Sept. 3, 1940. K. ZWICK 2,213,756

GRINDING MACHINE

Filed March 17, 1939 3 Sheets-Sheet 1

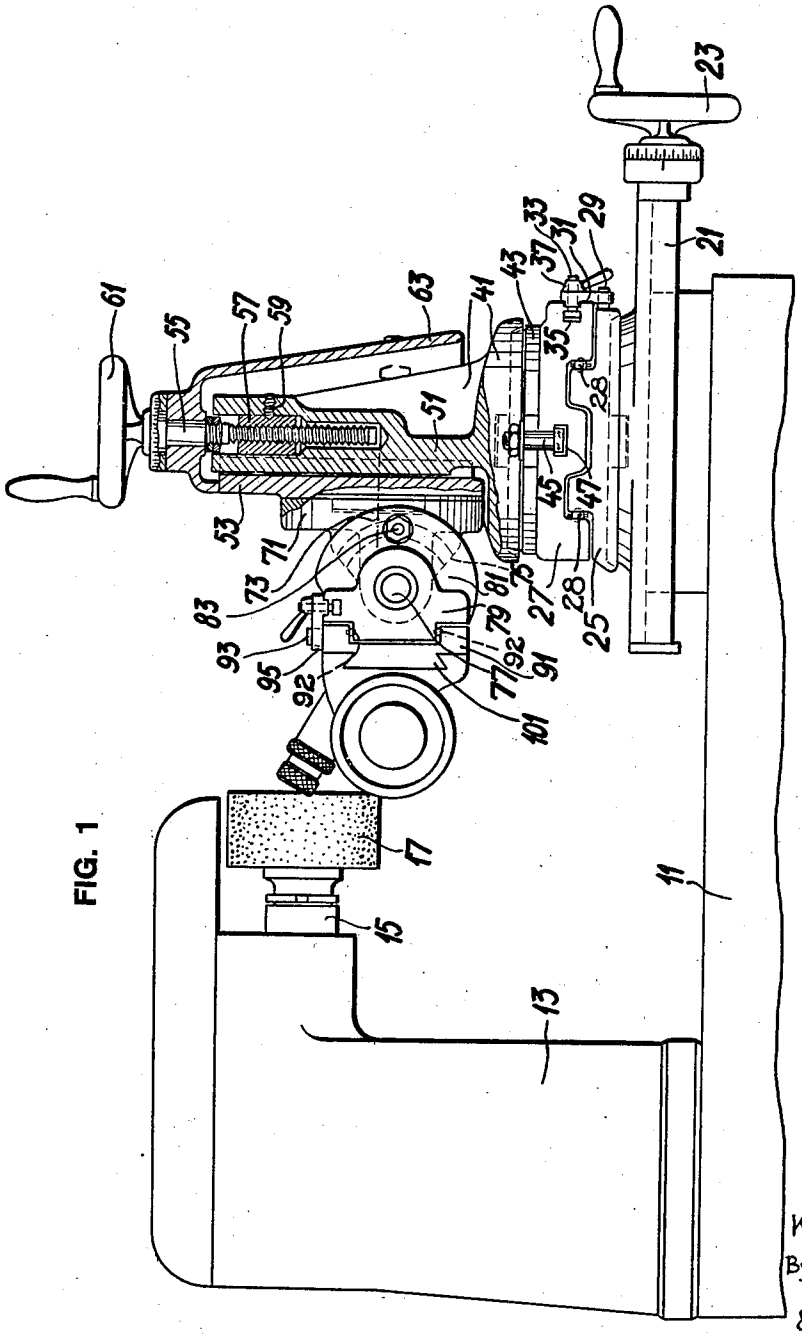


FIG. 1

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Filed March 17, 1939 3 Sheets-Sheet 2

