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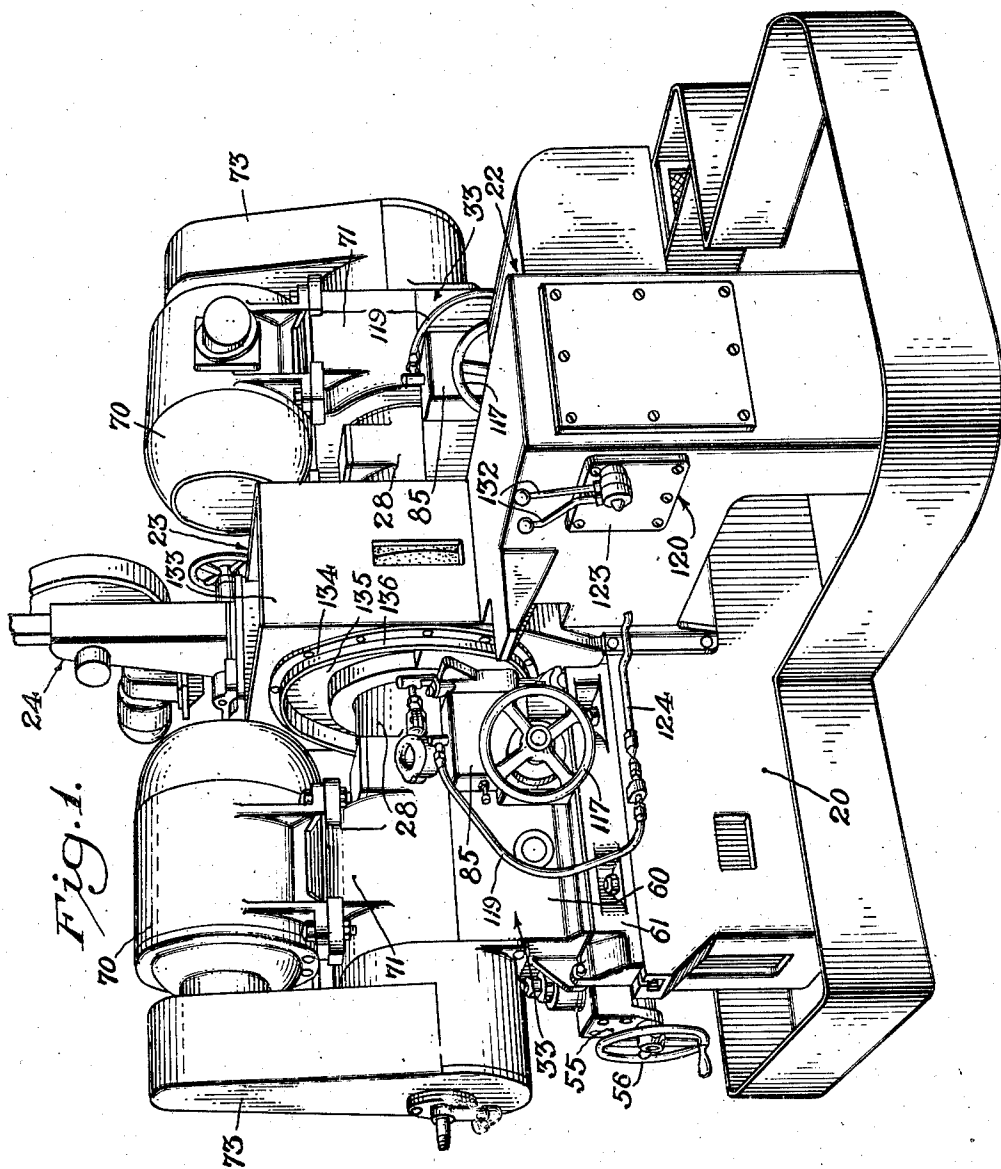
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2,424,448

GRINDING MACHINE

Filed Aug. 6, 1943

6 Sheets-Sheet 1



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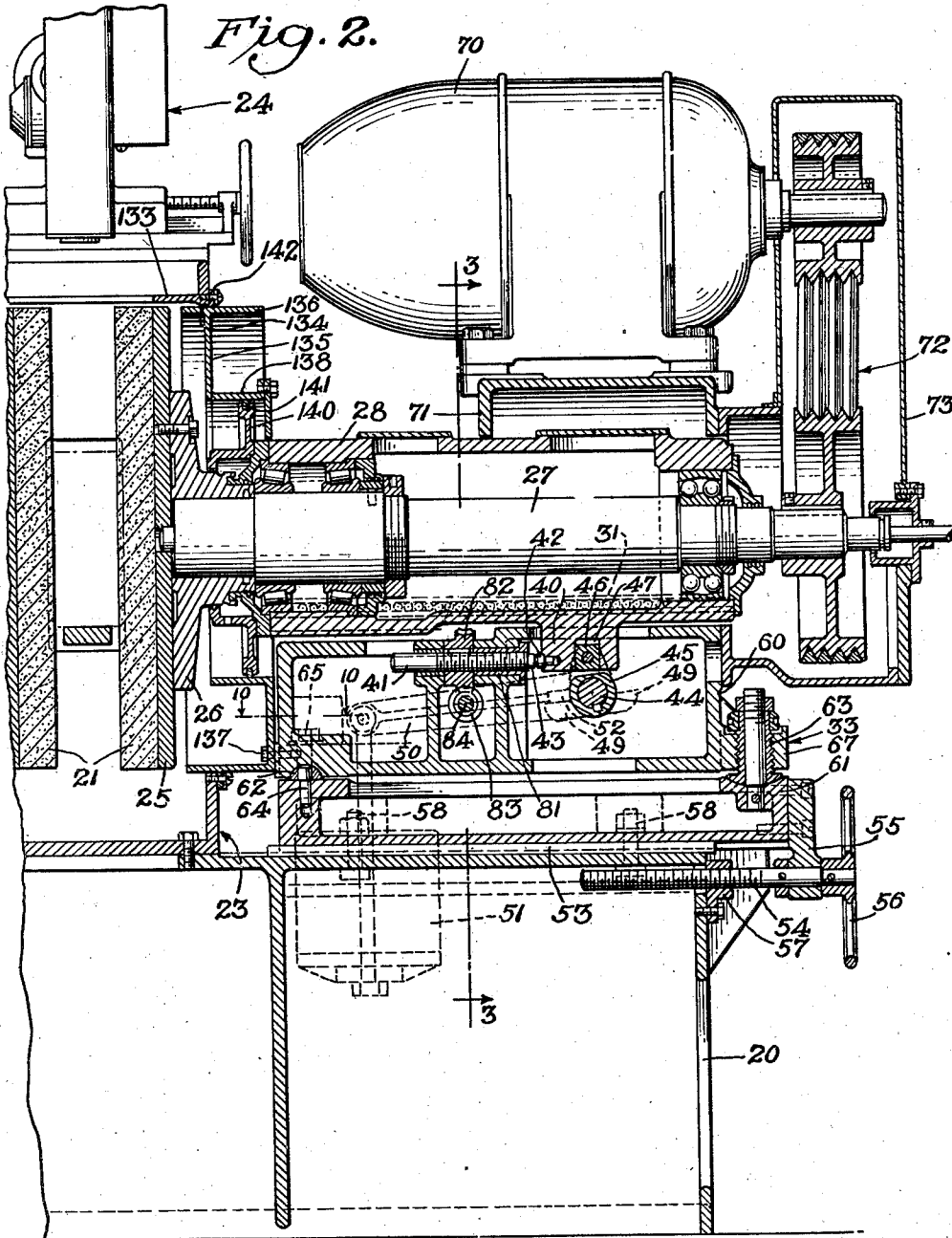
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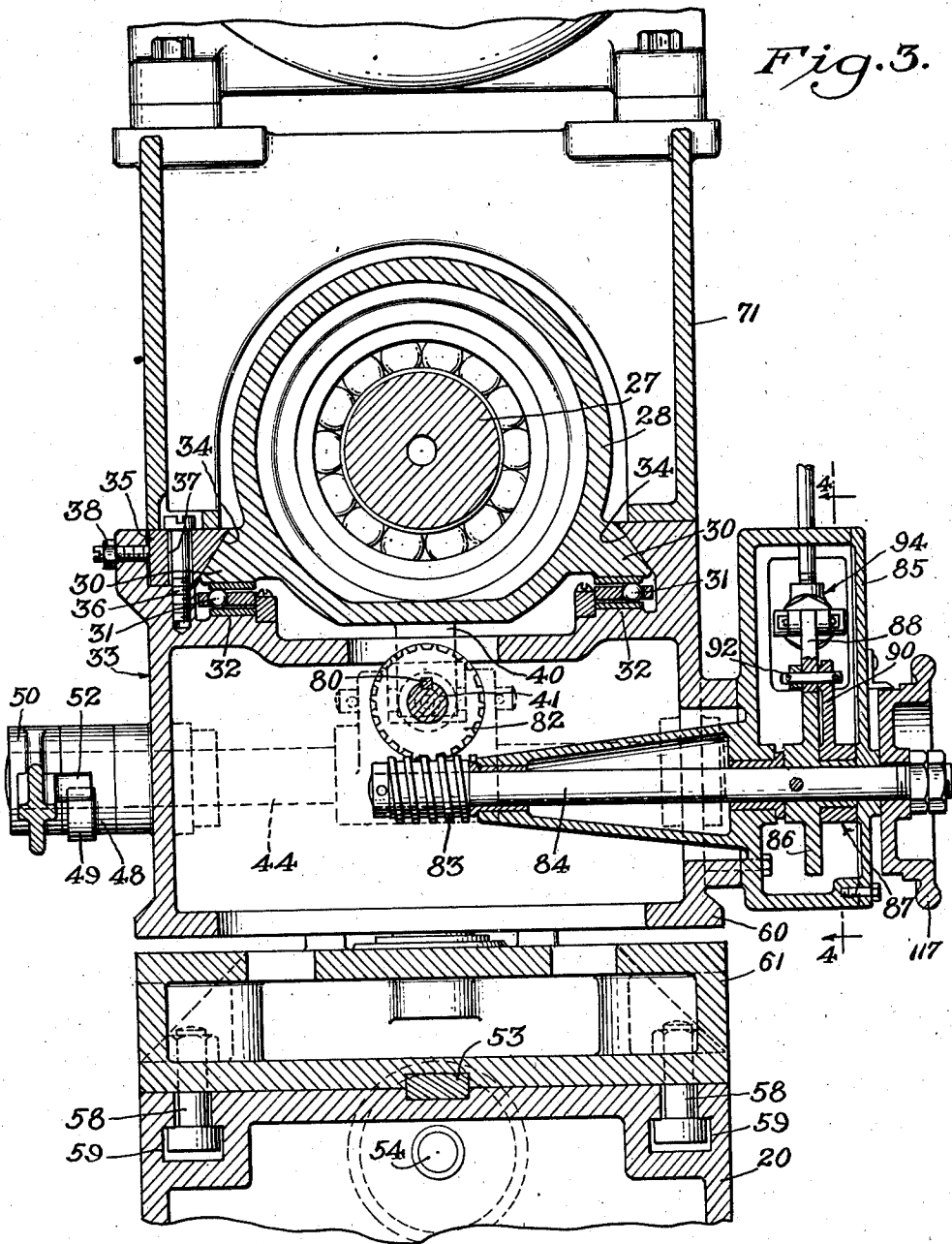
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GRINDING MACHINE

