ABSTRACT

In a grinding machine having a feed control device in which a first feed means is connected to a wheel support for performing grinding operations, a first grinding operation by the first feed means is controlled by a gauging member, and an advanced position thereof is memorized by a memory device. A second feed means is connected to the wheel support for compensating the same by a half of the difference in the diameters of a workpiece portion to be ground in the first grinding operation and of a second workpiece portion to be ground in a second grinding operation. The second grinding operation is controlled by a detecting means, whereby the first feed means is caused to be retracted when the first feed means comes up to the position memorized by the memory means in the first grinding operation.

11 Claims, 11 Drawing Figures
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GRINDING MACHINE WITH A FEED CONTROL DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates generally to grinding machines, and more particularly to a feed control device for use in a grinding operation.

2. Description of the Prior Art
When automatically successively grinding multi-stepped portions of a workpiece in an automatically or a numerically controlled grinding machine, it is desirable to grind the workpiece portions by using a gauging device which directly measures each of the stepped workpiece portions.

However, the application of a gauging device to a workpiece portion having slots or splines on the periphery thereof is not possible because the feelers of the gauging device drop into the slotted portions.

Accordingly, in a prior art device, dead stop machining has been applied to such slotted workpiece portions or discontinuous round portions. More specifically, dead stop machining is an operation in which the rotating end of a feed wheel is limited by a stop arrangement, and a workpiece is machined to its desired finished dimension in a single stroke of rotating the feed wheel up to the position of the stop.

However, because the position of the dead stop must be adjusted prior to all grinding operations, grinding wheel wear and machine element displacement exerted during the grinding operations adversely affect the finished diameter of the workpiece portions.

Further, in order to automatically grind multi-stepped workpiece portions in a dead stop machining operation, adjustments of the dead stop are necessary for each of the work diameters.

Therefore, dead stop machining processes as well known in the prior art are not applicable to the grinding of multi-stepped workpieces having continuous and discontinuous round portions.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a grinding machine with an improved control device for grinding wheel feeding.

Another object of the present invention is to provide a grinding machine which has an improved dead stop mechanism for eliminating the effects of grinding wheel wear and machine element displacement on a finished workpiece diameter.

A still further object of this invention is to provide a grinding machine having a feed control device which automatically memorizes an advanced position of the feed means in a previous grinding operation and automatically controls a successive grinding operation to precisely grind a workpiece portion according to the memorized reference position.

Yet another object of this invention is to provide a feed control device for a grinding machine which gives a grinding speed change signal upon reaching a predetermined work diameter and successively gives a size signal upon reaching the desired finished work diameter.

A yet further object is to provide a mechanism for use with a grinding machine which precisely detects a dead stop position and gives a size signal.

The foregoing and other objects are attained by the present invention according to one aspect thereof through the provision of an arm member being connected to an infed mechanism for being rotatably advanced and retracted thereby. A memory member following the advancing movement of the arm member is provided so as to memorize the advanced position of the infed mechanism in a previous grinding operation.

When the infed mechanism and the arm member retract, the memory member is held at its advanced position by a locking member engaging the periphery portion thereof. Then, in the next grinding operation, a detecting member mounted on the memory member produces a sizing signal for controlling the infed mechanism when the arm member subsequently comes up to the memorized advanced position of the memory member.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in conjunction with the accompanying drawings, wherein like reference numerals designate like or corresponding parts throughout the several views and in which:

FIG. 1 is a diagram showing a grinding wheel stroke with regard to a multi-stepped workpiece;

FIG. 2 is a transverse cross-sectional view showing a grinding machine having a feed control device constructed according to the present invention;

FIG. 3 is an enlarged cross-sectional view showing the portion lying within the circle III of FIG. 2;

FIG. 4 is a cross-sectional view taken on the line IV—IV in FIG. 3;

FIG. 5 is a cross-sectional view taken on the line V—V in FIG. 4;

FIG. 6 is a fragmentary cross-sectional view taken along the line VI—VI in FIG. 3;

FIG. 7 is a diagram of a hydraulic circuit arrangement for controlling the operation of the grinding machine of this invention;

FIG. 8 is an enlarged cross-sectional view of another embodiment showing the portion lying within the same circle III of FIG. 2 as the embodiment of FIG. 3;

FIG. 9 is a cross-sectional view taken along the line IX—IX in FIG. 8;

FIG. 10 is a cross-sectional view taken along the line X—X in FIG. 8; and

FIG. 11 is a cross-sectional view taken along the line XI—XI in FIG. 9.

