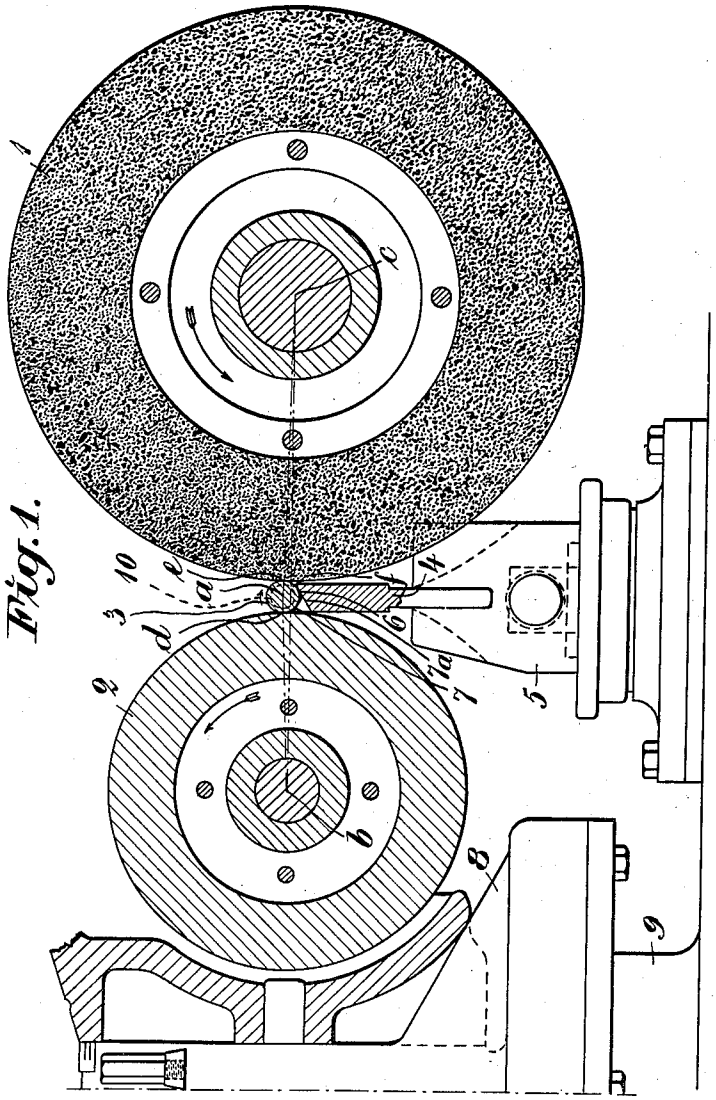
Sept. 29, 1942. J. E. BERGSTRÖM 2,297,045

CENTERLESS GRINDING MACHINE

Filed June 25, 1940 5 Sheets-Sheet 1

Fig. 1.



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CENTERLESS GRINDING MACHINE

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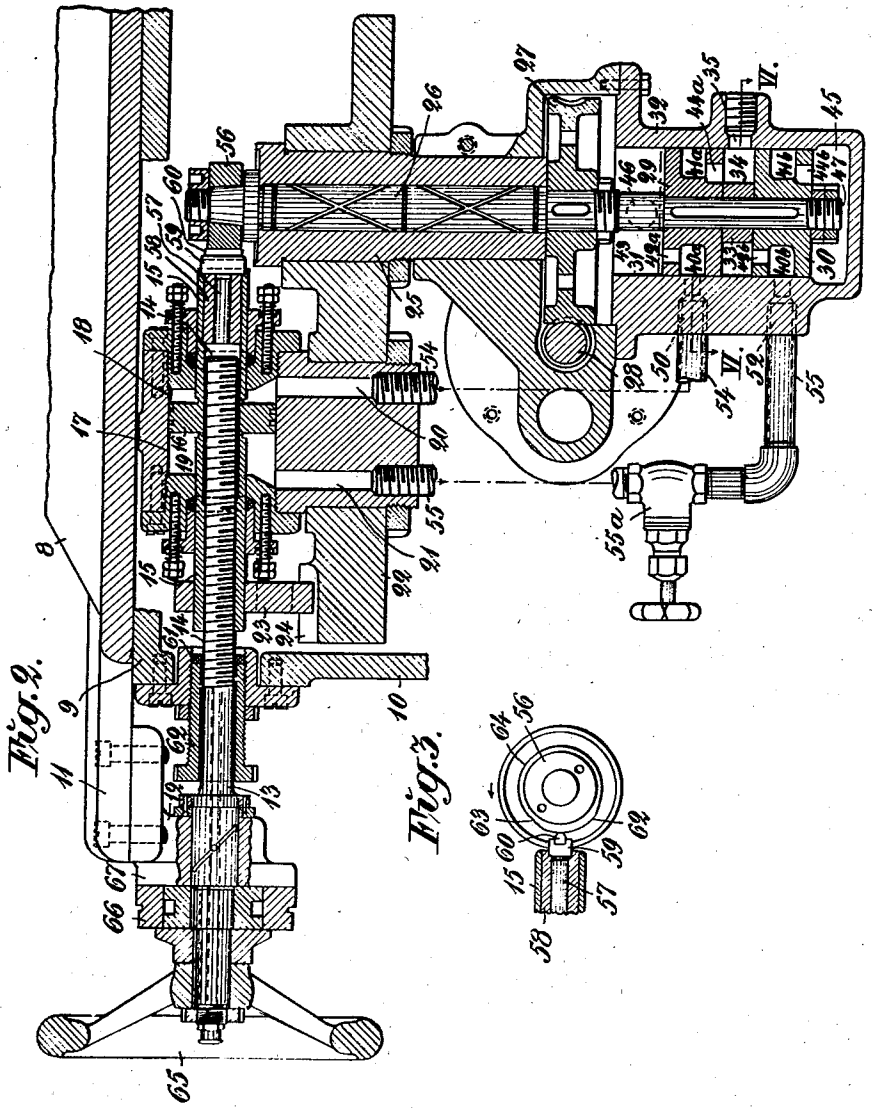


