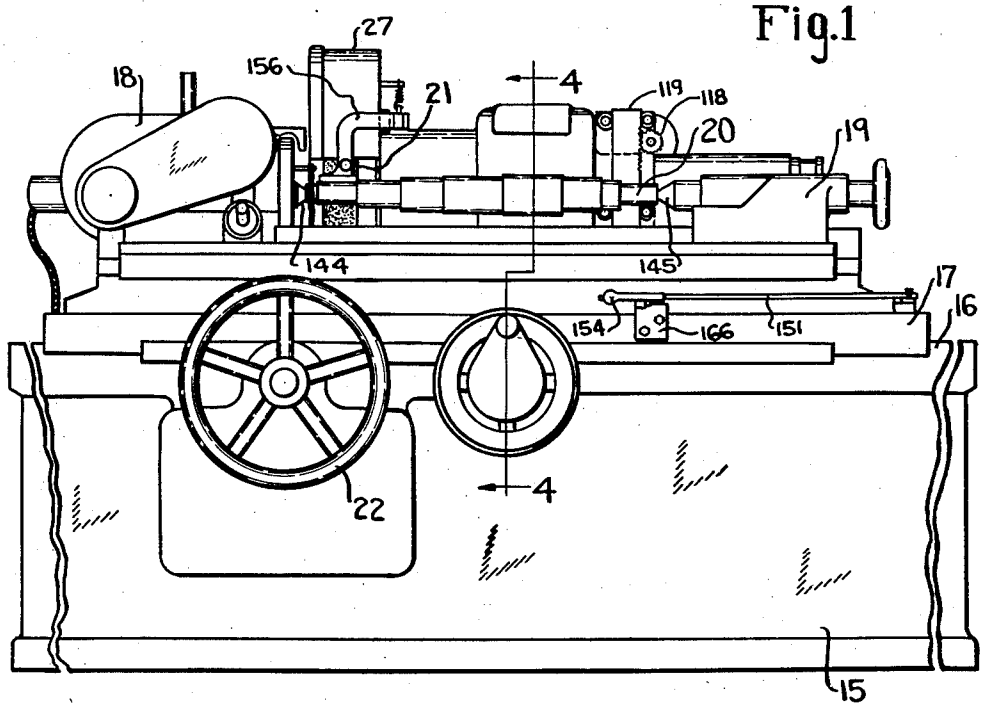
Aug. 6, 1935. A. G. PLIMMER 2,010,375

GRINDING MACHINE

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Fig.1



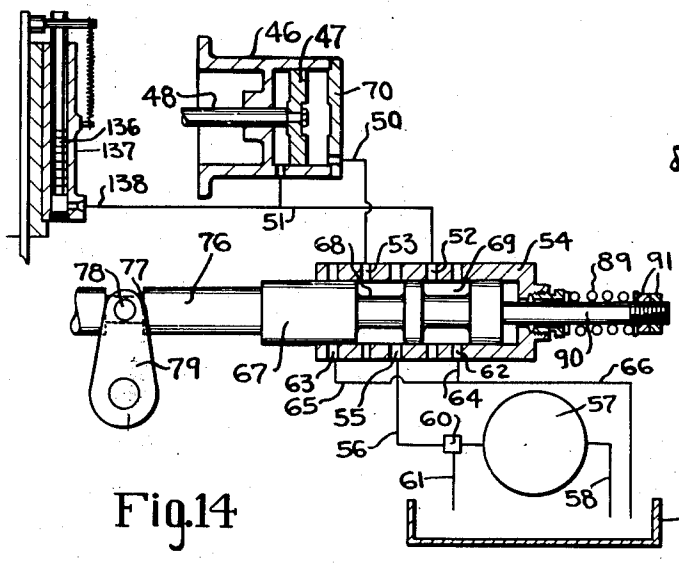


Fig.14

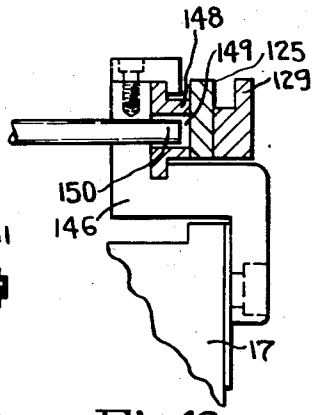


Fig.13

Inventor

ALFRED G. PLIMMER

By O'K Parsons

Attorney

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GRINDING MACHINE

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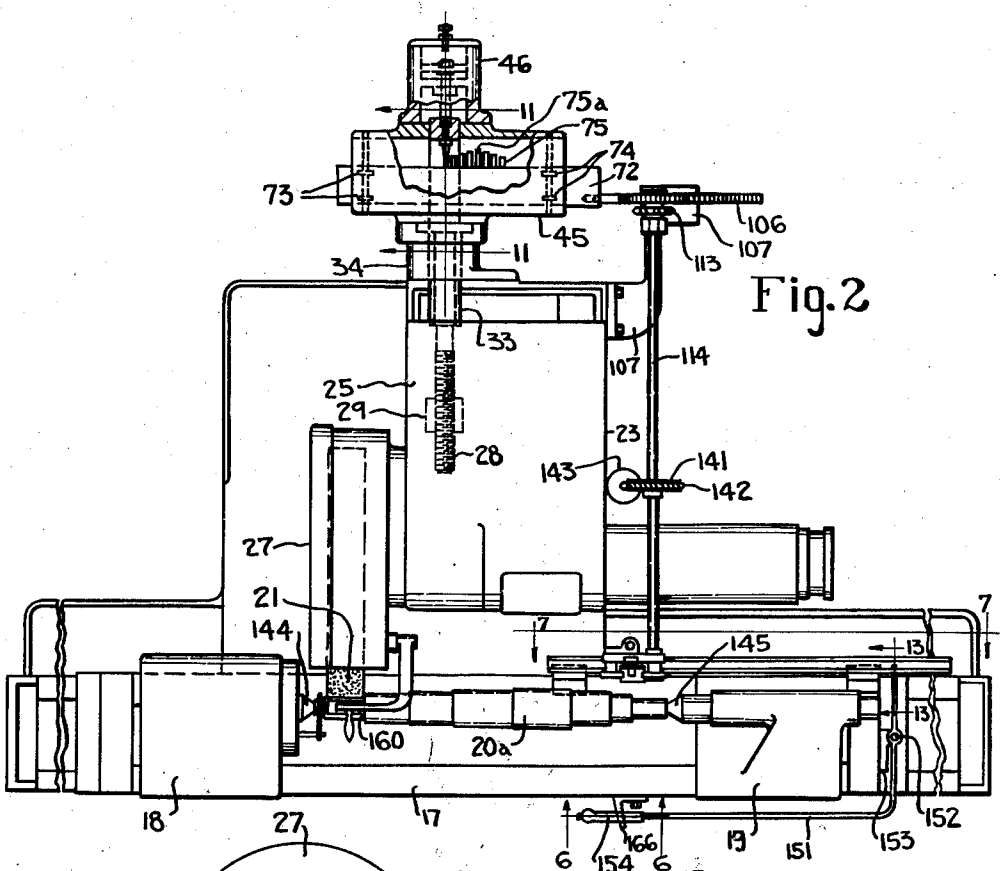