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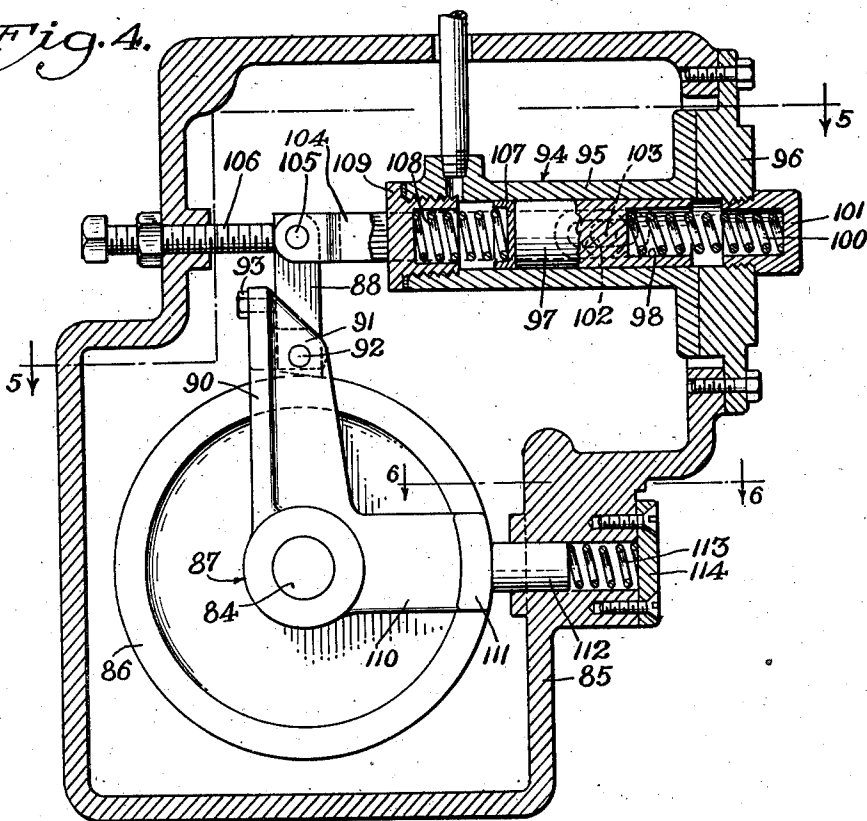
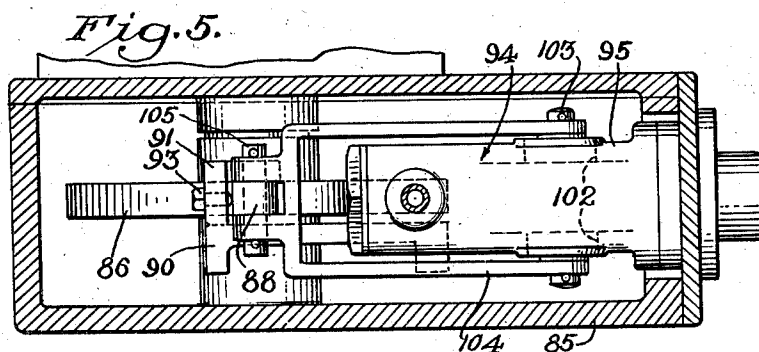
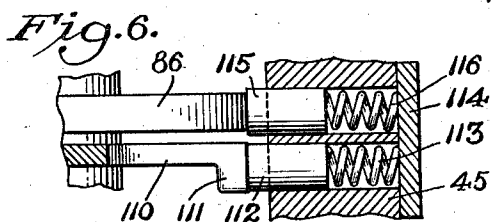
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GRINDING MACHINE

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Fig. 7.

