Aug. 14, 1934. W. H. WOOD 1,969,997

HYDRAULIC WHEEL FEEDING MECHANISM

Filed Jan. 23, 1933

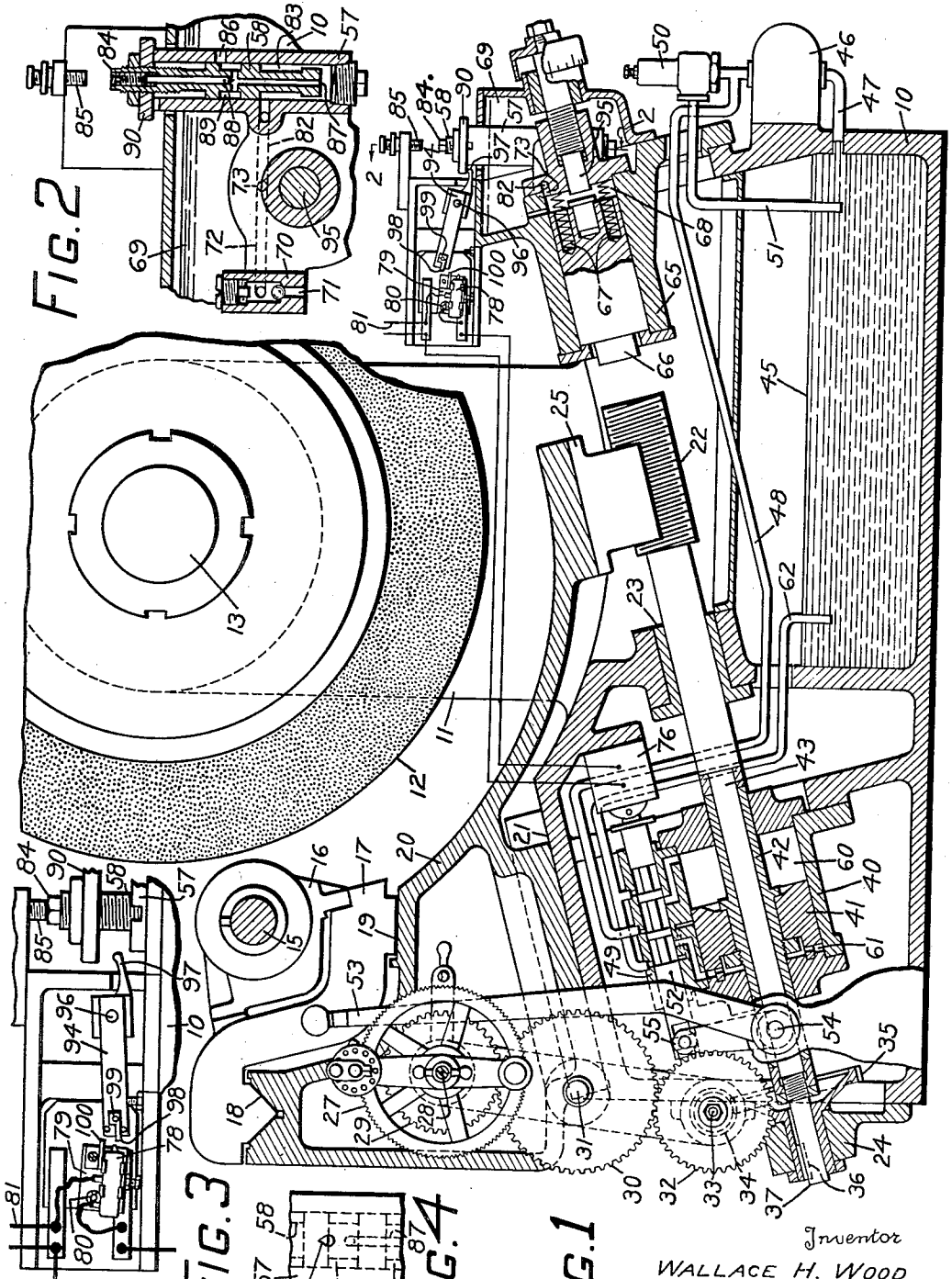


FIG. 2

FIG. 3

FIG. 4

FIG. 1

WITNESSES
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Patented Aug. 14, 1934 1,969,997

UNITED STATES PATENT OFFICE

1,969,997

HYDRAULIC WHEEL FEEDING MECHANISM

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Application January 23, 1933, Serial No. 653,056

18 Claims. (Cl. 51—165)

This invention relates to grinding machines, and more particularly to a hydraulically operated grinding wheel feeding mechanism.