Fig. 2

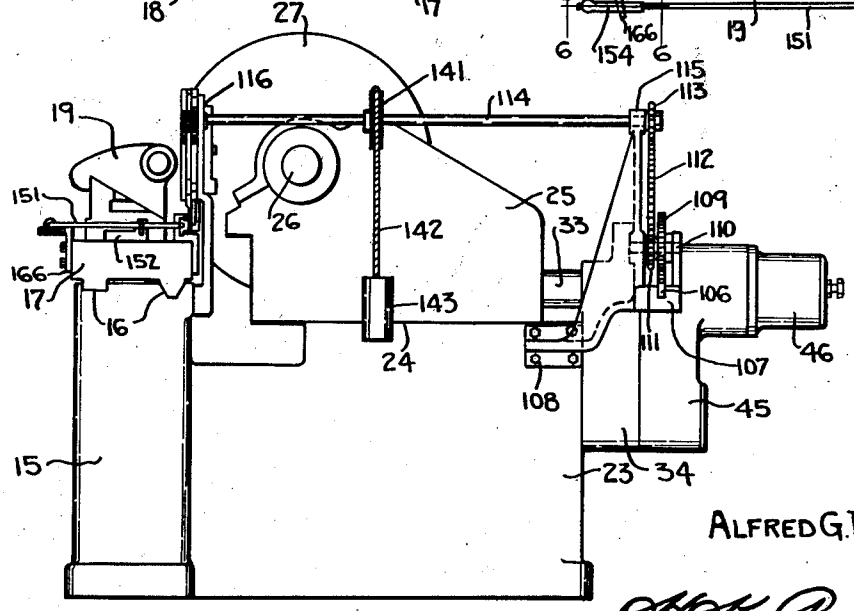


Fig. 3.

