March 19, 1946. M. DE YOUNG 2,396,775

GRINDING MACHINE

Filed April 2, 1945 4 Sheets-Sheet 1

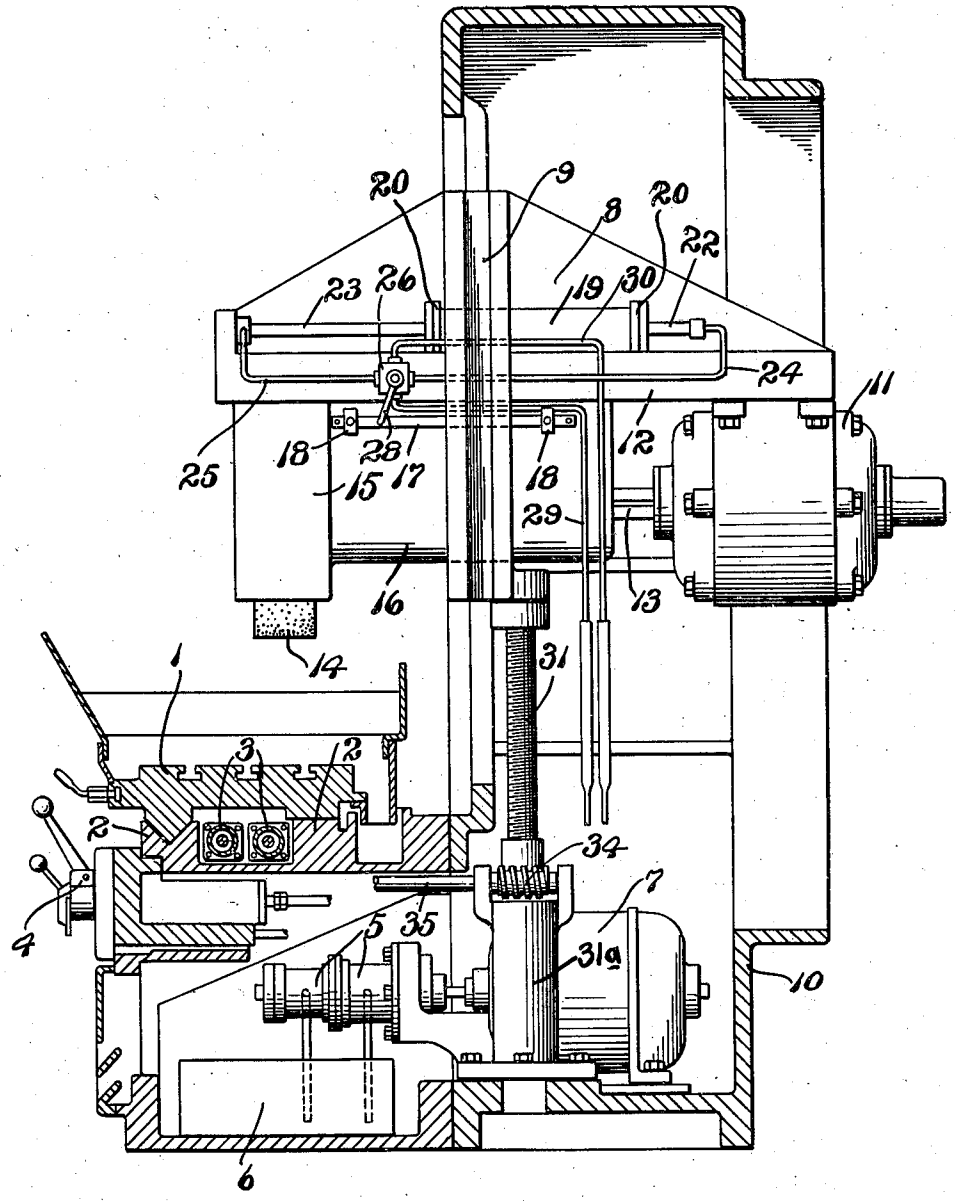


Fig. 1.

