Feb. 21, 1967 S. A. BOETTCHER 3,304,662

APPARATUS FOR LAPPING

Filed April 28, 1964 8 Sheets-Sheet 1

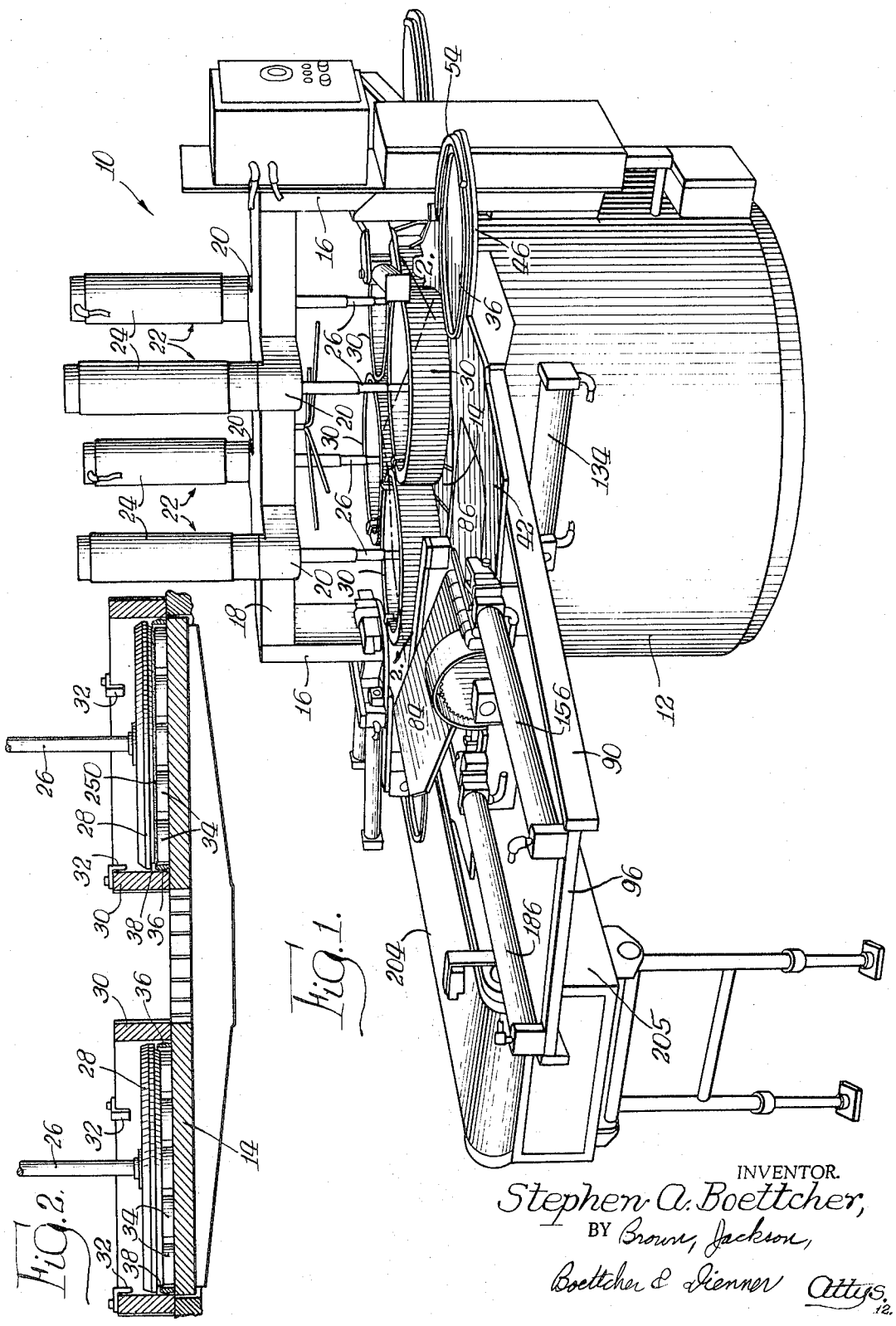

FIG. 1.

FIG. 2.

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APPARATUS FOR LAPPING

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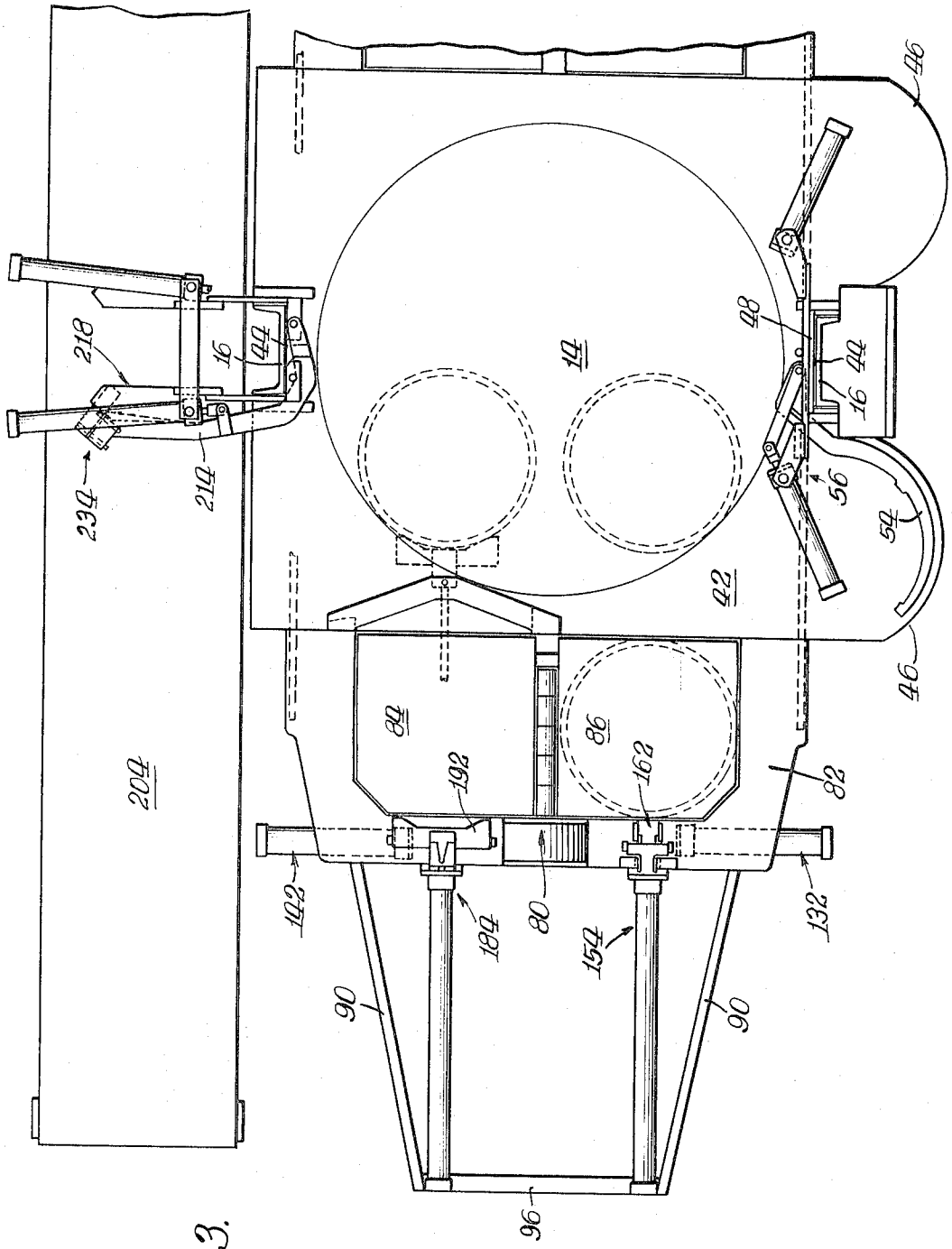

FIG. 3.