Inventor

ALFRED G. PLIMMER

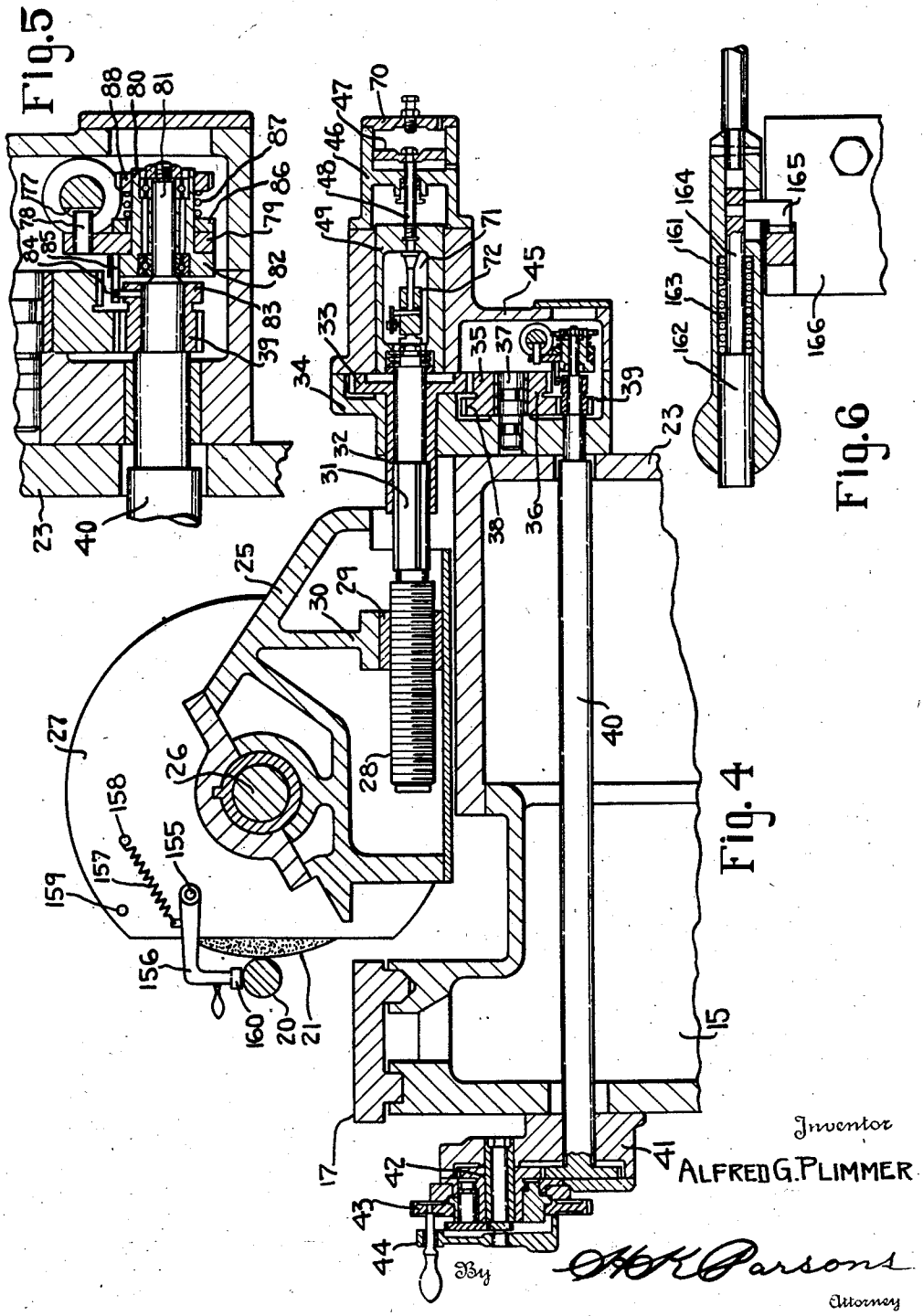
By O'K Parsons

Attorney

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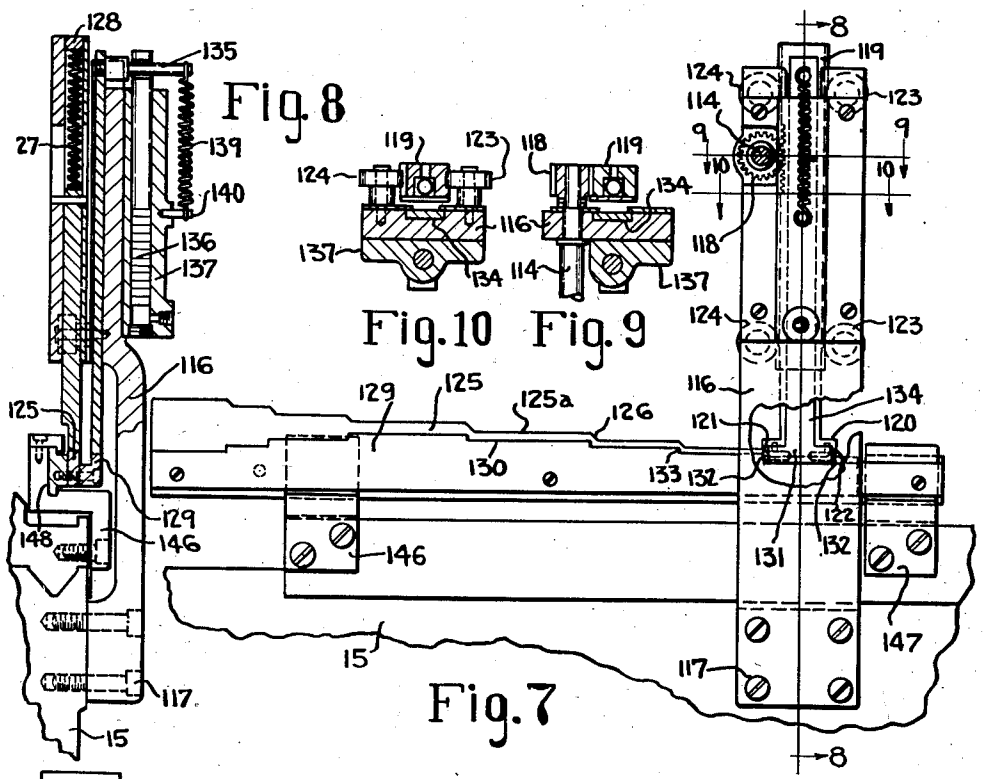


Fig. 8

Fig. 10

Fig. 9

Fig. 7

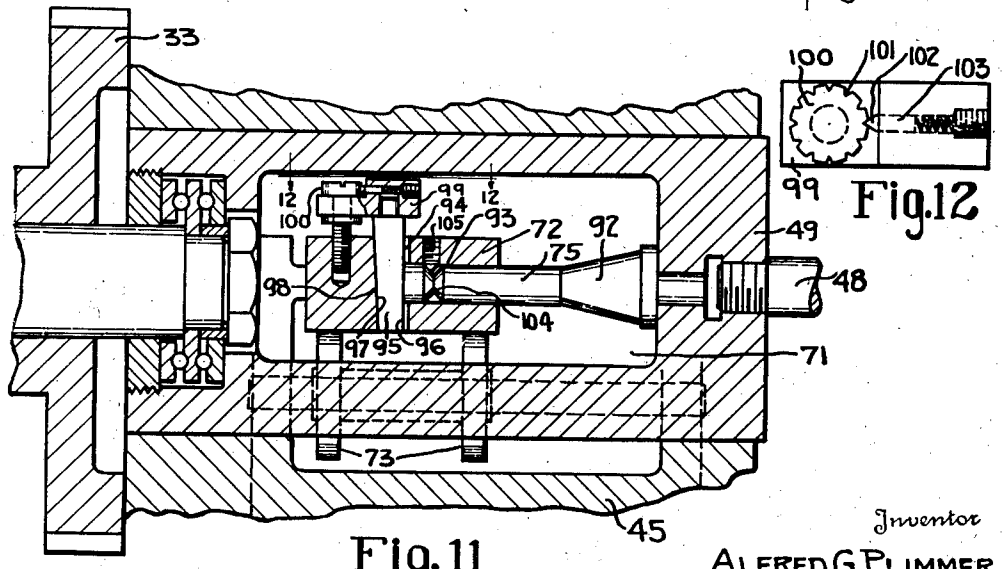


Fig. 11

Fig. 12

Inventor

ALFRED G. PLIMMER

By O'K Parsons

Attorney

Patented Aug. 6, 1935 2,010,375

UNITED STATES PATENT OFFICE

2,010,375

GRINDING MACHINE

Alfred G. Plimmer, Cincinnati, Ohio, assignor to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application May 3, 1932, Serial No. 608,957

26 Claims. (Cl. 51—72)

This invention relates to improvements in machine tools and especially to improvements in grinding machines.

An object of the invention is the provision of a machine tool for expeditiously grinding multiple diameter work pieces or shafts, such as armature shafts for electric motors, having a plurality of steps or individual diameters thereon.

Another object of the invention is the provision of improved means for insuring the accurate grinding of each step to its shoulder and insuring the reduction of said diameters to the desired size throughout their length and especially at the shoulder.

A further object of the invention is the provision of improved means for aligning the control mechanism with the first or initial step or diameter of the work to insure successive steps or diameters of successive work pieces having the same relation to one another.

A still further object of the invention is the provision of a machine for accomplishing the above objects that is inexpensive to manufacture and simple to operate.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification considered in conjunction with the accompanying drawings and it is to be understood that any modifications may be made in the exact structural details there shown and described within the scope of the appended claims without departing from or exceeding the spirit of the invention.

In the drawings:

Figure 1 is a front elevation of a grinding machine embodying the improvements of this invention.

Figure 2 is a top plan view of the machine as seen in Figure 1.

Figure 3 is an end elevational view as seen from the right hand side of Figures 1 and 2.

Figure 4 is a transverse sectional view through the machine showing the feeding or tool actuating mechanism as seen particularly from line 4—4 on Figure 1.

Figure 5 is a fragmentary enlarged sectional view of a portion of Figure 4 and particularly illustrating the valve actuating mechanism.

Figure 6 is an enlarged fragmentary sectional view of the locking mechanism of the adjusting device as seen particularly from line 6—6 of Figure 2.

Figure 7 is an elevational view of the cam and stop bars and parts actuated thereby as seen from line 7—7 on Figure 2.

Figure 8 is a sectional view taken on line 8—8 of Figure 7.

Figure 9 is a sectional view taken on line 9—9 of Figure 7.

Figure 10 is a sectional view taken on line 10—10 of Figure 7.

Figure 11 is an enlarged sectional view through the hydraulic stop mechanism taken on line 11—11 of Figure 2.

Figure 12 is a plan view of a micrometer adjusting mechanism employed with the hydraulic stop mechanism as seen from line 12—12 on Figure 11.

Figure 13 is a fragmentary view partly in elevation and partly in section as seen from line 13—13 of Figure 2.

Figure 14 is a diagrammatic view illustrating the hydraulic circuits involved in this invention.

Throughout the several views of the drawings similar reference characters have been employed to denote the same or similar parts.

