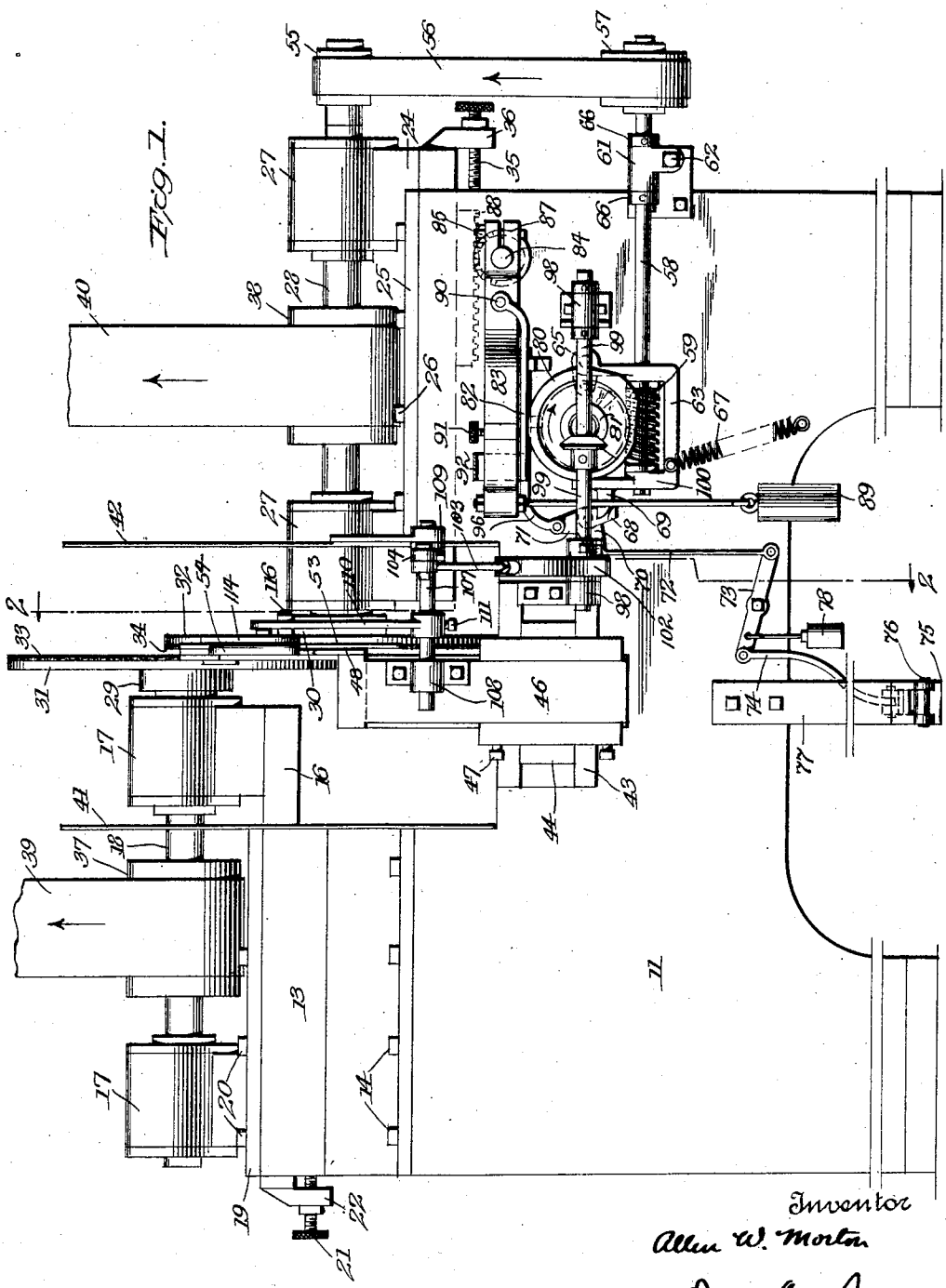
Aug. 30, 1927. 1,640,715

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FACE GRINDING MACHINE

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Fig. 1.