Detailed Description of the Invention

Referring now to the drawings, and particularly to FIG. 2 thereof, there is shown a bed 1 on which a slide base 6 is mounted to slidably support an intermediate slide base 7. Slidably mounted on the intermediate slide base 7 is a wheel support 8 for rotatably supporting a grinding wheel 9. Mounted in the slide base 6 is a rapid feed hydraulic cylinder 11 having a piston 13 slidably received therein and a piston rod 12 integrally formed with the piston 13. The piston rod 12 integrally forms at one end thereof a coaxially disposed first feed screw 15 which threadably engages a feed nut 16 depending from the lower surface of the intermediate slide base 7.

The first feed screw 15 is drivenly connected to a drive
shaft 26 rotatably supported in the bed 1 through a gear connection 27, 28 and 29. Mounted on the intermediate slide base 7 is a pulse-motor 20 which may be controlled in accordance with a tape command. A second feed screw shaft 17 connected with the pulse-motor 20 is rotatably supported in the intermediate slide base 7, being threadably engaged at its screw portion 18 with a feed nut 19 depending from the lower surface of the wheel support 8. A work table 2 is slidably mounted on one end of the bed 1 for movement in a direction perpendicular to the path of movement of the wheel support 8 and pivotally supports a swivel table 100 thereon. On the swivel table 100, there is provided a headstock 3 and a footstock, not shown, for supporting a workpiece B therebetween.

The swivel table 100 is also provided with a gauging device 4 having a pair of feelers 5 for engaging the periphery of the workpiece B. The gauging device 4 is capable of changing the operation from a rough grinding speed to a fine grinding speed at a predetermined workpiece diameter, and to retract the wheel support 8 when the workpiece is ground to a predetermined size. A manually operable feed wheel 22 is provided for imparting a rotary motion to the first feed screw 15 to advance the intermediate slide base 7 together with the grinding wheel 9 and the wheel support 8 mounted thereon. The feed wheel 22 is mounted on a pinion shaft 101 rotatably supported in the bed 1. The pinion shaft 101 keys a pinion 23 on the right end portion thereof to meshingly engage a pinion 24 fixed on the drive shaft 26 by means of a pin 25. A hydraulically operated feed mechanism generally designated by the numeral 31, as shown in FIGS. 2, 3 and 7, is provided for automatically actuating the first feed screw 15 and comprises a cylinder 33 in which is slidably mounted a piston rod 32 and a piston 34. The piston rod 32 is provided with rack teeth 36 which mesh with a gear 37 mounted on a shaft 102. The gear 37 meshes with a gear 38 integrally formed on a cylindrical member 39 which is rotatably mounted on the drive shaft 26 and is provided with another gear 46 on the left end portion. A clutch piston 42 is slidable received in the cylindrical member 39 but is restrained from rotation thereto by means of a key member 43. The clutch piston 42 has a conical surface 45 cooperatively associated with a conical surface 44 of the pinion 24. A spring 41 is disposed between the clutch piston 42 and the pinion 24 for normally urging them to move axially away from each other. Between the left end surface of the clutch piston 42 and the bottom of a bore formed in the cylinder 39 in which the clutch piston 42 is received, a chamber 40 is formed. Accordingly, when pressure fluid is admitted into the chamber 40, the clutch piston 42 and the pinion 24 are caused to be frictionally engaged. This clutch mechanism is provided to facilitate disconnecting the piston 34 during manual actuation of the feed mechanism.

It will be readily apparent that rotary motion of the first feed screw 15 is imparted either by manual actuation of the feed wheel 22 through shaft 101, pinions 23 and 24, shaft 26 and gears 27, 28 and 29, or by automatic actuation of the feed mechanism 31 through piston rod 32, rack 36, gears 37 and 38, cylinder 39, clutch piston 42, pinion 24 and shaft 26, to produce a transverse feeding movement of the wheel support 8 and the grinding wheel 9 thereon through the slide base 7.