As mentioned above, the mechanism disclosed and described in this application has particular reference to a machine for successively operating on individual steps or portions of a work piece. Accordingly the machine may comprise a bed 15 having formed on the upper surface thereof ways 16 for guiding the work supporting table 17 during its movement relative thereto. The table 17 supports at opposite ends thereof a self-contained head stock 18 and a tail stock 19 having projecting therefrom suitable centers for supporting a work piece 20 therebetween. Opposed to the work is a grinding wheel 21 for operation on the individual steps or diameters of the work 20. In order to align the grinding wheel 21 with said individual steps or diameters of the work either the grinding wheel or the work supporting table is axially adjusted relative to the other. For this purpose there is provided a hand wheel 22 rotatably journaled in the forward face of the bed 15.

The bed 15 has projecting from its rear surface the extension 23 having formed on the upper surface thereof guideways 24 for a carriage or support 25 in which is rotatably journaled a spindle 26. The spindle 26 has secured to it the grinding wheel 21 for rotation with one another and the carriage further supports a hood or guard 27 which substantially encloses the grinding wheel 21 for confining the coolant usual with machines of this type. In order to feed the grinding wheel and work relative to one another either the grinding wheel or the work is actuated to-

ward the axis of the other. In the drawings the mechanism for moving the grinding wheel is disclosed, for which purpose a cross feed or adjusting screw 28 is provided having its threaded end in threaded engagement with a nut 29 secured in a web 30 integral with the carriage 25. Intermediate the ends the screw 28 is provided with a splined portion 31 in splined sliding engagement with the sleeve 32 of a gear 33. The sleeve 32 is rotatably journaled in a bearing provided by a housing 34 secured to the rear wall of the bed extension 23. Meshing with the gear 33 is a pinion 35 of a compound gear 36 loosely journaled on a stud 37 carried by the housing 34. The large gear 38 of the compound gear 36 meshes with a pinion 39 keyed or otherwise secured to the end of a transverse shaft 40. The shaft 40 is journaled at its rear end in the housing 34 and at its forward end in a feed box 41 secured to the forward face of the bed 15. Journaled within the feed box 41 is a transmission and micrometer adjusting mechanism 42 which terminate respectively in a ratchet 43 and micrometer crank or hand wheel 44. These structures are usual with grinding machines whereby manual actuation of the hand crank 44 manually rotates the screw 28 for actuating the grinding wheel in opposite directions relative to the work, while the ratchet 43 is power actuated through the usual pick feed mechanism for actuating the grinding wheel toward the work.

The housing 34 on the rear of the bed extension 23 is closed by a cover plate 45 to which in turn is secured a cylinder 46 having enclosed therein a piston 47 adapted to be hydraulically actuated axially of the said cylinder. Projecting from the piston 47 is a piston rod 48 having its inner end secured to a cross head 49. The cross head 49 has rotatably journaled in its other end the rear end of the screw 28 whereby said screw may be rotated independently of the cross head 49 and whereby axial movement of the cross head 49 correspondingly axially adjusts the screw 28 for carrying with it the carriage 25.

As shown diagrammatically in Figure 14, the cylinder 46 has terminating at its opposite ends one end of pipes 50 and 51 whose other ends respectively terminate at ports 52 and 53 formed within a valve sleeve 54. The valve sleeve 54 is provided intermediate the ports 52 and 53 with a port 55 forming one terminus for a pressure line or pipe 56 which extends from a pump 57. The pump 57 draws an hydraulic medium, preferably oil, through a suction pipe 58 from a tank or sump 59 and discharges same under pressure into the conduit or line 56. Placed in the line 56 is a relief valve 60 connected by a conduit 61 to the tank 59 for spilling excess oil discharged by the pump 57 back into the tank 59. The sleeve 54 is provided with additional ports 62 and 63 with which is connected one end of branch discharge conduits 64 and 65, each connecting with a common discharge line 66 that terminates in the tank or sump 59 for returning the used or spent hydraulic medium to the tank. Enclosed within the sleeve 54 is a piston type valve 67 having formed therein cannelures 68 and 69 respectively employed for alternately connecting the pressure in the line 56 with the lines 51 and 50 thereby actuating the piston 47 in opposite directions relative to the cylinder 46.

As shown in Figure 14, the cannelure is connecting the ports 53 and 55 for connecting pressure in the line 56 with the line 50 thereby actuating the piston 47 to the left of the cylinder 46 and, through the cross head 49, actuating the grinding wheel toward the work. At this time the cannelure 69 is connecting the ports 52 and 62 for connecting the spent or exhaust hydraulic medium in the line 51 with the branch discharge line 64 and main discharge line 66 for returning the hydraulic medium to the tank or sump 59. Actuation of the valve 67 to the left, as seen in Figure 14, will connect the pressure port 55 with port 52 through the cannelure 69, while the cannelure 68 connects the port 53 with branch exhaust or discharge port 63 thereby actuating the piston 47 to the left for retracting the grinding wheel from the work.

In actual practice the cylinder head 70 on the right hand end of cylinder 46, as seen in Figure 4, forms the limit of movement of the piston 47 to the right, while the left hand limit of movement of the piston is variably determined by means of adjustable stops which are in alignment with the particular step or diameter of the work piece adapted to be operated on. For this reason the cross head 49 has formed therein the axial opening 71 through which extends a stop block 72. The stop block 72 is supported on opposite ends by rollers 73 and 74 journaled in the bracket cover 45. As seen in Figure 2, the stop block 72 has mounted therein a plurality of stop pins 75 each projecting a definite amount from the face of the block 72 depending upon the particular diameter of the work with which it is aligned. As shown in Figure 2, the steps or diameters of the work from left to right gradually increase until the step 20*a* is reached whereupon the steps of the work gradually decrease. Accordingly the pins 75 from left to right each project beyond the preceding one an amount equal to the difference in radii between the successive steps of the work until the pin 75*a* is encountered. From pin 75*a* on the pins gradually recede an amount equal to the difference in radii of the work portions on the right hand side of the diameter 20*a* of the work.

From this it will be seen that the grinding wheel and its carriage when actuated by the hydraulic piston 47 cannot inadvertently engage with the work or gouge same since the grinding wheel would be stopped before contact of the work and the wheel. Through mechanism to be subsequently described the stop bar 72 is actuated in unison with the longitudinal travel of the work table 17 thereby at all times keeping the work diameters and the stop pins in step.

In order to actuate the valve 67 it has projecting from it a valve stem 76 having formed intermediate its ends a circumferential groove 77 receiving a pin 78 projecting from the upper end of a crank or lever 79. The lever 79 is journaled on a sleeve 80 encircling the reduced extension 81 of the transverse shaft 40. The sleeve 80 is formed on one end with a collar 82 which lies adjacent a collar 83 formed on the pinion 39. The collar 83 has projecting from it a pin 84 adapted to engage with a pin 85 having its axis disposed at right angles to the axis of the pin 84 and carried by the sleeve collar 82. As shown in Figure 5, the crank arm 79 has one surface abutting the adjacent surface of the sleeve collar 82 and has contacting with it on its other surface a friction washer 86 against which abuts one end of a spring 87 compressed a desired amount by a nut 88 threaded on the end of the sleeve 80. From this it will be seen that the crank 79 is frictionally held between the sleeve collar 82 and the friction washer 86.