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Fig. 2

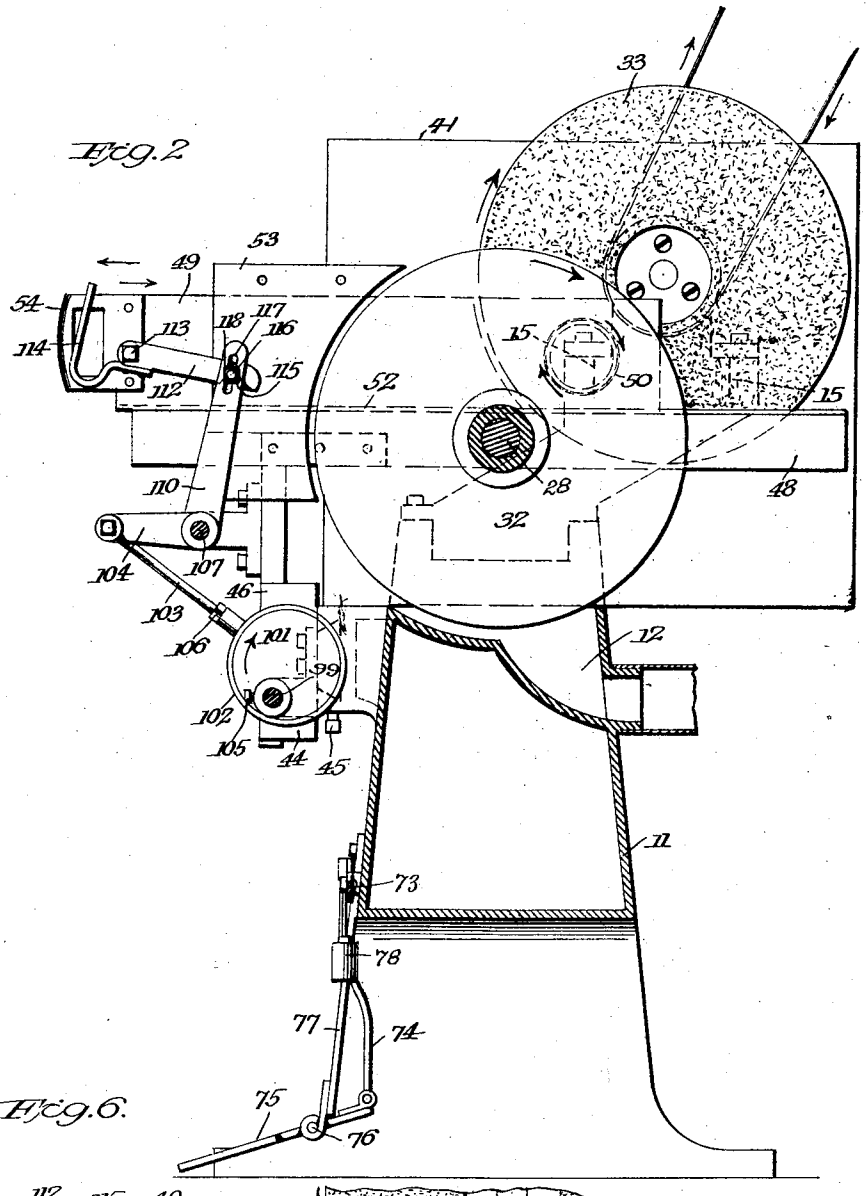
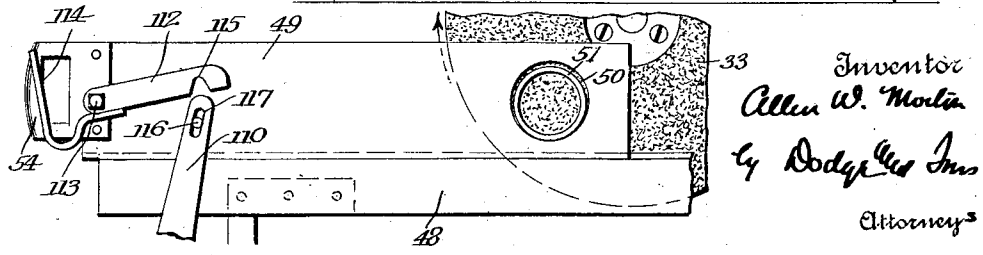


Fig. 6.