Fig. 2.

Fig. 3.

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CENTERLESS GRINDING MACHINE

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Fig. 4.

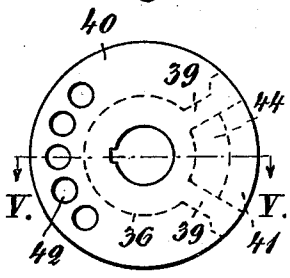


Fig. 6.

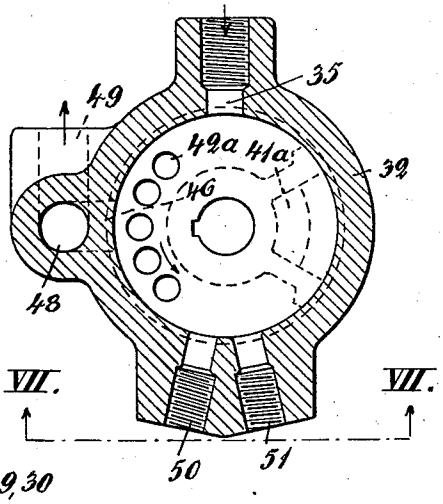


Fig. 5.

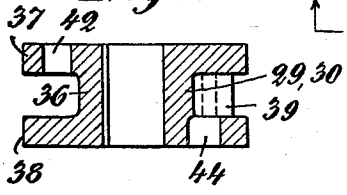
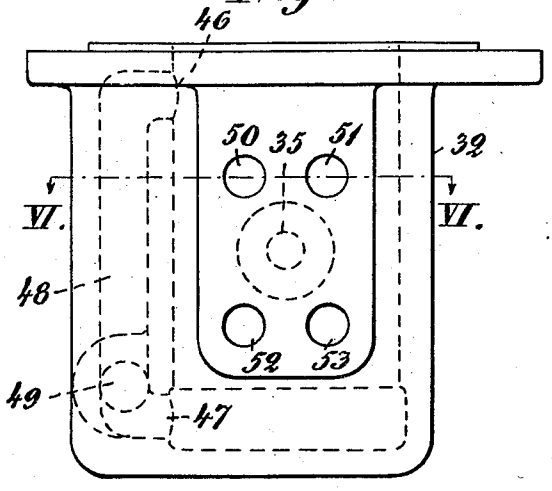


Fig. 7.



