May 21, 1940. H. E. BALSIGER ET AL 2,201,218

MACHINE FOR GRINDING NONCIRCULAR WORK

Filed Oct. 22, 1935 7 Sheets-Sheet 1

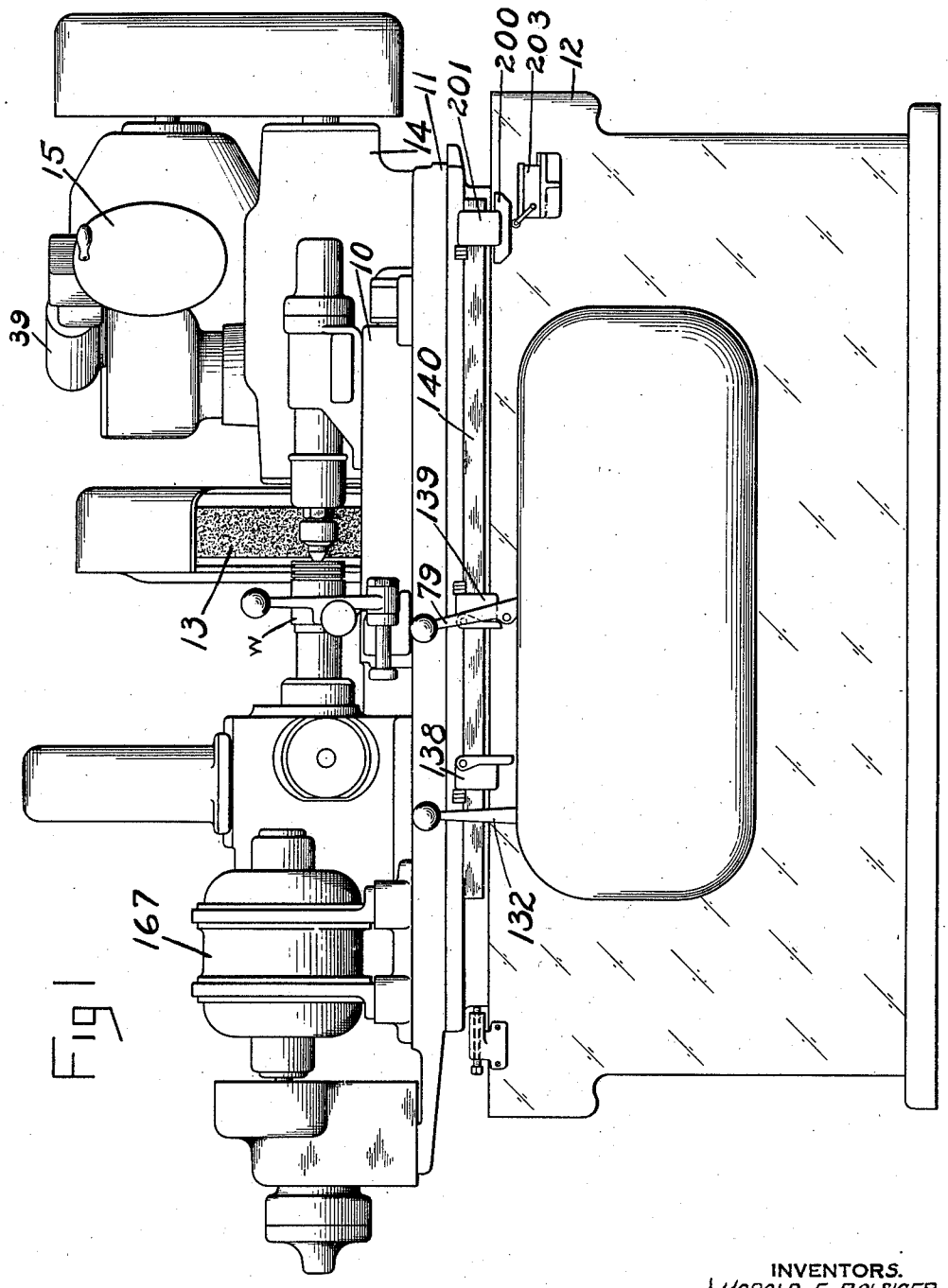

Fig 1

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MACHINE FOR GRINDING NONCIRCULAR WORK

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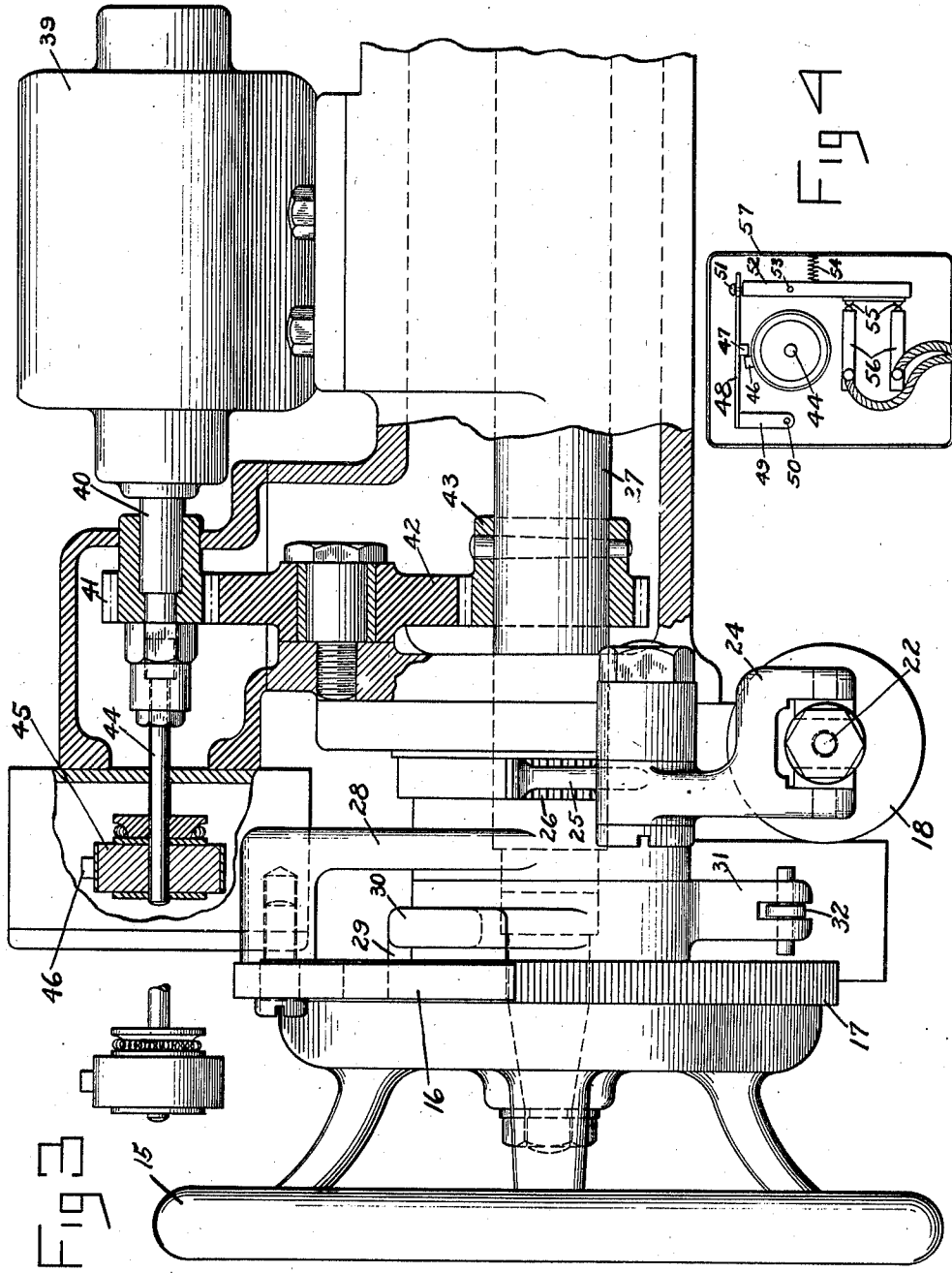