A feed control valve 77, as shown in FIG. 7, is provided for controlling the admission to and the exhaust of fluid from the cylinder 33. A compression spring 118 serves normally to hold the valve 77 in a rightwardly disposed position, and a solenoid 53 is provided for shifting the valve 77 into its leftwardly disposed position. When the solenoid 53 is energized, fluid under pressure passing through a pressure line 119 from a source P enters the right end chamber 120 of cylinder 33 through the right block of the valve 77 to move the piston 34 and the piston rod 32 leftward for actuating a hydraulically operated grinding feed. At the same time, fluid in a left end chamber 121 of the cylinder 33 passes through both a fine feed throttle valve 123 and a rough feed throttle valve 122, and through the feed control valve 77, into a reservoir 124.

The advance feed movement of the wheel support 8 is a faster feed speed substantially determined by the rough feed throttle valve 122.

When a speed change signal 126 is produced by the gauging device 4, or a memory device 103 described hereinafter, a speed change valve 128 is shifted leftward to close the circuit including the rough feed throttle valve 122. Accordingly, the speed of the grinding feed slows to a speed determined only by the fine throttle valve 123.

Referring now to FIGS. 3, 4, 5 and 6, there is shown a memory device generally designated by the reference numeral 103, which includes a casing 106 secured to a bed cover 105 fixed on the bed 1. Fittedly supported in the casing 106 is a supporting sleeve 104 which rotatably carries a shaft 48 therein by means of spaced needle bearings. The shaft 48 has on one end thereof a gear 47 meshingly engaging the gear 46 on the cylindrical member 39 and on its other end has an arm member 49 secured thereto by bolts or the like.

The arm member 49 is rotatably clockwise advanced and counterclockwise retracted through the gearings 47, 38 and 46 and 47 by actuation of the feed mechanism 31. The arm member 49 is provided, on its outer end and facing in the rotating direction thereof, with a first nozzle 61 wherein pressure air may be supplied through conduits 64, 65, 65' and 66. Pressure air ejects from the first nozzle 61. A pressure switch 62 is connected to the conduit 66 to provide an electric signal upon the first nozzle 61 being closed and pressure in the conduits building up, as described hereinafter.

On the outer periphery of the supporting sleeve 104, a memory plate 56 is rotatably mounted by means of a bearing bush 125, being axially secured by a collar 132 and a ring 133. The memory plate 56 is provided with an integrally formed gear 54 on one end thereof which meshingly engages rack teeth 53 on a rack piston 52, as shown best in FIG. 6. The rack piston 52 housed in the casing 106 is operable to be traversed toward the right direction, as shown in FIG. 6, by the supplying of pressure fluid in a chamber 107 so as to rotate the memory plate 56 counterclockwise, as it appears in FIG. 4.

The memory plate 56 is provided with a bolted block member 72 having a second nozzle 74 from which predetermined pressure air being supplied through conduits 73, 69, 68 and 67 may be ejected.

A pressure switch 75 is connected to the conduit 67 to provide an electric signal whenever the second nozzle 74 is closed, as described hereinafter.
A circular plate 76 is rotatably mounted on the one side of the memory plate 56 and is axially held in place by the collar 132. The circular plate 76 has a block member 71 bolted thereon which is located between the first and second nozzles 61 and 74. The block member 71 has two operating faces 71a and 71b, respectively, to close the first and second nozzles 61 and 74. The circular plate 76 is normally urged to rotate counterclockwise with respect to the memory plate 56 by the force of a spring 87 connected therewith and such rotation is restricted by an adjusting screw 58 which engages a stop pin 59 mounted on the memory plate 56.

Accordingly the clearance between the face 71a and the second nozzle 74 is regulated to a predetermined distance by adjustment of the adjusting screw 58.

A shoe 57, as shown in FIG. 4, is slidable mounted in the casing 106 and is urged by the force of a spring toward the periphery of the memory plate 56 to prevent free rotation thereof. This frictionally engaging force of the shoe is weaker than the rotary force of the arm member 49 and the rack piston 52, but is stronger than the force of the spring 87.

