeding means for surface grinders comprising in combination, a wheel slide, a lever for operating said slide, a worm mounted on said lever in engagement with a worm wheel to vary the position of said lever relative to said slide, motion reducing means on said lever to rotate said worm, and an indicator mounted on said motion reducing means.

16. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, means for operating said slide, a lever rotatable about said operating means, means to clamp said lever to the frame of the machine, and means in engagement with said lever to operate said slide operating means to raise and lower said slide.

17. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, rack and pinion means for operating said slide, a lever rotatable about said operating means, means to clamp said lever to the frame of the machine, and means in engagement with said lever to operate said slide operating means to raise and lower said slide.

18. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, means for operating said slide, a lever rotatable about said operating means, means to clamp said lever to the frame of the machine, and means comprising a worm and worm gear mounted in cooperative relation with said lever to operate said slide operating means to raise and lower said slide.

19. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, rack and pinion means for operating said slide, a lever rotatable about said operating means, means to clamp said lever in a definite position relative to the frame of the machine, and means comprising a worm and worm gear mounted in cooperative relation with said lever to operate said slide operating means to raise and lower said slide.

20. A wheel adjusting and feeding means for surface grinding machines comprising in combination, a wheel slide, means for operating said slide comprising a lever whereby the slide may be rapidly elevated or lowered, means to clamp said lever to the frame of the said machine, and means on said lever to slowly raise and lower the slide.

21. A table mounting for surface grinding machines comprising in combination, a horizontally pivoted table mounting, a vertical

shaft extending therethrough, driving means therefor, a flexible coupling between said shaft and driving means, and means to adjust said table mounting to variable oblique positions.

22. A table mounting for surface grinding machines comprising in combination, a horizontally pivoted table mounting, a vertical shaft extending therethrough, driving means therefor, a flexible coupling between said shaft and driving means, means to adjust said table mounting to variable oblique positions, and means to adjust said table mounting transversely.

23. A table mounting for surface grinding machines comprising in combination, a movable carriage, a table mounted thereon, a chuck rotatably mounted in said table, means to tilt said table relatively to said carriage, driving means for said table, and a flexible connection in said driving means to permit tilting of said table.

24. A table mounting for surface grinding machines comprising in combination, a movable carriage, a table mounted thereon, a chuck rotatably mounted in said table, means to tilt said table relatively to said carriage in a horizontal axis, driving means for said table, and a flexible connection in said driving means to permit tilting of said table.

25. A table mounting for surface grinding machines comprising in combination, a movable carriage, a table mounted thereon, a chuck rotatably mounted in said table, means to tilt said table relatively to said carriage, change speed driving means for said table, and a flexible connection in said driving means to permit tilting of said table.

26. A table mounting for surface grinding machines comprising in combination, a slidably mounted carriage, a table mounted thereon, a chuck rotatably mounted in said table, means to tilt said table upon said carriage about a horizontal axis, driving means for said table, and a flexible connection in said driving means to permit tilting of said table.

27. A surface grinding machine comprising in combination, a wheel supporting column, an abrasive wheel adjustably mounted thereon, a carriage movable toward and away from said column, a table on said carriage, and means permitting oblique adjustment of said table.

28. A surface grinding machine comprising in combination, a wheel supporting column, an abrasive wheel adjustably mounted thereon, a carriage movable toward and away from said column, a table mounting on said carriage, said mounting being angularly adjustable, and a work holding table carried by said mounting.

29. A surface grinding machine comprising in combination, a wheel supporting col-

umn, an abrasive wheel adjustably mounted thereon, a carriage movable toward and away from said column, a table mounting on said carriage, said mounting being angularly adjustable about a horizontal axis, and a work holding table carried by said mounting.

30. A surface grinding machine comprising in combination, a wheel supporting column, an abrasive wheel mounted thereon, a carriage movable toward and away from said column, a table mounting on said carriage, said mounting being angularly adjustable, and a rotatable work holding table carried by said mounting.

31. A surface grinding machine comprising in combination, an abrasive wheel, a work table, means for operating said table, a guard enclosing said wheel and table, and means permitting vertical movement of a part of said guard into and out of operative position.

32. A surface grinding machine comprising in combination, a vertically mounted abrasive wheel, a work table, means for rotating said table, a guard surrounding said wheel and table, and means permitting vertical oscillation of a part of said guard into and out of operative position.

33. A surface grinding machine comprising in combination, a vertically mounted grinding wheel, a work table, means for rotating said table, a guard surrounding said wheel and table, means permitting a part of said guard to be tilted about a horizontal pivot means from operative position into a position for loading said table, and a spring-pressed latch for normally holding said guard member in operative position.

34. A surface grinding machine comprising in combination, a vertically mounted abrasive wheel, a work table, means for supporting said table, and an extension to said last mentioned means forming a portion of a guard surrounding said table, said extension having connected thereto a member forming a movable guard surrounding said table.

35. A surface grinding machine comprising in combination, a vertically mounted abrasive wheel, a work table, means for supporting said table, and an extension to said last mentioned means forming a portion of a guard surrounding said table, said extension having horizontally pivoted thereto a member forming a movable guard surrounding said table.

36. A surface grinding machine comprising in combination, a vertically mounted abrasive wheel, a work table, means for supporting said table, an extension to said last mentioned means forming a portion of a guard surrounding said table, said extension having connected thereto a member forming

a movable guard surrounding said table, and means to detachably hold said movable guard in operative position.

37. A surface grinding machine comprising in combination, an abrasive wheel, a work table, means for operating said table, a guard enclosing said wheel and table, and means normally holding a movable portion of said guard in operative position, movement of said holding means permitting said movable portion to drop to inoperative position.

38. A surface grinding machine comprising in combination, an abrasive wheel, a work table, means for operating said table, a guard enclosing said wheel and table, and means normally holding a movable portion of said guard in operative position, movement of said holding means permitting said movable portion to tilt about a horizontal axis to inoperative position.

39. A surface grinding machine comprising in combination, an abrasive wheel, a work table, means for operating said table, a fixed guard enclosing said wheel, a movable guard member attached thereto, and means normally holding said movable guard member in operative position, movement of said holding means permitting said movable guard member to drop to inoperative position.

40. In a surface grinding machine, a rotatable work table, driving means therefor, and means permitting rotation of said work table in one direction independently of its driving connections.

41. In a surface grinding machine, a rotatable work table, change speed driving means therefor, and means permitting rotation of said work table in one direction independently of said change speed driving means.

42. In a surface grinding machine, a rotatable work table, gear driving means therefor, and means comprising a clutch permitting rotation of said table in one direction independently of its driving connections.

43. In a surface grinding machine, a rotatable work table, gear driving means therefor, and means comprising a clutch contained within one of said driving gears permitting rotation of said table in one direction independently of said driving means.

44. In a surface grinding machine, a rotatable work table, change gear driving means therefor, including a pair of bevel gears, and means comprising a clutch contained within one of said bevel gears permitting rotation of the table in one direction independently of said driving means.

45. A surface grinding machine comprising in combination, a work holding table, means for rotating said table, a clutch in

said driving means, a brake adapted to engage said table, and means to move said brake into operative position simultaneously with movement of said clutch out of operative position.

46. A surface grinding machine comprising in combination, a work holding table, means for rotating said table, a clutch in said driving means, a brake adapted to en-

gage said table, means to move said brake into operative position simultaneously with movement of said clutch out of operative position, and means to hold said clutch out of operative position.

In testimony whereof, I hereunto affix my signature.

CARROLL KNOWLES.