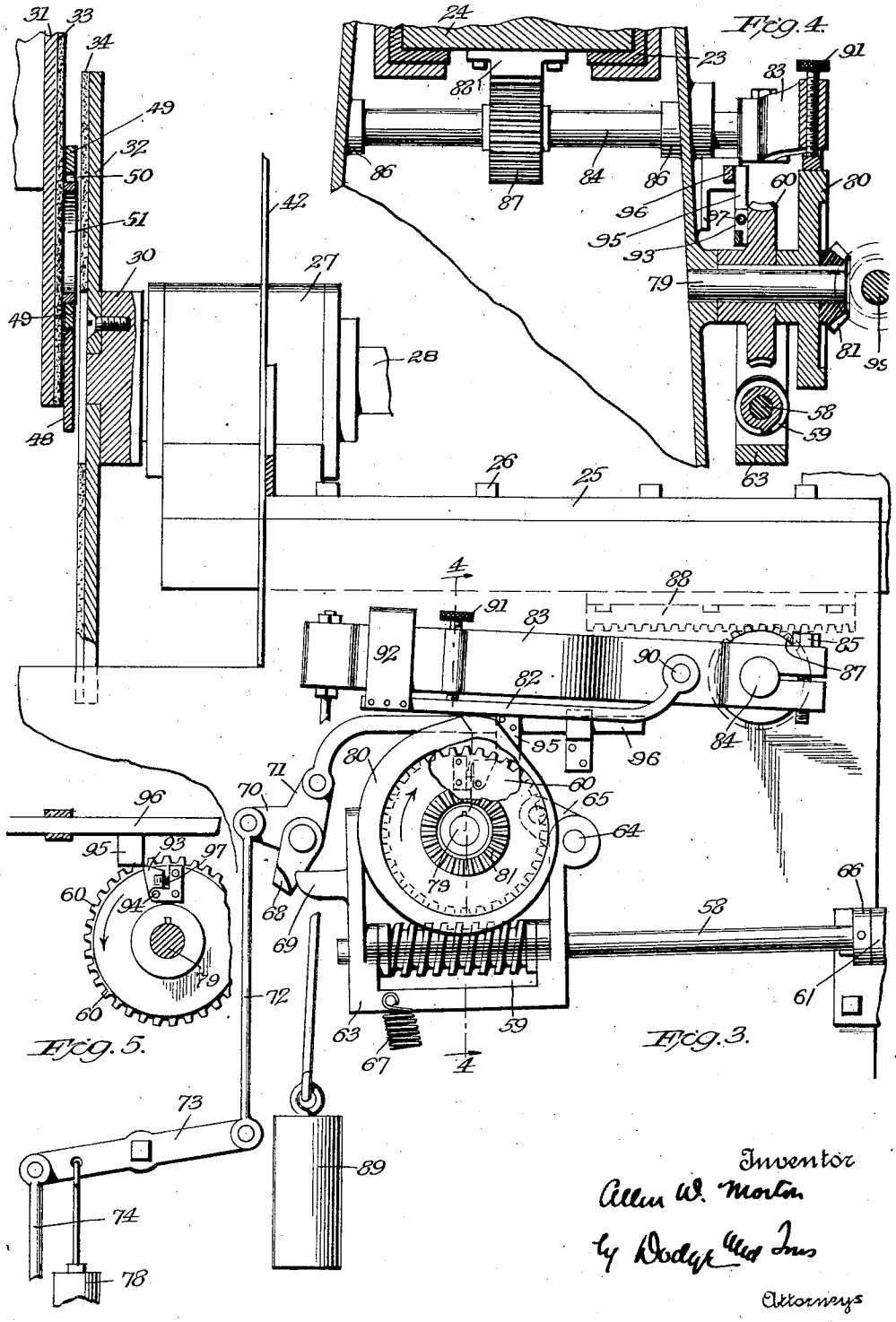
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UNITED STATES PATENT OFFICE.

