July 11, 1933. A. P. STEINER ET AL 1,917,468

BALL RACE GRINDER

Filed May 27, 1930 5 Sheets-Sheet 1

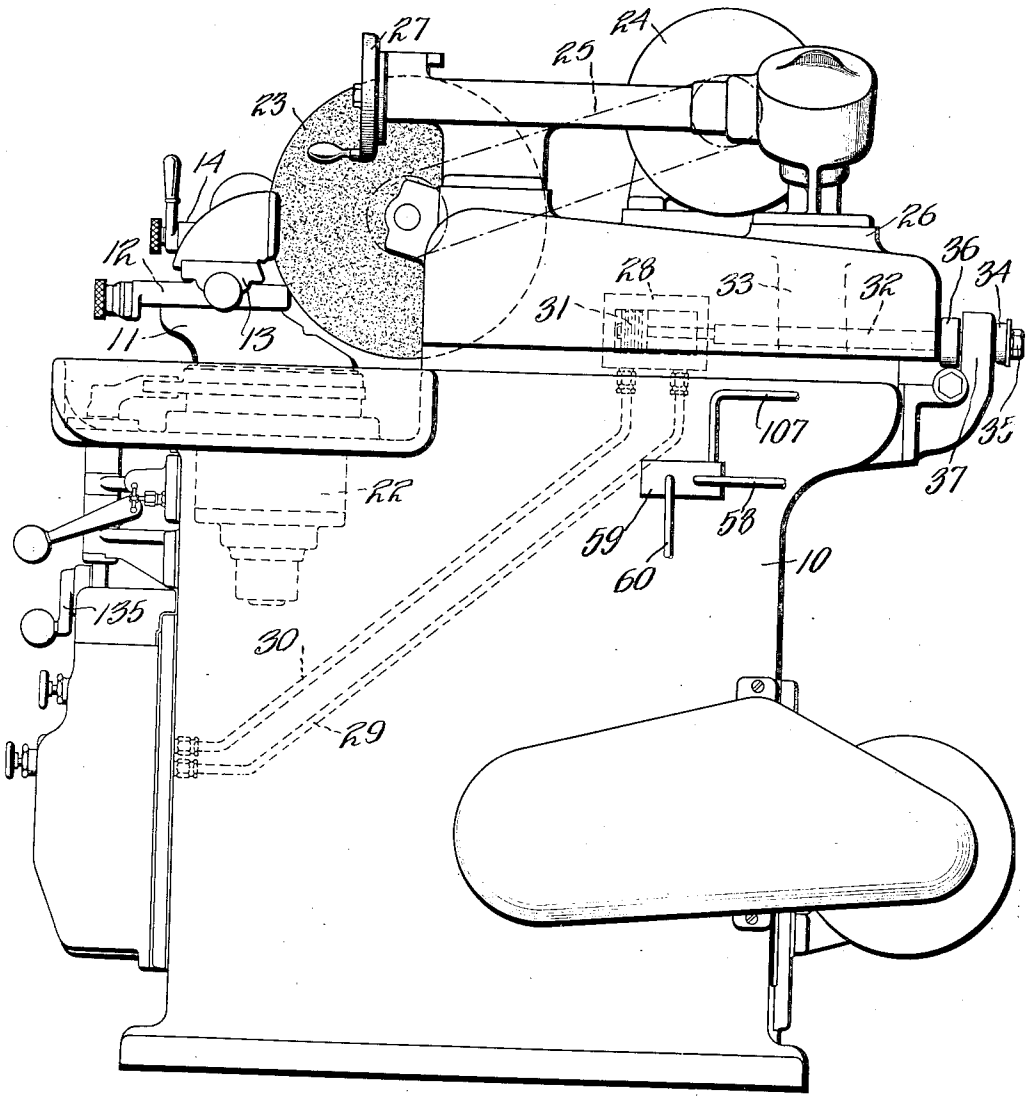


Fig 1

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BALL RACE GRINDER