The operation of these parts is as follows: In practice it is desired to maintain a definite clearance between the diameter or step of the work dseired to be ground and the grinding wheel for which purpose the stop pins **75** are properly adjusted. As seen from the left hand end of Figure 5, rotation of the shaft **40** in a counterclockwise direction will cause the pin **84** to leave the pin **85** without shifting or moving it. This free movement of the pin **84** would continue until the shaft **40** has made substantially one complete revolution whereupon the pin **84** would engage with the pin **85** at a point diametrically opposed to the point of contact illustrated in Figure 5 and would thereby cause the rotation of the collar **82** and sleeve **80** in unison therewith. This movement of the collar **82** due to the frictional engagement with the crank **79** actuates said crank correspondingly and thereby shifts the valve **69** to its other extreme position from that shown in Figure 14. The actuation of the shaft **40** in a counterclockwise direction causes a retraction of the carriage **25** thereby bringing the grinding wheel away from the work. It will be noted that the grinding wheel and work have been separated a distance represented by substantially a complete revolution of the ratchet wheel **43** in a re-retracting direction before the valve **67** was shifted and before complete retraction of the grinding wheel **25** by means of the piston **47**. The shifting of the valve **67** to the left, as seen in Figure 14, compressed the spring **89** that encircles a reduced extending portion **90** of the valve **67**. The spring **89** abuts on one end with the sleeve **54** and on the other end with lock nuts **91** carried by the valve extension **90**. From this it will be seen that reverse or clockwise actuation of the shaft **40** will cause the pin **84** to again immediately leave the pin **85** but this will relieve the tension on the spring **89** so that the said spring immediately expands and shifts the valve **67** to the position shown in Figure 14 thereby again connecting the hydraulic medium with the side of the piston **47** for feeding same toward the grinding wheel. This movement of the grinding wheel continues until engagement with the stop pins **75**. However, at this time the ratchet wheel **43** has made but a partial revolution in a feeding direction so that a substantial clearance exists between the work and the grinding wheel which is taken up in the usual manner either by manually actuating the mechanism through the hand crank **44** or automatically through the power ratchet **43**.

Actual contact with the stop pins **75** is had by a pin **92** carried by the cross head **49** in axial alignment with the piston rod **48**. The pins **75** in order to accurately position the grinding wheel relative to the work are adapted to be axially adjusted as respects the block **72**. For this purpose the block **72** is provided with as many perforations **93** as stop pins **75** are employed. Extending at right angles to the axis of the perforations **93** is a passage or way **94** in which is disposed a wedge **95** having a perpendicular or flat surface **96** abutting one end of the pin **75** and having a wedge surface **97** contacting with a correspondingly inclined surface **98** of the way **94**. The wedge **95** is pinned or otherwise secured at its upper end to a carrier **99** journaled at one end to a screw **100** which is threaded into the block **72**. To prevent inadvertent movement of the wedge **95** the head of the screw is provided with a plurality of notches **101** co-operating with the point **102** of a spring pressed detent **103** mounted in the wedge carrier **99**.

From the foregoing it will be noted that actuation of the screw **100** in a given direction will raise or lower the wedge **95** relative to the way **94** thereby through the engagement of the wedge surfaces **97** and **98** shifting the perpendicular or flat surface **96** toward or away from the end of the stop pins **75** and accurately axially positioning said pins relative to the perforations **93**. In order to hold the pins in adjusted positions and to maintain firm contact between the rear end of the pins **75** and the flat face **96** of the wedge **95**, they are provided intermediate their ends with circumferential grooves **104** having the sides inclined and co-operating with the cam or wedge point of clamp screw **105**, as will be evident from the disclosure in Figure 11.

The stop block **72** has projecting from one end thereof a rack bar **106** slidably supported by a bracket **107** secured as by screws **108** to the lateral side of the bed extension **23**, as seen particularly in Figure 3. Meshing with the rack bar **106** is a rack pinion or gear **109** secured to a shaft **110** journaled in the bracket **107**. Carried by the shaft **110** adjacent the gear **109** is a sprocket **111** about which is trained a sprocket chain **112** in turn passing over a sprocket **113** on one end of a shaft **114**. The shaft **114** is journaled at its rear end in a bearing **115** at the upper end of the bracket **107** and extends transversely of the bed extension **23** and is journaled at its forward end in a bracket **116**. The bracket **116** is secured in any desirable manner, such as by cap screws **117**, to the rear surface of the bed **15**, and as shown in Figure 2, is arranged just to the right of the bed extension **23**.

The shaft **114** has secured to its forward end a rack pinion **118** meshing with a vertical rack bar **119** having on its lower end a head **120** provided with cam faces **121** and **122** on opposite ends thereof. The bar **119** is guided in its vertical movement by means of rollers **123** and **124** mounted on opposite sides of the bar **119** and journaled in the bracket **116**. The head **120** rides on the upper surface of stop bar actuating cam **125**, which has as many cam portions **125a** thereon as there are individual steps or diameters on the work piece. The length of the steps **125a** is equal to the length of the steps or portions of the work, but the difference in height between the faces **125a** is uniform regardless of the differences in diameters between the successive portions of the work. It will further be noted that the faces **125a** continue to ascend even beyond the portion **20a** of the work for successively advancing the stop block **72** to align the several stop pins **75a** with the cross head. This is employed even though there may be portions or steps on each side of the portion **20a** of the work of the same diameter because due to a slight misalignment of the parts of the machine one diameter may be reduced to the same size while the other will be slightly above or below the desired size if the same stop pin were employed, whereas by using independent stop pins independently and individually adjusted, the size of each portion of the work can be accurately controlled. By reference to Figure 7 it will be seen that each stop **125a** of the cam bar **125** is connected by an inclined rise **126**, which cooperates with the cams **121** and **122** of the shoe **120** for raising the rack bar **119** as it is traversed from one end thereof to the next. To maintain contact between the shoe **120** and the steps **125a**, the rack bar **119** has abutting

on its upper end one end of a spring 127 which abuts on its other end with a plug 128 closing the aperture in which the spring 127 is disposed.

