March 6, 1934. E. M. TAYLOR ET AL 1,949,552

GRINDING MACHINE

Filed July 19, 1932 3 Sheets-Sheet 1

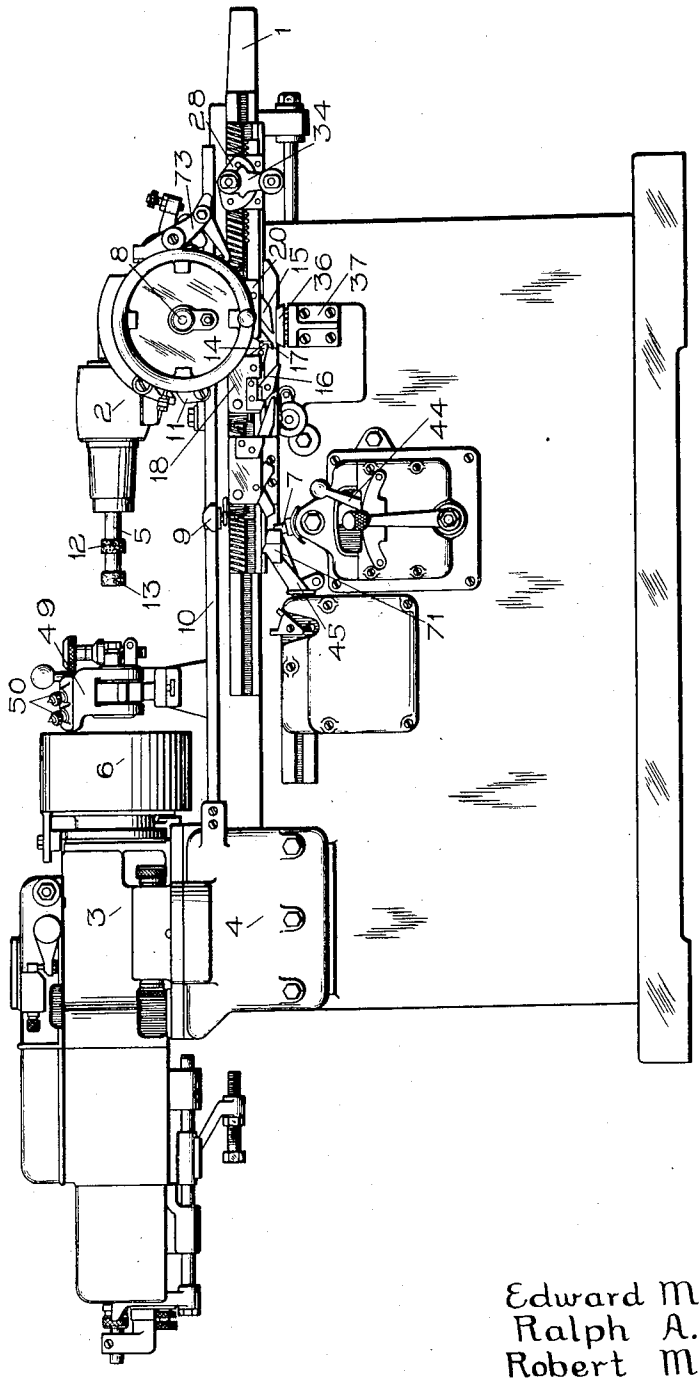


Fig. 1

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GRINDING MACHINE

Filed July 19, 1932 3 Sheets-Sheet 2

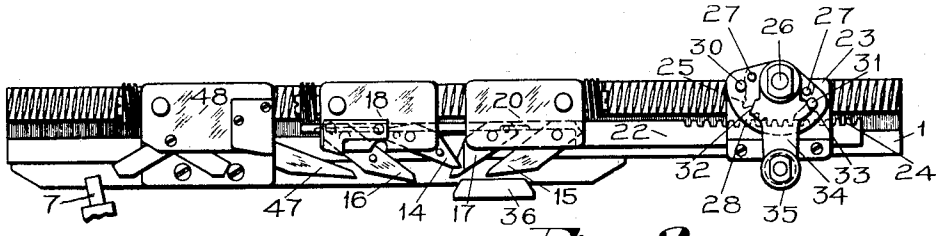


Fig. 2

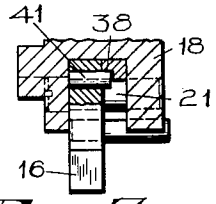


Fig. 7

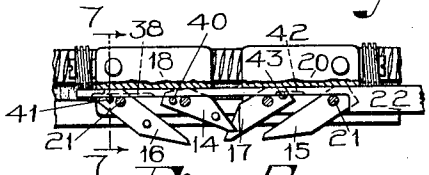


Fig. 5

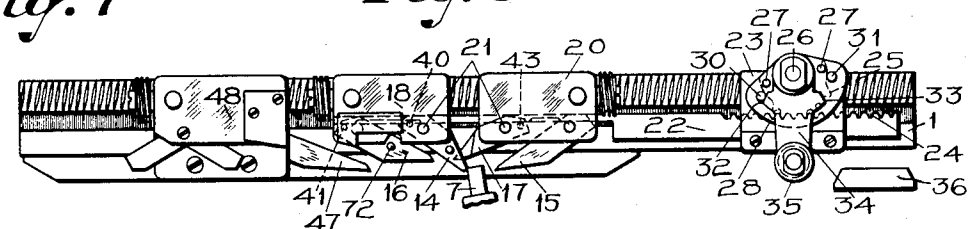


Fig. 3

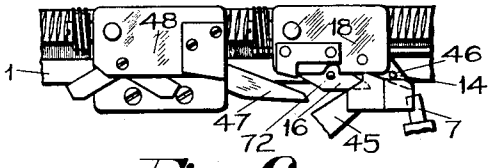


Fig. 6

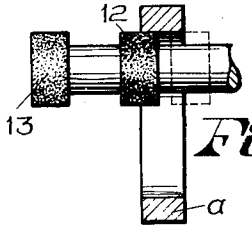


Fig. 8

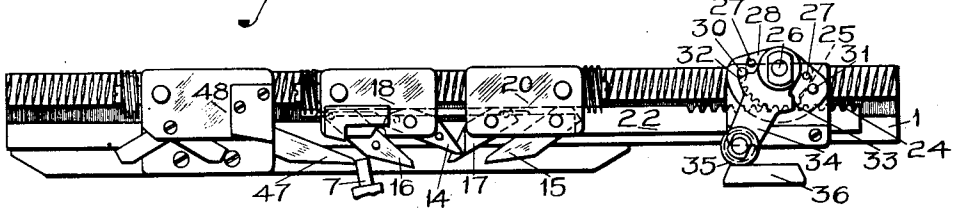


Fig. 4

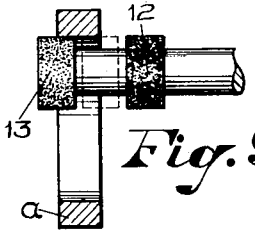


Fig. 9

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GRINDING MACHINE

