

April 14, 1942.

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2,279,902

PISTON GRINDING MACHINE

Filed Aug. 14, 1940

3 Sheets-Sheet 1

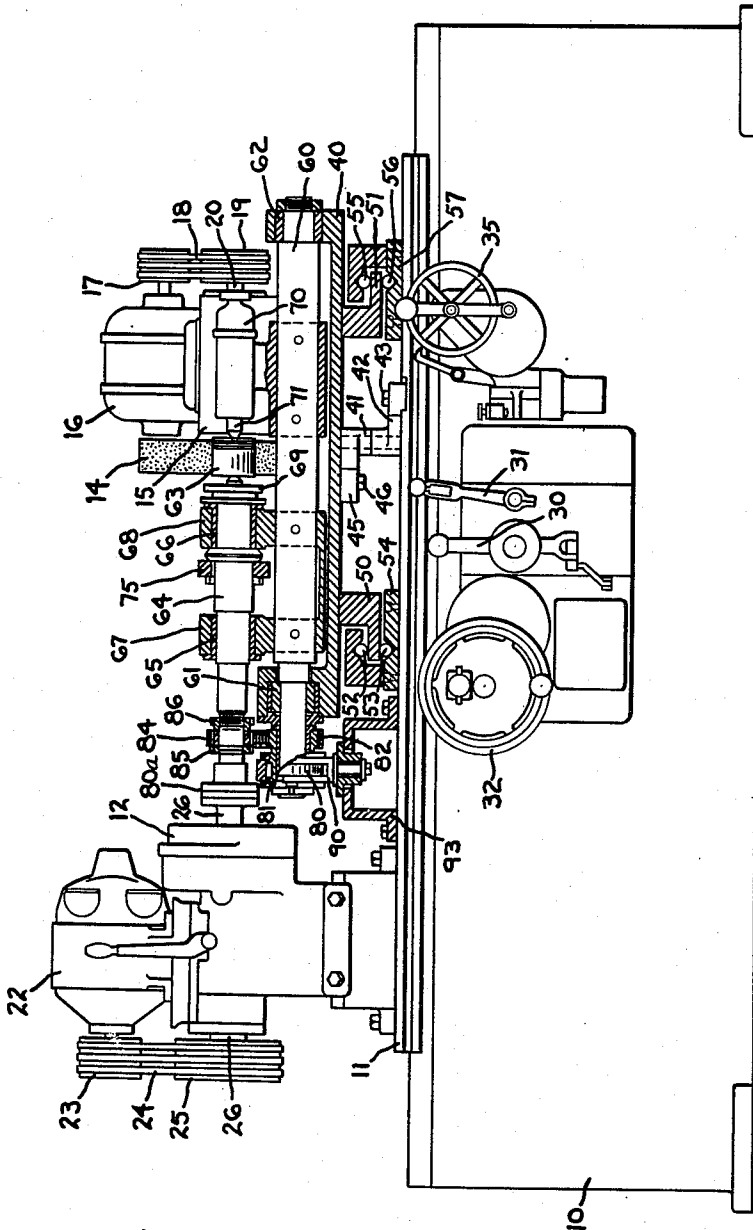


Fig. 1