Inventor
Martin DeYoung
By Liverance and Van Antwerp
Attorneys

March 19, 1946. M. DE YOUNG 2,396,775

GRINDING MACHINE

Filed April 2, 1945 4 Sheets-Sheet 2

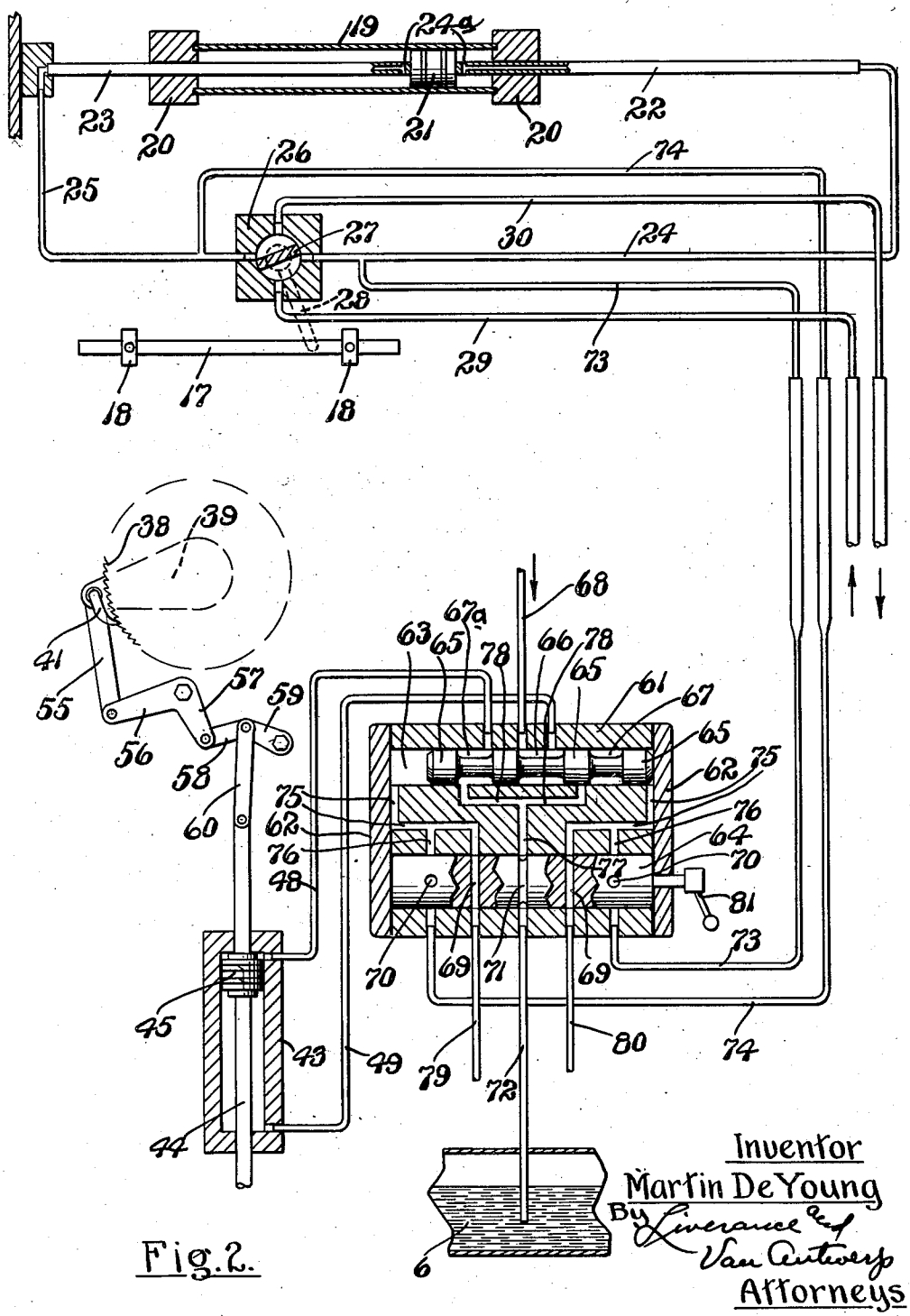


Fig. 2.

Inventor
Martin De Young
By Lawrence and Van Antwerp
Attorneys

March 19, 1946. M. DE YOUNG 2,396,775

GRINDING MACHINE

Filed April 2, 1945 4 Sheets-Sheet 3

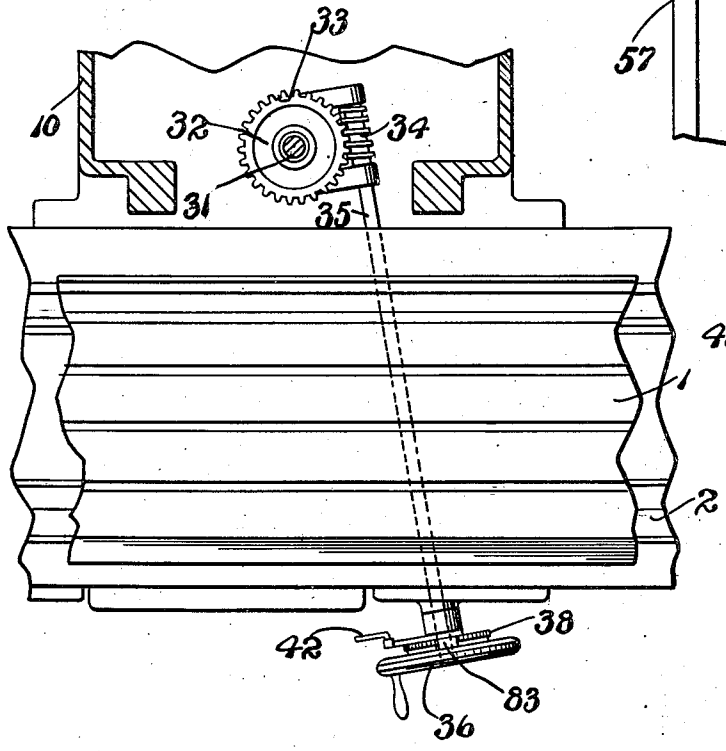


Fig.3.