Filed July 19 1932 3 Sheets-Sheet 3

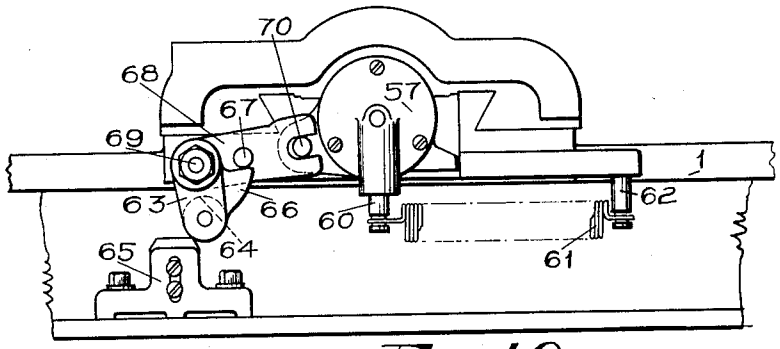


Fig. 10

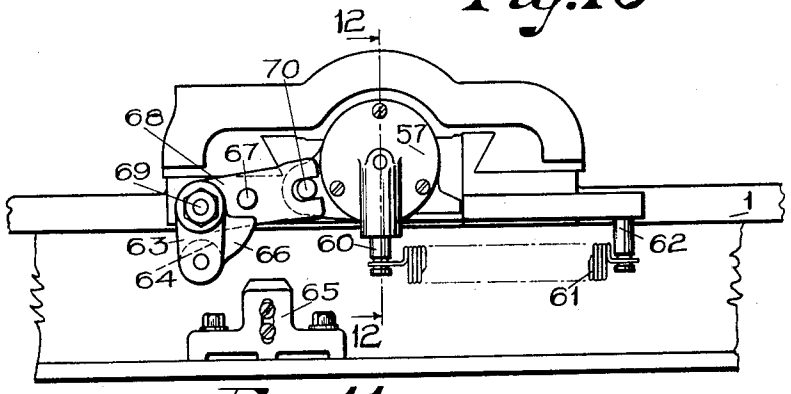


Fig. 11

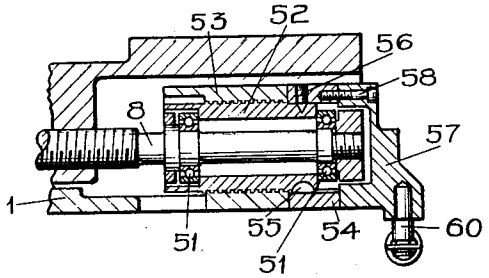


Fig. 12

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UNITED STATES PATENT OFFICE

1,949,552

GRINDING MACHINE

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Application July 19, 1932, Serial No. 623,400

25 Claims. (Cl. 51—50)

The present invention relates to grinding machines particularly of the internal type, and contemplates a machine which is adapted to procure successive grinding operations with separate grinding wheels on the same surface of the workpiece without removal of the workpiece from the workholding member.