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APPARATUS FOR LAPPING

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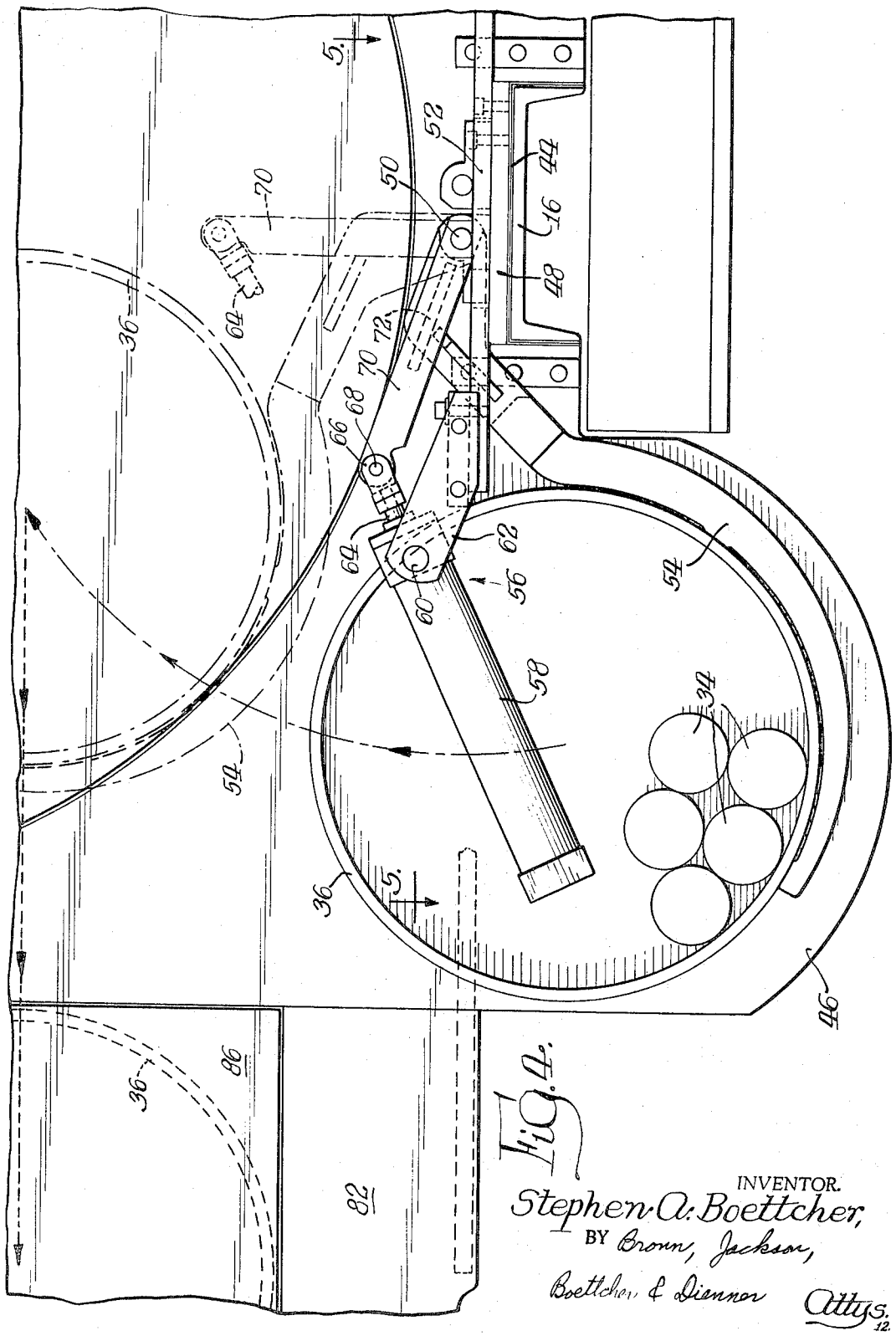

FIG. 4.

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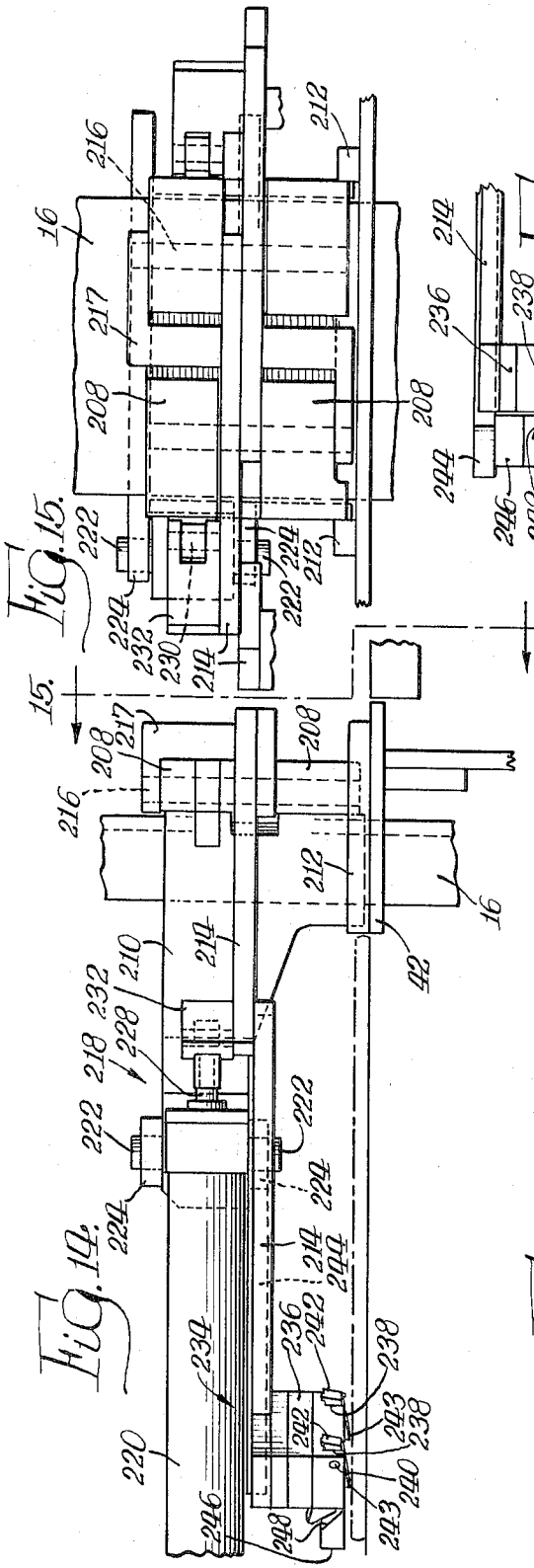

FIG. 15.

FIG. 14.

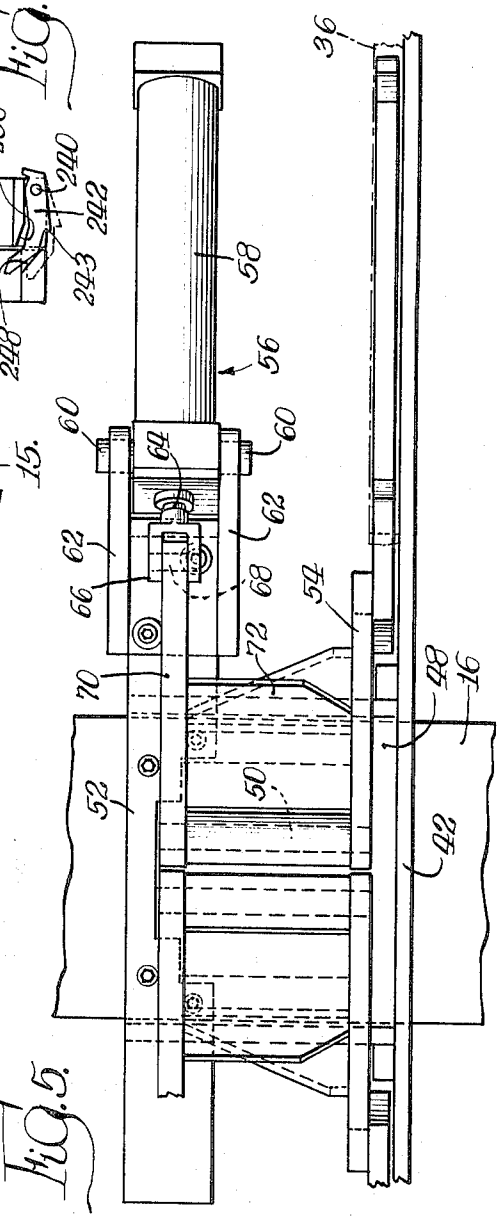

FIG. 16.

FIG. 5.

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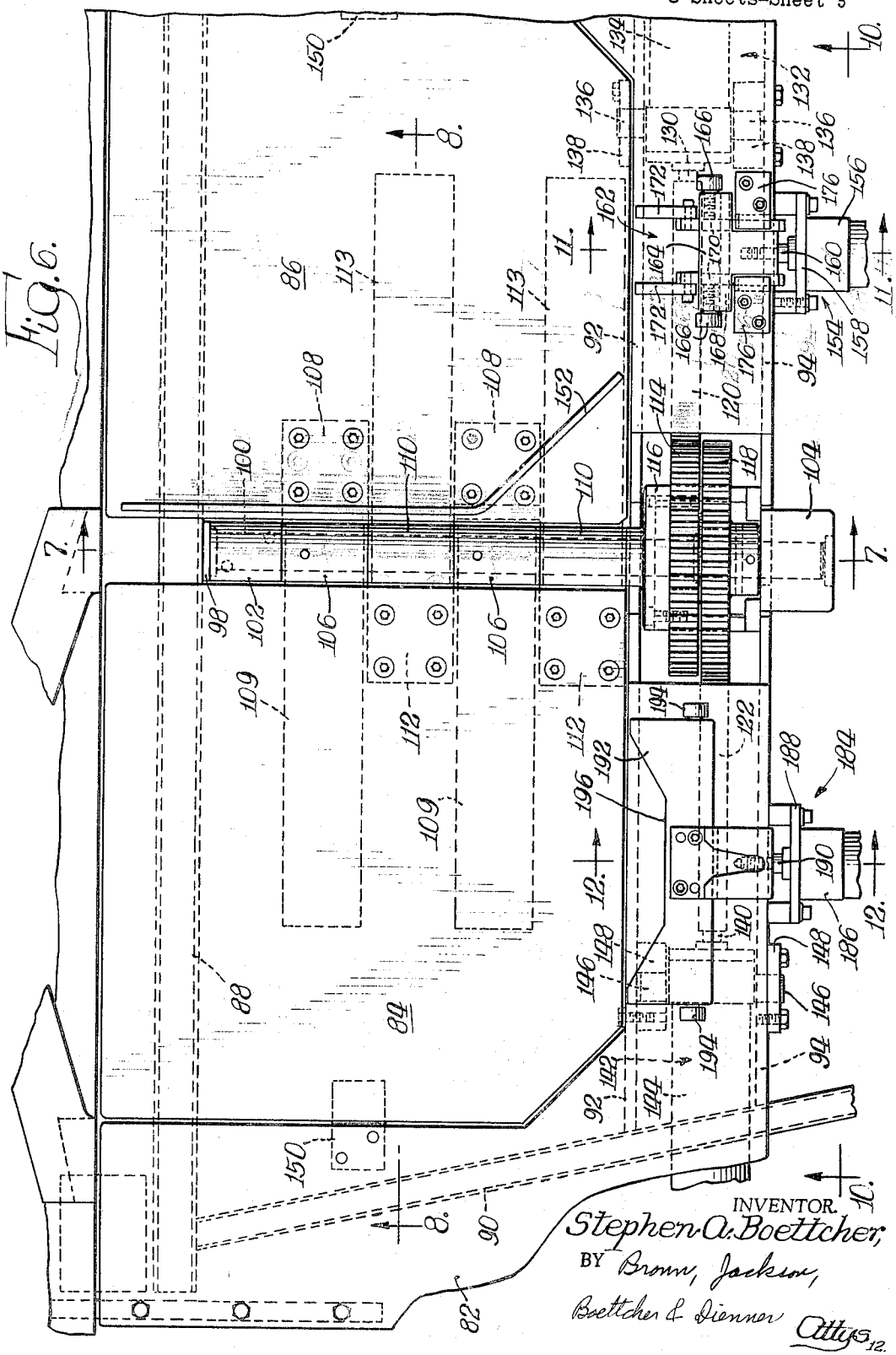
FIG. 6.



