June 20, 1933. W. J. GUILD 1,914,995

GRINDING MACHINE

Filed April 21, 1930 6 Sheets-Sheet 1

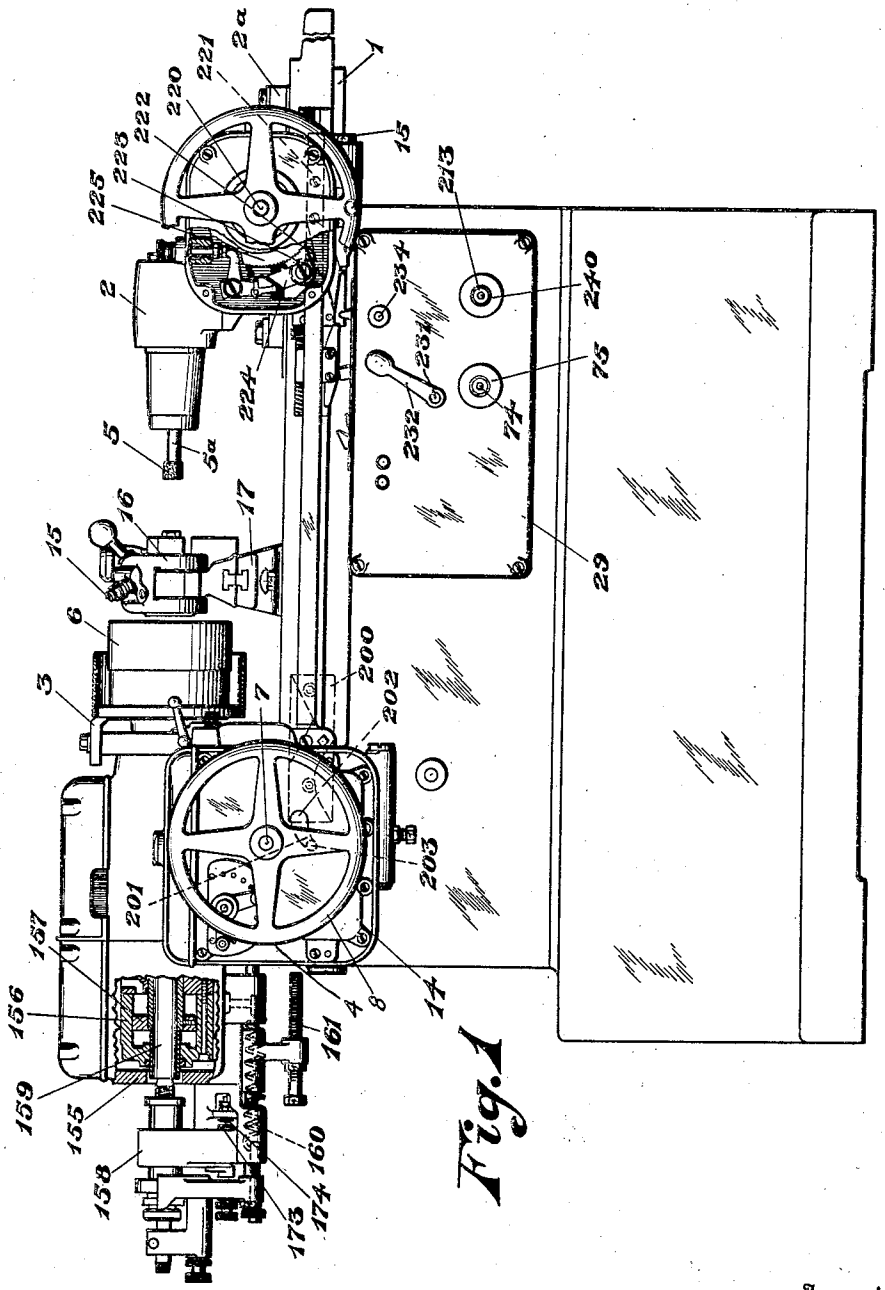

Fig. 1

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June 20, 1933. W. J. GUILD 1,914,995

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Filed April 21, 1930 6 Sheets-Sheet 2