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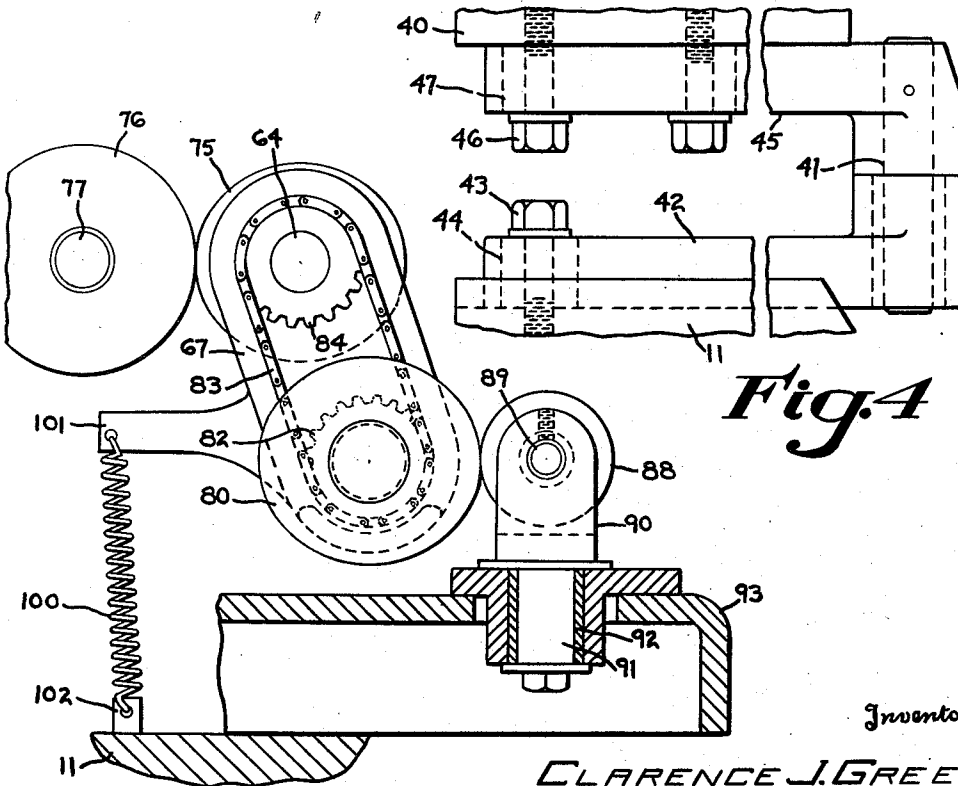
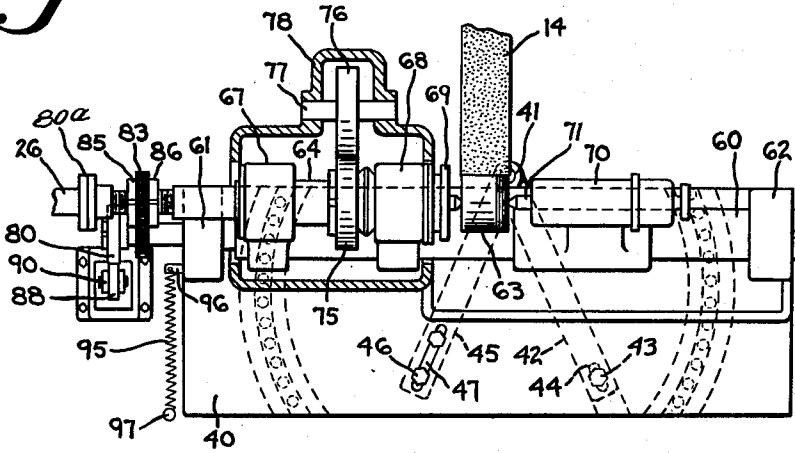
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3 Sheets-Sheet 2