Secured to the cam bar 125 is a second cam bar 129 which in contour has as many steps or faces 130 as there are steps or faces 125a on the bar 125 and steps or individual portions of the work. The steps 130 while of the same length as the steps 125a from the top of one rise 126 to the top of the next rise, which, as was noted above, is equal to the length of the step or portion of the work, is offset or spaced equally throughout regardless of the difference in diameters of the several portions of the work. Riding on the steps 130 is a shoe 131 having projecting from opposite vertical faces thereof hardened abutment screws 132 which are adapted to contact with the vertical shoulders 133 provided between successive steps 130 of the bar 129. The shoe 131 is integral with a slide 134 which is guided by the bracket 116 and connected at its upper end by means of a stud 135 to a piston 136 enclosed within a cylinder 137 secured in any desirable manner to the bracket 116. Connecting with the cylinder 137 at its lower end is a conduit or line 138, see Figure 14, which is an extension of the line 51 so that the piston 136 is actuated axially at the same time that the piston 47 is actuated to retract the grinding wheel from the work. By this construction, and since the work is actuated from diameter to diameter only when the grinding wheel is retracted, the shoe 131 is raised free of the shoulders 113 before axial adjustment thereof. To return the shoe 131 to the cam bar 129, the stud 135 has secured to it one end of a spring 139 which has its other end secured to a pin 140 projecting from the cylinder 137.

To return the stop block 72 to its normal position when the work is actuated to its unloading and loading position, the shaft 114 has secured to it intermediate its ends a pulley 141 to which is secured one end of a flexible cable 142 which carries at its other end a counterweight 143. In other words, as the table is actuated toward the left, as seen in Figure 7, the rack slide 119 is elevated, by-passing from one step 125a to the next. This rotates the shaft 114 in a counterclockwise direction, as seen in Figure 7, or in a clockwise direction, as seen in Figure 2, thereby wrapping the flexible cable 142 around the pulley or drum 141 and raising the weight 143 so that upon reverse actuation of the table the counterweight 143 tends to unwind the cable 142 and as the shoe 120 passes from one step 125a to the next in a declining direction, the stop block 72 is shifted to its normal or starting position, as shown in Figure 2.

In practice the work is supported on centers 144 and 145 respectively projecting from the head stock 18 and tail stock 19 being received in center bores formed in the ends of the work. It has been found that frequently the center bores are not uniform thereby permitting the centers 144 and 145 to more or less enter the work, thereby varying the position of the work as respects the grinding wheel, since this variation is taken up by a more or less shifting of the tail stock center because the head stock center is at all times fixed. This would normally destroy the relationship between the shoulders of successive diameters or portions of the work and the vertical shoulders 133 on the cam bar 129. In order, therefore, to align the side of the grinding wheel with the shoulders between the work and the grinding wheel and with the vertical shoulders 133 of the bar 129, the bars 125 and 129 are mounted in brackets or supports 146 and 147 secured to the rear surface of the bed 15 for limited axial movement relative thereto. The bracket 146, see Figure 13, to which the bars 125 and 129 are secured is provided with an aperture or socket 149 receiving the end 150 of a lever 151. The lever 151, see Figure 2, is bent at right angles, lying partially along the front of the work table 17 and partially along the side thereof. The portion extending along the side of the table has passing therethrough a pivot 152 which enters the bracket 153 carried by the table 17. The end or portion of the lever 151 paralleling the front of the table terminates in a spring pressed locking mechanism indicated generally by the numeral 154 for locking the lever in any position of adjustment about the axis of the pivot pin 152. By reference to Figure 2, it will be noted that if the locking mechanism 154, which also constitutes the operating handle were actuated toward the table, the lever would rotate in a clockwise direction about the pivot 152 and thereby axially slide the bars 125 and 129 to the right and reverse actuation of the handle 154 will reversely axially adjust the position of the said bars.

To accurately align the said bars 125 and 129 with the work, the grinding wheel hood 27 has pivoted thereto as at 155 a right angle lever 156. Secured to the lever is one end of a spring 157, the other end being secured or anchored at 158 to the side of the hood 27 for normally holding the said lever in elevated position. A stop pin 159 projects from the said hood for limiting the movement of the lever 156 under the influence of the spring 157. The lower end of the lever has secured thereto or formed integral therewith a shoe 160 adapted to rest on the surface of the work. The end of the shoe 160 is in exact alignment with the face of the wheel that engages the shoulder between one diameter or portion of the work and the next so that the table supporting the work is actuated until the end representing the grinding wheel engages with the said shoulder. With the parts in this position, the shoulder stop shoe 131 is resting on the step 130 of the bar 129 and unless the bar is aligned with the work the stop pin 121 or 122 will be spaced from the vertical shoulder 133 so that actuation of the lever 151 through the operating handle and locking mechanism 154 will bring the said shoulder 133 in contact with the stop screw 121 thereby accurately aligning the bars 125 and 129 with the work and insuring successive portions of the work being ground to the desired dimension as respects the desired length, as the axial traverse of the work will be limited by engagement of the stop screw 121 and the shoulder 133.

The locking mechanism 154 comprises a knob member 161 in which is slidably mounted a plunger 162 and spring 163 abutting on one end with the plunger and on the other end with the base of the bore in which it is mounted. Extending through the spring is a pin 164 carrying a dog 165 adapted to be received between the teeth formed in a bracket 166 secured to the forward face of the table 17. The operation of this type of a locking mechanism is well understood.

The operation of the machine is as follows: The hand crank 44 is actuated in a grinding wheel retracting direction a distance sufficient to shift the piston valve 67 for connecting the hydraulic

medium with the cylinder 46 to retract the grinding wheel to the limit of its movement. The work table 17 is then actuated through the hand wheel 22 to its extreme right hand position for aligning the first step or diameter of the work with the grinding wheel. The arm 156 is then actuated to bring the shoe carried thereby into contact with the work whereupon the table 17 is actuated to the left to cause engagement between the first shoulder on the work and the end of the shoe corresponding to the end or side face of the wheel. The grinding wheel is then fed toward the work through the actuation of the hand wheel or crank 44. This movement of the hand wheel permits the shifting of the valve to the position for connecting the hydraulic medium to the other end of the cylinder 46 whereupon the carriage 35 plunges toward the work until engagement of the contact pin 92 of the cross head 49 with the proper aligned stop pin 75. The lever 151 is then actuated through the locking and control member 154 for shifting the bars 125 and 129 until engagement is had between the vertical shoulder 133 of the bar 129 and the stop pin 132 of the shoe 131. It will be understood that this axial adjustment of the bars 125 and 129 is not of a great amount since it is only necessary to compensate for the difference in the center bores in the opposite ends of the work. With the parts thus adjusted the grinding wheel is fed into the work either manually or automatically as is the usual practice until the work is reduced to the desired size.

As soon as the first diameter or portion of the work is reduced to the desired size, the hand crank is actuated in a grinding wheel retracting direction, which after a complete revolution of the hand wheel shifts the valve 67 for connecting the hydraulic pressure with the cylinder 46 to further retract the grinding wheel. This shifting of the valve 67 also connects the hydraulic pressure with the piston 136 thereby raising the shoulder stop shoe 131 away from the bar 129 so that upon axial adjustment of the work relative to the wheel no interference is had by the vertical shoulders 133. As soon as the next portion of the work is aligned with the grinding wheel the hand crank 44 is actuated in a feeding direction thereby immediately connecting the hydraulic pressure for rapidly shifting the grinding wheel toward the work. The operation above described is then repeated except as to alignment of the bars 125 and 129 with the work. This adjustment is made only at the commencement of a new work piece because the individual steps or portions of the work will thereafter be kept in line.