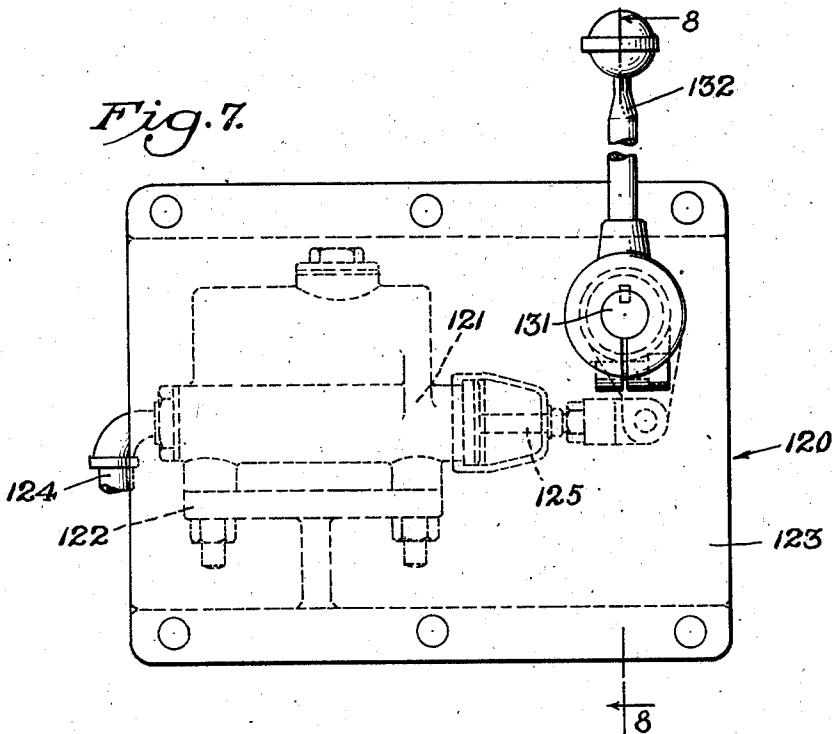
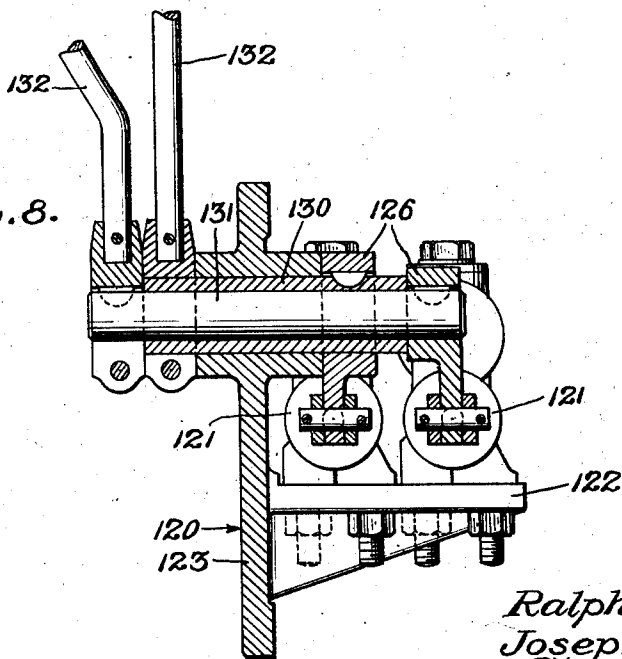


Fig. 8.



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GRINDING MACHINE

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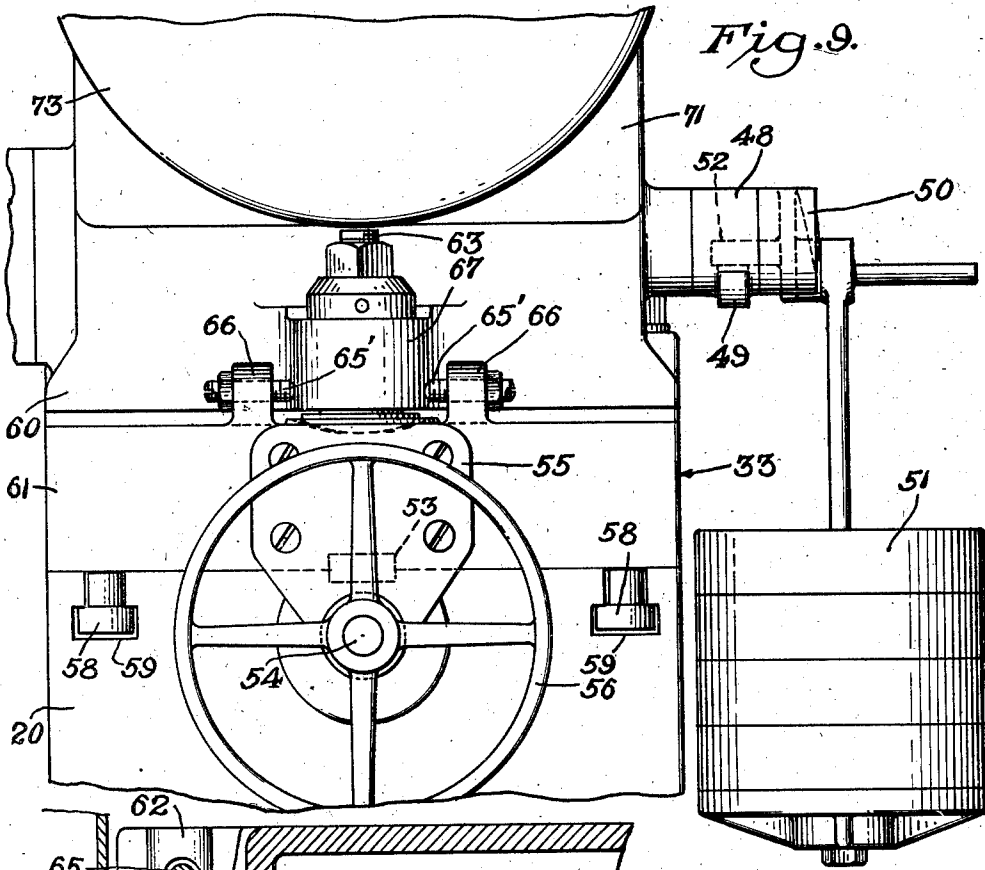
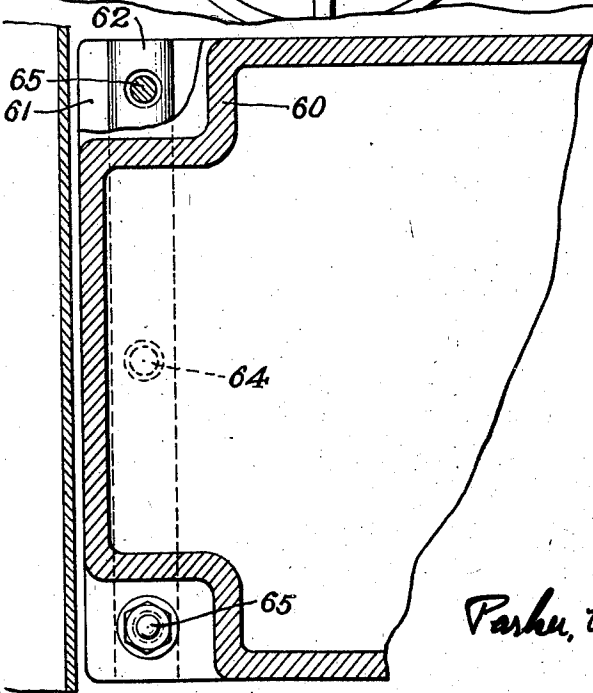


Fig. 10.



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UNITED STATES PATENT OFFICE

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GRINDING MACHINE

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Application August 6, 1943, Serial No. 497,654

15 Claims. (Cl. 51-111)

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The invention relates generally to machine tools and more particularly to a grinding machine.

The general object of the invention is to provide a grinding machine of the type having a pair of grinding wheels in spaced face-to-face relation between which workpieces are adapted to be ground, the machine having a novel structure for supporting the wheels whereby the wheels may be readily moved toward and from each other for adjustment to suit different types of workpieces and for gaining access to the wheels for dressing or replacing them, and the machine also having novel feed mechanism for feeding the wheels toward each other in very small and accurate increments.

Another object is to provide a grinding machine of the above-mentioned type having a feed mechanism for moving the grinding wheels toward each other in small and accurate increments, which mechanism is provided with controls which may be readily located at any convenient place on the machine, thereby permitting the controls for both grinding wheels to be located adjacent each other and at such a place in the machine where the operator is required to stand to perform some other duty such as controlling the feed of work to the machine.

A further object is to provide a control means for the feed mechanism referred to in the preceding object, comprising a pair of levers located side-by-side so that they may be readily operated in unison or separately, the feed mechanism for each head responding exactly to the extent of movement imparted to the lever therefor.

It is also an object to provide a feed mechanism for a grinding wheel of a machine of the above-mentioned type, which permits feeding the grinding wheel in increments limited as to the maximum size of each increment, but which permits increments of any size less than the maximum.

Still another object is to provide a grinding machine of the foregoing type having a feed mechanism controlled by hand actuated means, in which the maximum increment of feed may be readily adjusted, and in which reverse movement of the grinding wheel may be accomplished without the necessity of first releasing any part of the feed mechanism.

A still further object is to provide a feed mechanism for a grinding wheel in a grinding machine of the foregoing type, in which the feeding movement imparted to the head supporting the grinding wheel acts in a line parallel to and not greatly spaced from the axis of the grind-

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ing wheel, without any components of force transverse to such line.