Fig 4

Fig 3

Fig 2

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MACHINE FOR GRINDING NONCIRCULAR WORK

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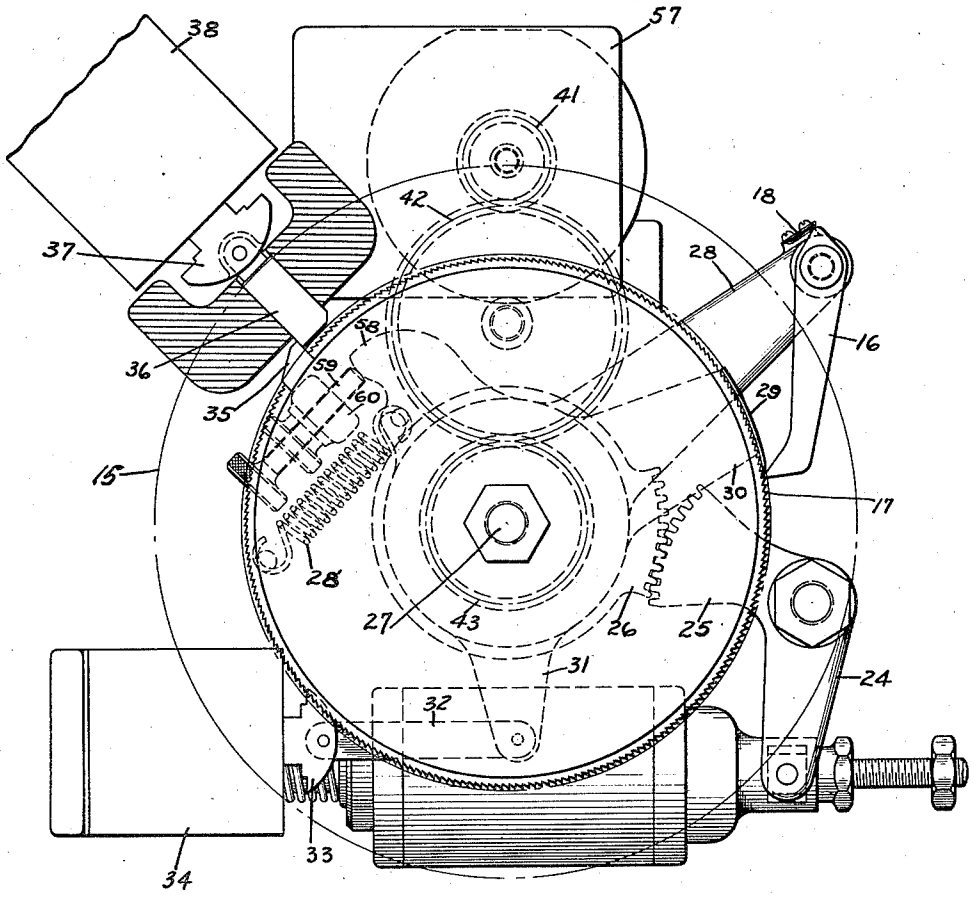

Fig 5

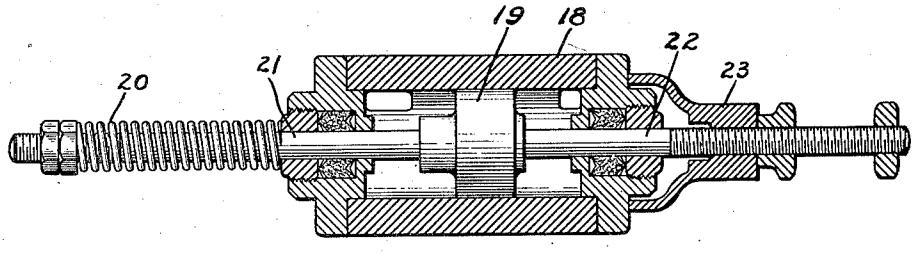

Fig 6

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MACHINE FOR GRINDING NONCIRCULAR WORK