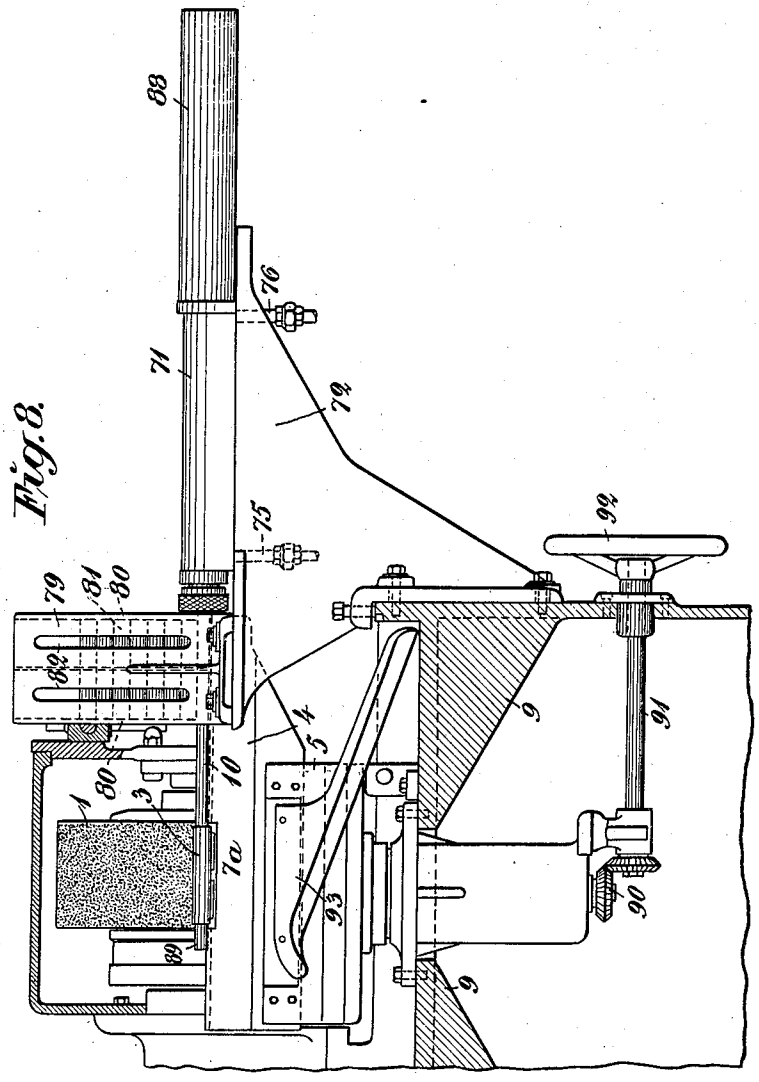
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CENTERLESS GRINDING MACHINE

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Fig. 8.



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CENTERLESS GRINDING MACHINE

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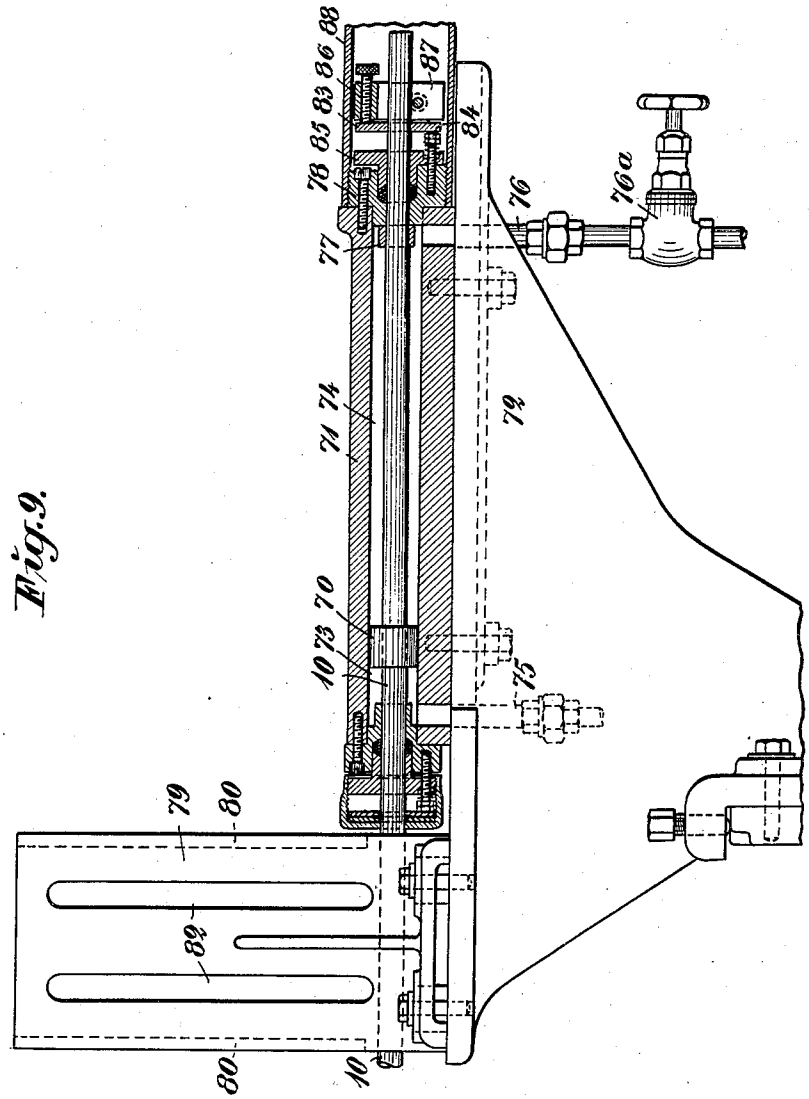


Fig. 9.

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UNITED STATES PATENT OFFICE

2,297,045

CENTERLESS GRINDING MACHINE

John Erik Bergström, Halmstad, Sweden

Application June 25, 1940, Serial No. 342,348
In Sweden June 16, 1939

4 Claims. (Cl. 51—103)

The present invention refers to an arrangement in centerless grinding machines wherein the work pieces are fed either continuously or discontinuously into the grinding position between a grinding disk and a rotating counter pressure roller, which disk and roller are mounted on slides displaceable in the frame of the machine.

