Feb. 4, 1936. A. P. STEINER ET AL 2,029,510

HYDRAULIC BALL RACE GRINDER

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Fig 2

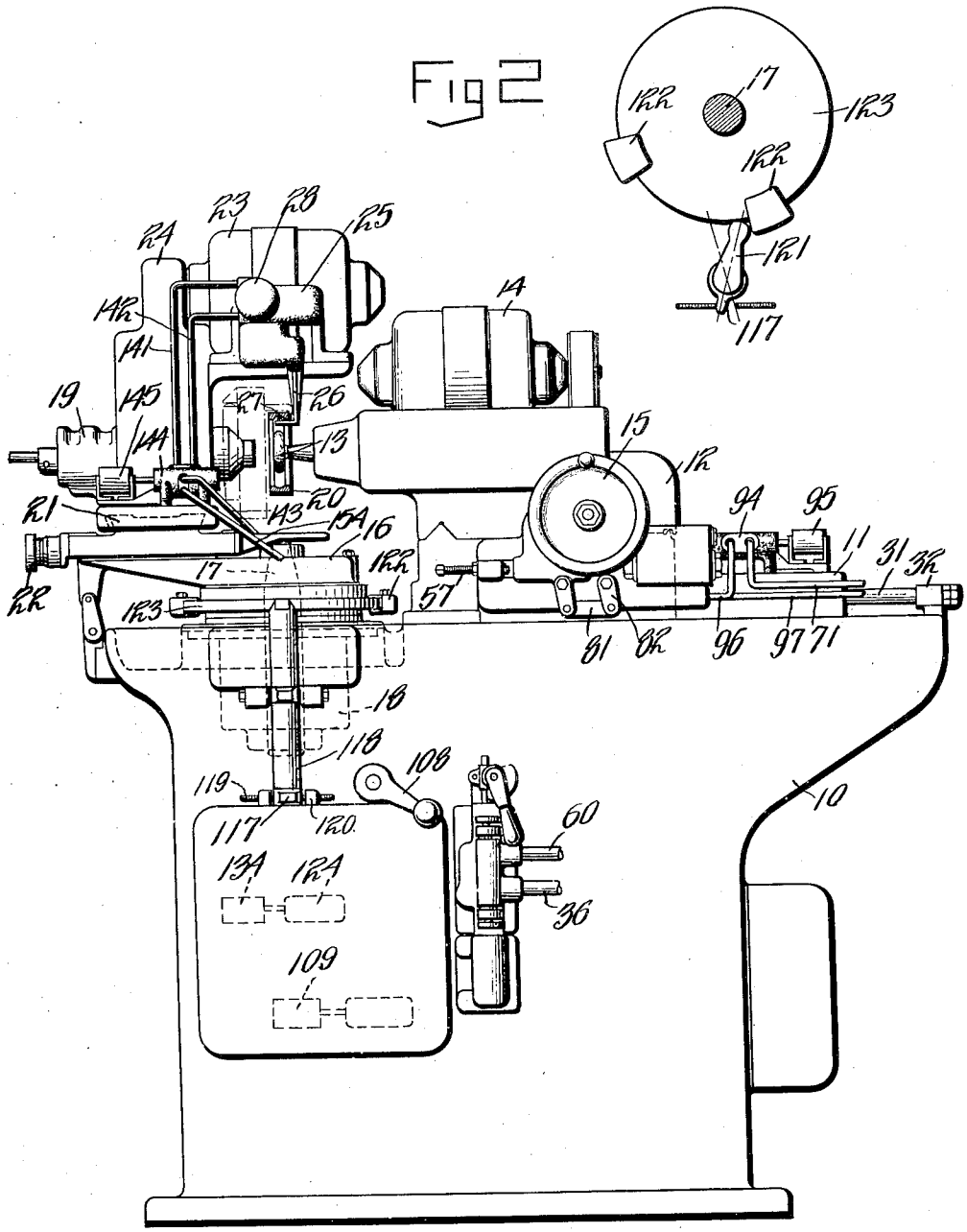


Fig 1

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HYDRAULIC BALL RACE GRINDER

Filed Aug. 30, 1929 6 Sheets-Sheet 2

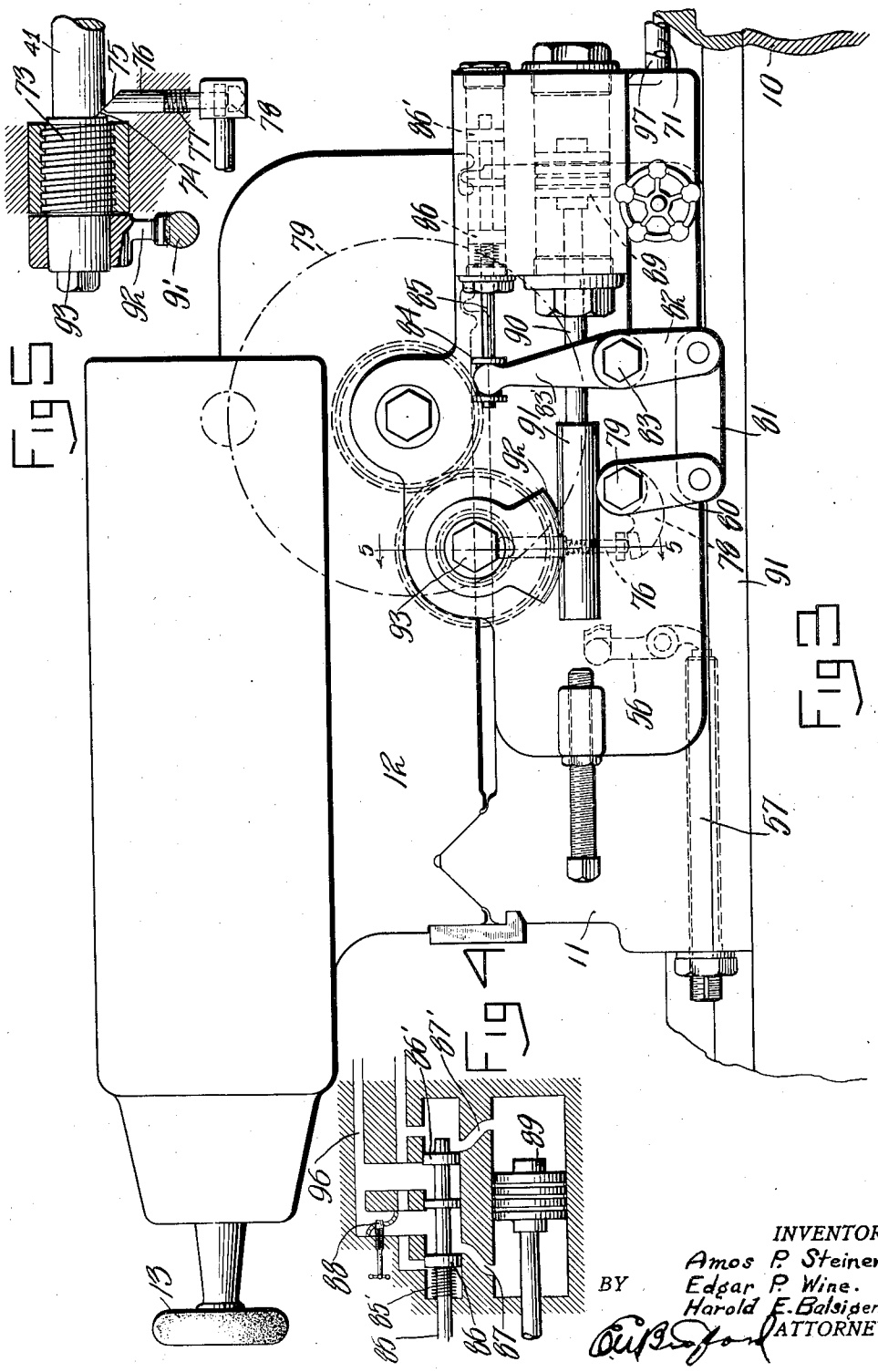