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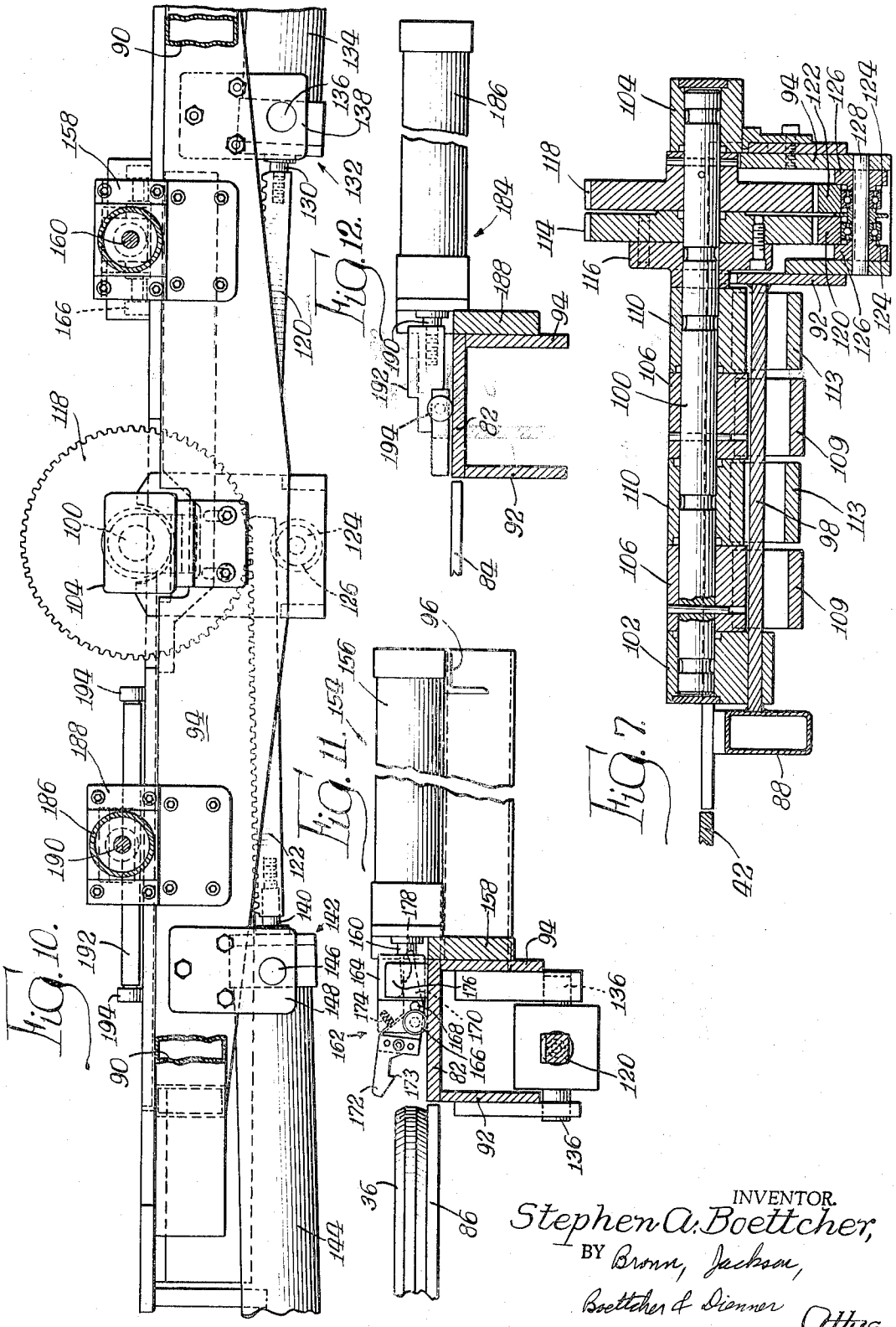

FIG. 10.

FIG. 12.

FIG. 11.

FIG. 7.

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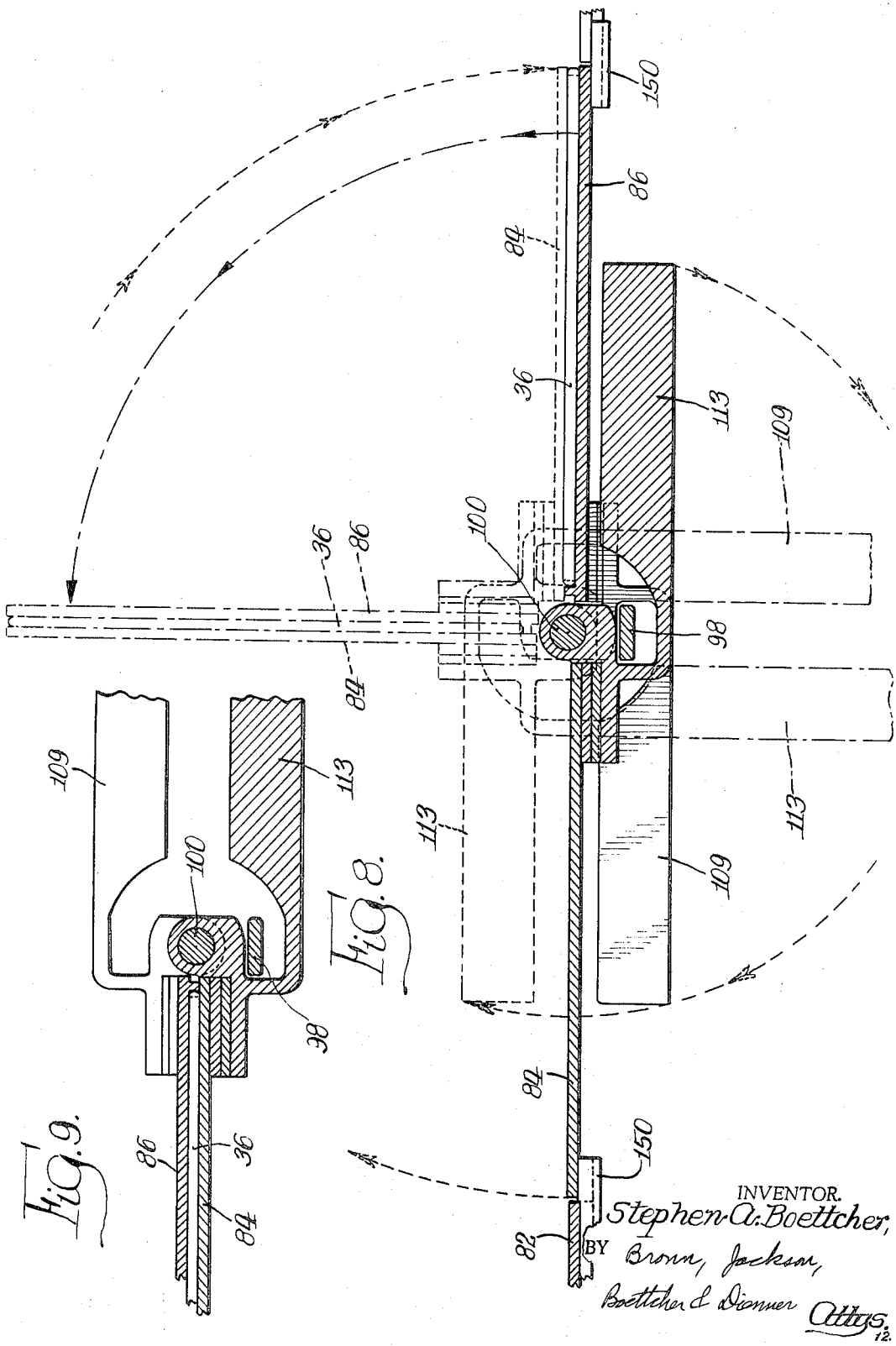

FIG. 8.

