July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 1

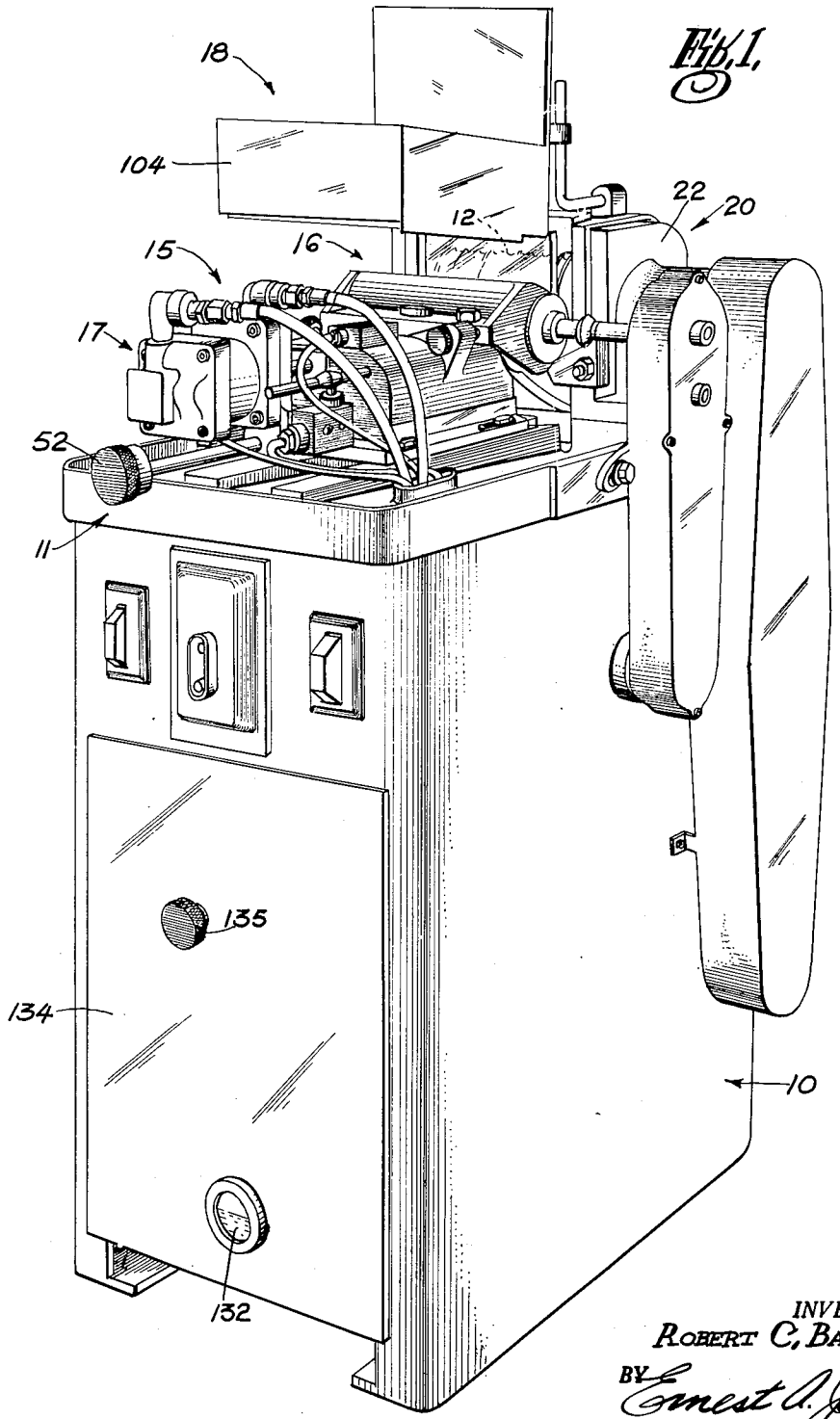


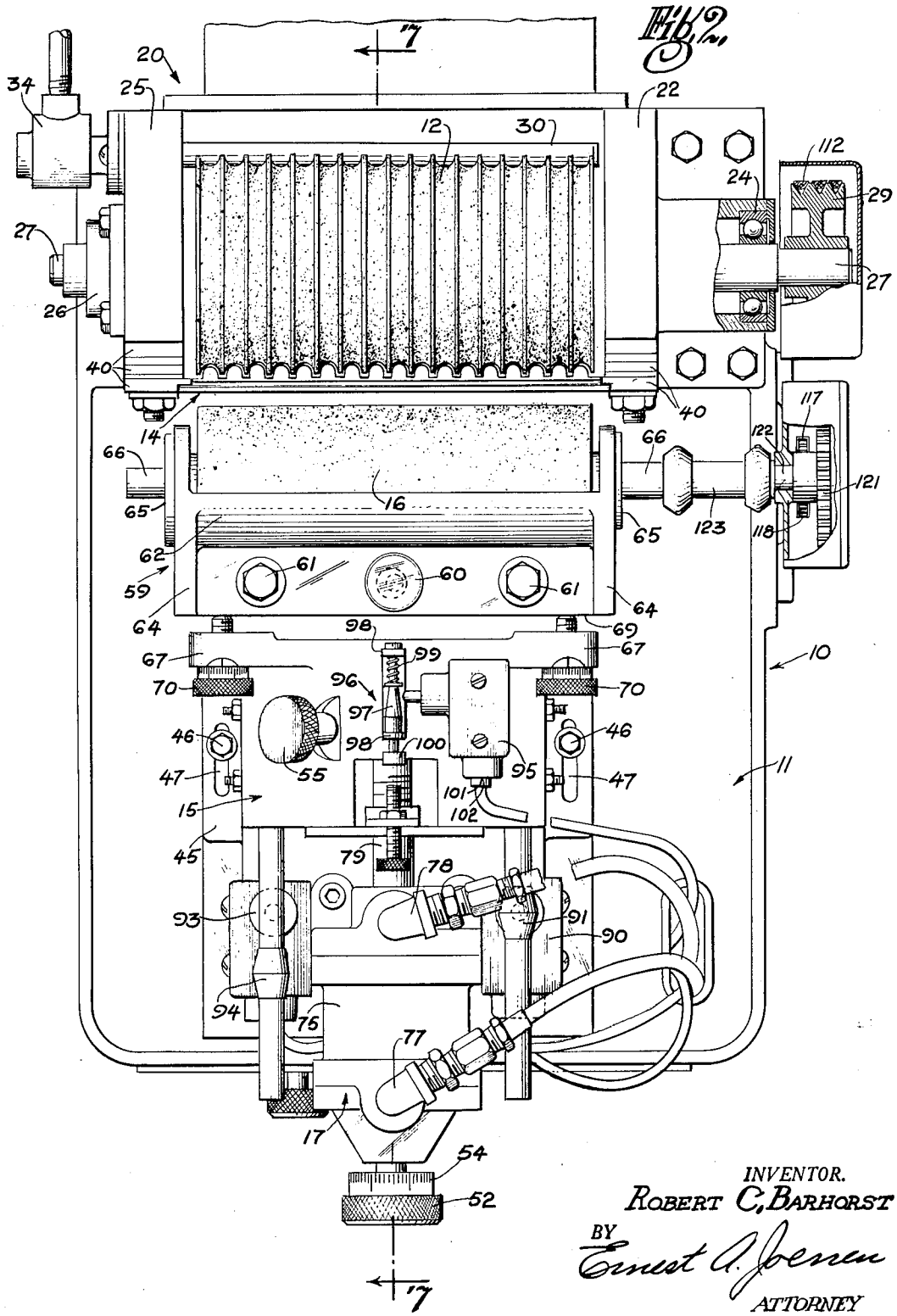
Fig. 1.