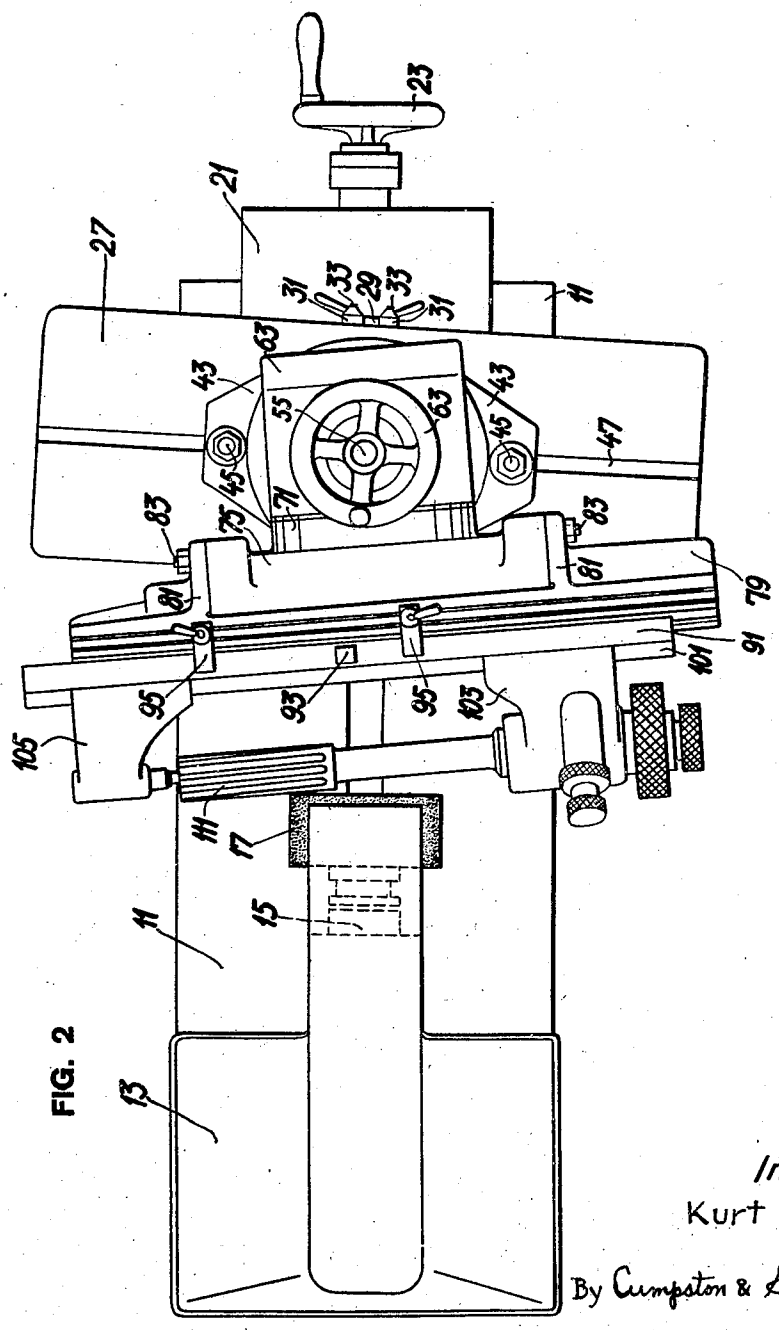


FIG. 2

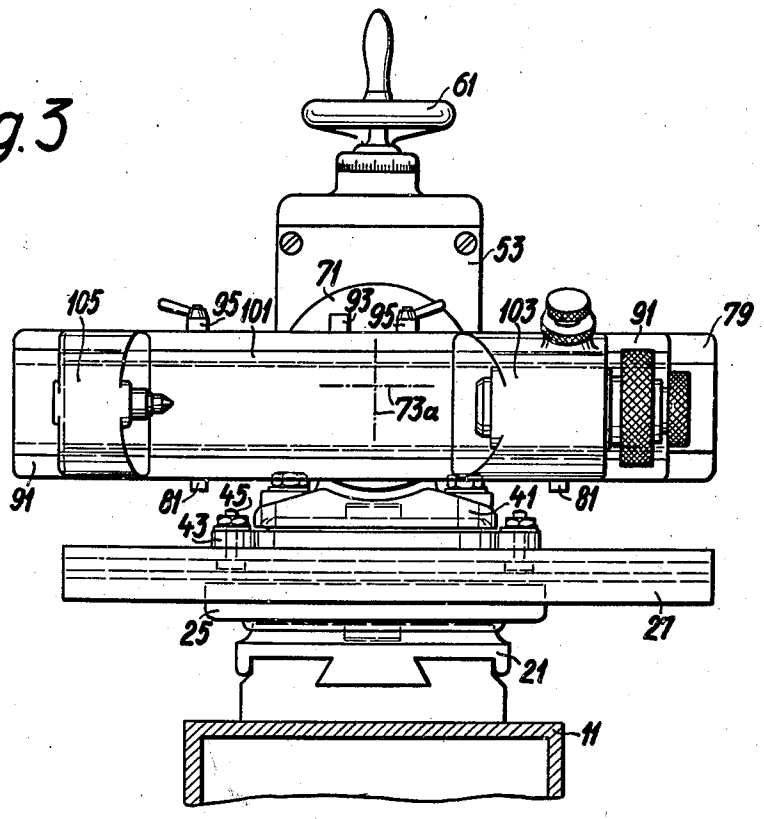
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Filed March 17, 1939 3 Sheets-Sheet 3