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5 Sheets-Sheet 2

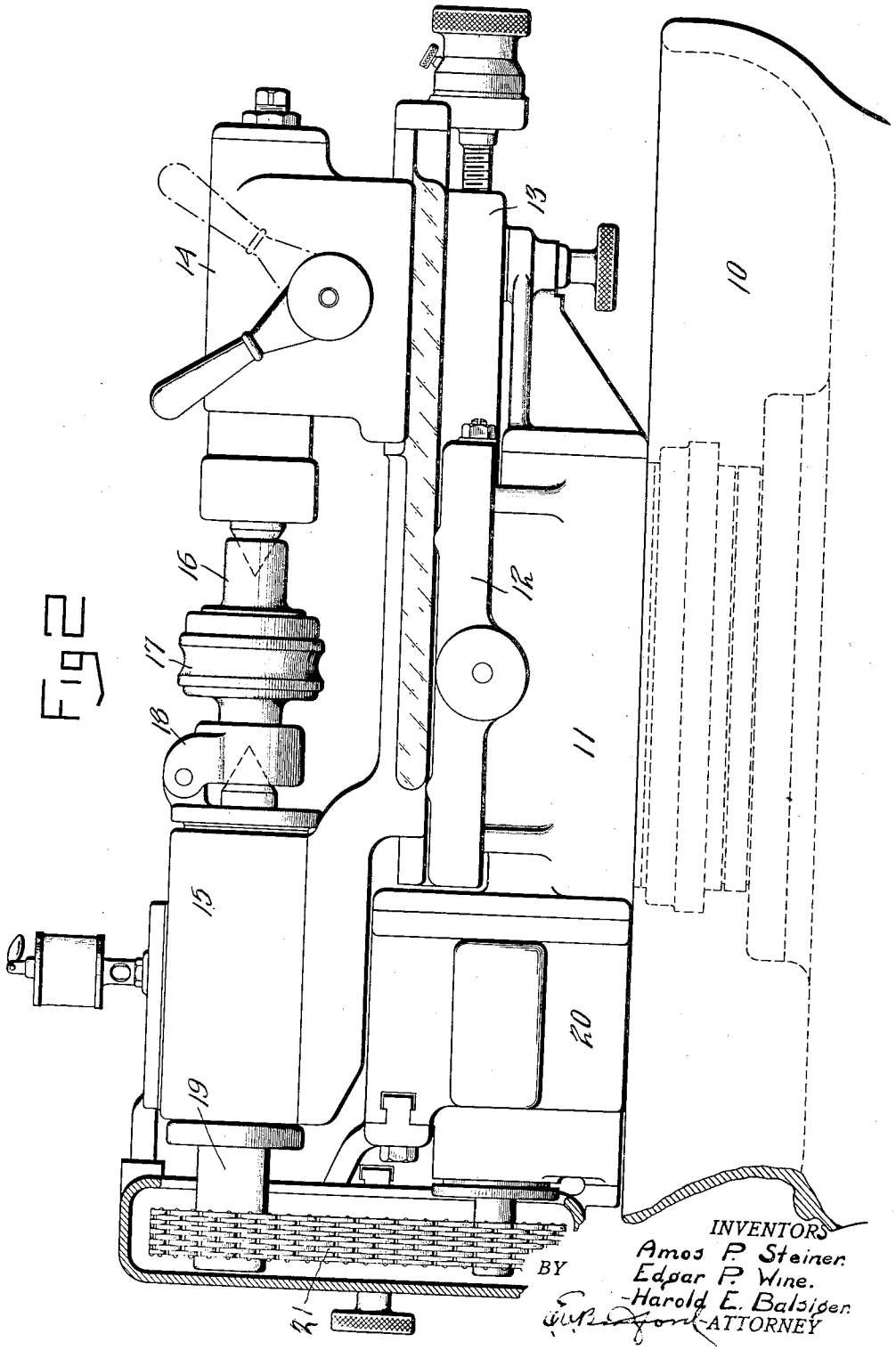


Fig 2

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BALL RACE GRINDER

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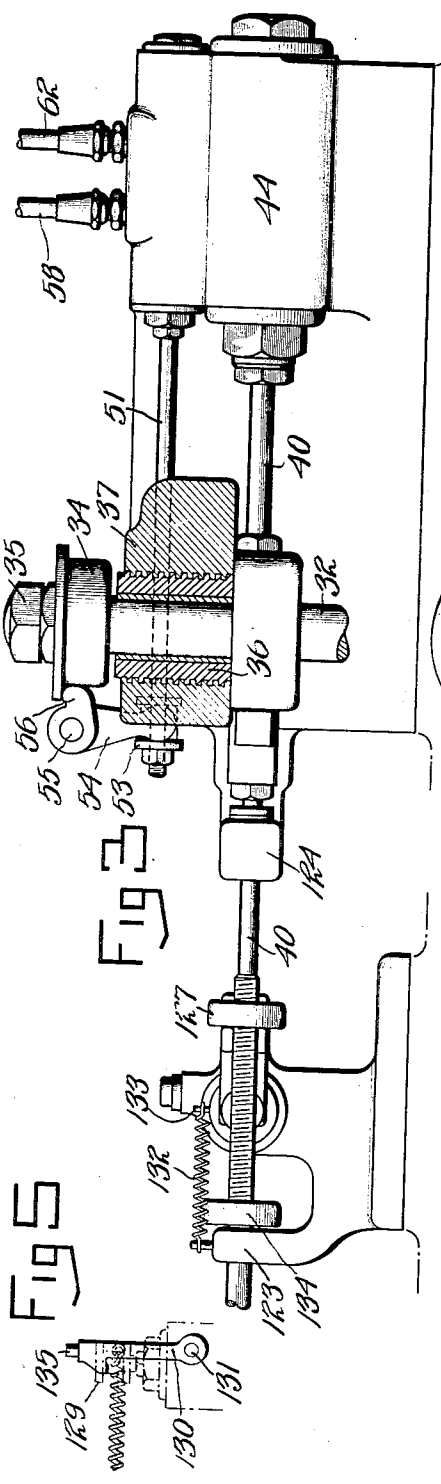


