July 23, 1957 A. J. JONES ET AL 2,799,977

MACHINE FOR GRINDING RING-LIKE WORKPIECES TO ACCURATE SIZE

Filed Aug. 2, 1954 4 Sheets-Sheet 1

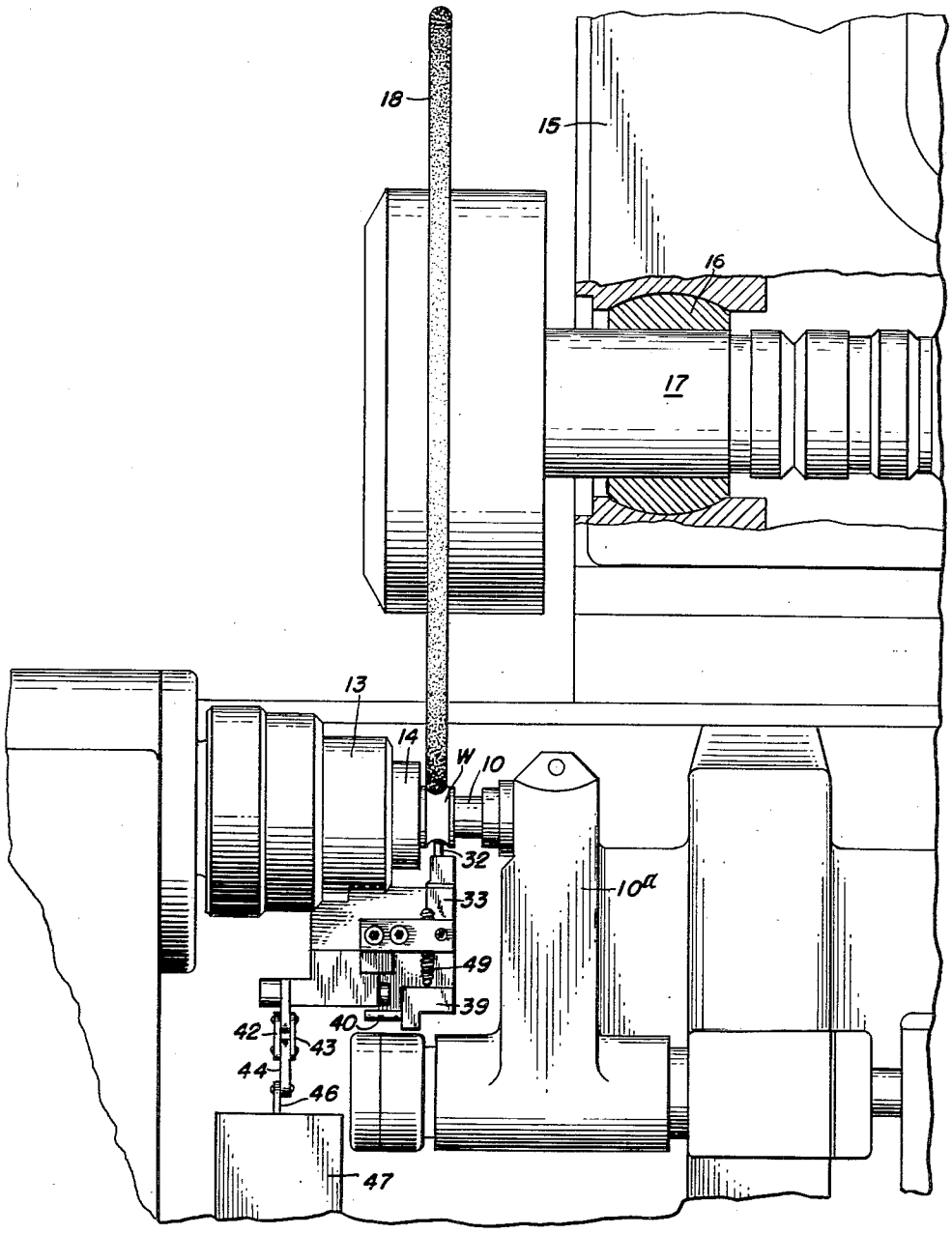

FIG. 1

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Filed Aug. 2, 1954 4 Sheets-Sheet 2