INVENTOR.
ROBERT C. BARHORST
BY Ernest A. Jensen
ATTORNEY

July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 2



INVENTOR.
ROBERT C. BARHORST
BY
Ernest A. Jensen
ATTORNEY

July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 3

Fig. 5.

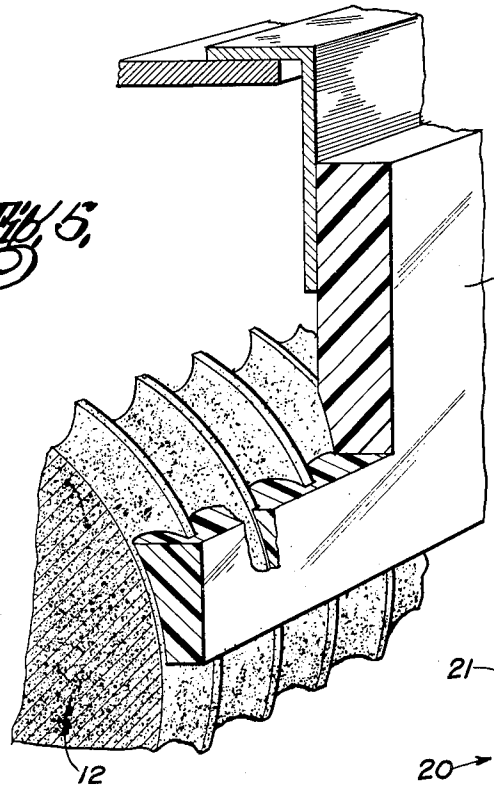
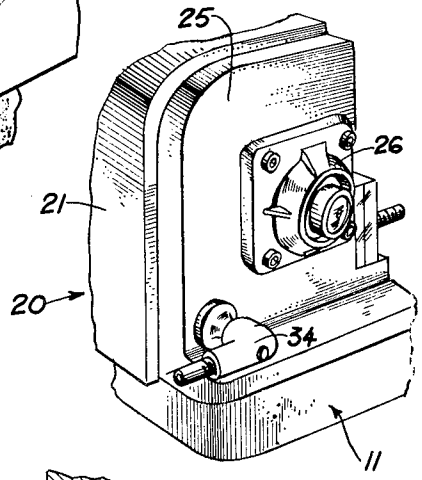


Fig. 13.



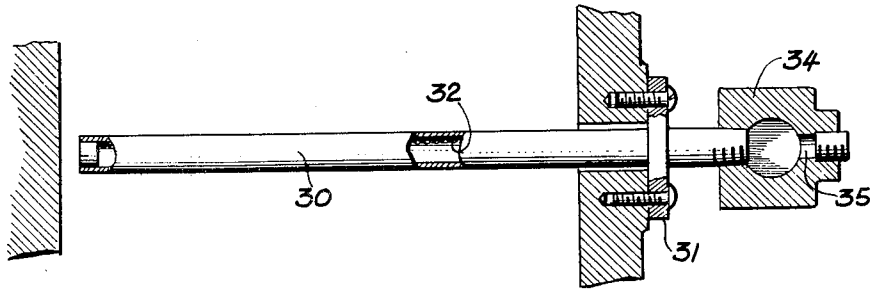


Fig. 14.

INVENTOR.
ROBERT C. BARHORST
BY Ernest A. Joerren
ATTORNEY

July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 4

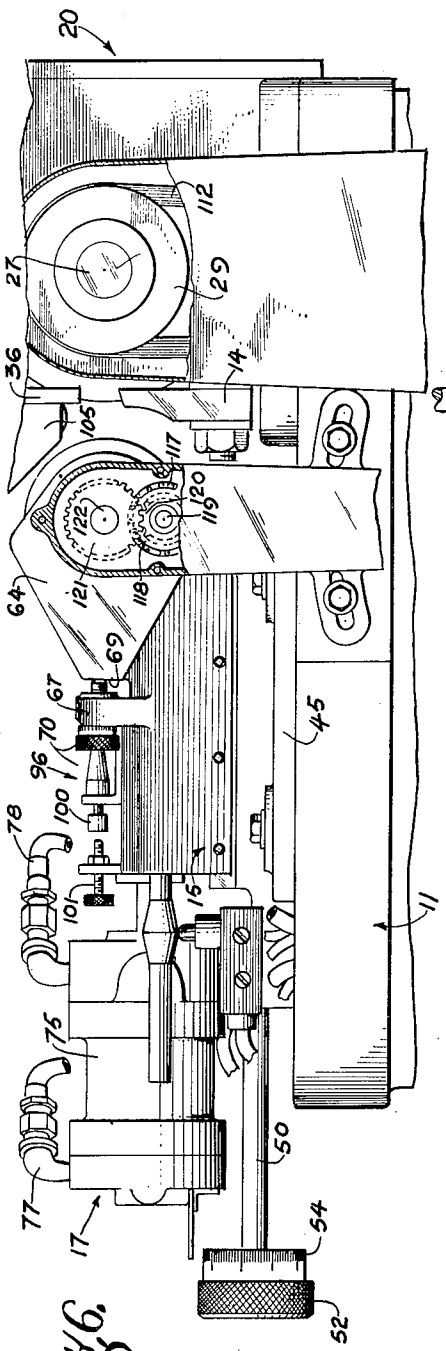


Fig. 6.