FIG. 9.

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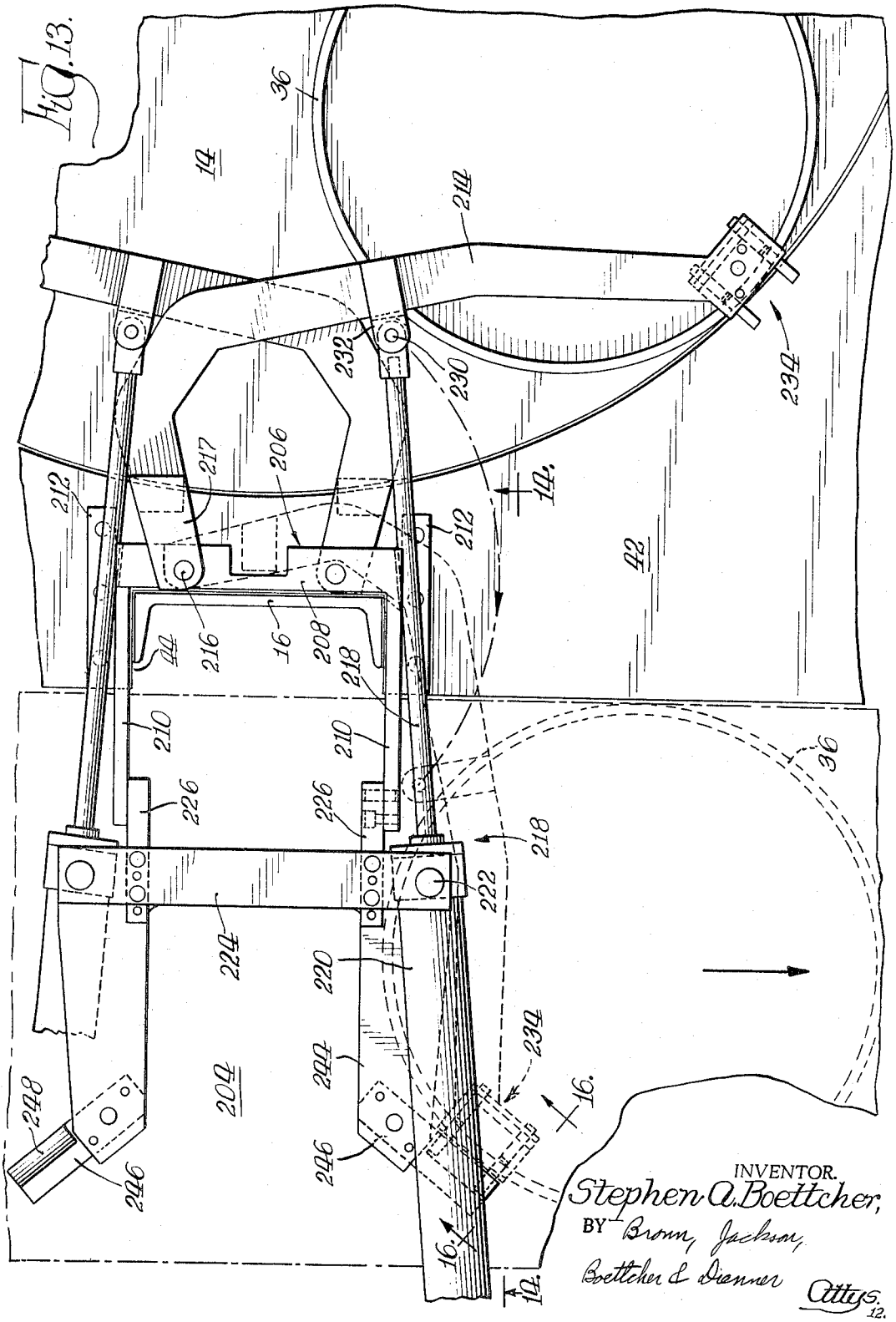

United States Patent Office 3,304,662 Patented Feb. 21, 1967

3,304,662

APPARATUS FOR LAPPING

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Filed Apr. 28, 1964, Ser. No. 363,196
17 Claims. (Cl. 51—131)

My present invention relates to apparatus for automatically lapping work pieces. The method described herein is claimed in a divisional application, Serial No. 591,047, filed August 19, 1966.

The general type of lapping machine with which the principles of my present invention may be incorporated includes an annular lapping disc, which is rotatably driven about a vertical axis, and on which work pieces are loaded in confined arrangement for the abrasive lapping of their surfaces by movement of the lapping disc relative to the work pieces. At the present time, work pieces to be lapped are manually moved onto the lapping disc and, after their surfaces have been lapped, are manually moved off of the lapping disc. When a group of work pieces are to be lapped on their opposite sides, the work pieces are first lapped on their one sides, then individually and manually turned over and lapped on their other sides. These procedures are time consuming and expensive.

It is an object of my present invention to provide apparatus for loading and unloading work pieces to and from the lapping disc of a lapping machine.

It is another object of my present invention to provide apparatus for inverting work pieces which have been lapped on their one sides so that they are in position to be lapped on their other sides.

It is another object of my present invention to provide apparatus for lapping a plurality of adjacently located work pieces on their one sides until the latter are flat, inverting the work pieces as a group, and lapping the work pieces on their other sides until the latter are parallel to the one sides thereof and the work pieces are of the desired thickness.

It is a further object of my present invention to provide apparatus for successively moving a plurality of adjacently located work pieces from a first loading station to a lapping disc where the work pieces are lapped on their one sides, moving the work pieces from the lapping disc to a first receiving station, inverting the work pieces and moving them from the first receiving station to a second loading station, moving the work pieces from the second loading station to the lapping disc where the work pieces are lapped on their other sides, and moving the work pieces from the lapping disc to a second receiving station.

It is a still further object of my present invention to provide apparatus for automatically loading and unloading substantially simultaneously at least two individual groups of adjacently located work pieces to and from a lapping machine.

Now in order to acquaint those skilled in the art with the manner of constructing and using apparatus in accordance with the principles of my present invention, I shall describe in connection with the accompanying drawings, a preferred embodiment of my invention.

In the drawings:

FIGURE 1 is a perspective view of a lapping machine incorporating the principles of my present invention;

FIGURE 2 is a partial vertical sectional view, taken substantially along the line **2—2** in FIGURE 1, looking in the direction indicated by the arrows;

FIGURE 3 is a partial plan view, with portions of the upper framework removed, of the lapping machine of FIGURE 1;

FIGURE 4 is an enlarged fragmentary plan view of

a portion of the apparatus of FIGURE 3 showing the power actuated arm means at the first loading station;

FIGURE 5 is a fragmentary elevational view of the power actuated arm means of FIGURE 4, taken substantially along the line **5—5** in FIGURE 4, looking in the direction indicated by the arrows;

FIGURE 6 is an enlarged fragmentary plan view of a portion of the apparatus of FIGURE 3 showing the inverting means, the power actuated engaging means at the first receiving station, and the power actuated pusher means at the second loading station;

FIGURE 7 is a vertical sectional view, taken substantially along the line **7—7** in FIGURE 6, looking in the direction indicated by the arrows;

FIGURE 8 is a vertical sectional view, taken substantially along the line **8—8** in FIGURE 6, looking in the direction indicated by the arrows;

FIGURE 9 is a fragmentary sectional view showing the parts of FIGURE 8 in an intermediate operative position;

FIGURE 10 is a fragmentary elevational view of the mechanism of FIGURE 6, taken substantially along the line **10—10** in FIGURE 6, looking in the direction indicated by the arrows;

FIGURE 11 is a vertical sectional view, taken substantially along the line **11—11** in FIGURE 6, looking in the direction indicated by the arrows;

FIGURE 12 is a vertical sectional view, taken substantially along the line **12—12** in FIGURE 6, looking in the direction indicated by the arrows;

FIGURE 13 is an enlarged fragmentary plan view of a portion of the apparatus of FIGURE 3 showing the power actuated arm means at the second receiving station;

FIGURE 14 is a fragmentary elevational view of the power actuated arm means of FIGURE 13, taken substantially along the line **14—14** in FIGURE 13, looking in the direction indicated by the arrows;

FIGURE 15 is a fragmentary elevational view of the power actuated arm means of FIGURES 13 and 14, taken substantially along the line **15—15** in FIGURE 14, looking in the direction indicated by the arrows; and

FIGURE 16 is a fragmentary elevational view of the latch mechanism of the power actuated arm means of FIGURE 13, taken substantially along the line **16—16** in FIGURE 13, looking in the direction indicated by the arrows.

Referring now to FIGURE 1, there is indicated generally by the reference numeral **10** a lapping machine incorporating the principles of my present invention. The lapping machine **10** comprises framework including a tubular base or housing **12** which provides support for a horizontal annular lapping disc **14**. Selective rotation of the lapping disc **14** about a vertical axis is effected by suitable drive means (not shown) mounted within the housing **12**. For details concerning one form of drive means for the lapping disc **14**, reference may be made to United States Patent No. 2,869,294, issued January 20, 1959. Suitably secured to the opposite sides of the housing **12** are the lower ends of vertical columns **16**. Extending between the upper ends of the columns **16**, above the lapping disc **14**, is a horizontal bridge member **18** provided with transverse arms **20** which number four in the particular lapping machine herein disclosed. Mounted at the outer ends of each of the transverse arms **20** is a vertical pneumatic piston and cylinder assembly indicated generally by the reference numeral **22**. Each of the pneumatic assemblies **22** includes a cylinder **24** and a piston rod **26**.