It is another object to provide a grinding machine of the foregoing type in which each grinding wheel is supported by a head movable horizontally on a carriage to provide small increments of feed and readily movable in the opposite direction to position the wheel for dressing; in which the carriage is of two-part construction permitting pivotal adjustment both in horizontal and vertical planes; and in which the carriage is mounted on the base of the machine for horizontal movement to permit the wheels to be widely spaced, as in the case of replacing the wheels, the motor drive for the spindle of the grinding wheel being carried on the carriage rather than on the head.

It is also an object to provide a grinding machine of the foregoing type in which the grinding wheels are located within a guard structure of three-part construction, one part being fixed to the base of the machine, each carriage carrying a second part, and each head carrying a third part, the various parts being telescopically movable one inside of the other so that the guard structure provides a complete closure for all positions of adjustment.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view of a grinding machine embodying the features of the invention.

Fig. 2 is a fragmentary vertical sectional view taken in a plane including the axis of one of the grinding wheel spindles.

Fig. 3 is a fragmentary sectional view taken on the line 3-3 of Fig. 2.

Fig. 4 is a vertical sectional view taken on the line 4-4 of Fig. 3.

Fig. 5 is a horizontal sectional view taken on the line 5-5 of Fig. 4.

Fig. 6 is a horizontal sectional view taken on the line 6-6 of Fig. 4.

Fig. 7 is an elevational view of the manual feed control means.

Fig. 8 is a vertical sectional view taken on the line 8-8 of Fig. 7.

Fig. 9 is a fragmentary and elevational view of the right-hand end of the machine as shown in Fig. 2.

Fig. 10 is a horizontal sectional view taken on the line 10-10 of Fig. 2.

A grinding machine embodying the features of the invention comprises a rigid base 20. The

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base is of generally elongated form from left to right and has mounted on the respective ends thereof structure to support a pair of grinding wheels 21 positioned on generally horizontal axes in face-to-face relation. At the center of the machine in the front thereof is located structure, indicated at 22, for feeding the work to the machine, while in the center of the machine overlying the base 20 is a guard structure, indicated generally at 23, for confining the dust and grit created by the grinding operation and supporting a wheel dressing device, indicated generally at 24.

A grinding machine of this type is adapted to simultaneously grind opposite faces of workpieces fed between the grinding wheels 21. Each grinding wheel is mounted on a horizontal spindle whereby it is rotatably driven, and various adjustments and feeding means are provided to position the wheels relative to each other to perform the desired work. For this purpose each wheel is supported by structure which provides for readily moving the wheel to its approximate grinding position and to bring it from its grinding position to a position where it may be readily replaced after it has been worn down. Each wheel is also movable in the same direction by a highly accurate feed mechanism adapted to move the wheel in relatively small increments so that the workpieces may be ground to accurate dimensions. Further, the wheel supporting structure is provided with adjustments which permit the wheel to be tilted slightly out of a vertical plane about a horizontal axis extending transversely to the spindle, as well as about a vertical axis. Thus the grinding faces of the wheels may be held in parallel vertical planes or may be tilted horizontally, or vertically, or a combination of both tilting adjustments. Since the grinding faces of the wheels have to be dressed frequently, the support for the wheels is so constructed that they may be readily separated sufficiently to permit the dresser to extend into the space between the wheels, and in the present structure, such separation is accomplished through utilization of a portion of the accurate feed mechanism.

The feeding movement of the grinding wheels in small accurate increments is usually effected during production operation of the machine. Therefore it is desirable that such feeding mechanism may readily be operated by the operator who supervises the feeding of work to the machine. Since both wheels are usually simultaneously fed toward each other in such increments, it is obviously desirable that the controls for such feeding mechanisms be placed adjacent each other as well as at a convenient location for the operator when he is supervising the feeding of workpieces to the machine. With a machine of this size, considerable time would be lost if the operator had to walk to one end of the machine to move one wheel the desired amount, and then have to walk to the other end of the machine to move the other wheel the desired amount.

The feeding mechanism for effecting such increments of feed comprises generally a pawl and ratchet device in which the pawl and ratchet preferably have a frictional driving engagement. The pawl is adapted to be actuated by a hydraulic actuator which is operated in one direction by pressure fluid, and which is spring pressed in the opposite direction. The pressure fluid is supplied to the actuator by a pump having a closed connection with the actuator so that the de-

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livery of the pump effects a predetermined movement of the actuator and a consequent predetermined feeding increment. The pump is adapted to be manually operated and since the closed connection between the pump and the actuator constitutes a pipe and a flexible hose, the pump may be located at any place on the machine to suit the convenience of the operator. Since both grinding wheels are usually fed toward each other simultaneously, the pumps for the respective feeding mechanisms are located side-by-side and are provided with hand levers which may be operated in unison or separately. These pumps are preferably placed on the work feeding structure so as to be conveniently located for the operator.

The guard structure 23 is of generally box-like form and has round openings in its ends sufficiently large to permit the grinding wheels to pass therethrough so that they may be readily replaced when necessary. The guard structure also comprises parts movable with the wheel supporting structures so that the grinding area is completely enclosed and none of the dust and grit can escape to the outside where it might collect on other parts of the machine and cause considerable damage.

As shown in the drawings, each grinding wheel 21 is mounted on a supporting wheel 25 (see Fig. 2) which is bolted to a flanged member 26 rigidly secured to a horizontal spindle 27. The spindle 27 is rotatably supported by a head 28 with the spindle extending beyond the head at both ends. The head 28 is provided with a pair of laterally extending ways 30 (see Fig. 3) which are located in a horizontal plane spaced only a short distance below the spindle axis and located at rather widely spaced points on either side of said axis. The ways 30 are carried on longitudinally extending ball bearings 31 which are in turn supported by ways 32 provided on a carriage, indicated generally at 33. The ball bearings 31 thus support the head for movement axially of the spindle 27. To hold the head 28 against lateral movement, the ways 30 are provided with angularly positioned surfaces 34, one of which slides against a similar surface formed on the carriage 31 and the other of which slides against a bar 35 rigidly secured to the carriage 33 by means of screws 36. The bar 35 is adjustably secured in the carriage 33 by the screws 36 so that lateral play between the head and carriage may be readily taken up. For this purpose the screws 36 extend through slightly elongated slots 37 in the bar 35, and laterally extending screws 38 in the carriage 33 hold the bar 35 in close contact with the coacting surface 34 on the head 28.

As hereinbefore mentioned, the head 28 is adapted to be moved horizontally on the ball bearings 31 by feeding mechanism capable of feeding the head in very small and accurate increments. Such feeding mechanism acts on the head in a line parallel to the spindle axis and not greatly spaced therefrom. The force exerted on the head to move it by such feeding mechanism is so applied to the head that it has no vertical components which might tend to cause a slight divergence from a straight axial movement for the head. To this end the head is provided with a lug 40 (see Figs. 2 and 3) which extends downwardly into the carriage 33 which for this purpose is made hollow. The feeding mechanism exerts its force on the lug 40 to move the head, and includes a longitudinally movable screw 41 controlling the movement of the head toward

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the work and a weight-actuated means holding the lug in abutment with the screw 41. To insure that the screw 41 exerts a force which is parallel to the spindle without any component transverse thereto, abutting anvils are provided in the lug 40 and the adjacent end of the screw 41, one of which anvils is preferably provided with a flat surface while the other is provided with a convex surface. Thus, as shown in Fig. 2, there is an anvil 42 mounted in the lug 40 which is provided with a convex surface, while a coacting anvil 43 in the adjacent end of the screw is provided with a flat surface.

The weight-actuated means for holding the lug 40 in abutment with the screw 41 comprises in the present instance a cross shaft 44 journaled at both ends in the carriage 33. Fixed on the shaft intermediate its ends is a lever 45 (see Fig. 2) carrying a block 46 pivotally mounted on the free end of the lever. The block 46 is located in a slot 47 in the lug 40 and is free to move vertically within such slot to compensate for the curvilinear movement of the lever 45, but is confined against lateral movement relative to the slot by the sides thereof. The cross shaft 44 extends externally of the carriage at the rear of the machine and on its outer end has fixed thereto a member 48 provided with oppositely extending bosses 49 (see Figs. 2, 3 and 9).