ALLEN W. MORTON, OF BALTIMORE, MARYLAND.

FACE-GRINDING MACHINE.

Application filed November 28, 1925. Serial No. 72,006.

This invention relates to machines for grinding the opposed faces of flat circular objects such as discs or rings and is applicable wherever it is necessary to impart to such an article true plane surfaces which are accurately spaced and in strict parallelism with each other.

The device is particularly intended for grinding the opposed flat surfaces of piston rings. Since the invention possesses certain peculiar advantages in this field of use, I shall describe it as used in grinding piston rings in order to develop its full utility, but it must be understood that the invention is applicable to the face grinding of any article having opposed parallel flat faces and capable of rotation in the manner hereinafter described. When so used, the device will offer some or all of the advantages which it has in the particular field of piston ring grinding.

The preferred embodiment of the invention is illustrated in the drawings in which

Fig. 1 is a front elevation of the machine.

Fig. 2 is a section of the grinder on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged view of a portion of Fig. 1 with parts broken away to show the construction of the feed cam.

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 3.

Fig. 5 is a view of the worm gear and feed trip looking from the back of the machine.

Fig. 6 is a view of the work carrier showing the ring in position and showing the latch, by means of which the carrier may be attached to the automatic feed.

Generally stated, the machine includes two grinding discs of any suitable material which are mounted on parallel axes offset from each other in such a manner that a portion of the face of one disc is opposed to a similar portion of the face of the other disc. The grinding surfaces are preferably of annular form, that is, cut away at the center, and when viewed in side elevation the outer margin of one disc is approximately tangent to the inner margin of the other. The work to be ground is introduced between the discs and the discs are fed toward each other until a definite interval exists between them when the feed stops.

The accuracy with which the work piece is ground is affected by its rate and direction of travel relatively to the axes of the discs and also by the rate at which the discs are fed relatively toward each other during grinding. Any thin disc or ring, particularly if it be individually cast as the better grades of piston rings are, is almost sure to have internal strains which are relieved by machining and particularly by the side grinding operation. It is therefore important that the grinding pressure exerted on the ring be not such as to accentuate or perpetuate the distorting effect of these strains, whether the distortion is initial or develops in the course of the grinding. The ideal way of relieving the strains is to subject the ring to light grinding pressure so that the grinding process is slow and so that the strains may be relieved so gradually that all distortion is corrected. Such slow grinding is not commercially practicable but an approximately equivalent result can be secured by feeding the grinding elements toward each other first rapidly, then at a decreasing rate, and finally, when the proper interval is reached, stopping the feed altogether and allowing the piece to remain between the discs, when it is finish ground to a true surface.

The grinding elements are rotated in the same direction and, by reason of this, a rotating couple is always exerted on the work piece in the same angular direction. This couple causes the work piece to rotate at all times and brings every portion of the work piece into the paths of all portions of the grinding elements. In this way the ring is accurately ground and the wear is uniformly distributed over the entire faces of the grinding elements.

While this turning couple is effective at all points in the opposed areas of the two discs, there is lateral thrust on the work piece in all positions between the discs, except one. This one position is that when the center of the ring is at the midlength of a line connecting the axes of the discs. In this position the rotating couple is balanced and the work piece exerts no thrust on its support or substantially none. The worst condition is reached when the work piece is adjacent the intersection of the outer peripheries of the two discs. There are two such positions and in each of them there is an undue unbalanced thrust on the work piece.