*Fig. 2*



*Fig. 4*

*Fig. 3*

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PISTON GRINDING MACHINE

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3 Sheets-Sheet 3

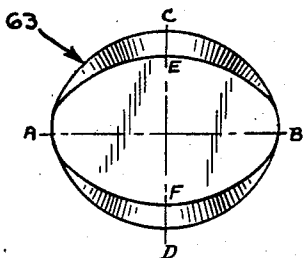


Fig. 5

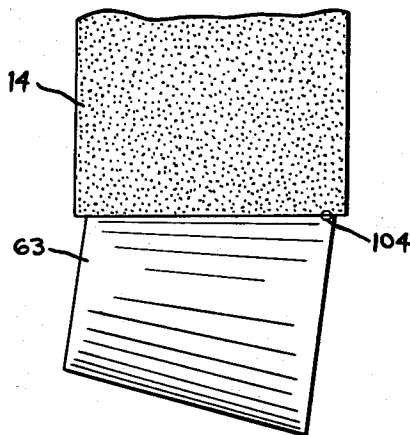


Fig. 6

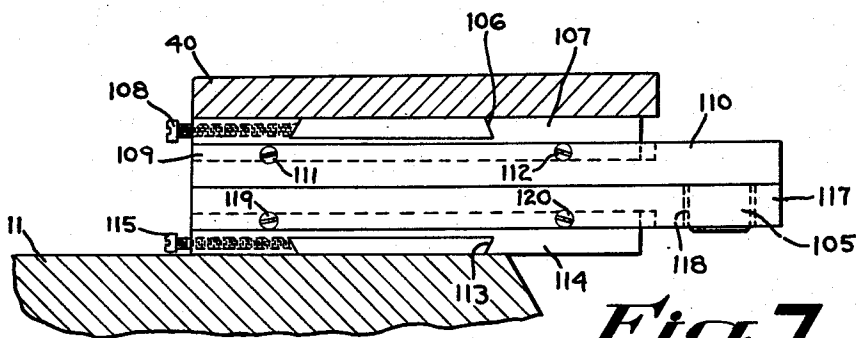


Fig. 7

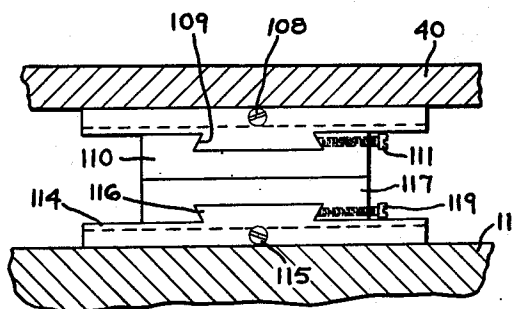


Fig. 8

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# UNITED STATES PATENT OFFICE

2,279,902

## PISTON GRINDING MACHINE

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tion of Massachusetts

Application August 14, 1940, Serial No. 352,567

12 Claims. (Cl. 51-101)

The invention relates to grinding machines, and more particularly to an apparatus for grinding a work piece of a non-circular cross-section, such as a tapered oval shape on an automotive piston.

One object of the invention is to provide a simple and thoroughly practical apparatus for grinding a work piece to a non-circular shape. Another object of the invention is to provide a grinding apparatus for grinding a work piece to a tapered non-circular cross-section in which the work piece is oscillated toward and from the grinding wheel by means of a rotatable cam.

A further object of the invention is to provide a grinding apparatus to grind a tapered oval shape on a piston in which the major axis of the oval cross-section is uniform throughout the length of the piston. A further object of the invention is to provide a piston grinding attachment in which a rock bar controlled by a master cam and follower serves to produce the desired oval shape on a piston and in which a swivel support for the rock bar is swivelled by means of a cam and follower angularly to shift the axis of the piston being ground to produce a tapered oval surface on the piston being ground.

Another object of this invention is to provide a piston grinding attachment in which the piston being ground is supported on a pivotally mounted rock bar which is rocked about an axis substantially parallel to the axis of the grinding wheel and in which the pivotal support for the rock bar is pivotally supported to swivel about an axis substantially normal to the axis of the rock bar so as to produce a tapered oval or elliptical shape on the piston being ground. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the mechanical features of this invention,

Fig. 1 is a front elevation of a grinding machine having the improved piston grinding attachment mounted thereon and shown in section;

Fig. 2 is a fragmentary plan view, on an enlarged scale, of the piston grinding attachment as shown in Fig. 1;

Fig. 3 is a fragmentary phantom view of the master cam and follower roller for rocking the

rock bar and the master cam and follower roller for swivelling the rock bar;

Fig. 4 is a fragmentary view showing the adjustable pivotal support for the piston grinding attachment;

Fig. 5 is an exaggerated end elevation of a tapered oval-shaped piston ground by this attachment;

Fig. 6 is a fragmentary plan view, on an enlarged scale, showing the relative positions of the grinding wheel, tapered piston and vertical pivotal support for the piston grinding attachment;

Fig. 7 is a fragmentary side elevation of a modified pivotal support for the piston grinding attachment in which provision is made for longitudinally and transversely adjusting the axis of the pivot; and

Fig. 8 is a fragmentary front elevation of the modified pivotal adjustment shown in Fig. 7.