Fig 5

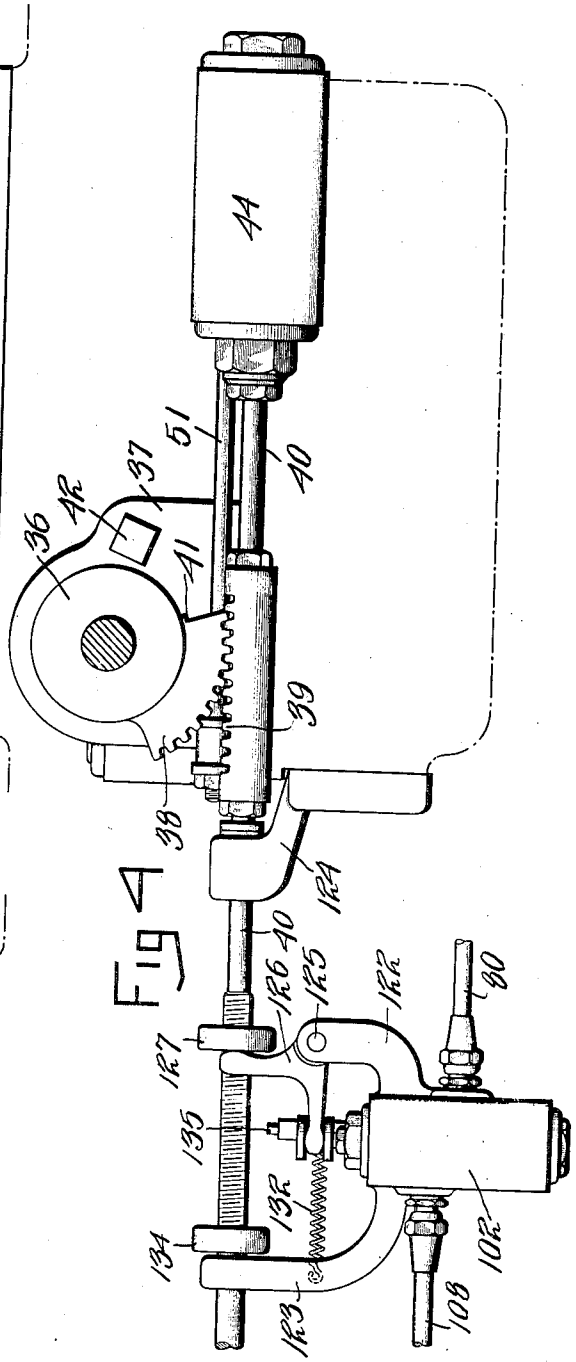


Fig 4

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BALL RACE GRINDER

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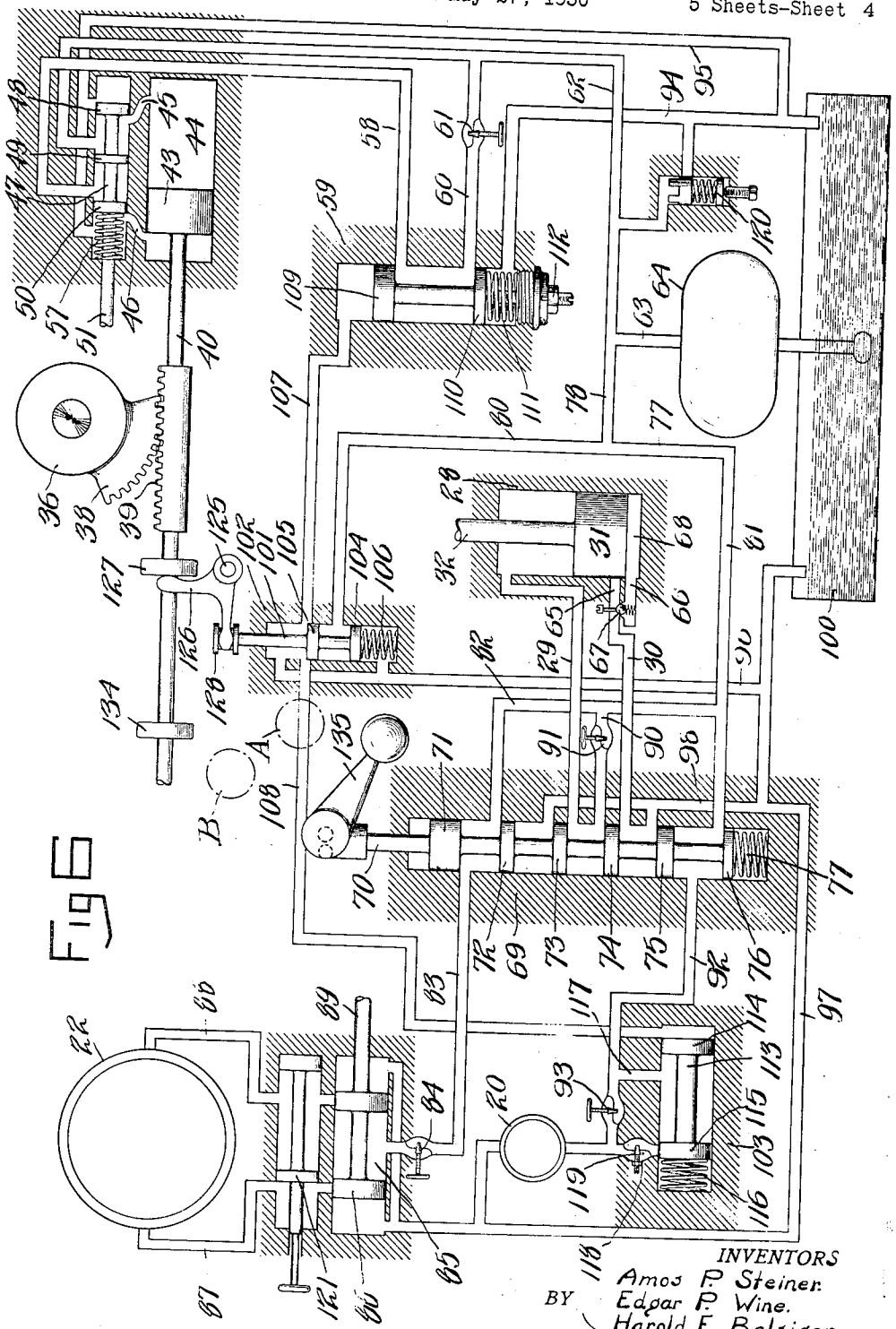