Fig. 3



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UNITED STATES PATENT OFFICE

2,213,756

GRINDING MACHINE

Kurt Zwick, Munich, Germany, assignor to Friedrich Deckel, Munich-Prinz Ludwigshohe, Germany

Application March 17, 1939, Serial No. 262,410
In Germany March 5, 1938

19 Claims. (Cl. 51—122)

This invention deals with a grinding machine, and more particularly with a machine capable of grinding rotary tools, although articles other than tools as well as tools not of the rotary type may also be ground.

Prior machines which have been adapted to grind both cylindrical rotary tools and conical rotary tools have been open to various objections. Setting the machine for grinding truly cylindrical tools has usually required the use of gauges or other measuring instruments which are cumbersome and time-consuming, and the slightest inaccuracy in such setting has resulted in grinding a tool somewhat conical instead of truly cylindrical. Furthermore, the adjustment of such machines has had to be changed whenever the grinding of a conical tool was finished and the grinding of a cylindrical tool was to begin, and vice versa. Also, a relatively large mass of slides, holding parts, etc., has had to be moved back and forth during the grinding of the tools, whether cylindrical or conical.

An object of the present invention is to provide a generally improved and more satisfactory grinding machine which is free of the above-mentioned objections.

Another object is to provide a grinding machine which will grind cylindrical rotary tools with the greatest accuracy, without the need for using gauges to insure proper settings for true cylindrical grinding, and which is nevertheless easily used also in grinding conical rotary tools, or tools of other forms.

Still another object is the provision of a grinding machine in which the work to be ground may be changed from a cylindrical rotary tool to a conical rotary tool, or vice versa, with the utmost ease and without requiring any special effort to obtain a correct cylindrical setting when the grinding of a conical tool has been finished and when it is again desired to grind a cylindrical tool.

A further object is the provision of a grinding machine so arranged that a cylindrical grinding tool may be moved past a grinding wheel in a direction exactly parallel to the rotary axis of the tool, to insure accurate cylindrical grinding, without the necessity of any special setting for the purpose of securing this parallel relation, and also having provision for moving other non-cylindrical types of tools (such as conical tools) past the grinding wheel in directions at an angle to their axes.

A further object is the provision of a machine in which, when operating upon cylindrical rotary tools, only a relatively small mass of holding parts, etc., is moved back and forth, the other holding parts having additional mass being movable back and forth only when conical or other non-cylindrical grinding is required.

A still further object of the invention is the provision of a grinding machine having means for supporting work to be ground and moving it past a grinding wheel, which means, although of relatively light and convenient form, has sufficient range of vertical movement so that the work may be brought into cooperation with either the lower edge or the upper edge or any desired intermediate part of the grinding wheel, even when a grinding wheel of relatively large diameter is employed.

A still further object is the provision of a grinding machine in which the work-holding means is so arranged as to be capable of two vertical adjustments which are additive with respect to each other.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a side elevation with parts in vertical section, of a grinding machine in accordance with a preferred illustrative embodiment of the present invention;

Fig. 2 is a plan thereof; and

Fig. 3 is an elevation of some of the parts shown in Fig. 1, viewed from a different direction.

The same reference numerals throughout the several views indicate the same parts.

In the machine shown in the drawings as a preferred illustrative embodiment of the invention, there is provided a base 11 on which is an upwardly extending support 13 carrying the approximately horizontal spindle 15 of a grinding wheel 17 which may be of any suitable form, such as an annular grinding wheel somewhat cup-shaped or tub-shaped. The spindle 15 is rotated by any suitable means.