A grinding machine embodying this invention may comprise a base 10 which supports a longitudinally movable table 11 on the usual V-way and flat way (not shown) for a longitudinal reciprocating movement relative to the base 10. A motor driven headstock 12 is mounted on the table 11 and is arranged rotatively to drive a work piece supported by the piston grinding attachment to be hereinafter described.

A transversely movable rotatable grinding wheel 14 is rotatably supported on a transversely movable slide 15 of the type such as, for example, that shown in the expired U. S. patent to Norton, No. 762,838 dated June 14, 1904. In the preferred form, an electric motor 16 is mounted on the upper surface of the wheel slide 15 and is provided with a driving pulley 17 which is preferably of the multiple V-groove type which is connected by a multiple V-belt 18 with a multi V-groove pulley 19 which is mounted on the right-hand end of a wheel spindle 20.

The headstock 12 is preferably a motor driven headstock in which an electric motor 22 is mounted on the upper surface of the headstock 12. The motor 22 is provided with a multi V-groove pulley 23 which is connected by multiple V-belts 24 with a multi V-groove pulley 25 supported on the left-hand end of the headstock spindle 26.

The machine illustrated in the present application is substantially the same as that shown in the prior U. S. patent to C. H. Amidon, No. 2,113,363 dated April 5, 1938, to which reference may be had for details of disclosure not contained herein. The table 11 may be traversed longitudinally by means of a hydraulically oper-

ated mechanism controlled by means of a stop and start lever 30 mounted on the front of the machine base 10. A reversing lever 31 may be actuated by table dogs (not shown) to reverse the direction of movement of the table 11 so as to control the length of its reciprocatory stroke. The lever 31 controls a reversing valve (not shown) which reverses the direction of flow of fluid to a table cylinder (not shown). The manually operable start and stop lever 30 controls a start and stop valve (not shown) which are identical in construction with that shown in the above-mentioned prior patent to Amidon.

The table 11 may be traversed longitudinally to position a work piece relative to the grinding wheel 14 by means of a manually operable table traverse mechanism including a manually operable hand wheel 32 which is rotatably supported on the front of the machine base 10 and which is connected by gearing (not shown) with a rack bar depending from the table 11 in a manner substantially the same as that shown in the above-mentioned prior patent to Amidon, to which reference may be had for details of disclosure not contained herein.

The transversely movable wheel slide 15 is supported on the usual V-way and flat way (not shown) and a wheel feeding mechanism of the nut and screw type is provided which is actuated by means of a manually operable feed wheel 35 rotatably supported on the front of the machine base 10. The details of the nut and screw feed mechanism have not been shown in the present application, since they are not considered to be a part of the present invention. For further details of the wheel feeding mechanism, reference may be had to the above-mentioned expired patent to Norton, No. 762,838.

The machine, as previously described, is substantially the same as that shown in the prior patent to Amidon, No. 2,113,363, to which reference may be had for details of disclosure not contained herein. A piston grinding attachment is provided which may be readily supported on the work supporting table 11. The piston grinding attachment may comprise a pivotally mounted supporting frame 40 which is supported to pivot about a substantially vertically positioned stud 41. The stud 41 is supported by an adjustably positioned bracket 42 which is adjustably supported on the table 11. A clamping screw 43 passes through an elongated slot 44 in the bracket 42 and is screw threaded into the table 11. It will be readily apparent from the foregoing disclosure that the bracket 42 may be adjusted to vary the position of the pivot stud 41 relative to the table 11. A bracket 45 is fixedly supported on the upper end of the pivot stud 41 and is adjustably clamped to the under surface of the frame 40 by means of a clamping screw 46 which passes through an elongated slot 47 in the bracket 45 and is screw threaded into the bracket 40. By adjustment of the frame 40 relative to the bracket 45, the pivotal axis of the frame may be varied as desired.