Fig 6

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5 Sheets-Sheet 5

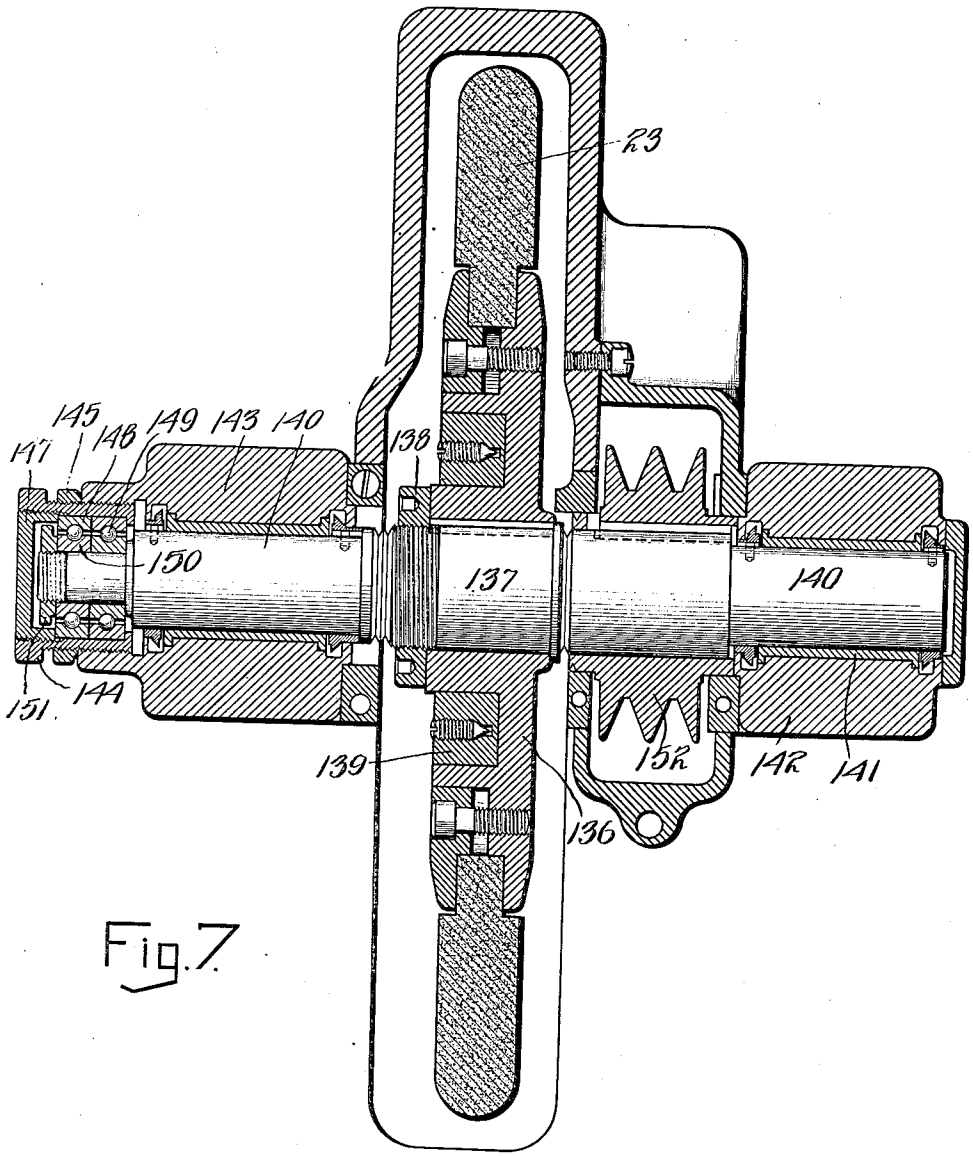


Fig. 7.