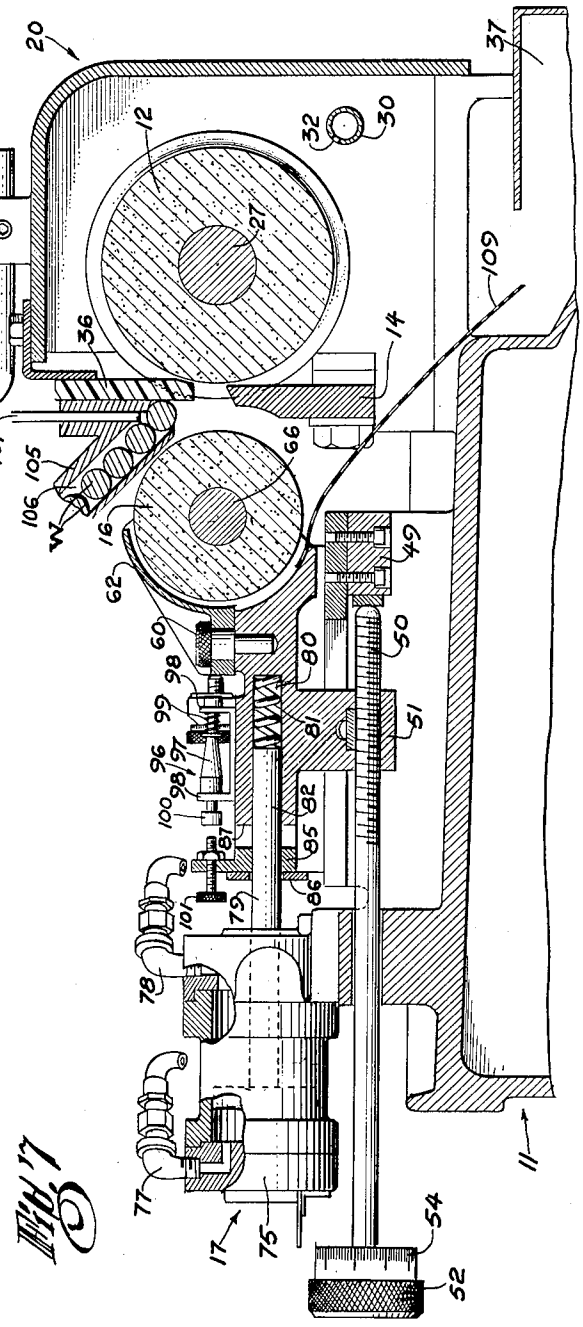


Fig. 7

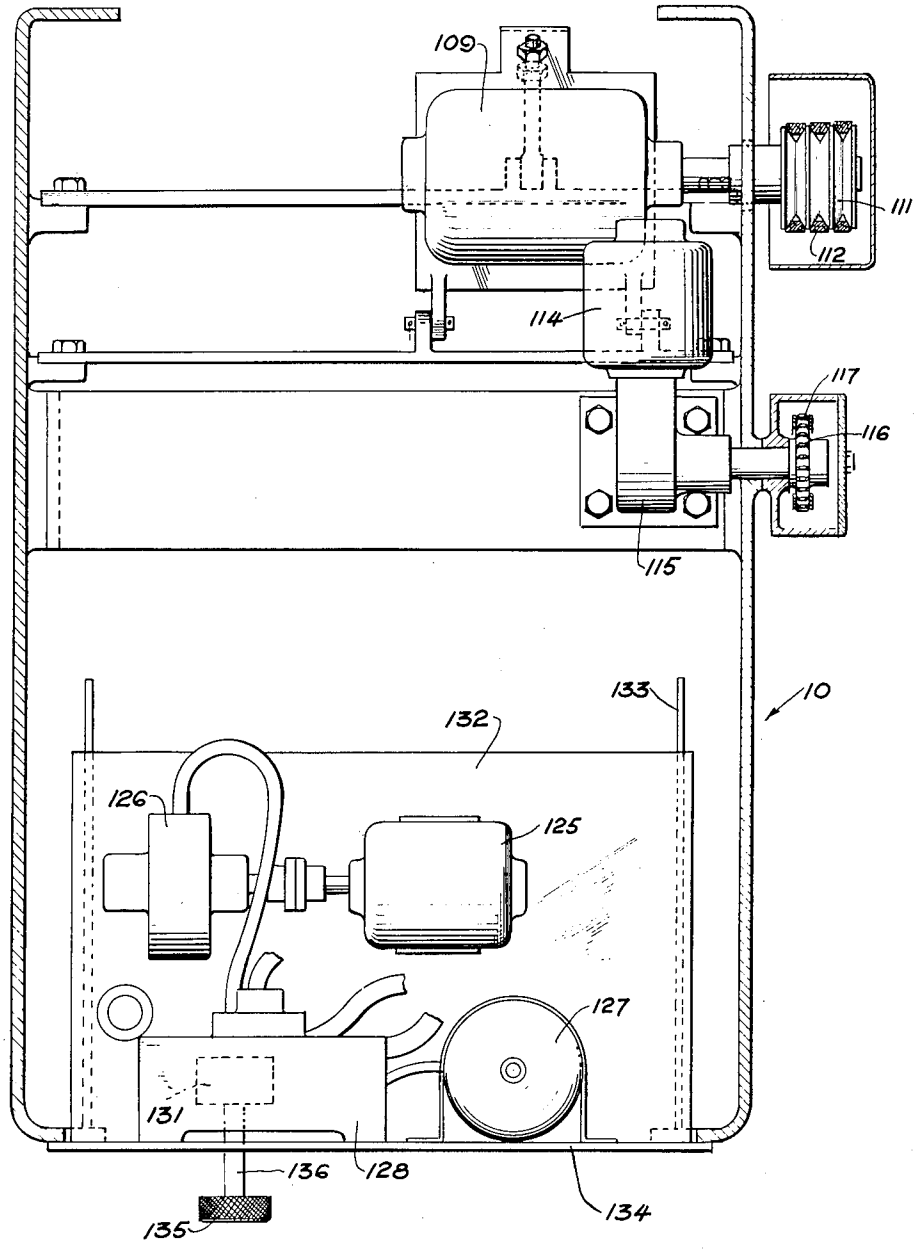
INVENTOR.
ROBERT C. BARHORST
BY Ernest A. Joerres
ATTORNEY

July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 5

Fig. 8.



