Feb. 4, 1958 H. E. McGEE ET AL 2,821,818

LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

Filed June 18, 1954 6 Sheets-Sheet 1

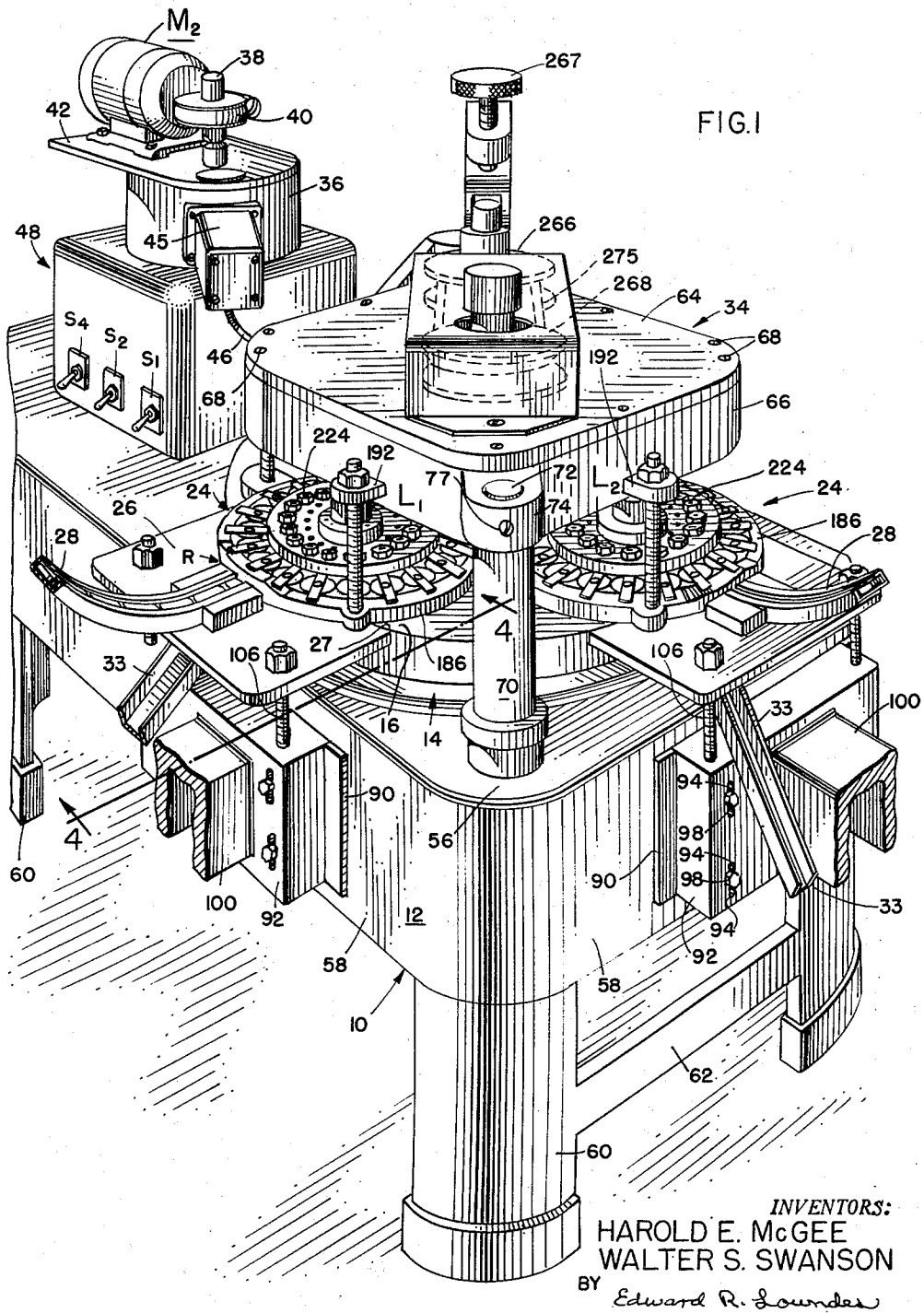