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Fig. 7

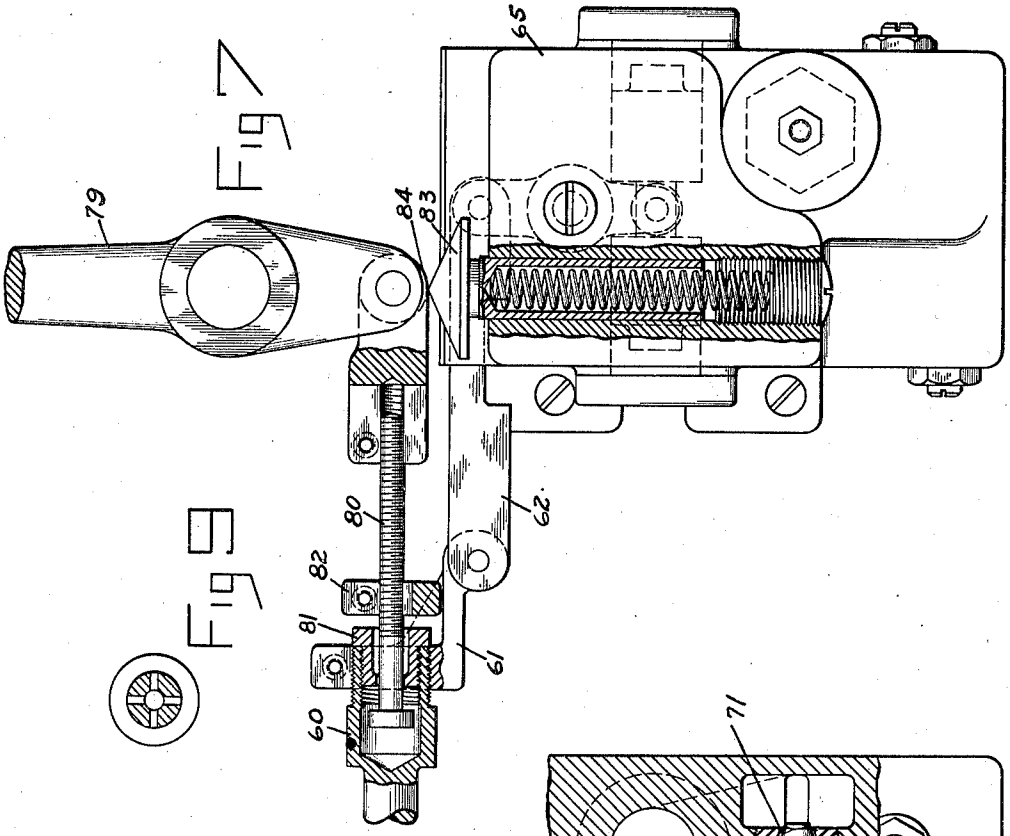


Fig. 8

Fig. 9

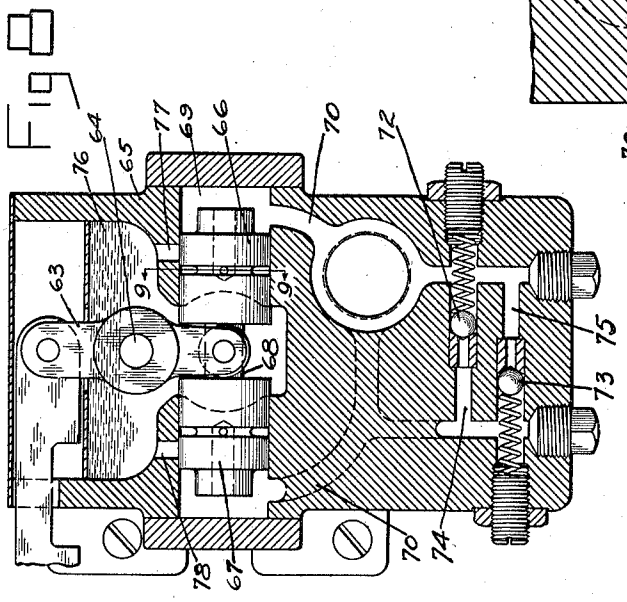
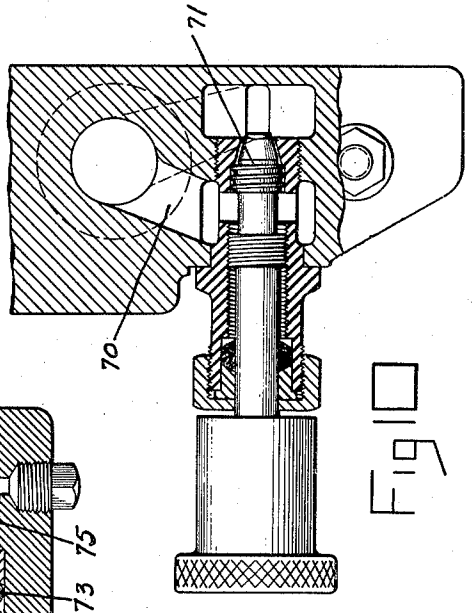


Fig. 10



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MACHINE FOR GRINDING NONCIRCULAR WORK