Also mounted on the end of the cross shaft 44 is a lever 50 provided at its free end with means for supporting a plurality of removable weights 51. The lever 50 is rotatable relative to the shaft 44 and is provided with a projection 52 adapted to bear against one or the other of the bosses 49 to rotate the shaft and thus urge the head in one direction or the other. When the lever 50 extends toward the center of the machine from the cross shaft 44, as shown in the drawings, the weights 51 tend to hold the lug 40 in abutment with the screw 41. Longitudinal movement of the screw 41 thus controls movement of the grinding wheel toward the work.

The grinding wheels frequently require dressing so that the faces thereof provide good cutting surfaces. If the grinding wheels are relatively close together when operating on the work, they must be moved farther apart for dressing in order to permit the dresser to enter the space between the wheels. Because of the frequency of such dressing, it is desirable to be able to move the wheels away from each other in an easy manner. With the present construction, such movement is readily accomplished merely by throwing the lever 50 over to the other side so that it extends toward the end of the machine from the cross shaft 44. In such position the projection 52 will contact the opposite lug 49 and tend to turn the lever 45 in such direction as to move the head outwardly or toward the end of the machine. After the dressing operation, the lever may then be swung back to its original position extending toward the center of the machine, and the wheels properly adjusted by the feeding mechanism including the screw 41.

As mentioned above, the feeding mechanism is utilized for imparting movement to the head 28 in small and accurate increments. For originally setting the head for the work, it is desirable that the head be capable of being moved by larger increments in a quick manner so that it may be roughly positioned for a given piece of work without utilizing the feeding mechanism which includes the screw 41. To provide for such approximate positioning of the head, the carriage

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33 is movable longitudinally of the spindle on the base 20. During such longitudinal movement, the carriage 33 and base 20 are held in alignment by a key in the form of a bar 53 (see Figs. 2, 3, and 9) positioned in slots formed both in the carriage 33 and the base 20. Movement of the carriage 33 relative to the base is effected by a hand-operated screw and nut. The screw, indicated at 54, is rotatably carried by a hanger 55 bolted on the end face of the carriage 33. On the outer end of the screw is a handwheel 56 for rotating it. The screw 54 extends inwardly into the base and operates in a nut 57 bolted to the end face of the base. Thus rotation of the handwheel will cause an adjustment of the carriage 33 along the base. Since such adjustment is utilized in setting up the machine for a given piece of work and is normally not used during production operation, it is desirable that the carriage be firmly locked on the base after it is so adjusted. To this end bolts 58 extend through the carriage 33 and have their heads positioned in T-slots 59 in the base 20. The carriage 33 may thus be rigidly clamped to the base 20 after the carriage is moved to its adjusted position.

In grinding some types of work it is desirable to be able to cant or tilt the grinding wheels relative to each other both about a vertical axis extending through the grinding wheel spindle and about a horizontal axis extending transversely to the spindle. To this end the carriage is made of a two-part construction comprising an upper part 60 and a lower part 61 (see Figs. 1, 2, 3, 9, and 10). These two parts are so connected that the pivotal movement about the above-mentioned axes may be accomplished. Thus on the upper face of the lower part 61 at the left-hand end thereof, as shown in Fig. 2, there is supported a transversely extending bar 62 of half-round cross section on which the corresponding end of the upper part 60 rests. At the right-hand end of the parts 60 and 61 there is a screw member 63 having a convex head bearing against the lower member 61 and threaded into the upper member 60 to adjust the upper member 60 pivotally about the axis of the semi-circular bar 62.

For tilting movement about a vertical axis, the bar 62 is arranged for pivotal movement in a horizontal plane about a pin 64 extending vertically from the left-hand end of the lower part 61. At each end of the semi-circular bar 62 are bolts 65 having a loose fit in the semi-circular bar 62 to permit the desired pivotal motion about the vertical axis, the bolt 65 being utilized to clamp the bar 62 firmly in place when adjusted pivotally about the vertical axis. The upper part 60 of the carriage is adapted to be moved about the vertical axis of the pin 64 by means of a pair of set screws 65' threaded in lugs 66 extending upwardly from the right-hand end of the lower part 61, with the ends of the set screws 65' bearing against a boss 67 in which the vertical adjusting screw member 63 is threaded. Thus with these two pivotal adjustments between the upper and lower parts of the carriage 33, the grinding wheel may be pivoted about a vertical axis or a horizontal axis extending transversely to the spindle, and the two parts may be clamped together in such adjusted position.

Each spindle 27 is adapted to be driven by its own motor, the motors being indicated in Figs. 1 and 2 at 70. If the motor were carried on the head 28, as has heretofore been the usual practice, the head would have to be of extremely heavy construction, and adjustment thereof, par-

ticularly in the case of the small accurate increments, would not be very sensitive. In the present machine, such heavy construction is avoided by supporting the weight of the motor on the carriage 33 instead of on the head. Such manner of supporting the motor is possible since the head is moved relative to the carriage only by the small increments and any major adjustment of the grinding wheels is effected by movement of the carriage relative to the base. In the preferred form, the motor 70 is mounted on a bridge 71 extending upwardly from the two sides of the carriage around and over the head 28 so that the head may slide through or under the bridge. The spindle is preferably driven by a V-belt connection, indicated generally at 72, which permits the pulleys on the motor and the spindle to be moved slightly out of alignment without materially affecting the effectiveness of the drive. The V-belt connection is preferably enclosed in a casing structure 73 which acts as a guard around the connection and also serves to prevent dirt from getting into the spindle bearings at the outer end of the spindle.

One of the principal features of the invention lies in the feeding means for imparting small and accurate increments of feed to the grinding wheel through the screw 41. The feeding mechanism is preferably actuated by a reciprocally acting hydraulic actuator which is connected with a manually operated pump, the connection between the pump and the actuator being closed so that the entire delivery of the pump is carried, without loss of fluid, to the actuator. Consequently each manual movement of the pump produces a predetermined movement of the actuator and a corresponding predetermined increment of feed. With a hydraulic pump and actuator, the connection therebetween may be in the form of a pipe which permits the pump to be located at any point on the machine convenient to the operator.

As shown in Figs. 2 and 3 of the drawings, the screw 41 is mounted for rotary and longitudinal movement in a bearing provided in the carriage 33. To operate the screw, a nut 81 is fixed in the carriage and a worm wheel 82 drives the screw 41 through a key 80 slidable in an elongated keyway in the screw. By this construction the only play affecting movement of the screw is what occurs between the nut and the screw. The worm wheel 82 meshes with a worm 83 mounted on the end of a cross shaft 84 journaled in and extending through the front face of the carriage 33. On the front face of the carriage is mounted a casing 85 (see Figs. 3, 4, and 5) enclosing the outer end of the shaft, and also mechanisms for rotating the shaft to produce the desired feeding increments of the head 28. To this end the shaft has fixed thereon a ratchet wheel 86 and a pawl carrier, indicated generally at 87. The ratchet wheel 86 is provided with a flat peripheral surface adapted to be frictionally engaged by a pawl 88 carried by the pawl carrier 87. To support the pawl 88 the pawl carrier is provided with an upwardly extending arm 90 having a yoke portion 91 overlying the ratchet wheel 86, the pawl 88 being pivotally supported between the arms of the yoke portion 91 by means of a pin 92. The pawl 88 is shaped to frictionally engage the periphery of the ratchet wheel 86 by being pivoted in a clockwise direction as viewed in Fig. 4. Release of the pawl 88 from the ratchet wheel consequently will be effected by pivoting the pawl

in a counterclockwise direction. However, only a slight movement is required to release the pawl from such frictional engagement and in order to avoid as much lost motion as possible, a screw 93 is threaded in the yoke portion 91 to limit the disengaging movement of the pawl 88.

The pawl is adapted to be both pivoted into engagement with the ratchet wheel and then swung to effect rotation of the ratchet wheel by means of a hydraulic actuator, indicated generally at 94. The hydraulic actuator comprises a cylinder 95 having a cover plate 96 detachably secured to the casing 85 so that it may be readily removed therefrom. The cylinder 95 extends in a horizontal direction and has a piston 97 therein. The piston is of elongated form and has a pocket 98 formed in its right-hand end, as viewed in Fig. 4, in which is positioned one end of a spring 100, the other end of the spring being supported by a plug 101 threaded into the cover plate 96. The spring 100 tends to move the piston to the left.