In order that the frame 40 may be readily swiveled, anti-friction supporting bearings are provided adjacent to the opposite ends thereof. An arcuate-shaped bracket of substantially L-shaped cross-section 50 depends from the left-hand end of the swivel frame 40. A row of balls 52 and 53 are interposed between the bracket 50 and a bracket 54 supported on the table 11. Similarly, an arcuate bracket 51 of substantially L-shaped cross-section depends from the right-

hand end of the swivel support 40. Opposed rows of balls 55 and 56 are interposed between the bracket 51 and a bracket 57 which is fixedly supported on the table 11. The provision of anti-friction bearings adjacent to the opposite ends of the pivotally mounted supporting frame 40 facilitates a free and easy swiveling action of the frame 40 whereby a taper may readily be produced in a manner to be hereinafter described.

In order to facilitate the grinding of an oval shape on a work piece, it is desirable to provide a rotatable work support which is arranged for a controlled transverse movement relative to the operative face of the grinding wheel. To accomplish this result, a rock bar 60 is supported in bearings 61 and 62 which are in turn fixedly supported on the swivel frame 40. The rock bar 60 serves rotatably to support a work piece, such as a piston 63. A headstock or master cam spindle 64 is rotatably supported in bearings 65 and 66 which are carried by brackets 67 and 68. The brackets 67 and 68 are fixedly mounted on the rock bar 60. The spindle 64 serves as a support for a piston supporting and driving head 69 which supports the headstock or open end of the piston 63. The footstock 70 is fixedly mounted on the rock bar 60 and serves as a support for a footstock center 71 which is arranged to support the right-hand end of a piston 63 to be ground.

In order to produce a predetermined oval or elliptical shape on the piston 63, it is desirable to impart a rocking or oscillating movement to the rock bar 60. This is preferably accomplished by providing a master cam 75 on the headstock or master cam spindle 64. The periphery of the master cam 75 is engaged by a rotatable follower roller 76 which is rotatably supported on a stud 77. The stud 77 is fixedly supported in a frame 78 which is mounted in fixed relation with the table 11. The master cam 75 is accurately shaped so as to produce the desired and predetermined oval or elliptical shape on the periphery of the piston 63. If desired, the master cam 75 may be interchanged for a master cam of a different shape in setting up the attachment for grinding different sizes and shapes of pistons.

It will be readily apparent from the foregoing disclosure that a rotary motion of the master cam spindle 64 and the master cam 75 which is in operative engagement with the master cam roller 76 will impart a rocking motion to the rock bar 60 to rock the piston 63 transversely toward and from the operative peripheral surface of the grinding wheel 14 to generate the desired and predetermined oval or elliptical shape thereon. The headstock spindle 26 is connected by means of a universal joint 80a with the left-hand end of the spindle 64. When the motor 22 is rotated to impart a rotary motion to the headstock spindle 26, this motion will be transmitted through the universal joint 80a to rotate the headstock or master cam spindle 64 which through the master cam 75 will impart a controlled rocking or oscillating movement of the rock bar 60 to rock the axis of the piston 63 being ground toward and from the periphery of the grinding wheel 14 to grind a predetermined oval or elliptical shape on the piston.

In the grinding of certain types of pistons, it is desirable not only to grind an oval shape on the periphery of the piston but also to grind a slight taper thereon. In order to accomplish this desired result, a mechanism is provided for oscillating the frame 40 in timed relation with the oscillating movement of the rock bar 60 so

that a tapered oval or elliptical surface may be produced. A rotatable cam 80 is keyed to a rotatable sleeve 81 which is journaled on the left-hand end of the rock bar 60 (Fig. 1). A sprocket 82 is formed integral with the sleeve 81. A link chain 83 drivingly connects the sprocket 82 with a sprocket 84 which is supported adjacent to the left-hand end of the master cam or headstock spindle 64. The sprocket 84 is preferably adjustably mounted on the shaft 64 and may be locked in adjusted position thereon by a pair of collars 85 and 86 which are screw threaded on the end portion of the spindle 64. The adjustable mount for the sprocket 84 serves to facilitate timing of the taper cam 80 relative to the master cam 75. If it is desired to adjust the relationship of the cam 80 relative to the master cam 75, one or both of the collars 85 and 86 may be loosened and the sprocket 84 rotated to angularly adjust the position of the cam 80, after which the collars 85 and 86 may again be tightened to lock the cam 80 in timed relation with the cam 75.