Thus, when the memory plate 56 is urged to rotate clockwise by the arm member 49 and counterclockwise by the rack piston 52, the shoe 57 cannot prevent the rotation. However, when the circular plate 76 counterclockwise rotates with respect to the memory plate 56 against the spring 87, the shoe 57 holds the memory plate 56.

The operation of the improved control device for grinding wheel feed will accordingly be readily apparent from the following disclosure.

A general description of an operation applied for a workpiece, as shown in FIG. 1, follows. Assuming a workpiece is mounted in the position for a grinding operation and the grinding wheel front face is adjusted at a position A,

When a start switch, not shown, is actuated, a tape reader is actuated to read a tape data. By a tape command from the tape reader, a solenoid 51, as shown in FIG. 7, is energized to supply pressure fluid to a rear chamber of the rapid feed hydraulic cylinder 11 to cause a rapid advancing movement of the intermediate slide base 7 together with the wheel support 8 and the grinding wheel 9.

Until the wheel support 8 reaches its rapid feed advance end position, pressure fluid is applied in the front chamber 121 of the infed mechanism 31 and the chamber 107 of the memory device 103. Accordingly, the piston rod 32 is positioned to set the arm member 49 through the gearings at the set position shown by dotted lines in FIG. 4. On the other hand the rack piston 52 is urged rightward to rotate the memory plate 56 counterclockwise toward the set position. Thereby the block member 71 and the circular plate 76 have been rotated counterclockwise by the counterclockwise rotary movement of the memory plate 56 and urged toward the arm member 49 in the set position.

When the wheel support 8 is advanced to its rapid feed end, the feed control valve 77 is shifted into its left end position to cause a grinding feed movement of the wheel support 8 at a speed determined by the rough feed throttle valve 122. At the same time the feed stroke adjusting valve 51 is shifted into a left hand end position to admit fluid being exhausted from the chamber 107 so that rack piston 52 may be shiftable toward the left when an external force is applied thereto, as hereinbefore described.

A grinding operation on the work portion B1 is achieved with the rough grinding infeed. At the same time, the arm member 49 is rotated clockwise in FIG. 4 through the gear connections by the infed mechanism 31. The arm member 49 engages the block member 71 to rotate it in an engaged state therewith. When block member 71 is rotated by a clearance 80, the block member face 71a of the circular plate 76 engages the block member 72 of the memory plate 56. Accordingly, the memory plate 56 and the circular plate 76 follow the rotary movement of the arm member 49 as a unit to be rotated together therewith.

During a grinding operation, the gauging device 4 engages the peripheral surface of the work portion B2 to measure the work diameter. When the workpiece is ground to a predetermined size, the gauging device 4 produces a speed change signal 126 to energize a solenoid 52 to shift the speed change valve 128 into its left end position to shut-off the circuit including the rough feed throttle valve 122, whereby the feed speed slows down in a slow decelerate manner. Accordingly, the grinding speed rate then is determined only by the fine feed throttle valve 123.

When the workpiece portion B3 is ground to a finished diameter D1, the gauging device 4 produces a size signal 131 to de-energize the solenoids 51 and 53 to respectively admit pressure fluid into the front chambers of the rapid and infed cylinders 11 and 33 to thereby traverse and rotate the first feed screw 15 in the reverse direction to reset the feed mechanism for the next grinding operation. Thus, the face A of the grinding wheel 9 is retracted through a distance L.

During the reverse movement of the infed mechanism 31 the arm member 49 retracts to the position I shown by the dotted lines in FIG. 4.

On the other hand the memory plate 56 is held at an advanced position thereof by the shoe member 57 so as to memorize the advanced position of the infed mechanism 31 in the present grinding operation. The memorized advanced position of the memory plate 56 serves in the production of a sizing signal in the next grinding operation.

The former integration between the memory plate 56 and the circular plate 76 now discontinues because the pushing force by the arm member 49 is released. More particularly, the circular plate 76 is rotated counterclockwise by the spring 87 until its rotation is restricted by the stop pin for producing a predetermined clearance between the surface 7la and the second nozzle 74. This clearance determines a fine feed grinding stroke for the next grinding operation and is adjustable by adjusting the screw 58.