A grinding wheel which has a suitable grain or fineness for rough grinding of the workpiece approximately to the desired size is not entirely suited for finish grinding to provide the desired finished surface on the workpiece. Prior to the present invention, the wheel used in the usual grinding machines has been a compromise between a wheel for roughing and a polishing or finishing wheel, and the time required for each grinding operation is thus greater than would be necessary when the proper wheel is used. It is accordingly the principal object of the present invention to provide for successive abrading operations on the same surface of a workpiece by separate abrading members carried on the same rotating spindle.

According to the present invention, a plurality of grinding or abrading members are mounted in axially spaced relation on a rotating spindle. One of the members is in operative relation to the surface of the workpiece to be operated upon and is maintained in that position during the preliminary grinding operation. The workpiece and the cutting tools are then shifted axially relative to one another to bring the second grinding or abrading member into operative relation with the workpiece and the cutting operation is completed. The invention involves mechanism for procuring a relative reciprocation between the separate wheels and the workpiece, and for dressing the wheels to maintain suitable cutting surfaces.

Other and further objects and advantages of the invention will appear from the following detailed description taken in connection with the accompanying drawings in which:—

Fig. 1 is a front elevation of a grinding machine embodying the invention.

Fig. 2 is a front elevation of the actuating dogs for the reciprocation of the machine carriage and the associated mechanism.

Fig. 3 is a view similar to Fig. 2 with the parts in a position for the grinding operation by one of the wheels.

Fig. 4 is a view similar to Fig. 2 showing the parts in a position for the grinding operation by the second grinding wheel.

Fig. 5 is a fragmentary view of the mechanism of Fig. 2, parts being broken away to show the construction more clearly.

Fig. 6 is a fragmentary view of the mechanism in Fig. 2, showing the lever by which the run out of the carriage for dressing is procured.

Fig. 7 is a section along the line 7—7 of Fig. 5.

Fig. 8 is a diagrammatic showing of the position of the grinding wheels during the preliminary grinding operation.

Fig. 9 is a view similar to Fig. 8 showing the position of the grinding wheels during the finish grinding.

Fig. 10 is a fragmentary view of the carriage from the rear, showing the back of the mechanism for withdrawing the grinding wheels from the work.

Fig. 11 is a view similar to Fig. 10, showing the carriage in a different position on the base.

Fig. 12 is a section along the line 12—12 of Fig. 11.

Like reference characters refer to like parts throughout the drawings.

Referring to Fig. 1, an internal grinding or abrading machine is shown having a reciprocatory table or carriage 1 usually provided in such a machine. Either the abrading wheel or the workpiece to be ground may be carried on the table 1 and the reciprocation of the latter is utilized in either case to produce a relative traversing movement between the abrading wheel and the work piece. In the construction shown, the table 1 supports and carries a wheelhead 2 while the workpiece *a* which is to be operated upon is held in suitable work supporting means on the workhead 3, the latter being carried by a bridge 4 which spans the slideways provided by the machine frame for the longitudinal back and forth movement of the table 1. An abrading wheel spindle 5 is suitably journaled in the wheelhead 2 and is rotated in any suitable manner as by the incorporation of an electric motor in the wheelhead, the spindle 5 forming an integral extension of the armature shaft of the motor. The workpiece is mounted in a suitable workholding member 6 carried by a spindle journaled in the workhead 3, said spindle being rotated desirably at a slower speed than the spindle 5 in any suitable manner, not shown.

The reciprocations of the table 1 to cause the rotating abrading wheel to make the required internal traverse of the rotating workpiece may be imparted in any well-known manner as by the use of fluid pressure controlling and reversing mechanism as described in United States Letters Patent No. 1,582,468, granted April 27

1926 to Heald and Guild. Such mechanism is well-known; it is sufficient to note for present purposes that the driving means employed for the reciprocation of the table 1, be it hydraulic drive or any other type, procures the reversal of the table at each end of the normal working stroke by the use of spaced adjustable dogs carried by the table 1 and adapted alternately to engage and move a reversing member 7 which latter, during the abrading operation when the wheel is moving back and forth within the workpiece *a*, is situated between the reversing dogs in a position to be struck alternately by said dogs and by resultant movement first in one direction and then in the other to effect the reversal of travel of the table 1.