The object of the present invention is primarily to bring about an automatically operative device which in the course of the work is adapted automatically to regulate the distance between the grinding disk and the counter pressure roller as required to effect the grinding and to feed in and discharge the work pieces, which regulating means operates accurately and without incurring the risk of clearances by various parts being worn down.

According to the invention, this is attained by the feature that the slide of the counter pressure roller, or the slide of the grinding disk, or both of these slides, are arranged to be displaced automatically and periodically in a direction toward and from the grinding position by means of a hydraulic control device consisting of a piston provided in a cylinder and actuated by a hydraulic pressure medium, such as oil, a rotary slide valve device being arranged alternatively to bring the cylinder spaces on both sides of the piston into communication with the pressure side and the suction side of a pump for the medium, in order thus to bring about the displacement to and fro of the respective slides.

Moreover, the invention aims at providing a feeding device for the work pieces, the operation of which device is timed relative to the displacements of the respective slides. According to the invention, this feeding device substantially consists of a feed rod which is provided with a double-acting piston working in a hydraulic cylinder, the cylinder spaces on both sides of said piston being connected to the slide valve device, in a manner such that the feed rod is caused to operate in synchronism with the hydraulic means operating on the counter pressure roller and the grinding disk respectively in such manner that the feed rod is moved away from the grinding position only after the counter pressure roller and the grinding disk have been removed from the grinding position, and performs its feeding-in movement of the next work piece, after the counter pressure roller and the grinding disk have been moved back to a certain position permitting the feeding-in movement, from which position the counter pressure roller and the grinding disk are then moved further so as to bear on the work piece.

An embodiment of a grinding machine constructed in accordance with the invention is illustrated in the accompanying drawings.

In the illustrated example, only the slide on the counter pressure roller is arranged to be displaced to and fro by means of a hydraulic control device. In place thereof, or simultaneously therewith, however, the grinding disk may also be arranged in the same manner to be displaced to and fro by means of a hydraulic control device of the same kind as that shown in the drawings.

Fig. 1 is a diagrammatic representation of the grinding disk and the counter pressure roller in a section at right angles to the axes of such disk and roller. Fig. 2 shows a vertical section through the mechanism responsible for the reciprocating displacement of the counter pressure roller. Fig. 3 is a part sectional plan view of a cam disk and follower. Fig. 4 is a plan view of a detail of a slide valve, and Fig. 5 is a section on line V—V in Fig. 4. Fig. 6 shows a section through the slide valve device on line VI—VI in Fig. 2. Fig. 7 is an elevation of the slide valve device viewed from line VII—VII in Fig. 6.

Fig. 8 shows an elevation at right angles to Figs. 1 and 2 of the feeding device for the work pieces. Fig. 9 is a longitudinal section through the hydraulic operating device for the feeding means according to Fig. 8.

In Fig. 1, 1 designates the grinding disk, 2 the counter pressure roller, and 3 the work piece fed in between them, said parts rotating in the directions indicated by the arrows. 4 denotes the supporting bar carrying the work piece and provided with a V-shaped supporting surface, said bar being secured in a holder 5 adapted to be raised and lowered.

The supporting bar is adjusted so that the center *a* of the work piece will be situated somewhat above the center line *b*—*c*. The work piece will then bear on the counter pressure roller at the point *d*, on the grinding disk at the point *e*, and on the supporting bar at the point *f* on one side 6 of the supporting surface of the supporting bar, whereas the side 7 of said supporting surface adjacent to the counter pressure roller is not touched by the work piece during the grinding operation.

The counter pressure roller 2 is mounted in a slide 8 which is arranged to be displaced to and fro on the machine frame 9 at right angles to the axis *a* by means of a mechanism to be de-

scribed more closely in the following, during which movement the slide brings the counter pressure roller along with it. When the grinding of a work piece has been finished, the said mechanism will displace the slide 8 and the counter pressure roller 2 to the left in Fig. 1, so that the gap between the roller 2 and the grinding disk 1 is increased. Between the grinding disk and the counter pressure roller, the one shank 7 of the supporting bar 4 is obliquely bevelled, as indicated at 7a in Fig. 1, so that the work piece, the grinding of which has been completed, is caused automatically to roll down into a collecting device when the counter pressure roller is removed from the grinding disk.

A feed rod 10 operating in the longitudinal direction of the work piece, the mode of operation of which rod will be described in the following, will then feed another work piece into the grinding position between the grinding disk and the counter pressure roller which is returned by the slide 8 toward the new work piece which is pressed against the grinding disk for the purpose of performing the grinding operation, whereupon the cycle of operations is repeated.

The mechanism for the displacement of the slide 8 to and fro and the mechanism for the actuation of the feed rod 10 are synchronized relatively to each other, and are operated according to the invention by means of a liquid pressure medium, such as oil.