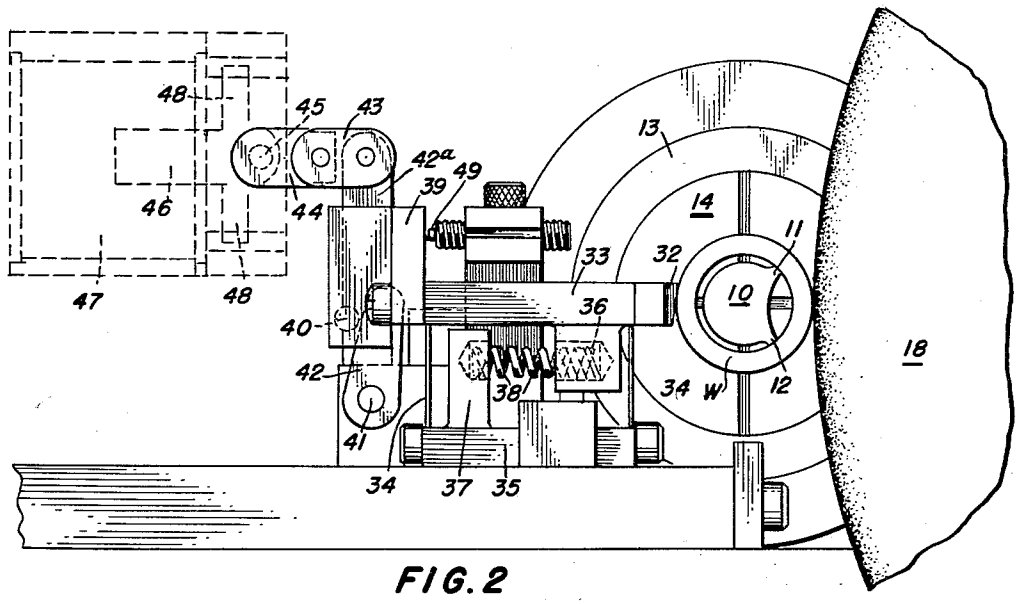

FIG. 2

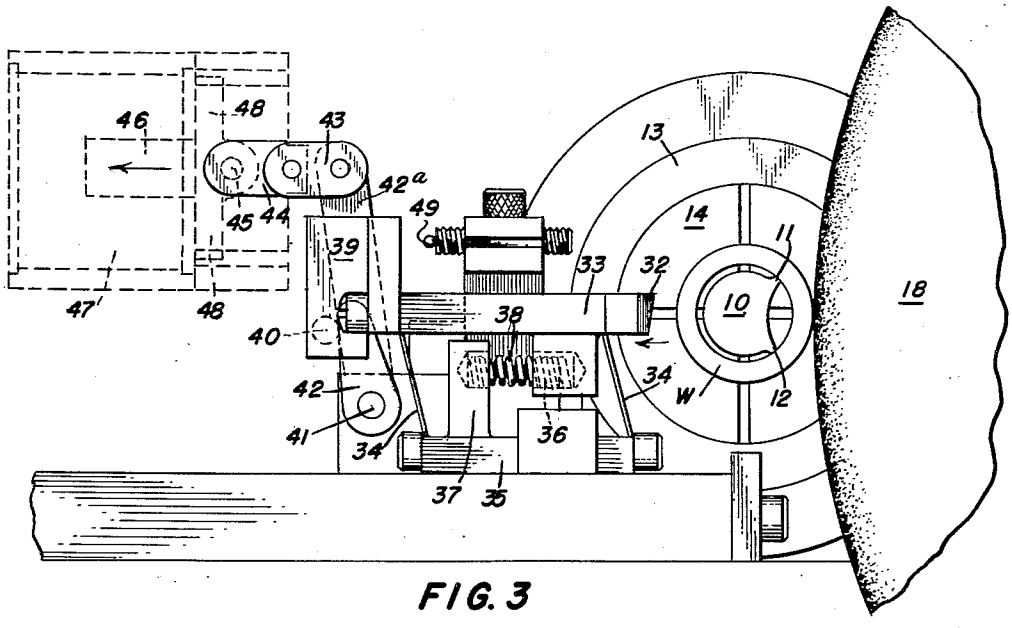

FIG. 3

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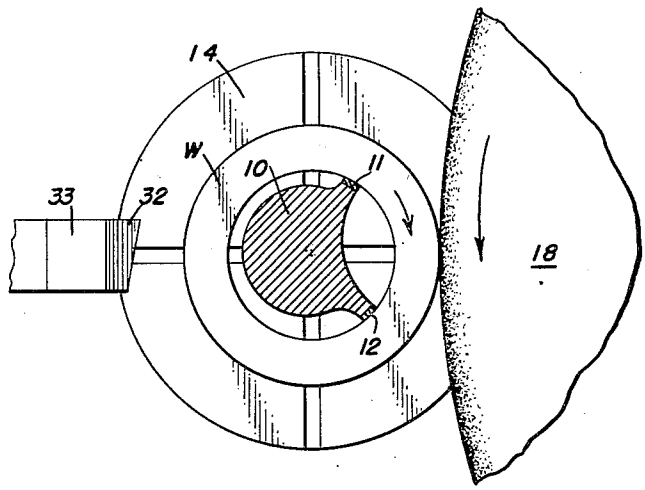