FIG. 1

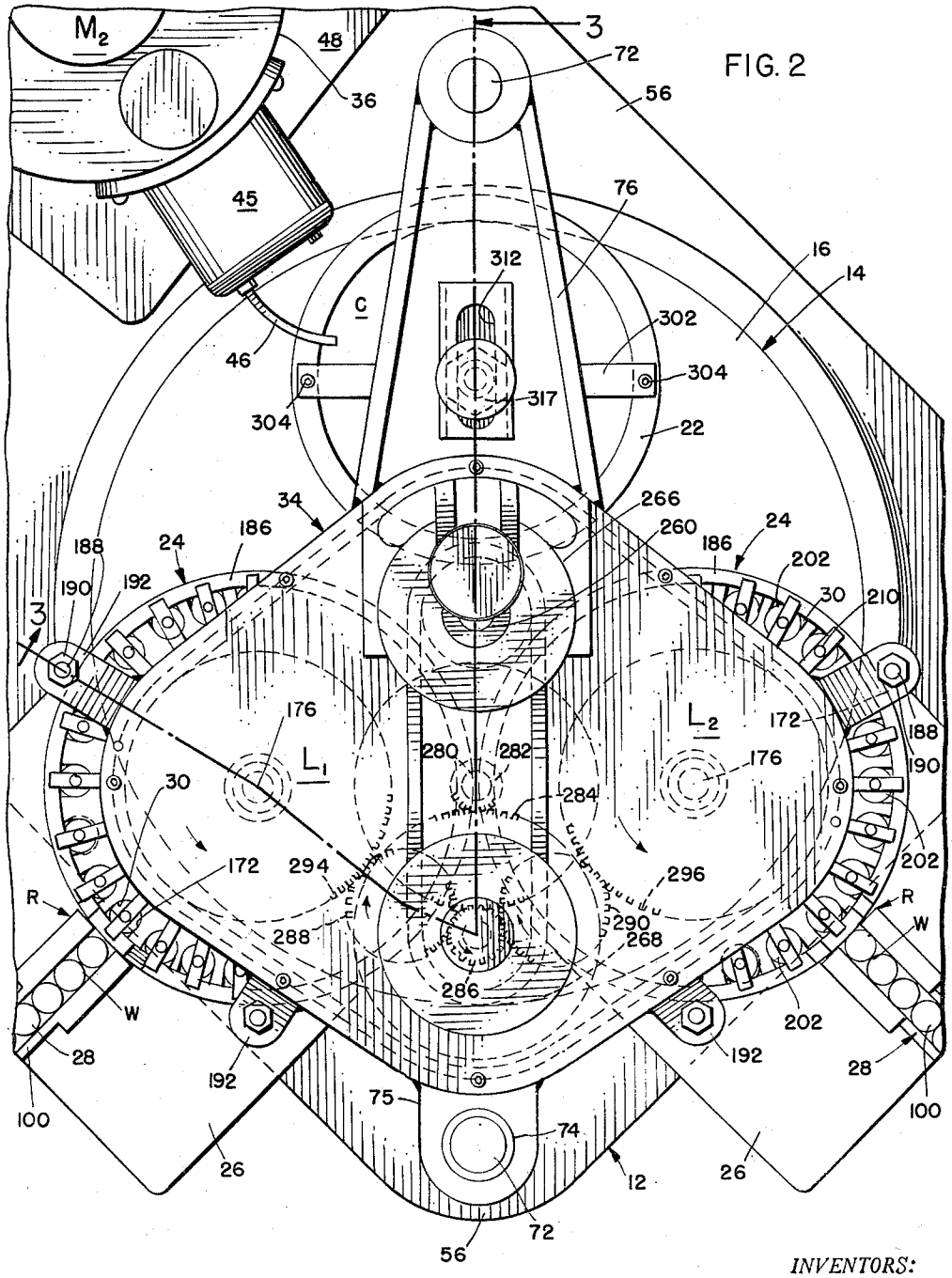
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LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