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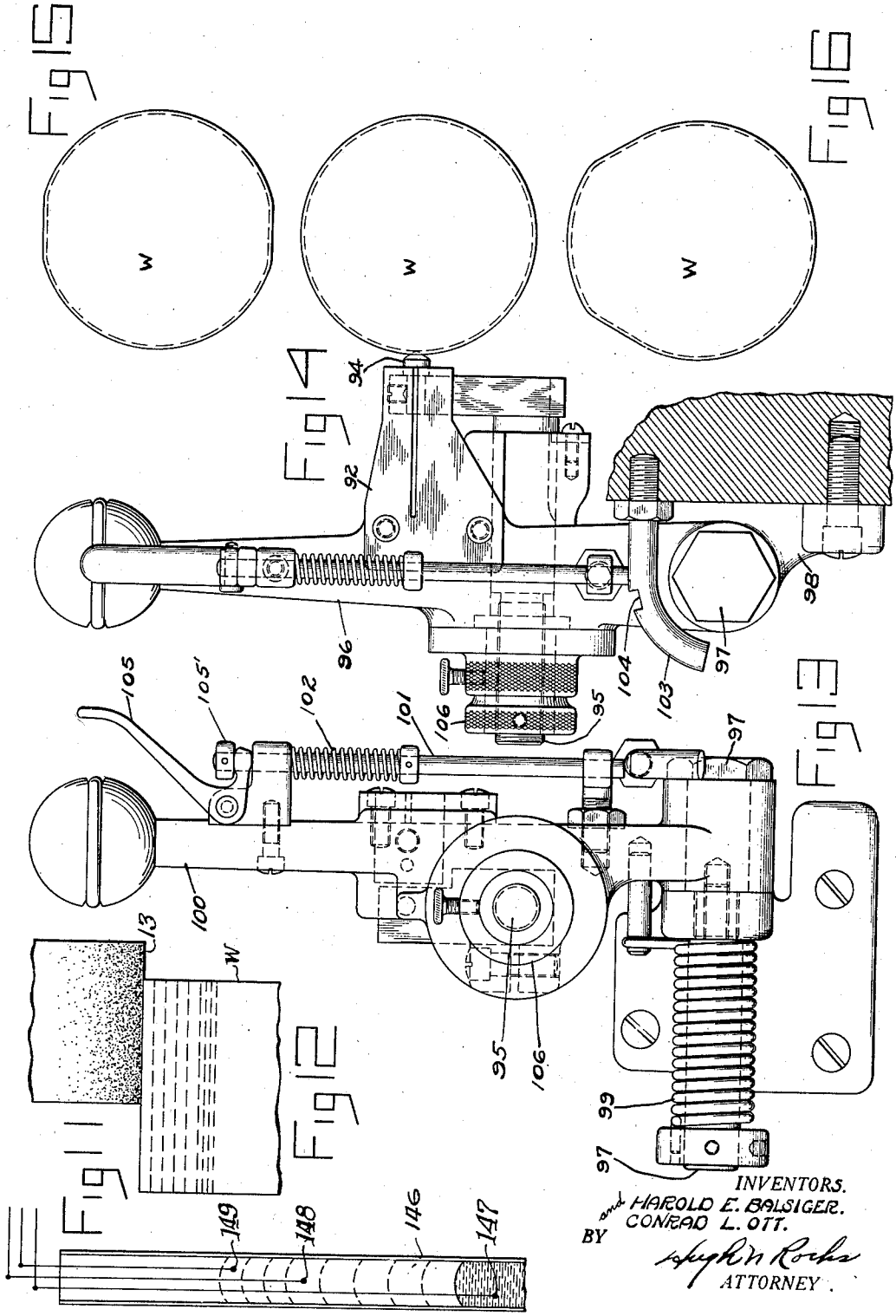

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MACHINE FOR GRINDING NONCIRCULAR WORK

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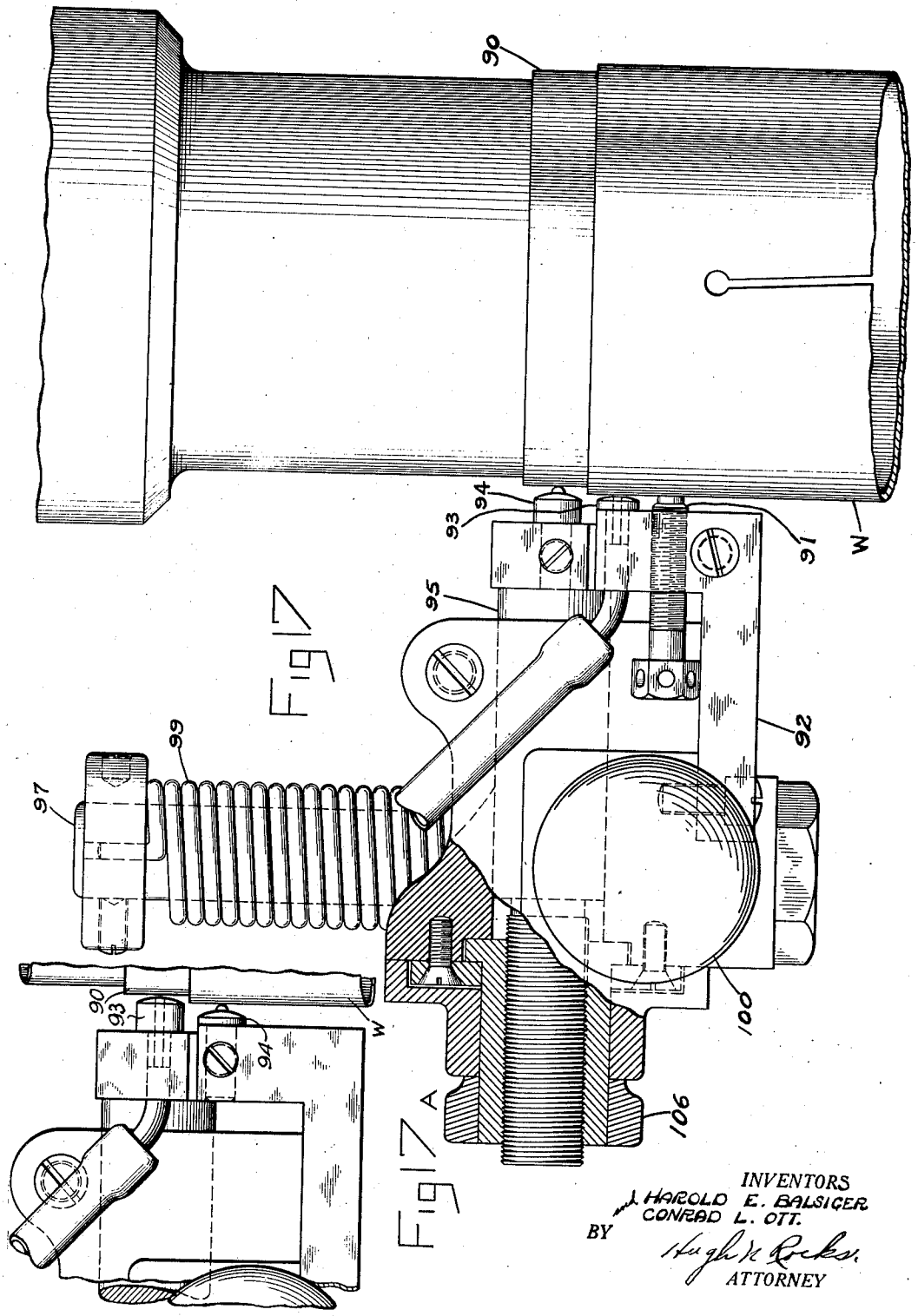