The piston 97 is adapted to be connected to the pawl 88, and to this end a pair of elongated longitudinally extending slots 102 are provided in the sides of the cylinder 95 and a pin 103 extends through the piston and the slots 102 to the outside of the cylinder 95. The pin 103 is connected to the pawl by means of a yoke 104, the two arms of the yoke straddling the cylinder 95 and extending to the left of the cylinder to be pivotally connected to the upper end of the pawl 88 by means of a pin 105. The piston is adapted to be moved to the right, as viewed in Fig. 4, by pressure fluid applied to the left-hand end of the piston the extent of such movement being equal to the space between the end of the piston and the plug 101, the spring 100 thereby being compressed. The spring 100 serves to force the piston to the left when the pressure of the fluid is released. To determine the maximum stroke of the piston and consequently the maximum increment of feed imparted to the head 28, adjustable means is provided for limiting the movement toward the left of the yoke 104. Preferably such means comprises a screw 106 adjustably threaded in the casing 85 and adapted to form an abutment for the pawl 88 as it is moved to the left. Leakage around the piston is prevented by a bushing 107 held in abutment with the left end of the piston 97 by means of a spring 108, the spring bearing at one end against the bushing 107 and at the other end against a removable plug 109 threaded into the end of the cylinder 95.

In order to be sure that movement of the piston 97 to the right will first cause the pawl 88 to move into firm frictional engagement with the ratchet wheel 86 and thereafter rotate the ratchet wheel, means is provided for yieldably holding the pawl carrier against swinging movement until the pawl has pivoted into full driving engagement with the ratchet wheel. To this end the pawl carrier 87 is provided with a horizontally extending arm 110 having a flange portion 111 at its outer end adapted to be engaged by a braking means. In the preferred form the brake means comprises a plunger 112 slidably mounted in the wall of the casing 85 and pressed toward the flange portion 111 by a spring 113. The spring 113 is held in place by means of a plate 114 detachably secured to the casing 85. Thus when the piston 97 is moved to the right under the influence of the pressure fluid, the pawl carrier 87 is held against movement until

the pawl 88 is pivoted about the pin 92 into firm driving engagement with the periphery of the ratchet 86. Thereafter further movement of the piston 97 pulls the pawl 88 to the right and effects partial rotation of the ratchet wheel 86. Through the connections heretofore described, such rotation of the ratchet wheel 86 causes a longitudinal movement of the screw 41 to the left to permit the weight-actuated means to move the grinding wheel toward the work. Because of the small angle of rotation of the ratchet wheel 86 by means of the pawl, and because of the large gear reduction between the ratchet wheel and the screw 41, the actual increment of movement of the grinding wheel is very small.

After the piston 97 has moved to its extreme right-hand position and the pressure of the fluid acting on the piston is released, the spring 100 acts to move the pawl 88 to the left. Because of the braking action of the plunger 112 on the pawl carrier, the first movement of the piston to the left causes the pawl 88 to pivot out of engagement with the ratchet. Such pivotal movement of the pawl, however, is very slight because of the limited movement permitted by the screw 93. Thereafter further movement of the piston to the left causes the pawl carrier and pawl to swing back to the original position, such position being determined by the screw 106.

In order to prevent the ratchet wheel 86 from being reversely rotated by the return movement of the pawl, braking means is also provided for the ratchet wheel, such braking means in the present instance comprising a second plunger 115 similar to the plunger 112 and located adjacent thereto. The plunger 115 is pressed into braking engagement with the periphery of the ratchet wheel by means of a spring 116 mounted in the wall of the casing 85 and held in place by the plate 114.

When the spring 100 moves the piston 97 to the left, the frictional resistance of the plunger 115 on the ratchet wheel causes the movement of the piston first to effect a pivotal motion of the pawl 88 about the pin 92 to release the pawl from frictional engagement with the ratchet wheel. As soon as the pawl 88 abuts the screw 93, further movement of the piston causes reverse swinging of the pawl carrier 87 to the original position, the ratchet wheel in the meantime being held against reverse rotation by the plunger 115 so that the next stroke of the piston will cause further rotation of the ratchet wheel. Since the pawl and ratchet mechanism is capable of rotating the shaft 84 in only one direction, a handwheel 117 is mounted on the outer end of the shaft 84 outside of the casing 85 to rotate the shaft 84 in the opposite direction. It will be noted that the handwheel 117 is free to reversely rotate the shaft 84 at any time that the actuator 94 is not in operation since the pawl 88 is released from the ratchet automatically by the actuator 94.

The above described ratchet mechanism provides for actuation of the feed mechanism in small and accurate increments of feed to the head 28. Such increments of feed are imparted to each head during the production operation of the machine to maintain the work being ground to accurate dimensions. Since during production operation the operator stands near the work feeding structure 22 in order to supervise the feeding of workpieces to the machine, considerable time would be lost in production if the operator had to walk first to one end of the machine and then

to the other to operate the feeding mechanisms. Therefore it is desirable to place the controls for the hydraulic actuators 94 in a place convenient to the operator when standing near the work feeding structure 22. To this end controls, indicated at 120, for the two hydraulic actuators of the respective heads, are mounted on the work feeding structure 22, preferably at one side thereof, as shown in Fig. 1.

The controls 120 control the flow of pressure fluid to the two actuators 94. Since it is desirable to have each actuator move in exact response to the manual operation of its control, each control preferably comprises a hand-operated pump of the piston and cylinder type in which the output of the pump conforms to the length of stroke imparted to it manually. Each pump is connected to its actuator 94 by a connection which is closed so that the entire output or discharge of the pump is conducted to the actuator. Movement of the piston in the actuator and consequent movement of the ratchet wheel thus accurately corresponds to the hand manipulation of the pump or control so that the feeding increment imparted to the grinding wheel is under direct control of the operator.

As shown in the drawings, and particularly in Figs. 7 and 8, the controls for the respective actuators comprise a pair of piston and cylinder pumps 121. The pumps are mounted side-by-side on a bracket 122 formed integrally with a plate 123 bolted to one side of the work feeding structure 22. Each pump has a closed connection with the actuator 94 in the form of a pipe 124 extending to and fixed to the base 20, and a flexible hose 119 which allows for the relative movement between the head and base. Since the closed connection takes this simple form, it is obvious that the controls 120 may be placed at any point desired on the machine.

Each pump 121 is of the piston and cylinder type and has its piston rod 125 extending beyond the end of the cylinder and connected to a lever 126. Extending through the plate 123 is a rotatable sleeve 130 in which is rotatably mounted a shaft 131. One of the levers 126 is keyed to the sleeve 130, while the other lever 126 is keyed to the shaft 131. The sleeve and shaft extend outside of the plate 123, the shaft extending beyond the sleeve. On the outer ends of the sleeve and shaft are secured hand levers 132. Thus each pump may be individually actuated by manual movement of its lever 132, or both pumps 121 may be operated in unison by moving the two hand levers 132 at the same time, the two hand levers being located side-by-side so that they may be readily actuated simultaneously or separately. Thus when the two hand levers 132 are simultaneously moved, a feeding increment is imparted to both grinding wheels in increments proportional to the distance through which the hand levers 132 are moved. If the operator desires to move only one of the grinding wheels its hand lever 132 alone is moved. The hand levers 132 are used to operate the piston of the pump 121 in one direction and at the end of a pumping stroke the pistons of the pump are spring-actuated in the opposite direction.

Another feature of the invention lies in the construction of the guard structure which surrounds the grinding wheels and which prevents the grit and dirt thrown off by the wheels from gaining access to the other parts of the machine. The guard structure 23 preferably comprises a generally rectangular box-like member 133 se-

cured to the base 20 (see Figs. 1 and 2) and provided with a round opening 134 in each end. Each opening 134 is of sufficient size to permit a grinding wheel 21 to be moved therethrough. To close the opening 134 an annular member 135 is provided which has a peripheral flange 136 fitting snugly and slidably in the opening 134. The annular member 135 at its lower portion is secured to the upper carriage member 60 as by bolts 137 so that the annular member moves with the carriage relative to the box-like member 133, the annular flange 136 thus telescoping inside of the box-like member.