Heretofore, it has been common practice in the grinding field, in cylindrical grinding operations, to move either the work or the grinding wheel relatively toward and from the other member to produce the desired grinding action and reduce the work piece to the required size. such feeding movement has been effected by manually controlled feeding mechanisms, as well as mechanically and hydraulically operated mechanisms. To obtain accuracy in regard to size of the finished work piece, as well as quality of finish, it is desirable to feed the wheel first at a rapid rate until the wheel and work engage each other, then at a slower rate or grinding feed to reduce the work to the required size, and then allow the wheel to finish grind or spark-out, with no relative feeding movement between the wheel and work, so as to produce the required finish on the work piece and to reduce it to the predetermined size. In previously devised feeding mechanisms, this has been accomplished manually by first turning the feed wheel at a rapid rate until the wheel engages the work, then at a slower manual rate to produce the desired grinding feed, and finally stopping the manual feed and allowing the wheel and work to remain in grinding contact, with no relative feeding movement between the two members. Such a feeding movement has also been accomplished by power actuated mechanisms for feeding the wheel until the wheel slide reaches a definite stop, and then allowing the wheel and work to remain in grinding contact. These mechanisms are arranged so as to require a manual intervention on the part of the operator to cause a separation of the wheel and work when the work has been reduced to the predetermined size. If the period of dwell or of the finish grinding or sparking-out of the wheel is left wholly to the judgment on the part of the operator, there is no assurance that the operator will grind successive pieces of work to the required and predetermined size. It is desirable, in such a feeding mechanism, that a suitable dwell control device be provided which will regulate the period during which the work and wheel remain in contact with no relative feeding movement, so that the finish grinding period may be definitely controlled to grind the work away to a predetermined size and finish with the minimum attention on the part of the operator.

It is the primary object of this invention to provide a hydraulically actuated feeding mechanism, by which the work and the wheel may be fed relatively toward and from each other, first at a rapid rate and then at a reduced rate for grinding.

It is another object of this invention to provide a suitable dwell control mechanism which operates in timed relation with the feeding movement to reverse the feeding movement of the wheel after a predetermined dwell between the wheel and work during the finish grinding period.

It is a further object of this invention to provide a feeding mechanism having a manually rotated feed screw mechanism to permit adjustment of the wheel position, a fluid pressure piston and cylinder to cause a rapid approaching and receding movement between the wheel and work, and a secondary mechanism to modify the approaching movement, and produce a slow grinding feed.

It is still another object of this invention to provide a mechanism which is actuated to give a predetermined dwell between the wheel and work and an electrically actuated mechanism operated by the dwell control which is arranged to cause a relative separation between the wheel and work.

Other objects will be apparent from the following disclosure. One embodiment of this invention has been illustrated in the drawing, in which like reference numerals indicate like parts:

Fig. 1 is a fragmentary cross-sectional view through a grinding machine, showing the improved feeding mechanism;

Fig. 2 is a fragmentary cross-sectional view, taken approximately on the line 2—2 of Fig. 1, showing the piston and cylinder actuating mechanism for the dwell control of the feeding mechanism;

Fig. 3 is a fragmentary side elevation, on an enlarged scale, of the dwell control mechanism showing the parts in an uppermost position; and

Fig. 4 is a fragmentary elevation, on an enlarged scale, showing the V-port for regulating the speed of movement of the dwell control.

This invention comprises a grinding machine feeding mechanism for causing a relative approaching and receding movement between the grinding wheel and a rotatable work piece, which is arranged so that the feeding movement will take place first at a rapid rate to bring the work

and wheel into engagement with each other, and then at a slow rate to obtain the desired grinding action between the work and the wheel to reduce the work in size, and finally in a sparking out or finish grinding operation during which there is no feeding movement. A hydraulic mechanism is provided to definitely limit the rate of the grinding feed and an adjustable stop serves to stop the feeding movement and to allow the wheel and work to remain in contact with each other to finish grind the work and to reduce it to the predetermined size. A suitable mechanism is provided to control the period of dwell or finish grinding period while the wheel sparks-out or finish grinds and to then reverse the feeding mechanism and cause a separation of the wheel and work after a definite period of finish grinding.