The crossfeed movement between the work and the abrading wheel to feed the wheel radially against the surface being ground is procured in this machine by lateral movement of the wheelhead 2 on the table 1, in any suitable manner, as by the mechanism disclosed in Patent No. 1,682,673, granted August 28, 1928 to Taylor, one of the present applicants. The wheelhead 2 is mounted on a cross-slide, not shown, which is adapted to have a transverse movement on the reciprocatory table 1 and movement of the cross-slide is procured by rotation of a crossfeed screw 8, the latter being suitably connected to the cross-slide. As clearly disclosed in the above cited Taylor patent, rotation of the crossfeed screw for the crossfeed movement is effected by a cam 9 adjustably mounted on a bracket 10 extending from the bridge 4; said cam during the reciprocation of the table 1 engages a roller carried on a pivotally mounted arm, not shown, to rock said arm. The latter carries on the outer end thereof a pawl 11 which, during the rocking of the arm, engages with a ratchet wheel positively connected to the crossfeed screw for rotation of said screw. In this manner, the crossfeed movement of the abrading wheel is responsive to the reciprocatory movements of the table 1.

The above described mechanism is all old and well-known in the art and of itself forms no part of the present invention, the latter involving the attainment, in connection with such or similar grinding machine instrumentalities, of the novel and useful results hereinbefore set forth. According to the present invention, the abrading wheel spindle 5 carries a pair of grinding or abrading wheels 12 and 13, the former constituting a wheel for rough grinding of the workpiece *a* substantially to the desired size and the wheel 13 constituting a wheel suitable for finish grinding or abrading of the workpiece to provide a suitable surface on the finished workpiece. In the grinding operation, the roughing wheel 12 is first reciprocated longitudinally over the surface of the workpiece, as shown in Fig. 8, by the mechanism above described, the wheel reciprocating between the full line position and the dotted line position of this figure, and, after the rough grinding is completed, the workpiece and grinding wheels are axially shifted relative to one another for the finish grinding in which the abrading wheel 13 is reciprocated over the surface of the workpiece *a*, as shown in Fig. 9, between the full and dotted line positions of this figure.

The reciprocations of the wheel 12 in rough grinding position are controlled by a pair of spaced dogs 14 and 15 on the table 1, and the reciprocations of the wheel 13 in position for finish grinding are controlled by spaced dogs 16 and 17 which, as in the case of dogs 14 and 15, alternately engage and rock the reversing member 7, the dogs 14 and 15 being inoperative during the finish grinding. The dogs 14 and 16 are carried on a member 18 slidably adjustable along the front of the table and the dogs 15 and 17 are similarly carried by an adjustable member 20. All of said dogs are pivotally mounted on pins 21 and normally hang by gravity in a position to engage the reversing member 7, said dogs being raised, as will hereinafter appear, for rendering one pair of dogs inoperative while the other pair is in operation.

Referring now to Figs. 2, 3 and 4, a horizontal bar 22 is supported for longitudinal movement along the front of the table by the members 18 and 20 and by a block 23 secured against movement on the front of the table. The right hand end of the bar 22 is provided with a rack 24 which is in engagement with a gear segment 25 pivotally mounted on a stud 26 carried by the block 23. Said gear segment is secured by pins 27 to an arcuate member 28, the latter having pins 30 and 31 extending therefrom for engagement with surfaces 32 and 33 respectively on an arm 34 pivotally mounted on and depending from the stud 26. The lower end of the arm 34 is provided with a roller 35 which is in a position to engage with a cam 36 carried by a bracket 37, Fig. 1, on the front of the machine in response to movement of the table. Swinging movement of the arm 34 in response to engagement of the roller 35 and cam 36 thus procures longitudinal shifting movement of the bar 22. The spacing of the pins 30 and 31 is such that the arm 34 may hang in vertical position for engagement by the cam 36 independently of the position of the gear segment 25 or the arcuate member 28, the spacing of the pins 30 and 31 being greater than the spacing of the surfaces 32 and 33 on the arm 34.

The bar 22 is provided with a recess 38 which is arranged to receive pins 40 and 41 on dogs 14 and 16 respectively, and a recess 42 which receives a pin 43 on the dog 17. The dogs 14, 16 and 17 are lowered into operative position when the pins on said dogs are in engagement with the recesses 38 and 42 and are raised into inoperative position when the bar is moved longitudinally to withdraw the recesses out of alinement with the pins. The recess 38 is of sufficient length to engage selectively with either the pin 40 or the pin 41.

With the machine in the rest position shown in Fig. 1, the dogs and the bar 22 being then in the position of Fig. 2, the table 1 is moved longitudinally to the right to bring the grinding wheel 12 into operative relation to the workpiece by manual shifting movement of a lever 44, Fig. 1, which operates to shift the reversing lever 7. During the movement of the carriage into operative position, the roller 35 on the arm 34 engages the cam 36 and the gear segment is rocked counterclockwise by engagement of the surface 33 on the arm 34 with the pin 31, rocking the gear segment 25 therewith and shifting the bar 22 to the position shown in Fig. 3. In this position, the pin 40 on the reversing dog 14 is received in the recess 38 and the pins 41 and 43 of the dogs 16 and 17 are out of alinement with the recesses 38 and 42, the bar 22 thereby holding said dogs 16 and 17, which control the finish grinding, in inoperative position to permit the rough or preliminary grinding operation to be under the control of the dogs 14 and 15.