As shown in FIGURE 2, the lower ends of the piston rods **26** are secured to horizontal pressure plates **28**. The pressure plates **28** fit, with slight clearance, within truing

and retaining rings **30** engageable with the lapping disc **14**. When the lapping disc **14** is rotated, the truing rings **30** rotate relative to the pressure plates **28** about the axes defined by the piston rods **26** whereby to dress the lapping disc **14** for maintenance of its planar condition. A plurality of lugs **32** are secured to the upper edges of each of the truing rings **30** and project radially inwardly and axially downwardly therefrom. When the pressure plates **28** are raised, they engage the free ends of the lugs **32** thereby raising the truing rings **30** from the lapping disc **14**.

Raising of the pressure plates **28** and the associated truing rings **30** is effected by introducing air under pressure into the lower ends of the cylinders **24**. Conversely, lowering of the pressure plates **28** and the associated truing rings **30** is effected by relieving the air pressure at the lower ends of the cylinders **24** and introducing air under pressure into the upper ends of the cylinders **24**. When work pieces **34** are moved into the confines of the truing rings **30** below the pressure plates **28**, air under pressure introduced into the upper ends of the cylinders **24** serves to impose a downward force or pressure on the pressure plates **28** and, in turn, on the work pieces **34**. In accordance with the principles of my present invention, the work pieces **34** are confined within annular retaining members **36** which are receivable within the truing rings **30**. The pressure plates **28** are each formed with an annular recess **38** to accommodate the retaining members **36**.

Surrounding the lapping disc **14**, as best shown in FIGURE 3, is a planar staging table **42** which has notched out portions **44** at its opposite sides for receiving the vertical columns **16**. The staging table **42** is supported from the housing **12** through the intervention of means (not shown) for slightly raising and lowering the table relative to the lapping disc **14** to facilitate loading and unloading of work pieces to and from the lapping disc **14**. One form of raising and lowering means for a staging table is shown in United States Patent No. 2,912,799, issued November 17, 1959. The staging table **42** is formed with a pair of lateral extension portions **46** that each serve as a first loading station. At each end of the staging table **42** I provide loading and unloading apparatus that cooperates with two of the pressure plates **28** and truing rings **30**. Since the apparatus at the opposed ends of the staging table **42** are substantially identical in construction and operation, except that the components thereof are mounted in reverse relation. I shall describe in detail the apparatus at one end only of the staging table.

The power actuated arm means that I provide for moving a retaining member **36** having a plurality of work pieces **34** confined therein from the first loading station **46** onto the lapping disc **14** is supported from a generally vertical C-shaped bracket assembly **48**. As shown in FIGURES 4 and 5, the bracket assembly **48** is disposed about the adjacent column **16** and is suitably secured to the staging table **42**. The bracket assembly **48** provides support for a vertical pivot shaft **50** and a horizontal support bar **52**. Secured to the lower end of the pivot shaft **50** is the inner end of an arm member **54** having a downwardly offset arcuate outer end portion that overlies the staging table **42** closely adjacent thereto. Arcuate movement of the arm member **54** about the axis of the pivot shaft **50** is effected by means of a pneumatic piston and cylinder assembly indicated generally by the reference numeral **56**. The pneumatic assembly **56** includes a cylinder **58** pivotally supported, at its forward end, by means of opposed pin members **60** journaled in a pair of vertically spaced strap members **62** secured to the upper and lower edges of the horizontal support bar **52**. The pneumatic assembly **56** further includes a piston rod **64** having an outer yoke portion **66** pivotally mounted, as at **68** to the outer end of a lever **70** which, at its inner end, is secured to the pivot shaft **50** at the upper

end thereof. The inner end of the arm member **54** and the lever **70** are interconnected by means of a web member **72**.

When air under pressure is admitted to the rear end of the cylinder **58** the piston rod **64** is distended which causes clockwise pivotal movement of the lever **70** and arm member **54** from the position shown in solid lines in FIGURE 4 to the position shown in dot-dash lines. During such pivotal movement of the arm member **54**, the retaining member **36** and work pieces **34** therein at the first loading station **46** are moved therefrom onto the lapping disc **14** where the work pieces may be lapped on their one sides. When air under pressure is admitted to the forward end of the cylinder **58**, the piston rod **64** is retracted causing counter-clockwise pivotal movement of the lever **70** and arm member **54** from the dot-dash line position to the solid line position.

In order that work pieces which have been lapped on their one sides may be turned over automatically so that they are in position to be lapped on their other sides, I provide inverting means indicated generally by the reference numeral **80** in FIGURE 3. The inverting means **80**, which is mounted in an extension portion **82** of the staging table **42**, comprises a pair of platens **84** and **86** disposed side by side in initial horizontal positions and pivotally mounted along adjacent edges for swinging movement in a manner to be presently described. The extension portion **82** is rigidly secured to, and vertically movable with, the staging table **42**.

Secured to the underside of the staging table extension **82**, as shown in FIGURES 3 and 6, are a forward transverse frame member **88**, a pair of rearwardly extending side frame members **90**, and a pair of transverse laterally spaced frame members **92** and **94**. The ends of the side frame member **90** that projects beyond the staging table extension **82** are interconnected by a rear transverse frame member **96**. As shown in FIGURE 7, the transverse frame members **88** are interconnected intermediate of their ends by a strap member **98**. Overlying the strap member **98** is a rotatable shaft **100** which, at its forward end, is journaled in a bearing block **102** carried by the strap member **98**, and, at its rearward end, is journaled in a bearing block **104** carried by the transverse frame member **94**. Secured to the rotatable shaft **100**, as shown in FIGURES 6, 7 and 8, are a pair of laterally spaced hinge members **106** which have flange portions **108** secured to the underside of the platen **86** and counterweight extension bars **109** normally underlying the platen **84**. By reason of this mounting arrangement, the platen **86** pivots upon rotation of the shaft **100** and is counterbalanced by the extension bars **109**. Arranged alternately with respect to the hinge members **106**, and rotatably mounted on the shaft **100**, are a pair of hinge members **110** which have flange portions **112** secured to the underside of the platen **84** and counterweight extension bars **113** normally underlying the platen **86**. Thus, the platen **84** is mounted for pivotal movement relative to the shaft **100** about the horizontal axis thereof and is counter-balanced by the extension bars **113**.

As shown in FIGURES 6, 7 and 10, pivotal movement of the platens **84** and **86** is adapted to be effected by means of power actuated rack and pinion means mounted intermediate of the transverse frame members **92** and **94**. Such means comprises a pinion **114** journaled on the shaft **100** and secured to a disc member **116** which, in turn, is secured to the adjacent hinge member **110**, and a pinion **118** secured to the shaft **100**. The pinions **114** and **118**, at their lower sides, are respectively engaged by a pair of oppositely extending rack members **120** and **122**. The rack members **120** and **122** are maintained in engagement with the pinions **114** and **118** by means of a pair of ball bearing assemblies **124** and a pair of side spacer members **126** supported by a rod **128** extending between and carried by the traverse frame members **92** and **94**. The rack member **120** at its outer

end is secured to the piston rod 130 of a pneumatic piston and cylinder assembly indicated generally at 132. The forward end of the cylinder 134 of the pneumatic assembly 132 is pivotally supported by means of opposed lateral pin member 136 journaled in depending plate members 138 secured to the transverse frame members 92 and 94. Similarly, the outer end of the rack member 122 is secured to the piston rod 140 of a pneumatic piston and cylinder assembly indicated at 142. The forward end of the cylinder 144 of the pneumatic assembly 142 is pivotally supported by means of opposed lateral pin members 146 journaled in a pair of depending plate members 148 secured to the transverse frame members 92 and 94.

When the pneumatic assembly 132 is actuated and the piston rod 130 thereof is distended, the rack member 120 is moved to the left as viewed in FIGURES 6 and 10 thereby causing rotation of the pinion 114, disc member 116, and the adjacent hinge member 110, whereupon the platen 84 is pivoted in the direction of the platen 86 from the position shown in solid lines in FIGURE 8 to the position shown in dotted lines. Withdrawal of the piston rod 130 effects movement of the rack member 120 to the right as viewed in FIGURES 6 and 10 thus effecting counter-rotation of the pinion 114, disc member 116, and the adjacent hinge member 110, whereupon the platen 84 is pivoted back to its initial horizontal position. When the pneumatic assembly 142 is actuated and the piston rod 140 thereof is distended, the rack member 122 is moved to the right as viewed in FIGURES 6 and 10 thus causing rotation of the pinion 118 and the shaft 100, whereupon the platen 86 is pivoted in the direction of the platen 84 from the position shown in solid lines in FIGURE 8 to the position shown in FIGURE 9. When the piston rod 140 is retracted the rack member 122 is moved back to the position shown in FIGURES 6 and 10, thus effecting counter-rotation of the pinion 118 and the shaft 100, whereupon the platen 86 is returned to its initial horizontal position. Stop plates 150 are secured to the staging table extension 82 adjacent the free sides of the platens 84 and 86 to prevent swinging movement of the latter below the plane of the extension 82.