In the preferred construction, as illustrated in the drawing, the feeding mechanism comprises a fluid pressure actuated piston in axial alignment with and arranged to move the feed screw endwise so as to feed a work blank towards and from the grinding wheel at a rapid rate. A dash pot also in axial alignment with the feed screw effective, after a predetermined rapid feed, to cause a slow feeding movement of the grinding wheel during the grinding operation, and an adjustable stop device associated with the dash pot positively limits the approaching movement between the grinding wheel and the work piece. A dwell control mechanism preferably comprises a fluid pressure gravity-actuated control valve, the feed of which is adjustable, which in turn actuates an electrical device after a predetermined period of dwell to reverse the valve in the feeding mechanism and cause a separation of the wheel and work.

This invention is equally applicable to either of the standard types of cylindrical grinding machine, in one of which the work is mounted on a slide movable toward and from the periphery of a stationary grinding wheel, and in the other the rotatable grinding wheel is mounted on a wheel slide arranged for a transverse feeding movement relative to a stationary work support. As illustrated in the drawing, a grinding machine is provided having a base 10 which is provided with upwardly projecting brackets 11 (only one of which is shown in the drawing) to rotatably support a grinding wheel 12 on a wheel spindle 13 which is suitably journalled in the upper ends of the projections 11. The grinding wheel may be rotated from any suitable source of power, either by means of a driving belt from an overhead countershaft or, as is the usual case in the modern grinding machines, driven from an electric motor either mounted within the base or on the wheel slide.

A work piece 15 is rotatably supported on a headstock 16 and footstock (not shown) which are in turn supported on a longitudinally movable slide 17. The slide 17 serves to position the work piece relative to the operative face of the grinding wheel. The longitudinal slide 17 is supported by V-way 18 and flat way 19 on a transversely movable slide 20 which is adapted to slide on the slideway 21. The slideway 21 is arranged to guide the slide 20 so that the axis of the work piece 15 may be moved toward and from the grinding wheel and in a direction at right angles to the axis of the wheel.

To produce a relative feeding movement between the wheel 12 and work piece 15, a suitable feeding mechanism is provided which may comprise a half nut 25 depending from the slide 20 and meshing with a feed screw 22 which is supported in bearings 23 and 24. To effect a feeding movement of the work relative to the grinding wheel, a suitable manually operable feeding mechanism is provided comprising a manually operable micrometer feed wheel 27, such as that shown in the prior patent to Norton No. 762,838 dated June 14, 1904.

Details of the micrometer adjustment of the feed mechanism have been omitted, since they are not part of the present invention. For further reference to detailed construction of the micrometer adjusting device, reference may be had to the above-mentioned patent. The feed wheel 27 is mounted on a stud 28 which also supports a gear 29 meshing with a gear 30 rotatably mounted on a stud 31. The gear 30 in turn meshes with a gear 32 rotatably mounted on a shaft 33. The shaft 33 carries a worm 34 which meshes with a worm wheel 35 which is slidably keyed by means of a key 36 to a reduced end portion 37 of the feed screw 22.

It will be readily apparent from the foregoing disclosure that rotation of the manually operable feed wheel 27 transmits motion through the gears 29, 30, 32, worm 34 and worm wheel 35 to rotate the feed screw 22 and cause a relative approaching or receding movement between the work piece 15 and grinding wheel 12. The mechanism above described serves to manually adjust the position of the grinding wheel relative to the work piece and may, if desired, be utilized to cause a grinding feed.

