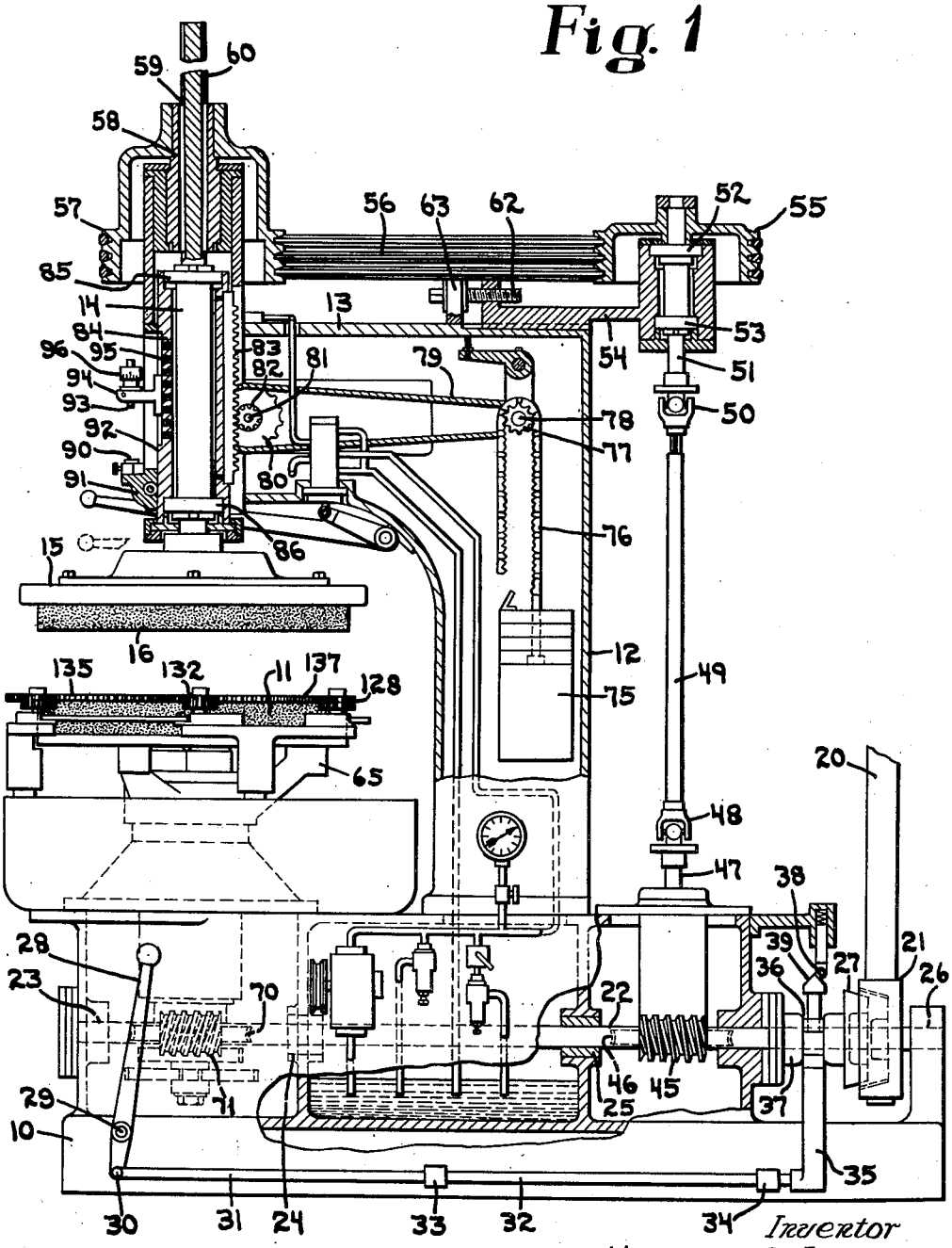
Nov. 25, 1952 H. S. INDGE 2,618,911

LAPPING MACHINE

Filed July 8, 1950 4 Sheets-Sheet 1