A follower roller 88 is arranged peripherally to engage the cam 80. The roller 88 is rotatably supported on a stud 89 which is in turn supported by a yoke-shaped bracket 90. The bracket 90 is preferably pivotally mounted so that it may swivel about a vertical axis whereby its peripheral face may be maintained in alignment with the peripheral face of the cam 80 during the oscillating movement of the frame 40. The bracket 90 is provided with a downwardly extending, cylindrically shaped integral stud 91 which fits within a bushing 92 which is held in fixed relation with the frame 93 which is fixedly supported on the table 11.

A yieldable device is provided for maintaining the taper forming cam 80 in operative engagement with the follower roller 88 during the grinding operation. As illustrated in Fig. 2, a spring 95 of the tension type is interposed between a stud 96 which is fixedly mounted on the frame 40 and a stud 97 which is fixedly supported on the table 11. The tension of the spring is sufficient to maintain the cam 80 in operative engagement with the roller 88 so that as the cam 80 is rotated against the roller 88, the axis of which is fixed, an oscillating motion will be transmitted to the frame 40 during the grinding operation to grind the desired oval-shaped taper on the piston 63.

Similarly, a yieldable device is provided for maintaining the master cam 75 in operative engagement with its follower roller 76 during the grinding operation. As shown in Fig. 3, a tension spring 100 is interposed between an arm 101 which is formed integral with the bracket on the rock bar 60 and a stud 102 which is fixedly mounted on the upper surface of the work table 11. It will be readily apparent from the foregoing disclosure that when the headstock spindle 26 is rotated by the motor 22, a rotary motion will be imparted to the master cam spindle 64 to oscillate the rock bar 60 and thereby produce a predetermined oval or elliptical shape on the work piece and at the same time, through the taper forming cam 80 and the follower roller 88, an oscillating movement will be imparted to the frame 40 about its pivot stud 41 to produce the desired elliptical taper on the periphery of the cam 63.

In grinding a tapered oval on the piston 63, it may be desirable to provide a slight oval shape to the piston which tapers toward the open end

of the piston, in which the long axis of the oval remains constant throughout the length of the piston. In such a case, it is desirable to locate the axis of the pivot stud 41, as indicated diagrammatically in Fig. 6 by a small circle 104 adjacent to the line of contact between the grinding wheel 14 and the piston 63 and at a point adjacent to the right-hand end of the piston 63.

To facilitate setting up the machine for grinding a piston in the above manner, the pivot stud 41 has been illustrated in Figs. 2 and 4 as being adjustable transversely relative to the table 11. In case the machine is to be utilized for grinding several types and sizes of pistons, it may be desirable to provide not only a transverse adjustment for the pivot stud 41 but also a longitudinal adjustment thereof. A modified pivot adjustment has been illustrated in Figs. 7 and 8 in which a pivot stud 105 may be adjusted both transversely and longitudinally so that its axis may be aligned and located in the position 104, as indicated in Fig. 6, or in any other desired position, depending upon the shape of the piston to be ground.

As indicated in Figs. 7 and 8, the swivel bracket 40 may be provided with a dovetailed slideway 106 which mates with a correspondingly shaped way formed on a longitudinally adjustable slide member 107. One or more clamping screws 108 are provided for clamping the slide 107 in adjusted position with the way 106. The longitudinally adjustable slide member 107 is provided with a transversely extending dovetailed slideway 109 which mates with a correspondingly shaped slideway formed in arm 110 which supports the pivot stud 105. Binding screws 111 and 112 are provided for clamping the transversely adjustable slide member 107 in adjusted position relative to the arm 110.