Ordinarily the grinding discs will be of equal diameters and as this is the simplest case for discussion this condition is as-

sumed. In such case the chord common to the outer peripheries of the two discs will bisect at right angles the "center line" connecting the axes on which the discs rotate. At this point of intersection which I call the neutral point, there is no resultant thrust on the work piece. At all other points in the center line there is a very slight resultant thrust on the work piece perpendicular to the center line. At all other points on the common chord above defined there is a resultant thrust on the work piece perpendicular to the common chord and hence parallel with the "center line". The rotating couple, as has been stated, is effective at all points. If the work piece be so guided that its center moves on a straight line passing through the neutral point and dividing the angle formed by the center line and the common chord, the resultant thrust exerted by the wheels or discs on the work piece always has a component in the line of feeding travel and by a proper choice of direction of rotation this can be caused to urge the work piece toward the neutral point.

This can be demonstrated graphically only on a large scale, but the effect in the operation of the device is pronounced, sufficiently pronounced that in a machine embodying my invention and having a hand-fed work carrier the operator can tell when grinding has ceased from the fact that the work piece no longer seeks the neutral position.

After considerable experiment I have found that a satisfactory and probably the best result is secured when the center of the work piece is guided in a line which passes substantially through the neutral point at substantially 45° to the line connecting the centers of the wheels, the neutral point being the mid-point of such center connecting line.

It is usually desirable to have the work carrier travel in a horizontal path, and to accomplish this result and yet secure the desired relation of the feed path to the grinding disc axes, these axes must be offset so that the "center line" above mentioned is inclined. The machine illustrated in the drawings and now to be described in detail has the discs offset at 45°, the preferred but not the only practicable angle.

The base 11 consists of a hollow casting and is provided with an offtake connection 12 through which particles of metal and abrasive may be drawn off. The general form of the base is illustrated in the drawings and is subject to considerable variation at the option of the designer.

Mounted on this base at one end is an offset bracket 13, preferably constructed as a separate piece, but not necessarily so. This is inclined upwardly and toward the rear of the machine. The dimensions of this bracket determine the direction and amount of the offset of the two grinding discs, and since the bracket 13 is held in place by bolts 14, it may be removed and interchanged with a different bracket in case it is desired to change the offset of the two discs.

The bracket 13 is provided with ways 15 in which there is guided a carriage 16. The carriage 16 supports combined thrust and radial bearings 17 for a shaft 18, the shaft 18 being supported with its axis parallel with the ways 15 so that the movements of the carriage 16 in ways 15 shift the shaft 18 accurately in the direction of its axis. The carriage 16 may be clamped fast in ways 15 by means of overhanging retaining plates 19 held by bolts 20. A micrometer adjusting screw 21 threaded on a lug 22 on carriage 16 serves to adjust the position of the carriage accurately prior to such clamping.

In the operation of the machine carriage 16 is clamped fast, and it is released and shifted only when the machine is being adjusted or "set up."

At the opposite end of the base 11 (the end remote from the bracket 13) there are ways provided with gibs 23 whose guiding surfaces are parallel with the ways 15. These support and guide a second carriage 24 and offer means for taking up wear. The carriage 24 is confined but not clamped by the retaining plates 25 which in turn are held by bolts 26.

Mounted on carriage 24 are combined thrust and radial bearings 27 in which turns a shaft 28. The axis of the shaft 28 is parallel with the ways 23 and hence parallel with the axis of shaft 18. The axes of the two shafts are offset an amount determined by the design of bracket 13, and in the example illustrated, the shafts are so positioned that the plane common to the two parallel axes is inclined at 45° to the horizontal.

Each of the shafts 18 and 28 carries a corresponding hub or flange 29, 30. To these are fixed by means of screws, or any suitable means, corresponding discs 31, 32 having annular plane facings 33, 34 of any suitable abrasive material.

The motion of the carriage 24 toward the carriage 16 is limited by a stop screw 35 which is threaded in a lug 36 on carriage 24 in such position that its end collides with a portion of the base 11.

The shafts 18 and 28 carry pulleys 37 and 38 respectively, and through these belts 39 and 40 drive the shafts and hence the discs 31 and 32 in the same angular direction and preferably at equal speeds. Guard plates 41 and 42 are fixedly mounted on base 11 and partially house the grinding discs. The carriages 16 and 24 project through suitable openings on these plates.