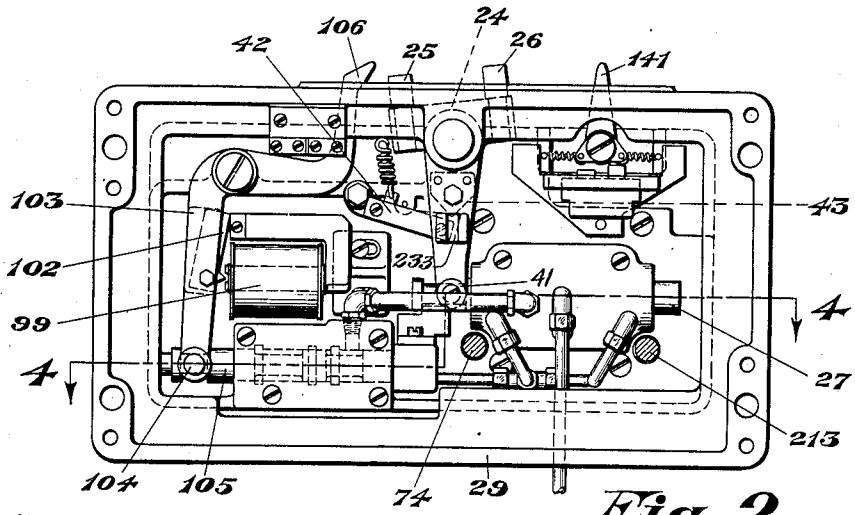

Fig. 2

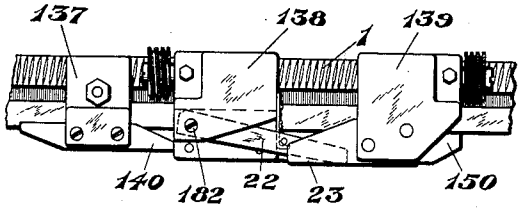

Fig. 3

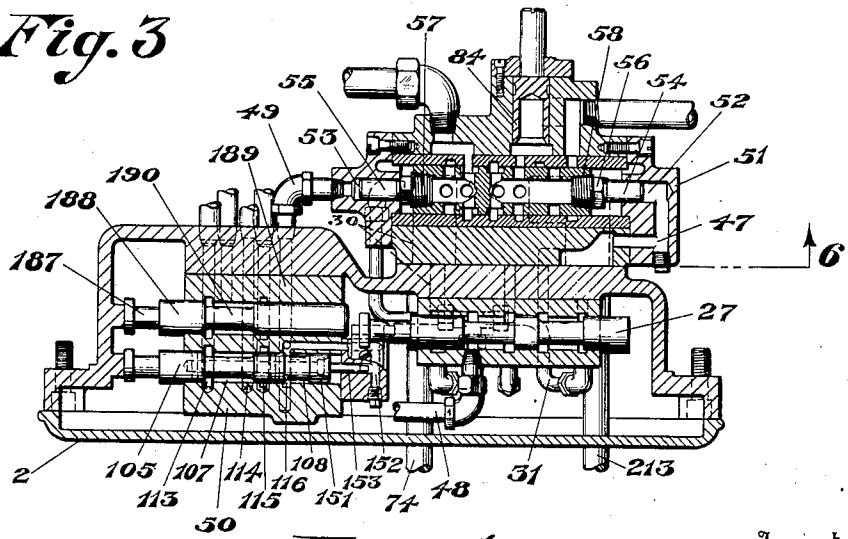

Fig. 4

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GRINDING MACHINE

Filed April 21, 1930 6 Sheets-Sheet 3

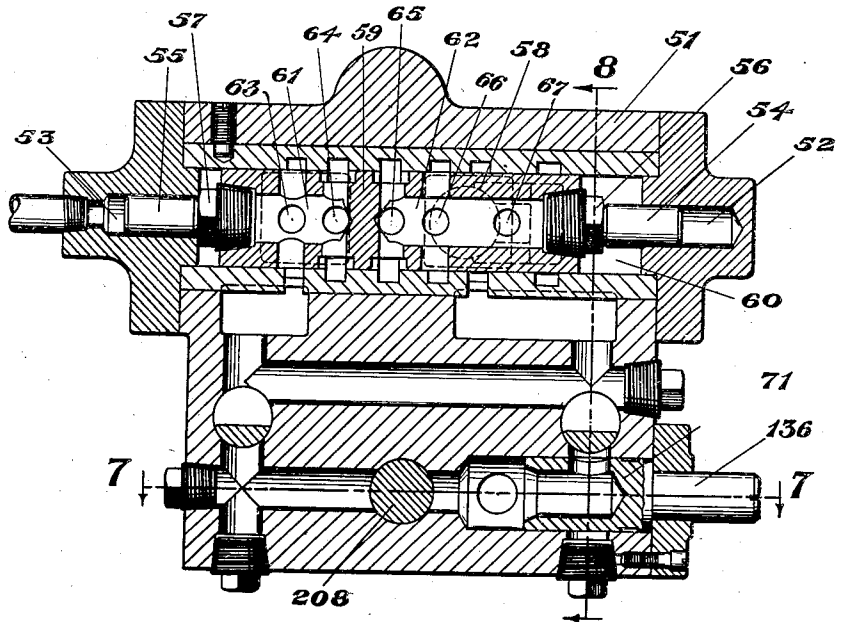

Fig. 5

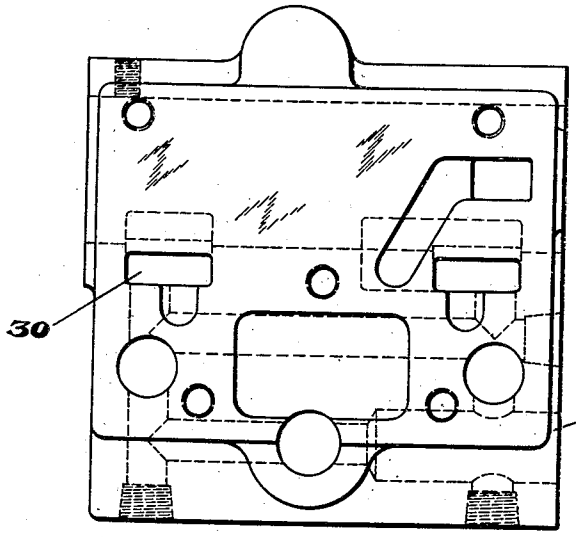

Fig. 6

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GRINDING MACHINE

Filed April 21, 1930 6 Sheets-Sheet 4

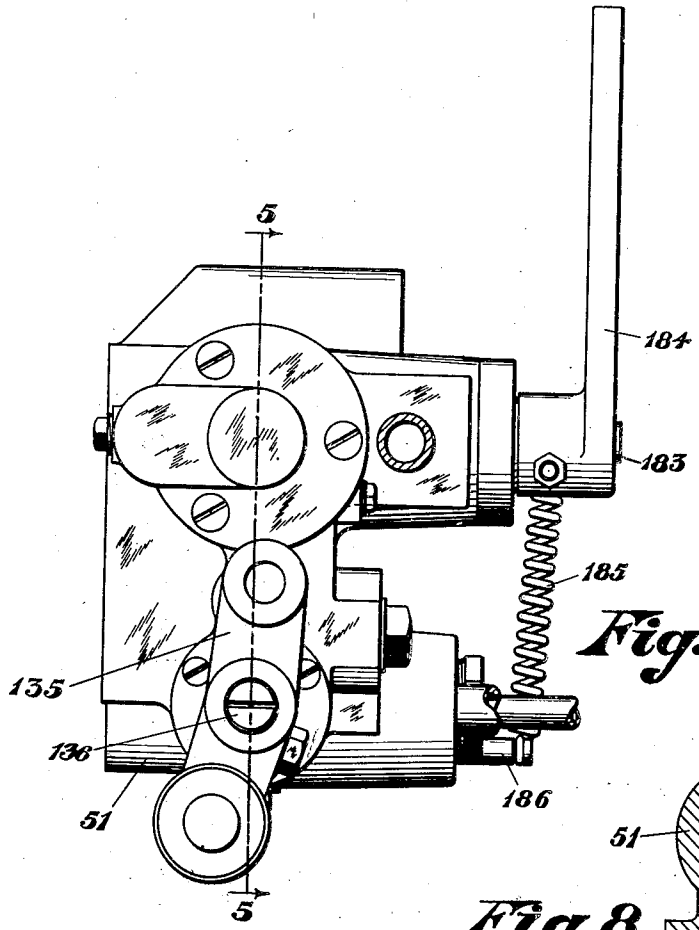

Fig. 9

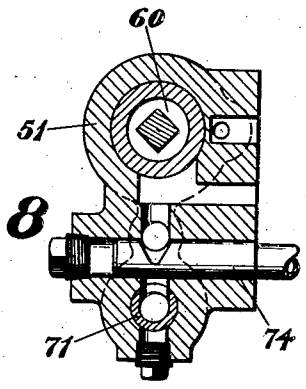

Fig. 8

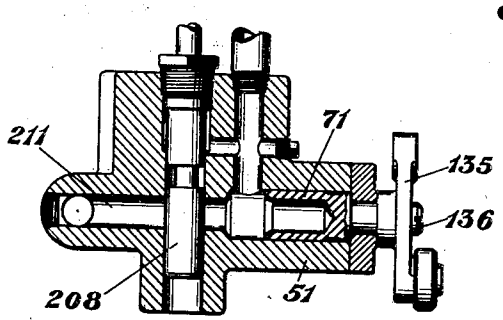

Fig. 7

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June 20, 1933. W. J. GUILD 1,914,995

GRINDING MACHINE

Filed April 21, 1930 6 Sheets-Sheet 5

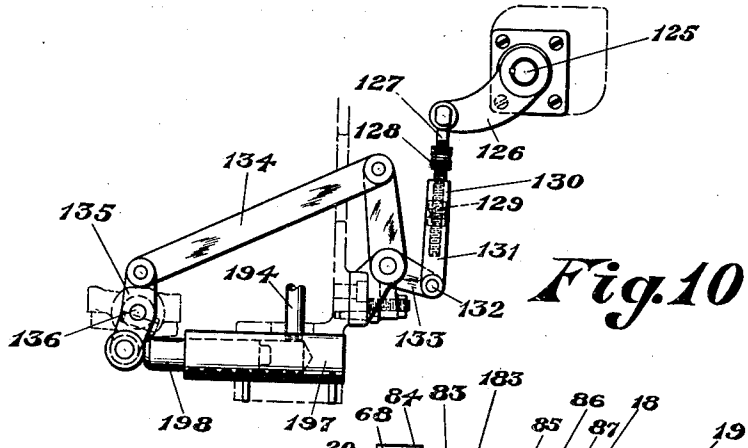

Fig.10

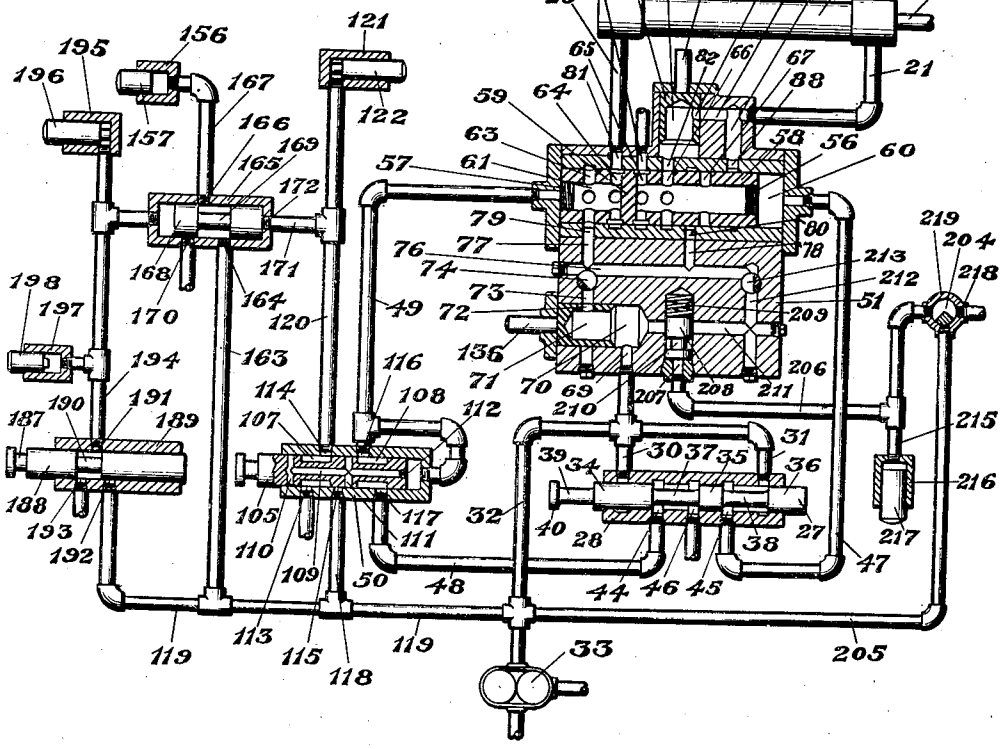

Fig.11

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June 20, 1933. W. J. GUILD 1,914,995