INVENTOR.
ROBERT C. BARHORST
BY Ernest A. Joerren
ATTORNEY

July 31, 1956 R. C. BARHORST 2,756,546

CENTERLESS GRINDER

Filed July 1, 1953 6 Sheets-Sheet 6

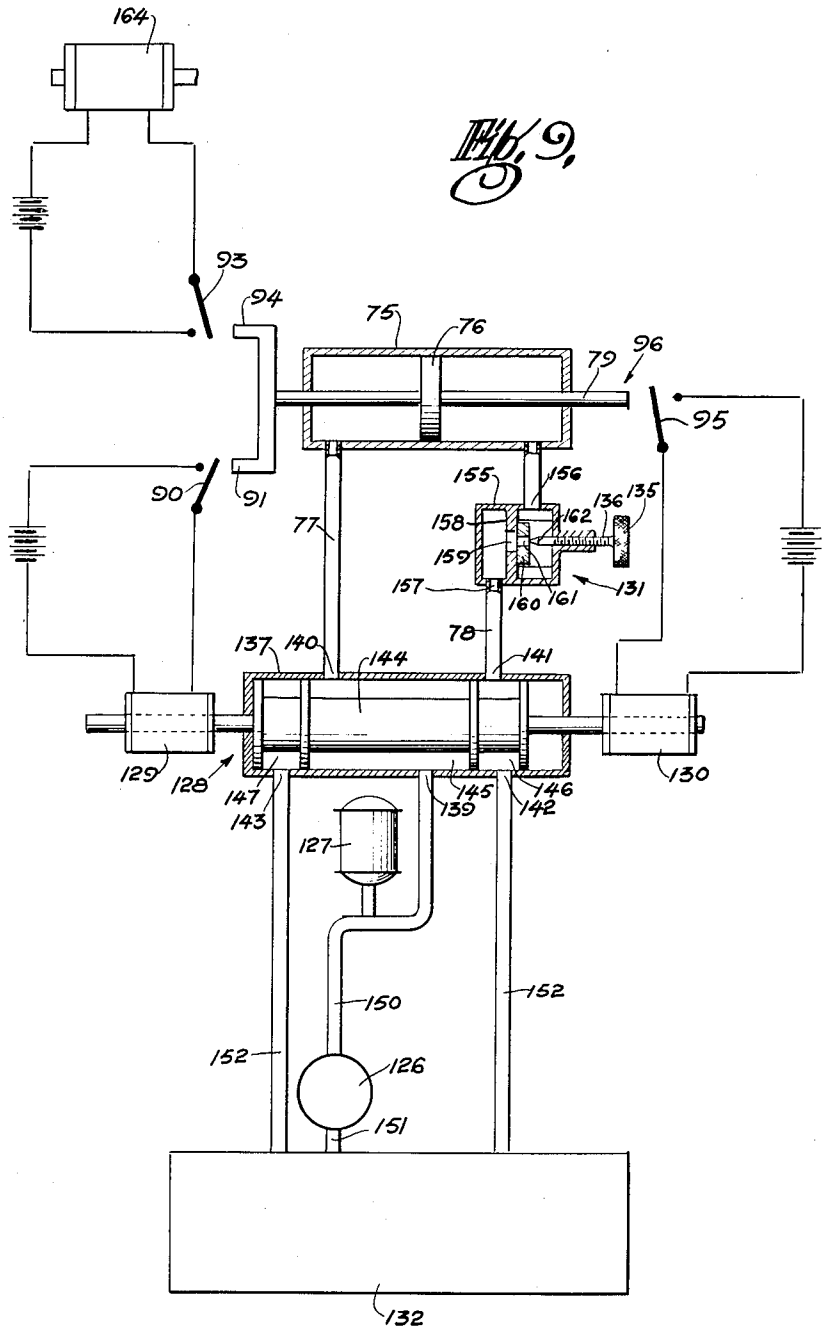


Fig. 9.

INVENTOR.
ROBERT C. BARHORST
BY Ernest A. Jensen
ATTORNEY

United States Patent Office

2,756,546

Patented July 31, 1956

2,756,546

CENTERLESS GRINDER

Robert C. Barhorst, Pompton Plains, N. J., assignor, by mesne assignments, to Glebar Company, Franklin Lakes, N. J., a partnership

Application July 1, 1953, Serial No. 365,367

14 Claims. (Cl. 51—103)

The present invention relates to abrading or grinding machines, and, more particularly, to centerless grinders of the plunge-feed type, although certain features thereof are applicable to other types of centerless grinders.

The present invention is primarily concerned with centerless grinders for producing large numbers of small parts which are generally circular in cross-section. Such machines generally comprise a work wheel or grinding wheel, a regulating or feeding wheel, and a plunge-feed mechanism including a ram on which the latter wheel is mounted for moving the same towards and away from the work wheel. Since quantities of parts of various sizes and shapes and materials are to be produced on such machines, it is necessary to adjust the surface speed of the work and regulating wheels and the length of the stroke of the ram as well as the timing thereof.

Heretofore, grinding machines of this type have been proposed but have never been commercially successful because numerous interchangeable belts, cams, gears and levers or other mechanical means were depended upon to make these adjustments. Consequently, such machines required a great number of spare parts which increased the tooling cost of the machines and required interchanging of these parts each time it was desired to set up the machines for a different operation

The present invention aims to overcome the foregoing difficulties and disadvantages by providing a machine of the character described herein which embodies many improved features, among which are separate drive means for the work and regulating wheels and a hydraulically operated system for controlling the ram, these being adjustable for producing various parts, including changing the relative speed of the wheels and the length of the stroke and the speed of movement of the ram; means for rendering the machine completely automatic in duplicating operations, including the feeding of work pieces in synchronism with the ram; spray means for cleaning the work wheel wherein the orifices are easily cleaned to prevent them from being clogged; shield means cooperating with the work wheel to confine a spray of cooling liquid within a predetermined zone and adapted to be dressed by the work wheel to cooperate therewith; improved mounting means for the work and regulating wheels to maintain them in parallelism and to facilitate removal and replacement thereof; improved means for discharging the machined parts; and numerous other features which will become apparent from the detailed description herein.

Accordingly, an objection of the present invention is to provide such a machaine which has a low initial cost, a low operating cost, a low maintenance cost and a low tooling cost.

Another object is to provide such a machine which is simple and compact in construction and practical in use.

Another object is to provide such a machine which is readily adjusted, certain of these adjustments being adapted to be made while the machine is in operation.

Another object is to provide such a machine which is vibrationless in operation and extremely accurate in duplicating the parts produced.

A further object is to provide such a machine adapted to produce parts formed of many different materials, for example, carbon, ceramics, cork, fiber, hard rubber, metal, plastics, wood and the like.

A still further object is to provide such a machine which is automatic, rapid and safe in operation, and requires a minimum of manual supervision.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawings, forming a part of the specification, wherein:

Fig. 1 is a perspective view of a machine in accordance with the present invention.

Fig. 2 is a plan view of the top of the machine with certain parts broken away.

Fig. 3 is a fragmentary perspective view of a readily removable tail stock bearing for the work wheel.

Fig. 4 is a fragmentary plan view of an improved spray pipe.

Fig. 5 is a enlarged fragmentary perspective view of the spray confining shield cooperating with the work wheel.

Fig. 6 is a fragmentary side elevational view of the upper portion of the machine.

Fig. 7 is a fragmentary sectional view taken substantially along the line 7—7 on Fig. 2.

Fig. 8 is a plan view of the drive means for the work and regulating means and the hydraulic system for operating the ram.

Fig. 9 is a schematic view of the hydraulic system including the means for automatically controlling the same to repeat operations.