The grinding operation continues under the control of the dogs 14 and 15 with the roughing wheel 12 reciprocating over the surface of the workpiece and with the lateral crossfeed movement, above described, until the workpiece is ground approximately to finished size at which time the table is given an extended movement to the left to procure a dressing operation on the grinding wheels. The extended movement may be procured by any suitable mechanism, as, for example, mechanism under the control of a gauge as in the Conradson Patent No. 1,534,302, granted April 21, 1925, or mechanism responsive to the crossfeed movement as in the patent to Guild No. 1,682,672, granted August 28, 1928; in either case, the operation of the gauge or the crossfeed movement energizes an electromagnet which procures elevation of a lever 45 pivotally mounted on the front of the machine as fully described in said patents. The upper end of said lever 45, as shown in Fig. 6, engages a pin 46 on the reversing dog 14, thereby raising said dog from operative position as the carriage moves toward the right, so that, during this movement, the reversing member 7 is not shifted and the carriage continues to move to the right until a dog 47, carried by a block 48 on the table, engages and shifts the reversing lever 7 to reverse the carriage movement and return the carriage to grinding position.

During the extended movement of the carriage, a double wheel dressing device 49, Fig. 1, which is mounted on the base of the machine and carries spaced dressing tools 50 corresponding in spacing to the spacing of the wheels 12 and 13, is rocked downwardly to position said dressing tools in the path of the wheels 12 and 13 by any suitable mechanism such as that shown in Patent No. 1,779,094, granted October 21, 1930 to Heald and Guild. The wheels 12 and 13 are thus dressed simultaneously and thus provide smooth sharp cutting surfaces for the grinding operations.

The machine is provided with a back-off mechanism to withdraw the grinding wheels radially from the surface of the workpiece temporarily as the carriage is run out for the dressing operation. Referring to Figs. 10, 11 and 12, the crossfeed screw 8 is provided at the rearward end thereof with a pair of spaced ball bearing members 51 which support a sleeve 52 against axial movement on said crossfeed screw and at the same time provide for rotation of said sleeve on the screw. The sleeve member 52 is externally threaded and is received in a threaded portion 53 of a portion of the table 1. It will be seen that as long as the sleeve 52 is held against rotation, the crossfeed shaft 8 is held against axial movement and all end play of the crossfeed shaft is eliminated. The sleeve 52 has a ring 54 secured thereto as by a key 55 and set screw 56, said ring carrying a bracket 57, the latter being secured to the ring 54 by screws 58. The bracket 57 has a depending pin 60 to one end of which a spring 61 is secured, the other end of the spring engaging a pin 62 on the table 1, said spring normally maintaining the bracket 57 and accordingly the sleeve 52 in the position shown in Figs. 10 and 11.

As the carriage is given an extended movement to withdraw the grinding wheels from the workpiece for the dressing operation above described, such movement of the carriage being a movement to the left in Figs. 10, 11 and 12, an arm 63 normally hanging by gravity in the position shown in Fig. 11 and having a roller 64 on the lower end thereof, engages an adjustable cam 65 secured to the base of the machine, said cam rocking the arm 63 counterclockwise, as best shown in Fig. 10. Rocking of the arm 63 brings a lug 66 on said arm into engagement with a pin 67 carried by an arm 68 pivotally mounted on a stud 69 which forms the pivotal support for the arm 63. The end of the arm 68 is bifurcated and engages a pin 70 carried by the bracket 57, and counterclockwise movement of the arm 68 in response to engagement of the cam 65 and the roller 64, procures clockwise rotation of the bracket 57 and thus corresponding rotation of the sleeve 52. This rotation of the sleeve 52 shifts the crossfeed shaft 8 axially carrying therewith the cross-slide and the grinding wheels mounted thereon, (this movement of the cross-slide being toward the front of the machine) to carry the grinding wheels radially out of contact with the surface of the workpiece. The position of the cam 65 is such that the bracket 57 is rotated at the beginning of the extended movement of the wheel before the roughing wheel has been entirely withdrawn axially from within the bore of the workpiece and accordingly before the finishing wheel has been moved into engagement with said workpiece, this back-off preventing the finish wheel from performing an undesired cutting operation during the withdrawal movement. After the table has moved to the left (Figs. 10 and 11) to carry the roller 64 past the cam 65, said roller is released and the spring 61 returns the crossfeed shaft to normal position. As will be apparent, the return of the crossfeed shaft to normal position occurs before the grinding wheels on the carriage reach dressing position in order to permit engagement of said grinding wheels with the dressing tools.