Fig. 1



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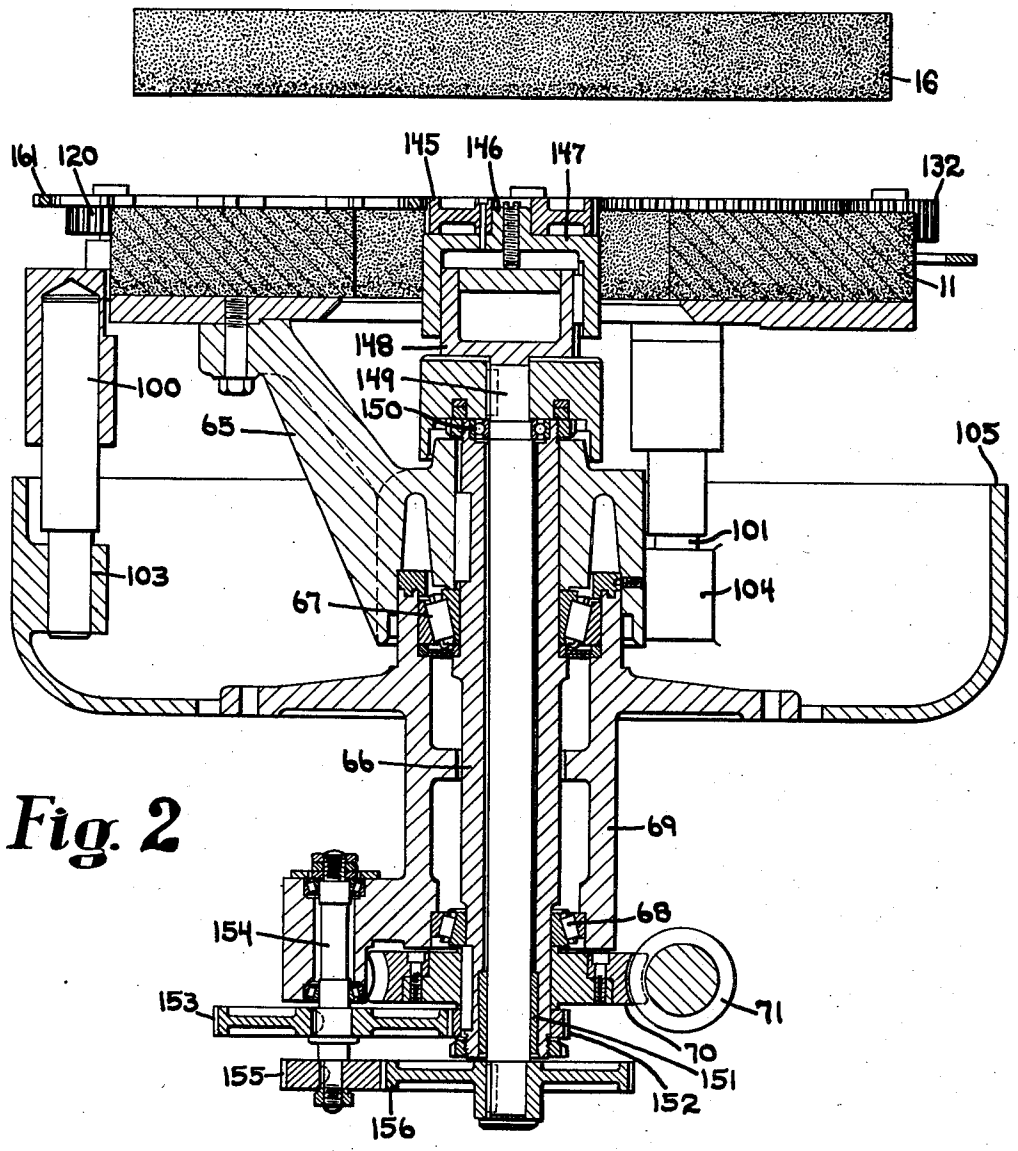