In the following, the mechanism for the displacement of the slide 8 will first be described. The general arrangement thereof appears from Fig. 2.

The slide 8, which is displaceably mounted on the machine frame 9, is provided with a projection 11 to the left in Fig. 2, said projection being secured to a bracket 12, which is rotatably but not displaceably mounted relatively to a regulating rod 13 extending through a bore in the bracket 12.

The regulating rod 13 is provided with a threaded portion 14 which is screwed into a hollow threaded piston rod 15 carrying a piston 16 arranged in a cylinder 17, so that cylinder spaces 18 and 19 respectively are formed on both sides of the piston 16.

The cylinder spaces 18 and 19 communicate through passages 20 and 21 respectively in the material of the cylinder with conduits for pressure oil and are alternately brought into connection with the pressure side and the suction side respectively of an oil pump, so that the piston 16 becomes double-acting and will alternately displace the piston rod 15, the regulating rod 14, and the slide 8 to the right or left in Fig. 2.

The cylinder 17 is mounted on a plate 22 secured to the machine frame 9. 23 is a latch secured on the piston rod 15 and adapted so to engage a slot 24 in the frame member 22 that displacement of the piston rod 15 is permitted while rotary movement thereof is prevented.

Furthermore, the frame member 22 has mounted therein a vertical bearing 25 for a vertical shaft 26. Secured on shaft 26 is a worm wheel 27 engaging a worm 28 on the shaft of which is mounted an electric motor (not shown) adapted to rotate the shaft 26 at the desired speed. Secured on the shaft 26 at the lower end thereof are two rotary slide valves 29 and 30 fitting a cylindrical bore 31 in the valve housing 32.

The arrangement of the slide valves 29, 30 and of the valve housing 32 is illustrated in detail in Figs. 4–7. The slide valves 29 and 30 are constructed identically according to Figs. 4 and 5, and are separated by an intermediate piece 33 arranged on the shaft 26, so that an intervening space 34 is formed between the valves 29 and 30.

This space 34 is in constant communication with the pressure conduit from an oil pump through the opening 35 provided in the housing of the slide valve, so that the space 34 will always be under pressure. The slide valves consist of a hub 36 with two cylindrical flanges 37, 38, between which is formed an annular space. This space is divided into two sectors by means of two radial walls 39 extending from the hub 36, said sectors forming, together with the cylinder wall 31, a larger room 40 and a smaller room 41. In order in the following to distinguish between the spaces and openings of the valves 29 and 30 from one another, the rooms and openings of the valve 29 have been designated by an index *a*, while the rooms and openings of the valve 30 have been designated by an index *b*. Provided in the upper valve flange 37 are a number of apertures 42*a* and 42*b* connecting the room 40*a* with the cylinder space 43 in the upper portion of the valve housing and the room 40*b* with the cylinder space 34 respectively. Provided in the lower valve flange 38 is an opening 44*a* and 44*b* respectively, which connects the room 41*a* with the cylinder space 34 and the room 41*b* with the cylinder space 45 in the lower portion of the valve housing. The cylinder spaces 43 and 45 communicate through the openings 46 and 47 respectively with the passage 48 which, in turn, is connected through the passage 49 (see Figs. 6 and 7) to an oil conduit (not shown), which is connected with the suction conduit of the oil pump or with an oil receptacle from which the suction conduit of the oil pump extends.

While a pressure above atmospheric always prevails in the cylinder space 34, the cylinder spaces 43 and 45 are always under a pressure below atmospheric.

Furthermore, the wall of the valve housing has four passages 50, 51, 52, 53, provided therein in a manner such that two of them 50, 51 are during the rotary movement of the slide valves brought alternately into communication with the rooms 40*a* and 41*a* in the upper slide valve 29, while the two others 52, 53, which are arranged vertically below the passages 50 and 51 respectively, are in the same manner brought alternately into communication with the rooms 40*b* and 41*b* in the lower slide valve 30. As indicated in Fig. 2, the passages 50 and 52 respectively are connected by means of conduits 54 and 55 respectively to the passages 20 and 21 respectively, which latter lead to the cylinder 17. In the same manner the passages 51 and 53 are connected through conduits not shown to the mechanism controlling the feed rod 10 for the work pieces, which will be described more closely hereinafter.

Provided in the conduit 55, or, if desired, in the conduit 54, is a throttle valve 55*a* to adjust the velocity of flow of the pressure medium to a value as required to attain an operation free from shocks.

Secured on the upper end of shaft 26 is a cam disk 56 cooperating with a pin 57 inserted into a sleeve 58, which is secured in the bore in the right hand end of the piston rod 15 in Fig. 2.