On the front of base 11 are horizontal guide ways 43 in which a support 44 may be adjustably clamped by means of screws 45. A vertical stock 46 is clamped in support 44 by means of screws 47, and carries a narrow horizontal guide or bed 48, which extends to the rear between the opposed faces of the discs 31 and 32. Slidable on this bed is a thin blade-like work carrier 49, which has a circular aperture 50 of such size as freely to receive the work piece, shown in Figs. 2, 3 and 6 as a ring 51. The blade or carrier 49 and bed 48 have a tongue and groove engagement indicated at 52 in dotted lines in Fig. 2. The blade 49 is further guided by confining cheek plates 53 (see Fig. 2) forward of disc 32.

In order that the blade 49 may be moved manually, a handle 54 is provided at its forward end. It is manually retracted to insert and remove work pieces and may be manually shifted during the grinding operation if desired, though I provide and consider it better to use mechanical means to accomplish this last named function. Such means are associated with the general feed mechanism of the machine and will be described in connection therewith.

The main function of the feed mechanism is to move the disc 32 toward the disc 31 at an appropriately varying rate, allow it to dwell while grinding in its limiting position and then restore the disc to its initial position. The feed then automatically disengages to permit the operator to remove the finished piece and insert a new one, after which the operator re-engages it.

The shaft 28 carries at its end remote from disc 32 a wide faced pulley 55 connected by a belt 56 with a pulley 57 on feed drive shaft 58. The shaft 58 carries a worm 59 and must be capable of a swinging movement to carry the worm 59 into and out of engagement with a worm wheel 60, to start and stop the feed. Hence, the shaft 58 is mounted near pulley 57 in a bearing 61 pivoted at 62 to base 11. The other end of shaft 58 is guided by a yoke 63 swiveled thereon and embracing worm 59, the yoke 63 being steadied by pivotal connection at 64 to a swinging arm 65, supported on base 11. The thrust of the worm is taken by collars 66 at bearing 61 and sufficient clearance is allowed between the yoke and the ends of the worm to permit the swinging movement described.

The yoke 63 is capable of limited downward motion and is constantly urged downward by a spring 67. It may be drawn upward (to mesh the worm with the wheel) and there retained, by the camming and latching action of a beveled latch nose 68 upon a beveled lug 69 on yoke 63. The latch nose 68 is fixed to a bell crank having a horizontal arm 70 and a substantially vertical arm 71. The arm 70 is connected by link 72, lever 73 and link 74 with a treadle 75 pivotally supported at 76 on a bracket 77 which is carried by base 11. Depression of the pedal causes latch nose 68 to engage lug 69 and lift yoke 63. In the latched positions the parts are retained by friction of the members 68 and 69 and are automatically disengaged upon the completion of the grinding cycle by means associated with the worm wheel 60, when the weight 78 hung on lever 73 pulls latch nose 68 away from lug 69.

The worm wheel 60 is mounted to turn freely on a stub shaft 79 fixed in base 11, and fixed to worm wheel 60 to turn therewith is a cam 80 which controls the feed of carriage 24 and a bevel gear 81 which drives the work carrier or blade 49. The form of cam 80 is quite clearly shown in Fig. 3. The cam turns clockwise (as viewed in Figs. 1 and 3) and coacts with a follower plate 82 on lever 83. The lever 83 is adjustably fixed on shaft 84 by means of the machine screw 85 which clamps a slotted end of the lever upon the shaft. The shaft 84 turns in bearings 86 in base 11 and carries a pinion 87 which meshes with rack 88 on the lower side of carriage 24. A weight 89 constantly urges lever 83 downward, urging carriage 24 toward carriage 16, with sufficient pressure thus transmitted to the abrasive to grind the work piece.