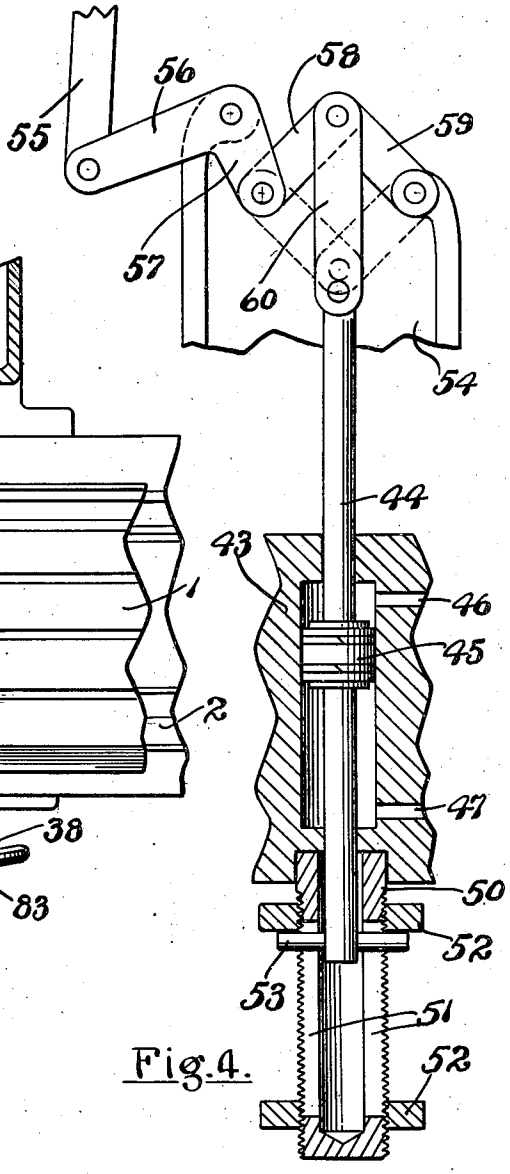


Fig.4.

Inventor
Martin DeYoung
By Liverance and
VanAntwerp
Attorneys

March 19, 1946. M. DE YOUNG 2,396,775

GRINDING MACHINE

Filed April 2, 1945 4 Sheets-Sheet 4

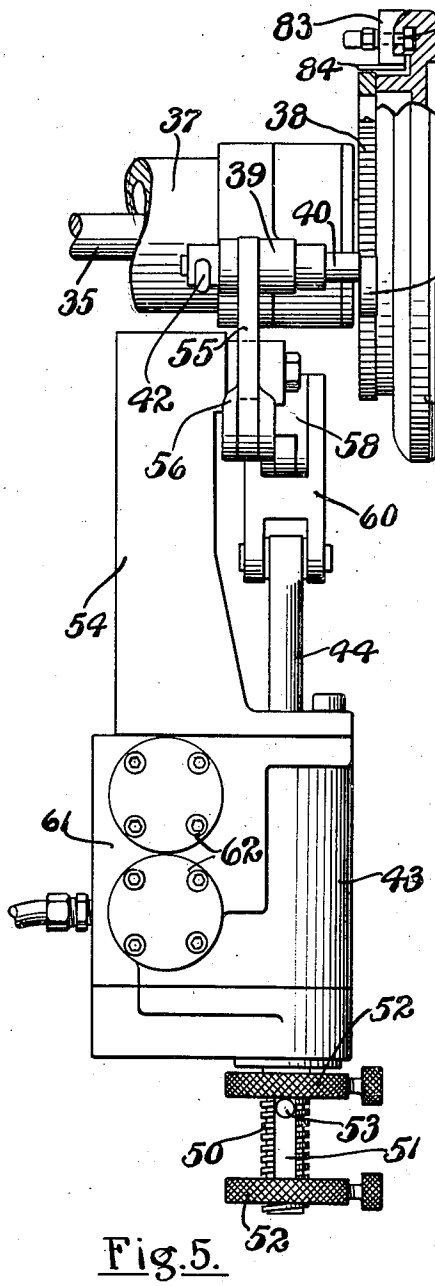


Fig.5.

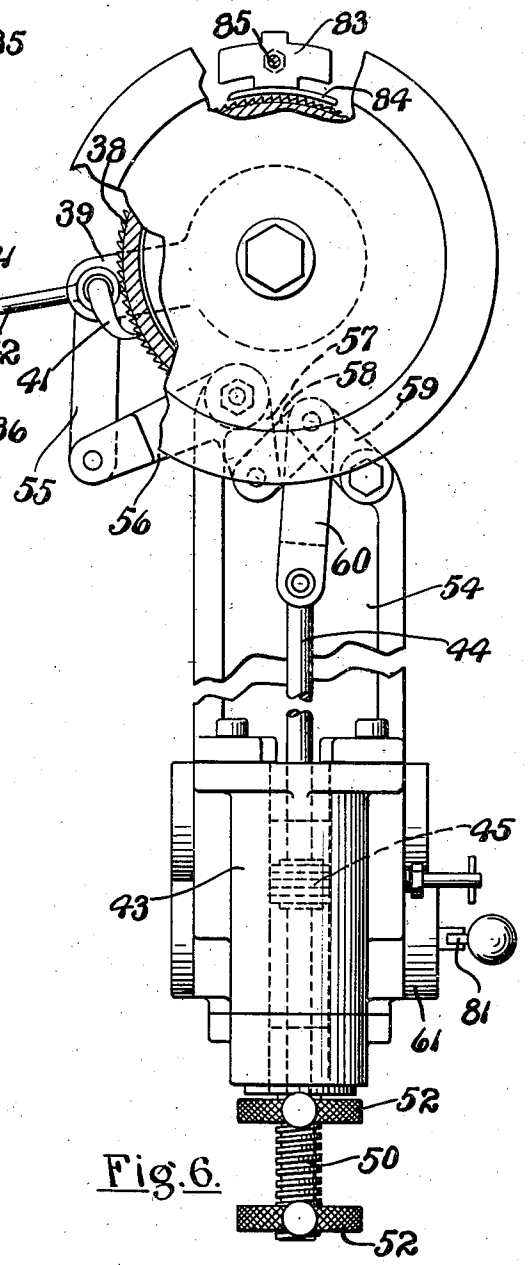


Fig.6.