Secured in the end portion of the pin 57 formed into a head 59 is a wearing piece 60 from hard metal, such as "seco-metal," such hard metal piece being located in a slot in the head 59 (Figs. 2 and 3) and cooperating directly with the cam disk 56. The cam disk 56 is intended to form an

abutment for the pin 57 and thus also for the piston rod 15 at the movement of the latter in Fig. 2, but is not intended to displace the piston rod 15 directly, which is solely effected hydraulically. An abutment for the movement of the piston rod to the left in Fig. 2 is formed by an elastic rubber packing 61, the position of which may be adjusted by means of the threaded sleeve 62 surrounding the regulating rod 13 with some clearance.

In the position of the piston rod 15 and the slide 8 as illustrated in Fig. 2, the work piece is subjected to the grinding operation. The pressure oil is then conveyed from the pump through the passage 35 in the valve housing 32 into the intervening space 34 and hence through openings 42b, room 40b, passage 52, passage 55, and passage 21 into the cylinder space 19 so as to tend to displace the piston 16 to the right in Fig. 2, which movement is limited by the cam disk 56. The cylinder space 18 is at the same time under a low pressure and communicates with an oil receptacle or with the suction side of the pump through passage 20, conduit 54, passage 50, room 40a, openings 42a, cylinder space 43, opening 46, and passages 48 and 49. The shaft 26 is rotated and rotates the cam disk 56 and the slide valves 29, 30 at the same angular speed.

After the latter have been tuned to such an extent that the passages 50 and 52 are brought into communication with the rooms 41a and 41b respectively, reversal of the pressure conditions within the cylinder spaces 18, 19 is effected. The pressure oil will then flow from the passage 35 and the intervening space 34 through the opening 44a, room 41a, passage 50, conduit 54, and passage 20 into the cylinder space 18, so that the oil pressure tends to displace the piston 16 to the left in Fig. 2, which is readily rendered possible by the fact that the cylinder space 19 is at the same time brought under pressure below atmospheric, inasmuch as it is now connected to the suction side of the pump through passage 21, conduit 55, passage 52, room 41b, opening 44b, cylinder space 45, opening 47, and passages 48 and 49. The piston 16 is now moved to the left until the piston rod 15 abuts against the packing 61. The counter pressure roller 2 has then been moved so far away from the grinding disk 1 that the work piece, the grinding of which has been completed, may roll down the obliquely bevelled surface 7a on the supporting bar 4 (Fig. 1) to a collecting device for the grinding goods. The reversal of the pressure condition within the cylinder spaces 18 and 19 is determined according to the above by the positions of the rooms 40a, 40b, 41a, and 41b relatively to the passages 50 and 52. The rooms 41a and 41b have a far less peripheral extension than the rooms 40a and 40b. The cylinder space 18 consequently serves as a space for pressure above atmospheric during a far shorter period of time than does the cylinder space 19.

When in accordance with the above the cylinder space 18 was transformed into a pressure space and the piston rod 15 was displaced to the left, the cam disk 56 was turned at the same time, so that the highest curved portion 62 thereof was brought right opposite the wearing piece 60 on the pin 57 so as to prevent returning of the counter pressure roller into the grinding position until the curved portion 62 would pass beyond the wearing piece 60. This position of the cam disk 56 is shown in Fig. 3. In the meantime, during the continued rotary movement of the slide valves 29 and 30, the rooms 40a and 40b are brought into communication with the passages 50 and 52 respectively, so that the cylinder space 19 now becomes the space for pressure above atmospheric, while the space 18 becomes the space for pressure below atmospheric, the rod 15 and the counter pressure roller being thus displaced to the right, which movement is stopped, to begin with, by the curved portion 62 of the cam disk 56. After the curved portion 62 has then moved past the wearing piece 60, further displacement of the piston rod 15 to the right commences. In the meantime, the feed rod 10 (Fig. 1) feeds another work piece into grinding position between the grinding disk and the counter pressure roller. When the wearing piece 60 is brought into contact with the point 63, the counter pressure roller will have pressed the last fed work piece against the grinding disk, whereupon the rough grinding of the latter is commenced, during which the cam disk is rotated, until a suitable point 64 on the latter is finally brought into contact with the wearing piece 60.

From the point 64, the radius of the cam disk is further decreased to some extent, so that the piston rod 15 and the counter pressure roller may be further displaced somewhat to the right, during which the fine grinding of the work piece is taking place, at the termination of which operation the cycle of operations is repeated in the manner above described.

The cylinder spaces 18, 19, the passengers 20, 21, the conduits 54, 55, all passages and spaces in the valve housing 32 and in the slide valves 29 and 30, and the conduits extending to and from the pump unit, are always filled with oil as a coherent liquid column, so that the pressure variations will be instantaneously transferred to the cylinder spaces 18 and 19. The changes in the movements of this slide 8 and of the pressure roller will consequently be instantaneous and always accurate, inasmuch as no such mechanical transmission means are necessary that by reason of wear and clearances produced in consequence thereto could effect any dead motion and shocks when reversing the direction of movement. Instead, a very uniform and quiet operation is attained, without any dead motion or any shocks whatever.