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UNITED STATES PATENT OFFICE

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BALL RACE GRINDER

Application filed May 27, 1930. Serial No. 456,196.

This invention relates to machines for grinding the inside race of ball bearings and it is an object to provide a machine having a simple centralized control for all of the several mechanisms on the machine.

A further object is to provide hydraulic means for slowing down the feed for finish grinding the work and stopping the feeding of the grinding wheel toward the work and to increase the speed of the work at a predetermined time for polishing the work.

Further objects and advantages will become apparent as the description proceeds.

Referring to the accompanying drawings which are made a part hereof and on which similar reference characters indicate similar parts.

Figure 1 is an end elevation of the machine.

Figure 2, a front elevation of the oscillating work carriage assembly,

Figure 3, a plan view of the wheel feed mechanism,

Figure 4, a front elevation of the wheel feed mechanism,

Figure 5, a detail of the latch for holding the timing valve in inoperative position,

Figure 6, a diagrammatic view showing the control valves and the relationship between the various mechanisms, and

Figure 7, a sectional elevation showing adjustment of the grinding wheel.

In the drawings numeral 10 indicates the bed of a grinding machine having an oscillating work supporting carriage 11. Numerals 12 and 13 respectively indicate transverse and longitudinal slides and 14 and 15 indicate a foot stock and head stock respectively. A grinding fixture 16 having a work piece 17 secured thereon is mounted between the head stock and the foot stock. The grinding fixture is driven by means of a work drive coupling 18 of any well-known construction. The head stock spindle 19 is driven by means of a fluid motor 20, driving connection between the motor and head stock spindle being by means of a chain belt 21. Any suitable driving connection, however, may be provided. The work carriage 11 is oscillated by means of a fluid motor 22. Means for controlling the motive fluid to said motor will later be described. The work carriage assembly oscillates about an axis in line with the center of the groove desired to be ground in the work piece 17, so as to produce the necessary groove in the periphery of the work to be ground.

A grinding wheel 23 is driven from a motor 24 by means of a belt 25. The grinding wheel is mounted on a wheel base 26 which may be manually moved toward and from the work by means of a hand wheel 27 in manner well-known in grinding machines, such for example as that shown in our copending application, Ser. No. 389,492, filed August 30, 1929 for Hydraulic ball race grinders. Means for automatically feeding the grinding wheel toward the work is quite similar to that shown in the copending application above referred to, except that in this present application the wheel feed control is mounted at the rear of the machine. This arrangement avoids the necessity of long operating rods and thus simplifies the mechanism. Briefly stated the feed mechanism consists of a cylinder 28 mounted in the bed of the machine having pressure fluid lines 29 and 30 connected to the rear and front ends of the cylinder to conduct pressure fluid to and from the cylinder. A piston 31 operates in the cylinder and has a piston rod 32 extending rearwardly and attached to a bracket 33 secured to and depending from the wheel base 26. At its rear end the rod 32 has secured thereon a flanged collar 34 by means of nuts 35. The rod 32 passes through a sleeve 36. This sleeve is threaded on its exterior to cooperate with threads in a bracket 37 on the machine base. The forward end of the sleeve 36 is flanged and has a gear segment 38 extending a portion of the way around it. This gear segment is engageable by a rack 39 on a piston rod 40. The segment 38 has a projecting lug 41 thereon which engages a stop 42 secured to the bracket 37, the purpose of the stop being to limit rotation of the sleeve 36 beyond a predetermined point. Rotation of the sleeve 36 is produced by means of a piston 43 operating in a cylinder 44, the piston 43 being connected to the piston rod 40. Fluid ports 45 and 46 in the cylinder 44 at opposite sides of the piston 43 are controlled

by means of a valve 47 having disks 48, 49 and 50 thereon and having a valve stem 51 on the outer end of which is a spool 53. This spool is engaged by one arm 54 of a bell crank lever pivoted at 55. The other arm 56 of this lever is engageable by the flange on the collar 34. As the wheel base moves toward grinding position it will be seen that the flange on the collar 34 will engage the arm 56 just before the collar comes into engagement with the sleeve 36 so that the valve 47 will be shifted to the left against tension of spring 57, the spring tending normally to hold the valve to the right.