FIG. 4

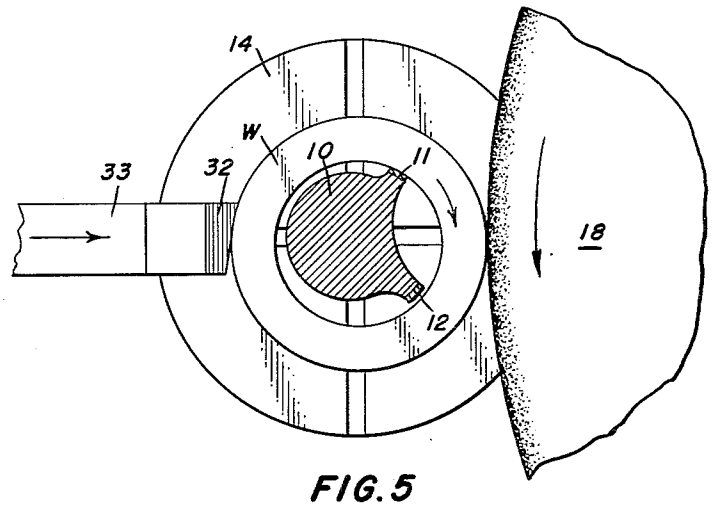

FIG. 5

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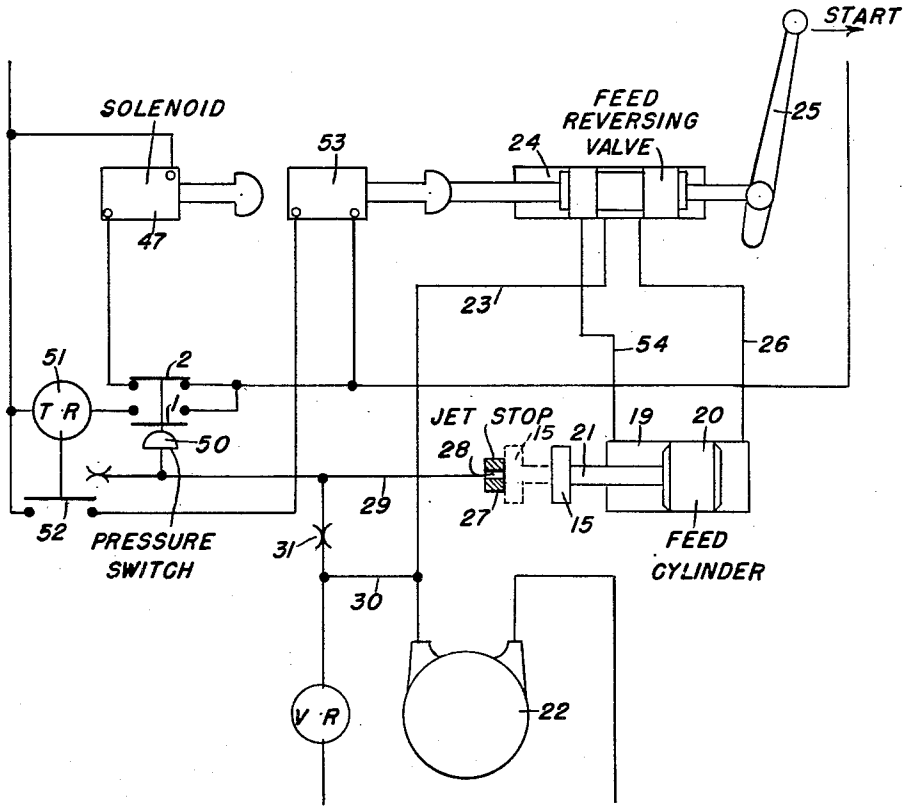

FIG. 6

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United States Patent Office 2,799,977 Patented July 23, 1957

2,799,977

MACHINE FOR GRINDING RING-LIKE WORKPIECES TO ACCURATE SIZE

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Application August 2, 1954, Serial No. 447,267

10 Claims. (Cl. 51—103)

This invention relates to new and useful improvements in a machine for grinding ring-like workpieces.

In the application of Harold E. Balsiger, Serial No. 280,509, filed April 4, 1952, now Patent No. 2,694,883, November 23, 1954 there is shown and described a method of grinding ring-like workpieces wherein the method disclosed consists of the following steps: First, grinding the end surfaces of a ring-like workpiece parallel to the annular faces of grinding wheels; second, supporting and rotating the work by any suitable means while grinding the internal surface concentric to the axis of the workpiece; and, third, rotating the workpiece through one of the surfaces ground in the first step, supporting the workpiece on the internal surface ground in the second step, and grinding the peripheral surface concentric to said internal surface.

An object of the invention is to provide a grinding machine for grinding the periphery of the workpiece of the above type wherein the grinding wheel is fed against the rotating workpiece until the peripheral surface is concentric to the inner surface of the workpiece and then stopping the feed of the grinding wheel, and wherein the stopping of said grinding wheel feed initiates a mechanism for feeding the workpiece against the grinding wheel until the peripheral surface is ground to a predetermined size.