GRINDING MACHINE

Filed April 21, 1930 6 Sheets-Sheet 6

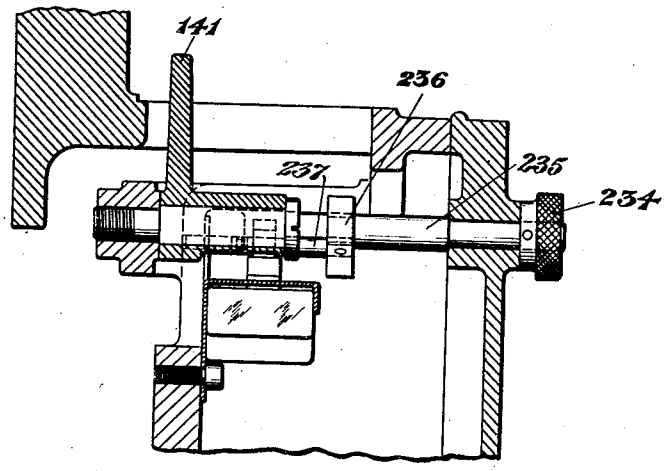

Fig. 12

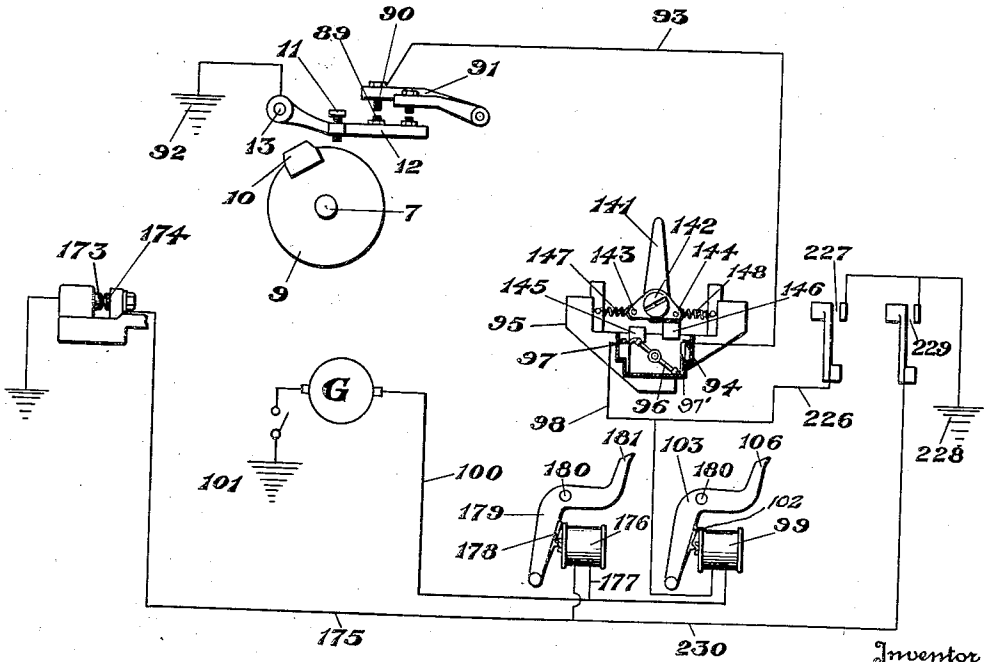

Fig. 13

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Patented June 20, 1933 1,914,995

UNITED STATES PATENT OFFICE

WALDO J. GUILD, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO THE HEALD MACHINE COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

GRINDING MACHINE

Application filed April 21, 1930. Serial No. 445,989.

The invention relates particularly to grinding machines and fluid pressure mechanism for controlling them. The invention involves certain improvements upon prior machines as particularly pointed out in the specification.

A particular object of the invention is to cause the extension of the normal reciprocatory traverse between wheel and workpiece to dress and true the grinding wheel without the use of somewhat complex mechanical instrumentalities described in certain prior patents. In other words, in this aspect the present invention involves a simplification of prior machines.

The invention makes use of a rotating gauge of the type disclosed in McDonough Reissue Patent No. 16,141. A particular object of the invention is to provide a simplified control for holding such a rotating gauge away from the workpiece during the preliminary grinding, allowing it to engage with the workpiece during the taking of the final and finishing cuts thereon. To this end fluid pressure means is provided for controlling the position of the gauge, and a valve device for controlling such means is provided, said valve device being placed in one position at the end of a grinding operation, which position it maintains until the actuation of the dressing diamond during a succeeding grinding operation. The essential novel feature in this mechanism consists in the use of the pressure of the fluid that actuates the dressing diamond and the pressure of the fluid that controls certain instrumentalities at the finish of a grinding operation, to actuate the valve that controls the position of the gauge.

One of the main objects of the invention is to provide a pilot valve system of control for the reciprocatory grinding carriage. Pilot valves to control main valves, which in turn control the flow of fluid to the opposite ends of a cylinder operating a carriage for a grinding machine, are by no means new, but the coordination of such, for the particular movements necessary in this type of internal grinding machine involved new problems. To the solution of these the present invention is particularly directed.

The invention further involves improvements in instrumentalities for controlling the speed with which the grinding carriage moves. It is desirable in the machine of the class to which the invention is applied to cause the grinding carriage to move at one speed during the preliminary grinding, at a reduced speed for the final and finishing cuts, at a still different speed for certain special operations such as dressing the wheel, and at a high speed for general movements such as separating the wheel and workpiece. It is also highly important that the speed control devices be adjustable. The present invention involves improvements in mechanism of this type.

The invention further consists of a novel valve per se, and in certain combination of parts and motions, all of which will more fully appear from the following detailed description taken in connection with the accompanying drawings, in which:—

Fig. 1 is a front elevation of a grinding machine constructed according to the invention.

Fig. 2 is a front elevation of a certain casing located on the front of the machine with the cover thereof removed, the parts being shown on an enlarged scale.

Fig. 3 is an enlarged fragmentary view of the dogs and stops carried by the grinding carriage which cooperate with the mechanism shown in the upper part of Fig. 2.

Fig. 4 is a horizontal sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a vertical sectional view on an enlarged scale of the main fluid pressure valve for the grinding carriage, being taken on the line 5—5 of Fig. 9.

Fig. 6 is a front elevation of a certain casing contained in the inside of the machine, which elevation is taken on the line 6 of Fig. 4.

Fig. 7 is a sectional view on the line 7—7 of Fig. 5.

Fig. 8 is a vertical sectional view on a reduced scale taken on the line 8—8 of Fig. 5.

Fig. 9 is a side elevation of part of the valve mechanism shown in Fig. 4.

Fig. 10 is a fragmentary side elevation of certain valve controlling mechanism on the rear of the machine.

Fig. 11 is a diagrammatic view of the hydraulic or fluid pressure system.

Fig. 12 is a detailed vertical sectional view of a certain switch actuating mechanism.

Fig. 13 is a wiring diagram.

Like reference characters refer to like parts throughout the drawings.

Referring to the drawings, particularly to Fig. 1, the machine provides the usual reciprocatory table or carriage 1, which is ordinarily provided in any internal grinding machine. In such a machine either the grinding wheel or the work to be ground may be carried on the table 1, the reciprocation of the latter being utilized in either case to produce a relative traversing movement between the grinding wheel and the work. As here shown, the table 1 supports and carries a wheelhead 2 of the usual construction,—while the work which is to be operated upon is held in a workhead 3, the latter being carried by a bridge 4, which spans the slideways provided by the machine frame for the back and forth movement of the table 1.

The normal cross or transverse feeding motion to cause the grinding wheel 5 to produce successively deeper cuts on the workpiece held in the chuck 6 is, in this embodiment of the invention, procured by moving the workhead 3. To that end, the said workhead 3 is mounted in guideways, not shown, provided by the bridge 4 so that it may be moved transverse to the direction of travel of the table or carriage 1. The actual mechanism for producing this motion forms no part of the present invention, and may be of any suitable type, such as that disclosed in the copending application No. 367,401, filed May 31, 1929, of Guild and Burns, now Patent No. 1,830,358, granted November 3, 1931, wherein ratchet and pawl means actuated by a piston and cylinder procure intermittent angular movement of a screw shaft 7 which cooperates with a nut element associated with the workhead 3 to produce the feeding increments. Desirably a hand wheel 8 is fastened to the shaft 7 for manual adjustment of the position of the workhead 3.

The machine of the present invention, the same as that of the aforesaid Patent No. 1,830,358, utilizes a rotating gauge of the type invented by James G. McDonough and disclosed in reissue Letters Patent No. 16,141, August 11, 1925, to bring the grinding operation to a close. Also in common with Patent No. 1,830,358, the machine provides for automatic dressing and truing of the grinding wheel, as disclosed in Patent No. 1,731,719 to Kempton and Gallimore. Likewise as in Patent No. 1,830,358, this automatic dressing is inaugurated by an electric contact completed by mechanical instrumentalities actuated by the cross slide actuating means, substantially as disclosed in my former Patent No. 1,682,672, dated August 28, 1928. In order that the improvements of the present invention may be more readily understood, a brief description of the general operation of the machine, so far as it follows these prior patents and the application will now be given.

The grinding operation involves a large number of short reciprocatory movements of the carriage 1 in order to move the grinding wheel 5 back and forth within the hollow workpiece in the chuck 6, accompanied of course by rotation of said chuck and workpiece, and very rapid rotation of the spindle 5a and grinding wheel 5. At one or both ends of the grinding stroke the shaft 7 is moved angularly by a slight amount, which causes the grinding wheel 5 to cut deeper and deeper into the workpiece. Such angular motion of the shaft 7 produces corresponding angular motion of a wheel 9 attached to it (see Fig. 13), and a cam 10 ultimately comes in contact with an adjustable screw 11. This screw 11 is located in an arm 12 pivoted at 13 inside the cross feed box 14, and angular movement of the arm 12 is adapted to close a circuit which procures the automatic dressing operation. Without describing the mechanism for this, which constitutes, in part, the subject matter of the present invention, it will be noted that in common with the aforesaid patents this dressing operation involves extensions of the normal reciprocatory working traverse of the table 1, and a simultaneous lowering of the dressing device or diamond 15, which is carried by an oscillatory member 16 suitably journalled in an adjustable base 17. The consequent movement of the grinding wheel 5 past the diamond 15 results in dressing of the rotating grinding wheel, and the carriage 1 immediately returns said wheel to the workpiece. There the normal reciprocatory working traverse is resumed, and the cross feed is continued, until a rotating gauge such as shown in the McDonough reissue patent referred to enters the bore in the workpiece.

Entry of such gauge procures the closing of a circuit which causes the carriage 1 to travel outwardly, this time without any lowering of the diamond 15 into the path of the grinding wheel 5, the carriage being ultimately brought to a stop substantially in the position shown in Fig. 1.