For operation upon work pieces of different diameters it is necessary to be able to adjust the counter pressure roller and thus the slide 8 at different distances from the grinding disk. To this end, the threaded portion 14 of the regulating rod 13 is made sufficiently long, so that it may be screwed more or less into the piston rod 15.

This is effected by rotating the hand wheel 65 secured on the end of the regulating rod 13. To read off the adjustment of the counter pressure roller there is secured a graduated disk 66 on the regulating rod 13, so that said disk will be rotated together with the rod. The graduation of the disk 66 is read off, for example, against a fixed index on the flange 67 of the bracket 11.

The mechanism serving to feed the work pieces into the grinding position is illustrated in Figs. 8 and 9 and will now be described more closely. In Figs. 8 and 9 this mechanism is in the grinding position.

As already stated, the work pieces are advanced by means of the feed rod 10, which is arranged to be displaced to and fro. Secured on the rod 10 is a piston 70 which is fitted into the double-acting hydraulic cylinder 71 carried by the table 72 secured to the machine frame 9.

To the cylinder spaces 73 and 74 on both sides of the piston 70 leads an oil conduit 75 and 76 respectively, which conduits are connected to the passage 51 and 53 respectively in the slide valve housing 32 (Figs. 6 and 7). From the explanation already given hereinabove relative to the mode of operation of the slide valves 29, 30, it will thus be immediately seen that, when during the rotary movement of the slide valves the passage 53 is brought into communication with the room 40*b*, pressure oil will be fed through the conduit 76 to the cylinder space 74, while the cylinder space 73 is at the same time brought into communication with the suction side of the oil pump through passage 75, passage 51, and room 40*a*.

During this period the piston 73 and the feed rod 10 are therefore pressed, or tend to be pressed, in the feeding direction, that is to say to the left in Fig. 9. Again, when the passages 53 and 51 are brought into communication with the valve spaces 41*b* and 41*a* respectively, the pressure conditions in the cylinder spaces 73 and 74 are reversed, so that the piston 70 and the feed rod 10 will be pressed back to the right in Fig. 9.

Arranged in the conduit 76, or, if desired, in the conduit 75, is a throttle valve 76*a* for adjusting the velocity of flow of the pressure medium to a value as required to obtain an operation free from shocks.

As described hereinabove, the counter pressure roller is moved away from the grinding position when the passages 50 and 52 are brought into connection with the rooms 41*a* and 41*b* respectively. Immediately thereafter, the passages 51 and 53 are brought into communication with the same rooms 41*a* and 41*b* respectively, by reason of which the cylinder space 73 will now be one under pressure, so that the feed rod 10 is now driven to its extreme right hand position in Fig. 9, which is determined by the fact that the piston 70 abuts against a bushing 77 provided in the cylinder 7, said bushing having the feed rod extending loosely therethrough and being driven against the stuffing box 78 of the cylinder 71.

Then, when the passages 50 and 52 are brought into communication with the rooms 40*a* and 40*b* respectively, as above described, the counter pressure roller is moved back in a direction toward the grinding disk, which movement is limited, however, by the curved portion 62 of the cam disk 56, so that a sufficiently large intervening space remains between the counter pressure roller and the grinding disk for feeding another work piece in between them. This feeding of another work piece commences when the passages 51, 53 are immediately thereafter brought into communication with the spaces 40 and 40*b* respectively, when the cylinder space 74 is transformed into a pressure space, so that the feed rod 10 is driven to the left in Fig. 9.

79 designates a magazine provided on the table 72, in which the work pieces to be ground are piled upon one another. The magazine comprises two vertical plates arranged on the table 72 on both sides of the feed rod 10, said plates having vertical border flanges 80 facing each other. Between said plates and the flanges 80 thereof is formed a vertical pocket right over the feed rod 10, in which pocket the work pieces 81 are piled upon one another. 82 are grooves provided in the walls of the magazine, through which grooves the work pieces may be observed and manipulated. As will be seen from Fig. 8, the lowermost work piece 81 in the magazine rests directly on the feed rod 10, the end of which keeps the fed-in work piece 3 in the grinding position.

When upon completed grinding the feed rod 10 was retracted to the right in Fig. 8 past the magazine 79, the pile of work pieces in the magazine 79 was lowered by one step, so that the lowermost work piece was aligned with the feed rod 10 in front of the end thereof. This work piece consequently has automatically taken a position wherein it is seized by the end of the feed rod so as to be moved to the left into the grinding position when the feed rod is moved to the left in the manner above described. The work piece is then moved in onto the supporting surfaces 6 and 7 of the supporting bar 4. The curved portion 62 of the cam disk 56 is so adapted that the counter pressure roller is moved to bear against the work piece at the very moment when the latter is brought into the grinding position. The movement of the feed rod to the left in Fig. 9 is limited by the provision on the right end of the feed rod 10 projecting from the cylinder 71, of an abutment disk 83 abutting against the ends of the bolts 84 serving to secure the packing gland 85. The position of the abutting disk 83 may be adjusted by means of a couple of set screws 86 screwed into a holder 87 clamped onto the feed rod. The projecting end of the feed rod is protected by a cylindrical sleeve 88 secured to the cylinder 71 or the stuffing box 78 and surrounding the feed rod.