Inventor
Martin DeYoung
By Linerance and Van Antwerp
Attorneys

Patented Mar. 19, 1946 2,396,775

UNITED STATES PATENT OFFICE

2,396,775

GRINDING MACHINE

Martin De Young, Grand Rapids, Mich., assignor to Gallmeyer & Livingston Company, Grand Rapids, Mich., a corporation of Michigan

Application April 2, 1945, Serial No. 586,120

8 Claims. (Cl. 51—92)

The present invention relates to the hydraulic operation and control of grinding machines. I have heretofore obtained Patent No. 2,378,006, issued June 12, 1945, for Grinding machine control, in which novel mechanism is disclosed for hydraulically operating a horizontal work carrying table upon a suitable carrying bed therefor, with periodic reversals of movement of the table at preselected points in its longitudinal movements which points are adjustable in accordance with the length of the work processed. Such prior invention also fully shows a hydraulic operation and control of a cross feed carriage which carries the driven grinding wheel in movements transversely of the table so as to move the grinding wheel across the work being processed in periodic step by step movements, substantially simultaneous with the reversal of the reciprocating movements of the work carrying table and for reversing the cross feed carriage when the entire width of the work being processed has been acted upon by the grinding wheel.

The present invention is directed to the hydraulic operation and control for the downfeed of the grinding wheel with relation to the work being processed. It is a primary object and purpose of the present invention to provide a novel, practical relatively simple and very effective hydraulically governed downfeed which may be controlled to move the grinding wheel downwardly different distances which may be preselected; and to render the same operative whenever a grinding cut has been taken over the full surface of the work which is being ground, and under either the condition in which the peripheral width of the grinding wheel acting upon the work is equal to or greater than the width of the work as in plunge grinding or if the width of the work is greater than such peripheral width of the wheel; and to also selectively control the operation of the downfeed at the ends of all reciprocating movements of the work carrying table, or at only alternate reciprocations.

An understanding of the invention may be had from the following description taken in connection with the accompanying drawings, in which,

Fig. 1 is a vertical section through the grinding machine to which my invention is applied, showing the general structural environment of the invention.

Fig. 2 is a diagrammatic view illustrative of the hydraulic circuits and the mechanism used for controlling the grinding wheel downfeed.

Fig. 3 is a fragmentary plan partly in section showing the work carrying table and the manually operable means for raising and lowering the grinding wheel and the head on which it is carried and to which the automatic hydraulic control mechanism of the present invention is applied.

Fig. 4 is a fragmentary section and elevation of the hydraulic mechanism used for governing the extent or degree of downfeed and for controlling at which end or whether at both ends of the table or wheel head reciprocatory movements such downfeed is operated.

Fig. 5 is a side elevation of the hydraulic unit for the operation and control of the downfeed, and

Fig. 6 is a front elevation thereof with parts broken away and in section for a better disclosure of structure.

Like reference characters refer to like parts in the different figures of the drawings.

As shown in Fig. 1, the grinding machine to which this invention is applied includes a horizontal work carrying table 1, mounted for lengthwise reciprocating movements upon ways 2, and which in practice is hydraulically operated by means including piston cylinder apparatus indicated at 3 and located underneath the table, the detail of which is not concerned with the present invention, and full disclosure of which is made in my prior filed application, together with the control therefor of a manually operable nature, indicated at the front of the machine, at 4, in Fig. 1.

The double pump 5 with a liquid (usually oil) holding tank 6 below the table, the pumps being driven by a motor 7 are also fully disclosed in said prior application.

An upper head 8 is mounted for vertical adjustment by means of suitable guide ways 9 on the frame or supporting body 10 of the machine. A driving motor 11 is suspended from the lower side 12 of the head on which a carriage for carrying the grinding wheel is mounted to move back and forth horizontally in a direction transverse to the length of the work carrying table, and to its direction of movement. The motor by means of its splined shaft 13 is connected with the grinding wheel 14 located over the table 1, said wheel being covered except at its lower portion by a hood 15 at the forward end of a housing 16 connected with and forming a part of the crossfeed carriage, and on which a horizontal bar 17 is permanently secured with adjustable blocks 18 on the bar which may be selectively set at different positions in spaced relation to each other.

A horizontal cylinder 19 with ends 20 is connected and moves with the crossfeed carriage within which (Fig. 2) a piston 21 is located. From opposite ends of the piston, tubular piston rods 22 and 23 extend away from each other which are connected, respectively, to liquid carrying pipes or conduits 24 and 25 leading to opposite sides of a valve housing 26. Within the housing is a direction control valve 27, the stem of which extending outside of the housing has a

downwardly projecting handle 28 attached which when a stop 18 comes thereto in the movements of the crossfeed carriage, swings the valve from a position, as shown in Fig. 2, to a position in which the side edges of the valve 27 shown cross the ports in the valve housing with which the pipes 24 and 25 are connected. A pressure inlet pipe 29 for carrying liquid under pressure is connected to the valve housing 26 between the port entrances of pipes 24 and 25 at one side of the valve and an outlet liquid carrying pipe 30 is connected at the opposite side.