In the preferred construction, however, a suitable fluid pressure mechanism is provided which is arranged to move the work slide so as to cause a rapid approaching movement between the wheel and work and then a slow relative movement during the grinding operation. This mechanism may comprise a fluid pressure cylinder 40 having a piston 41 slidably mounted within said cylinder in axial alignment with the cross feed screw. The piston is mounted on a sleeve 42 which surrounds a reduced portion 43 on the feed screw 22. A fluid pressure system is provided including a reservoir 45 within the base 10 and a pump 46 which pumps fluid through a pipe 47 and pipe 48 through a reversing valve 49 into the cylinder 40. A suitable relief valve 50 is provided in the pipe line 48 which is arranged so that excess pressure in the system will by-pass fluid through a pipe 51 back to the reservoir. The reversing valve 49 is provided with a valve piston 52 which is preferably manually controlled by means of a lever 53 pivotally mounted on a stud 54 and connected by a short arm 55 with the stem of valve piston 52. In the position of the valve 49, as illustrated in Fig. 1, fluid under pressure is admitted through the reversing valve into the cylinder chamber 60 to move the feed screw bodily toward the left, and cause a separation of the work piece from the wheel. The parts illustrated in Fig. 1 are shown with the work and wheel in a separated position. During the separating movement, fluid exhausts from cylinder chamber 61 through a pipe 62 into the reservoir. When it is desired to cause a forward feeding movement of the work support, the operator moves the manually operable control lever 53 in a counterclockwise direction, as indicated in Fig. 1, so as to admit fluid under pressure from the pipe 48 into the cylinder chamber

61 to cause an endwise movement of the feed screw toward the right, as viewed in Fig. 1.

Grinding feed and dwell control

It is desirable to provide a suitable mechanism for reducing the rapid approaching movement to a grinding feed when the work piece has been brought into engagement with the operative face of the grinding wheel. In the preferred construction, a secondary fluid pressure system is provided which, as illustrated, comprises a dash pot 65 having a piston 66 arranged in axial alignment with the feed screw and preferably arranged as a separate device, although if desired the dash pot piston may be mounted on the end of the feed screw. When the work is fed toward the wheel, a rapid approaching movement is obtained until the end of the feed screw 22 engages the dash pot piston 66 which serves to modify the rapid approaching movement of the grinding wheel so as to reduce the feed to a proper feed for grinding. A plurality of springs 67 serve to return the dash pot piston to its initial position, as illustrated in Fig. 1, during the separating movement between the wheel and work. During the idle returning movement of the dash pot piston, oil is drawn into the dash pot chamber 68 from a self-contained reservoir 69 in the rear of the machine base. Oil is sucked through a ball check valve 70 from a passage 71 in the reservoir through passages 72 and 73 into the dash pot chamber 68 so that the dash pot is then in condition for the next grinding operation. When the feed screw attempts to move the dash pot piston 66 to the right, the oil can escape but slowly from the chamber, as more fully described hereinafter, so that the feed screw is constrained to move at a desired slow grinding rate.

To attain one of the objects of this invention, namely, to provide a suitable dwell control mechanism which permits the wheel to dwell in contact with the work piece after the forward feed has been stopped, it is desirable to provide a suitable means for controlling the fluid pressure system so that after a definite period of dwell or finish grinding, the wheel and work will automatically separate. In the preferred form, the dwell control mechanism is a combined fluid pressure and electrical control which is arranged so that after a predetermined period of finish grinding, a solenoid 76 which is connected to the reversing valve piston 52 will be energized to cause a movement of the valve piston 52 toward the right, into the position as illustrated in Fig. 1, so as to cause a separating movement between the wheel and the work piece. A mercury switch 78 is mounted on a plate 79 pivoted on a stud 80 at the rear of the machine base. In the position illustrated in Fig. 1, the circuit is broken and the solenoid 76 is de-energized. When the mercury switch 78 is tipped in a counterclockwise direction, the circuit is closed so that electrical energy from the source as indicated by power wires 81 closes the circuit to energize the solenoid 76.

A fluid pressure actuated device is provided to control the periods of grinding and of sparking out. This comprises a cylinder 57 having a piston 58 slidably mounted therein. When the dash pot piston 66 is moved toward the right, as viewed in Fig. 1, by means of the feed screw to cause a slow grinding feed, fluid from the dash pot chamber 68 is exhausted through the passage 73 and passage 82 into the chamber 83 in the dwell control cylinder. This fluid under pressure in the dwell control cylinder causes the piston 58 to move in an upward direction until the end of the piston rod 84 engages an adjustable screw 85 which limits the upward movement of the piston 58. This upward movement uncovers a V-port 86 in the wall of the cylinder 57 and allows fluid under pressure in the chamber 83 to pass through a central aperture 87 in the piston 58, then through a needle valve 88 into a chamber 89 and outwardly through the V-port 86 into the fluid reservoir 69. The piston 58, when in its uppermost position, uncovers more or less of the V-port 86 depending upon the adjustment of the screw 85 and controls the escape of fluid through the port 86, thereby regulating the rate of the grinding feed which is determined by the rate of exhaust of fluid from the dash pot chamber 68.