In the memory device 103, when the first and second nozzles 61 and 74 are closed, the pressure switches 62 and 75, respectively, produce change speed and sizing signals. However, these signals are caused to be ineffective by means of an electric circuit 127 in the operation using a gauging device.

In a next step, the grinding operation is applied to a discontinuous round work portion B3 having a slot C. In accordance with the tape command, the work portion B2 is longitudinally positioned by the work table
2 in front of the grinding wheel 9, and the pulse-motor 20 is rotated to retract the wheel support 8 with regard to the intermediate slide base 7 by a predetermined distance \( h \), which equals a distance which is half the difference between the diameters \( D_2 \) and \( D_3 \) of the workpiece portions \( B_2 \) and \( B_3 \). The front surface of the grinding wheel 9 is shown at \( A_2 \) in dotted line in FIG. 1. After that, the rapid feed cylinder 11 is actuated to advance the intermediate slide base 7 together with the wheel support 8 and the grinding wheel 9, and the infed mechanism 31 is actuated to perform a grinding operation on the work portion \( B_2 \). However, the gauging device 4 remains in an inoperative position, that is in a retracted position.

During the advancing movement of the piston rod 32 in the feed mechanism 31, the arm member 49 is rotated in the clockwise direction from the re-set position \( la \) toward the memorized advanced position \( lb \) of the block member 71, as shown in FIG. 4. When the arm member 49 contacts the face \( 71 b \) of the block member 71, the first nozzle 61 is closed to cause the pressure switch 62 to produce a speed change signal 126 which serves for shifting the speed change valve 128 leftward to render the rough feed throttle valve 122 ineffective. Accordingly, the infed mechanism 31 continues a grinding operation at a precise speed rate determined only by the fine feed throttle valve 123.

During the grinding operation performed at this precise speed rate, the arm member 49 also continues to rotate clockwise to urge the block member 71 in the same direction, but the memory plate 56 remains in the position memorized in the previous grinding operation. When the arm member 49 is further rotated by the clearance \( l_4 \) after engagement with the block member 71, the second nozzle 74 is closed by the face \( 71 a \) of the block member 71 to cause the pressure switch 75 to produce a sizing signal. This sizing signal serves to deenergize the solenoids \( S_1 \) and \( S_3 \), thereby shifting the rapid feed valve 129 and the feed control valve 77 toward the right. Accordingly, the wheel support 8 and the infed mechanism 31 rapidly retract into the re-set position.

Thus, the work portion \( B_2 \) is finished to the size \( D_3 \) by the sizing signal which is produced at the position memorized in the previous grinding operation.

A grinding operation to a slotted work portion is controlled by a dead stop memorized in the previous grinding operation using a gauging device.

Referring now to FIGS. 8, 9, 10 and 11, details of another embodiment according to the invention are described, the members thereof which function the same as in the previous embodiment being designated by the same reference numerals.

The memory plate 56 in this embodiment is provided for rotatably supporting a first block member 81 on the left side portion thereof and in concentric relation therewith. On the left side portion of the first block member 81 is rotatably mounted a second block member 82 which is connected with the first block member 81 by means of a lever 84. The first block member 81 is provided with an operating surface 91 for closing the second nozzle 74, which when closed makes the second pressure switch 75 exhibit an electric signal. The second block member 82 is provided with an operating surface 92 for closing the first nozzle 61 provided on the arm member 49, which when closed makes the first pressure switch 62 give an electric signal.

The lever 84 is pivotally mounted on the memory plate 56 at pin 83, which is positioned on a line which is perpendicular to the axis 90 on the line connecting the axis 90 and the second nozzle 74. The lever 84 is provided with a sphere-headed portion 85 at the end thereof and a stud 88 threaded down at the intermediate portion thereof. The first and second block members are connected to each other in such a manner that the sphere portion 85 and the stud 88 are respectively engagedly received in a slot portion 86 provided in the first block member 81 and a slot portion 89 provided in the second block member 82.