As the carriage is moved to the right, Fig. 1, away from the workpiece during the extended movement, the roller 35 on the arm 34 engages the cam 36, rocking the lever 34 clockwise and swinging the gear segment 31 clockwise therewith by engagement of the surface 32 with the pin 30, thereby procuring a longitudinal shifting movement of the bar 22 to the left into the position of Fig. 4. This movement of the bar 22 positions the recess 42 in position to receive the pin 43 on dog 17, and the recess 38 moves into a position to receive the pin 41 on the dog 16, said recess 38 at the same time being withdrawn from alinement with the pin 40 on dog 14, thereby lowering the dogs 16 and 17 into position for engagement with the reversing lever 7 and raising the dog 14 into inoperative position. As will be apparent from a consideration of Fig. 4, which shows the carriage at the right hand end of the extended dressing stroke, the cam 36 is positioned to rock the arm 34 just as the carriage is reversed. Actuation of the arm at this point prevents the roller 35 on the arm 34 from passing over the right hand end of the cam 36 and thus avoids a subsequent counterclockwise rocking of the gear segment 25. The bar 22 accordingly remains in the position of Fig. 4 during the final grinding operation.

Upon return of the carriage to operative position, after the dressing operation, the grinding continues with the finish wheel 13 in engagement with the workpiece, as shown in Fig. 9, with the reciprocations of the table under the control of the dogs 16 and 17 until the workpiece reaches the desired finished size, at which time, in any suitable manner, as in response either to a gauge

mechanism as in the above cited Conradson patent or to the crossfeed movement as in the above cited Guild patent, a lever member 71, Fig. 1, pivoted on the front of the machine, is actuated to raise the upper end thereof into a position in horizontal alinement with a pin 72 on the dog 16, raising said dog into inoperative position as the carriage moves to the right to prevent actuation of the reversing member 7, thereby procuring an extended movement of the table to the right into rest position where it is brought to rest by any suitable mechanism as, for example, the means shown in the aforesaid patent to Heald and Guild No. 1,582,468.

During the run-out of the carriage to rest position, the roller 35 again engages the cam 36 for clockwise rocking of the arm 34, but the rocking movement of said arm in ineffective to shift the bar 22 since said bar has already been shifted to the left hand position by the extended pressing stroke of the carriage. The cam 65, which actuates the back-off mechanism during run-out of the carriage for dressing is so positioned that during the final run-out of the carriage at the end of the grinding operation, no back-off takes place, the roll 64, during the final grinding of the workpiece passing along the upper surface of the cam 65 without dropping down on the right hand side thereof (Figs. 10, 11 and 12). Clockwise rocking of the arm 63 has no effect on the back-off arrangement by reason of the connection between said arm 63 and the arm 68. The run-out of the carriage to rest position carries the roller 35 beyond the cam 36 into the original position of Fig. 2, so that a subsequent movement of the carriage to carry the wheels into operative engagement with the workpiece will procure a shifting movement of the bar 22 to the right to render the dogs 14 and 15 operative and to withdraw the dogs 16 and 17 in the manner above described.

During the run-out of the carriage to rest position, the reduction in diameter of the grinding wheels is compensated for by mechanism of the type disclosed in the above cited Taylor Patent No. 1,632,673, this mechanism being indicated in general by the reference character 73. The grinding wheels are thus positioned for the reduction of successive workpieces all to the same size.

From the foregoing, it will be apparent that the present invention provides a machine by which successive grinding or abrading operations may be procured on a single surface of a workpiece while the latter is mounted in and rotated by a workholding member. In this manner, the necessity for removal of the workpiece and reinsertion of the workpiece in a second workholding member in order to procure the separate grinding or abrading operations is avoided. The machine accordingly permits the workpiece to be reduced to substantially a proper size by a rough grinding operation and then to be finish ground to the desired finished surface on the workpiece in a single grinding or abrading machine. The cuts made by the individual wheels 12 and 13 on the workpiece *a* are spoken of, in the above specification, as separate abrading operations. It will be noted, however, that the machine once having been set in operation, the cuts by the separate wheels are successively procured without interruption of the machine and the machine comes to rest only upon completion of the abrading by both wheels. The complete abrading operation, as determined by the automatic cycle of the machine, thus includes the rough grinding by the wheel 12 and also the finish grinding by the wheel 13.

We claim,

1. In an abrading machine, a work supporting member, a rotary spindle, a plurality of abrading wheels on said spindle, means to maintain one of said wheels in engagement with a surface of a workpiece in said work supporting member, and means governed by the progress of the abrading operation to position the second abrading wheel in engagement with the same surface of the workpiece.