A further object of the invention is to provide a grinding machine of the above type wherein the workpiece is fed against the grinding wheel by a feed shoe which contacts the workpiece at a point diametrically opposite the point of contact between the grinding wheel and the workpiece.

A still further object of the invention is to provide a grinding machine of the above type wherein the feed shoe is moved to feed the workpiece against the grinding wheel by a spring under compression and a stop pin limits further feeding movement of the feed shoe when the workpiece has been ground to a predetermined size.

A still further object of the invention is to provide a grinding machine of the above type wherein the work feeding shoe is normally held out of contact with the workpiece by an energized solenoid and wherein the solenoid is automatically deenergized by the stopping of the grinding wheel feed and the feed of the workpiece mechanism set in action for finish grinding to a predetermined size.

These and other objects will in part be obvious and will in part be hereinafter more fully disclosed.

In the drawings which illustrate the preferred embodiment of a machine for carrying out the invention:

Figure 1 is a view in plan showing many of the essential features of the improved machine.

Figure 2 is a view in side elevation showing the mechanism for feeding the workpiece against the grinding wheel for the finish grind.

Figure 3 is a view similar to Figure 2 but showing the feed shoe for feeding the workpiece against the grinding while retracted and out of operation.

Figure 4 is a view showing partly in side elevation and partly in section the relation of the workpiece to the grinding wheel during the grinding of the peripheral surface of the workpiece until it is concentric with the inner surface thereof.