Fig. 2

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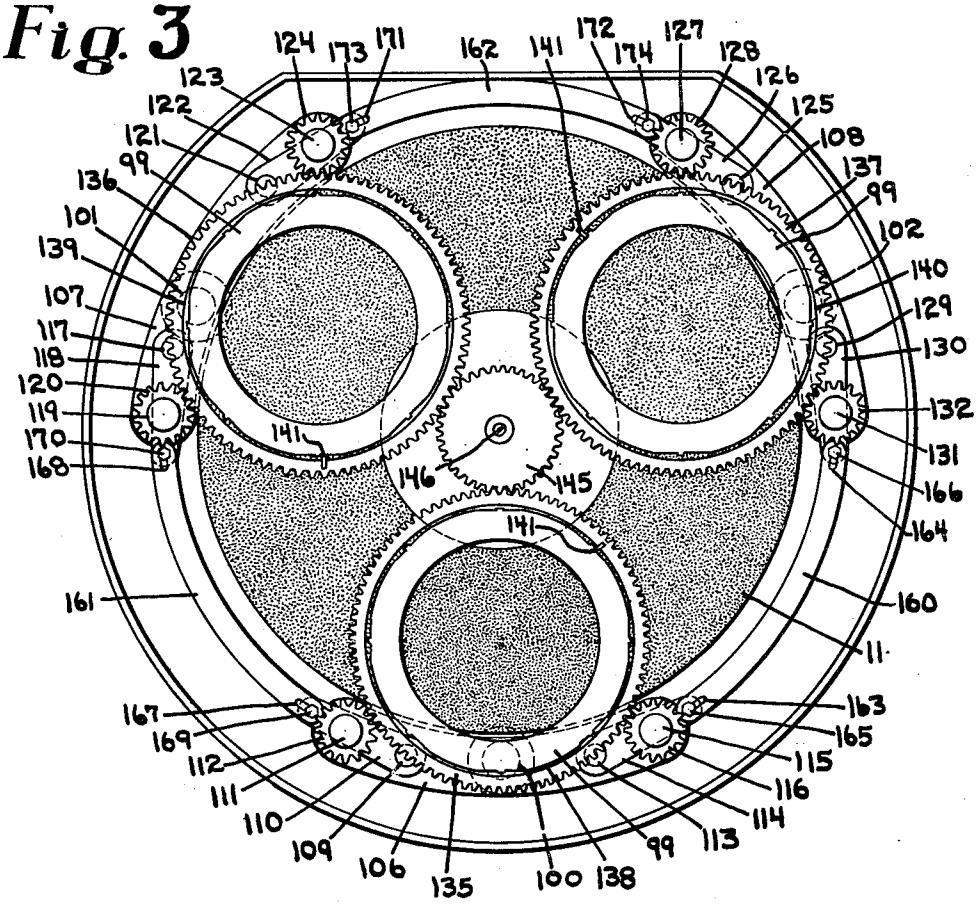
Fig. 3