Described generally, the machine shown in Figs. 1 and 2 comprises a base or support, preferably a stand, bench or cabinet-like structure **10** for housing the drive mechanism for the work and regulating wheels and the hydraulic system, and supporting a platform **11** at the top thereof; a work wheel **12** mounted on the stand; a work rest **14** cooperating with the work wheel; a ram **15** slidably mounted on the platform; a regulating wheel **16** mounted on the ram for cooperation with the work wheel; mechanism generally indicated by the reference numeral **17**, for controlling the movement of the ram; and a magazine **18** for feeding pieces of stock to the wheels to produce parts therefrom.

These elements and the mechanisms associated therewith will now be described in detail.

The base

The base or stand **10** of the machine is best illustrated in Figs. 1, 2, 7 and 8, and comprises a frame structure of a strength to support the various mechanisms thereon, and a casing or housing enclosing the front and sides thereof to confine the drive motors and the hydraulic system therein in the manner described hereinafter, whereby a neat, safe and compact arrangement is provided. The stand has a height of about that of a work bench or tool stand so that the platform **11** and the other elements supported thereon are at a level to facilitate manual supervision and interchanging of various elements.

The work wheel

The work wheel **12** is shown completely or partially in Figs. 1, 2, 3, 5, 6 and 7, and is rotatably supported by a housing **20** (Figs. 1, 2, 3, 6 and 7) mounted on top of the stand adjacent the back thereof. This housing comprises a casing part **21** for enclosing the top and back of the work wheel and having a side **22** provided with a bearing **24** (Fig. 2), and a second part, constituting a side frame or bracket **25** opposite the side **22**, has a bearing **26** therein in alignment with the bearing **24**.

The work wheel **12** is removably held on a shaft **27** for rotation therewith. One end of this shaft extends through the bearing **24** and carries a pulley **29** adapted to be driven in the manner as described hereinafter. This side of the housing may be termed the head stock. The other end of the shaft **27** is supported by the bearing **26** of the bracket **25** which may be termed the tail stock of the housing.

As shown in Figs. 2, 3 and 7, the tail stock part **25** is removably secured to the platform adjacent the open end of the casing part **21** which preferably has a recess or opening for receiving a portion of the tail stock part to put the parts **21** and **25** together in a manner to align the bearings **24** and **26** thereof. The part **25** is readily removed whereby access to the work wheel for removing and replacing the same is made possible.

The work wheel shaft or spindle **27**, by being supported at both ends thereof, is accurately maintained in a predetermined position to facilitate alignment of the regulating wheel **16** in parallelism therewith, and spindle whip thereof is prevented to assure uniformity of the finished parts.

The work wheel spray pipe

In order to lubricate the work wheel and clean the same, a spray pipe **30** (Figs. 2, 3, 4 and 7) extends through an opening in the tail stock bracket **25** and carries a flange or collar **31** which is removably secured to the bracket (Figs. 3 and 4) by bolts or screws. The spray pipe has a closed inner end and has a plurality of orifices **32** for directing a spray of water upwardly against the back of the work wheel (Fig. 7). The pipe is coextensive with the work wheel and is parallel to the axis of rotation of this wheel.

This arrangement facilitates positioning the spray pipe orifices with respect to the work wheel in the foregoing manner, in the event the spray pipe is removed and replaced. However, the spray pipe can also be cleaned without removal of the same by providing the outer end of the spray pipe with an opening which is in alignment with the bore thereof, and applying a readily removable fitting or closure **34** to the open outer end of the pipe which has an inlet **35** for connecting a flexible water supply hose thereto. Upon removal of this closure, a brush can be inserted into the pipe to scrub the same and clear the orifices of any particles that may have obstructed the same.

The spray of water is confined within the work wheel housing, and is prevented from being thrown by centrifugal force from the wheel by a shield **36** (Figs. 5 and 7) extending across the front of the work wheel housing and being secured thereto. The lower edge of the shield is closely adjacent the work wheel and conforms to the contour of the wheel to serve in effect to seal in any water carried by the wheel. This arrangement is attained by formation of the shield of plastic material, preferably of the transparent type, and dressing of the lower edge thereof with the work wheel to conform the same with the wheel.

The shield **36** not only confines the sprayed water, but also directs the water to the actual line of contact of the work wheel and the work piece.

The spray water, after being directed on the work wheel, is deposited on a trough **37** (Fig. 7) below the wheel and is drained from the trough through an opening (not shown) at the back of the stand. If desired, the spray water may be collected in a tank, filtered and recirculated to reduce water costs.

The work rest

The work rest **14** is removably bolted at both ends to the work wheel housing (Figs. 2, 6 and 7), and is accurately positioned adjacently and in parallelism with the work wheel by a plurality of shims or thickness gauges **40** disposed between the front face of the housing and the work rest. This arrangement enables the work rest to be accurately located with respect to work wheels of various diameters to thereby facilitate interchangeable work wheels to be used on the machine.

Since the work rest is fastened at both ends, vibration thereof is prevented to assure a vibrationless support for the parts being ground and to prevent damage to the work rest by the work wheel.

The regulating wheel ram

The ram **15** carrying the regulating wheel **16** is best illustrated in Figs. 2, 6 and 7.

The ram is slidably mounted on a horizontal slide **45** supported by the platform **11** for movement towards and away from the work wheel **12** in a direction perpendicular to the axis of rotation of the work wheel, and is arranged on the slide to prevent lateral movement or deviation from true perpendicularity. The slide is secured to the platform by a number of bolts **46** extending through slots **47** in the slide to enable the slide to be adjusted inwardly and outwardly with respect to the work wheel. The slide has a stop **49** (Fig. 7) at its inner end for limiting the inward movement of the ram upon engagement by the inner end of a rod **50** threaded through a depending lug **51** of the ram. The outer end of the rod extends to the front of the machine and carries a manually engageable knob **52** having index means **54** thereon for adjusting the rod **50** with respect to the stop **49** micrometrically, whereby the diameter of the parts ground between the work and regulating wheels can be controlled within accurate limits. The rod **50** is securely held in its position of adjustment by a set screw **55** which is readily accessible from the top of the ram (Fig. 2).

The regulating wheel **16** is mounted on the inner end of the ram **15** by a yoke **59** which is pivoted on a stud **60** and is secured to the ram by a pair of screws **61** (Figs. 2 and 7).

The stud **60** has an eccentric stem, as shown in broken lines in Fig. 2, which is mounted on the ram, and thus enables the yoke to be moved towards and away from the work wheel within a short range.

The yoke comprises an arcuate shield section **62** for the upper outward portion of the regulating wheel, and parallel side portions **64** at the ends of the shield section, each having a bearing **65** (Fig. 2). The regulating wheel is mounted on a shaft **66** having the lefthand end supported by one of the bearings and having the righthand end extending through the other bearing, as viewed in Fig. 2.

The ram **15** has a pair of lugs **67**, one at each side, facing an outer straight edge **69** of the section of the yoke secured to the ram by the screws **61**, and micrometer adjusting screws **70** are threaded through the lugs **67** and have their free ends engaging the straight edge **69**. Upon loosening of the screws **61**, the screws **70** can be set to adjust the yoke so that the axis of rotation of the regulating wheel is in true parallelism with the axis of rotation of the work wheel.