In common with the machine of the aforementioned patents, the present machine provides a cylinder 18 which desirably is attached to the base of the machine, this cylinder containing a piston, not illustrated, whose piston rod 19 is connected to the carriage 1. See Figs. 1 and 11. Fluid under pressure is admitted alternately to opposite ends of the cylinder 18, by means of pipes 20

and 21, Fig. 11, and in this manner the reciprocatory traverse of the carriage 1 is procured.

The normal reciprocatory traverse to procure the working reciprocation between grinding wheel and workpiece, is procured, as in the aforementioned patents, by dogs or stops 22 and 23, carried by the carriage 1, which alternately engage the upwardly extending arms 25 and 26 of a reversing member 24. However, the construction and mode of operation of the fluid pressure system which ultimately causes fluid to flow through the pipes 20 and 21 responsive to shifting of the reversing member 24 is, according to the present invention, quite different from the fluid pressure system described in the aforesaid patents. The present invention also involves a decided simplification of the stops and dogs and like actuating mechanism carried by the table 1 in order to control the amplified or extended movement of said table, both to dress and true the grinding wheel, and to bring the carriage 1 to its position of rest, as shown in Fig. 1.

The fluid pressure actuating and reversing mechanism of the present invention involves the use of a pilot valve which is actuated by the reversing member 24, said pilot valve in turn controlling a main valve which connects the pipes 20 and 21, one to pressure and the other to exhaust.

Referring now to Figs. 2, 4 and 11, the pilot valve 27 is located in a suitable casing 28 which is in turn attached to a large or general casing 29 suitably attached to the machine base, the front of which may be plainly seen in Fig. 1. The pilot valve casing 28 comprises simply a piece of suitable material having a cylindrical bore extending therethrough, the valve member 27 making a close fit within said bore. Pressure fluid is admitted to the bore in the casing 28 by means of a pair of conduits 30 and 31 which are shunted into a main fluid supply line 32 which is connected with any suitable source of fluid under pressure, such as a pump 33. The valve member 27 comprises three portions of full diameter 34, 35 and 36 which fit with a close sliding fit within the bore of the casing 28, and which are spaced apart by reduced portions 37 and 38. At one end of the valve member 27 there is a further reduced portion 39, bounded on the end by a full diameter portion 40. A forked portion 41 of the reversing member 24 surrounds the reduced portion 39, and the width of the fork and length of the reduced portion is such that when the reversing member is moved from one extreme position to the other, the valve 27 is not moved until said reversing member passes its central position. Associated with the reversing member 24 is any convenient form of the usual snap-over device, the actuating member 42 of which operates a wedge member 43 fastened to the reversing member 24.

The valve casing 28 provides a pair of ports 44 and 45 which lead fluid to the opposite ends of the main valve, and an exhaust or discharge port 46. When fluid is admitted to the port 45, which is the right hand port of the pilot valve 27, 28, it flows through a conduit 47 which leads to the right hand end of the main valve, which will cause the main valve to be positioned to drive the carriage 1 to the right, Fig. 1. When fluid is admitted to the port 44 of the pilot valve, however, the fluid flows through a pair of conduits 48 and 49 to the left hand end of the main reversing valve. During the normal operation of the machine the conduits 48 and 49 are always in communication, being connected through a valve whose casing is numbered 50. Under what conditions the connections between the conduits 48 and 49 is broken will be hereinafter pointed out.

The main valve casing 51, which may be attached to the rear of the box 29 as shown in the sectional view of Fig. 4, is illustrated in that figure, and is shown in front elevation in Fig. 6. A right hand elevation of it is shown in Fig. 9, and a vertical sectional view of it is shown in Fig. 5. Referring now to Figs. 4 and 5 for the actual structure, and to Fig. 11 for an easy understanding of the functional operation of the valve, it will be seen that the conduit 47 connects to a cylinder bore 52, while the conduit 49 connects to a similar bore 53. In these bores 52 and 53 are located pistons or plungers 54 and 55 whose ends abut plugs or the like 56 and 57 in the ends of the main valve member designated generally by the numeral 58.

As shown in Figs. 4, 5 and 11, the main valve 58 comprises a hollow cylindrical member, the ends of which are closed off by the plugs 56 and 57 aforesaid, a divisional wall 59 being left in between these plugs thus dividing the interior of the valve into two chambers. The valve member 58 fits slidably in a bore 60 provided by the casing 51, and is adapted to be urged into either of its end positions as the fluid from the pilot valve is alternately admitted to the chambers 52 and 53. The left hand chamber of the valve member 58 is numbered 61 and the right hand chamber is numbered 62. The chamber 61 provides two sets of ports through the side wall of the valve, 63 and 64. The chamber 62 provides three sets of ports through its side wall, 65, 66 and 67. These five ports 63, 64, 65, 66 and 67 control the admission of fluid from the main supply source 33 to the conduits 20 and 21 leading to the opposite ends of the cylinder 18 in order to move the carriage 1;—at any given time one of said conduits 20 and 21 being connected to the pressure, and the other of said conduits being connected to an exhaust or dis-

charge port 68, excepting only when the table is held at the idle position by a stop valve which will be described. Before describing the ports with which the aforesaid ports cooperate, the manner in which fluid is introduced into the valve casing 51 will be described.

The main fluid supply line 32 connects at 69 to a chamber 70 in which is contained a rotatable valve 71 which normally, however, offers free passage through a port 72 for the pressure fluid. Port 72 connects with the passage 73 in which is located a throttle valve 74 which may be manually controlled from the front of the machine by means of a knob 75. The other side of the throttle valve 74 connects to a cross passage 76 which connects with passages 77 and 78. Passage 77 terminates in a port 79 and the passage 78 terminates in the port 80.

When the main valve 58 is in its left hand position as shown in all figures, the port 79 is in communimation with the port 63, thus admitting fluid to the chamber 61. At that time also the port 64 through the valve 58 is in communication with a port 81 at the end of the conduit 20, so that fluid is admitted to the left hand end of the cylinder 18. At that time also the port 65 of the valve member 58 is in communication with the exhaust port 68, while the chamber 62 receives the fluid from the right hand end of the cylinder 18 for exhaust, through a port 82 that is at that time in communication with the port 66 of the valve member. The port 82 is not at the end of the conduit 21, but communicates with a chamber 83 in which is located a rotatable valve 84 which normally allows fluid to flow through a port 85 that communicates with a passage 86 which is directly connected to the end of the conduit 21. A cross passage 87 connects the passage 86 with a port 88 for a purpose which will hereinafter appear.

When the valve member 58 is moved to the right hand position, the port 63 is moved away from the port 79, and fluid can therefore no longer flow to the left hand end of the cylinder 18, said left hand end being on the contrary connected to the exhaust port 68. This connection is effected by reason of the fact that the port 63 now is in communication with the port 81, while the port 64 is in communication with the port 68. At the same time fluid is admitted to the right hand end of the cylinder 18 by reason of the fact that the port 66 is in communication with the port 80 at the end of the passage 78, thus admitting fluid to the chamber 62. The inside of the chamber 62 is at that time completely cut off from the exhaust port 68, but the ports 65 and 67 are in communication respectively with ports 82 and 88, and so two passages are provided for the flow of fluid to the conduit 21 and to the right hand end of the cylinder 18.

From the foregoing it will be seen that when the table or carriage 1 has carried the grinding wheel to the left to cause said grinding wheel 5 to enter the chuck 6, and to place the reversing dogs 22 and 23 on either side of the reversing member 24 and projections 25 and 26, the carriage 1 will be reciprocated back and forth, as said reversing member 24 is mechanically shifted first to one side and then the other, because of the fact that the pilot valve 27 is shifted back and forth, thus admitting fluid to the chambers 52 and 53 and therefore alternately moving the main valve member 58 from one extreme position to the other, to admit the fluid through the passages described first to the right and then to the left hand side of the operating cylinder 18. The use of the pilot valve 27 to operate the main valve permits a small balanced valve to be operated by the mechanical means responsive to the movement of the carriage 1, and thus to obtain a quick action of said pilot valve, which in turn procures fluid pressure actuation of a larger valve that will handle the full volume supply of pressure to move the carriage 1. The use of the fluid pressure system herein described also permits the amplification of the traverse of the carriage 1 for wheel dressing purposes to be obtained with a very simple mechanical mechanism in place of the rather complicated mechanical devices shown in the aforesaid patents. The manner and mode of operation of this part of the present invention will now be set forth.

Once the carriage 1 is started reciprocating in working position, it continues its reciprocation with continual small angular movement of the cross feeding wheel 8 and screw shaft 7 until such time as the cam member 10 on the wheel 9, which is also fastened to the shaft 7 (see Fig. 13) comes into contact with the aforesaid screw 11 and so rocks the lever arm 12. Such movement of the arm 12 brings a contact member 89 carried by the arm into engagement with a contact 90 on a suitably mounted and insulated arm 91. The arm 12 is grounded, as illustrated at 92, while the contact 90 is connected by a conductor 93 to one terminal 94 of a switch which is designated as a whole by the numeral 95, and whose oscillatory switch member 96 at that time connects the terminal 94 with a terminal 97, a connector 97′ providing an electrical connection from the terminal 94 to the end of switch member 96. The terminal 97 is connected by a conductor 98 to one terminal of an electromagnet 99, the other terminal of which is connected by a power line 100 to a suitable source of electric current G whose other terminal is grounded as shown at 101. It will thus be seen that a complete circuit is formed to energize the magnet 99, and this

procures the dressing operation in a manner that will now be set forth.