At another convenient place on the base 11, preferably directly in front of the spindle 15, is a slide 21 mounted for horizontal movement in a direction generally toward and away from the grinding wheel 17. Preferably the slide 21 moves in the direction of a vertical plane passing along the axis of the spindle 15, though deviation from this relationship is possible without departing from the invention. The slide 21 is moved by any suitable means such as a common screw feed controlled by the hand-wheel or crank 23.

The parts for holding the tool or other work to be operated upon by the wheel 17, are all carried by and supported from the slide 21, and by feeding the slide 21 toward the wheel 17, the work is fed against the wheel 17.

A turn-table 25 is mounted on the slide 21 for rotation about an approximately vertical axis. Suitable means (not shown) is provided for clamping the turn-table in any desired position, to prevent rotation thereof.

Mounted on this turn-table 25 is a second slide 27, accurately guided for movement in a straight line, the guideways preferably being provided with ball or roller bearings or other suitable anti-friction means 28 so that the slide 27 may move smoothly and easily with respect to the turn-table 25 on which it is mounted. By turning the turn-table 25 on the slide 21, the direction of movement of the slide 27 can be brought to any desired angular relation to the direction of movement of the slide 21. Usually the turn-table 25 will be so placed that the slide 27 moves approximately transverse to the direction of movement of the slide 21, and such a relationship is shown in the drawings.

Suitable means is provided for clamping the slide 27 at any desired position along its range of travel, and for limiting its travel to any desired length. Such clamping means preferably includes a fixed lug 29 projecting from one side of the turn-table 25, and a pair of adjustable lugs 31 mounted on the slide 27 on opposite sides of the lug 29. For instance, the lugs 31 may be mounted on bolts 33 which have heads received in and slidable along an undercut or T-shaped slot 35 running along approximately the full length of the slide 27. Clamp nuts 37, preferably provided with suitable handles as shown, are threaded on the outer ends of the bolts 33. When these are loosened, the bolts 33 may be moved to any desired position along the slot 35, and when these nuts 37 are tightened, the bolts 33 and the adjustable lugs 31 which they carry are clamped in fixed position with respect to the slide 27.

When the lugs 31 are clamped at some distance from each other, the slide 27 may move in one direction or the other until one lug or the other hits against the cooperating stationary lug 29 on the turn-table 25. If it is desired to hold the slide 27 immovable on the turn-table preventing any longitudinal movement, then the two adjustable lugs 31 are brought close together and clamped tightly against opposite sides of the lug 29, so that no movement of the slide 27 relatively to the turn-table 25 is possible.

On this slide 27 is mounted a second turn-table 41. Preferably, however, the turn-table 41 has an approximately vertical axis of rotation which is not fixed with respect to the slide 27, but which may be shifted to various positions along the slide 27. This may be conveniently accomplished by mounting the turn-table 41 on a base 43 which is slidable along the top of the slide 27 in a lengthwise direction thereon, and which is secured in any desired position on the slide 27 by means of bolts 45 passing through the base 43 and having heads engaged in an undercut or T-shaped slot 47 in the slide 27. The turn-table 41 turns on the base 43 about an approximately vertical axis which is fixed with respect to the base.

Rising from the turn-table 41 is an upwardly extending post or pillar 51, provided with an approximately vertical guideway on which is slidably mounted a vertical slide 53 controlled in its upward and downward movements by any suitable feeding means such as the feeding screw 55 mounted on the slide 53 and held against longitudinal movement with respect thereto, and which has a threaded part engaging the threads of a nut 57 held stationary in the pillar 51 by suitable means such as a set screw 59. A hand-wheel or crank 61 on the screw 55 may be turned to raise or lower the slide 53 with respect to the pillar 51. The slide 53 includes a skirt flange or canopy 63 which encloses the upper part of the pillar 51 and protects the screw feed parts 55 and 57 from grinding dust or other foreign matter.

Mounted on one side of the vertical slide 53 is a support 71 capable of being rotated relatively to the slide 53 about the axis indicated by the dot dash line 73 in Fig. 1, this axis being indicated at the point of crossing of the two dot dash lines 73a in Fig. 3. In effect, this support 71 is a turntable oscillatable for adjustment about a substantially horizontal axis with respect to the slide 53 on which it is mounted. It is clamped in any desired position on the slide 53 by clamping bolts or any other suitable clamping arrangement.