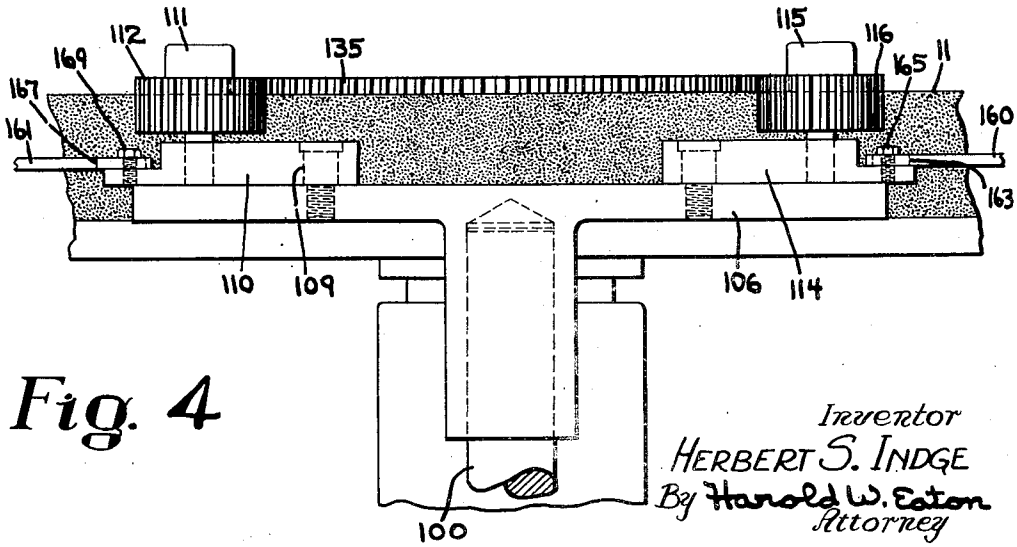


Fig. 4

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Fig. 5

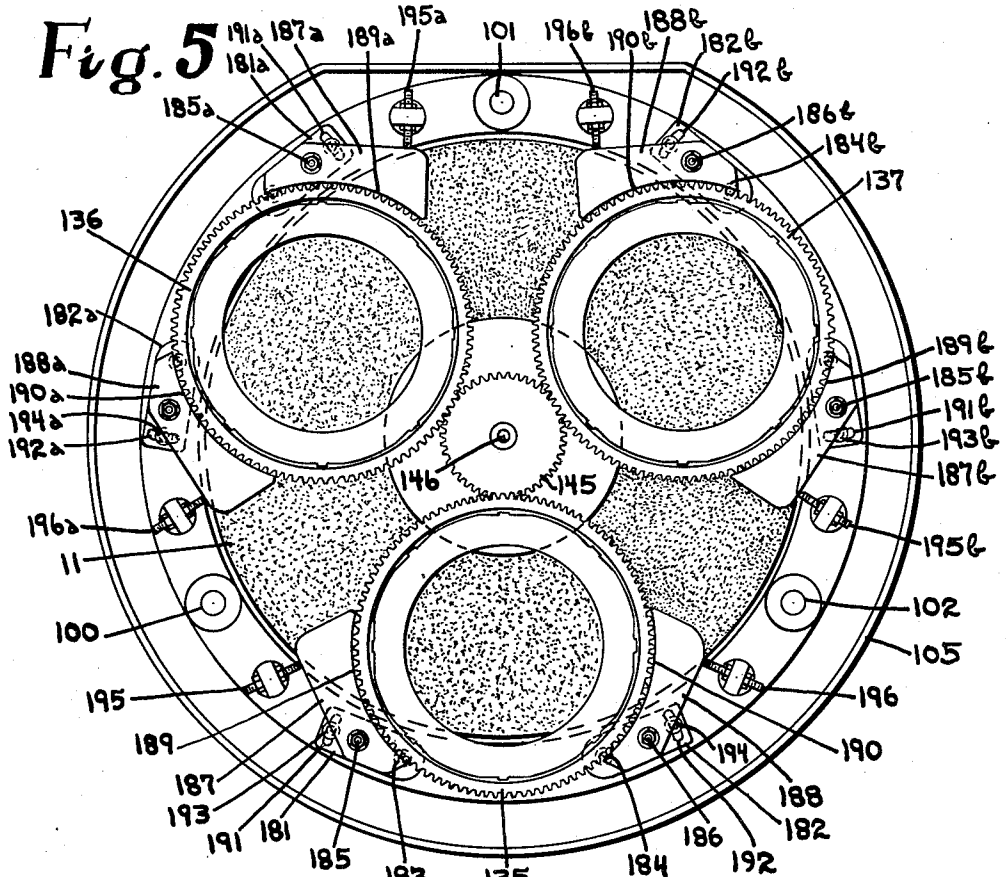
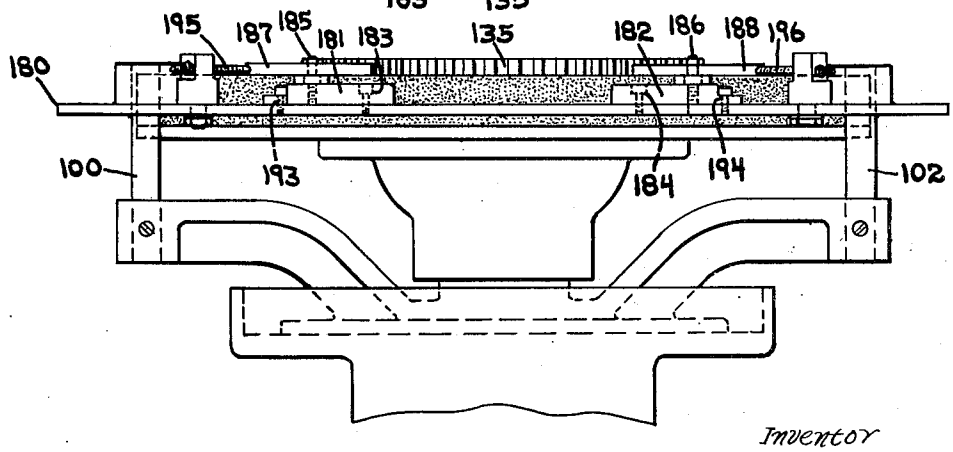


Fig. 6



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UNITED STATES PATENT OFFICE

2,618,911

LAPPING MACHINE

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Application July 8, 1950, Serial No. 172,741

8 Claims. (Cl. 51—118)

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The invention relates to lapping machines and more particularly to a machine for automatically lapping the opposite faces of relatively large diameter, relatively thin workpieces to a predetermined size and finish.