Fig 17

Fig 17 A

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MACHINE FOR GRINDING NONCIRCULAR WORK

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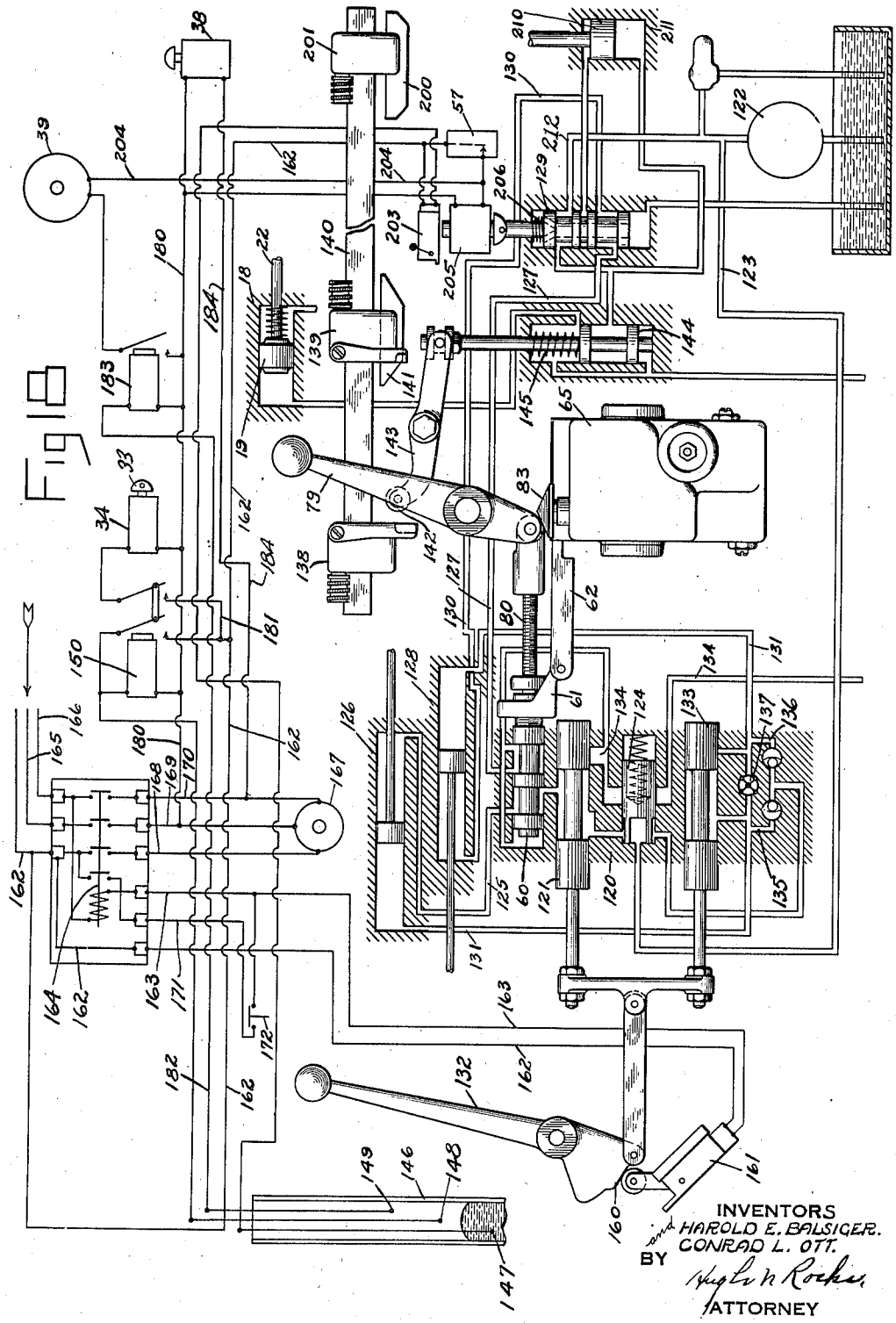

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Patented May 21, 1940 2,201,218

UNITED STATES PATENT OFFICE

2,201,218

MACHINE FOR GRINDING NONCIRCULAR WORK

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Application October 22, 1935, Serial No. 46,168

11 Claims. (Cl. 51—101)

Our invention relates to grinding machines and particularly to the machines for grinding noncylindrical work.

It is an object of our invention to provide a machine in which elliptical or other noncylindrical shapes may be ground automatically to a predetermined size.

A further object is to provide a sizing device which may be used on noncylindrical work.

A further object is to provide means to stop the grinding operation when the work reaches a predetermined size and with the wheel and work in a predetermined relative axial position.

A further object is to provide novel means for delaying the action of the reversing valve after it has been actuated by a dog on a work table.

A further object is to provide means to render said delaying means ineffective.

In the drawings Figure 1 is a front elevation of our machine.

Figure 2 is a partial end elevation of the wheel feed mechanism.

Figures 3 and 4 are end and front elevations, respectively of the cutout switch for the feed back off motor.

Figure 5 is a front elevation of that portion of the automatic feed mechanism mounted on or near the hand wheel.

Figure 6 is a sectional front elevation of the piston which actuates the feed mechanism.

Figure 7 is a front elevation of the tarry mechanism and a portion of the reversing valve showing the relation between these two parts.

Figure 8 is a sectional front elevation of the tarry mechanism.

Figure 9 is a sectional plan view on line 9—9 of Figure 8.

Figure 10 is a sectional end elevation of the throttle valve in the tarry mechanism.

Figure 11 is a front elevation of a portion of the manometer tube showing in imaginary lines the increments of movement of the mercury column.

Figure 12 is a partial view of the grinding wheel and a work piece, the imaginary lines on the work piece showing increments of change in size corresponding to the above mentioned increments of movement in the mercury column.

Figure 13 is a front elevation of the sizing device.

Figure 14 is an end elevation of the sizing device.

Figures 15 and 16 show type of noncylindrical contours which may be sized with the sizing device.