The magnet 99 is located in the casing 29 on the front of the machine, and has associated therewith an armature 102 which is attached to a lever 103, the bottom end of which is connected at 104 to a valve member 105, and the upper end of which provides an inclined projecting surface 106 for a purpose which will hereinafter appear. Energization of the magnet 99 draws the arm 103 in a counter-clockwise direction to move the valve member 105 to the right.

The valve member 105 is located in the casing 50, and said valve member and said casing really operate as two separate valves. Thus the movement to the right of the valve member 105 performs two functions, namely, it causes the movement down into dressing position of the diamond 15, and it acts to prevent normal reversal of the carriage 1 at the right hand end of its normal reciprocatory working stroke.

Referring now particularly to Figs. 4 and 11, the valve member 105 is generally cylindrical and fits with a sliding fit in the cylindrical bore in the casing 50. It provides two portions of reduced diameter 107 and 108, and it also provides a longitudinal bore 109 which is pierced by a pair of transverse bores 110 and 111. The bore 109 is blocked at the end from which it is drilled by a plug 112, and does not extend beyond the left hand transverse bore 110.

The casing 50 provides five ports which are, reading from left to right, ports 113, 114, 115, 116, and 117. During the normal operation of the grinding machine, while the carriage 1 is being reciprocated as hereinbefore described, the reduced portion 108 of the valve member 105 connects the ports 116 and 117, the former being the terminus of the conduit 49 at one end, and the latter being the terminus of the conduit 48 at one end. It is thus that fluid normally flows from the pilot valve 27, 28 to the main valve 58. When, however, the valve member 105 is shifted to the right as just described, the ports 116 and 117 are no longer in communication;—the transverse bore 111 is placed in line with the port 116, and the transverse bore 110, is placed in line with the port 113, which latter port is an exhaust port, so that the conduit 49 is connected to the exhaust and thus the bore 53 is connected to exhaust and the piston 55 can be moved to the left.

It therefore follows that at the end of the leftward movement of the carriage 1 (providing the carriage is so moving when the valve 105 was shifted), the reversing lever 24 will be shifted as usual, and the pilot valve 27 will be moved, and this will cause fluid to be admitted to shift the main valve 58 to the left, causing the carriage 1 to be withdrawn to the right, but the subsequent reshifting of the reversing lever 24, as the carriage travels to the right, which will result in movement of the pilot valve 27, will not be effective to move the main valve 58, since the bore 53 is cut off from the pressure fluid and connected to exhaust through the valve 50, 105. The carriage 1 will therefore continue its movement to the right, draw the grinding wheel out of the workpiece, where it will be ultimately reversed as will be hereinafter described.

The other function of the valve 50, 105, is to cause the diamond 15 to be lowered into the path of the wheel 5. In the position of parts shown in Figs. 4 and 11, the port 114 is connected to the port 113 and disconnected from the port 115. The port 115 is connected by means of one or more conduits 118, 119 with the source of pressure such as the pump 33. The port 114 is connected by a conduit 120 with a cylinder 121 in which is located a piston 122. Movement of the valve member 105 to the right, connects together the ports 114 and 115, so as to admit fluid through the pipe 120 to the cylinder 121. This cylinder 121 is located in the base 17 for the diamond oscillatory member 16, and admission of fluid to it causes downward movement of the dressing device by reason of oscillation of the member 16. The manner in which this takes place responsive to movement of the piston 122 forms no part of the present invention, since the mechanism for moving the diamond is the invention of Heald and Guild and described in application Serial No. 25,900 now Patent No. 1,779,094, granted October 21, 1930, while the specific mounting for the oscillatory member 16 and the various parts associated with it are fully described in Patent No. 1,655,903 granted to Guild and Grimshaw on January 10, 1928.

The movement of the diamond 15 into position and the withdrawal of the grinding wheel 5 from the workpiece causes contact between the wheel and dressing device with consequent truing of the former. The movement of the carriage 1 to the right takes place at a slow rate of speed since the valve member 71 is moved to restrict the flow of the fluid to the cylinder 18 through the passage 72. Movement of the valve member 71 is obtained through action of mechanism which is substantially the same as that shown in the aforesaid patent to Heald and Guild, but insomuch as the present invention involves a novel means for resetting this valve, the mechanism for operating it will be described.

As disclosed in the aforementioned patent to Heald and Guild, movement of the piston 122 actuates a lever arm which is attached to a shaft 125. This shaft 125 extends along the back of the machine and forms the pivotal mounting for the actuating mechanism for the diamond. On one end of it is fastened an arm 126, Fig. 10. The end of the

arm 126 has pivotally attached thereto a threaded rod 127 having two pairs of nuts 128 and 129 thereon. Between the double pair of nuts 128 and 129 is a lug 130 through which the threaded rod passes. Upward movement of the rod 127 raises the lug 130, and as the lug 130 is formed on an arm 131 which is attached at 132 to a bell crank lever 133, it causes counterclockwise oscillation of the said bell crank lever 133. The bell crank lever 133 is connected by a link 134 to a lever 135 which is fastened to the shaft 136 of the slow-down valve 71. It will thus be seen that rocking of the shaft 125 causes oscillation of the slow-down valve 71, and consequently whenever the diamond 15 is lowered, the speed of the carriage 1 is reduced.

When, as will presently be described, the carriage 1 returns the grinding wheel 5 to the workpiece, the shaft 125 is automatically rocked back into its original position, from the fact that the fluid pressure is no longer connected to the cylinder 121, and by reason of the action of mechanical means described in the aforesaid patent to Heald and Guild. This repositioning of the shaft 125 causes resetting of the valve 71, more or less, in accordance with the setting of the nuts 128, as will be readily apparent from Fig. 10.

It will be recollected that on the right hand movement of the carriage 1, the reversing lever 24 was shifted as usual by the engagement of the table dog 22 with its projection 26. The mounting of the lever 24 provides for sufficient movement so that the dog 22 may ride beyond it, which it does during the dressing of the grinding wheel described. The pilot valve 27 is, therefore, in position to cause the carriage 1 to return the grinding wheel 5 to the work, except that it is inoperative to do so owing to the shifting of the valve 105. Consequently reshifting of the valve 105 into its original position, will cause the return of the carriage. This is effected in the following manner.

Referring to Fig. 3, the carriage 1 provides a carrying block 137 which, the same as the carrying blocks 138 and 139 for the dogs 22 and 23, is adjustably mounted on the front of said carriage. A striking dog 140 is attached to said carrying block, and in the path of travel of this dog 140 is the projecting portion 106 of the lever 103. Consequently it will be seen that movement to the right of the carriage 1 will cause engagement of the dog 140 with the portion 106 of the lever 103, and this will forcibly reposition this lever and therefore also the valve member 105. Prior to this time, the magnet 99 is deenergized, so as to let the valve 105 remain repositioned, and this deenergization of the magnet 99 is accomplished in the following manner.

The switch member 95 whose oscillatory member 96 connects the magnet 99 with the circuit that energizes it, comprises a button operated switch of a common and well known type, and an operating mechanism for it. The operating mechanism comprises an upwardly extending arm 141 mounted on a pivot 142 and having operating portions 143 and 144 which are located above the buttons 145 and 146. Springs 147 and 148 normally hold the member 141 in the position shown in Figs. 12 and 13. When, during the outward movement of the carriage 1, a dog or stop 150 carried by the carrying block 139 strikes the arm 141, the right hand button 146 is depressed, and this snaps the switch member 96 to open position. This placing of the switch 95 in off position occurs just prior to the actuation by the dog 140 of the lever 103, and consequently there is no force opposing repositioning of the valve 105.

As soon as the portion 108 reestablishes the connection between the ports 116 and 117, the main valve 58 will be shifted and the carriage 1 will be reversed. In order to shift the valve 105 completely to its original position, and in order to quicken the action of the mechanical means just described, the following fluid pressure connections are established to create a positive force holding the valve member 105 in its normal position.

Referring now to Figs. 4 and 11, the port 116 has shunted into it a passage 151 which connects with a bore 152 in which is located a small piston 153. The small piston 153 is an integral part of the plug 112, and consequently the least opening of the port 116 will admit fluid to the bore 152 and cause the piston 153 to be urged to the left, thus positively assisting in the return of the valve member 105.

It will be understood that shifting of the valve 105 reconnects the port 113 with the port 114, and so opens the conduit 120 to exhaust, allowing the fluid to be pressed out of the cylinder 121 when the mechanical means operates to reposition the diamond. This mechanical means is described in the patent to Heald and Guild and operates as the carriage 1 returns the wheel 5 to grinding position.

It has already been mentioned that the machine of the present invention makes use of a rotating gauge according to the McDonough Reissue Patent No. 16,141 in order to cause the grinding operation to cease when the workpiece has reached the correct size. The means for reciprocating this gauge so that it will be repeatedly urged against the workpiece desirably takes the form of a spring or other resilient means, and may be somewhat as shown in Patent No. 1,534,302 to Prentice Conradson and others, granted April 21, 1925. It has been found very desirable, however, that the gauge should not contact with the workpiece during all of the

grinding operation, since repeated shocks are apt to cause some misalinement in the chuck or other damage. In the above noted Patent No. 1,830,358, one manner of holding the gauge out of position and away from the workpiece until the workpiece is almost brought to correct size is shown and described. The present invention involves an improvement in the apparatus therein set forth, in the particular means for allowing the gauge to operate, and for holding it inoperative during the preliminary grinding.