Figure 5 is a view similar to Figure 4 showing the grinding wheel feed as stopped and the work feeding shoe as having fed the work against the grinding wheel and the work ground to a predetermined size.

Figure 6 is a diagrammatic view showing the sequence of operation of the feeding mechanism for feeding the grinding wheel against the work and the work shoe feeding mechanism for feeding the work against the grinding wheel for a grinding operation.

The machine shown in the drawing is particularly adapted for grinding ring-like workpieces, such as the inner race of a ball bearing. The workpiece is ground previous to the operation thereon by the illustrated machine, so that the side faces are parallel and the inner surface is concentric to the axis of the workpiece. This may be accomplished in the manner disclosed in the Balsiger Patent No. 2,694,883. The ring-like workpiece W is placed on arbor **10**, mounted in a work loading arm **10a** which can be swung from loading position to operating position. The arbor is fixed against rotation and carries an upper work supporting shoe **11** and a lower work supporting shoe **12**. These shoes support the work during its rotation.

Associated with the work-supporting arbor **10** is a spindle **13** carrying a magnetic chuck **14**. The workpiece is moved by the work arm and supporting arbor into engagement with the magnetic chuck. The spindle **13** may be rotated by any suitable means. This imparts rotation to the magnetic chuck carried thereby and the chuck imparts rotation to the workpiece on the supporting shoes carried by the arbor.

Mounted on the bed of the machine is a feed slide **15** which carries bearings **16**, **16** in which a shaft **17** is rotated preferably by a motor mounted on the feed slide. Carried by the shaft **17** is the grinding wheel **18**. When the raceway of a workpiece is being formed in the peripheral surface thereof, the grinding wheel is shaped on its peripheral surface to conform to the shape of the groove or race which is to be formed in the workpiece. The grinding wheel is normally in a retracted position while the work is being placed in the machine. The grinding wheel feed slide is preferably moved to position the grinding wheel for grinding the peripheral surface of the work by a hydraulic feed cylinder which is connected to the feed slide in any suitable way. The feed cylinder is indicated diagrammatically in Figure 6 at **19**, the piston therein at **20**, and the piston rod which is connected to the feed slide at **21**.

Fluid is directed to the cylinder **19** for shifting the piston therein from a pump **22** which receives fluid from a supply and forces the same through the pipe line **23** to a reversing valve **24**. The reversing valve may be moved by a hand lever **25**. When the reversing valve is in the position shown in Figure 6, fluid will be directed through the pipe **26** to the right hand side of the cylinder, thus forcing the piston to the left and this will cause the grinding wheel feed slide to move the grinding wheel up to the work and against the work for a grinding operation.

In the starting of the grinding cycle the starting lever **25** is used to shift the valve **24** to the position shown in Figure 6 and the valve remains in this position until the peripheral surface of the workpiece is ground so that it is concentric to the inner surface of the workpiece. The grinding wheel feed is then stopped. This is preferably accomplished by a jet stopping device **27**. This is a positive stopping means and is set so as to stop the feed as

soon as the peripheral surface is concentric to the inner surface. The jet stopping device has an opening **28** therethrough which is connected to the pipe line **29** which in turn is connected to a second fluid supply line **30** through a restriction **31**. The piston rod **21**, as it approaches the stopping device, is slowed down by any suitable means and finally stopped by positive stop **27**. This mounting of a grinding wheel and the feeding of the same into grinding contact with the work is of a well known construction. A further detailed description thereof is not thought necessary.