The annular member 135 also has an internal flange 138 extending axially of the spindle, and slidably mounted within the flange 138 to close the opening therethrough is a flange member 140 secured to the head 28 for movement therewith. Thus when the head 28 is moved relative to the carriage, the flange member 140 slides within the internal flange 138. To provide a tight seal so that no dust or grit can escape between the relatively sliding members, a flexible wiper 141 is mounted in the periphery of the flange member 140 to wipe against the internal surface of the internal flange 138, and a similar flexible wiper 142 is mounted on the outer face of the box-like member 33 to rub on the outer surface of the peripheral flange 136.

In the operation of the machine, the carriages 33 are adjusted on the base 20 by means of the handwheel 56 and screw 54, to a position where the grinding wheels 21 are approximately spaced from each other a suitable distance for grinding the particular workpiece involved. However, the grinding wheels 21 are positioned slightly farther apart than is required for the actual grinding operation. The carriage is then locked to the base by means of the bolts 58. If any canting of the grinding wheels is required for the particular grinding operation to be performed, the upper and lower parts of the carriage are relatively tilted about the vertical axis of the bolt 63, or about the horizontal axis of the bar 62. After such canting adjustment is made, the two parts of the carriage are locked in that position.

The grinding wheels are then ready to be moved toward each other in small accurate increments to grind the workpieces to the desired dimensions. The operator stands at the front of the machine adjacent the work feeding structure 22 and supervises the feeding of work to the space between the grinding wheels. For such feeding of the work, a feeding device may be mounted on the structure 22 with suitable guides extending into and through the space between the wheels to guide the work. Such structure is not shown herein as it relates to the particular job to be performed and will vary with different types of workpieces.

As the workpieces are fed through the space between the grinding wheels and are ground, the finished pieces are gauged. If the dimension being ground is too great, or in other words, if the grinding wheels have not removed sufficient stock, the operator manually moves the hand levers 132. If both hand levers 132 are actuated, each grinding wheel will be moved toward the other. If only one hand lever is actuated, then obviously only one grinding wheel is moved. Movement of each hand lever 132 actuates the pump 121, the discharge of which is conducted to the cylinder 95 of the hydraulic actuator 94. The

pressure of the fluid forces the piston 97 to the right, as shown in Fig. 4.

Movement of the piston 97 to the right through the yoke 104 actuates the pawl 88. First movement of the pawl 88 is a pivotal movement about the pin 92 caused by virtue of the braking action of the plunger 112 on the flange portion 111 of the pawl carrier 87. Such pivotal movement of the pawl 88 brings the lower end thereof into frictional driving engagement with the peripheral surface of the ratchet wheel 86. Continued movement of the piston 97 to the right then causes rotation of the ratchet wheel 86.

Rotation of the ratchet wheel 86 causes rotation of the worm 83 (see Figs. 2 and 3) and consequent rotation of the screw 41 in the nut 81 so that the screw moves to the left as viewed in Fig. 2. Such movement of the screw 41 permits the head 28 and the grinding wheel 21 to be moved to the left by the weight-actuated lever 50.

Since the pump 121 is spring actuated, as soon as the hand lever 132 is released, the piston of the pump is moved back to its original position as well as the hand lever 132. With the release of hydraulic pressure in the actuator 94 the spring 100 causes the piston 97 to be moved to the left, as viewed in Fig. 4. This causes the pawl 88 to swing out of engagement with the ratchet wheel 86 because of the brake 115 for the ratchet wheel, and then swings the pawl 88 with the pawl carrier 87, back to its original position. The stroke of the piston and the consequent rotational movement of the pawl 88 may be adjustably limited by the screw 106. The brake 115 holds the ratchet wheel 86 against reverse rotation so that rotation of the ratchet wheel by the pawl is effected always in the same direction. Before resetting the machine for a new workpiece, the head 28 and the grinding wheel 21 is moved away from the other grinding wheel by means of the handwheel 117 on the cross shaft 84. During such reverse rotation of the shaft 84 no part of the ratchet need be released to permit such reverse rotation since the hydraulic actuator 94 leaves the pawl 88 out of engagement with the ratchet wheel.

Since the screw 41 and the lug 40 on the head 28 are provided with abutting anvils 43 and 42, one of which is flat and the other of which is convex, and since the weight-actuated lever 50 exerts its force on the head 28 through the block 46 which is free to slide vertically in the slot 47, there is no force exerting any vertical component which might tend to cause a slight canting of the head 28. Thus the increments of feed imparted to the head 28 by means of the feeding mechanism are accurately parallel to the spindle axis, resulting in a consequent accuracy of the grinding operation. Movement of the head 28 is sensitive to the feeding mechanism since the head 28 is carried on ball bearings and since it does not carry the large weight of the motor 70.

During production operation of the machine, the grinding wheels require fairly frequent dressing. If the wheels are close together, they have to be separated sufficiently to permit entrance of the dresser therebetween. Such separation is readily effected merely by swinging the weighted levers 50 upwardly through 180° so that the projection 52 on the lever 50 will abut against the outer boss 49, thereby moving the head 28 and the grinding wheel 21 away from the other grinding wheel. At such time the anvils 42 and 43 are separated but swinging the weighted

lever 50 back into its original position again brings these anvils into abutment and places the positioning of the head 28 under the control of the screw 41. During such movement of the head 28, the flange member 140 of the guard structure is free to slide within the internal flange 138, thereby maintaining the sealed closure around the grinding wheels but permitting relative movement of the parts.

When a grinding wheel is worn out, it obviously has to be replaced, the old grinding wheel being removed from the supporting wheel 25. At such time the head 28 as well as the carriage 33 is moved far enough to move the grinding wheel outside of the guard structure. During this time the peripheral flange 136 of the annular member 135 slides out of the opening 134 which is big enough likewise to permit passage therethrough of the grinding wheel. Thus the grinding wheel can be positioned outside of the guard structure where it may be readily removed and a new wheel put in its place. Movement of the carriage for this purpose is effected by the handwheel 56 and the screw 54.

From the foregoing description it will be apparent that we have provided a novel grinding machine of the type comprising a pair of grinding wheels in spaced face-to-face relation between which workpieces are adapted to be ground. The machine has a novel structure for supporting the wheels whereby the wheels may be readily fed toward each other by small accurate increments to grind the workpieces to accurate dimensions. In this machine the grinding wheels may be readily separated a sufficient distance for dressing them merely by swinging the weight actuated levers 50 through 180°, the grinding wheels likewise being movable to a position where they may be replaced by means of the handwheel 56 which does not entail operation of a fine feed such as the screw 41 to effect such a major movement. The feeding mechanism for moving the grinding wheels toward each other in small accurate increments is provided with controls which may be positioned at a convenient place on the machine for use by the operator when he is supervising the feeding of workpieces to the machine. Thus the controls comprise the two hand levers 132 which are mounted side-by-side so that they may be readily operated in unison or separately. The increment of feed imparted to the grinding wheels is in exact proportion to the movement of the hand levers 132, and the increments therefore may be of any size desired up to a predetermined maximum. The maximum increment may be adjusted by means of the screw 106. The feeding mechanism also includes a handwheel 117 which may be used to reverse the screw 41, the pawl 88 being released from the ratchet wheel 86 at any time that the handwheel 117 is put into use.

The grinding wheels are not only adjustable in large steps for bringing the wheels into approximate position for the work, as well as in small increments for the final adjustment, but also the grinding wheels may be canted either about a vertical axis or a horizontal axis transverse to the grinding spindle which for certain types of workpieces is desirable. The head 28 is supported in such a manner that it is sensitive to the increments imparted by the feeding mechanism, the head being supported on ball bearings and not being required to support the weight of the motor and the consequent heavy construction required for such support.

We claim as our invention:

1. In a machine of the character described, the combination of feeding means for shifting a grinding machine element pawl and ratchet mechanism operable in a forward direction to actuate said feeding means, a hydraulic actuator having a reversibly movable actuator element for actuating said mechanism, spring means for urging said element in one direction and a hand-operated piston pump having a reversibly movable pump element for displacing fluid and having a closed connection with said actuator, said actuator and pump defining a sealed system containing a body of fluid shiftable by said pump element toward said actuator to move said actuator in opposition to said spring means, whereby movement of the actuator element will be in exact response to the hand movement of the pump element.