Since both the work and regulating wheels are rotatably supported at both ends thereof, they are maintained in such parallel relation at all times during the operation of the machine, particularly when pressure is applied on the work piece during the grinding thereof.

The ram operating mechanism

The ram **15** is reciprocated inwardly and outwardly by the mechanism **17** which comprises a cylinder **75** (Fig. 9) mounted on the platform adjacent the front of the machine, a double acting piston **76** in the cylinder, conduit means **77** and **78** at the ends of the cylinder for respectively supplying and alternately discharge hydraulic fluid to effect reciprocation of the piston, and a piston rod **79** carried by the piston and having a section thereof extending out of the cylinder for reciprocating the slide in the manner about to be described.

The free end **82** of the piston rod **79** extends into a bore **80** of the ram **15** and engages a relatively strong spring **81** within the closed end of the bore through which the ram is moved inwardly towards the work wheel by the piston rod (Fig. 7). This spring serves two useful functions. It provides a resilient or yieldable connection between the piston rod and the ram which prevents damaging impact when the rod **50** engages the stop **49**, and also permits relative movement between the piston rod and the ram after the rod has engaged the stop due to the compression of the spring **81**. This relative movement is taken advantage of to allow the ram to dwell for an interval of time while the work and regulating wheels are finishing the parts being ground, before the ram is retracted or moved outwardly again.

This latter movement is effected by a collar **85** secured to the piston rod **79** which is normally urged by the spring **81** against a stop **86** secured to the ram at the upper outer end thereof, whereby upon movement of the piston rod towards the left (as viewed in Fig. 7) engagement of the stop **86** by the collar **85** causes the ram to be retracted. While the ram dwells due to compression of the spring **81**, the collar **85** moves away from the stop **86** (towards the right as viewed in Fig. 7) until it engages the rearward end surface **87** of the ram which acts as a stop to limit compression of the spring **81**.

It will be noted that the hydraulic cylinder and its piston rod are centralized with respect to the ram and the regulating wheel, whereby pressure is evenly distributed over the work and regulating wheel surfaces to produce identical parts from any section along the length of the work pieces.

The ram **15** carries cams which cooperate with switches for reversing the direction of movement of the ram and for controlling the magazine, the operation of which will be described hereinafter. These elements include a stationary microswitch **90** mounted at one side of the cylinder **75** and operated by a cam rod **91** secured to the ram and extending towards the front of the machine for controlling the flow of fluid to the cylinder **75** to cause the ram to be moved inwardly; a second microswitch **93** similarly mounted at the other side of the cylinder and operated by a second cam rod **94** similarly secured to the ram for causing a work piece to be fed from the magazine **18** at or about the time the ram is caused to be moved inwardly; and a third microswitch **95** carried by the ram and operated by a cam mechanism **96** for controlling the flow of fluid to the cylinder to cause the ram to be retracted.

The cam mechanism **96** controls the interval of time the ram is allowed to dwell with the regulating wheel in its work feeding position, and comprises a cam rod **97** having a central cam section for operating the switch **95**, a pair of spaced apart lugs **98** on the ram slidably supporting the cam rod at the ends thereof, a light compression spring **99** cooperating with one of the lugs **98** and the cam rod **97** to urge the latter towards the left (as viewed in Fig. 7), a head **100** on the cam rod at the outer side of the other lug, and a screw **101** threaded through the piston rod collar **85** having its free end positioned for engaging the head **100** and provided with a lock nut **102** for securing the same in positions of adjustment.

The cam mechanism **96** is actuated during the time the spring **81** is being compressed and the collar **85** moves forwardly with respect to the ram, so that, upon engagement of the head **100** by the screw **101**, the cam rod **97** is moved forwardly to operate the micro switch **95** associated therewith.

The adjustment of the screw **101** determines the exact moment the ram is caused to be retracted, whereupon the screw **101** disengages the head **100** and the spring **99** returns the cam rod **97** to its initial position.

As previously indicated, the extent of inward movement of the ram is governed by the adjustable rod **50** which engages the stop **49**. The extent of outward movement or the length of the stroke is governed by adjustment of the cam section of the cam rod **91** with respect to the microswitch **90** associated therewith. Similarly, the instant a work piece is to be fed from the magazine is governed by adjustment of the cam section of the cam rod **94** with respect to its microswitch **93**.

Work piece feeding and parts removal

The magazine **18** may be of conventional construction, and, as shown in Figs. 1 and 7, includes a work piece supply box **104**, a hopper having a chute section **105** formed with an opening **106** adjacent the front of the shield **36** through which work pieces W are fed to the wheels **12** and **16**, and a gate **107** (Fig. 7) under the control of a solenoid (to be described hereinafter) for causing the work pieces to be fed one by one in response to operation of the switch **93**.

The work pieces are dropped on the work rest **14**, and are held between the wheels **12** and **16** to produce the parts therefrom which then drop into the trough **37**. In order to insure delivery of the parts to the trough and to break the fall thereof to prevent damage thereto, a flexible flap or apron **109** (Fig. 7), coextensive with the grinding wheels, has one end secured to the inner end of the ram **15** just below the regulating wheel **16** and has its other end extending into the trough. The flap, in this manner, prevents the parts from landing on the platform portion beneath the work rest, and the flap is agitated by the movement of the ram to shake the parts therefrom into the trough.

The flap or apron **109** preferably is formed of a sheet of rubber, rubberized fabric, flexible plastic or some other pliable water repellent material which will not mar the parts.

The wheel drive means

In accordance with the invention, extreme flexibility in the setting up of the machine for producing various types of parts is provided for by separate drive means for the work wheel and the regulating wheel.

As shown in Figs. 2, 6 and 8, the work wheel shaft pulley **29** is driven directly by a motor **110** (Fig. 8), mounted within the stand **10**, through a pulley **111** on the motor shaft and a belt **112** connecting the pulleys **29** and **111**.

The regulating wheel shaft **66** is driven by a motor **114** (Fig. 8) through a gear box **115** having a sprocket **116** on its output shaft, a chain **117** connecting this sprocket to a sprocket **118** on a stub shaft **119** (Figs. 2 and 6) carrying a gear **120**, a gear **121** meshing with the gear **120** and mounted on a second stub shaft **122** which is journalled for rotation adjacent the regulating wheel, and a flexible coupling **123** connecting this shaft to the regulating wheel shaft **66** to permit reciprocating movement of the regulating wheel during rotation thereof. The gears **120** and **121** are at the outer end of their respective stub shafts and are mounted thereon to interchange the same without disturbing the chain and sprockets.