It will be apparent that with the valve 27 in the position shown in Fig. 2, liquid forced under pressure through the pipe 29 enters the valve housing 26 and is forced to the only port open for its escape in such position of the valve, and thence through the pipe 24 and through the openings 24*a* which are made in the tubular piston rod 22, into the cylinder at the right hand side of piston 21. The piston remains stationary and the cylinder is thereupon moved to the right. Such movement continues until the crossfeed carriage with which the cylinder 19 is connected has moved to bring one of the reversing blocks 18 against the handle 28 to turn valve 27 to open the port leading to the pipe 25. When this occurs the flow of liquid under pressure is carried through the tubular rod 23 and escapes through the like openings 24*a* in rod 23 at the opposite side of the piston 21 thereby reversing the movement of the crossfeed. The structure thus described is disclosed in my prior filed application and is disclosed herein only so far as is necessary for an understanding of the structure and utility and mode of operation of the hereinafter described invention.

The head 8 (Fig. 1) carries the cross feed carriage and is raised and lowered by the rotation of a nut 32 through which a vertical screw 31 extends into a sleeve 31*a* at the upper end of which the nut 32 is located and which, at its periphery, is formed as a worm gear 33. A worm 34 at the end of an outwardly extending horizontal shaft 35 is mounted at the upper end of the sleeve 31*a* in mesh with the worm teeth 33 (Fig. 3). Said shaft at its outer end in front of and below the table has a hand wheel 36 permanently secured thereto for manual operation, whereby the crossfeed carriage head 8 may be raised and lowered manually for the placing of work to be processed upon the table 1 and for moving the grinding wheel roughly into a close proximity to the surface which is to be ground.

It is the shaft 35 to which the operating mechanism of my invention is applied to automatically and hydraulically control the subsequent downfeed movements to lower the grinding wheel periodically, and at selected intervals with relation to the work, upon which the grinding wheel is operating. As shown in Fig. 5, the shaft 35 passes through a covering sleeve 37 at its outer end and at the inner face of the hand wheel 36 a disk or ring 38 with consecutive closely spaced ratchet teeth is secured. An arm 39 is loosely mounted at one end on and around the sleeve 37, extending radially outward to a point beyond the periphery of the ratchet 38. Through the outer end portion of the arm a short horizontal shaft 40 extends and is mounted for rocking movement therein. At its end adjacent the ratchet teeth 38 shaft 40 is formed with a downwardly extending pawl 41 (Fig. 6), the free end of which engages between consecutive teeth of the ratchet 38. At the other end a handle 42 extends outwardly from the shaft 40, for manual operation to connect or disconnect the pawl from the ratchet teeth.

A vertical cylinder 43 is secured to the body or frame of the machine at its front, being closed at both ends and having a piston rod 44 extending therethrough and above and below the ends, said rod, within the cylinder, carrying a piston 45 (Figs. 4 and 6). Upper and lower ports 46 and 47 lead respectively to the upper and lower ends of the cylinder with which liquid carrying conduits 48 and 49 are respectively joined, as diagrammatically shown in Fig. 2. It is apparent that when liquid under pressure is introduced into the upper end of the cylinder the piston is forced downwardly, and any liquid below the piston will be forced out at the port 47. When the liquid under pressure is carried by the pipe 49 to the cylinder below piston 45, it and its connected rod 44 will be moved upwardly and liquid above the piston will be forced outwardly through the port 46 and pipe 48.

At the lower end of the cylinder 43, a member 50 is fixedly secured at its upper end (Fig. 4). Said member is interiorly bored from its upper end (nearly through to its lower end, and into the axial opening provided the lower end) portion of the rod 44 extends. The member 50 at diametrically opposed sides for the intermediate portion of its length is formed with vertical slots 51. Said member 50 of a cylindrical form is exteriorly threaded. An upper and lower nut 52 are screwed onto said member 50, and through the lower end of the rod 44 a transverse pin 53 extends passing through the vertical slots 51 and having its end portions located between the spaced apart nuts 52. The nuts 52 are adjustable for spacing at different distances apart, and are held at any adjustable position by suitable set screws (Fig. 5). Accordingly, the stroke of the piston 45 and the piston rod 44 connected therewith is controlled by the adjusted space between the nuts 52 and may be changed to provide different lengths of stroke by changing the relative positions of the nuts 52 to each other.

A vertically extending bracket support 54 is secured to and extends upwardly from a block in which cylinder 43 is made, terminating a short distance below the plane of the shaft 35 (Fig. 5). A link 55 is pivotally connected to and depends from the outer end portion of the arm 39, and at its lower end has a pivotal connection to the end of one arm 56 of a bell crank lever which is pivotally mounted between its ends at a face of and to one side of the upper end of the bracket 54. The other arm 57 of the bell crank lever extends downwardly and substantially at right angles to the arm 56 (Fig. 4). Two toggle links 58 and 59 are provided, pivotally connected together at meeting ends and to the upper end of a vertical link 60 which at its lower end has pivotal connection at the upper end of the rod 44. The other end of link 58 is pivotally connected to the arm 57 of the bell-crank lever and the other end of link 59 is pivotally connected to the bracket 54 at the same face thereof that the bell crank lever is mounted.

With this construction reciprocation of the rod 44 rocks the bell crank lever about its pivot. On downward movement of the rod 44 from the position shown in Fig. 4, if the pivot axis of link 60 to the toggle links 58 and 59 does not pass below a line connecting the pivots of links 58 and 59, respectively, to the bell crank lever and support, said bell crank lever will be rocked in one direc-

tion only with a corresponding movement of the pawl 41 in one direction. But if said pivot passes below said dead center line, the bell crank lever will be initially rocked in one direction until said line is reached and then in the opposite direction after passing across and beyond in a downward direction. As the extent of movement imparted to the bell crank lever by the reciprocating movements of the piston 45 is controlled by the position of the nuts 52, it is apparent that shaft 35 may be turned either at both reciprocations of the rod 44 or at one only thereof. In the former case, the movement of rod 44 will be sufficient to carry the knee or knuckle pivotal axis of the toggle links 58 and 59 below the dead center line. While in the other case, such movement will terminate above or at the dead center line.