2. In an abrading machine, a work supporting member, a rotary spindle, a plurality of abrading wheels on said spindle, means to maintain one of said wheels in engagement with a surface of a workpiece in said work supporting member, means governed by the progress of the abrading operation to position the second abrading wheel in engagement with the same surface of the workpiece, and other means thereafter operable to procure separation of said wheels from the workpiece.

3. In an abrading machine, a plurality of abrading wheels and a work supporting member, means to position and maintain one of said wheels in engagement with a surface of a workpiece in said work supporting member, and means governed by the progress of the abrading operation to position and maintain a second of said wheels in engagement with the same surface of the workpiece while the latter is positioned in said work supporting member.

4. In an abrading machine, a plurality of abrading wheels and a work supporting member, means to position and maintain one of said wheels in engagement with a surface of a workpiece in said work supporting member, means governed by the progress of the abrading operation to position and maintain a second of said wheels in engagement with the same surface of the workpiece while the latter is positioned in said work supporting member, and means thereafter operable to procure separation of said wheels and the workpiece.

5. In an abrading machine, a work supporting member and a wheel supporting member, a carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, means to maintain said carriage in a position to support one of the abrading wheels in engagement with a surface of a workpiece in said work supporting member, and means governed by the progress of the abrading operation to shift said carriage to position a second abrading wheel in engagement with the same surface of the workpiece.

6. In an abrading machine, a work supporting member and a wheel supporting member, a carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, means to maintain said carriage in a position to support one of the abrading wheels in engagement with a surface of a workpiece in said work supporting member, means governed by the progress of the abrading operation to shift said carriage to position a second abrading wheel in engagement with the same surface of the workpiece, and means thereafter operable to procure movement of the carriage to withdraw the abrading wheels from operative position relative to the workpiece.

7. In an abrading machine, a work supporting member and a wheel supporting member, a car-

riage on which one of said members is mounted, a plurality of abrading wheels on said wheel supporting member, means to reciprocate said carriage to procure a traversing movement between either of said wheels and a workpiece in said work supporting member, means to locate the position of reciprocation of the carriage to maintain one of said abrading wheels in engagement with a surface of the workpiece, and means governed by the progress of the abrading operation to vary the location of reciprocation of said carriage to position a second of said abrading wheels in engagement with the same surface of the workpiece to procure a reciprocation between said second abrading wheel and said surface.

8. In an abrading machine, a work supporting member and a wheel supporting member, a carriage on which one of said members is mounted, a plurality of abrading wheels on said wheel supporting member, means to reciprocate said carriage to procure a traversing movement between either of said wheels and a workpiece in said work supporting member, means to locate the position of reciprocation of the carriage to support one of said abrading wheels in engagement with a surface of the workpiece, and means governed by the progress of the abrading operation to vary the location of reciprocation of said carriage to position a second of said abrading wheels in engagement with the same surface of the workpiece to procure a reciprocation between said second abrading wheel and said surface, and means thereafter operable to procure an extended movement of said carriage to separate the abrading wheels and the workpiece.

9. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, means to locate the position of reciprocation of the carriage in a position to procure reciprocatory traverse of one of said grinding wheels relative to a workpiece in said work supporting member, means operable during the abrading operation to shift the position of reciprocation of the carriage to procure reciprocation of another of said abrading wheels over the same surface of the workpiece, and means for procuring dressing operations simultaneously on said abrading wheels.

10. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels axially spaced on said wheel supporting member, means to locate the position of reciprocation of said carriage to procure a relative traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, means operable during the abrading operation to shift the position of reciprocation of said carriage to procure a reciprocatory traverse of a second abrading wheel relative to the same surface of the workpiece, and means operable at the completion of the abrading operation to procure an extended movement of the carriage to withdraw said wheels from operative position relative to the workpiece.

11. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position to obtain a reciprocatory traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, said second position of reciprocation obtaining a traversing movement of another of said abrading wheels relative to the same surface of the workpiece, and means operable during the progress of the abrading operation to render said first pair of reversing dogs inoperative and to render said second pair of dogs operative to shift said carriage from one position of reciprocation to the other.

12. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position to obtain a reciprocatory traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, said second position of reciprocation obtaining a traversing movement of another of said abrading wheels relative to the same surface of the workpiece, means operable during the grinding operation to procure an extended movement and subsequent return of the carriage toward the work supporting member, and means responsive to the extended movement of said carriage to render said first pair of dogs inoperative and to render said second pair of dogs operative.

13. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position to obtain a reciprocatory traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, said second position of reciprocation obtaining a traversing movement of another of said abrading wheels relative to the same surface of the workpiece, means operable while said first pair of reversing dogs is in operation to render one of said dogs inoperative to procure an extended movement of the carriage, the latter being subsequently automatically returned to operative position, and means responsive to said extended movement to withdraw said first pair of dogs from operative position and to place said second pair of dogs in operative position.