To retain the work piece 3 in the grinding position during the grinding operation, a special abutting rod 89 may be arranged coaxially with the feed rod 10.

Inasmuch as in grinding machines of this type the counter pressure roller is swingably arranged about an axis at right angles to the axis of the grinding disks, so that the counter pressure roller may be adjusted into different oblique positions at continuous feeding of the work piece for the purpose of controlling the feeding, this circumstance, however, may also be utilized to retain the work piece in connection with grinding by the fact that the counter pressure roller is positioned obliquely in the opposite direction, so that the feeding force exerted by the same on the work piece will be directed against the feed rod 10 so as to keep the work piece pressed against the end of the feed rod during grinding.

The holder 5 carrying the supporting bar 4 is adapted to be raised and lowered by means of shafts 90, 91, which are coupled together by means of a bevelled gearing and may be rotated by means of the hand wheel 92. 93 denotes a groove or the like provided below and laterally of the bevelled supporting surface 7*a* of the supporting bar, said groove catching the finished work pieces rolling down, and carrying them further to a collecting box or the like.

A hydraulic feeding device of the type hereinbefore described may be arranged, if desired, on both sides of the grinding position between the counter pressure roller and the grinding disk and in alignment with each other, the feeding means being connected hydraulically in such manner, for instance by the conduits 75 and 76 communicating with corresponding conduits in the other feeding device, that feeding of work pieces takes place from both sides at the same time.

If the slides both of the grinding disk and of the counter pressure roller are arranged so as to be automatically displaceable to and fro relatively to the grinding position by means of hydraulic controlling means, the latter may be so

arranged that the two slides will be displaced simultaneously from and toward the grinding position, or will perform such movements alternatively.

Having now particularly described the nature of my invention and the manner of its operation what I claim is:

1. In a centerless grinding machine having a grinding disk and a counter pressure roller movable relatively toward and from each other by hydraulically controlled means including a slide carrying said counter pressure roller, a single cylinder, a piston on a piston rod within said cylinder, a set of two rigidly connected rotary valves operating in one and the same housing connected with a pump for a hydraulic pressure medium and with said cylinder in such a way that said two rotary valves are adapted alternately to bring the cylinder spaces on both sides of said piston in connection with the pressure and the suction side respectively of said pump in order thus to approach the grinding disk and the counter pressure roller to each other and to remove them from each other respectively.

2. In a centerless grinding machine having a grinding disk and a counter pressure roller movable relatively toward and from each other by hydraulically controlled means including a slide carrying said counter pressure roller, a cylinder, a piston on a piston rod within said cylinder and actuated by a hydraulic pressure medium, the combination of a slide valve rigid with a rotary shaft and adapted by the rotary movement of the latter alternately to bring the cylinder spaces on both sides of said piston under hydraulic pressure and to relieve said spaces of hydraulic pressure respectively, and a cam disk rigid with said shaft and cooperating with said piston rod at the movement of said slide for the purpose of regulating the distance between said counter pressure roller and said grinding disk.

3. In a centerless grinding machine having a grinding disk and a counter pressure roller movable relatively toward and from each other by hydraulically controlled means including a slide carrying said counter pressure roller, a cylinder, a piston on a piston rod within said cylinder and actuated by a hydraulic pressure medium, the combination of a slide valve rigid with a rotary shaft and adapted by the rotary movement of the latter alternately to bring the cylinder spaces on both sides of said piston under hydraulic pressure and to relieve said spaces of hydraulic pressure respectively, and a cam disk rigid with said shaft and cooperating with said piston rod at the movement of said slide toward the grinding position for the purpose of regulating the distance between said counter pressure roller and said grinding disk, the rotary slide valve being arranged during each revolution thereof to bring about a change of the hydraulic pressure on both sides of the piston so that the slide is moved to and fro once during every revolution of the slide valve, the cam disk being provided on its circumference with an elevation adapted at the relative movement of the counter pressure roller and the grinding disk toward the grinding position to stop the same and to retain the same at a sufficient distance for the introduction of another work piece as well as with portions of the circumference adapted for rough grinding and fine grinding, such portions permitting an automatic relative adjustment of the counter pressure roller and of the grinding disk to distances intended for these operations and retaining the same at these distances during predetermined periods of time.

4. A centerless grinding machine as claimed in claim 1, wherein the slide is connected with a rod which is threaded into the piston rod of the piston, in order by a rotary movement of the threaded rod to permit adjustment of the respective slide into different positions relatively to the piston.

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