When the valve 47 is held to the left, port 46 is put in communication with pressure fluid line 58. Line 58 connects through valve casing 59 with fluid line 60, through needle valve 61 with fluid line 62 and 63 to the pump 64. Pressure fluid may therefore be delivered by the pump to the left of the piston 43 to move this piston to the right and to rotate the sleeve 36 counterclockwise as shown in Figure 6 to allow it to be withdrawn as shown in Figure 3 to permit the wheel base to be fed toward the work by pressure fluid delivered through the line 29 to the rear of the piston 31. The rate with which the piston 43 moves to the right is determined by the needle valve 61 which may be adjusted to permit fluid to flow therethrough at any predetermined rate. Fluid line 30 enters directly into cylinder 28 through a port 65 and also enters through a port 66 and restricted valve 67. There is provided therefore a small fluid chamber 68 at the end of the piston which acts as a cushion to slow down movement of the wheel base toward the work after the piston has shut off the port 65 as is shown in Figure 6. When the piston has reached this position the restricted valve 67 slows down its movement until collar 34 strikes sleeve 36 when the wheel base is fed into final position, as previously described.

At 69 is shown a valve casing which houses the main control valve for the various operating mechanisms. Within this valve casing is positioned a valve 70 having a plurality of disks 71, 72, 73, 74, 75 and 76 thereon. A spring 77 is positioned beneath the disk 76 and normally tends to hold the valve stem in forward position as viewed in Figure 6. A motive fluid line 78 coming from the discharge side of the pump branches into pipes 80 and 81. The pipe 81 branches off into a line 82 which enters valve chamber 69 above the disk 72 and in the position shown in Figure 6 communicates through pipe 83 and needle valve 84 with a valve chamber 85. A valve 86 directs fluid from the valve chamber 85 to either of two lines 87 and 88 which operate the motor 22 which oscillates the work carriage 11. Valve 86 is operated by means of a valve stem 89 by any suitable mechanism on the machine not shown, such for example as the mechanism shown in our copending application above referred to. Fluid conduit 82 branches and the branch 90 passes through an adjustable needle valve 91 into a chamber in the valve 69 which is formed between disks 73 and 74. The fluid passage 90 connects with fluid passage 29 when the valve stem is in the position shown in Figure 6 to admit fluid from the pump to the rear side of the piston 31 to move the wheel base toward grinding position. Pressure fluid line 81 also communicates with a valve chamber formed between disks 75 and 76 which communicates with a fluid line 92. This fluid line leads to the work rotating motor 20, passage of fluid thereto being controlled by a needle valve 93. Fluid lines 94, 95, 96, 97, 98 and 99 all indicate return fluid lines to the reservoir 100 positioned in the bed of the machine.

At 59, 102 and 103 are valve chambers which will now be described. The valve chamber 102 has a valve stem 101 having disks 104 and 105 thereon, a spring 106 being positioned beneath the disk 104 and the disk 105 controlling admission of fluid from the line 80 to both of fluid lines 107 and 108. Fluid line 107 communicates with the valve chamber in valve 59 above the piston 109. A disk 110 has a spring 111 positioned therebeneath. Downward movement of the disk 110 is limited by an adjustable screw 112. When the valve disk 105 is in elevated position so that fluid may pass from the line 80 through the valve chamber 102 to the line 107 the piston 109 is depressed against the tension of the spring 111 until disk 110 strikes stop screw 112 so that fluid line 60 is partially closed from line 58, thus restricting flow of fluid to the left hand end of piston 43, thereby retarding rotation of segment 38 and sleeve 26 to slow down feed of the grinding wheel when the work is nearly to size.

Positioned in the valve chamber 103 is a valve 113 having pistons 114, 115 thereon, a spring 116 being positioned in the end of the chamber against the disk 115 normally to hold the valve to the right as shown in Figure 6. When fluid line 108, however, is open to pressure line 80 pressure is delivered to the right of the disk 114 to move the disk 115 to the left to open communication between valve ports 117 and 118 so that fluid may pass directly from pressure line 92 through ports 117. valve chamber 103 and port 118 to the work drive motor 20. An adjustable needle valve 119 may be set to control the passage of fluid through this circuit. This additional course for the fluid, however, will cause the work drive motor to be speeded up. This increased speed, as will presently be seen, is caused to occur while the wheel base is moving in at retarded speed to its final limit of grinding position when stop 41 strikes stop 42, thus adding a polish-

ing effect to the surface of the work during the final grinding of the work to size. A pressure relief valve is shown at 120. A manually operable valve shown as a whole at 121 enables the operator to connect both sides of the oscillating motor 22 with the exhaust line 97 so that the work carriage may be manually freely oscillated.