One object of the invention is to provide a simple and thoroughly practical lapping machine for lapping the opposite plane faces of relatively large diameter thin workpieces. Another object of the invention is to provide a lapping machine having two opposed lapping wheels and a work cage therebetween including a plurality of positively driven workholder members for rotating the workpieces during a lapping operation. Another object of the invention is to provide a work cage mechanism comprising a plurality of ring gear workholders having central apertures to support the workpieces to be lapped. Another object of the invention is to provide a work cage driving mechanism comprising a central driving gear for imparting a simultaneous rotation to a plurality of workholders and to provide idler supports for maintaining the workholders in driving relationship with the central gear. 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 vertical sectional view through the lapping machine;

Fig. 2 is a vertical sectional view, on an enlarged scale, through the lower lapping wheel, the work cage, and the supporting and driving mechanisms therefor;

Fig. 3 is a fragmentary plan view of the lower lapping wheel and the work cage mechanism;

Fig. 4 is a fragmentary elevation, on an enlarged scale, of the work cage mechanism as shown in Fig. 3;

Fig. 5 is a fragmentary plan view of a modified form of the work cage mechanism; and

Fig. 6 is a fragmentary elevation of the work cage mechanism as shown in Fig. 5.

The lapping machine illustrated in the drawings in its general aspects is similar to the lapping machine disclosed in my prior U. S. Patent No. 2,103,984 dated December 28, 1937. This machine, as illustrated, may comprise a base 10

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which rotatably supports a lower lapping wheel 11. The base 10 is provided with an upwardly extending column 12 having an outwardly extending hollow portion 13 which rotatably supports a vertical spindle 14. The spindle 14 is provided at its lower end with a supporting plate 15 which carries an upper lapping wheel 16. The lapping wheels 11 and 16 are each provided with plane operative opposed faces for simultaneously lapping the opposite sides of a plurality of workpieces.

Power may be obtained from any suitable source, such as an overhead drive shaft, or an electric motor mounted on or adjacent to the machine. For the sake of illustration, a belt drive has been shown comprising a driving belt 20 which serves to rotate a pulley 21 which is rotatably mounted on a horizontally arranged shaft 22. The shaft 22 is journalled in bearings 23, 24, 25, and 26 which are supported in the base 10. The inner portion of the pulley 21 is formed as one part of a cone clutch. A slidably mounted cone-shaped clutch member 27 is keyed on the shaft 22 and serves to cooperate with the clutch face formed within the pulley 21 to transmit power from the driving belt 20 to the shaft 22. When the clutch is in the full line position as shown in Fig. 1, no power is transmitted to the shaft 22. When it is desired to rotate the shaft 22, the clutch member 27 is moved toward the right (Fig. 1) into engagement with the clutch member within the pulley 21 so as to cause a rotation of the shaft 22. In order that the clutch may be readily operated from the front of the machine, a pivotally mounted control lever 28 is supported on a stud 29 on the base 10. The lower end of the lever 28 is connected by a pin 30 with a link 31 which is in turn connected with a slide rod 32 supported in bearings 33 and 34 mounted on the base 10. A yoked member 35 is mounted on the right-hand end of the slide rod 32 and engages a groove 36 formed in the hub 37 of the clutch member 27. By movement of the control lever 28 in a counter-clockwise direction, the clutch member 27 may be thrown into engagement with the clutch member within the pulley 21 to cause rotation of the shaft 22. A spring pressed roller 38 cooperating with an arrow point 39 on the yoked member 35 serves to hold the clutch parts either into or out of engagement.

The shaft 22 is provided with a worm 45 which meshes with a worm gear 46 mounted on the lower end of a vertical shaft 47. The shaft 47 is connected by a universal joint 48 with a ver-

tical shaft 49. The shaft 49 is preferably a telescopic shaft and is connected by a universal joint 50 with a vertical shaft 51. The shaft 51 is supported in a pair of spaced bearings 52 and 53 carried by an adjustably mounted bracket 54 which is supported on top of the column 12. The shaft 51 is provided with a pulley 55 which is connected by driving belts 56 with a pulley 57 which is keyed on a rotatable sleeve 58. The sleeve 58 is slidably keyed by means of keys 59 to an upwardly extending projection 60 of the spindle 14, so that when the clutch 27 is engaged, the vertical spindle supporting the upper lapping wheel 16 will be rotated.

The bracket 54 is adjustably mounted on the upper surface of the column 12 and is provided with a screw adjustment comprising a screw 62 which is rotatably supported in a bracket 63 fixed to the column 12 and is screw threaded into the bracket 54, so that the bracket 54 may be adjusted transversely of the machine to obtain the desired drive tension on the belts 56.