What is claimed is:

1. In a grinding machine of the class described the combination of a bed, a grinding wheel carriage mounted thereon for movement transversely thereof, a grinding wheel rotatably supported by the carriage, a multiple diameter work piece support carried by the bed for translation relative thereto across the operative face of the grinding wheel, means for actuating the work and grinding wheel toward and from one another, means for stopping the movement of the grinding wheel just before it contacts with the work including a stop bar having a plurality of stop pins mounted therein one for each diameter of the work, and means coupling the work support and stop bar whereby movement of the work support simultaneously shifts the stop bar thereby keeping the work and stop bar in step.

2. In a grinding machine for grinding the individual portions of a multiple diameter work piece the combination of a work support, a grinding wheel actuable toward and from the work, a stop pin for each diameter of the work for limiting the approach of the grinding wheel to the particular diameter with which it is aligned, and means for simultaneously shifting the work support and stop pins in the same direction, including a cam bar having a plurality of cam surfaces thereon, a rack slide actuated by said cam surfaces, and an operative connection between the rack slide and stop pins.

3. In a grinding machine for grinding multiple diameter work pieces the combination of a bed, a grinding wheel mounted thereon for movement transversely thereof, a work support carried by the bed for translation relative thereto, means carried by the bed for stopping the movement of the grinding wheel relative to the work means for limiting the translation of the work support for limiting the axial relative movement between the work and grinding wheel, means for varying the stopping and limiting means in each direction, and additional means for positioning said stopping and limiting means with each work piece prior to the operation of the machine.

4. In a grinding machine of the class described for grinding individual portions of a work piece the combination of a bed, a grinding wheel carriage mounted thereon for movement relative thereto, a work support carried by the bed for translation relative thereto and for supporting a multiple diameter work piece adapted to have its individual portions aligned with the grinding wheel, said portions of the work each terminating in a shoulder, means for limiting the axial traverse of the work and grinding wheel to align each shoulder with the edge of the grinding wheel, and means for adjusting said traverse limiting means with each work piece prior to the operation of the machine.

5. In a grinding machine of the class described for grinding individual portions of a multiple diameter work piece the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support mounted on the bed for translation relative thereto and for traversing a multiple diameter work piece supported thereby relative to the grinding wheel, each portion of the work terminating in a shoulder adapted to be aligned with the adjacent edge of the grinding wheel, means for limiting the transverse shifting of the grinding wheel toward the work comprising a plurality of stop pins each individual to a diameter of the work, means for limiting the traverse of the work with respect to the wheel, means for positioning said traverse limiting means in accordance with the position of each work piece as it is placed on the work support and prior to the operation of the machine.

6. In a grinding machine of the class described for grinding individual portions of a multiple diameter work piece the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support mounted on the bed for translation relative thereto and for traversing a multiple diameter work piece supported thereby relative to the grinding wheel, each portion of the work terminating in a shoulder adapted to be aligned with the adjacent edge of the grinding wheel, means for limiting the transverse shifting of the grinding wheel toward the work comprising a plurality of stop pins each individual to a diameter of the work, means for limit-

ing the traverse of the work with respect to the wheel, and means for positioning successive stop pins relative to the grinding wheel as the work is traversed relative thereto including a cam bar having a plurality of steps thereon corresponding to the number of steps on the work, means for securing the cam bar to the work support for movement therewith, and an operative coupling between the cam bar and stops whereby movement of the cam bar shifts the position of the stops.

7. In a grinding machine of the class described for grinding individual portions of a multiple diameter work piece the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support mounted on the bed for translation relative thereto and for traversing a multiple diameter work piece supported thereby relative to the grinding wheel, each portion of the work terminating in a shoulder adapted to be aligned with the adjacent edge of the grinding wheel, means for limiting the transverse shifting of the grinding wheel toward the work comprising a plurality of stop pins each individual to a diameter of the work, and means for limiting the traverse of the work with respect to the wheel, said means comprising a cam bar having a plurality of steps thereon corresponding to the number of steps on the work, each step having a vertical shoulder at the end thereof, means for securing the cam bar to the work support for movement therewith, and means riding on the step of the cam bar representing the portion of the work being ground for engagement with the shoulder to limit the traverse of the work.

8. In a grinding machine of the class described for grinding individual portions of a multiple diameter work piece the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support mounted on the bed for translation relative thereto and for traversing a multiple diameter work piece supported thereby relative to the grinding wheel, each portion of the work terminating in a shoulder adapted to be aligned with the adjacent edge of the grinding wheel, means for limiting the transverse shifting of the grinding wheel toward the work comprising a plurality of stop pins each individual to a diameter of the work, means for limiting the traverse of the work with respect to the wheel, said means comprising a cam bar having a plurality of steps thereon corresponding to the number of steps on the work, each step having a vertical shoulder at the end thereof, means for securing the cam bar to the work support for movement therewith, means riding on the step of the cam bar representing the portion of the work being ground for engagement with the shoulder to limit the traverse of the work, and means for raising said limiting means riding on the cam bar step for raising it therefrom prior to the traverse of the work from one step to the next.

9. In a grinding machine the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support carried by the bed for translation relative thereto, hydraulic means for shifting the grinding wheel at a rapid rate toward the work support, a plurality of stop pins positionable in the path of movement of the grinding wheel to limit the approach of the wheel and work, means supported by the work support for adjusting the position of the stop pins and thereby varying the approach of the grinding wheel and work support, and means individual to each stop pin for very minutely adjusting its position.

10. In a grinding machine of the class described for grinding individual diameters of a multiple diameter shaft the combination with a bed, a grinding wheel mounted thereon for transverse movement relative thereto, means for effecting the said movement of the grinding wheel in reverse directions and a work support carried by the bed for translation relative thereto and to the grinding wheel, of means for limiting said translatory movement of the work support to limit the approach of the grinding wheel to the shoulder between each pair of diameters of the work, and a connection between the grinding wheel actuating means and the work traversing limiting means whereby said limiting means is rendered inoperative during the movement of the grinding wheel in one direction.

11. In a grinding machine of the class described for grinding individual diameters of a multiple diameter shaft the combination with a bed, a grinding wheel mounted thereon for transverse movement relative thereto, a work support carried by the bed for translation relative thereto and to the grinding wheel, of means for limiting said translatory movement of the work support to limit the approach of the grinding wheel to the shoulder between each pair of diameters of the work, said means comprising a cam bar having a plurality of shoulders thereon each representative of a shoulder on the work, a shoe carried by the bed riding on the cam face representative of the work being operated upon by the grinding wheel and engaging the shoulder at the end thereof simultaneously with the engagement of the side of the grinding wheel with the shoulder of the work, and means disassociating the shoe and cam face prior to the translation of the work to align the next portion thereof with the grinding wheel.