Means for moving the valve 101 in the valve chamber 102 will now be described. The valve casing 102 has a pair of bracket arms 122, 123. Attached to the base of the machine is another bracket 124 in which the outer end of the rod 40 slides. Pivoted at 125 on the upper end of the bracket 122 is a rock arm 126. One end of the rock arm is engaged by a disk 127 on the rod 40. The other end of the rock arm engages a spool 128 on the upper end of the valve stem 101. From the side of the spool opposite to that in which the arm of the bell crank lever 126 engages extends a pin 129. A latch 130 is pivoted at 131 to the side of the valve casing 102. This latch engages over the pin 129 normally to hold the valve stem down against the tension of the spring 106 to hold the disk 105 in the position shown in Figure 6. A tension spring 132 is secured to a pin 133 on the latch at one end and secured at its other end to a pin on the bracket 123. Positioned near the end of the rod 40 and spaced from the disk 127 is an adjustable disk 134. When the rod 40 is moved to the right and reaches a predetermined point in its movement in that direction the disk 134 engages the top 135 of the latch 130 and releases the pin 129 so that the valve may move upward under the tension of the spring 106. It will be apparent that when the piston has reached this point in its movement to the right, as just stated, the wheel base will have moved a major part of its travel rapidly, and will at this point be slowed down to bring the grinding wheel to its forward limit to complete grinding of the work to size. The disk 134 of course may be adjusted, as indicated by the screw threads on the rod 40 to cause the latch 130 to be tripped at any desired time.

The operation of the device is as follows: Assume that the valve stem 70 is in the position shown in Figure 6 in which position it will be when the lever 135 is in the position shown in full lines in Figure 6. The wheel base has moved to the position at which the flange on the collar 34 has engaged the arm 56. Further movement of the wheel base forward will move the valve stem 47 to the left so that valve disk 50 will open communication between the line 58 and the port 46. Pressure fluid from the pump will pass through needle valve 61 through valve chamber 59 and line 58 to the left of the piston 43 to start movement of this piston to the right, its movement in that direction being limited by the rate of flow of fluid through the needle valve 61. It should be noted that fluid line 81 is in communication through line 90, needle valve 91 and line 29 with the chamber to the rear of the piston 31 so that the wheel base will be moved forward. The grinding operation will begin and the speed with which the grinding wheel may be moved into the work will be limited by the rate with which the sleeve 36 is retracted as this sleeve is rotated by the rack 39 and the gear segment 38. Of course the distance through which the wheel base moves during feeding is very slight as only a very small amount of stock is to be taken off the work. When the wheel has reached a predetermined point in its forward grinding position the disk 134 strikes the upper end of the latch 130 and releases the pin 129 which holds down the valve stem 101. As soon as it is released this valve stem moves up so that fluid line 80 is brought into communication with fluid lines 107 and 108. As soon as fluid line 108 is opened up pressure fluid from this line moves the piston 114 to the left to speed up rotation of the work drive motor as previously described. Pressure fluid through the line 107 depresses piston 109 so that line 60 is partly cut off from line 58. So long as the mechanism remains in the position just described, the work drive motor continues to operate at increased speed and the oscillating motor will continue to operate at its normal speed while the wheel base will be moved at retarded speed to its final grinding position, as determined by stops 41 and 42. The operator then moves the lever 135 to the position shown in dotted lines at A. This moves valve disk 71 to close off fluid line 83 and stop oscillation of the work. Valve disk 73 closed off communication between lines 90 and 29, opening 29 to exhaust through 98. Disk 74 opens communication between lines 90 and 30, through adjustable check valve 67 and port 66 to cylinder 68, withdrawing wheel base. After piston 31 has uncovered port 65 the pressure fluid enters through port. The work drive motor continues rotation. The operator may then place a new piece of work in the machine. As the wheel base moved to the rear the flange on the collar 34 released the arm 56 of bell crank lever to permit the spring 57 to shift valve 47 to the right; pressure fluid from line 62 therefore passes through port 45 to the right of the piston 43 to move the piston to the left to position the threaded sleeve 36 in position to be engaged by the sleeve 34 again when the wheel base again moves forward. As piston 43 moves to the left disk 127 through crank 126 depresses valve 101 thus closing off line 107 from line 80 and opening both lines 107 and 108 to exhaust line 96, allowing springs 111 and 116 to reposition valves 109 and 114 respectively, at the same time latch 130 engages pin 129 to hold valve 101 against pressure of spring 106. The apparatus is then reset for a second grinding

operation and the cycle continued as before.

In Figure 7 is shown more in detail the construction and mounting of the grinding wheel, the grinding wheel shown being somewhat different from that shown in Figure 1 but any grinding wheel may be mounted in accordance with the structure about to be described.

The grinding wheel 23 is removably attached to a hub 136 which is keyed to a shaft 137 and secured against axial movement on the other end by a nut 138. Balancing weights 139 may be secured about the hub 136 to balance it. Spindles 140 of the shaft are carried in sleeve bearings 141 secured within bearing supports 142 and 143. In the outer end of the support 143 is screw threaded a sleeve nut 144, the nut being held in adjusted position by a lock nut 145. The inner end of the sleeve nut 144 is provided with an integral flange 146 and a nut 147 is threaded into the outer end of the sleeve nut 144, the inner ring portion of the nut 147 co-operating with the flange 146 to hold the outer races 148 of ball bearing 149, the inner race bearing 150 being held against the end of the spindle 140 by means of a nut 151 which is threaded on the end of the spindle. The sleeve nut 144 may be adjusted axially and locked in adjusted position to adjust the shaft 140 and consequently to position the grinding wheel in any predetermined axial position. A pulley 152 is mounted on the shaft, the pulley here shown being grooved to adapt it to be driven by a plurality of belts.