After the work has been ground so that the outer peripheral surface of the workpiece is concentric to the inner surface, the feed of the grinding wheel stops and the grinding wheel remains in this stopped position during the finish grinding of the workpiece. For this finish grind of the workpiece to a predetermined size the machine is provided with a novel mechanism for feeding the work against the grinding wheel which will now be described. The ring-like workpiece is supported on the shoes **11** and **12** during the grinding of the peripheral surface thereof by the feeding of the grinding wheel against the periphery of the workpiece. The workpiece is fed against the grinding wheel by a workpiece feeding shoe **32**. The workpiece is rotated by the magnetic chuck **14** which prevents endwise movement of the workpiece but which permits a limited lateral shifting movement of the workpiece. This workpiece feed shoe contacts the work diametrically opposite where the grinding wheel contacts the workpiece (see Fig. 2) although the actual position may be varied. Pressure on the workpiece by the feed shoe **32** will lift the workpiece off from the shoe **12**. The work shoe **11** remains in contact with the workpiece due to gravity and the fact that the workpiece rotates in a clockwise direction. This shifting of the workpiece on the shoe **11** and away from the shoe **12** enables the work to be fed against the workpiece and the peripheral surface ground to reduce the diameter of the workpiece. The feed of the workpiece is continued until it is ground to the predetermined diameter. This can be accurately accomplished as the work feeding shoe is approximately diametrically opposed to the contact of a grinding wheel with the workpiece.

The movements of the feed slide carrying the grinding wheel have been positively stopped and means is provided for stopping the movement of the work shoe feed when the predetermined diameter or size of the workpiece is reached. The feed shoe for feeding the workpiece is carried by a bar **33**. This bar is mounted at the upper ends of flexible steel members **34, 34**. These steel members are rigidly attached to a block **35** which is secured to the base of the machine. Depending from the bar **33** is an abutment member **36** which is movable with the bar. Extending upwardly from the block **35** is a fixed abutment member **37**. A compression spring **38** is mounted in sockets in these abutment members and normally operates to force the bar **33** to the right as viewed in Figure 2 and this will force the shoe **32** against the workpiece and in turn force the workpiece against the grinding wheel. Rigidly connected to rear end of the bar **33** is a block **39**. A pin **40** is mounted in said block **39**.

Journaled in suitable bearings carried by the bed of the machine is a shaft **41**. This shaft **41** has fixed to the end thereof an upstanding arm **42**. This arm when turned counterclockwise will contact the pin **40** and will forcibly withdraw the bar **33** from contact with the periphery of the workpiece. Extending upwardly on the other end of the shaft **41** is an arm **42a** connected to a pair of links **43** which in turn are pivotally connected to a bar **44**. The bar **44** is pivoted at **45** to a member **46** which is in turn connected to the core of a solenoid **47**. The member **46** has guiding arms **48, 48** which guide the movement of the core in the solenoid. When the solenoid is energized the arm **42** will be pulled upon and this will turn the shaft **41** in a counterclockwise direction as viewed in Figure 2. This turning of the shaft **41** will cause the arm **42** to contact the pin **40** and hold the bar withdrawn from the workpiece. This is the position of the workpiece feeding shoe during the feeding of the grinding wheel slide for feeding the grinding wheel against the workpiece. The shoes **11** and **12** on the arbor hold the workpiece in a fixed rotating position while the grinding wheel is grinding the peripheral surface of the workpiece through the feeding movement of the grinding wheel slide. As the grinding wheel slide comes to a stop the solenoid **47** is deenergized and this releases the bar **33** so that the spring **38** will move the workpiece feeding shoe **32** into contact with the workpiece and shift the workpiece on the arbor as above noted and thus it is that the workpiece is fed against the grinding wheel for the finish grinding of the workpiece to a predetermined size. When the desired size is reached the stop **49** mounted on the base is engaged by the block **39** and this prevents any further feeding movement of the workpiece against the grinding wheel. This stop **49** can be adjusted so that any desired predetermined size can be obtained.