Referring now to Fig. 1, at the left hand end of the workhead 3 is a casing 155, which contains a cylinder 156 having a piston 157 thereon. The piston has a piston rod which is located just in front of a member 158 which is attached to the gauge rod 159. A spring 160 tries to urge the gauge rod 159 and associated parts to the right, while a screw 161 is urged to the left at each leftward reciprocation of the table 1 to move the gauge back. But when the pressure fluid is admitted to the right hand end of the cylinder 156, the gauge rod is shifted to the left and held there so as to prevent the gauge from gauging the workpiece.

During the preliminary grinding, the fluid is admitted to the cylinder 156, passing by way of the supply conduit 119 and a branch conduit 163 to a port 164 in a valve casing 165. The port 164 is at that time in communication with a port 166 leading to a conduit 167 that connects to the cylinder 156. In the valve casing 165 is a valve member 168 comprising a pair of full diameter portions, connected by a reduced portion 169. During the preliminary grinding operation, the reduced portion 169 allows communication between the ports 164 and 166 as aforesaid, while one of the full diameter portions blocks off the exhaust port 170.

A conduit 171 is shunted into the conduit 120 and this connects the conduit 120 with a port 172 in the end of the valve casing 165. When fluid is admitted into the port 172 and valve casing 165, the valve member 168 is urged to the left, and the fluid supply port 164 is shut off, while the port 166 leading to the cylinder 156 is connected by way of the reduced portion 169 with the exhaust passage 170. Thus it will be seen that energization of the magnet 99 and consequent shifting of the valve member 105, allowing fluid to flow through the conduit 120, also shifts the valve 168 and allows fluid to exhaust from the cylinder 156, thus permitting the gauge on the gauge rod 159 thereafter to engage the workpiece under the influence of the spring 160, the gauge being urged out of engagement at each left hand movement of the carriage 1 as described in the patent to Conradson aforesaid.

After the dressing operation and the reentry of the grinding wheel 5 into the workpiece as described, the carriage 1 continues its limited reciprocatory traverse over the same working range as during the preliminary grinding operation, which is determined by the setting of the adjustable blocks 138 and 139 that carry the table dogs 22 and 23. The rate of movement of the carriage, however, is determined by the setting of the valves 71 and 74, the carriage reciprocating with a speed determined by the more restricted of these two valves. Ordinarily this would be the valve 71, whose position during the final and finishing cuts taken on the workpiece is determined by the setting of the adjustable nuts 128 shown in Fig. 10.

During this time the gauge, not shown, which is continually rotating at the same speed as the workpiece, as set forth in the patents to McDonough and Conradson and which is intermittently urged against the workpiece as also set forth in those patents, is continually endeavoring to enter the bore of the workpiece. Such entry occurs, however, only when the workpiece reaches the ultimate finished diameter. When that occurs the gauge rod 159 undergoes a greater movement to the right than heretofore, and this action brings together two contact terminals 173 and 174, the former of which is grounded, and the latter of which is connected by a conductor 175 to an electromagnet 176. The other terminal of the electromagnet 176 is connected by a shunt lead 177 to the conductor 100 coming from the generator G, and thus at that time the electromagnet 176 is energized.

The electromagnet 176 is illustrated only in Fig. 13, but it is located directly behind the electromagnet 99 and has associated therewith an armature member 178 on a lever 179, which is pivotally mounted on the same pivot 180 that holds the lever 103. Likewise it has a portion 181 extending upwardly from the casing 29, and indeed all these parts are duplicates of the armature lever etc. associated with the magnet 99.

The upper end 181 of the lever 179 is directly in the path of travel of the left hand table dog 22, which is a pivotally mounted dog mounted upon a screw or the like 182 provided by the carrying block 138, and normally extending downwardly in the position shown in Fig. 3, but capable of being lifted up beyond said position. Raising of the end 181 of the lever 179 lifts the dog 22 (it will be noted that the dog 22 is very long as shown, and the contact of the portion 181 therewith may actually take place near the pivot point 182), so that on the subsequent right hand movement of the carriage 1 the dog 22 is lifted entirely clear of the portion 26 of the reversing lever 24. The pilot valve 27 is therefore not shifted to the left, and the carriage 1 continues outwardly, carrying the

grinding wheel to idle position where it is stopped in the following manner:—

It will be remembered that on the right hand stroke of the carriage 1, the fluid from the right hand end of the cylinder 18 passes through a valve 83. This valve 83 has a stem 18^ to which is fastened an arm 184 (Fig. 9). A spring 185 attached to the arm and to a pin 186 normally urges the arm in such a direction as to keep the port 85 of the valve open. When the carriage 1 travels to the position shown in Fig. 1, however, an abutment, not shown, carried thereby engages the arm 184, and this swings the arm shutting off the port 85, and thus locking the fluid in the right hand end of the cylinder 18. It will be apparent that thereafter the carriage can move no further to the right. It should be noted, however, that whenever the pilot valve 27 is moved to move the main valve 58 to its right hand position, fluid can pass to the right hand end of the cylinder 18 by way of the passage 87 and ports 67 and 88.

Movement of the lever 179 also operates a valve and causes the grinding wheel to move laterally away from the workpiece before it is removed therefrom axially, causes a resetting of the speed control valve 71 to its wide open position, and causes the gauge to be held back in its inoperative position. To that end the lever 179 is operatively connected at 187 to a valve member 188 which is located in a casing 189 which may be desirably formed integrally with the casing 29. The valve member 188 provides a single reduced portion 190 which is adapted to connect a port 191 either with a pressure supply port 192 or with an exhaust port 193. Before movement to the right of the valve member 188 responsive to the energization of the magnet 176, this valve member 188 connects together the ports 191 and 193, so that any fluid in conduit 194 is connected to exhaust. The movement of the valve member 188 to the right, however, closes the exhaust port 193 and opens the fluid entrance port 192 (which connects to the supply conduit 119) so as to admit the pressure fluid to the conduit 194. This conduit 194 leads to a cylinder 195 in which is a piston 196 that causes lateral separation of the wheel and workpiece. The rest of the mechanism for performing this operation, however, forms no part of the present invention, and may be of any desired form and is set forth in previous patents so that it will not be herein described.

Fluid from the conduit 194 also enters a cylinder 197 having a piston 198. Referring now to Fig. 10, this piston and cylinder are herein shown, and the piston is in engagement with one end of the lever arm 135. Outward movement of the piston therefore moves the lever arm and the valve 71 in a clockwise direction, Fig. 10, and completely resets this slow-down valve to its wide open position, bringing the lug 130 down against the lower adjustment nuts 129. This resetting permits the next grinding operation to take place with the roughing cuts at a speed determined solely by the manually adjusted valve 74.

The conduit 194 also connects to the cylinder 165, at the left hand end thereof, Fig. 11, and consequently repositions the valve 168 in its right hand position, allowing pressure fluid to flow into the cylinder 156 and to maintain the gauge away from the workpiece during the first part of the next grinding operation.

Movement of the carriage 1 to idle position is desirably at a high rate of speed irrespective of the setting of the valve 74, and this is provided for in the following manner:—

On the back of the carriage 1 is a track cam member 200 which cooperates with a short arm 201 having a roller 202 that fits in the track of the cam, the arm being fastened to a shaft 203. Movement of this arm may operate the draw rod to open and close the chuck 6, and/or turn on and off the water supply for the grinding operation. At all events, a valve 204, Fig. 11, is formed on the shaft 203, and this valve is located in a fluid supply line 205. When the carriage 1 starts outwardly, it goes at slow speed during the first part of its movement until the cam 200 has moved its arm 201 and the valve 204, whereupon fluid is admitted to a conduit 206 leading to a chamber 207 in the casing 51. A piston or plunger 208 is located in this chamber or bore and is normally shown in the position in Fig. 11 by reason of the pressure of a spring 209. The plunger 208 has a reduced portion 210, which when the plunger is moved upwardly permits fluid to flow along a passage 211 which connects to the chamber 70 at one end and to a cross passage 212 at the other end. The cross passage 212 leads by way of a valve 213 to the passage 76, and thus when the plunger 208 is raised, fluid can enter this passage independently of the valve 74, and so the carriage 1 will be moved at a speed determined only by the setting of the valve 213.

The conduit 206 also connects to a shunt conduit 215 which leads to a cylinder 216 having a piston 217 that operates a clutch in the workhead to stop rotation of the chuck 6. The mechanical features of this mechanism, however, do not concern the present invention and will not be described. An exhaust port 218 is provided in the valve casing 219 for the valve 204, so that when the valve is replaced as it will be by the cam 200 as the grinding wheel 5 enters a new workpiece, the chamber 207 will be connected to exhaust and thus the passage 211 will be blocked in order to compel the fluid to pass in series through the valves 71 and 74.