Figure 17 is a plan view of the sizing device showing the relation of the feelers and the nozzle with the work piece, and 17*a* another arrangement of the same parts.

Figure 18 is a diagrammatic piping and wiring layout.

The traverse mechanism on our machine is similar to that shown in the copending application 524,706; now Patent Number 2,103,808 dated December 28, 1937. The headstock and foot stock are mounted on a cradle which is rocked toward and from the wheel by a master cam in a manner similar to that disclosed in copending application 384,068, now Patent 2,017,927 dated October 22, 1935. Because of the disclosure in the copending applications a description of these structures will not be repeated here.

The reversing mechanism is retarded in functioning by a tarry mechanism consisting of a pair of pistons reciprocably mounted in a cylinder and adapted to be reciprocated therein by the reversing mechanism. Movement of the pistons is obstructed by a body of fluid which is forced out of the cylinder and thru a variable restriction. After a predetermined movement of the piston the pressure is released so that the piston and the reversing mechanism are shifted rapidly thru the remainder of the stroke.

Our machine is designed for grinding work having a noncylindrical contour, particularly oval or elliptical shaped pistons, cams and the like. The work is rocked toward and from and is traversed past the grinding wheel which is fed intermittently at one or both ends of the stroke of the work carriage until the work has been ground to size when the work carriage moves to one end of its stroke and completes an electrical circuit originated by the sizing device to start a small electric motor which reverses the direction of rotation of the hand wheel shaft and backs the wheel off sufficiently to permit the removal of the finished work and insert a new piece. The amount of rotation of this motor is limited by a switch which is operated by the rotation of the motor to break the circuit thereto. At the same time the work cradle is rocked to inoperative position by a hydraulic motor. The sizing device incorporates a feeler which is adapted to ride on a surface adjacent the work piece and corresponding in shape to the finished work. An air nozzle is mounted to move with the feeler in such a position that the flow of air therefrom is directed toward the work piece.

Back-off mechanism

Mechanism for backing the grinding wheel away from the work consists of an electric motor 39 mounted on the housing of the hand wheel shaft. Gear 41 is mounted on the end of the motor shaft 40. Said gear 41 meshes with an idler gear 42 and the idler gear in turn meshes with gear 43 which is secured to the hand wheel shaft 27. The friction operated cut out switch is mounted on an extension 44 of the motor

shaft 40. Said switch consists of a friction operated disc 45 on which is mounted a lug 46. Said lug 46 is adapted to engage a lug 47 on strip 48, which in turn is attached to an arm 49 rotatable about a pivot 50. Said strip 48 is attached loosely at another point 51 to arm 52 pivoted at 53. On one end of said arm 52 is a pair of contacts 55 which are normally held in engagement with terminals 56 by means of a spring 54 acting against said arm 52.

A work piece W, in this case a piston having a noncylindrical skirt is mounted between centers on a rocking support or cradle 10 which in turn is mounted on a work carriage 11, in a manner similar to that disclosed for a cam shaft in the above mentioned Patent No. 2,017,929. Said cradle may be rocked toward or from operative position by a piston 210 in cylinder 211, Figure 18. Fluid under pressure is directed to opposite ends of said cylinder by valve 129. Said carriage may be reciprocated on said base by a hydraulic mechanism disclosed diagrammatically in Figure 18 and described in detail in the above mentioned copending application 524,706.

A grinding wheel 13 is rotatably mounted on a wheel base 14 which in turn is slidably mounted on said base 12, and movable transversely of the work carriage toward and from the work piece. The mechanism for moving the wheel toward and from the work is of the well known pawl and ratchet type working in conjunction with the hand wheel 15.

The hand wheel 15 is automatically actuated to feed the wheel base toward the work by means of a pawl 16 and a ratchet 17. Said pawl and ratchet may be operated at either or both ends of the carriage reciprocation by mechanism disclosed diagrammatically in Figure 18 and described in detail in the above mentioned copending application 524,706. This portion of the automatic feeding mechanism which is mounted on or adjacent the hand wheel assembly consists briefly of a cylinder 18 in which is mounted the piston 19 movable in one direction by fluid under pressure and in the opposite direction by a spring 20 which is mounted on a tail road 21 of piston 19. A piston rod 22 carries an element 23 to which is attached one end of a bell crank 24. The other end of the bell crank is a gear segment 25 which meshes with another gear segment 26 mounted on hand wheel shaft 27. A pawl arm 28 forms a projection of said segment 26 and pawl 16 is mounted on the end of said arm and held in engagement with ratchet 17 by means of a spring 18. A shield 29 covering a portion of the teeth on said ratchet wheel is attached to an element 30 which is rotatably mounted on hand wheel sheft 27. Pawl arm 28 is normally held in inoperative position by means of spring 28' attached to another portion of the element of which arm 28 forms a part. In this position pawl 16 is drawn back of shield 29 and thus held out of engagement with the teeth of ratchet 17. An arm 31 extending from said element 30 at another point is attached by a link 32 to the armature 33 of a solenoid 34. An adjustable stop 35 is mounted on the hand wheel and adapted to engage a removably mounted stop 36. Said stop 36 is attached to an armature 37 of solenoid 38, said solenoid being effective to withdraw stop 36 from operative position. Stop 36 may be held in operative position by any suitable means such as by gravity or by a spring not shown. The solenoid for operating said stop is connected directly into the circuit on motor 167.