The cam follower plate 82 is not fixed on lever 83 but is pivoted thereto at 90 and is adjusted relatively thereto by screw 91. A confining guide 92 gives lateral support to follower plate 82. Ordinary adjustments are made by screw 91. Adjustments beyond the range of screw 91 are made by loosening screw 85 and shifting lever 83 on shaft 84.

In Fig. 3 the cam is shown in the position assumed between grinding operations, in which the lever 83 is held elevated, thus retracting disc 32 for the removal and insertion of work pieces. As the cam rotates from this position the lever 83 is lowered, first quite rapidly and then slower and slower. Before the cam has brought its smallest radius into contact with the follower, screw 35 arrests carriage 24 and from then on until the nose lifts follower 82 once more, the discs grind at a fixed spacing gauged by the screw 35 and the cam revolves free of the follower 82. The length of time in which the cam revolves free of the follower, or conversely the time taken to bring the discs together, affects the final thickness and accuracy of the work piece to some extent. Therefore, by means of screw 91 very accurate adjustments can be made, determined by the point at which cam breaks away from follower as screw 35 hits base and carriage 24 reaches its maximum inward travel or the total force of weight 89 presses

the carriage 24 against the work piece, which, due to its unfinished thickness, holds the discs apart and arrests the inward travel of the carriage.

At the end of the cam's rotation, a finger 93 (see Fig. 5) pivoted to the worm wheel 60 at 94 engages a lug 95 on the trip rod 96, and sustained by spring 97 trips latch 68 so that yoke 63 drops and interrupts the feed drive. When the treadle 75 is pressed, the resulting movement of rod 96 overpowers spring 97 causing lug 95 to wipe back finger 93 and over-ride it.

Mounted in bearings 98 on base 11 is a shaft 99. This carries a bevel gear 100 which meshes with bevel gear 81 and serves to rotate shaft 99 whenever worm 59 is engaged with wheel 60. The shaft 99 carries an eccentric 101. A strap 102 encircles eccentric 101 and is connected by a rod 103 with a lever 104. The eccentric 101 is angularly adjustable on shaft 99, being held by a set screw 105, and the strap 102 and its rod 103 are threaded together and locked by a check nut as shown at 106, so that the effective length of the eccentric rod is adjustable. The arm 104 is fixed on a shaft 107 which turns in bearings 108, on post 46, and 109 supported by frame 11 and guard plate 42.

A second arm 110 is adjustably fixed by means of a set screw 111 on shaft 107 and is operatively connected to move the work carrier blade back and forth. Such connection is releasable and includes a latch arm 112 pivoted to carrier 49 at 113 and having an actuating trigger 114. The latch arm 112 has a notch 115 to receive a pin 116 projecting laterally from arm 110. This pin 116 is adjustable toward and from shaft 107 to vary the effective radius of arm 110, by means of slot 117 and nut 118. Thus, by means of the angular adjustment of the eccentric 101 and the adjustment of the effective length of eccentric rod 103, together with the angular adjustment of the arm 110 on its shaft 107, an adjustable stroke of the work carrier 49 is provided to take care of various size work pieces as well as to determine the starting or stopping point of the grinding cycle.

By changing the gear ratios of the bevel gears 81 and 100, a greater or lesser number of strokes of the carrier plate per grinding cycle may be had as well as a variable starting or stopping point. Such adjustments may be advantageous in certain classes of work, but in the drawings shown this gear ratio of the bevel gears is 1 to 1, hence the carrier plate moves back and forth once only to a grinding cycle, as described herewith. In the machine with the 1 to 1 ratio I prefer to form the cam and so to time the parts that the principal grinding operation is started as the work carrier moves inward toward the neutral point, the feed of the wheels toward each other terminating at or substantially at the time the work carrier reverses its motion. From this it follows that the finish grinding or lapping occurs on the reverse or outward movement of the carrier and continues substantially throughout this movement. In this way the heavy grinding on the in-stroke is distributed over the entire working faces of the discs, and similarly the light grinding or lapping is distributed so that the discs are subjected to substantially uniform wear throughout their effective areas and so that a relatively long lapping period is secured.