Fig 5

Fig 3

Fig 4

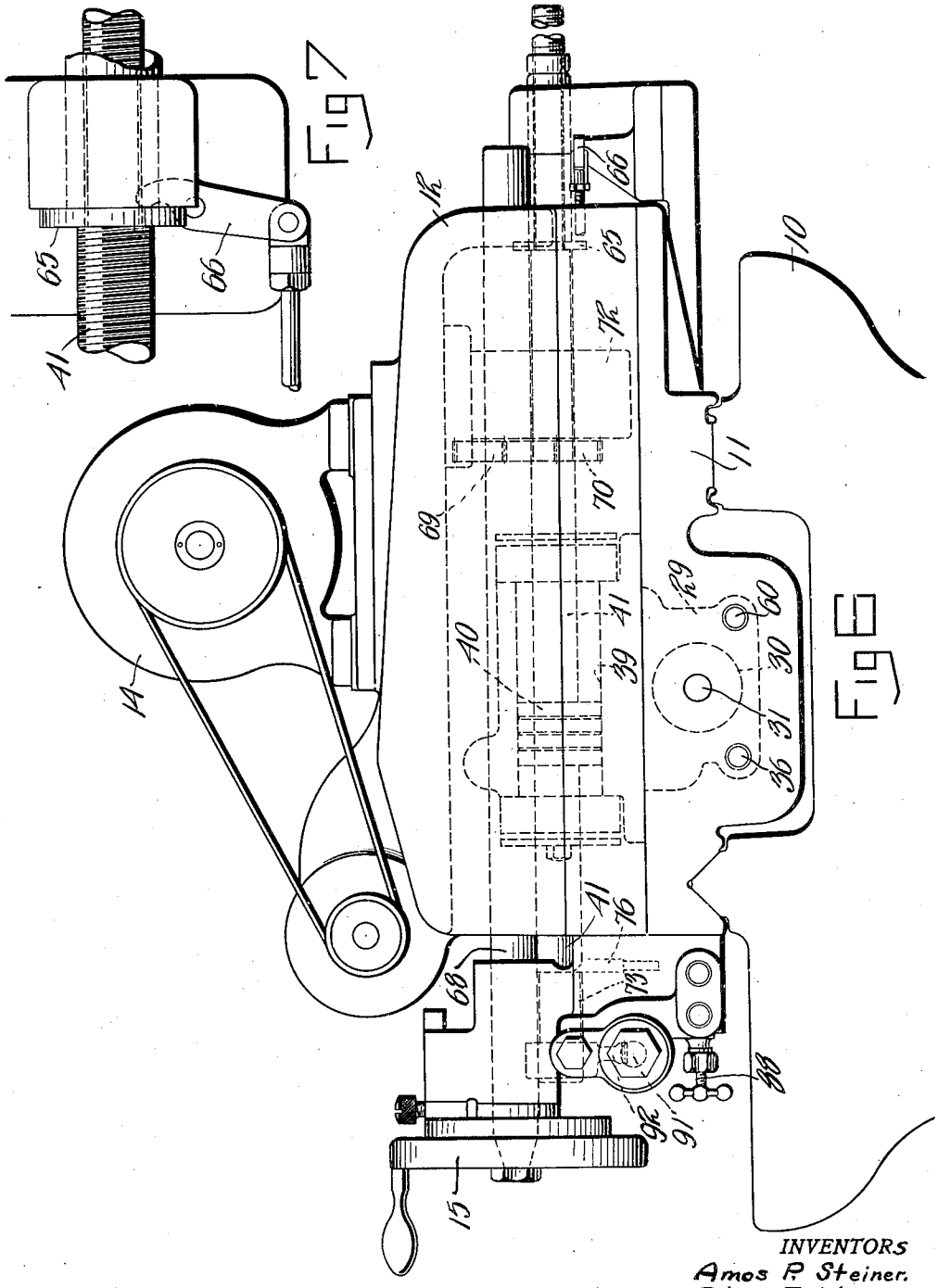
Fig 7

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HYDRAULIC BALL RACE GRINDER

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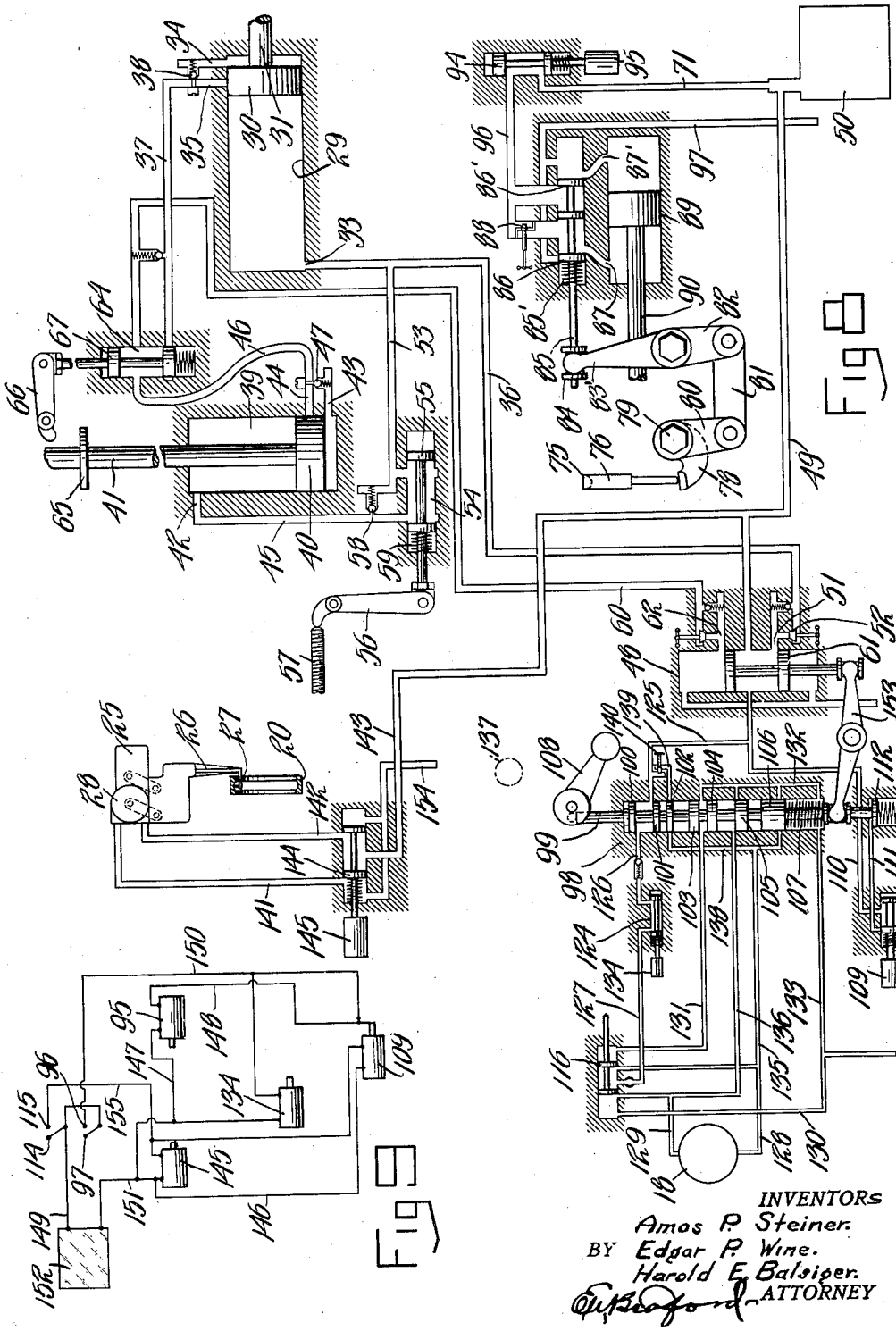
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HYDRAULIC BALL RACE GRINDER