On this rotary support 71 is a projecting bracket 75 carrying a shaft 77 on which is pivotally mounted a bed or carrier 79, which may be turned about the axis of the shaft 77 as a center of rotation. Flanges 81, of approximately semi-circular outline in the form here shown, are formed on the carrier 79 in position to overlap the ends of the bracket 75, as indicated in Fig. 2. Bolts 83 pass through holes in these flanges 81 and have heads in arcuate T-shaped slots formed in the bracket 75, so that by loosening the nuts on these bolts, the carrier 79 may be tilted to any desired angle (within a substantial angular range of travel of approximately 90°) with respect to the bracket 75, and then may be clamped in any desired position by tightening the nuts on the bolts 83.

Frequently the rotary support 71 will be clamped to the slide 53 in such position that the shaft 77 is approximately horizontal, and this is the position shown in the drawings, but by turning the support 71 with respect to the slide 53, the shaft 77 may be tilted in either direction to a substantial angle to a horizontal plane, if the work to be ground is of a character where such an angle is advisable.

The bed or carrier 79 is provided with a guideway extending in a diriection preferably parallel to the shaft 77, and a work slide 91 is mounted for movement along this guideway. As in the case of the guideway between the parts 25 and 27, this guideway between the parts 79 and 91 is preferably provided with ball bearings, roller bearings, or other anti-friction means 92 so that the work carriage 91, although guided accurately for perfectly straight movement, is able to move freely and easily along its path of travel. It may be clamped in fixed position relative to the carrier 79, or allowed any desired range of movement thereon, by means of a clamping arrangement substantially the same as that used between the parts 25 and 27. That is, there are a fixed lug 93 formed on the slide 91 and a pair of cooperating adjustable lugs 95 lying on opposite sides of the lug 93 and capable of being clamped in different positions on the carrier 79, in a manner substantially the same as the adjustable lugs 31 previously mentioned.

On the work slide 91 there is suitable means for holding the work to be ground by the grinding wheel 17. Conveniently, the slide 91 may be provided with a dove-tailed portion 101 running lengthwise of the slide 91 in a direction parallel to the direction of movement of the slide 91. On this dove-tailed portion 101 may be clamped the means for holding the work to be ground. When rotary cutting tools (whether cylindrical or conical) are to be ground, the holding means may comprise a clamping head stock 103 of any convenient construction, and a tail stock 105. The head stock 103 is provided as usual, with any suitable arrangements for clamping the shank of a rotary cutting tool, such as the cylindrical reamer shown at 111 in Fig. 2, and for turning this shank from time to time by any desired increments, while the tail stock is provided with the usual conical pin on which the opposite end of the rotary cutting tool 111 may be centered.

The dove-tailed track 101 on which the head stock 103 and tail stock 105 are mounted is constructed so as to be exactly parallel to the direction of the guideway on which the slide 91 moves with respect to the carrier 79. The head stock 103 and tail stock 105 are so constructed that the axis of any rotary cutting tool properly clamped in the head stock 103 and centered in the usual manner on the pin on the tail stock 105, is exactly parallel to the dove-tailed track 101 and, consequently, exactly parallel to the direction of movement of the slide 91 on the carrier 79.

If tools other than rotary cutting tools are to be ground, the head stock 103 and tail stock 105 may be removed from the dove-tailed track 101 and any other suitable clamping means adapted to hold the tools to be ground may be applied to this dove-tailed track. The same is possible when articles other than tools are to be ground.

It will be seen that the machine in the illustrative form herein described as a preferred embodiment of the invention, has many and important advantages over tool grinding machines of the prior art. The parts, although capable of a great variety of adjustments to different positions, are compact and relaitvely light, thus not being open to the objection of heavy and cumbersome parts present in so many prior machines, which by their weight and size make operation difficult and which require heavy and expensive frame work for supporting them.

In spite of the lightness and compactness of the present arrangement, it is capable of adjustment through a wide range. For certain types of grinding, it is desirable to be able to bring the work at one time into contact with the lower edge of the grinding wheel 17 and at another time into contact with the upper edge thereof. With the modern tendency toward the use of grinding wheels of relatively large diameter, this has required, in the prior art arrangements, relatively bulky means for holding the work to be ground, in order that the holding means shall be capable of shifting the work from the bottom edge to the top edge, or vice versa, of a grinding wheel of relatively large diameter.