The platen 86 serves as a first receiving station for a retaining member 36 having a plurality of work pieces 34 confined therein that have had their one sides lapped on the lapping disc 14. To accomplish inversion of a retaining member and work pieces therein moved onto the platen 86, the platen 84 is swung in the direction between the platens 84 and 86, then the platens are together swung in the other direction until the platen 84 is returned to its initial horizontal position, and finally the platen 86 is returned to its initial horizontal position. To prevent the retaining member from interfering with the action of the hinge members 106 and 110 during inversion, a guide strip 152 (FIGURE 6) is secured to the surface of the platen 86.

The power actuated engaging means that I provide for moving a retaining member and work pieces therein from the lapping disc 14 onto the platen 86, as best shown in FIGURES 6 and 11, comprises a pneumatic piston and cylinder assembly indicated generally at 154. The pneumatic assembly 154 includes a cylinder 156 which, at its forward end, is secured to plate means 158 carried by the transverse frame member 94, and, at its rearward end, is secured to the transverse frame member 96. The piston rod 160 of the pneumatic assembly 154 serves to actuate latch mechanism indicated generally at 162. The latch mechanism 162 comprises a T-shaped support member 164 secured to the outer end of the piston rod 160. A pair of rollers 166 are mounted at the outer ends of the lateral arms of the T-shaped support member 164 and serve to facilitate movement of the latter over the staging table extension 82, the platen 86, and the staging table 42. Extending transversely across a recessed formed in the T-shaped support member 164 is a pin member 168 upon which is pivotally mounted a pair of laterally spaced pawl members 170. Secured to the forward ends of the pawl members 170 are latch members 172 having tongue portions 173. Arranged within the support member 164 are springs 174 that engage and serve to bias the pawl members 170 and latch members 172 in a counterclockwise direction as viewed in FIGURE 11. Secured to the staging table extension 82 adjacent the forward end of the cylinder 156 are a pair of laterally spaced block members 176 having laterally facing flange portions that define camming surfaces 178 on their undersides. When the pawl members 170 engage the camming surfaces 178, the latch members 172 are pivoted to the unlatching position shown in FIGURE 10 with the springs 174 being thereby compressed.

When the pneumatic assembly 154 is actuated and the piston rod 160 is distended, the latch mechanism 162 is moved forwardly across the staging table extension 82, the platen 86 and the staging table 42. As soon as the pawl members 170 are moved out of engagement with the camming surfaces 178 of the block members 176, the springs 174 bias the latch members 172 downwardly to their latching positions. As the latch members 172 approach a retaining member 36 on the lapping disc 14, the tongue portions 173 ride over the retaining member 36 and drop down into engagement with the inner annular surface thereof. When the piston rod 160 is now retracted, the latch mechanism 162 serves to pull the retaining member 36 and work pieces therein off of the lapping disc 14 and onto the platen 86. As the piston rod 160 approaches full retraction, the pawl members 170 engage the camming surfaces 178 of the block members 176 causing the latch members 172 to pivot upwardly and the tongue portions 173 to be moved out of engagement with the retaining member 36 thereby releasing the latter.

The platen 84 serves as a second loading station, and power actuated pusher means is provided for moving a retaining member 36 having a plurality of work pieces confined therein (which have been lapped on their one sides and inverted) from the platen 84 across the staging table 42 onto the lapping disc 14. Such pushing means, as shown in FIGURES 6 and 12, comprises a pneumatic piston and cylinder assembly indicated generally at 184. The pneumatic assembly 184 includes a cylinder 186 which, at its forward end, is secured to plate means 188 carried by the transverse frame member 94, and, at its rearward end is secured to the transverse frame member 96. The outer end of the piston rod 190 of the pneumatic assembly 184 is secured to a generally T-shaped frame member 192 supported on a pair of rollers 194 and having a recessed forward face 196. Upon actuation of the pneumatic assembly 184, the piston rod 190 is distended thereby causing forward movement of the T-shaped frame member 192 whereby a retaining member 36 and work pieces therein may be moved from the platen 84 across the staging table 42 onto the lapping disc 14. Upon retraction of the piston rod 190, the T-shaped pusher member 192 is returned to the position shown in FIGURES 6 and 12.

Referring again to FIGURES 1 and 3, there is shown alongside of the staging table 42, opposite the first loading station 46, a second receiving station in the form of a conveyor belt 204 supported on framework 205. Power actuated arm means is provided at this station for moving a retaining member 36 and work pieces therein (which have been lapped on their opposite sides) off of the lapping disc 14 across the staging table 42 and onto the conveyor belt 204. As best shown in FIGURES 13, 14 and 15, support for the power actuated arm means is provided by a generally C-shaped frame assembly 206 which comprises a pair of vertically spaced

bar members **208**, rearwardly extending side flange members **210**, and foot members **212** suitably secured to the staging table **42** at the sides of the adjacent column **16**. A generally L-shaped arm member **214** is pivotally mounted at the end of its shorter leg on the intermediate portion of a vertical rod **216** secured within the bar members **208**. To gain rigidity an angle bracket **217** is provided with one leg being secured to the arm member **214** and with the other leg being pivotally mounted on the upper end of the rod **216**. Pivotal movement of the arm member **214** about the axis of the rod **216** is effected by means of a pneumatic piston and cylinder assembly indicated generally at **218**. The cylinder **220** of the pneumatic assembly **218** is pivotally supported at its forward end, by means of opposed pin members **222** journaled in the ends of a pair of vertically spaced strap members **224** secured to brackets **226** carried by the side flange members **210**. The outer end of the piston rod **228** of the pneumatic assembly **218** is pivotally mounted by means of a pin member **230** in a boss member **232** carried by the arm member **214** intermediate of the ends thereof.

When the pneumatic assembly **218** is actuated and the piston rod **228** is distended, the arm member **214** is pivoted along an arcuate path from the position shown in dotted lines in FIGURE 13 to the position shown in solid lines. Upon retraction of the piston rod **228**, the arm member **214** is returned from the solid line position shown in FIGURE 12 to the dotted line position. The arm member **214** is spaced vertically above the staging table **42** and carries at its outer end latch mechanism indicated generally by the reference numeral **234**. The latch mechanism **234**, as shown in FIGURES 14 and **16**, comprises a depending support member **236** which is provided with laterally spaced recesses **238** in its underside. Pivotally mounted on a horizontal pin **240** extending transversely of the recesses **238** are a pair of latch members **242** having tongue portions **243**. The latch members **242**, due to gravity, normally assume the position shown in dotted lines in FIGURE 16. When the arm member **214** is pivoted to the position shown in solid lines in FIGURE 13, the tongue portions **243** of the latch members **242** ride over the edge of the retaining member **36** and engage the inner annular surface thereof. Then, as the arm member **214** is pivoted back to the dotted line position shown in FIGURE 13, the engaged retaining member **36** is moved off of the lapping disc **14** across the staging table **42** and on to the conveyor belt **204**. Means for effecting release of the latch members **242** from engagement with the retaining member **36** comprises a support member **244** secured at its inner end to the lower strap member **224** and carrying at its outer end a depending block member **246** having a camming surface **248** formed thereon. As the retaining member **36** is pulled onto the conveyor belt **204**, the projection ends of the latch members **242** engage the camming surface **248** and are pivoted in a clockwise direction from the dotted line position shown in FIGURE 16 to the solid line position, whereby the tongue portions **243** are withdrawn from engagement with the retaining member **36**.

I will now describe the steps involved in lapping the opposite sides of a plurality of adjacently confined work pieces with the above described apparatus in accordance with the principles of my present invention. At the beginning of operations, the various power actuated components of the loading and unloading mechanism assume the position shown in FIGURE 3. A retaining member **36** is first placed on the lateral extension portion **46** of the staging table **42** at the first loading station, and the retaining member **36** is then filled with unlapped work pieces. Preferably, the retaining member **36** has a height greater than that of the work pieces therein so that the retaining member may be conveniently engaged by the latch mechanisms **162** and **234**. After the pressure plates **28** and truing rings **30** have been raised from the lapping disc **14**, the arm member **54** is pivoted from the solid line position shown in FIGURES 3 and 4 to the dotted line position shown in FIGURE 4, thereby pushing the retaining member **36** and work pieces therein onto the lapping disc **14** beneath the adjacent first pressure plate **28** at a first lapping station. After the arm member **54** has been pivoted back to the solid line position, the pressure plates **28** and truing rings **30** are moved downwardly into engagement respectively with the work pieces and the lapping disc. At this time, the lapping disc **14** is rotated for lapping the one sides of the work pieces flat.

At the completion of this lapping operation, the pressure plates **28** and truing rings **30** are raised, the latch mechanism **162** is moved forwardly into engagement with the retaining member, and the retaining member is then pulled off of the lapping disc **14**, across the staging table **42**, and onto the platen **86** of the inverting means **80** at the first receiving station. To effect inversion or rotation through 180° of the work pieces that have been lapped on their one sides, the platen **84** of the inverting means **80** is first pivoted in one direction toward the platen **86** from the solid line position shown in FIGURE 8 to the dotted line position, whereupon the retaining member **36** and work pieces therein are confined between the platens **84** and **86**. Then, through simultaneous actuation of the pneumatic assemblies **132** and **142**, the platens **84** and **86** are pivoted conjointly in the other direction until the platen **84** is returned to its initial horizontal position whereupon the retaining member and work pieces therein are inverted with the lapped sides of the work pieces facing upwardly. An intermediate pivotal position of the platens **84** and **86** is shown in dot-dash lines in FIGURE 8, while the position of the platens **84** and **86** at the completion of inversion is shown in FIGURE 9. During this step of inversion, the retaining member and work pieces therein are moved from the first receiving station or platen **86** to the second loading station or platen **84**. To complete the cycle of inversion, the platen **86** is pivoted back to its initial horizontal position shown in solid lines in FIGURE 8.