For the control of the pressure liquid to the opposite ends of the cylinder 43, as diagrammatically shown in Fig. 2 a block 61 is provided with a cylindrical opening 63 therethrough and a second cylindrical opening paralleling it in which a cylindrical valve 64 is rotatably mounted, the ends of the openings being closed by closure plates 62. In practical structure, as shown in Figs. 5 and 6, the block in which the vertical cylinder 43 is made is the same one in which the horizontal cylindrical chamber 63 and also the opening to receive the valve 64 are made.

In said elongated chamber 63, a valve of the shape shown with end and intermediate sections 65 spaced from each other of a size to fit the boring of the chamber 63 is provided, the over-all length of the valve being less than the distance between the closure end plates 62 permitting a lengthwise movement of the valve in the chamber 63. Around the reduced portions of the valve between said sections 65 are a central chamber 66, and two end chambers 67 and 67a as shown. Liquid under pressure is conducted through an inlet conduit as indicated at 68 into the central chamber 66, which in the position of the valve parts 65 as shown in Fig. 2, is connected with the lower end of the cylinder 43 through the diagrammatically indicated conduit 49. However if the valve is moved to the opposite end of the cylinder 63 the pressure inlet carrying conduit 68 remains connected with the central chamber 66, but said chamber will have been moved over to uncover and connect with the diagrammatic conduit 48 so that the pressure liquid under such circumstances will be carried to the upper end of the cylinder 43.

The valve 64 has two series of passages 69 and 70 therethrough, the passages 69 being parallel to each other and in the same plane and extending across the longitudinal axis of the valve, while the passages 70, located outwardly toward the ends of the valve 64 from the passages 69, are located at right angles to passages 69, are parallel to each other and also extend across the longitudinal axis of the cylindrical valve 64. Midway in its length said valve 64 has a continuous annular exterior groove 71 cut therein, with which a port through the lower side of the block 61 (Fig. 2) is in conjunction, with a pipe 72 in conjunction with said port leading to the oil supply tank 6 for delivery of oil back to the tank after it has been used.

A pipe or conduit 73 connected with and in conjunction with the previous described conduit 24 connects with the block 61 and a port through a side thereof which is in the same plane with one of the passages 70 through valve 64. Similarly a pipe or conduit 74 connects with the previously described conduit 25 and leads to a port in the block 61 in the same plane with the other of the passages 70 through valve 64. Between the valve 64 and the valve chamber 63 are two passages 75 each with a branch as shown at 76. The ends of the passages 75 are connected, respectively, with the ends of the valve chamber 63 and with the chamber in which the valve 64 is located, in the same planes as the passages 69 through said valve 64. The branch passages 76 from the passages 75 extend likewise to the valve 64 in the same plane as the passages 70 therethrough.

Communicating with the groove 71 in the valve 64, a passage 77 extends toward the valve chamber 63, and has two branches 78 extending in opposite directions communicating with said chamber 63 as shown. Ports are also made through lower sides of the block 61 with which pipes 79 and 80 are connected, said ports being in the same planes as the passages 69, to therefore connect with said passages when the valve 64 is turned to proper position; or, as shown in Fig. 2, there is a direct passage from pipe 79 through one of the passages 69 in valve 64 to the passage 75, thence to the left hand end of the valve chamber 63, and also a corresponding connection between the opposite end of the valve receiving chamber 63 to the pipe 80. The passages 70 through valve 64 however do not join and make connection between the passages 76 and the respective pipes or conduits 73 and 74, but will do so when the valve 64 is turned through an arc of 90°, such turning disrupting the connection previously described as made by the passages 69 through the valve. Of course at an intermediate position of the valve 64 none of the passages 69 or 70 will be effective to carry liquid and, therefore, the entire unit which has been described will be cut off and operatively ineffective. As shown in Fig. 2 a handle 81 for manually turning the control valve 64 is supplied so that it may be moved to desired positions.

In Figs. 5 and 6 a member 83 provided at its inner side with a shroud 84 is adjustably mounted, at the rear side of the hand wheel 36, the shroud being of arc shape and located closely adjacent to and over a sector of the ratchet ring 38. The wheel 36 has an annular T-slot therein for receiving the head of a securing bolt 85, for adjustably securing said shroud at any desired position with reference to the ring 38. In the operation of the shaft 35, with a consequent turning of the hand wheel secured at its outer end, the shroud 84 will be carried to and into the path of movement of the pawl 41 and will disconnect the pawl from the ratchet teeth and render such pawl ineffective to move the shaft 35, even though thereafter the piston 45 be continuously reciprocated. Such structure is used as a limit control of the downfeed by setting the member which carries the shroud 84 at a preselected position, such that when the selected amount of the downward movement of the grinding wheel has taken place, no further downfeed will occur irrespective of continuing operation of the machine.