From the foregoing description it will be

seen that each grinding operation is determined by the entry of the gauge into the bore of the workpiece. Since, however, the gauge is not allowed to operate until the dressing operation takes place, and since the dressing diamond 15 must have a certain definite relationship to the grinding wheel 5 in order to true it during each dressing operation, despite wear and previous dressing, it is necessary to make some adjustment between the dressing device and the grinding wheel at periodic intervals. The adjustment should involve an advance between these two elements, which advance should be enough to take care of the greatest amount of wear which normally occurs between grinding wheel and workpiece, together with a slight added increment to secure actual removal of material from the wheel 5, in order to true its surface and render it sharp and free cutting. To that end the wheelhead 2 is mounted upon a cross slide 2*a* which is adapted to be moved laterally of the machine frame by means of a screw shaft 220. Every time the carriage 1 runs out to rest position a cam member 221, carried on a stationary part of the machine is engaged by a roller 222, fastened to a pivotally mounted member 223 upon which is also mounted a pawl 224;—consequent elevation of the pawl 224 actuates a ratchet 225 attached directly or indirectly to the screw shaft 220, and thus causes movement of the wheelhead 2, this action being termed compensating for wheel wear and dressing. This particular mechanism is not per se subject to the present invention being illustrated in the aforesaid Patent No. 1,830,358.

The grinding machine of the present invention is intended to operate automatically from the time that the workpiece is placed in the chuck 6 until it is removed therefrom and another workpiece substituted in its stead. Nevertheless, the carriage 1 has to be manually started to commence the grinding operation, and it is also desirable that the machine have manual controls in order that one or two workpieces may be ground non-automatically, and in order, indeed, that the machine may be properly set to grind a series of workpieces automatically. To that end provision is made for energizing the magnet 99 at any time; so as to cause the diamond 15 to be lowered and the carriage 1 to withdraw the grinding wheel from the workpiece, such means constituting simply a conductor 226 shunted into the conductor 98 and connected to a push button switch 227, one terminal of which is grounded at 228. Similarly also, a push button switch 229 is adapted at any time to energize the electromagnet 176 to cause the carriage 1 to run out to idle position, one terminal of this switch 229 being connected to a conductor 230 that connects to the lead 175, and the other terminal being connected to ground 228. A shaft 231, having a lever 232 on the front of the machine, is rotatably mounted in the general casing and provides an eccentric pin which fits in a slot 233 provided by the reversing member 24, and thus the reversing member 24 may be manually operated at any time.

The switch 95 must be susceptible of manual operation and in order that this may be done without touching the arm 141, a knob 234 is provided on the front of the machine on the end of a shaft 235. On the shaft 235 is a block 236 having a pair of pins 237 which fit underneath the projecting portions 143 and 144 to oscillate the member 141 on its pivot 142, and thus to actuate the push buttons 145 or 146. Also the shafts for the valves 74 and 213 project through the front of the casing 29 and terminate in dial members 75 and 240 respectively. By turning the dial 240, the valve 213 can be entirely shut off so as to prevent the carriage from travelling at its highest rate of speed, or at least limiting it to the speed determined by the valves 74 and 71.

It should be noted that the valve 58 will shift rapidly under the impulses given it by the small pistons 54 and 55, because the valve is hollow, and therefore has little inertia. Notwithstanding this, the valve 58 controls a large number of ports, and is perfectly balanced both radially and axially. The ends of the main bore 60 desirably provide vent holes (not shown) so that neither air nor escaping fluid (oil) will impede the movement of the valve member 58. These vent holes may be connected by a pipe to each other or to the sump provided by machines of this character for the pressure fluid.

The operation of the machine has been largely indicated in the foregoing description of the various parts and mechanisms, but in the interest of a thorough understanding of the invention it will be briefly reviewed. Assuming a workpiece is placed in the chuck 6, and all adjustments made, with the carriage 1 in the position shown in Fig. 1, the grinding operation will be started by shifting the lever 232 to the left thus disposing the reversing member 24 in its right hand position, and placing the pilot valve 27 in its left hand position. This causes fluid to pass through the valve member 105, which at that time is in the position shown in Fig. 11, the fluid being admitted to the left hand end of the main valve member 58, thus disposing said valve member in its right hand position and causing fluid to be admitted to the right hand end of the cylinder 18. The carriage 1 thereupon moves to the left carrying the grinding wheel into the workpiece, the left hand pivotally mounted dog 22 lifting over the right hand prong 26 of the reversing lever 24 as it does so.

The carriage continues to reciprocate back

and forth to maintain the grinding wheel in contact with the workpiece, and causing the gradual enlargement of the bore thereof by reason of cross feed mechanism not described herein, the reciprocatory motion being effected by alternate shifting of the pilot valve 27 and consequent movement of the main valve member 58.

When the work by grinding has reached a certain predetermined diameter, which is desirably just short of finished size, the cam 10 which is connected to the cross feed screw shaft 7 engages the adjustable screw 11 and brings together contacts 89 and 90. The switch member 96 is at this time in the position shown in Fig. 12 where it connects the terminal 94 to terminal 97. During the aforesaid passage of the carriage 1 from its inoperative position, to begin its grinding reciprocation, it caused engagement of the switch dog 150 with the arm 141 and necessarily depressed the left hand button 145 of the switch 95. In passing it should be noted that the mechanism of the switch is not illustrated, as it would have to be shown on a very enlarged scale, and the switch is of a very common type and no part of the present invention.

The bringing together of the contacts 89 and 90 with the switch member 96 in the position shown in Fig. 12 closes the circuit which energizes the magnet 99. This, as already described, causes the attraction of an armature 102, the shifting to the right of valve member 105, and the raising of the projection 106. By this action, fluid pressure being prevented from reaching the left hand side of the main valve 58, the ultimate travel to the right of the carriage 1 is assured, at the same time fluid is directly admitted to the cylinder 121 and the diamond 15 is lowered as soon as it is permitted to do so by mechanical controlling instrumentalities which are the subject matter of the patent to Heald and Guild already referred to. At the same time admission of the fluid to the pipe 120 leading to the diamond operating cylinder 121 causes the fluid to flow into the right hand end of the cylinder 165, thus causing shifting of the valve member 168 therein and cutting off the supply of fluid to the gauge controlling cylinder 156. Previously to this time the gauge had been maintained by the piston 157 in said cylinder out of the range of the grinding wheel and workpiece. By the cutting off of the pressure from the cylinder 156, however, the gauge operating spring 160 is allowed to shift the gauge rod 159 to the right and thereafter, for the remainder of the grinding operation, the gauge engages the workpiece at each stroke of the carriage 1, being urged against the workpiece by the spring 160, and being removed away from the workpiece at each left hand stroke of the grinding wheel 5 in order that the grinding wheel may completely grind the workpiece by the engagement of the left hand end of the carriage 1 with the adjustable bolt 161.

The right hand extended travel of the grinding carriage 1 and the lowering of the diamond 15 causes the dressing and truing of said wheel. The lowering of the diamond 15 is accompanied by partial rotation of a certain rock shaft 125, the relation of which to the diamond operating mechanism has been explained by reference to the aforesaid patent to Heald and Guild. This procures, through the connections described and shown in Fig. 10, an angular displacement, more or less, of the valve 71, thus slowing down the speed of travel of the carriage 1 for the dressing operation.

The outward travel of the carriage does not fail to shift the pilot valve 27 to its left hand position by reason of engagement of the table dog 22 with the right hand prong 26 of the reversing lever 24. This is ineffective, however, at first to stop the travel of the carriage by reason of the shifting of the valve 105, as fully described. Ultimate reshifting of the valve 105 to its original position by engagement of the dog 140 with the projection 106, however, causes immediate shifting of the main valve 58 and return of the grinding wheel to the workpiece. Just before this return motion, the dog 150 strikes the arm 141 and causes shifting of the switch member 96, so that the magnet 99 is deenergized despite maintenance of the engagement between contacts 89 and 90.

The reshifting of the valve 105 to its original position also cuts off the fluid pressure to the diamond operating cylinder 121 and the diamond is raised again by mechanical means associated with the carriage 1 and described in the Heald and Guild patent. Such repositioning of the diamond 15 involves movement of the shaft 125 and disrepositions the valve 71, more or less, according to the setting of the nuts 128. Thus the grinding operation is resumed at any speed or traverse from the original grinding speed as determined by the adjustment of the valve 74 to the reduced speed or traverse for the dressing operation as determined by the original shifting of the valve 71, both inclusive. It will be noted that the opening of the supply pipe 120 to the exhaust to allow repositioning of the diamond, while it relieves the pressure against the right hand end of valve member 168, does not change the position of that valve member, because there is at that time no force to move it to the right.

The grinding wheel now takes the final and finishing cuts upon the workpiece, reciprocating back and forth until the workpiece bore comes to the desired size and the gauge enters therein. When that happens, the gauge rod 159 moves and brings to-

gether contacts 173 and 174. This energizes the magnet 176, with the consequent lifting of the projection 181, which projection raises the left hand dog 22 high enough to cause it to clear the right hand prong 26 of the reversing lever 24. The carriage 1, therefore, continues to move to the right carrying the grinding wheel out of the workpiece, thus definitely terminating the grinding operation.

The energization of the magnet 176 also shifts the valve member 188 to the right and causes the actuation of several other instrumentalities. In the first place fluid is admitted to the cylinder 195 which actuates the piston 196 to cause the wheel to move laterally away from the workpiece before it has entirely left the bore thereof in order to prevent scratch marks being formed on the surface of the workpiece. This mechanism is not per se part of the present invention and is not described herein, but the same conduit 194 which leads fluid pressure to this back-off cylinder may be used for other purposes, as described.