Several sets of interchangeable gears like the gears **120** and **121** may be supplied with each machine to facilitate a wide and accurate range of speed adjustment of the regulating wheel with respect to the work wheel in a minimum time and in a simple and convenient manner.

The motors are concealed within the stand but are

readily accessible from the back thereof, while the drive pulleys, sprockets, belts and chains are encased in guards which are readily removable and replaceable.

The hydraulic system

The hydraulic system for supplying fluid to the cylinder **75** is illustrated in Figs. 8 and 9, and generally comprises a motor **125**, a pump **126** driven by the motor, a hydraulic accumulator **127**, a flow reversing valve **128**, solenoids **129** and **130** for operating this valve, an adjustable one way return flow restricting valve **131**, and a reservoir **132** for hydraulic fluid. All of these elements are mounted on a drawer or chassis **133** at the front of the stand which carries a panel **134** constituting a front end closure for the stand. In this manner, the hydraulic system is compactly arranged, and is concealed from view, but is readily accessible. Adjustment of the valve **131** can be made, without sliding out the drawer, by means of a knob **135** on a stem **136** extending through the front panel.

As described in greater detail with reference to Fig. 9, the flow reversing valve **128** is of the shuttle type and comprises a housing **137** having a centrally located inlet port **139**, outlet ports **140** and **141** and return ports **142** and **143**; and a slidable valve member **144**, adapted to be moved back and forth in the housing by the solenoids **129** and **130**, having recesses **145**, **146** and **147** therein for the purpose about to be explained.

The inlet port **139** is connected to the outlet of the pump **126** by a conduit **150** in which the accumulator **127** is connected, and the inlet of the pump is connected to the reservoir **132** by the conduit **151**. The outlet port **140** is connected to the cylinder **75** by the conduit **77** to supply fluid for moving the piston in the direction to cause the ram to be moved inwardly during the feeding stroke, and the outlet port **141** is connected to the cylinder by the conduit **78** to supply fluid for moving the piston in the opposite direction to cause the ram to be moved outwardly or retracted during the return stroke, the valve **131** being connected in the conduit **78** for the purpose about to be made apparent. The return ports **142** and **143** are connected to the reservoir by a conduit **152**.

When the valve member **144** is at the left of its housing, as shown in Fig. 9, fluid flow communication is established between the inlet port **139** and the outlet port **140** by the recess **145** to direct fluid to the cylinder by way of the conduit **77**, and fluid flow communication is established between the outlet port **141** and the return port **142** by the recess **146** to permit fluid to leave the cylinder by way of the conduit **78**. Alternately, when the valve member is at the right of its housing, fluid flow communication is established between the inlet port **139** and the outlet port **141** by the recess **145**, and fluid flow communication is established between the outlet port **140** and the return port **143** by the recess **147**. The solenoid **129** is adapted to move the valve member to the left, while the solenoid **130** is adapted to move the valve member to the right upon momentary energization thereof.

The one way flow restricting valve **131**, connected in the conduit **78**, is constructed and arranged to restrict the return flow of fluid from the cyclinder **75** but to permit free flow of the fluid to the cylinder, whereby this valve serves to slow down the feed stroke of the cylinder but enables the return stroke to take place rapidly.

To accomplish the foregoing, the valve **131** comprises a housing **155** having ports **156** and **157**, respectively, in direct communication with the cylinder **75** and the port **141**, a valve seat **158** between the ports **156** and **157** having an opening **159** about equal to the bore of the conduit **78**, a check valve member **160** slidably arranged in the housing between the port **156** and the seat **158** and provided with an opening **161** smaller than the opening **159**, and a tapered portion **162** on the adjusting stem **136** extending partially into the opening **161** to restrict the same when the valve member **160** is seated but being ineffective to restrict flow when the valve member **160** is unseated and is moved fully to the right of the housing. The stem **136** is threaded into the valve housing **155** to facilitate adjustment even while the machine is in operation. Since the return flow of the fluid is so restricted, the speed of the feed stroke can be accurately adjusted in a practical and convenient manner without resorting to a set of interchangeable cams or other complex mechanisms.

The operation of the machine

Assuming that the switch **90** has been manually operated to actuate the solenoid **129** to position the shuttle valve member **144** as shown in Fig. 9, the piston **76** is now in its feed stroke. Fluid flows from the pump **126**, through the valve **128** and the conduit **77** to the cylinder **75** in back of the piston **76** causing the piston to move towards the right as viewed. Fluid in the cylinder at the right or in front of the piston flows through the conduit **78** and the valves **131** and **128** to reservoir **132**. The flow of this fluid in passing through the valve **131** is restricted by the opening **161** of the check valve member **160** which is moved on its seat **158** by the fluid, the amount of such restriction being adjusted by the portion **162** on the stem **136**, so that the movement of the piston **76** is retarded and the regulating wheel ram moves slowly during the feed stroke thereof.

When the feed stroke has been completed and the cam mechanism **96** has been actuated in the manner described herein to close the switch **95**, the solenoid **130** is actuated momentarily to move the valve member **144** to the right of its housing to condition the valve **128** for controlling the return stroke. Fluid flows from the pump **126**, through the valves **128** and **131** and the conduit **78** to the cylinder **75** at the right of the piston, as viewed, causing the piston to move towards the left. This fluid in passing through the valve **131** unseats the check valve member and passes directly through the opening **159** of the seat **158** without any flow restricting effect. At the same time, fluid in the cylinder at the left of the piston freely flows through the conduit **77** and the valve **128** to the reservoir **132**, whereby the movement of the piston is unretarded and the ram is moved rapidly during its return stroke.

When the ram has been retracted the desired distance, the cam rod means **91** and **94** momentarily close their respective switches **90** and **93**, whereby the solenoid **129** is again actuated to condition the valve **128** for controlling the feed stroke and a solenoid **164** is actuated to operate the gate **107** for releasing a work piece from the hopper throat **105** just as the regulating wheel approaches the work wheel.

The machine now is in automatic operation and the cycle, including the feed stroke, work piece release and the return stroke, is repeated until the machine is shut off manually.

While the electrical energy for the solenoids is shown schematically as being supplied from several sources, it will be understood that, in practice, they are operated from a single source.

From the foregoing description, it will be seen that the present invention provides a centerless grinding machine having many novel features and advantages which enable the machine to be operated at many different speeds of wheel rotation or ram movement with ram strokes of varying lengths. This is accomplishd without resorting to complicated cam sets or other mechanism which requires considerable time to set up for a particular operation. The machine in accordance with the invention on the other hand can be quickly and accurately adjusted for performing a wide variety of operations in a highly simple and convenient manner. Furthermore, the machine can withstand continuous use over long periods without parts getting out of alignment or being worn or otherwise impaired, whereby servicing and maintenance costs are greatly reduced.