The tarry mechanism

This mechanism is attached directly to a reversing valve 60 by means of a bracket 61 adjustably mounted therein and adapted to be locked in adjusted position. Link 62 connects said bracket with a lever 63 pivoted at 64 in a housing 65 which contains the operating parts of the tarry mechanism. The principal working element of said mechanism is a pair of pistons 66 and 67 joined by reduced portion 68 to which is attached the other end of lever 63. Each of said pistons has a hole extending axially into the piston from the ends; and from this hole extends several smaller radial passages opening into a groove in the peripherial surface of the piston. The purpose of this construction is to provide for retarding the initial movement of the reversing valve and then permit a quick movement to reverse position as said passages line up with ports 77 or 78 and permit fluid to be released. Said pistons are adapted to be reciprocated in a cylindrical bore 69 in housing 65. The fluid passage 70 connects opposite ends of said bore but the movement of fluid through said passage is restricted by valve 71 which is omitted from Figure 8, but shown in detail in Figure 10. In the lower portion of housing 65 is a pair of check valves 72 and 73 in by pass passages 74 and 75 respectively. The purpose of these check valves is to permit fluid to pass directly from one end of the bore 69 to the other without going through valve 71. These check valves are not operable during the automatic operation of the reversing valve since the pressure exerted in such operation is not sufficient to open them. However, if the operator desires to shift the reversing lever manually and rapidly, pressure on the fluid will be sufficient to open the valve and permit the fluid to pass from one side of the bore to the other without going through the throttle valve 71. In the upper portion of the housing 65 is a fluid reservoir 76 connected to bore 69 by ports 77 and 78. Reversing lever 79 is adjustably connected to valve 60 by rod 80, one end of which is headed and adapted to be inserted in the hollow end of said valve 60. Hollow plug 81 is threaded into the end of said valve and prevents said rod from being withdrawn from said valve. A nut 82 is threaded on said rod and the distance between the nut and the head on said rod is the amount of lost motion permitted in the operation of the reversing valve. This of course is adjustable. A movement of the reversing valve is completed by means of the well known snap action mechanism consisting of a spring pressed plunger 83 engaging roller 84 on the end of reversing lever 79.

Sizing device

The sizing device used on this machine is shown in Figures 11 to 17 inclusive.

The method of sizing consists in utilizing a master surface or pattern which is identical in shape with the finished work piece. In this particular case the master surface or pattern 90 is axially aligned with the work piece W and forms a part of the driving mechanism therefore. An adjustable shoe 91 supported on a bracket 92 rides on the work piece W during the preliminary grinding operation. Adjacent said shoe and in the same bracket is a nozzle 93 directed against the work piece. Adjacent said nozzle and adapted to engage the master surface is a diamond pointed feeler 94 mounted in a holder 95 which is adjustable toward and from said master surface or pattern independently of the

adjustment of the shoe 91 or the nozzle 93. This is the preferred arrangement of work engaging elements although obviously the position of the nozzle and feeler might be reversed and the shoe eliminated as in Fig. 17*a*. The reference numerals used in Fig. 17 apply to corresponding parts in Fig. 17*a*. W indicates the work piece, numeral 90 a pattern, 93 a nozzle directed against the surface of said pattern, and 94 a feeler engaging the surface of work W. In this case the space between the nozzle and the pattern decreases as the work is ground to size. Both the bracket 92 and the holder 95 are mounted on bracket 96, which in turn is pivotally mounted at 97 to another bracket 98 secured to the work carriage or cradle 10. The feelers are held in operative relation to the work by means of a spring 99 and a stud 97. The handle 100 may be used to move the device toward or from operative position. The device may be held in inoperative position by means of a rod 101 attached thereto and urged by a spring 102 against the stud 103 in which is cut a notch 104. Said rod is adapted to drop into said notch when the device is withdrawn from operative position. The rod may be withdrawn from the notch by means of a lever 105, one end of which engages a collar 105' on the rod 101.

Piston grinder operation

The flow of fluid to the various mechanisms passes thru a main valve body 120 which has been described in the copending application 524,706. In the normal operation of the machine fluid is supplied by pump 122 thru line 123 to relief valve 124 in said valve body. From said relief valve the fluid passes thru a start and stop valve 121 to reversing valve 60. Said reversing valve is actuated by dogs 138 and 139 adjustably mounted on rail 140 on the carriage 11 and directs the fluid thru passage 125 to cylinder 126, or thru passage 127 to valve 129 and passage 130 to cylinder 128. As described in the copending application 524,706 cylinders 126 and 128 are connected by passage 131 in which is placed a throttle valve 137 to control the rate of flow of fluid between said cylinders and hence the rate of movement of the carriage 11. To stop the traverse mechanism the operator shifts lever 132 to the left thereby shifting valves 121 and 133 to the right. In this position fluid under pressure which is at valve 121 is returned to the reservoir thru passage 134 instead of to the reversing valve. Movement of valve 133 to the right connects passages 135 and 136 to form a by pass around valve 137 and so permit the carriage to be traversed manually with a minimum of resistance. Cam 141, adjustably attached to dog 139 engages roller 142 on lever 143 to actuate valve 144 to supply fluid under pressure to one end of feed cylinder 18. Spring 145 normally holds said valve in position to exhaust the fluid from said cylinder.

When lever 132 is shifted to the right, cam 160 closes switch 161 to close a circuit from supply line 162 thru line 163 to relay 164. Closing said relay completes circuits from supply lines 162, 165, 166 to headstock motor 167 thru lines 168, 169 and 170. A fourth circuit is closed from line 162 thru line 171 and stop switch 172 to line 163 thereby providing a holding circuit for relay 164. To provide current for the various mechanisms on the machine, line 169 is tapped by line 180 to which said mechanisms are connected. Either line 162 or line 166 may be used for the return line. In this case line 162 is used.

To bring the grinding wheel rapidly into contact with the work the operator turns the hand wheel 15 until adjustable stop 35, mounted thereon, engages the removable stop 36. Stop 35 thus serves to facilitate positioning the grinding wheel close to the surface of the work. As soon as the headstock motor 167 is started by shifting lever 132 to close switch 161, solenoid 38 becomes energized thru lines 180 and 184 and withdraws stop 36 from the path of stop 35, to permit the operation or rotation of hand wheel 15 during the grinding operation. After the completion of the grinding operation when the hand wheel has been automatically reversed the headstock motor is stopped by shifting lever 132 to the left. Since solenoid 38 depends on the motor circuit it becomes deenergized and stop 36 is permitted to return to a position in the path of stop 35.