The lower lapping wheel 11 is mounted on a rotatable spider 65 which is keyed to the upper end of a rotatable sleeve 66. The sleeve 66 is journalled in bearings 67 and 68 which are in turn supported within a housing 69 fixedly mounted on the base 10. The lower end of the sleeve 66 supports a worm gear 70 which meshes with a worm 71 mounted on the shaft 22. It will be readily apparent from the foregoing disclosure that rotary motion of the shaft 22 will be imparted through the driving mechanism above described to impart a rotary motion to the upper lapping wheel 16 and the lower lapping wheel 11 to rotate the lapping wheels in opposite directions.

A suitable counter-balance mechanism is provided to counter-balance the weight of the upper lapping wheel 16 and its supporting mechanism. This mechanism may comprise a counter-balance weight 75 which is connected by means of a link chain 76 with a sprocket 77 rotatably supported on a shaft 78. The shaft 78 also supports a second sprocket, not shown, which is connected by a link chain 79 with a sprocket 80 mounted on a shaft 81. The shaft 81 supports a small gear 82 which meshes with a rack bar 83 fastened to a vertically movable sleeve 84. The sleeve 84 is provided with bearings 85 and 86 rotatably to support the vertical spindle 14. This counter-balance mechanism is identical with that shown and fully described in my prior U. S. Patent No. 2,103,984 dated December 28, 1937, to which reference may be had for details of disclosure not contained herein.

In order to limit the downward movement of the upper lapping wheel 16, a suitable stop mechanism is provided positively to limit the downward movement of the lapping wheel so that it bears a definite and predetermined relationship with the lower lapping wheel and work. This stop mechanism may comprise a stop stud 90 which is carried by a bracket 91 fixedly mounted on a housing 92 which supports the sleeve 84. An adjustable stop screw 93 is carried by a bracket 94 which is adjustably supported on the sleeve 84, a plurality of threaded holes 95 being provided on the sleeve 84 to facilitate vertically adjusting the bracket 44 relative to the sleeve 84 in setting up the machine for lapping a predetermined workpiece. A micrometer adjusting knob 96 is provided for the adjustably mounted stop 93 to facilitate a precise adjustment of the stop 93 to determine the lowermost position of the upper lapping wheel 16.

A work cage mechanism is provided for simultaneously supporting and lapping a plurality of relatively large diameter relatively thin workpieces 99. This cage mechanism is supported by three vertically extending studs 100, 101 and 102 (Fig. 3) which are supported in bosses 103 and 104 formed integral with a pan 105. Only two of these supporting bosses have been illustrated in Fig. 2. The studs 100, 101 and 102 support arcuate shaped plates 106, 107 and 108 respectively. The plate 106 is provided with a stud 109 which supports a rock arm 110 having a stud 111 rotatably to support an idler gear 112. Similarly the plate 106 is provided with a stud 113 which supports a rock arm 114 carrying a stud 115 rotatably to support an idler gear 116. The arcuate shaped plate 107 is provided with a stud 117 which supports a rock arm 118 having a stud 119 rotatably to support an idler gear 120. The plate 107 also is provided with a stud 121 supporting a rock arm 122 carrying a stud 123 rotatably to support an idler gear 124. The plate 108 is provided with a stud 125 supporting a rock arm 126 having a stud 127 rotatably to support an idler gear 128. The plate 108 also is provided with a stud 129 supporting a rock arm 130 having a stud 131 rotatably to support an idler gear 132.

A plurality of workholders or cages are provided comprising annular gear-type workholders 135, 136 and 137 provided with central apertures 138, 139 and 140 respectively each being arranged to support a workpiece 99 for a lapping operation. Each of the ring gears or cages 135, 136 and 137 is provided with a work driving stud 141 so that the workpiece supported thereby will be rotated with the cage supporting the same.