In the operation of the device both grinding discs are rotated constantly. When the feed is at rest and the discs separated, the operator releases latch 112 by trigger 114 and draws carrier 49 toward him. He then inserts a ring to be ground in hole 50, pushes carrier 49 to the rear, engages latch 112 with pin 116 and then depresses treadle 75. Depression of the treadle connects the feed drive so that carrier 49 is reciprocated and carriage 24 feeds toward carriage 16 with the motion characteristics already described in detail. When cam 80 has completed one rotation, finger 93 trips latch 68 and brings the feed to rest. At this moment carriage 24 has completed its retractive motion to the right. The stopping of the feed includes stoppage of the reciprocation of the carrier 49, and one grinding cycle is completed.

What I claim is:

1. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs in the same angular direction about offset parallel axes, with portions of said discs opposed to and parallel with each other; and a work carrier arranged to support a work piece for rotation about an axis parallel with the axes of said discs and to guide the same in a path between said discs which is oblique to the line connecting the axes of said discs and which approximately bisects said line.

2. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs in the same angular direction about offset parallel axes, with portions of said discs opposed to and parallel with each other; and a work carrier arranged to support a work piece for rotation about an axis parallel with the axes of said discs and to guide the same in a straight line which bisects the line connecting the axes of said discs and makes an angle of 45° therewith.

3. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs about offset parallel axes with portions of said discs opposed to and paral-

lel with each other; a work carrier arranged to support a work piece for rotation about an axis parallel with the axes of said disc, and to guide the same in a path between said discs which is oblique to the line connecting the axes of said discs and which approximately bisects said line and automatic feed means constructed and arranged to move said discs relatively toward each other at a variable rate, then, when a definite interval between said discs is reached, to arrest such movement, and finally after an interval of rest to separate said discs.

4. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs in the same direction about offset parallel axes with portions of said discs opposed to and parallel with each other; a work carrier movable between the opposed portions of said discs and having an opening in which a work piece may be rotatably confined; and automatic means for reciprocating said carrier in a substantially right line path which is oblique to and which approximately bisects the line connecting the axes of said discs.

5. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs in the same direction about offset parallel axes with portions of said discs opposed to and parallel with each other; a work carrier movable between the opposed portions of said discs and having a circular opening in which a work piece may be confined and permitted to rotate about an axis parallel with the axes of said discs; and automatic means for traversing said work carrier, the parts being so arranged that the work piece moves in a path oblique to the line connecting the axes of said discs and substantially bisecting the same.

6. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs in the same direction about offset parallel axes with portions of said discs opposed to and parallel with each other; a work carrier movable between the opposed portions of said discs and having an opening in which a work piece may be confined and permitted to rotate about an axis parallel with the axes of said discs; automatic means for traversing said carrier; and a manually operable releasable connection between said traversing means and said carrier.

7. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs about offset parallel axes with portions of said faces opposed to and parallel with each other; a feeding mechanism arranged to move said discs relatively toward each other until a definite interval between said discs is reached and thereafter to dwell and then separate said discs; a work carrier movable with a reciprocating motion between the opposed portions of said discs and having a portion in which a work piece may be confined and permitted to rotate about an axis parallel with the axes of said discs, and driving connections for said feeding means and for said work carrier.

8. In a face grinding machine, the combination of two discs having plane grinding faces; means for supporting and rotating said discs about offset parallel axes with portions of said faces opposed to and parallel with each other; a feeding mechanism arranged to move said discs relatively toward each other until a definite interval between said discs is reached and thereafter to dwell and then separate said discs; a work carrier movable between the opposed portions of said discs and having a portion in which a work piece may be confined and permitted to rotate about an axis parallel with the axes of said discs; driving connections for said feeding means and for said work carrier; starting means under the control of the operator for establishing said driving connections; and automatic interrupting means ararnged to terminate said driving connection upon the separation of said discs.

In testimony whereof I have signed my name to this specification.

ALLEN W. MORTON.