Filed Aug. 30, 1929 6 Sheets-Sheet 4



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HYDRAULIC BALL RACE GRINDER

Filed Aug. 30, 1929 6 Sheets-Sheet 5

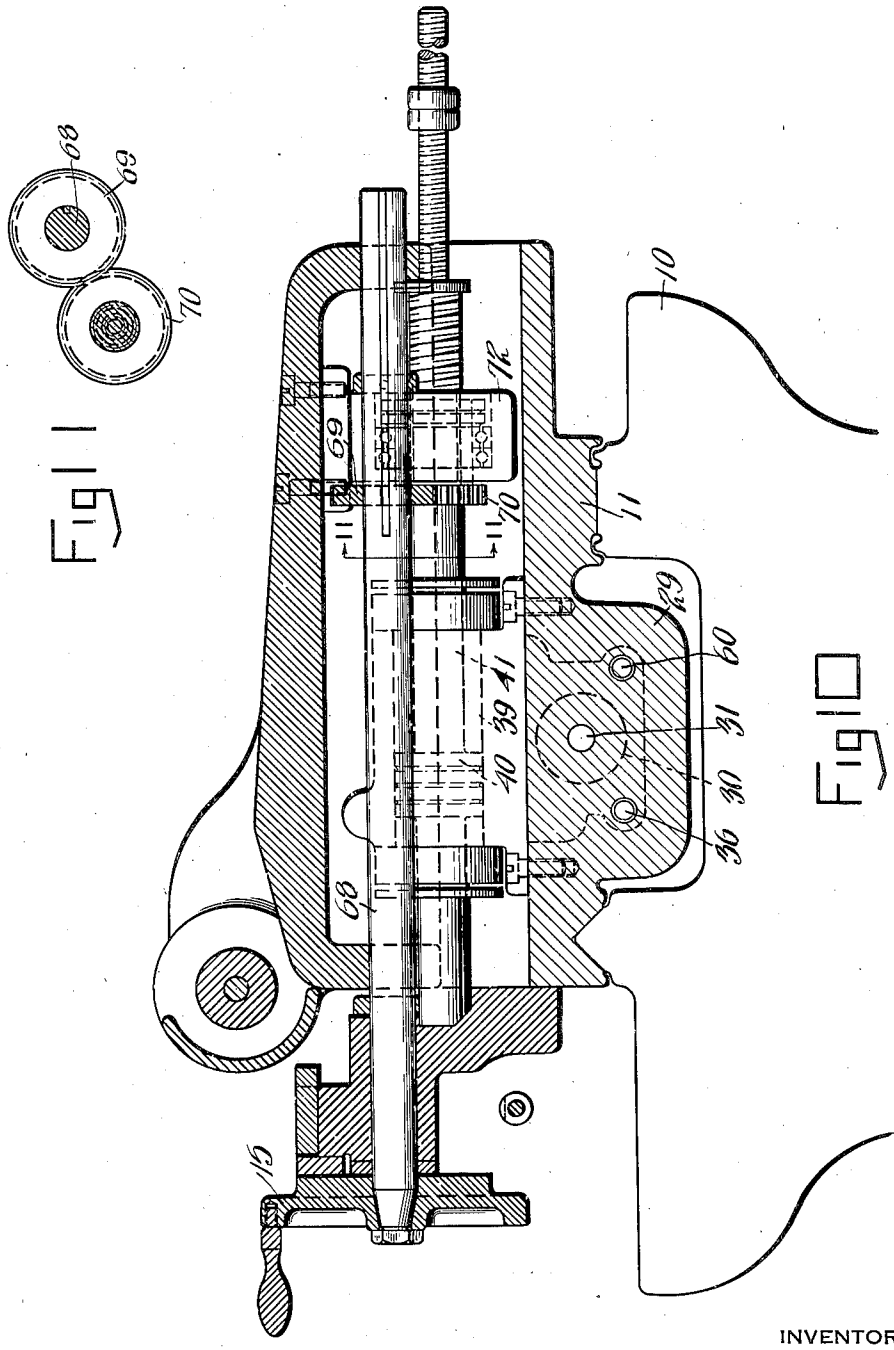


Fig. 11

Fig. 10

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HYDRAULIC BALL RACE GRINDER

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Fig. 12.