Connected to the pipe 194 is the left hand end of the cylinder 165 and also the cylinder 197. The latter completely resets the automatically operated slow-down valve 71 to its wide-open position when fluid is admitted to it. Admission of fluid to the former reshifts the valve member 168 to its right hand position and thus causes the gauge to be thereafter held out of range of the workpiece. This is not important for the grinding operation that has just been terminated, but sets the machine for the preliminary grinding of the next workpiece.

The actual travel of the carriage 1 to its position of rest also causes the track cam 200 to engage the roller 202, thus disconnecting the clutch for the chuck 6 and causing the opening of said chuck so that the workpiece may be quickly taken out. It also causes fluid to be admitted through pipe 206 to chamber 207 thus raising the plunger 208 and admitting fluid through the by-pass passage 211 so that the travel to either position of the carriage will take place at a speed which is controlled only by the setting of the valve 213 by the knob 240. The final occurrence in a cycle of grinding involves the engagement of some portion of the carriage with the arm 184, thus turning the valve member 84 and preventing fluid from escaping from the right hand end of the cylinder 18. This stops the carriage 1 but, as will be remembered, does not prevent the carriage from being started again by shifting of the hand lever 232, since an ultimate passage is provided for the fluid when the main valve 58 is moved to its right hand position.

Although the invention has been described in considerable detail, it will be evident that various modifications may be made within the spirit thereof, which is set forth in the following claims.

I claim:

1. In a grinding machine, a table or carriage reciprocation of which causes relative traverse between grinding wheel and workpiece, fluid pressure mechanism to actuate said carriage, a valve to control said fluid pressure mechanism, mechanical means to actuate said valve including dogs or stops carried by said carriage, said means normally actuating said valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement, and an additional valve to procure an extended movement of said carriage beyond the normal traverse independently of the normal actuation of the first valve by said mechanism.

2. In a grinding machine, a table or carriage reciprocation of which causes relative traverse between grinding wheel and workpiece, fluid pressure mechanism to actuate said carriage, a valve to control said fluid pressure mechanism, mechanical means to actuate said valve including dogs or stops carried by said carriage, said means normally actuating said valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement, an additional valve to procure extended movement of said carriage beyond the normal traverse independently of the normal actuation of the first valve by said mechanism, and an additional stop on said carriage to actuate said second valve upon the extended movement of said carriage beyond normal position to reverse the direction of carriage movement, and return said carriage to the normal reciprocatory position.

3. In a grinding machine, a table or carriage reciprocation of which procures the grinding traverse between the grinding wheel and workpiece, a fluid pressure motor to actuate said carriage, a main valve to control admission of fluid to said motor to cause the said reciprocation, a pilot valve to actuate the main valve, pressure lines connecting one end of said pilot valve to one end of said main valve and the other end of said pilot valve to the other end of said main valve, and an additional valve in one of said pressure lines to qualify the movements of said main valve in response to movement of said pilot valve.

4. In a grinding machine, a table or carriage reciprocation of which causes the grinding traverse between the grinding wheel and workpiece, a fluid pressure motor to actuate said carriage, a reversing valve for the pressure fluid, a stop valve actuated by the carriage in one position which cuts off the flow of fluid to one end of said motor, and an alternate passage for flow of said fluid through said reversing valve to said end of

said motor with the reversing valve in one of its end positions only.

5. In a grinding machine, a table or carriage reciprocation of which procures the grinding traverse between the grinding wheel and workpiece, a fluid pressure motor to actuate said carriage, and valve mechanism to control said carriage and to stop it comprising a valve member and a valve casing having one port leading to one end of said motor and a pair of ports leading to the other end of said motor, a shut-off valve associated with one of the last named ports and connections to a source of pressure, the reversing valve being adapted to direct the pressure either to the first port or to the pair of ports as it is placed in different positions.

6. In apparatus as claimed in claim 5, the combination with the parts and mechanisms therein specified, of a pilot valve to actuate the said reversing valve.

7. In apparatus of the class described, a fluid pressure motor, a main reversing valve to control said fluid pressure motor, a pilot valve to control said main reversing valve to reverse the flow of fluid, connections between said pilot valve and said main valve, and a cut-off valve in one of said connections to prevent shifting of said main valve in response to shifting of said pilot valve.

8. In apparatus as claimed in claim 7, the combination with the parts therein specified, of means for maintaing fluid pressure on the cut-off valve to normally hold it in position to allow the fluid to flow freely from the pilot valve to the reversing valve.

9. In apparatus of the class described, a table or carriage, fluid pressure means to reciprocate said table or carriage, valve means to control the said reciprocation, a throttle valve to limit the speed of reciprocation, a by-pass around the throttle valve to allow the speed to be increased without changing the setting of said throttle valve, and fluid pressure means to open said by-pass.

10. In apparatus of the class described, a table or carriage fluid pressure means to reciprocate said table or carriage, valve means to control the said reciprocation, a throttle valve to limit the speed of reciprocation, and fluid pressure actuated means to render said throttle valve ineffective to control the speed of reciprocation.

11. In apparatus of the class described, a table or carriage, a fluid pressure motor to actuate said table or carriage, a reversing valve to reverse the travel of said carriage, a fluid pressure supply line leading to said reversing valve, a throttle valve in said fluid pressure supply line, a second fluid pressure supply line also leading to said reversing valve, a shut-off valve normally closed in said second fluid pressure supply line, and fluid pressure means for opening said shut-off valve.

12. In a grinding machine, a table or carriage, reciprocation of which procures the grinding traverse between grinding wheel and workpiece, a valve to control the speed of reciprocation of said carriage, automatic means to move said valve to restrict the flow of fluid, said valve remaining in restricted position independently of the fluid flow through said valve, and fluid pressure operated means to reset said valve.

13. In a grinding machine, a grinding wheel, a dressing device, fluid pressure means to reciprocate said grinding wheel in relation to a workpiece, valve means to reverse said fluid pressure means to procure a reciprocatory movement, fluid pressure means to place said dressing device in the path of said wheel, and a single valve to operate said last fluid pressure means and also to prevent movement of said valve means to extend the path of travel of said grinding wheel to bring it into engagement with said dressing device.

14. In a grinding machine, a dressing device, fluid pressure actuating means therefor, a rotating gauge, fluid pressure means to hold said gauge out of operative position, means governed by the progress of the grinding operation for rendering said first mentioned fluid pressure actuating means operative, and means actuated in response to operation of said last means to render said last mentioned fluid pressure means inoperative.

15. In a grinding machine, a dressing device, fluid pressure actuating means therefor, a rotating gauge, fluid pressure means to hold said gauge out of operative position, means governed by the progress of the grinding operation to admit fluid under pressure to said first mentioned fluid pressure actuating means, and valve means actuated by said fluid under pressure to control the supply of fluid under pressure to the second fluid pressure means to permit said gauge to move to operative position.

16. In a grinding machine, a table or carriage, reciprocation of which causes relative traverse between a grinding wheel and a workpiece, fluid pressure mechanism to actuate said carriage, a main valve to control said fluid pressure mechanism, a pilot valve to control the movements of said main valve, mechanical means to actuate said pilot valve including dogs or stops carried by said carriage, said means normally actuating said pilot valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement and an additional valve to procure an extended movement of said carriage beyond the normal traverse independently of the normal actuation of the pilot valve by said mechanism.

17. In a grinding machine, a table or carriage, reciprocation of which causes relative

traverse between a grinding wheel and a workpiece, fluid pressure mechanism to actuate said carriage, a main valve to control said fluid pressure mechanism, a pilot valve to control the movements of said main valve, mechanical means to actuate said pilot valve including dogs or stops carried by said carriage, said means normally actuating said pilot valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement, an additional valve to procure an extended movement of said carriage beyond the normal traverse independently of the normal actuation of the pilot valve by said mechanism, and a valve actuated by said carriage movement to bring said carriage to rest during the extended movement.

18. In a grinding machine, a table or carriage, reciprocation of which causes relative traverse between a grinding wheel and a workpiece, fluid pressure mechanism to actuate said carriage, a main valve to control said fluid pressure mechanism, a pilot valve to control the movements of said main valve, mechanical means to actuate said pilot valve including dogs or stops carried by said carriage, said means normally actuating said pilot valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement, an additional valve to procure an extended movement of said carriage beyond the normal traverse independently of the normal actuation of the pilot valve by said mechanism, said additional valve preventing movement of the main valve in response to said pilot valve, and valve actuated in response to the extended movement of said carriage to bring said carriage to rest, said last valve having a by-pass normally closed by said main valve during the extended movement of the carriage and opened upon shifting movement of the main valve to procure return of the carriage to normal reciprocating position.

19. In a grinding machine, a table or carriage, reciprocation of which causes relative traverse between a grinding wheel and a workpiece, fluid pressure mechanism to actuate said carriage, a main valve to control said fluid pressure mechanism, a pilot valve to control the movements of said main valve, mechanical means to actuate said pilot valve including dogs or stops carried by said carriage, said means normally actuating said valve at opposite ends of the traversing movement of the carriage to procure a reversal of the carriage movement, an additional valve to procure an extended movement of the carriage beyond the normal traverse independently of the normal actuation of the first valve by said mechanism, and an additional stop on said carriage to actuate said additional valve upon the extended movement of said carriage beyond normal position to reverse the direction of carriage movement and return said carriage to the normal reciprocating position.

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