A suitable driving mechanism is provided for the work cages 135, 136 and 137 comprising a central driving gear 145 which is fixedly supported on a boss 146. The boss 146 is formed integral with a cup-shaped member 147 which is slidably keyed on an enlarged portion 148 of a central driving shaft 149. The drive shaft 149 is supported at its upper end by an anti-friction bearing 150 and at its lower end by means of a sleeve-type bearing 151. A gear 152 is keyed on the lower end of the rotatable sleeve 66. The gear 152 meshes with a gear 153 which is keyed on a rotatable shaft 154. A gear 155 is keyed on the lower end of the shaft 154 and meshes with a gear 156 keyed on the lower end of the shaft 149. It will be readily apparent from the foregoing disclosure that rotary motion of the worm 71 will be imparted through the gear mechanism just described to rotate the shaft 149 and the driving gear 145 to impart a rotary motion to the workholders 135, 136 and 137. The gears 112, 116, 120, 124, 128 and 132 serve as idler gears which mesh with the work cages which mesh with the gear teeth formed on the peripheries of the workholders or cages 135, 136 and 137 and maintain the holders in driving mesh with the driving gear 145.

In order to adjust the idler gears to maintain them in the proper relationship with the work cages, a plurality of arcuate shaped links 160, 161 and 162 are provided to adjustably connect with the rock arm supporting the idlers. The arcuate shaped link 160 is provided with elongated slots 163 and 164 located adjacent to its opposite ends. Clamping screws 165, 166 pass through the elongated slots 163 and 164 respectively and are screw threaded into the rock arms

114 and 130 respectively. Similarly the arcuate shaped link 161 is provided with elongated slots 167 and 168. Clamping screws 169 and 170 pass through the elongated slots 167 and 168 and are screw threaded into the rock arms 110 and 118 respectively. Similarly the arcuate shaped link 162 is provided with elongated slots 171 and 172. Clamping screws 173 and 174 pass through the elongated slots 171 and 172 respectively and are screw threaded into the rock arms 122 and 126 respectively. It will be readily apparent that by adjusting the position of the rock arms to position the idler gears into proper mesh with the gear teeth on the peripheries of the workholders or cages 135, 136 and 137 after which the clamping screws above described are clamped to clamp the arcuate shaped links 160, 161 and 162 so as to hold the rock arms 114, 110, 118, 122, 126 and 130 with their idler gears in the desired meshing engagement with the workholder or cage gear teeth.

A modified form of support for the workholders or cages 135, 136 and 137 has been illustrated in Figs. 5 and 6. In this construction the vertical rods 100, 101 and 102 serve as a support for an annular ring 180. The ring 180 serves as a support for a plurality of rock arms 181, 182 which are pivotally supported by means of studs 183 and 184 carried by the ring 180. The rock arms 181 and 182 are provided with studs 185 and 186 respectively which support pivotally mounted shoes 187 and 188 respectively. The shoes 187 and 188 are provided with partial cylindrical surfaces 189 and 190 respectively which are shaped to mate with and engage the outer peripheral surfaces of the teeth formed on the workholder 135. The rock arms 181 and 182 are provided with elongated slots 191 and 192 respectively. Clamping screws 193 and 194 pass through the elongated slots 191 and 192 and are screw threaded into the ring 180. It will be readily apparent from the foregoing disclosure that the rock arms 181 and 182 may be swung about their supporting pivots 183 and 184 respectively so as to vary the position of the pivot studs 185 and 186 respectively thereby varying the position of the shoes 187 and 188 respectively. A pair of stop screws 195 and 196 are carried by the ring 180. The stop screws 195 and 196 are each provided with lock nuts and serve to steady and hold the shoes 187 and 188 respectively in predetermined adjusted positions. It will be readily apparent from the foregoing disclosure that by adjustment of the position of the pivot studs 185 and 186 and by adjustment of the stop screws 195 and 196, the shoes 187 and 188 may be readily adjusted into supporting engagement with the workholder 135.

Similar adjustably mounted shoes 187*a* and 188*a* are provided for supporting the periphery of the gear teeth on the work cage or holder 136. The supports and adjustments for the shoes 187*a* and 188*a* are identical with those described in connection with shoes 187 and 188. These corresponding parts have been identified by the same numerals with the suffix "*a*". A description of the details of these supporting members is not deemed necessary since they operate identical with those previously described. Similarly pivotally mounted adjustable shoes 187*b* and 188*b* are provided for engaging the peripheries of gear teeth formed on the work cage or holder 137. The corresponding parts for supporting the shoes 187*b* and 188*b* are identical with those described in connection with the shoes 187 and 188 and have been designated by the same numerals with the suffix "*b*." These parts similarly have not been described in detail since they are identical with those described in connection with shoes 187 and 188.