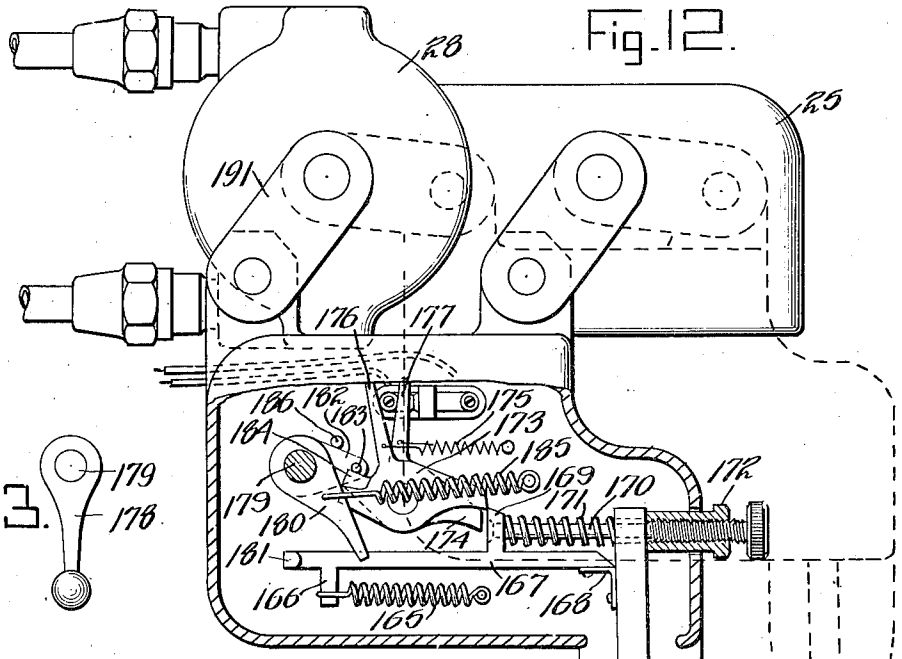


Fig. 13.

Fig. 14.

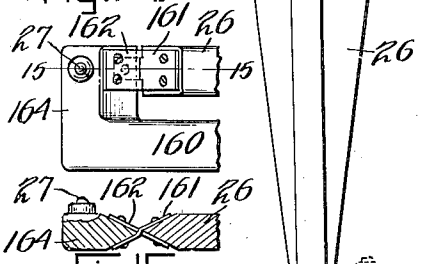


Fig. 15.

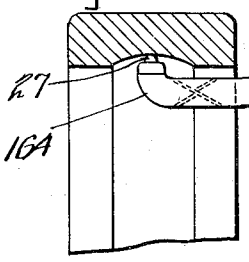
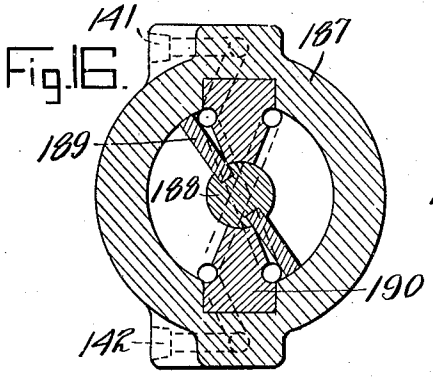


Fig. 16.



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UNITED STATES PATENT OFFICE

2,029,510

HYDRAULIC BALL RACE GRINDER

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Application August 30, 1929, Serial No. 389,492

22 Claims. (Cl. 51—97)

Our invention relates to semi-automatic hydraulically operated machines for grinding the bearing surfaces of ball races and is an improvement on our co-pending application Ser. No. 401,500 filed October 22, 1929 for Hydraulic ball race grinders.

Among the objects of the invention are to provide a simplified mechanism for operating the wheel base, to provide means to stop the grinding operation automatically when a piece of work has been ground to size and return the various mechanisms to inoperative position, to provide positive slow-down means for the wheel base, to provide control means and timing means for the various mechanisms and to provide a new and improved work sizing device.

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

Figure 1 is a front elevation of the machine,

Figure 2 is a plan view of a part of the work head oscillating mechanism,

Figure 3 a front elevation of the wheel base and automatic wheel feed mechanism,

Figure 4 is a sectional front elevation of the driving mechanism for the automatic wheel feed,

Figure 5 is a section on line 5—5 of Figure 3, showing the automatic feed screws and the valve shifting plunger,

Figure 6 is a right hand elevation of the wheel base and carriage,

Figure 7 is a plan view of the rear end of the wheel base feed showing a part of the wheel carriage control,

Figure 8 is a somewhat diagrammatic view in section showing the relation of the valves and fluid connections to the various mechanisms throughout the machine,

Figure 9 is a diagrammatic view of circuits and devices controlled by the sizing device,

Figure 10, a vertical section similar to Figure 6 to show in full lines the various relationships to each other of the piston rod, the carriage gears and shaft,

Figure 11, a section on line 11—11 of Figure 10,

Figure 12 is a view in elevation partly in section of the sizing device,

Figure 13, a detail view of a crank for resetting the sizing device,

Figure 14, a plan view of the lower end of the sizing device,

Figure 15, a section on line 15—15 of Figure 14, and

Figure 16, a section of the motor for operating the sizing device.

In the drawings reference character 10 indicates the bed of a grinding machine having a wheel carriage 11 mounted to move longitudinally of the bed. A wheel base 12 is mounted upon the carriage 11 to move transversely of the carriage, the wheel base carrying a grinding wheel 13 suitably mounted thereon which grinding wheel is driven by means of a motor 14. The wheel base 12 may be manually adjusted transversely of the carriage 11 by means of a hand wheel 15. A bracket 16 is mounted on the bed 10 so as to be oscillated about a shaft 17 by means of a motor 18. The bracket 16 carries a head stock 19 upon which the work 20 is carried. The head stock 19 may be adjusted transversely of the bracket 16 on a slide 21 and may be adjusted longitudinally of the bracket 16 by means of an adjusting screw 22. The head stock may be driven by means of a motor 23 through any suitable driving connection enclosed in a housing 24. The head stock also carries a sizing device 25 mounted thereon which sizing device comprises an arm 26 which carries a diamond 27 in its lower end which diamond is adapted to be positioned within the work to engage the work piece 20. The sizing device is movable into and out of operative positions by means of a motor 28. The sizing device is positioned and operated so as to require a minimum of space for its movement into and out of operative position. The sizing device 25 has a depending bracket 26 upon which is mounted a lever 160 which is pivoted at its lower end to a bent out portion of the bracket 26 by means of straps or hinges 161, 162, best shown in detail in Figures 14 and 15. A suitable contacting element 27 is seated in the bent end portion 164 of the lever 160. The upper end of the lever 160 is free to swing and is moved in a clockwise direction by means of a spring 165 which is attached to a lug 166 on an arm 167. The arm 167 is attached by means of a bracket 168 to the upper end of the lever 160. The upper side of the arm 167 has a lug 169 through which passes a bolt 170. A spring 171 surrounds the bolt and is confined between the lug 169 and the end of the lever 160. The side of the lever 160 opposite the spring has secured thereon a sleeve 172 through which the end of the bolt 170 is threaded. By means of the bolt 170 the angular position of the arm 167 with respect to the lever 160 may be adjusted. Triggers 173 and 174 are pivoted to the side of the casing of the sizing device 25 and their ends are adapted to engage the sharp edge of the upper portion of the lug 169. The triggers are each moved in a clockwise direction by means of springs 175. The triggers 173 and 174 carry arms 176 and 177 on their opposite ends. Means for resetting the triggers against the tension of the springs 175 consists of a crank 178 attached to the outer end of a shaft 179. The shaft carries an arm 180 which is adapted to engage a lug 181 on the end of the arm 167 to swing the lever 160 counterclockwise. The shaft also carries a short arm 182 having a pin 183 which engages lugs 184 on