The above-mentioned block assembly is urged in the counterclockwise direction as seen in FIGS. 9 and 10, by the spring 87 connected between the first block member 81 and the memory plate 56, and its movement is prevented by the adjusting screw 58 engaging the second block member 82.

When the second block member 82 is rotatably urged clockwise by the arm member 49, the movement thereof is magnified and transmitted to the first block member 81 by means of the lever 84. More particularly, when the second block member 82 rotates clockwise, the slot portion 89 therein rotates the lever 84 counterclockwise around the axis 83. The movement of the lever 84 is magnified in proportion to the lever ratio and is transmitted to the first block member 81 to rotate the same clockwise through the engagement of the sphere headed portion 85 thereof with the slot 86 of the first block member 81.

A magnifying rate may be shown as \( d_2 f_2/d_1 f_1 \), in which \( d_1 \) and \( d_2 \) are respectively the radii extending from the axis 90 to the sphere 85 and the stud 88, \( f_1 \) is the distance between the stud 88 and the axis 83, and \( f_2 \) is the distance between the sphere 85 and the axis 83.

The operation of the second embodiment will be readily apparent from the foregoing disclosure referring to the previous disclosure about the first embodiment.

When the previous grinding operation has been performed on the work portion \( B_1 \), the advanced position of the infed mechanism 31 is memorized by the memory device 103 as a position of the memory plate 56 being securely held by the shoe 57. Fluid in the chamber 107 of the memory device 103 is exhausted to the reservoir, as shown in FIG. 7. The piston 34 in the infed mechanism 31 is thus located in the right end position and thereby the arm member 49 is positioned in the re-set position \( la \) shown in FIG. 9.

The block assembly is rotated counterclockwise by the spring 87 to thereby produce a clearance \( l_2 \) which serves as a fine feed stroke and is adjustable by the adjusting screw 58.

After compensation by the pulse-motor of the differential diameter between \( D_2 \) and \( D_1 \), grinding operation is performed on the work portion \( B_2 \) having the slot C.

The rapid feed cylinder 11 is actuated to advance the grinding wheel 9. After that, the infed mechanism 31 is actuated to grind the work portion \( B_2 \) in a rough feed. During the rough grinding operation, the arm member 49 is rotated in clockwise direction from the re-set position \( la \) toward the position \( lb \).

When the arm member 49 contacts with the operating surface 92 of the second block member 82, the first nozzle 61 is closed to cause the pressure switch 62 to produce a speed change signal to thereby reduce the speed of the infed mechanism 31 to perform a fine
grinding operation. During fine grinding operation, the arm member 49 also continues clockwise to rotate the block assembly, the movement of the second block member 82 being magnified and transmitted to the first block member 81. When the first block member 81 is rotated by the clearance \( l_2 \), the second nozzle 74 is closed by the operating surface 91 of the first block member 81 to cause the second pressure switch 75 to produce a sizing signal. This sizing signal serves for rapidly retracting the wheel support 8 and the infeed mechanism 31.

A differential transformer or an air switch may generally be used to detect the advanced position of the first block member 81. In such a detecting device, a differential gap must be considered. The air switch having an air nozzle and a pressure switch, as used in the present embodiment, produces a sizing signal before the first block member 81 completely closes the second nozzle 74, because when the first block member 81 approaches the nozzle 74, back pressure exerted in the second nozzle 74 and the conduit thereto reaches a level to actuate the pressure switch. The gap between the front surface of the nozzle and the position actuating the pressure switch is called a differential gap. The differential gap affects the finished size of the workpiece to thereby result in grinding of the workpiece such that it is larger than the predetermined finished size.

In the second embodiment, the effect of the differential gap is minimized in inverse proportion to the magnifying rate \( d_s f_s/d_t f_t \).

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is to be understood, therefore, that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein. Accordingly,

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A grinding machine for automatically successively grinding a workpiece which comprises:
   a bed;
   a work table for rotatably supporting a workpiece;
   a wheel support slidably mounted on said bed for rotatably supporting a grinding wheel;
   infeed means connected to said wheel support for advancing and retracting said wheel support;
   gauging means for measuring the work diameter to provide control signals at predetermined diameters of said workpiece for controlling said infeed means; and
   feed control means comprising displaceable means connected to said infeed means for being advanced and retracted proportionately with the movement thereof, memory means advanced by said displaceable means in engagement therewith, and holding means for holding said memory means at an advanced position to memorize said advanced position of said infeed means controlled by said gauging means in previous grinding operation whereby in the next grinding operation an advancing position of said infeed means is restricted by said advanced position of said memory means.