12. In a grinding machine of the class described for grinding individual diameters of a multiple diameter shaft the combination with a bed, a grinding wheel mounted thereon for transverse movement relative thereto, a work support carried by the bed for translation relative thereto and to the grinding wheel, of means for limiting said translatory movement of the work support to limit the approach of the grinding wheel to the shoulder between each pair of diameters of the work, said means comprising a cam bar having a plurality of shoulders thereon each representative of a shoulder on the work, a shoe carried by the bed riding on the cam face representative of the work being operated upon by the grinding wheel and engaging the shoulder at the end thereof simultaneously with the engagement of the side of the grinding wheel with the shoulder of the work, means disassociating the shoe and the cam face prior to the translation of the work to align the next portion thereof with the grinding wheel, and means for initially aligning the cam bar and work with the grinding wheel including a gauge associated with the grinding wheel and co-operating with the shoulder on the work, and means shifting the cam bar relative to the work support.

13. In a grinding machine of the class described for grinding individual portions of a multiple portioned work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed movable in a direction transversely to the movement of the grinding wheel, hydraulic means for effect-

ing the movement of the grinding wheel, means for limiting the movement of the work support to align the individual portions of a work piece thereon with the grinding wheel, and hydraulic means for rendering the limiting means inoperative prior to the alignment of successive portions of the work with the wheel.

14. In a grinding machine of the class described for grinding individual portions of a multiple portioned work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed movable in a direction transversely to the movement of the grinding wheel, hydraulic means for effecting the movement of the grinding wheel, means for limiting the movement of the work support to align the individual portions thereof with the grinding wheel, hydraulic means for rendering the limiting means inoperative prior to the alignment of successive portions of the work with the wheel, and a connection between the hydraulic wheel shifting means and the hydraulic means for limiting the movement of the work whereby they are actuated simultaneously.

15. In a grinding machine of the class described for grinding individual portions of a multiple portioned work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed movable in a direction transversely to the movement of the grinding wheel, hydraulic means for effecting the movement of the grinding wheel, means for limiting the movement of the work support to align the individual portions thereof with the grinding wheel, hydraulic means for rendering the limiting means inoperative prior to the alignment of successive portions of the work with the wheel, a connection between the hydraulic wheel shifting means and the hydraulic means for limiting the movement of the work whereby they are actuated simultaneously, and yielding means for again rendering the limiting means operative.

16. In a grinding machine for grinding successive portions of a work piece the combination of a bed, a grinding wheel mounted thereon for operation on each portion of the work, a work support on the bed for translation relative thereto transversely of the grinding wheel, and means for limiting the said translation of the work to accurately align the different portions of the work with the wheel comprising a bar having a plurality of shouldered stops thereon and corresponding to the number of portions on the work, means on the table for supporting the stop bar for translation therewith, a stop member carried by the bed cooperating with the stop bar and adapted to engage the shouldered stops thereon, and yielding means for holding the stop member in engagement with the shouldered stop bar.

17. In a grinding machine for grinding successive portions of a work piece the combination of a bed, a grinding wheel mounted thereon for operation on each portion of the work, a work support on the bed for translation relative thereto transversely of the grinding wheel, and means for limiting the said translation of the work to accurately align the different portions of the work with the wheel comprising a bar having a plurality of shouldered stops thereon and corresponding to the number of portions on the work, means on the table for supporting the stop bar for translation therewith, a stop member carried by the bed cooperating with the stop bar and adapted to engage the shouldered stops thereon, yielding means for holding the stop member in engagement with the shouldered stop bar, and hydraulic means operable against the resistance of the yielding means for rendering the stop member inoperative.

18. In a grinding machine for grinding successive portions of a work piece the combination of a bed, a grinding wheel mounted thereon for operation on each portion of the work, a work support on the bed for translation relative thereto transversely of the grinding wheel, and means for limiting the said translation of the work to accurately align the different portions of the work with the wheel comprising a bar having a plurality of shouldered stops thereon and corresponding to the number of portions on the work, means on the table for supporting the stop bar for translation therewith, a stop member carried by the bed cooperating with the stop bar and adapted to engage the shouldered stops thereon, yielding means for holding the stop member in engagement with the shouldered stop bar, hydraulic means operable against the resistance of the yielding means for rendering the stop member inoperative, and means for shifting the shouldered stop bar relative to the bed to align the shouldered stops thereon with the work in accordance with the relation of the work to the wheel.

19. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, and a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith.

20. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, said transmission including a cam follower, and yielding means maintaining contact between the cam follower and cam.

21. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement

of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, and a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, and means for initially positioning the cam bar with respect to the work table in accordance with the alignment of the work with the grinding wheel.

22. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces are there are diameters on the work, a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, means for initially positioning the cam bar with respect to the work table in accordance with the alignment of the work with the grinding wheel, and gauge means for initially positioning the work with respect to the wheel.

23. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, and means for positioning successive diameters of the work piece with the wheel.

24. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, and a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, means for positioning successive diameters of the work piece with the wheel including a shouldered stop bar having as many shouldered stops thereon as there are diameters on the work piece, and cam faces on the cam bar, a cam follower on the bed cooperating with the stop bar, and yielding means for maintaining contact between the follower and stop bar.

25. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work table, a cam bar on the table having as many cam faces as there are diameters on the work, a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, means for positioning successive diameters of the work piece with the wheel including a shouldered stop bar having as many shouldered stops thereon as there are diameters on the work piece and cam faces on the cam bar, a cam follower on the bed cooperating with the stop bar, yielding means for maintaining contact between the follower and stop bar, and hydraulic means for rendering said yielding means inoperative.

26. In a grinding machine for grinding individual diameters of a multiple diameter work piece, the combination of a bed, a grinding wheel mounted thereon for movement relative thereto, a work support on the bed for movement relative thereto transversely of the direction of movement of the grinding wheel and means for limiting the approach of the grinding wheel to each diameter of the work comprising a plurality of stop pins one for each diameter of the work, a slide for the pins movable in the same direction as the work tab'e, a cam bar on the table having as many cam faces as there are diameters on the work, a transmission mechanism between the cam bar and stop pins slide whereby the work table and stop pins slide are simultaneously shifted to successively position the stop pins in operative relation with the grinding wheel as the different diameters of the work are aligned therewith, means for positioning successive diameters of the work piece with the wheel including a shouldered stop bar having as many shouldered stops thereon as there are diameters on the work piece, and cam faces on the cam bar, a cam follower on the bed cooperating with the stop bar, yielding means for maintaining contact between the follower and stop bar, hydraulic means for effecting the movement of the grinding wheel, hydraulic means for rendering the stop bar follower inoperative, and a connection between the said hydraulic means whereby they are simultaneously operable.

ALFRED G. PLIMMER.