the triggers 173 and 174 to move the triggers counterclockwise to reset the sizing device. The arm 180 is rotated in a counterclockwise direction by means of a spring 185. A pin 186 limits the action of the spring 185. Arm 177 serves to close contacts 96 and 97 and arm 176 controls contacts 114 and 115 shown in Figure 9. No novelty resides in the switch and hence they are not shown as any suitable make and break switch may be used. The motor 28 is of the oscillating type and consists of a casing 187 having a shaft 188 mounted therein with blades 189 mounted on the shaft. The opposite chambers of the motor are divided by partition walls 190. Pressure fluid lines 141 and 142 are connected to the motor chambers. The outer end of the shaft 188 has attached thereto a link 191 which is attached at its other end to the housing of the sizing device.

In operation the sizing device is moved to position the feeler in contact with the work which is to be ground. The triggers 173 and 174 are positioned so that they rest upon the top of the lug 169. When the work has been reduced nearly to finished size and the contacting element 27 moves in, it permits the lever 160 to be rotated in a clockwise direction until the trigger 174 drops off the lug 169. This closes contacts 96 and 97. When the work has been reduced to finished size the lever 160 moves to permit trigger 173 to drop off lug 169 so that contacts 114 and 115 are brought together. The sizing device controls a number of mechanisms including means for slowing down the rate of oscillation of the work head as the grinding nears the finished size, stops oscillation of the work when it is ground to size, stops the automatic feeding of the grinding wheel toward the work, removes the sizing device from the work, and returns the wheel base and the carriage to inoperative position, all of which mechanisms will be later described more in detail.

The wheel base and wheel carriage mechanism

The means for feeding the carriage longitudinally of the bed of the machine and for moving the wheel base transversely to move the grinding wheel into and out of grinding position will now be described. The means for moving the carriage longitudinally of the bed of the machine comprises a cylinder 29 formed within the carriage 11 and having a piston 30 movable therein to which piston is attached a piston rod 31 which is secured to a bracket 32 on the bed of the machine. It will be seen therefore that the cylinder moves and that the piston remains stationary, being fixed to the bed of the machine. The cylinder 29 has a fluid port 33 at one end and port 34 at the other end, and a port 35 spaced from the port 34. Fluid lines 36 and 37 are connected to the port 33 and ports 34 and 35 respectively. The ports 34 and 35 are connected through a spring pressed check valve 38, the valve being provided with a restricted opening to permit fluid to flow freely into the cylinder 29 through port 34 but to restrict its flow out of the cylinder through port 34, the purpose of which is to slow down movement of the wheel carriage after the piston has closed off the port 35. The wheel carriage 11 is chambered also to provide a cylinder 39 in which a piston 40 operates. A piston rod 41 connects the piston to a bracket 72 on the wheel base 12. Fluid port 42 at one end of the cylinder and ports 43 and 44 at the other end of the cylinder provide for the passage of fluid to and from the cylinder. A fluid line 45 is connected to port 42 and a fluid line 46 to ports 43 and 44. An adjustable check valve 47 controls passage of fluid from port 43 to line 46, this valve being spring pressed to permit fluid to freely flow into the line 43 and to restrict its flow from the port 43 to line 46 as was described with respect to ports 34 and 35.

In order to bring the grinding wheel into position it is necessary first to move the wheel base back so that the grinding wheel 13 may enter the work piece and then to move the wheel carriage axially of the work to position the grinding wheel within the work. This is accomplished by using a common direction valve 48, which, as shown in Fig. 8, is in positon to admit fluid from pump 50 through line 49, valve chamber 48 and out through port 51, needle valve 52 through line 36 to cylinder 29 and through branch 53, valve chamber 54 and line 45 to port 42 in cylinder 39. In order that the grinding wheel may be positioned within the work before the wheel base moves the grinding wheel to grinding position in contact with the work passage through valve chamber 54 is delayed. This is accomplished by a valve 55 which is operated by a lever 56, one end of which comes into engagement with an abutment 57 on the bed of the machine as the grinding wheel reaches almost the end of its travel axially into the work to open communication between line 53 and 45. A spring pressed check valve 58 permits return of fluid freely through line 45 to line 53. As previously described the wheel carriage will move longitudinally of the bed until it nears the end of its travel at which time piston 30 will close off port 35 whereby travel of the carriage is slowed down due to the restriction at 38 which permits fluid to pass slowly from port 34 into the line 37. The wheel base likewise moves radially until it nears grinding position at which its movement is checked by the check valve 47 to permit slow travel of the wheel base to grinding position.

The valve 55 is biased toward position to close off the line 53 and 45 by means of a spring 59. To return the carriage and wheel base to inoperative position valve 61 is shifted by mechanism later to be described so that pressure fluid is directed through the line 60. Fluid then passes from line 49 through valve chamber 48 out through the port 62 to the line 60. Fluid passes from the line 60 through the valve chamber 64 and line 46, check valve 47 and port 43 below the piston 40 to move the wheel base to the rear and this movement will be gradual at first until the piston 40 passes port 44 at which time fluid may enter the cylinder 39 through the port 44 to freely move the wheel base to the rear. The piston rod 41 has a collar 65 which strikes a lever 66 as the carriage nears its retracted position to shift a valve 67 to admit fluid from the line 60 through the valve chamber 64 directly to the line 37. This will freely admit fluid to the right of the piston 30 at first slowly through port 34 until port 35 is opened and then freely to retract the wheel carriage rapidly to the right.

The wheel feed mechanism consists of manual and automatic means for feeding the wheel into the work. The manual feed consists of the hand wheel 15 mounted on a shaft 68. A gear 69 is mounted inside the wheel base on the shaft and is keyed to the shaft so as to slide axially of the shaft. The gear 69 meshes with a gear 70 on the piston rod 41 which is screw-threaded at its outer end. The piston rod 41 is threaded through a bracket 72 depending from the wheel base 12.

Rotation of the shaft 68 causes screw shaft 41 to rotate and move the bracket 72 and hence move the wheel base 12 transversely of the carriage 11. The automatic wheel feed consists of the wheel base cylinder 39 and the piston rod 41 which have been described above and which furnish the motive power for operating the wheel base.