Referring again to Figure 6, as the grinding wheel feed slide approaches a stopped position the resistance to the flow of fluid from the passage **28** is increased as the piston rod approaches the stop **27** and this builds up the pressure in the fluid line **29** and in turn builds up the pressure in a switch **50**. This pressure switch has a normally open contact **1** and a normally closed contact **2**. When the pressure switch is actuated the contact **2** opens, breaking the circuit to the solenoid **47** which holds the work feed shoe **32** out of engagement with the work. The feed shoe **32** is then free to be moved by its actuating spring **38** to shift the workpiece against the grinding wheel and to grind the work to a predetermined diameter. This is reached when the block **39** contacts the fixed stop **49**. This opening of the contact **2** of the pressure switch **50** initiates the feed of the workpiece against the grinding wheel and also closes the contact **1** of this pressure switch **50** and this brings into the circuit a timer relay **51**. The timer relay is set so that it does not close the switch **52** until after the feed of the workpiece has been stopped by contact of the block with the stop pin **49**. The closing of the switch **52** will energize a solenoid **53** which will shift the reversing valve **24** to the left and connect the fluid supply line **23** with the line **54** to the opposite end of the feed cylinder **19** and this will withdraw the grinding wheel slide and the grinding wheel to its retracted position. When the piston **21** moves away from the jet stop **27** the pressure of the fluid in the line **29** will drop and the contact **2** of the pressure switch **50** will close and this will energize the solenoid **47** which retracts the bar **33** moving the feed shoe **32** out of contact with the work. This completes the cycle and the workpiece is finished and the machine set for loading a new workpiece and starting a new cycle. It is noted that the work shoe for moving the workpiece against the grinding wheel is rigidly carried by a bar mounted on flexible steel strips and the bar is moved by a compression spring for bringing the shoe into contact with the workpiece. There is little or no frictional resistance to the movement of this bar by the spring. Furthermore, the bar may be stopped in its movement positively and quickly by contact with a stop. Therefore, due to the lightness of these parts and their positive movement great accuracy can be accomplished in the finish grinding of the workpiece to a predetermined size.

The novel method employed in the grinding of a ring-like workpiece consists in first grinding the outer surface of the workpiece to a uniform thickness of wall and to produce a surface on the workpiece which is concentric with the inner surface of the ring-like workpiece. This includes the rough grinding of the workpiece and preferably through a part of the finish grind at which time the

feeding of the grinding wheel slide is positively stopped. The stopping of the feed of the grinding wheel slide automatically initiates a feeding mechanism which contacts the workpiece and feeds the workpiece against the grinding wheel for the finish grinding of the workpiece to a predetermined size. This grinding of the workpiece by the advancing of the grinding wheel against the workpiece until the outer surface is concentric with the inner surface and then advancing the workpiece against the grinding wheel for the grinding of the workpiece to a finished size, all of which is accomplished in a single cycle grinding operation, enables the workpiece to be ground rapidly to a very accurate size. Furthermore, it enables the workpiece to be loaded in the machine and the finishing of the grinding of the workpiece to a predetermined size without stopping the grinding cycle of the machine.

It is obvious that many changes may be made in the details of construction of the machine without departing from the spirit of the invention as set forth in the appended claims.

We claim:

1. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of said workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel when the external surface of the workpiece is concentric with the internal surface thereof, and means normally out of operation and automatically brought into operation upon the stopping of the feed of the grinding wheel for feeding the workpiece against the grinding wheel, for finish grinding said workpiece to a predetermined diameter.

2. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of said workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel when the external surface of the workpiece is concentric with the internal surface thereof, a power actuated feed shoe normally out of engagement with the workpiece and brought into contact therewith upon the stopping of the grinding wheel feed for moving the workpiece against the grinding wheel for finish grinding the workpiece to a predetermined size.

3. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of the workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for feeding the grinding wheel against the workpiece, said shoes being disposed one above and the other below a horizontal plane through the axis of the workpiece, means for stopping the feed of the grinding wheel when the external surface is concentric to the internal surface, a spring actuated feed shoe normally out of contact with the workpiece and brought into contact with the external surface of the workpiece and in said horizontal plane upon the stopping of the feed of the grinding wheel for feeding the workpiece against the grinding wheel for finish grinding the workpiece to a predetermined size.

4. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of the workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for feeding the grinding wheel against the workpiece, said shoes being disposed one above and the other below a horizontal plane through the axis of the workpiece, means for stopping the feed of the grinding wheel when the external surface is concentric to the internal surface, a spring actuated feed shoe brought into contact with the external surface of the workpiece and in said horizontal plane upon the stopping of the feed of the grinding wheel for feeding the workpiece against the grinding wheel, and an adjustable stop for stopping the feeding of the workpiece when it has been ground to a predetermined size.

5. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of said workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel when the external surface of the workpiece is concentric with the internal surface thereof, a bar mounted for endwise movement toward and from the workpiece and on the side thereof opposite the grinding wheel, a feed shoe carried at the inner end of said bar, a spring for moving the bar toward the workpiece, means for holding the shoe out of contact with the workpiece while the grinding wheel feed is in operation, and means brought into operation when the grinding wheel feed stops for releasing said holding means whereupon the spring will cause the feed shoe to contact said workpiece and feed it against the grinding wheel for finish grinding the workpiece and a stop for stopping the movement of the bar when the workpiece has been ground to a predetermined size.

6. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of said workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel when the external surface of the workpiece is concentric with the internal surface thereof, a bar mounted for end-wise movement toward and from the workpiece and on the side thereof opposite the grinding wheel, a feed shoe carried at the inner end of said bar, a spring for moving the bar toward the workpiece, a solenoid when energized operating to hold the shoe out of contact with the workpiece while the grinding wheel feed is in operation, and means brought into action when the grinding wheel feed stops for deenergizing the solenoid whereupon the spring will cause the feed shoe to contact said workpiece and feed it against the grinding wheel for finish grinding the workpiece and a stop for stopping the movement of the feed shoe when the workpiece has been ground to a predetermined size.

7. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means for supporting and rotating the workpiece operable on an end face of said workpiece, an arbor having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel when the external surface of the workpiece is concentric with the internal surface thereof, upstanding parallel flexible members, a bar mounted on the upper ends thereof for endwise movement toward and from the workpiece and on the side thereof opposite the grinding wheel, a feed shoe carried at the inner end of said bar, a spring for moving the bar toward the workpiece, means for holding the shoe out of contact with the workpiece while the grinding wheel feed is in operation, and means brought into action when the grinding wheel feed stops for releasing said holding means whereupon the spring will cause the feed shoe to contact the workpiece

and feed it against the grinding wheel for finish grinding the workpiece and a stop for stopping the movement of the bar when the workpiece has been ground to a predetermined size.

8. A machine for grinding the external surface of a workpiece comprising means operable on an end face of the workpiece for supporting and rotating the workpiece, a pair of peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, means for feeding the grinding wheel against the workpiece, said feeding action being effective to hold said workpiece in engagement with said shoes, means for stopping the feed of the grinding wheel at a predetermined point in the grinding operation, a spring actuated feed shoe for engaging the external surface of the workpiece for feeding the workpiece against the grinding wheel after the wheel feed has stopped.

9. A machine for grinding the external surface of a workpiece comprising means operable on an end face of the workpiece for supporting and rotating the workpiece, a pair of peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, means for feeding the grinding wheel against the workpiece, said feeding action being effective to hold said workpiece in engagement with said shoes, means for stopping the feed of the grinding wheel at a predetermined point in the grinding operation, a feed shoe for engaging the external surface of the workpiece for feeding the workpiece

against the grinding wheel after the wheel feed has stopped, means for yieldingly urging said feed shoe against the work, and an adjustable stop for stopping the feeding of the workpiece when it has been ground to a predetermined size.

10. A machine for grinding the external surface of a ring-like workpiece to accurate size comprising means operable on an end face of the workpiece for supporting and rotating the workpiece, work supporting means having peripherally spaced shoes engaging the internal surface of the workpiece for supporting the same, a grinding wheel, means for rotating the same, means for feeding the grinding wheel against the workpiece, means for stopping the feed of the grinding wheel, and means operable upon the stopping of the feed of the grinding wheel for feeding the workpiece out of contact with one of said internal supporting shoes and against the grinding wheel for finish grinding said workpiece to a predetermined diameter.

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