But in the present construction, the parts can still be kept small while achieving this result. If the vertical range of movement of the slide 53 on the pillar 51 is not sufficient to shift the work from the bottom edge to the top edge of the grinding wheel, then a still further vertical movement may be attained by turning the carrier 79 relatively to the bracket 75 about the axis of the shaft 77 as a center, this shaft being placed roughly horizontally by suitable adjustment of the turn-table 71 on the slide 53. Since the tool or other work to be ground is placed at a position offset a substantial distance horizontally from the shaft 77, it follows that when the parts are turned about the shaft 77 as above indicated, the work being operated upon will be correspondingly raised or lowered through a substantial extent. This possibility of adjusting the work upwardly and downwardly is in addition to the upward and downward range of movement of the slide 53 on the pillar 51, and thus the work holding means may be described as capable of separate upward and downward adjustments which are additive with respect to each other, and which together result in a great upward and downward range of movement of the work being operated upon, in spite of a very small over-all height of the holding means. The turning of the parts about the shaft 77 may be used as a rough adjustment of the height of the work, fine adjustment of the height being obtained by moving the slide 53 by means of the screw 55, which screw may be provided with graduations or reference marks if desired.

In operation, assuming that a cylindrical rotary cutter, such as indicated at 111 in Fig. 2, is to be ground, the cutter 111 is centered on the tail stock 105 and clamped in the head stock 103, and the axis of the cutter 111 is adjusted to the desired angle with respect to the grinding wheel 17, by turning either of the turn-tables 25 or 41 on its corresponding support, and also by turning the vertical turn-table 71 about its horizontal axis 73 if desired. The direction of the slide 27 at this time is unimportant, and no pains need be taken to set this slide to any particular direction. The slide 27 is, however, clamped against longituinal movement by means of the clamping lugs 29 and 31.

All these settings may be made while the tool 111 to be ground is kept a substantial distance away from the grinding wheel 17, obviating danger to the operator if the grinding wheel is in motion. Then, by turning the feed wheel 23, the slide 21 is moved in a direction toward the grinding wheel 17 until the tool 111 to be ground is brought against the grinding wheel 17 and to a position to make the desired depth of cut. Then the work slide 91 is moved by hand in one direction or the other along its guideway on the support 79, carrying successive portions of the tool 111 past the grinding wheel 17 in cooperative relation thereto. Since the movements of the slide 91 may be performed by direct manual pressure, the grinding operation is under the sensitive control of the operator and subject to his direct "feel" so that best results can be attained.

It is to be especially noted that this grinding of cylindrical cutters does not require any special or complicated setting of the holding mechanism in order to obtain truly cylindrical grinding, and especially it does not require the use of gauges or indicators or graduations, as required in many of the prior art devices, in order to insure parallel setting and accurate cylindrical grinding. The mere fact of centering the tool 111 properly with respect to the head stock 103 and tail stock 105 automatically insures the axis of the tool being parallel to the direction of movement of the slide 91 on its guideway, and automatically insures the correct cylindrical grinding of the tool without any possibility of accidental conical grinding.

When a conical cutter is to be ground, then it

is clamped in the head stock 103 and tail stock 105 as before, but this time the slide 91 is held against longitudinal movement by the clamping lugs 95, and the slide 27 is set at an angle to the axis of the conical cutting tool corresponding to the desired conical angle of the tool. Then the slide 27 is moved back and forth along its guideway on the member 25, this movement carrying with it all of the parts supported from the slide 27, such as the turntable 41, pillar 51, carrier 79, and head stock 103 and tail stock 105. As in the case of cylindrical grinding, the parts are preferably moved back and forth by direct hand pressure, to secure greatest sensitivity and so that the operator may get the "feel" of the work as it progresses, but screw feeds or other mechanical feeding means could be used, if desired.

It should be noted that when grinding cylindrical tools, the parts to be moved back and forth are few and of low mass, consisting only of the work slide 91, head stock 103, tail stock 105, and the tool being ground. The mass of the other parts 27, 41, 51, 71, and 79 remains stationary during cylindrical or parallel grinding, and must be moved back and forth only when performing conical or oblique grinding, which in many shops is not done so frequently as cylindrical grinding.

Another noteworthy feature is that when the grinding of a conical cutter has been completed, if it is desired to grind a cylindrical cutter, this may be done without resetting the mechanism. Slide 27 may be left in any angular position to which it was previously set for grinding the conical tool (being clamped, of course, against movement by means of the clamps 31) and without any change in this position of the slide 27, the cylindrical tool may now be ground by moving the slide 91 back and forth on its carrier 79.