The wheel base 12 moves forward rapidly under hydraulic pressure until the slow-down mechanism previously described catches it and a front extension of the piston rod 41 strikes a lead screw 73. The front end of the rod 41 has an inclined surface 74 which engages a corresponding inclined surface 75 on a plunger 76 and depresses the plunger against the action of a compression spring 77. The lower end of the plunger engages an arm 78 which acts through shaft 79 to rotate an arm 80. By means of a link 81 the arm 80 rocks a lever 82 secured to a shaft 83. To the other end of the shaft is secured a lever 83' which engages a spool 84 on a valve stem 85. The valve stem 85 has valve disks 86 and 86' in a valve chamber and a spring 85' is biased to hold the valves in closed position. By means of the lever 82 the valve is shifted against the tension of the spring to admit pressure fluid through the port 87 to move a piston 89 to the right. Pressure fluid entering this side of the piston is controlled by an adjustable needle valve 88. The piston 89 has a piston rod 90 to the outer end of which is attached a bar 91 having rack teeth on its upper side. These teeth mesh with a gear segment 92 which is mounted on the end of the lead screw 73. When the piston 89 moves from left to right the lead screw 73 is rotated to allow the wheel base to move forward. The speed of feed is determined by adjustment of the needle valve 88. Pressure fluid is supplied to the valve 86 from pump 50 through a line 71 and a starting and stopping valve 94 which is controlled by a solenoid 95. When the solenoid 95 is energized by movement of the sizing device which closes contacts 96 and 97 the port 96 is closed by the valve disk 94. By mechanism above described contacts 96 and 97 are brought together by the sizing device just shortly before the work is reduced to its finished size. When the wheel base 12 is retracted on completion of the work the plunger 76 is released and the spring 85' shifts valve 86 to the position to return the piston 89 and the lead screw 73 to the starting position. As shown in Figure 4 the supply of pressure fluid through port 87' is not restricted when directed to this side of the piston 89. When the valve 86' is shifted to open ports 87' to pressure fluid line 96 the screw 73 is quickly rotated to starting position. 97 indicates an exhaust line to a reservoir in the bed of the machine.

The valve for controlling oscillation of the head stock is shown in diagrammatic form as a whole at 98. This valve consists of a piston rod 99 having valve disks 100, 101, 102, 103, 104, 105 and 106 spaced along it. A compression spring 107 in the bottom of the valve casing presses against the lower side of the disk 106 to hold the valve disks normally in their elevated position. The disks may be manually moved in the valve chamber by means of a lever 108, or they may be moved down automatically by means of a solenoid 109. The solenoid 109 controls fluid passages 110 and 111 which admit pressure fluid above the piston 112 to move the valve 99 down against the tension of compression spring 107. The disks are moved down when solenoid 109 is energized upon closing of contacts 114, 115. These contacts are closed by suitable mechanism in the sizing device after the work has been reduced to correct size. The control valve just described controls the operation of the motor 18 which oscillates the bracket upon which the head stock is mounted. Oscillation of the motor is taken care of by a reversing valve 116. This valve is operated by means of an arm 117 on a shaft 118, the arm operating between screws 119 adjustably threaded through lugs 120 on the outer end of the valve stem 116. The shaft 118 has an arm 121 on its upper end which is engaged by dogs 122 on a ring 123 secured to and surrounding the oscillating frame 16. When the frame is oscillated the shaft 118 is rocked to reciprocate the piston 116 to open fluid ports to opposite sides of the motor 18. When the valve 99 and the valve 116 are in the positions shown in Fig. 8 pressure fluid may pass from the source of pressure 49 through the valve 48 through line 125 to the valve chamber out through line 126 through valve 124, line 127 to the valve chamber, in the valve 116 and out through line 128 to the oscillating motor 18. Exhaust fluid may pass from the motor through line 129, valve chamber of valve 116 and out through exhaust line 130 to a reservoir in the base of the machine. The oscillating motor will be caused to make one stroke at the end of which valve 116 will be shifted to the left to allow pressure fluid from the line 127 to pass through the valve chamber to line 129 to the motor 18, and exhaust from the motor 18 through the line 128, valve 116, line 131 through the valve chamber in valve 98 to the line 132 and to the exhaust line 133. Shifting of the valve 116 will therefore reverse the stroke of the oscillating motor to cause continuous oscillation of the bracket 16 carrying the head stock on which the work is supported. When the work nears completion and contacts 96, 97 are brought together by the sizing device, the solenoid 134 is energized to move the valve stem in valve chamber 124 to restrict the flow of fluid from the line 126 to line 127 to cause the oscillating motor to slow down. When the work has been finished contacts 114 and 115 are brought together to energize solenoid 109 to open communication between ports 110 and 111 to admit pressure fluid above piston 112 to pull down valve stem 99 to close off communication between pressure fluid line 125 and line 126 but to open exhaust lines 135 and 136 to line 132 so that both sides of the oscillating motor 18 are open to the exhaust line so that the head stock may be freely manually moved. The valve stem 99, of course, may be manually operated by lever 108 instead of by the solenoid 109, as just described.

The operator may lift the lever 108 to an intermediate position shown in dotted circle 137. When in this position valve disk 100 closes off pressure line 126 so as to stop oscillation of the motor 18. Valve disk 102 moves down to open communication between pressure line 125 and line 138 through line 139 and needle valve 140. Pressure fluid then passes through line 125 to the motor 18 to move it to a position to swing the work toward the front of the machine when it may be easily removed. When the valve stem is moved to this position disk 106 closes communication between line 138 and 132. Valve stem 99 is connected to valve 61 by a pivoted lever 153 so that depressing the valve stem 99 moves disk 61 to close port 51 and open port 62.

The sizing device itself is operated by a fluid motor **28** supplied by fluid lines **141** and **142**. Admission of pressure fluid from line **143** is controlled by a valve **144**. This valve is operated by a solenoid **145**. When the solenoid is energized the valve is opened to admit fluid to the motor **28** to swing the sizing device free from the work. The solenoid is in circuit with contacts **114** and **115** which are closed when the work is reduced to finished size. Line **154** is an exhaust to a fluid reservoir in the base of the machine.