With the parts in the position shown in Fig. 2, and with pipes 79 and 80 connected with the opposite sides of the reversing valve mechanism for the reciprocating table as disclosed in my previously filed application, and with the pressure which operates one of the piston cylinder apparatus 3 (Fig. 1) to move the table 1 in one direction carried to and through the pipe 79, thence through the passages 69 and 75, the valve within the chamber 63 is moved as shown to the right and there is a flow of liquid under pressure from the pipe 68 through chamber 66 and conduit 49

to the lower side of the piston 45 moving it in an upward direction. Liquid above the piston forced out at the conduit 48 carried to the chamber 67a through the passages 78 and 77 and the groove 71 and to the outlet conduit at 72. On the reverse movement of the table the pressure is directed through the pipe 80, passages 69 and 75 to the opposite end of the chamber 63, with an interruption of the connection of the pipes 68 and 48, reversing the movement of the piston 45 and with the exhaust of liquid from below the piston carried through the pipe 49 which will be connected with the chamber at 67 with the flow through the passages 78, 77, groove 71 and pipe 72 back to the tank 6.

It is therefore apparent that with each reciprocatory movement of the work carrying table 1, there is a corresponding reciprocation of the rod 44 and a swinging of the arm 39 about the axis of the shaft 35; and, as previously described, with the adjustment provided by the nuts 52, the dog 41 may be moved upwards (Fig. 2) at the end of one reciprocation of the table and moved downwardly at the end of the other, to produce an effective downfeed at one end only of the work carried on the table attained. Also, as previously described, the extent of movement of piston 45 may be controlled to get a downfeed at both ends of the work, that is, at each reciprocation of the table. This is the operation when the work to be processed, for example, is of a width which is not greater than the grinding face of the wheel bearing against it; and the valve 64 will be in the position shown in Fig. 2. When the work is wider than the peripheral face of the grinding wheel 14 valve 64 is turned to bring one passage 76 and the pipe 73 in connection by one of the passages 70 through the valve, the other pipe 74 being similarly connected by the other passage 70 with the other of the branch passages 75. In such case, the automatic movement of the valve 65 in the chamber 63 will be only at the time that the cross-feed is reversed, or when a stop 18 moving against the handle at 28 reverses the position of the valve 27. The flow of the liquid under pressure conducted by the pipe 68 will be through the diagrammatic conduits 48 and 49 to opposite ends of the cylinder 43 in accordance with reversal of the crossfeed, irrespective of the number of reciprocations of the work carrying table 1 may have occur in covering the width of the work ground.

The construction which has been outlined and described has proven to be practical and very useful, and with it an automatic downfeed which is fully and completely controlled and capable of adjustment for all conditions has been made and very successfully produced and operated. The invention is defined in the appended claims and is to be considered comprehensive of all forms of structure coming within their scope.

I claim:

1. In a grinding machine having a horizontal reciprocable work carrying table to be reversed in its movements at preselected times, and having a head with a carriage thereon for carrying a grinding wheel, said carriage being mounted for reciprocatory movements transversely to the direction of movements of the work carrying table, means for raising and lowering said head including a shaft, the turning of which in opposite directions will raise and lower the head, hydraulic means including a hydraulic cylinder closed at both ends, a piston within the cylinder, means for supplying liquid under pressure alternately to opposite ends of the cylinder, and a manually operable control means for selectively directing said forcing of liquid into opposite ends of the cylinder either upon reversing the direction of movement of the work carrying table or upon reversing the direction of movement of the grinding wheel carriage.

2. A construction as defined in claim 1, and hydraulic means for moving said grinding wheel carrying carriage comprising, a hydraulic piston cylinder structure, means for alternately forcing liquid under pressure into opposite ends of the cylinder and against opposite ends of the piston therewithin, connections for carrying liquid under pressure from the supply of liquid delivered to said last mentioned cylinder, said manually operable control means being disposed between said connections and the first mentioned hydraulic cylinder, and a manual operable valve included in said control means for providing communication between said connections and said second mentioned cylinder, combined with automatic means associated with said control means for directing liquid under pressure into the opposite ends of the first mentioned hydraulic cylinder upon change of the direction of said liquid under pressure to alternate ends of the cylinder of the second piston cylinder apparatus.

3. In a grinding machine having a horizontal reciprocable work carrying table, a vertically adjustable head and a grinding wheel carriage reciprocable on said head in a direction transverse to the direction of the work carrying table, means for raising and lowering the head including a rotatable shaft, a hydraulic cylinder mounted adjacent said shaft, a piston within said cylinder, means for supplying liquid under pressure alternately to opposite ends of the cylinder at the end of reciprocatory movements in one direction of the table and the beginning in the opposite direction, means for rendering said last mentioned means inoperative and for rendering operative means for supplying liquid under pressure alternately to opposite ends of the cylinder at the ends of the transverse reciprocatory movements of the grinding wheel carriage and the beginning of such movements in the other direction, and means interposed between the piston and said shaft for turning the shaft in amounts corresponding to the movement of said piston to move said head downwardly a predetermined distance selectively between said reciprocatory movements of said work carrying table, or change in direction of the reciprocatory movements of the grinding wheel carriage.