2. A grinding machine according to claim 1, wherein said feed control means further comprises detecting means mounted on said memory means for producing a control signal for controlling said infeed means when said displaceable means comes up to said memorized advanced position of said memory means.

3. A grinding machine according to claim 2, wherein said detecting means comprises an air nozzle for producing a control signal when actuated by said displaceable means.

4. A grinding machine for automatically successively grinding a workpiece which comprises:
   a bed;
   a work table;
   a wheel support slidably mounted on said bed to rotatably support a grinding wheel;
   infeed means connected to said wheel support for advancing and retracting said wheel support toward a workpiece;
   gauging means for measuring the work diameter to produce control signals at predetermined diameters of said workpiece for controlling said infeed means; and
   feed control means comprising an arm member connected to said infeed means for being rotatably advanced and retracted proportionately with the movement thereof, memory means rotatably engageable with said arm member for following the same to an advancing position of rotation thereof, a locking member engaging said memory means to hold said memory means at an advanced position to memorize said advanced position of said feed means controlled by said gauging means in a previous grinding operation, and a first detecting member mounted on said memory means to exert a control signal for controlling said infeed means when said arm member comes up to said memorized advanced position of said memory means.

5. A grinding machine according to claim 4, wherein said memory means further comprises:
   a memory plate having said first detecting member thereon;
   a circular plate rotatably mounted on said memory plate and having a pair of operating surfaces; and
   means flexibly holding said circular plate with a predetermined clearance between one of said operating surfaces and said detecting member so that one of said operating surfaces actuates said detecting member to retract said wheel support when said circular plate is moved through said predetermined clearance by said arm member engaging the other of said operating surfaces.

6. A grinding machine according to claim 5, wherein said arm member has a second detecting member for producing a speed change signal for said infeed means when said arm member comes up to the other operating surface of said circular plate.

7. A grinding machine according to claim 4, wherein said memory means comprises:
   a memory plate having said detecting member thereon;
   a first block member having a first operating surface and being rotatably mounted on said memory plate;
   means flexibly holding said first block member with a predetermined clearance between said operating surface and said first detecting member;
   a second block member having a second operating surface and being mounted on said memory plate; and
connecting means for connecting said second block member to said first block member, whereby said first operating surface actuates said detecting member to retract said wheel support when said first block member is moved through said predetermined clearance through said connecting means by said arm member engaging said second operating surface of said second block member.

8. A grinding machine according to claim 7, wherein said connecting means is a lever for magnifying rotary movement of said second block member and transmitting said movement to said first block member.

9. A grinding machine according to claim 8, wherein said arm member has a second detecting member for producing a speed change signal for controlling said infeed means when said arm member comes up to said second operating surface.

10. A grinding machine according to claim 8, wherein said lever is pivotally mounted on an outer portion of said memory plate, and is provided at the inner end thereof with a sphere portion for engaging said second block member, and at an intermediate portion thereof with a stud for engaging said first block member.

11. In a grinding machine for successively performing a plurality of grinding operations on a workpiece having multi-stepped portions:
   a bed;
   a work table for rotatably supporting a workpiece;
   a wheel support slidably mounted on said bed to rotatably support a grinding wheel;
   first feed means connected to said wheel support for performing grinding operations;
   control means for controlling said first feed means to grind a first work portion to a predetermined dimension in a first grinding operation;
   memory means for memorizing an advanced position of said first feed means controlled by said control means in said first grinding operation;
   second feed means connected to said wheel support for compensating the same by a half of the diameter difference between said first work portion and a second work portion to be ground in a second grinding operation; and
   second control means for retracting said first feed means to grind said second work portion to a predetermined dimension in said second grinding operation when said first feed means come up to the position memorized by said memory means in said first grinding operation.

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