The operation of the device is as follows: Assume the parts to be in position in which they are shown diagrammatically in Fig. 8, in this position the grinding wheel is within the work and is in working position to grind the work and the sizing device is positioned within the work. As the stock is removed within the work the sizing device follows it until the work is nearly finished to size, at which time mechanism within the sizing device closes contacts **96** and **97**. This closes circuit through lines **149**, **150**, **148**, solenoid **95**, lines **147**, and **151** to close circuit with the battery **152**. This first energizes solenoid **95** to move the valve **94** to close fluid line **96** to cut off fluid to the motor **89**. This stops movement of the wheel base toward the work and at the same time solenoid **134** is energized to move the valve **124** to restrict the flow of fluid through the line **127** to slow down the oscillating motor **18**. The machine continues to grind until the work is reduced to its finished size at which time contacts **114** and **115** are brought together to energize solenoid **109**. This opens communication between pressure fluid lines **110** and **111** to admit pressure fluid above piston **112** to move the valve stem **99** against the tension of the spring **107**. This causes valve disk **100** to shut off fluid line **126** to stop oscillation of the motor **18**. Fluid, however, may exhaust from the motor so that it may be freely manually moved. As the valve stem **99** is drawn down lever **153** is rocked on its pivot to move the valve **61** forward of its position as shown in Fig. 8 to close communication between fluid line **49** and port **51** and to open communication with port **62**. Pressure fluid then first flows through line **60** to valve **64**, line **46**, check valve **47** and port **43** to the rear of the piston **40** to withdraw the wheel base to move the grinding wheel out of contact with the work. As soon as the piston **40** has cleared port **44** fluid freely flows through this port to quickly withdraw the wheel base. After the wheel base has reached its rear position the dick **65** rocks the lever **66** to shift valve **67** to open communication between lines **60** and **37**. This delivers pressure fluid through check valve **38** into port **34** at the right of piston **30** to begin slow movement of the wheel carriage to the right. As soon as the carriage has moved far enough to clear the port **35** pressure fluid is rapidly delivered to the cylinder **29** and the wheel carriage is rapidly withdrawn to the rear.

As the wheel base begins its withdrawal movement the tapered edge **74** on the piston **41** allows the plunger **75** to be moved forward by the spring **77**. This allows the rockarm **78** to move up to shift valve **86** to close port **87'** to allow pressure fluid to enter to the right of the piston to shift the abutting screw **73** to position it in the path of the wheel carriage for the next grinding operation. As the work reached its finished size closing contacts **114** and **115** also closed a circuit through line **155**, solenoid **145**, line **151** to energize this solenoid to cause it to operate valve **144** to admit pressure fluid from the line **143** to the line **141** to the motor **28**, to move the sizing device out of contact with the work.

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 ball races comprising a bed, a work carrier mounted to oscillate on said bed, a wheel carriage slidably mounted for longitudinal movement on said bed, a wheel base slidably mounted for transverse movement on said carriage, a grinding wheel rotatably mounted on said wheel base, a source of pressure fluid, fluid pressure means to move said carriage and said wheel base rapidly into grinding position, and positive acting means to slow the wheel base down to grinding speed, substantially as set forth.

2. A grinding machine comprising a bed, a wheel carriage mounted on said bed, a wheel base mounted on said wheel carriage, a fluid motor to move said wheel carriage longitudinally of the base, a second fluid motor to move said wheel base transversely of the wheel carriage, and interconnected means controlling operation of said motors, said means causing operation of the first-named motor to move said wheel base forward to grinding position and then to operate said second motor to move the grinding wheel to contact with the work and pressure fluid operated means for determining the speed with which the grinding wheel is fed into the work by the said second motor, substantially as set forth.

3. A grinding machine comprising a bed, a wheel carriage mounted on said bed, a wheel base mounted on said wheel carriage, a fluid motor to move said wheel carriage longitudinally of the base, a second fluid motor to move said wheel base transversely of the wheel carriage pressure fluid means for controlling the speed with which the second fluid motor moves the wheel base during grinding of the work, interconnected means controlling operation of said motors, said means operating to withdraw the grinding wheel from contact with the work and then to operate the second fluid motor to withdraw the grinding wheel out of grinding position with the work, substantially as set forth.

4. A grinding machine comprising a bed, a work carrier mounted to oscillate upon the bed, a grinding wheel base, a grinding wheel rotatably mounted in the base, a sizing device mounted on the work carrier and having means adapted to move it to engage the surface of the work, and a circuit controlled by said sizing device adapted when closed to stop feeding movement of the grinding wheel toward the work and to reduce the rate of oscillation of the work head at a predetermined point in the grinding operation, substantially as set forth.

5. A grinding wheel comprising a bed, a work carrier mounted on said bed, means for oscillating the work carrier, a grinding wheel base, a grinding wheel mounted in the base, a sizing device mounted on the work carrier and adapted to engage the surface of the work, a circuit in said sizing device adapted to be closed by the sizing

device when the feeding movement of the grinding wheel reaches a predetermined point, the said circuit controlling means to reduce the rate of oscillation of the work head, and a second circuit in said sizing device adapted to be closed by the sizing device at the completion of the work, this circuit controlling means to stop oscillation of the work carrier and rotation of the work and to move the grinding wheel to inoperative position, substantially as set forth.

6. A grinding machine comprising a bed, a work carrier mounted upon said bed, means for oscillating the work carrier, a grinding wheel support, a grinding wheel rotatably mounted on the support, a sizing device mounted on the work carrier and adapted to close a circuit to stop feeding movement of the grinding wheel and reduce the rate of oscillation of the work at a predetermined point in the grinding operation, and means controlled by said sizing device for stopping feeding movement of the grinding wheel and oscillation of the work, and means for stopping oscillation of the work carrier at a position in which the work may be freely accessible when the oscillating means is stopped, substantially as set forth.

7. A grinding machine comprising a bed, a work support and a grinding wheel support, the grinding wheel support comprising a carriage movable longitudinally of the bed and a wheel base movable transversely of the bed, hydraulically operated means for moving the wheel carriage toward the work and the wheel base to a grinding position, means for timing operation of the said hydraulic means whereby in moving into operative position the wheel carriage will first move approximately to the limit of its travel and then the wheel feed will be moved to position the grinding wheel in grinding position and a hydraulically operated abutment for controlling the rate of feed of said wheel into said work, substantially as set forth.

8. A ball race grinder comprising a bed, a work support, means for oscillating the work support, a grinding wheel support, the grinding wheel support comprising a carriage movable longitudinally of the bed, means for moving the carriage comprising a cylinder in said carriage and having a piston rod movable in said cylinder and secured to the said bed, a second cylinder in said carriage having a piston rod secured to the said wheel base, and a valve controlling motive fluid to the said cylinders, means associated with said cylinders for delivering fluid first to move the carriage forward to position the grinding wheel within the work and then to move the wheel base forward to position the grinding wheel in contact with the work, substantially as set forth.

9. A ball race grinding machine comprising a bed, a work support, means for oscillating the work support, a grinding wheel support, the grinding wheel support comprising a carriage movable longitudinally of the bed and a wheel base movable transversely of the bed, means for moving the carriage comprising a cylinder in said carriage having a piston rod movable therein and secured to the said bed, means for moving the wheel base comprising a cylinder in the said wheel carriage having a piston rod movable therein and secured to the said wheel base, pressure fluid lines to the said cylinders, a valve for controlling flow of fluid through said lines, restricted valves in said lines arranged so as to deliver fluid to withdraw the wheel base to move the grinding wheel out of contact with the work and then to move the wheel carriage to withdraw the grinding wheel out of the work, substantially as set forth.