Similarly, the table 11 is provided with an upwardly projecting dovetailed slideway 113 which extends longitudinally relative to the table 11. A longitudinally adjustable slide 114 is provided with a dovetailed slideway which mates with the way 113. A clamping screw 115 is provided for clamping the longitudinally adjustable slide 114 in adjusted position relative to the table 11. The longitudinally adjustable slide 114 is provided with a transversely extending dovetailed slideway 116 which mates with a correspondingly shaped way in an arm 117. The arm 117 is provided adjacent to its right-hand end (Fig. 7) with a bushing 118 which mates with the pivot stud 105. Clamping screws 119 and 120 are provided for clamping the longitudinally adjustable slide 114 in its adjusted position relative to the arm 117.

It will be readily apparent from the foregoing disclosure that the axis of the pivot stud 105 may be adjusted both longitudinally and transversely relative to the table 11 and also relative to the pivotally supported frame 40 which supports the rocking bar. By utilizing this construction, the axis of the pivot stud 105 may be adjusted into the desired relationship both longitudinally and transversely so that the pivot point for producing the taper on the piston to be ground may be located in a desired and predetermined relationship with the surface to be ground.

The taper produced on the piston as well as the extent of the oval produced thereon may be only a few thousandths of an inch. This relationship has been materially exaggerated in Figs. 5 and 6 to clarify the illustration. As shown in Fig. 5, the oval or ellipse A, C, B, D is the oval produced

at the large end of the piston and the oval A, E, B, F is the oval produced at the small end of the piston. It should be noted that the long axis of each oval or ellipse is of the same measurement so that an element of the piston along point A or point B will present parallel lines.

It will be readily apparent from the foregoing disclosure that practically any desired shape, either oval, elliptical or otherwise, may be produced on the periphery of a work piece, such as the piston 63, and any taper either uniform or otherwise may be produced by providing a master cam 75 and a taper producing cam 80 of the required shape and size. The cam 80 may be readily timed with the cam 75 so as to coordinate the rocking of the rock bar 60 and the oscillation of the pivotally supported frame 40 so that the desired and predetermined shape may be produced on the peripheral surface of the work piece 63.

The operation of this machine will be readily apparent from the foregoing disclosure. Assuming the proper cams 75 and 80 have been placed in the machine and the taper producing cam 80 timed in the desired relationship with the master cam 75, and assuming also the axis of pivot stud 41 or 105 to have been previously adjusted into the desired location such as, for example, that shown in the diagram (Fig. 6), a piston 63 is placed in position between the piston holder 69 on the master cam spindle 64 and the footstock center 71. The motor 22 is then started to produce a rotary motion of the work piece 63 and at the same time to oscillate the rock bar 60 and to swivel the pivotally mounted frame 40. The grinding wheel 14 is fed forward into grinding position by means of the manually operable feed wheel 35 and the piston 63 is ground during the combined rocking movement of the rock bar 60 and the oscillation of the frame 40 to produce a peripheral surface on the piston 63 in the form of a tapered oval shape. If it is desired to grind a piston of a slightly different shape, the cams 75 and 80 may be readily replaced by master cams of the desired shape and size and the pivot studs 41 or 105 again adjusted into the desired operating position.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinbefore set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a grinding machine having a base, a rotatable grinding wheel, a transversely movable rotatable work support, means including a master cam and a follower to impart a transverse movement to said work support, an oscillatable platen to support said work support which is oscillatable about an axis normal to said transverse movement, and means including a cam and a follower to oscillate said work support about an axis substantially parallel to the axis of the grinding wheel during the transverse movement of the work support.

2. In a grinding machine having a base, a transversely movable rotatable work support, means including a master cam and a follower to impart a transverse movement to said work sup-

port about an axis substantially parallel to the axis of the grinding wheel, said cam and follower serving to determine the cross-sectional shape of a work piece, an oscillatable member to support said work support, and means including a cam and a follower to oscillate said member and work support during the transverse movement thereof about an axis normal to said transverse movement, said latter cam and follower serving to determine the extent of taper produced on a work piece.