It will be obvious to those skilled in the art that various changes may be made in our device without departing from the spirit of the invention and therefore we do not limit ourselves to what is shown in the drawings and described in the specification, but only as indicated in the appended claims.

Having thus fully described our said invention, what we claim as new and desire to secure by Letters Patent, is:

1. A machine for grinding the inside race of ball bearings comprising a work support work driving means, a wheel base, a motor for moving said wheel base toward the work support, hydraulic means for limiting the speed of movement of the wheel base toward the work support, and automatic means for speeding up the work driving means as the wheel base reaches a predetermined point in its movement toward the work grinding position, substantially as set forth.

2. A machine for grinding the inside race of ball bearings comprising a work support, a motor for oscillating the work support, means for centering the work about the axis of oscillation of the work support, a work drive motor, a wheel base having a grinding wheel mounted thereon, a fluid motor for moving the wheel base toward the work support, fluid controlled means for limiting the speed of movement of the wheel base toward the work support and means for cushioning movement of the wheel base toward the work support as it nears the limit of its travel in that direction, and means for speeding up the work drive motor as the wheel base reaches a predetermined point in its feeding movement, substantially as set forth.

3. In a machine for grinding the inside race of ball bearings having a work carriage, a work drive motor, a wheel base and a motor for moving the wheel base toward the work carriage, a central control valve for operating the work drive motor and the work feeding motor, and automatic means for speeding up the operation of the work drive motor after the wheel feeding motor has moved the wheel base to a predetermined point in its grinding movement, substantially as set forth.

4. In a machine for grinding the inside race of ball bearings having a work carriage, a work drive motor, a wheel base and a motor for moving the wheel base toward the work carriage, a central control valve for operating the work drive motor and the work feeding motor, automatic means for speeding up the operation of the work drive motor after the wheel feeding motor has moved the wheel base to a predetermined point in its grinding movement, and means for slowing down movement of the wheel base toward the work support as the wheel base approaches the limit of its travel during the work feeding movement, substantially as set forth.

5. In a grinding machine for the inside race of ball bearings, a work support, a wheel base, means for oscillating the work support and for rotating the work means to move the wheel base toward and away from the work and a central control valve for all of said means, whereby all of the operations of the machine may be controlled in proper sequence by a single lever, substantially as set forth.

6. In a ball race grinding machine, a wheel base movable toward and from grinding position and means for feeding it during grinding operation comprising a fluid motor operable to move the wheel base toward grinding position, and means including a second fluid operated mechanism for limiting the speed with which the wheel base moves toward grinding position, and means operable by said last-named mechanism for speeding up rotation of the work when the wheel base has reached a predetermined point in its movement in the direction for grinding the work, substantially as set forth.

7. A machine for grinding the inside race of ball bearings comprising a base, a work carriage mounted to oscillate upon the base, means for centering the work with respect to the axis of oscillation of the work support, a fluid motor for oscillating the work support, a fluid motor for rotating the work, a

wheel base, a grinding wheel mounted upon the wheel base, a fluid motor for moving the grinding wheel toward the work during grinding operation, means including a fluid operated mechanism for limiting the speed with which the said fluid motor moves the wheel base during grinding operation, and means controlled by the said fluid motor for speeding up rotation of the work after the grinding wheel base has reached a predetermined point in the wheel feeding movement, substantially as set forth.

8. A machine for grinding the inside race of ball bearings comprising a base, a work carriage mounted to oscillate upon the base, means for centering the work with respect to the axis of oscillation of the work support, a fluid motor for oscillating the work support, a fluid motor for rotating the work, a wheel base, a grinding wheel mounted upon the wheel base, a fluid motor for moving the grinding wheel toward the work during grinding operation, means including a fluid operated mechanism for limiting the speed of the fluid motor which moves the wheel base during grinding operation, and means controlled by the said last-named fluid motor for speeding up rotation of the work after the grinding wheel base has reached a predetermined point in the wheel feeding movement, said last-named means comprising a valve operable at a predetermined time in the operation of said motor for admitting additional fluid to the said work drive motor to speed up rotation of the work, substantially as set forth.

9. In a machine for grinding the inside race of a ball bearing, a grinding wheel support, a grinding wheel mounted thereon, a motor for moving the grinding wheel support toward the work, means for supporting and means for rotating the work, a motor for regulating the speed with which the grinding wheel moves into work grinding position, a valve for controlling operation of the said regulating motor, a second valve having means thereon for locking it in open position to permit the motor for controlling movement of the grinding wheel into grinding position to operate at normal speed, and means for releasing said valve to allow it to move to a position to cause a slowing down of the said speed regulating motor and at the same time speed up the work drive means, substantially as set forth.

In witness whereof, we have hereunto set our hands at Waynesboro, Pennsylvania, this 20th day of May, A. D. nineteen hundred and thirty.

AMOS P. STEINER.
HAROLD E. BALSIGER.
EDGAR P. WINE.