10. A ball race grinding machine comprising a bed, a work support, means for oscillating the work support, a grinding wheel support, the grinding wheel support comprising a carriage movable longitudinally of the bed and a wheel base movable transversely of the bed, means for moving the carriage comprising a cylinder in said carriage having a piston rod movable therein and secured to the said bed, means for moving the wheel base comprising a cylinder in the said wheel carriage having a piston rod movable therein and secured to the said wheel base, pressure fluid lines to the said cylinders, a valve for controlling flow of fluid through said lines, restricted valves in said lines arranged so as to deliver fluid to withdraw the wheel base to move the grinding wheel out of contact with the work and then to move the wheel carriage to withdraw the grinding wheel out of the work, and a sizing device controlling operation of said valve to withdraw the grinding wheel from the work when the work has been reduced in size, substantially as set forth.

11. A grinding machine comprising a bed, a work holding element, a grinding element, a carriage mounted for longitudinal movement on said bed, a base, supporting one of said elements and mounted for movement on said carriage, a fluid pressure motor adapted to move said carriage longitudinally of said bed, a fluid pressure motor adapted to move said base transversely of said carriage and interconnected means controlling the operation of said motors, said means causing operation of said first motor to move said carriage forward to telescoping relationship of the grinding element and the work and then to cause said second motor to move said base transversely of said carriage to bring the grinding element and the work into contacting relationship and additional pressure fluid means for controlling the transverse movement of said base as the grinding element contacts with the work.

12. A grinding machine comprising a bed, a work support and a grinding wheel support, one of said supports comprising a carriage movable longitudinally of the bed and a base movable transversely of the bed, hydraulically operated means for moving the carriage toward the other support and the base to a grinding position, means for timing operation of the said hydraulic means whereby in moving into operative position the carriage will first move approximately to the limit of its travel and then the base will be moved to grinding position and a hydraulically operated abutment for controlling the rate of feed of said base for the grinding action, substantially as set forth.

13. A grinding machine including a bed, a grinding wheel unit, a work holding unit supported by the bed in substantial alignment with the axis of the grinding wheel, hydraulic means for shifting one of said units in the direction of the grinding wheel axis for presentation of a work piece in circumscribing relation to the grinding wheel, additional hydraulic means for shifting said unit in a direction at right angles to the direction of said first movement for effecting the grinding contact of the wheel and the work piece, a grinding determinator, and means controlled by movement of the determinator for reversing the aforesaid movements of said units.

14. A grinding machine comprising a bed, a work holding element, a grinding element, a carriage mounted for longitudinal movement on said bed, a base supporting one of said elements and mounted for movement on said carriage, a fluid pressure motor adapted to move said carriage longitudinally of said bed, a fluid pressure motor adapted to move said base transversely of said carriage and interconnected means controlling the operation of said motors, said means causing operation of said first motor to move said carriage forward to telescoping relationship of the grinding element and the work and then to cause said second motor to move said base transversely of said carriage to bring the grinding element and the work into contacting relationship, and additional pressure fluid means for controlling the transverse movement of said base as the grinding element contacts with the work.

15. A grinding machine comprising a bed, a work holding element, a grinding element, a carriage mounted for longitudinal movement on said bed, a base supporting one of said elements and mounted for movement on said carriage, a fluid pressure motor adapted to move said carriage longitudinally of said bed, a fluid pressure motor adapted to move said base transversely of said carriage and interconnected means controlling the operation of said motors, said means causing operation of said first motor to move said carriage forward to telescoping relationship of the grinding element and the work and then to cause said second motor to move said base transversely of said carriage to bring the grinding element and the work into contacting relationship, and hydraulically operated means for controlling cross feed movement.

16. A grinding machine comprising a bed, a work holding element, a grinding element, a carriage mounted for longitudinal movement on said bed, a base supporting one of said elements and mounted for movement on said carriage, a fluid pressure motor adapted to move said carriage longitudinally of said bed, a fluid pressure motor adapted to move said base transversely of said carriage and means controlling the operation of said motors, said means causing operation of said first motor to move said carriage in one direction and then to cause said motor to move said base in another direction at right angles to the first movement to bring the grinding element and the work into contacting relationship, and fluid operating means for controlling further transverse movement of said base.

17. A grinding machine comprising a bed, a work holding element, a carriage mounted for longitudinal movement on said bed, a base mounted for movement on said carriage, a grinding element mounted on said base, a fluid motor for moving said carriage longitudinally of said bed, a fluid motor for moving said base transversely of said carriage, interconnected means controlling the operation of said motors, said means causing operation of said first motor to move said carriage forward to move the grinding element within the work and then to cause said second motor to move said base transversely of said carriage to bring the grinding element into grinding contact with the work, and pressure fluid means for controlling the feeding movement of the grinding element into the work.

18. A grinding machine comprising a bed, a work holding element, a grinding element, a carriage mounted for longitudinal movement on said bed, a base supporting one of said elements and mounted for movement on said carriage, a fluid pressure motor adapted to move said carriage in both directions longitudinally of said bed, a fluid pressure motor adapted to move said base in both directions transversely of said carriage and interconnected means controlling the operation of said motors, said means causing operation of said first motor to move said carriage forward to telescoping relationship of the grinding element and the work and then to cause said second motor to move said base transversely of said carriage to bring the grinding element and the work into contacting relationship.

19. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby for movement relative thereto, a work support mounted on the bed, a pair of hydraulically actuable pistons for movement at right angles to one another, means for stopping the movement of the grinding wheel toward the work support, and means connecting one of the pistons with the grinding wheel for effecting the movement thereof and the other of the pistons with the stopping means for effecting its actuation.

20. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby for movement relative thereto, a work support mounted on the bed, a pair of hydraulically actuable pistons for movement at right angles to one another, means for stopping the movement of the grinding wheel toward the work support, means connecting one of the pistons with the grinding wheel for effecting the movement thereof and the other of the pistons with the stopping means for effecting its actuation, and a common hydraulic mechanism for actuating the pistons including a pressure source and conduits from the pressure source to the pistons.

21. In a grinding machine, the combination of a bed, a grinding wheel support, a grinding wheel mounted thereon for rotation, fluid pressure means for moving said grinding wheel support rapidly transversely of said bed to position the grinding wheel for grinding, means for controlling the movement of the wheel support for producing a slow continuing grinding feed including a screw, fluid pressure operated means for rotating said screw, and means operated by said first-named fluid pressure means for initiating the operation of said last-named fluid pressure means when said feed wheel is positioned for grinding.

22. In a grinding machine, the combination of a bed, a grinding wheel support, a grinding wheel mounted thereon for rotation, fluid pressure means for moving said grinding wheel support rapidly transversely of said bed to position the grinding wheel for grinding, means for controlling the movement of the wheel support for producing a slow continuing grinding feed of the wheel support in the same transverse direction, including a screw, fluid pressure operated means for rotating said screw, and automatic means for initiating the operation of said last-named fluid pressure means when said grinding wheel is positioned for grinding.

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