14. In an abrading machine, a work supporting member and a wheel supporting member, a

reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, means to locate the position of reciprocation of the carriage to maintain one of said abrading wheels in engagement with a surface of a workpiece in said work supporting member, means to procure an extended movement of said carriage to withdraw said grinding wheels axially from operative position relative to the workpiece and subsequent return of the wheels to operative position, means responsive to the withdrawal movement to procure a temporary radial withdrawal movement of the wheels relative to the surface of the workpiece, and means to shift the location of reciprocation of said carriage subsequent to the withdrawal movement to position a second of said abrading wheels in engagement with the same surface of the workpiece to procure a reciprocation between said second abrading wheel and said surface of the workpiece.

15. In apparatus of the class described, a reciprocatory carriage, a reversing lever, reversal of which procures reversal of the carriage movement, a plurality of pairs of reversing dogs on said carriage, each pair of dogs being arranged for engagement with said reversing lever to procure reciprocation of the carriage in a predetermined position, and means to render each pair of dogs selectively operative.

16. In apparatus of the class described, a reciprocatory carriage, a reversing lever, reversal of which procures reversal of the carriage movement, a plurality of pairs of reversing members on said carriage, each pair of members being arranged for engagement with said lever to procure reciprocation of said carriage in a predetermined position, and means to render one pair of said members operative and the remaining members inoperative.

17. In apparatus of the class described, a reciprocatory carriage, a reversing lever, reversal of which procures reversal of the carriage movement, a plurality of pairs of reversing members on said carriage, each pair of members being arranged for engagement with said lever to procure reciprocation of said carriage in a predetermined position, and means responsive to movement of said carriage to render one pair of said members operative and the remaining members inoperative.

18. In apparatus of the class described, a reciprocatory carriage, a reversing lever, reversal of which procures reversal of the carriage movement, a plurality of pairs of reversing members on said carriage, each pair of members being arranged for engagement with said lever to procure reciprocation of said carriage in a predetermined position, and means responsive to movement of said carriage to render each air of members successively operative, the remaining members being supported in inoperative position.

19. In apparatus of the class described, a reciprocatory carriage, a reversing lever, reversal of which procures reversal of the carriage movement, reversing members on said carriage in position for engagement with said lever to procure reciprocation of the carriage in a predetermined position, other reversing members on said carriage in inoperative position, and means to render said operative members inoperative and to position said other reversing members in operative position to procure reciprocation of the carriage in another predetermined position.

20. In apparatus of the class described, a reciprocatory carriage, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, and means automatically operable during the operation of the apparatus for rendering one of said pairs of dogs inoperative to procure shifting movement of said carriage from one position of reciprocation to the other.

21. In apparatus of the class described, a reciprocatory carriage, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, means for rendering one of the dogs of one pair inoperative for an extended movement of the carriage, and means responsive to the extended movement for rendering one pair of said dogs inoperative for a subsequent reciprocation of the carriage under the control of the other pair of dogs.

22. In apparatus of the class described, a reciprocatory carriage, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, means for procuring an extended movement of the carriage and a subsequent return of the carriage, and means responsive to the extended movement for shifting the position of said dogs, thereby shifting the position of reciprocation of said carriage.

23. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position to obtain a reciprocatory traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, said second position of reciprocation obtaining a traversing movement of another of said abrading wheels relative to the same surface of the workpiece, and means operable during the progress of the abrading operation to render one pair of said reversing dogs inoperative for shifting of said carriage from one position of reciprocation to the other.

24. In an abrading machine, a work supporting member and a wheel supporting member, a reciprocatory carriage on which one of said members is mounted, a plurality of abrading wheels carried by said wheel supporting member, a reversing lever to procure reversal of the carriage

movement, a pair of reversing dogs on said carriage to engage said reversing lever and procure reciprocation of said carriage in one position to obtain a reciprocatory traverse of one of said abrading wheels relative to a surface of a workpiece in said work supporting member, a second pair of reversing dogs on said carriage to engage and actuate said reversing lever to procure reciprocation of said carriage in a position spaced from the above-mentioned position of reciprocation, said second position of reciprocation obtaining a traversing movement of another of said abrading wheels relative to the same surface of the workpiece, means operable during the grinding operation to procure an extended movement and subsequent return of the carriage toward the work supporting member, and means responsive to the extended movement of said carriage to render one pair of said dogs inoperative for shifting the position of reciprocation of said carriage.

25. In apparatus of the class described, a reciprocatory carriage, a reversing lever to procure reversal of the carriage movement, a pair of reversing dogs on said carriage to engage said reversing member and procure reciprocation of said carriage in one position, means to procure an extended movement of said carriage and subsequent return of said carriage, and means responsive to the extended movement of said carriage for rendering said reversing dogs inoperative.

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