With the pressure plates **28** and truing rings **30** in a raised position, the pusher member **192** is moved forwardly for moving the retaining member and work pieces off of the platen **84**, across the staging table **42**, and onto the lapping disc **14** beneath the adjacent second pressure plate **28** at a second lapping station. Upon retraction of the pusher member **192**, the pressure plates **28** and truing rings **30** are again lowered into engagement respectively with the work pieces and the lapping disc. As the lapping disc **14** is rotated, the opposite sides of the work pieces are lapped parallel to their one sides. Upon completion of this lapping operation, the pressure plate **28** and truing rings **30** are raised, and the arm member **214** is pivoted from the solid line position shown in FIGURE 3 to the solid line position shown in FIGURE 13 until the latch mechanism **234** engages the retaining member **36**. Finally, as the arm member **214** is returned to the solid line position shown in FIGURE 3, the retaining member and work pieces therein are moved off of the lapping disc **14**, across the staging table **42**, and onto the conveyor belt **204** that serves as a second receiving station. This completes the description of the path followed by one group of work pieces confined within a retaining member.

In the normal sequence of operation, retaining members and work pieces therein are successively introduced into the lapping cycle. Therefore, at any given time, except at the very initiation or termination of operations, there will be several groups of work pieces in the lapping apparatus each at a different location and in a different stage of the lapping cycle. As one illustration, at one point in the lapping cycle, one retaining member and

work pieces therein are at the first lapping station and another retaining member and work pieces therein are at the second lapping station. As the work pieces at the first lapping station are having their one sides lapped flat, and the work pieces at the second lapping station are having their other sides lapped parallel to their one sides, a retaining member having work pieces lapped on their one sides and confined therein is inverted and moved from the platen **86** or first receiving station to the platen **84** or the second loading station, and still another retaining member is filled with unlapped work pieces at the first loading station **46**. Upon completion of lapping of the work pieces on the lapping disc **14**, the pressure plates **28** and truing rings **30** are raised. Then the latch mechanisms **162** and **234** are moved substantially simultaneously in the direction of the lapping disc until they engage the pair of retaining members thereon. Upon return of the latch mechanisms **162** and **234** to their normal positions shown in FIGURE 3, the retaining member having work pieces lapped on their one sides and confined therein is moved onto the platen **86** or first receiving station, and the retaining member having work pieces lapped on their opposite sides and confined therein is moved onto the conveyor belt **204** or second receiving station. Next, the arm member **54** is actuated for moving the retaining member having unlapped work pieces therein from the first loading station **46** to the first lapping station. Substantially simultaneously, the pusher member **192** is actuated for moving the inverted retaining member and work pieces therein from the platen **84** or second loading station to the second lapping station. The described lapping cycle is then repeated. Thus, in the manner explained, two individual groups of adjacently located work pieces are substantially simultaneously loaded and unloaded to and from the lapping disc **14**. It will be appreciated that when loading and unloading apparatus embodying the principles of my present invention is used at both ends of the staging table **42**, four individual groups of adjacently located work pieces may be substantially simultaneously loaded and unloaded to and from the lapping disc **14**.

At the first lapping station, the one sides of the work pieces are lapped flat; at the second lapping station, the other sides of the work pieces are lapped parallel to the one sides thereof, and the work pieces are lapped to the desired thickness. Because these two operations are different, a greater amount of stock may be removed from the work pieces at the second lapping station than from the work pieces at the first lapping station. Even though the amount of stock removed from the work pieces at the two lapping stations may be unequal, it is desirable that the time required to remove necessary stock from the work pieces at these stations be maintained substantially equal. Therefore, to attain this objective, and in accordance with the principles of my present invention, the pressure applied to the work pieces being lapped at the second lapping station may be different in magnitude than the pressure applied to the work pieces being lapped at the first lapping station.

All of the pneumatic assemblies of the above described apparatus are supplied air under pressure from a conventional pump and through a conventional control system (not shown). Suitable known air regulators are incorporated in the control system to control the pressure of the air delivered to the various pneumatic assemblies, and a conventional electric circuit, including limit switches arranged at various locations on the described apparatus, is employed to control the proper sequence of operation of the air regulators or valves associated with the pneumatic assemblies. Those skilled in the art will readily appreciate that a hydraulic system may be used in place of all or part of the pneumatic system described herein.

To accommodate unevenness in the surfaces of unlapped work pieces, a pad **250** of felt or the like is preferably interposed between the pressure plate **28** and the work pieces **34** at the first lapping station as shown in FIGURE 2. Such a pad is unnecessary at the second lapping station because the sides of the work pieces that bear against the pressure plate **28**, which serves as a hard reference member, have been lapped flat. To minimize space requirements, it is to be noted that the power actuated arm members **54** and **214** are each arranged to move a retaining member and work pieces therein along an arcuate path. However, the latch mechanism **162** and pusher **192** must have straight line motion because a retaining member and work pieces therein must be moved onto and off of the inverting platens **84** and **86** along a path parallel to the hinge axis thereof due to the interference of the projecting portions of the hinge members.

While I have shown and described what I believe to be a preferred embodiment of the apparatus of my present invention, it will be understood by those skilled in the art that various rearrangements and modifications may be made therein without departing from the spirit and scope of my invention.

I claim:

1. In a lapping machine having a framework and a lapping disc rotatably mounted on the framework, means for moving an entire retaining member adapted to confine a plurality of work pieces therein onto the lapping disc where the one sides of the work pieces may be lapped, and means independent of said last-named means for moving the entire retaining member and work pieces therein off of the lapping disc after the said one sides of the work pieces have been lapped.

2. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, means for moving the entire retaining member and work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped, and means independent of said last-named means for moving the entire retaining member and work pieces off of the lapping disc after the said one sides of the work pieces have been lapped.

3. In a lapping machine having a framework and a lapping disc rotatably mounted on the framework, at least one truing ring engageable with the lapping disc, a pressure plate within said truing ring, means for raising and lowering said truing ring and said pressure plate, means for moving a retaining member adapted to confine a plurality of work pieces therein onto the lapping disc beneath said pressure plate when the latter and said truing ring are in a raised position, said truing ring and said pressure plate being disposable in engagement respectively with the lapping disc and the work pieces while the one sides of the latter are being lapped, and means for moving the retaining member and work pieces therein off of the lapping disc when said truing ring and said pressure plate are in a raised position after the said one sides of the work pieces have been lapped.

4. In a lapping machine having a framework and a lapping disc rotatably mounted on the framework, means for moving a retaining member adapted to confine a plurality of work pieces therein onto the lapping disc where the one sides of the work pieces may be lapped, means for moving the retaining member and work pieces therein off of the lapping disc after the said one sides of the work pieces have been lapped, means for inverting the retaining member and work pieces therein, means for moving the inverted retaining member and work pieces therein onto the lapping disc where the other sides of the work pieces may be lapped, and means for moving the retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

5. In a lapping machine having a framework and a lapping disc rotatably mounted on the framework, means for moving a retaining member adapted to confine a plurality of work pieces therein onto the lapping disc, means for applying pressure of a predetermined magnitude on the work pieces while the one sides thereof are being lapped, means for moving the retaining member and work pieces therein off of the lapping disc after the said one sides of the work pieces have been lapped, means for inverting the retaining member and work pieces therein, means for moving the inverted retaining member and work pieces therein onto the lapping disc, means for applying pressure of a higher magnitude on the work pieces while the other sides of the work pieces are being lapped, and means for moving the retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

6. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, power actuated arm means for moving the entire retaining member and work pieces therein onto the lapping disc where the one sides of the work pieces may be lapped, and power actuated engaging means independent of said power actuated arm means for moving the entire retaining member and work pieces therein off of the lapping disc after the said one sides of the work pieces have been lapped.

7. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, power actuated pushing means for moving the entire retaining member and work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped, and power actuated arm means independent of said power actuated pushing means for moving the entire retaining member and work pieces therein off of the lapping disc after the said one sides of the work pieces have been lapped.

8. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, inverting means mounted in said staging table, power actuated arm means for moving the retaining member and work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped, power actuated engaging means for moving the retaining member and work pieces therein off of the lapping disc onto said inverting means, said inverting means serving to invert the retaining member and work pieces therein, power actuated pushing means for moving the inverted retaining member and work pieces therein from said inverting means onto the lapping disc where the other sides of the work pieces may be lapped, and power actuated arm means for moving the retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

9. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, at least two truing rings engageable with the lapping disc, a pressure plate within each truing ring, means for raising and lowering said truing rings and said pressure plates, a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, power actuated arm means for pushing said retaining member and work pieces therein from said staging table onto the lapping disc beneath one of said pressure plates when the latter and its associated truing ring are in a raised position, said one pressure plate and its associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the one sides of the work pieces are being lapped, inverting means mounted in said staging table, power actuated engaging means for moving said retaining member and work pieces therein off of the lapping disc onto said inverting means when said one pressure plate and its associated truing ring are in a raised position after the said one sides of the work pieces have been lapped, said inverting means serving to invert said retaining member and work pieces therein, means for pushing said retaining member and work pieces therein from said inverting means onto the lapping disc beneath the other of said pressure plates when the latter and its associated truing ring are in a raised position, said other pressure plate and its associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the other sides of the work pieces are being lapped, and power actuated arm means for moving said retaining member and work pieces therein off of the lapping disc when said other pressure plate and its associated truing ring are in a raised position after the said other sides of the work pieces have been lapped.

10. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a pair of platens disposed side by side in initial horizontal positions adjacent the lapping disc and being pivotally mounted along their adjacent edges about a horizontal axis for swinging movement through 180°, one of said platens serving to receive a retaining member adapted to confine a plurality of work pieces therein, and means for first pivoting the other of said platens in one direction toward the said one platen whereby to confine the retaining member and work pieces therein between said platens, then pivoting said platens together in the other direction until said other platen is returned to its initial horizontal position whereupon the retaining member and work pieces therein are inverted, and finally pivoting said one platen in said one direction until the latter is returned to its initial horizontal position.

11. In a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc; means for moving a retaining member adapted to confine a plurality of work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped; a pair of platens disposed side by side in initial horizontal positions in said staging table and being pivotally mounted along their adjacent edges about a horizontal axis for swinging movement through 180°; means for moving the retaining member and work pieces therein off of the lapping disc and onto one of said platens after the said one sides of the work pieces have been lapped; means for first pivoting the other of said platens in one direction toward the said one platen whereby to confine the retaining member and work pieces therein between said platens, then pivoting said platens together in the other direction until said other platen is returned to its initial horizontal position whereupon the retaining member and work pieces therein are inverted, and finally pivoting said one platen in said one direction until the latter is returned to its initial horizontal position; means for moving the retaining member and work pieces therein from said other platen onto the lapping disc where the other sides of the work pieces may be lapped; and means for moving the retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

12. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein; power actuated arm means for moving the retaining member and

work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped; a pair of platens disposed side by side in initial horizontal positions in said staging table and being pivotally mounted along their adjacent edges about a horizontal axis for swinging movement through 180°; power actuated engaging means for moving the retaining member and work pieces therein off of the lapping disc onto one of said platens after the said one sides of the work pieces have been lapped; means for first pivoting the other of said platens in one direction toward the said one platen whereby to confine the retaining member and work pieces therein between said platens, then pivoting said platens together in the other direction until said other platen is returned to its initial position whereupon the retaining member and work pieces therein are inverted, and finally pivoting said one platen in said one direction until the latter is returned to its initial horizontal position; power actuated pushing means for moving the retaining member and work pieces therein from said other platen onto the lapping disc where the other sides of the work pieces may be lapped; and power actuated arm means for moving the retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

13. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a pair of platens disposed side by side in initial horizontal positions adjacent the lapping disc and being pivotally mounted along adjacent edges about a horizontal axis for swinging movement through 180°, one of said platens serving to receive a retaining member adapted to confine a plurality of work pieces therein, first power actuated rack and pinion means for pivoting the other of said platens in one direction toward the said one platen whereby to confine the retaining member and work pieces therein between said platens, second power actuated rack and pinion means acting conjointly with said first rack and pinion means to pivot said platens together in the other direction until said other platen is returned to its original horizontal position whereupon the retaining member and work pieces therein are inverted, and said second rack and pinion means serving to pivot said one platen in said one direction until the latter is returned to its initial horizontal position.

14. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, at least two truing rings engageable with the lapping disc, a pressure plate within each truing ring, means for raising and lowering said truing rings and said pressure plates, a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, said retaining member having a height greater than the work pieces therein, first arm means mounted for movement along an arcuate path for pushing said retaining member and work pieces therein from said staging table onto the lapping disc beneath one of said pressure plates when the latter and its associated truing ring are in a raised position, pneumatic piston and cylinder assembly means for actuating said first arm means, said one pressure plate and its associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the one sides of the work pieces are being lapped, inverting means mounted in said staging table, latch means movable along a straight line path and engageable with said retaining member for pulling the latter and the work pieces therein off of the lapping disc onto said inverting means when said one pressure plate and its associated truing ring are in a raised position after the said one sides of the work pieces have been lapped, pneumatic piston and cylinder assembly means for effecting movement of said latch means, said inverting means serving to invert said retaining member and work pieces therein, means for pushing said retaining member and work pieces therein along a straight line path from said inverting means onto the lapping disc beneath the other of said pressure plates when the latter and its associated truing ring are in a raised position, pneumatic piston and cylinder assembly means for actuating said pushing means, said other pressure plate and its associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the other sides of the work pieces are being lapped, second arm means including latch means being mounted for movement along an arcuate path for engaging said retaining member and pulling the latter and the work pieces therein off of the lapping disc when said other pressure plate and its associated truing ring are in a raised position after the said other sides of the work pieces have been lapped, and pneumatic piston and cylinder assembly means for actuating said second arm means.

15. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, at least two truing rings engageable with the lapping disc, a pressure plate within each truing ring, means for raising and lowering said truing rings and said pressure plates, a staging table adjacent the lapping disc for supporting a retaining member adapted to confine a plurality of work pieces therein, said retaining member having a height greater than the work pieces therein, first arm means mounted for movement along an arcuate path for pushing said retaining member and work pieces therein from said staging table onto the lapping disc beneath one of said pressure plates when the latter and its associated truing ring are in a raised position, pneumatic piston and cylinder assembly means for actuating said first arm means, said one pressure plate and associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the one sides of the work pieces are being lapped, a pair of platens disposed side by side in initial horizontal positions in said staging table and being pivotally mounted along their adjacent edges about a horizontal axis for swinging movement through 180°, latch means movable along a straight line path and engageable with said retaining member for pulling the latter and the work pieces therein off of the lapping disc onto one of said platens when said one pressure plate and its associated truing ring are in a raised position after the said one sides of the work pieces have been lapped, pneumatic piston and cylinder assembly means for effecting movement of said latch means, first power actuated rack and pinion means for pivoting the other of said platens in one direction toward the said one platen whereby to confine said retaining member and work pieces therein between said platens, said power actuated rack and pinion means acting conjointly with said first rack and pinion means to pivot said platens together in the other direction until said other platen is returned to its initial horizontal position whereupon said retaining member and work pieces therein are inverted, said second rack and pinion means serving to pivot said one platen in said one direction until the latter is returned to its initial horizontal position, means for pushing said retaining member and work pieces therein along a straight line path from said other platen onto the lapping disc beneath the other of said pressure plates when the latter and its associated truing ring are in a raised position, pneumatic piston and cylinder assembly means for actuating said pushing means, said other pressure plate and its associated truing ring being disposable in engagement respectively with the work pieces and the lapping disc while the other sides of the work pieces are being lapped, second arm means including latch means mounted for movement along an arcuate path for engaging said retaining member and pulling the latter and work pieces therein off of the lapping disc when said other pressure plate and its associated truing ring are in a raised position after the said

other sides of the work pieces have been lapped, and pneumatic piston and cylinder assembly means for actuating said second arm means.

16. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, the combination of a staging table adjacent the lapping disc, inverting means mounted in said staging table, power actuated arm means for moving a first retaining member adapted to confine a plurality of unlapped work pieces therein from said staging table onto the lapping disc where the one sides of the work pieces may be lapped, power actuated pushing means operable substantially simultaneously with said first power actuated arm means for moving a second retaining member adapted to confine therein a plurality of work pieces lapped on their upper sides from said inverting means onto the lapping disc where the other sides of the work pieces may be lapped, power actuated engaging means for moving said first retaining member and work pieces therein off of the lapping disc onto said inverting means after the said one sides of the work pieces have been lapped, and second power actuated arm means operable substantially simultaneously with said power actuated engaging means for moving said second retaining member and work pieces therein off of the lapping disc after the said other sides of the work pieces have been lapped.

17. For use with a lapping machine having a framework and a lapping disc rotatably mounted on the framework, at least two truing rings engageable with the lapping disc, a pressure plate within each truing ring, means for raising and lowering said truing rings and said pressure plates, a staging table adjacent the lapping disc, inverting means mounted in said staging table, power actuated arm means for pushing a first retaining member adapted to confine a plurality of unlapped work pieces therein from said staging table onto the lapping disc

beneath one of said pressure plates when the latter and its associated truing ring are in a raised position, power actuated pushing means operable substantially simultaneously with said first power actuated arm means for moving a second retaining member adapted to confine therein a plurality of work pieces lapped on their upper sides from said inverting means onto the lapping disc beneath the other of said pressure plates when the latter and its associated truing ring are in a raised position, said pressure plates and their associated truing rings being disposable in engagement respectively with the work pieces and the lapping disc while the sides of the work pieces in contact with the lapping disc are being lapped, power actuated engaging means for moving said first retaining member and work pieces therein off of the lapping disc onto said inverting means when said pressure plates and their associated truing rings are in a raised position after the work pieces have been lapped, and second power actuated arm means operable substantially simultaneously with said power actuated engaging means for moving said second retaining member and work pieces therein off of the lapping disc.

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