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FIG. 2



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LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

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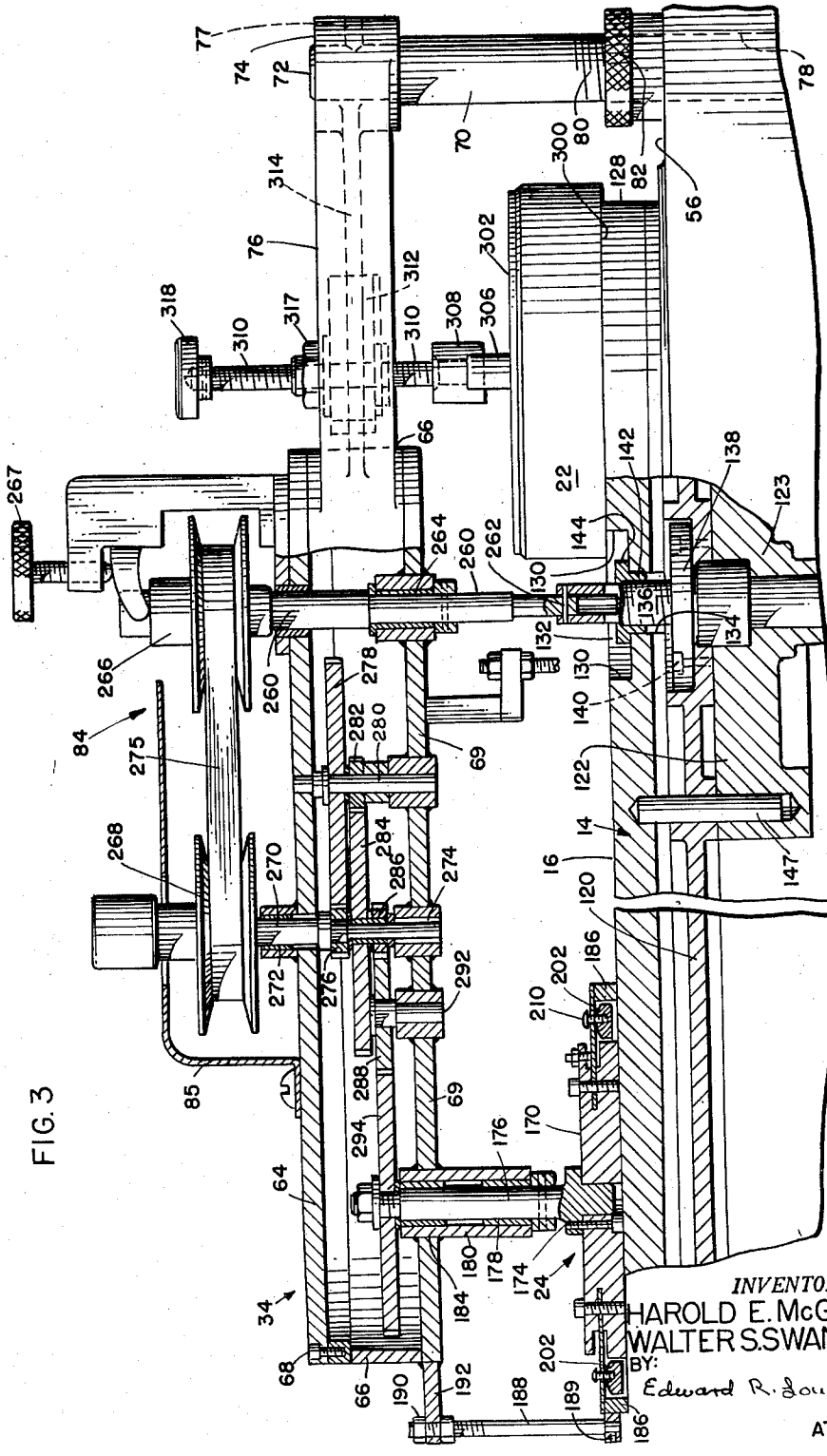