When the rough grinding operation is completed the mercury in tube 146 will complete a circuit between contacts 147 and 148 to close relay 150. This closes a circuit from line 180 thru solenoid 34, then thru line 181 to line 162. However the supply from line 162 to contacts 147 is available only when the carriage is at the extreme left hand position when adjustable cam 200 carried by a support 201 adjustably mounted on rail 140 closes switch 203 to complete the circuit. Said solenoid shifts the shield 29 to prevent pawl 16 from picking up more than enough teeth of ratchet 17 for a finish feed. The grinding operation continues at a reduced rate until the mercury engages contact 149. Part of the circuit is closed thru line 182 to relay 183 and thence thru line 180. Contact 147 remains dead until the circuit from line 162 thereto is completed when cam 200 on the carriage 11 closes switch 203. Relay 183 is thus closed permitting current to pass to motor 39 and back thru line 204 and stop switch 57 to line 162. Motor 39 causes a reverse movement of the feed mechanism and at a predetermined point actuates stop switch 57 to break the circuit thereto. Opening said switch also breaks the circuit to solenoid 205 permitting spring 206 to shift valve 129 to its lowermost position in which the connection is broken between fluid lines 127 and 130 thru which fluid under pressure is directed to move the work carriage to the right. In this position of valve 129 fluid is directed therethru to the rod end of cylinder 211 to move piston 210 to rock cradle 10 to an inoperative position. Said carriage completes its movement to the left and shifts reversing valve 60 to reverse said movement but since fluid cannot reach the motor due to the position of valve 129 the carriage remains motionless in its left hand position where finished work may be removed and a new piece placed in the machine.

We claim:

1. In a machine of the kind described, a work support, a tool support, means to effect a relative transverse feeding movement between said supports, means to effect a relative longitudinal reciprocating movement between said supports, a reversing mechanism in control of said reciprocating movement, additional mechanism separate from said reversing mechanism and operable in response to a change in size of a work piece for rendering said reversing mechanism ineffective to continue said longitudinal reciprocating movement.

2. In a machine of the kind described a work support, a pattern member mounted thereon in axial alignment with a work member, means for changing the size and contour of said work mem-

ber to approach the size and contour of said pattern member comprising a grinding wheel mounted thereon, mechanism for effecting a relative feeding movement between said supports, and a sizing device for controlling said feeding movement including a feeler in contact with one of said members and a nozzle directed against the other.

3. In a machine of the kind described a work support, a tool support, mechanisms to effect relative transverse and longitudinal movements of said supports, a reversing mechanism for controlling said longitudinal movement, mechanism separate from said reversing mechanism to prevent the operation of said longitudinal moving means in one direction, a solenoid attached to said last named mechanism, means to reverse said transverse movement to separate the tool and the work and means actuated by said reversing means to control said solenoid.

4. In a machine of the kind described a work support, a pattern member mounted thereon in axial alignment with a work member, means for changing the size and contour of said work member to approach the size and contour of said pattern member comprising a wheel support, a grinding wheel mounted thereon, mechanism for effecting a relative feeding movement between said supports and a sizing device by controlling said feeding movement, including a feeler in contact with one of said elements and a nozzle directed against the other and means to maintain a fixed relation between said nozzle and the surface against which it is directed until the work reaches a predetermined size.

5. In a machine of the kind described a work support, a pattern member mounted thereon in axial alignment with a work member, means for changing the size and contour of said work member to approach the size and contour of said pattern member comprising a wheel support, a grinding wheel mounted thereon, mechanism for effecting a relative feeding movement between said supports and a sizing device by controlling said feeding movement, including a feeler in contact with one of said elements and a nozzle directed against the other, means to maintain a fixed relation between said nozzle and the surface against which it is directed until the work reaches a predetermined size, and means for causing a variation in the relation between said nozzle and said surface until another predetermined size has been reached.

6. A cam grinding apparatus comprising a rotatable grinding wheel, a rotatable work support, a reversible feeding mechanism for feeding the grinding wheel and work support relatively toward and from the work to grind a cam blank to a predetermined size, means including a master cam and roller to move the grinding wheel and work support relatively toward and from each other during the grinding operation to grind a cam blank to a predetermined contour, a sizing device including a movable feeler which continuously engages the periphery of the cam being ground during grinding automatically to control said feeding mechanism, and means to automatically move the sizing head into an operative position so that the contact member engages the periphery of the cam being ground.

7. A cam grinding machine of the type having a rotatable camshaft support which is rocked toward and from a rotatable grinding wheel by means of a master cam and a follower, a rotatable support for said wheel, a reversible feeding mechanism to cause a relative transverse feeding movement between the grinding wheel and the cam being ground to grind the same to a predetermined size and contour, a size controlling apparatus including a movable contact member which engages the periphery of the cam being ground, and means responsive when said contact member reaches a predetermined position to reverse said feeding mechanism to separate the cam and the grinding wheel.

8. In a machine of the kind described, a work support, means for rotating a work piece thereon, a tool support, a grinding wheel rotatably mounted thereon, a manually operated feeding mechanism comprising a hand wheeel, a positive stop to stop the operation of said hand wheel with the grinding wheel in position to start grinding a work piece, automatic means to actuate said feed mechanism during the grinding operation and additional automatic means operable in response to starting said work rotating means to withdraw said stop whereby to permit said first automatic means to actuate said feed mechanism.

9. In a machine of the kind described, a work support, a tool support, mechanisms to effect relative transverse and longitudinal movements of said supports, a reversing mechanism for controlling said longitudinal movement, mechanism separate from said reversing mechanism to prevent the operation of said longitudinal moving means in one direction, actuating means attached to said last named mechanism, means to reverse said transverse movement to separate the tool and the work and means actuated by said reversing means to control said actuating means.

10. In a grinding machine, a work support, a tool support, mechanisms for effecting relative transverse and longitudinal movements of said supports, a size control mechanism for controlling said transverse movement and means operable thereby in response to a predetermined change in size of a work piece for initiating said transverse movement in a direction to separate the tool and work, means operable by said separating means to stop said transverse movement and means controlled by said stopping means for preventing further operation of said longitudinal moving mechanism.

11. In a grinding machine, a work support, a tool support, mechanisms for effecting relative transverse and longitudinal movements of said supports, means for controlling said longitudinal movement including a reversing mechanism, control means separate from said reversing mechanism for effecting operation of said longitudinal moving mechanism in one direction, means for initiating operation of said transverse moving mechanism for feeding said tool toward said work, additional mechanism for separating the tool and work and means responsive to operation of said additional mechanism for rendering said reversing mechanism inoperative and for effecting said longitudinal movement in one direction.

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