2. In a machine of the character described, the combination of feeding means for shifting a grinding machine element, pawl and ratchet mechanism having a reversibly movable pawl operable in one direction to actuate said feeding means incrementally, a hydraulic actuator operative to move the pawl in said one direction, a spring for moving said pawl in the opposite direction, a manually operated piston pump remotely located from said actuator and having a hand operator for displacing the pump piston, and a closed flow connection between said pump and said actuator, whereby movement of said hand operator through a predetermined distance in a direction to displace fluid from said pump will produce a corresponding movement of the actuator to move said pawl in opposition to said spring through a feed increment.

3. In a machine of the character described, in combination, a pair of spindle supporting heads, feeding mechanisms for the respective heads, a pair of hydraulic actuators for actuating the respective feeding mechanisms, and a pair of manually operable pumps located remotely from the respective actuators and each having a closed connection with one of the actuators, said pumps being positioned side-by-side and each having an operating lever positioned closely adjacent the operating lever of the other pump whereby the operating levers of the two pumps may be readily manipulated in unison or separately.

4. In a machine of the character described, in combination, a pair of spindle supporting heads, a pair of feeding mechanisms for said heads, a pair of hydraulic actuators for actuating said feeding mechanisms, a pair of pumps located side-by-side and having closed connections with the respective actuators, a shaft and a sleeve concentrically and rotatably mounted adjacent said pumps, said shaft and sleeve being connected to the respective pumps to operate the pumps on rotation of the shaft and sleeve, and a pair of hand levers respectively mounted on the shaft and sleeve and closely adjacent each other whereby the hand levers may be manipulated in unison or separately.

5. In a machine of the character described, the combination of feeding means including a rotatable shaft, a wheel fixed on said shaft for rotating the shaft, a pawl carrier rotatably mounted on said shaft adjacent said wheel, a pawl pivotally supported by said pawl carrier and adapted to be pivoted into frictional driving engagement with the periphery of said wheel, a reciprocable actuator adapted when moved in one direction to pivot said pawl into such engagement and

rotate said wheel, and friction brake means acting on said pawl carrier whereby reciprocation of said actuator will first cause pivotal movement of the pawl and thereafter rotation of said wheel.

6. In a machine of the character described, the combination of feeding means including a rotatable shaft, a wheel fixed on said shaft for actuating said feeding means, a pawl carrier rotatably mounted on said shaft, a pawl pivotally supported by said pawl carrier and adapted to be pivoted into frictional driving engagement with said wheel, a reciprocable actuator adapted to move in one direction to pivot the pawl into engagement with the wheel and then to rotate the wheel, and frictional brake means engaging said wheel to prevent reverse rotation when the actuator moves in the other direction.

7. In a machine of the character described the combination of feeding mechanism, a wheel for operating said feeding mechanism, a pawl carrier mounted for swinging movement about the wheel axis, a pawl pivotally supported by said pawl carrier, a reciprocable actuator adapted when moved in one direction to pivot said pawl into frictional driving engagement with said wheel and then to rotate said wheel, and a pair of brake means, one engaging said pawl carrier whereby movement of the actuator in said direction first causes pivotal movement of the pawl and thereafter rotation of the wheel, the other brake means engaging the wheel and preventing reverse rotation thereof when the actuator moves in the opposite direction.

8. In a machine of the character described, the combination of feeding means, a wheel adapted to be rotated to operate said feeding means, a pawl carrier mounted adjacent to and coaxially with the wheel, said pawl carrier comprising a pair of arms extending from the axis thereof, a pawl pivotally supported by one of said arms and adapted to be pivoted into frictional driving engagement with the periphery of said wheel, a reciprocable actuator adapted when moved in one direction to pivot said pawl into such frictional engagement and thereafter rotate said wheel, and a pair of spring pressed plungers, one frictionally engaging the other arm of the pawl carrier whereby movement of the actuator in said direction will first cause the pawl to pivot into driving engagement with said wheel, and the other of said plungers frictionally engaging the periphery of said wheel to prevent reverse rotation thereof when the actuator moves in the opposite direction.

9. In a machine of the character described, the combination of feeding means including a rotatable shaft, a wheel fixed on said shaft, a pawl carrier rotatably supported by said shaft, a pawl pivotally mounted on said pawl carrier adapted to be pivoted into frictional driving engagement with said wheel, a reciprocable actuator moving in one direction to first pivot said pawl into such driving engagement and thereafter rotate said wheel, braking means tending to hold said pawl carrier against rotation whereby movement of the actuator in the opposite direction first swings the pawl out of driving engagement with said wheel and thereafter swings said pawl carrier, and a hand wheel fixed on said shaft for manually operating said feeding means, said shaft being freely rotatable by said hand wheel except when said actuator swings said pawl into driving engagement with said wheel.

10. In a machine of the character described,

the combination of a translatable spindle supporting head, a lug extending transversely from said head, feeding means for controlling the movement of said head in one direction including a longitudinally movable screw abutting one face of said lug, a shaft extending transversely to the direction of movement of said head and located adjacent said lug, a lever fixed on one end of said shaft in abutment with the opposite face of said lug, a member mounted on the opposite end of said shaft provided with a pair of bosses on opposite sides of said shaft, and a weight-actuated lever rotatably mounted on said shaft and having a projection selectively engageable with said bosses, said projection normally engaging one of said bosses whereby the weight tends to hold the lug on the head in engagement with said screw, said lever being swingable through 180° to bring its projection into engagement with the other boss for readily moving said head in the opposite direction.

11. In a grinding machine, in combination, a base, a horizontal grinding wheel spindle located above the base, a head rotatably supporting said spindle, a carriage supporting said head for movement axially of the spindle and being supported on said base for movement in the same direction, means for moving said head relative to said carriage in small increments through a limited distance, a bridge carried by said carriage and extending upwardly around and over said head, and a motor mounted on said bridge and having a driving connection with said spindle.

12. A grinding machine comprising, in combination, a base, a carriage supported for horizontal movement on said base, a head supported for horizontal movement in the same direction on said carriage, a grinding wheel spindle carried by said head with its axis parallel to the direction of movement thereof, a grinding wheel carried by said spindle, a guard structure surrounding the grinding wheel and having a round opening in one face large enough to permit passage therethrough of the grinding wheel, an annular member secured to said carriage having a peripheral flange fitting snugly in and slidable relative to said opening upon movement of the carriage relative to the base, said annular member having an internal axially extending flange, and a flanged member secured to said head and fitting snugly within and slidable relative to the internal flange of said annular member.

13. A grinding machine comprising, in combination, a base, a grinding wheel located above said base with its axis horizontal, a spindle supporting said grinding wheel, a head rotatably supporting said spindle, a carriage supporting said head for movement axially of the spindle and being mounted on said base for movement in the same direction, a box-like guard structure enclosing said grinding wheel and having a round opening of a size sufficient to permit the grinding wheel to pass therethrough, an annular member movable with the carriage and having a peripheral flange fitting snugly within said opening, said annular member also having an internal flange, and a member carried by said head fitting snugly within said internal flange, said guard structure and said last-mentioned member having flexible wiping members respectively engaging the peripheral flange and the internal flange of said annular member to provide a dust proof seal therebetween.

14. In a machine of the character described,

in combination, feed mechanism including a rotatably supported wheel, a pawl carrier supported to rock about the rotational axis of said wheel, a pawl mounted on said carrier and adapted to frictionally engage the periphery of said wheel when the carrier is rocked in one direction, means for rocking said carrier back and forth, said pawl providing a driving connection operative to turn said wheel with the carrier in its movement in said one direction, and means frictionally engaging said wheel to prevent it from turning with said carrier when the latter is rocked in the other direction.

15. In a grinding machine, in combination, a horizontal base, a carriage mounted on said base for longitudinal adjustment, a head mounted on said carriage for adjustment in the same general direction as said carriage, a spindle adapted to support a grinding wheel and mounted in said head for movement therewith, said spindle extending parallel to the direction of movement of said head on said carriage, means for adjusting said carriage through a relatively large distance whereby to permit retraction of said spindle to facilitate ready removal of the grinding wheel, an abutment element anchored in said carriage for adjustment longitudinally thereof, weight actuated means mounted on said carriage and coacting with said head to maintain the latter in separable abutting engagement with said element, and means for adjusting said abutment element to effect adjustment of said head through the action of said weight actuated means, said weight actuated means being reversible at will to act on said head in a reverse direction and thereby separate said head from said abutment element for the purpose of retracting the grinding wheel from the work to facilitate wheel dressing.

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