FIG. 3

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LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

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FIG. 4

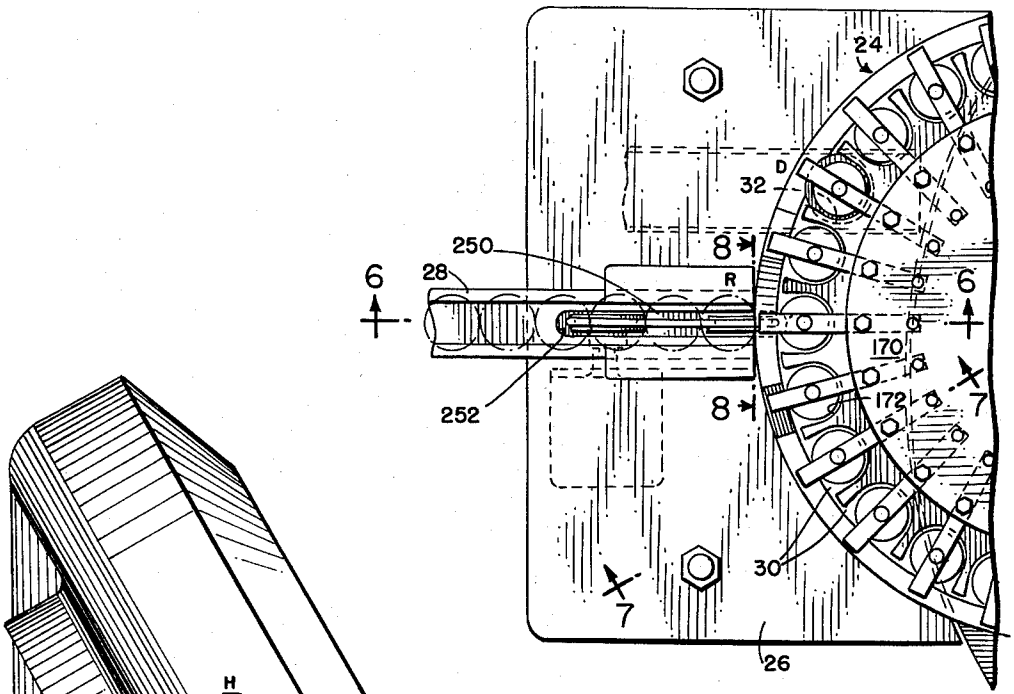
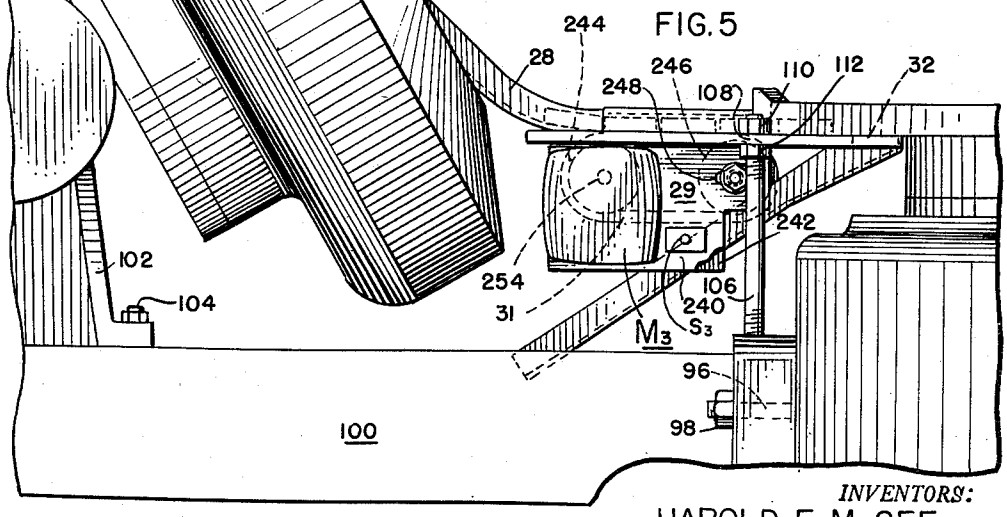