3. In a grinding machine having a base, a rotatable grinding wheel, a transversely movable rotatable work support, work driving means on said support, means including a movable master cam and a follower to impart a transverse movement to said work support about an axis substantially parallel to the axis of the grinding wheel, means to synchronize the work driving means and cam, an oscillatable platen, a rotatable work support including headstock and footstock centers to support said work support, a movable cam and a follower to oscillate said platen about an axis normal to said transverse movement, and driving means to synchronize the movement of said cams so as to produce a tapered oval shape on a work piece.

4. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, a transversely movable rotatable work support on said table, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, means to synchronize the work driving means and cam, an oscillatable platen interposed between the table and work support, a rotatable cam and a follower to oscillate said platen, and driving means to synchronize the rotation of said cams so as to produce a tapered oval shape on a work piece.

5. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, a vertically arranged pivotal connection between said table and platen, a transversely movable rotatable work support on said platen, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, a rotatable cam and a follower to impart an oscillating movement to said platen, and driving means to synchronize the work driving means and cams so as to produce a tapered oval shape on a work piece.

6. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, an adjustable vertical pivot stud interposed between said table and platen, a transversely movable rotatable work support on said platen, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, a rotatable cam and a follower to impart an oscillating movement to said platen, synchronous driving connections between the work driving means and said cams, and means to adjust the position of said pivot stud relative to said table and platen.

7. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, an adjustable vertical pivot stud interposed between said table and platen,

a transversely movable rotatable work support on said platen, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, a rotatable cam and a follower to impart an oscillating movement to said platen, synchronous driving connections between the work driving means and said cams, and a transverse adjusting means for said pivot stud to facilitate a transverse adjustment of the pivotal axis of the platen relative to the operative face of the grinding wheel.

8. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, an adjustable vertical pivot stud interposed between said table and platen, a transversely movable rotatable work support on said platen, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, a rotatable cam and a follower to impart an oscillating movement to said platen, synchronous driving connections between the work driving means and said cams, and a longitudinal adjusting means for said pivot stud to facilitate a longitudinal adjustment of the pivotal axis of the platen relative to the operative face of the grinding wheel.

9. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, an adjustable vertical pivot stud interposed between said table and platen, a transversely movable rotatable work support on said platen, work driving means on said support, means including a rotatable master cam and a follower to impart a transverse movement to said work support, a rotatable cam and a follower to impart an oscillating movement to said platen, synchronous driving connections between the work driving means and said cams, and a longitudinal and transverse adjusting means for said pivot stud to facilitate adjustment of the pivotal axis of the platen relative to the operative face of the grinding wheel.

10. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, a pivotally mounted rock bar on said table, a rotatable work support on said rock bar, work driving means thereon, means including a master cam and a follower roller to rock said bar, an oscillatable supporting platen interposed between the rock bar and table, an adjustable vertical pivotal connection between said platen and table, means to adjust the position of said pivotal connections, and means including a master cam and follower roller interposed between the table and platen to oscillate said platen during the oscillation of the rock bar so as to produce a tapered oval shape on a work piece.

11. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a longitudinally movable work table, an oscillatable platen on said table, an adjustable vertical pivot stud between the table and platen, a rock bar on said platen, a rotatable work support on said rock bar, a work driving means therefor, a rotatable master cam and a follower roller to rock said bar, a rotatable cam and a follower to oscillate said platen, and synchronous driving connections between the work driving means and said cams so as to impart a combined rocking and oscillating movement of said work support to produce a tapered oval on a work piece.

12. In a grinding machine having a base, a transversely movable rotatable grinding wheel, a work table, an oscillatable platen on said table, a vertical pivot stud between the table and platen, a rotatable work support, horizontal pivotal connections between said platen and work support, a work driving means, a rotatable master cam and a follower to rock said work support, synchronous driving connections between the work driving means and master cam, a rotatable cam and a follower to oscillate said platen, synchronous driving connections between said master cam and said rotatable cam, and adjustable means to time the rotatable cam relative to the master cam.

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