Thus a grinding machine of the utmost flexibility and at the same time with great simplicity and compactness is provided. The many advantages of this construction over the prior available constructions will be readily seen by those skilled in this art upon a careful study of the present construction, and its adaptability to practically any grinding problem will be apparent, although the machine is especially useful, as above indicated, for grinding rotary cutters of either the cylindrical or the conical type.

Although grinding has been referred to, it will be understood that a milling tool or other cutting tool could be substituted for the grinding wheel 17 without otherwise altering the principles of the invention.

While one embodiment of the invention has been disclosed, it is to be understood that the inventive idea may be carried out in a number of ways. This application is therefore not to be limited to the precise details described, but is intended to cover all variations and modifications thereof falling within the spirit of the invention or the scope of the appended claims.

I claim:

1. A grinding machine capable of grinding rotary tools, including a grinding wheel rotatable about an axis, a slide capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said grinding wheel axis, a second slide supported from said first mentioned slide and capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said path of travel of said first mentioned slide and held during a normal grinding operation against movement in any direction except along said path of travel of said first mentioned slide, and means on said second slide for holding a rotary tool to be ground in a position with its axis in definite fixed relation to said grinding wheel and parallel to said path of travel of said second slide, so that when a cylindrical rotary tool is mounted in said holding means, accurate cylindrical grinding thereof may be insured by holding said first mentioned slide against movement and by moving said second slide through its said path of travel to carry the tool past said grinding wheel in cooperative relation thereto, and when a conical rotary cutting tool is mounted in said holding means, it may be ground by adjusting the paths of travel of the two slides to the required angle with respect to each other and by carrying the tool past said grinding wheel in cooperative relation thereto by moving said first mentioned slide along its path of travel while maintaining said second slide in fixed relation to said first mentioned slide.

2. A grinding machine capable of grinding rotary tools, including a grinding wheel rotatable about an axis, a slide capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said grinding wheel axis, a second slide supported from said first mentioned slide and capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said path of travel of said first mentioned slide and held during a normal grinding operation against movement in any direction except along said path of travel of said first mentioned slide, and means on said second slide for holding a rotary cutting tool to be ground, said holding means being adjustably mounted on said second slide to be capable of holding cutting tools of different sizes and being so constructed that in every position of adjustment of said holding means a rotary cutting tool held thereby has its axis in fixed parallel relation to said path of travel of said second slide.

3. A grinding machine capable of grinding rotary tools, including a grinding wheel rotatable about an axis, a slide capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said grinding wheel axis, a second slide supported from said first mentioned slide and capable of movement back and forth along a path of travel capable of adjustment to various angular positions with respect to said path of travel of said first mentioned slide, a headstock and a tailstock mounted on said second slide for holding a rotary tool in position to be ground by said grinding wheel, at least one of said stocks being movable toward and away from the other so as to accommodate tools of different lengths, said stocks in all positions thereof serving to maintain a rotary tool held thereby with its axis parallel to the path of the travel of said second slide.

4. A grinding machine as described in claim 2, further including means for holding either of said slides against movement along its respective path of travel.

5. A grinding machine capable of grinding rotary tools, including a griding wheel rotatable about an axis, a first slide mounted for approximately horizontal movement in a direction approximately toward and away from said

grinding wheel, a second slide supported from said first slide for rotation relative thereto about an approximately vertical axis and also for approximately horizontal rectilinear movement relative thereto, a work slide supported from said second slide for rotation relative thereto about an approximately vertical axis and also for rectilinear movement relative thereto, and holding means on said work slide for holding a rotary tool to be ground in a position to be acted upon by said grinding wheel and with its axis parallel to the direction of said rectilinear movement of said work slide.

6. A grinding machine capable of grinding rotary tools, including a grinding wheel rotatable about an axis, a first slide mounted for approximately horizontal movement in a direction approximately toward and away from said grinding wheel, a second slide supported from said first slide for rotation relative thereto about an approximately vertical axis and also for approximately horizontal rectilinear movement relative thereto, a work slide supported from said second slide for rotation relative thereto about an approximately vertical axis and also for rectilinear movement relative thereto, holding means on said work slide for holding a rotary tool to be ground in a position to be acted upon by said grinding wheel and with its axis parallel to the direction of said rectilinear movement of said work slide, and means interposed between said first slide and said work slide for raising and lowering said work slide with respect to said first slide.