The operation of the improved lapping machine will be readily apparent from the foregoing disclosure. Assuming the parts to have been previously adjusted, three workholders 135, 136 and 137 are placed in operative position in mesh with the driving gear 145 and supported either by idler gears as shown in Fig. 3 or by pairs of peripherally engaging shoes as shown in Fig. 5. Workpieces 99 to be lapped on opposite flat faces are then placed one in each workholder. The machine is set in motion, by engagement of the clutch 27, to start the rotation of the upper lapping wheel 16 and the lower lapping wheel 11 in opposite directions. The upper lapping wheel 16 is then moved downwardly into operative engagement with the upper faces of the workpieces by a hydraulically operated mechanism such as for example that shown in my prior U. S. Patent No. 2,103,984 dated December 28, 1937 to which reference may be had for details of disclosure not contained herein. The downward movement of the upper lapping wheel 16 continues under pressure until the stop screw 93 engages the stop surface 90 during which time the work cages or holders 135, 136 and 137 will be continuously rotated so that the opposite flat faces of the workpieces 99 will be lapped to the desired and predetermined extent. After the lapping operation has been completed, the upper lapping wheel 16 may again be raised to an inoperative position so that the lapped workpieces 99 may be readily removed from the workholders 135, 136 and 137 after which new workpieces may be inserted therein.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinabove 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 embodiments 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 lapping machine having a base, a pair of opposed axially-aligned lapping wheels supported on said base having opposed plane operative faces, a driving mechanism supported on said base and operatively connected positively to rotate said wheels, and a work cage therebetween for supporting a plurality of relatively large diameter relatively thin flat workpieces comprising a plurality of positively driven ring-type workholders having central work receiving apertures, a central positively rotated driving gear rotatably supported on the base which meshes with all of said workholders, and independently adjustable members supported on said base adjacent to the periphery of the work holders, each of said members having a surface mating with the periphery of a work holder to maintain them in mesh with the central driving gear during a lapping operation.

2. In a lapping machine, as claimed in claim 1, in combination with the parts and features therein specified in which the independent adjustable means includes an annular ring on said

base surrounding the lower lapping wheel and having an adjustably mounted shoe pivotally supported on said ring, said shoe having an arcuate surface shaped for engaging the periphery of each of the work holders, and means including an independent adjusting screw on said ring to adjust each of said shoes to maintain the work holders in meshing engagement with the central driving gear during a lapping operation.

3. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified of an annular ring surrounding the lower lapping wheel and supported by said base, means including a pair of spaced adjustably mounted shoes supported on the ring, said shoes having an arcuate surface shaped for engaging the periphery of each of the work holders, and means including independent adjusting screws on said ring to adjust each of said shoes to maintain the work holders in meshing engagement with the central driving gear during a lapping operation.

4. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified an annular ring surrounding the lower lapping wheel and supported by said base, a pivotally mounted shoe supported by the ring, said shoe having an arcuate surface shaped for engaging the periphery of each of the work holders, and means including an adjusting screw on said ring to adjust the shoe relative to said ring so as to maintain the work holders in meshing engagement with a central driving gear during a lapping operation.

5. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified an annular ring surrounding the lower lapping wheel and supported by said base, a pair of independent spaced pivotally mounted shoes supported by the ring, said shoes having an arcuate surface shaped for engaging the periphery of each of said work holders, and means including independent adjusting screws on said ring independently to adjust said shoes relative to said ring so as to maintain the work holders in meshing engagement with the central driving gear during a lapping operation.

6. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified of means including a plurality of independent adjustably mounted idler gears supported by the base and positioned in mesh with said work holders, and means independently to adjust each of said idler gears relative to said base to maintain the work holders in meshing engagement with the central driving gear during a lapping operation.

7. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified of means including a plurality of pairs of spaced idler gears surrounding the lower lapping wheel and positioned in mesh with each of said work holders at points spaced from the central driving gear, a pivotally mounted arm on said base for supporting each of said idler gears, and means to adjust the position of said arms and idler gears to maintain the work holders in meshing engagement with the driving gear during a lapping operation.

8. In a lapping machine as claimed in claim 1, in combination with the parts and features therein specified of means including a plurality of pairs of spaced idler gears, a plurality of pivotally supported arms on said base surrounding the lower lapping wheel, each of said arms supporting one of said idler gears in mesh with one of the work holders at points spaced from the central driving gear, and means including adjustably mounted links connecting the ends of adjacent arms to facilitate adjusting the position of the idler gears so as to maintain the work holders in meshing engagement with the driving gear during a lapping operation.

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