4. In a grinding machine having a work carrying table mounted for horizontal reciprocatory movements and having a head located above the table, and a carriage mounted on said head for horizontal reciprocatory movements in a direction transverse to the movements of the table, means for raising and lowering said head including, a shaft to be turned, a ratchet wheel on said shaft, a vertical hydraulic cylinder with closed ends, a piston in said cylinder, means for alternately forcing liquid under compression into opposite ends of the cylinder and exhausting liquid at the end opposite to where the pressure is applied, an arm mounted at one end on said shaft extending alongside of and beyond the edge of the ratchet wheel, a pawl carried by said arm normally engaging with the teeth of the ratchet wheel, a piston rod connected with said piston, a support located in substantial

alinement with the piston at one end, a bell crank lever pivotally mounted at its end on and to one side of said support having an arm extending laterally and outwardly therefrom and a second arm extending substantially at right angles to the first arm, a link connecting said first arm to the bell crank lever and the pawl carrying arm, toggle links pivotally connected together at their meeting ends, one of said links having a pivotal connection at its opposite end to said support and the other link a pivotal connection to the other arm of the bell crank lever, and a link connecting the pivot rod with said toggle links at their pivotal connection.

5. In a grinding machine having a work carrying table mounted for horizontal reciprocatory movements and having a head located above the table and a carriage mounted on said head for horizontal reciprocatory movements in a direction transverse to the movements of the table, means for raising and lowering said head including, a shaft to be turned, a ratchet wheel on the shaft, a vertical hydraulic cylinder with closed ends, a piston in said cylinder, means for alternately forcing liquid under compression into opposite ends of the cylinder and exhausting liquid at an end opposite to where the pressure is applied, an arm mounted at one end on said shaft extending alongside of and beyond the edge of the ratchet wheel, a pawl carried by said arm normally engaging with the teeth of the ratchet wheel, a piston rod connected with said piston, said piston rod extending beyond both ends of the piston, a tubular fixture into which the other end portion of the rod extends, said fixture having oppositely disposed longitudinal slots therein, a pin extending through said piston rod and through said slots, said fixture being exteriorly threaded, and two nuts on said fixture spaced from each other and between which said pin passing through the rod is located, the position of the nuts on said fixture governing the extent of movement of the piston within the cylinder, and means connecting one end of the piston rod with said arm for lifting the arm and pawl and for drawing said arm and pawl downwardly upon reciprocation of said piston to turn the shaft in a direction to lower the head.

6. In a grinding machine having a horizontal reciprocable work carrying table adapted to be reversed in its movements at preselected times and having a cross-head carrying a grinding wheel, means for raising and lowering said head including, a shaft the turning of which in opposite directions will raise and lower the head, hydraulic means including a hydraulic cylinder closed at both ends, a piston rod extending through the cylinder, a piston within the cylinder, means for alternately forcing liquid under pressure into opposite ends of the cylinder upon reversing the direction of movement of the work carrying table, a toothed ratchet wheel on said shaft, a movable pawl to engage with the teeth of the ratchet wheel to turn the shaft when moved in one direction and pass over said teeth when moved in the opposite direction, connections between one end of the piston rod and pawl for effecting said movements upon movement of the piston within said cylinder, and means connected with the cylinder in association with the other end of the piston rod for selectively controlling the extent of movement within the cylinder.

7. In a grinding machine having a horizontal reciprocable work carrying table adapted to be reversed in its movements at preselected times, and having a cross-head carrying a grinding wheel, means for raising and lowering said head including a shaft, the turning of which in opposite directions will raise and lower the head, hydraulic means including a hydraulic cylinder closed at both ends, a piston rod extending through the cylinder, a piston within the cylinder, means for alternately forcing liquid under pressure into opposite ends of the cylinder upon reversing the direction of movement of the work carrying table, a toothed ratchet on said shaft, a movable pawl to engage with the ratchet teeth to turn the shaft when moved in one direcion and pass over said teeth when moved in the opposite direction, connections between one end of said piston rod and pawl have effecting said movements upon movement of the piston within said cylinder, means connected with said cylinder and associated with the opposite end of the piston rod for adjustably limiting and controlling the extent of movement of the piston within said cylinder, said means between the first mentioned end of the rod and said pawl including a support, a bell crank lever pivotally mounted within its end at one side of said support, two toggle links pivotally connected at their meeting ends, one of said links being pivotally connected at its other end to said support and the other link to one arm of the bell crank lever, an arm mounted at one end on said shaft to rock thereabout on which said pawl is carried, a link connecting the other arm of the bell crank lever with said pawl carrying arm, and link connections between the piston rod and the pivotal connections of said toggle links, the extent of movement of the piston within the cylinder controlling the extent of movement of said toggle links, whereby when the links are moved across their dead center line, the pawl is both lifted and lowered with respect to the ratchet wheel.

8. Operating means for raising and lowering the grinding wheel carrying head of a surface grinding machine with respect to work carried on the work table of said grinding machine including a shaft, means between said shaft and said head for raising and lowering the head on turning the shaft in opposite directions, a ratchet wheel on said shaft having consecutive ratchet teeth at its periphery, an arm loosely mounted on said shaft extending upon the edge of said wheel, a pawl carried by the arm to engage said ratchet teeth, a hydraulic cylinder, a piston within the cylinder, means for alternately forcing liquid under pressure into opposite ends of the cylinder, a piston rod connected with said piston and extending at both ends beyond the cylinder, means connecting one end of said piston rod with said arm for swinging said arm back and forth about the shaft on which it is mounted upon movements of said piston, combined with means associated with the other end of said piston rod for limiting the extent of movement of said piston in said cylinder, said means connecting the first end of said rod with said arm including, linkage which upon the piston being moved less than a preselected distance in one direction will move the arm in one direction only, but upon adjustment permitting movement of the piston in one direction a greater distance than such preselected distance will swing the arm in one direction and back in the opposite direction.

MARTIN DE YOUNG.