7. A grinding machine capable of grinding rotary tools, including a grinding wheel rotatable about an axis, a first slide mounted for approximately horizontal movement in a direction approximately toward and away from said grinding wheel, a second slide supported from said first slide for rotation relative thereto about an approximately vertical axis and also for approximately horizontal rectilinear movement relative thereto, a work slide supported from said second slide for rotation relative thereto about an approximately vertical axis and also for rectilinear movement relative thereto, holding means on said work slide for holding a rotary tool to be ground in a position to be acted upon by said grinding wheel and with ints axis parallel to the direction of said rectilinear movement of said work slide, and two means interposed between said first slide and said work slide for raising and lowering said work slide with respect to said first slide, said two means being additive with respect to each other.

8. A grinding machine as described in claim 7, in which one of said two means includes a slide mounted for approximately vertical movement.

9. A grinding machine as described in claim 7, in which one of said two means includes an oscillatable connection between said first slide and said work slide so that said work slide may be oscillated relative to said first slide about an axis spaced from and substantially parallel to the axis of a rotary tool held in grinding position on said work slide.

10. A grinding machine as described in claim 5, further including an oscillatable connection between said second slide and said work slide for enabling adjustment of the position of said work slide by oscillating it about an axis extending in a direction generally transverse to said direction of rectilinear movement of said work slide.

11. A machine for operating upon rotary tools and the like, said machine including an operating element rotatable about an axis, a first slide mounted for approximately horizontal movement in a direction approximately toward and away from said operating element, a second slide supported from said first slide for approximately horizontal rectilinear movement relative thereto, an oscillatable connection between said first slide and said second slide so that the direction of rectilinear movement of said second slide may be swung about an approximately vertical axis to various positions with respect to the direction of movement of said first slide, an upstanding pillar mounted on said second slide for rotary adjustment relative thereto about an approximately vertical axis, a third slide mounted for upward and downward movement on said pillar, a work slide supported from said third slide for rectilinear movement relative thereto, and means on said work slide for holding a rotary tool in a position to be acted upon by said operating element and with its axis parallel to the direction of rectilinear movement of said work slide.

12. A machine as described in claim 11, further including an oscillatable connection between said third slide and said work slide so that the direction of rectilinear movement of said work slide may be adjusted relative to the direction of movement of said third slide by swinging it about an axis approximately perpendicular to both of said directions.

13. A machine as described in claim 11, further including an oscillatable connection between said third slide and said work slide so that the position of a tool held by said work slide may be altered relative to said third slide by swinging said work slide relative to said third slide about an axis spaced from and approximately parallel to the axis of said tool.

14. A machine as described in claim 11, further including a slidable connection between said pillar and said second slide so that said pillar may be adjusted to various positions along the length of said second slide.

15. A machine as described in claim 11, further including means for holding any one of said slides against movement along its path of travel.

16. A machine as described in claim 11, in which said second slide and said work slide are both provided with anti-friction bearings means so that each of them may move easily along its path of movement.

17. A machine as described in claim 11, in which said first slide and said third slide are both provided with screw feed means.

18. A machine for grinding tools and the like, said machine including a grinding wheel, a support, a slide carried from said support and movable approximately vertically with respect to said support, a carrier mounted on said slide for oscillation with respect to said slide about an approximately horizontal axis, a member mounted on said carrier for oscillation with respect to said carrier about an axis approximately perpendicular to the axis of oscillation of said carrier, a work slide mounted on said member for rectilinear movement along a line parallel to the axis of oscillation of said member, and means on said work slide for holding work in position to cooperate with and be ground by said grinding wheel.

19. A machine for grinding tools and the like, said machine including a grinding wheel, a support, a slide carried from said support and movable approximately vertically with respect to said support, a carrier mounted on said slide for oscillation with respect to said slide about an approximately horizontal axis, a member mounted on said carrier for oscillation with respect to said carrier about an axis approximately perpendicular to the axis of oscillation of said carrier, and a head stock and tail stock supported from said member with their centers at equal distances from the axis of oscillation of said member for holding an elongated rotary tool in a position with its axis parallel to the axis of oscillation of said member and in cooperative relation to said grinding wheel to be ground thereby.

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