As various changes may be made without departing from the spirit and scope of the invention and without

sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. In a grinding machine of the class described, the combination of a work wheel, a slidably mounted ram, a regulating wheel on said ram, fluid pressure medium operated means including a cylinder, a piston and a piston rod for moving said ram towards and away from said work wheel to feed and return said regulating wheel, a spring positioned between said ram and said piston rod, a stop for limiting the movement of said ram towards said work wheel, means for supplying fluid pressure medium including a pump and a reservoir, a valve and conduits for establishing connections to supply pressure medium to one side of said piston to move the same in a direction to feed said regulating wheel and to return pressure medium from the other side of said piston to said reservoir and alternately to supply pressure medium to said other side of said piston to move the same in a direction to return said regulating wheel and to return pressure medium from said first mentioned side of said piston to said reservoir, means for operating said valve to alternately establish said connections, means for actuating said valve operating means operable to reverse said valve at about the completion of the feed stroke of said ram including a slideable cam and yieldable means for resisting movement of said cam, and means on said piston rod for effecting movement of said cam and render said valve actuating means effective upon compression of said spring after said ram engages said stop, and means for actuating said valve operating means operable to reverse said valve upon completion of the return stroke of said ram.

2. A grinding machine according to claim 1, wherein a stop engaging element is carried by said ram and means are provided to predetermine the position of said stop and said element to regulate the length of the stroke of said ram.

3. A grinding machine according to claim 1, including work piece supplying means, means for operating said last mentioned means to deliver one work piece at a time to said wheels, and means for actuating said supplying means operating means at about the completion of the return stroke of said ram.

4. A grinding machine according to claim 1, wherein the conduit for returning pressure medium from said other side of said piston to said reservoir includes flow restricting means whereby the feed stroke of said ram is slowed down.

5. A grinding machine according to claim 1, wherein the conduit connecting said other side of said piston and said valve includes a check valve means formed with a flow restricting opening and arranged to seat during the feed stroke of said ram whereby the feed stroke of said ram is slowed down and arranged to unseat during the return stroke of said ram whereby the return stroke of said ram is unimpeded.

6. A grinding machine according to claim 5, wherein said check valve means includes means for adjusting said flow restricting opening.

7. In a grinding machine of the class described, the combination of a frame, a work wheel supported by said frame, a ram slidably mounted on said frame, a regulating wheel on said ram, a cylinder secured to said frame, a piston in said cylinder, a piston rod connected to said piston for moving said ram towards and away from said work wheel to feed and return said regulating wheel, a spring positioned between said ram and said piston rod, a stop for limiting the movement of said ram towards said work wheel, means for supplying hydraulic fluid under pressure including a pump and a reservoir, a shuttle valve and conduits for establishing connections to supply fluid to one side of said piston to move said ram towards said work wheel and to return fluid from the other side of said piston to said reservoir and alternately supply fluid to said other side of said piston to move said ram away from said work wheel and to return fluid from said first mentioned side of said piston to said reservoir, a solenoid for positioning said valve to effect movement of said ram towards said work wheel, a second solenoid for positioning said valve to effect movement of said ram away from said work wheel, a switch mounted on said frame for effecting energization of said first solenoid, an extension on said ram for momentarily closing said switch upon the completion of the return stroke of said ram, a second switch mounted on said frame for effecting energization of said second solenoid, and means on said ram for momentarily closing said second switch at about the completion of the feed stroke of said ram including a slideable cam and yieldable means for resisting movement of said cam, and means on said piston rod for effecting movement of said cam to operate said second switch upon compression of said spring after said ram engages said stop.

8. A grinding machine according to claim 7, including means for mounting said extension on said ram to predetermine its position with respect to said second switch.

9. A grinding machine according to claim 7, including work piece supplying means, a solenoid for operating said last mentioned means to deliver one work piece at a time to said wheels, a third switch on said frame adjacent said first switch for effecting energization of said last mentioned solenoid, and a second extension on said ram for momentarily closing said third switch at about the completion of the return stroke of said ram.

10. A grinding machine according to claim 9, including means for mounting said second extension on said ram to predetermine its position with respect to said third switch.

11. In a grinding machine of the class described, the combination of a table, a work wheel mounted on said table, a ram slidably mounted on said table, a regulating wheel mounted on said ram, means for effecting rotation of said wheels, a drawer slidably mounted in said table, hydraulic fluid operated means for actuating said ram, and means for supplying hydraulic fluid under pressure to said last mentioned means mounted on said drawer including a hydraulic fluid reservoir, a pump, a motor for operating said pump and valve means for controlling said ram actuating means.

12. In a grinding machine of the class described, the combination of a support having a trough provided with an opening, for receiving the parts worked upon by the machine, a work wheel on said support above said trough and spaced therefrom, a ram slidably mounted on said support, a regulating wheel on said ram positioned to cooperate with said work wheel, and a flexible flap having one edge attached to said ram and extending under said regulating wheel and into said trough beneath said work wheel to receive the parts and direct the same into said trough.

13. In a grinding machine, a housing providing an enclosure having an open front, a work wheel supported by said housing within the enclosure adjacent the front thereof, a regulating wheel positioned to cooperate with said work wheel to define a grinding throat, a work rest beneath the grinding throat with its upper edge adjacent said work wheel, and a sheet of plastic depending from said housing at the front thereof and having its lower edge above the grinding throat and being in engagement with said work wheel.

14. A grinding machine according to claim 13, including a spray pipe in the enclosure for directing liquid on said work wheel, said work rest and said sheet being constructed and arranged to cooperate to confine the liquid within the enclosure.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

618,293	Ridley	Jan. 24, 1899
987,982	Hardie	Mar. 28, 1911
1,416,462	Hanson	May 16, 1922
1,416,463	Hanson	May 16, 1922
1,483,748	Sanford	Feb. 12, 1924
1,680,360	Bath	Aug. 14, 1928
1,721,477	Spafford	July 16, 1929
1,777,607	Ekholm	Oct. 7, 1930
1,840,231	Harrison	Jan. 5, 1932
1,844,653	Hechenbleikner	Feb. 9, 1932
1,969,997	Wood	Aug. 14, 1934
1,982,298	Haas	Nov. 27, 1934
1,985,237	Booth	Dec. 25, 1934
2,020,541	Ernst	Nov. 12, 1935
2,065,099	Romaine	Dec. 22, 1936
2,065,100	Romaine	Dec. 22, 1936
2,147,891	Graf	Feb. 21, 1939
2,163,967	Strawn	June 27, 1939
2,224,423	Binns	Dec. 10, 1940
2,228,386	Burns	Jan. 14, 1941
2,363,831	Clausen	Nov. 28, 1944
2,382,311	Heald	Aug. 14, 1945
2,478,562	Binns	Aug. 9, 1949
2,496,520	Daniel	Feb. 7, 1950
2,567,589	Alvord	Sept. 11, 1951
2,597,242	Hill	May 20, 1952
2,633,674	Fouquet	Apr. 7, 1953