The grinding feed at the reduced rate governed by the position of the piston 58 relative to the V-port 86 continues until the dash pot piston 66 engages an adjustable stop 95 on the machine base 10. Engagement of the dash pot piston with the stop 95 serves to limit the endwise movement of the feed screw and consequently limit the approaching movement between the wheel and work piece. It is desirable to permit the grinding wheel and the work to remain in contact with each other during the predetermined period so that the wheel may spark-out or finish grind the work. This period of dwell is regulated by controlling the rate of downward movement of the piston 58. When the dash pot piston 66 reaches its rearward position, the pressure within the passage 82, cylinder chamber 83, passage 87 will be relieved and the valve piston 58 will move downwardly under the influence of gravity into the position as illustrated in Figs. 1 and 2. The rate of downward movement of the piston 58 under the influence of gravity is regulated by means of the needle valve 88 adjustably threaded into the piston 58 which serves to control the passage of fluid through the central passage 87 in the piston. The valve 58 may be of insufficient weight to move at the required speed and consequently a weight 90 which is mounted on the valve piston serves to aid in increasing the action of gravity to return the valve 58 to its downward position, as illustrated in Fig. 2. The dwell period lasts until the piston 58 has moved downwardly to a point at which it actuates the switch 78.

To actuate the mercury switch, a pivotally mounted lever 94 is supported on a stud 96 and has a short arm 97 arranged in the path of movement of the weight 90. The other end of the lever 94 is provided with a pawl 98 which is arranged so that when the lever 94 swings in a counterclockwise direction into the position as illustrated in Fig. 3, the pawl pivots on its supporting stud 99 and readily passes a projection 100 on the mercury switch plate 79. As the piston 58 moves downwardly, the weight 90 engages the arm 97 of lever 94 and rocks the lever 94 in a clockwise direction. The pawl 98 engages the under side of the projection 100 and continued movement of the lever 94 rocks the mercury switch in a counterclockwise direction so as to make contacts and thereby energize the solenoid 76 which in turn serves to pull the reversing valve 52 into the position illustrated in Fig. 1 and thereby admit fluid under pressure into the chamber 60, so as to cause

a separating movement between the wheel and work. This moves the parts into the position illustrated in Fig. 1, with the piston 41 engaging the end of the cylinder 40 which limits the separation between the wheel and work.

The operation of this mechanism will be readily apparent from the foregoing disclosure. The operator places the desired piece of work in the machine, moves the manual control lever 53 toward the left, as viewed in Fig. 1, to cause a rapid approaching movement of the grinding wheel toward the work piece. This approaching movement of the work toward the wheel continues until the feed screw 22 engages the dash pot piston 66 which, as previously described, serves to modify the rapid approaching movement of the grinding wheel so as to produce a slower grinding feed until the dash pot piston 66 engages the adjustable stop 95 on the base 10. The mechanism then allows the grinding wheel and work to remain in contact so that the grinding wheel may spark-out or finish grind the work piece for a definite predetermined period until the downward movement of the piston 58 operates through the weight 90 and lever 94 to actuate the mercury switch so as to energize the solenoid 76, which in turn reverses the valve 52 and causes a separating movement of the work relative to the grinding wheel. By manipulating the adjustable stop 95 and the stop screw 85 and needle valve 88, the stopping of the infeed, the rate of the grinding feed and the period of dwell may be regulated. By means of the manually operable feed wheel 27, the grinding wheel 12 may be manually positioned relative to the fluid pressure system which is preferably utilized only in setting up the machine for a given grinding operation.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement towards and from the other, a manually rotatable feed screw operatively connected to move the slide, a fluid pressure system including a piston and cylinder operatively connected to and arranged in axial alignment with said feed screw to move the screw bodily endwise and cause a rapid approaching and receding movement between the wheel and work, means operative independently of said fluid pressure system to control the rate of endwise movement of the screw and cause a slow grinding feed, means for stopping the endwise movement of the screw and causing the wheel to grind the work during a predetermined dwell period.

2. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement toward and from the other, a manually rotatable feed screw operatively connected to move the slide, a fluid pressure system including a piston and cylinder operatively connected to and arranged in axial alignment with said feed screw to move the screw bodily endwise and cause a rapid approaching and receding movement between the wheel and work, means operating independently of said fluid pressure system to control the rate of endwise movement of the feed screw and cause a slow driving feed, means for stopping the endwise movement of the screw, and means including a dwell control device for causing the wheel to grind the work during a predetermined but adjustable dwell period.

3. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement toward and from the other, a nut and feed screw mechanism operatively connected to move said slide, manually operable means to rotate said screw and move the slide, a fluid pressure system including a piston and cylinder arranged in axial alignment with and operatively connected to move said screw endwise and cause a rapid approaching and receding movement between the wheel and work, means to control the endwise movement of the screw and cause a uniform, slow grinding feed, and means to cause a predetermined dwell of the screw and cause the grinding wheel to finish grind the work.

4. A grinding machine of the type covered by claim 3 comprising means for reversing the endwise movement of the feed screw after a predetermined period of dwell and the grinding operation has been completed.

5. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure piston and cylinder operatively connected to feed said slide to cause an approaching and receding movement between the wheel and work support, a reversing valve in said system which is arranged to admit fluid to either end of said cylinder to cause either an approaching or a receding movement between the wheel and the work support, manual means to move said valve to initiate an approaching movement between said elements, means including an adjustable dwell device arranged to stop said approaching movement and allow the grinding wheel to remain in operative engagement with the work, and electrically controlled means which is actuated by and in response to said device after a predetermined dwell period to move said valve to a reverse position so as to cause a receding movement between the grinding wheel and the work.

6. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure piston and cylinder operatively connected to feed said slide to cause an approaching and receding movement between the wheel and work support, a reversing valve in said system which is arranged to admit fluid to either end of said cylinder to cause either an approaching or a receding movement between the wheel and the work support, manual means to move said valve to initiate an approaching movement between said elements, means to stop the approaching movement, and an adjustable dwell control device including an electrically controlled means which is actuated when said elements have remained in contact for a predetermined finish grinding operation to move said valve to a reverse position so as to cause a separation of the wheel and work.

7. A grinding machine of the type of claim 3 comprising means to limit the feeding movement and a control device which causes the wheel and work to remain in contact for a predeter-

mined dwell period and thereafter to separate.

8. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a rapid relative approaching and receding movement between the wheel and work support, a secondary piston and cylinder arranged in axial alignment with the first piston and cylinder which is operative when the slide reaches a predetermined position to modify the movement of the slide by the first piston and cylinder and produce a slower movement of said slide during grinding, and means actuated by and in timed relation with said secondary piston to automatically shift said reverse valve to a reverse position after a predetermined slow feeding movement of said slide to cause a separating movement between the wheel and work support.

9. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a secondary piston and cylinder which is operative when the slide reaches a predetermined position to produce a slower movement of said slide during grinding, and means actuated by movement of the second piston which automatically shifts a reversing valve to cause a separating movement between the wheel and work support.

10. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a secondary piston and cylinder which is operative when the slide reaches a predetermined position to produce a slower movement of said slide during grinding, an electrically operated device including a switch connected to shift the reversing valve to cause a separating movement between the wheel and work support, and a fluid pressure device actuated by the exhaust of fluid from said secondary cylinder which serves to actuate said electrically operated device.

11. A grinding machine comprising a base having a work support and a rotatable grinding wheel, a support for moving one of said elements toward and from the other to a finish grinding position, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching or receding movement between the wheel and the work support, a valve in said system which is arranged to admit fluid to either end of said cylinder to cause either an approaching or receding movement between said elements, a dash-pot mechanism which is operative after a predetermined approaching movement between said elements to modify the rate of the approaching movement between said elements, and electrically actuated means responsive after a predetermined movement of said dash pot to move said valve into a reverse position and cause a receding movement between the grinding wheel and the work.

12. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from each other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a dash pot piston and cylinder arranged in axial alignment with the first piston and cylinder which is operative when the slide reaches a predetermined position to produce a slow feeding movement of the slide during grinding, a positive stop to definitely limit the forward feed of the grinding wheel, and an adjustable dwell device actuated by and in timed relation with the dash pot piston which permits the wheel to remain in contact with the work to finish grind the same for a definite period after the forward advance has been arrested and to thereafter reverse the feed and cause the separation of the wheel and work.

13. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and the work support, a dash pot which is operative when the wheel and work have approached each other by a predetermined distance to modify the movement of said slide to cause a slow grinding feed, a positive stop to limit the movement of said dash pot and said slide, means including an adjustable dwell control valve which is actuated by movement of said dash pot, and electrically actuated means controlled by movement of said valve to move the reversing valve into its reverse position to cause a relative separation between the wheel and the work.

14. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a secondary fluid pressure system including a piston and cylinder which is operative when said slide reaches a predetermined position in its approaching movement to modify the rate of said approaching movement to produce a predetermined relative grinding feed between the wheel and the work, a positive stop for limiting the forward feed, an adjustable fluid pressure dwell control device in said second system, and electrically actuated means controlled by said device to reverse the position of said reversing valve to cause a separation of the wheel and work after a predetermined finish grinding operation.

15. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder op-

eratively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a reversing valve in said system arranged to control the direction of movement of said slide, a secondary fluid pressure piston and cylinder which is effective after a predetermined approaching movement between the wheel and work support to modify the rate of movement therebetween to produce a predetermined grinding feed, a fluid pressure operated dwell control device actuated by said second piston, an electrical switch actuated by said dwell control device, a solenoid energized by closing of said switch to move said reversing valve into a reverse position and cause a separation of the wheel and the work after a predetermined finish grinding operation.

16. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a reversing valve in said system arranged to control the direction of movement of said slide, a secondary fluid pressure system including a piston and cylinder which is effective after a predetermined approaching movement between the wheel and work support to modify the rate of movement therebetween to produce a predetermined grinding feed, a vertically arranged dwell control device which is moved in one direction by exhaust fluid from said second cylinder and in the other direction by gravity to regulate the period of dwell while the grinding wheel remains in grinding contact with the surface of the work to finish grind the same, a solenoid which is operatively connected to move the reversing valve to cause a separation between the wheel and work, and means including an electrical switch which is actuated by the downward movement of the dwell control device to energize the solenoid and cause a separation of the wheel and work.

17. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a reversing valve in said system arranged to control the direction of movement of said slide, a secondary fluid pressure system including a piston and cylinder which is effective after a predetermined approaching movement between the wheel and work support to modify the rate of movement therebetween to produce a predetermined grinding feed, a vertically arranged dwell control device which is moved in one direction by fluid from said second cylinder and in the other direction by gravity to regulate the period of dwell while the grinding wheel remains in grinding contact with the surface of the work to finish grind the same, a pivotally mounted electrical switch, connections between said dwell control device and said switch to rock said switch after a predetermined dwell, and a solenoid energized by closing of said switch which is connected to move the valve into a reverse position and cause a receding movement between the wheel and work.

18. A grinding machine comprising a base having a work support and a rotatable grinding wheel thereon, a transversely movable slide carrying one of said parts for movement relatively toward and from the other, a fluid pressure system including a piston and cylinder operatively connected to feed said slide to cause a relative approaching and receding movement between the wheel and work support, a reversing valve in said system arranged to control the direction of movement of said slide, a secondary fluid pressure system including a piston and cylinder which is effective after a predetermined approaching movement between the wheel and work support to modify the rate of movement therebetween to produce a predetermined grinding feed, a fluid pressure dwell control device including a vertically movable piston which is arranged to be moved vertically by exhaust fluid from said second cylinder, an adjusting screw to limit the upward movement of said device, said device being arranged to move downwardly under the influence of gravity, a needle valve in said control piston which is arranged to regulate the downward movement thereof, an electrical switch actuated by downward movement of said piston, and a solenoid energized by closing of said switch to shift the reversing valve and cause a receding movement between the wheel and work support.

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