FIG. 5



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LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

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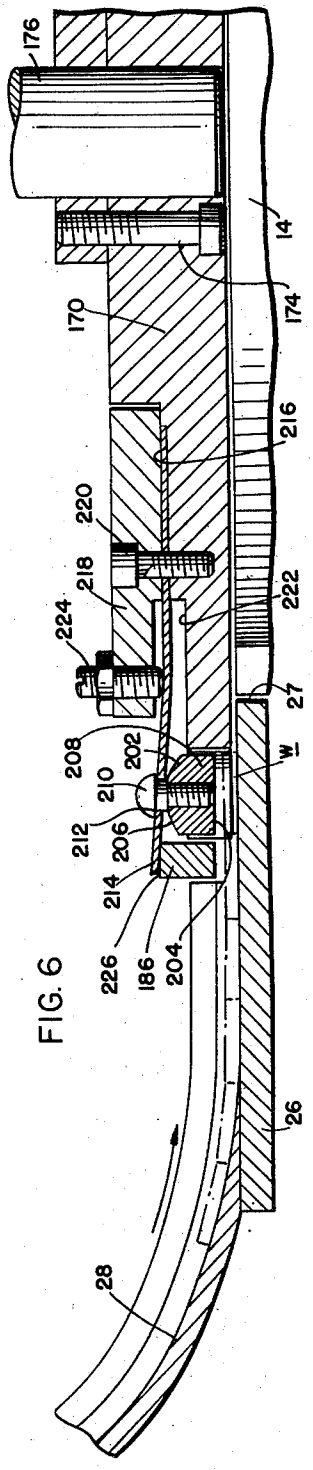


FIG. 6

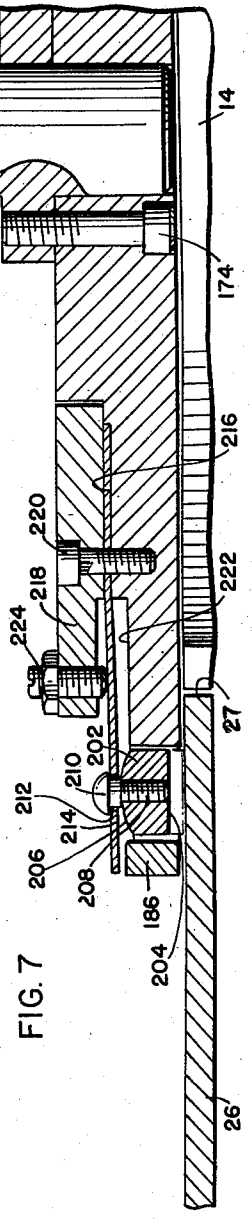


FIG. 7

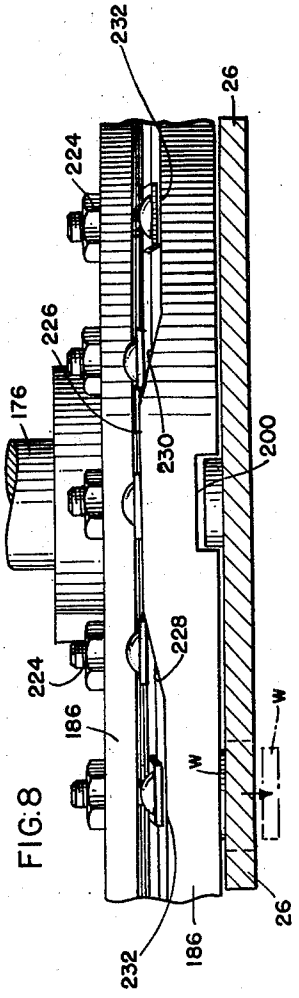


FIG. 8

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LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

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FIG. 9

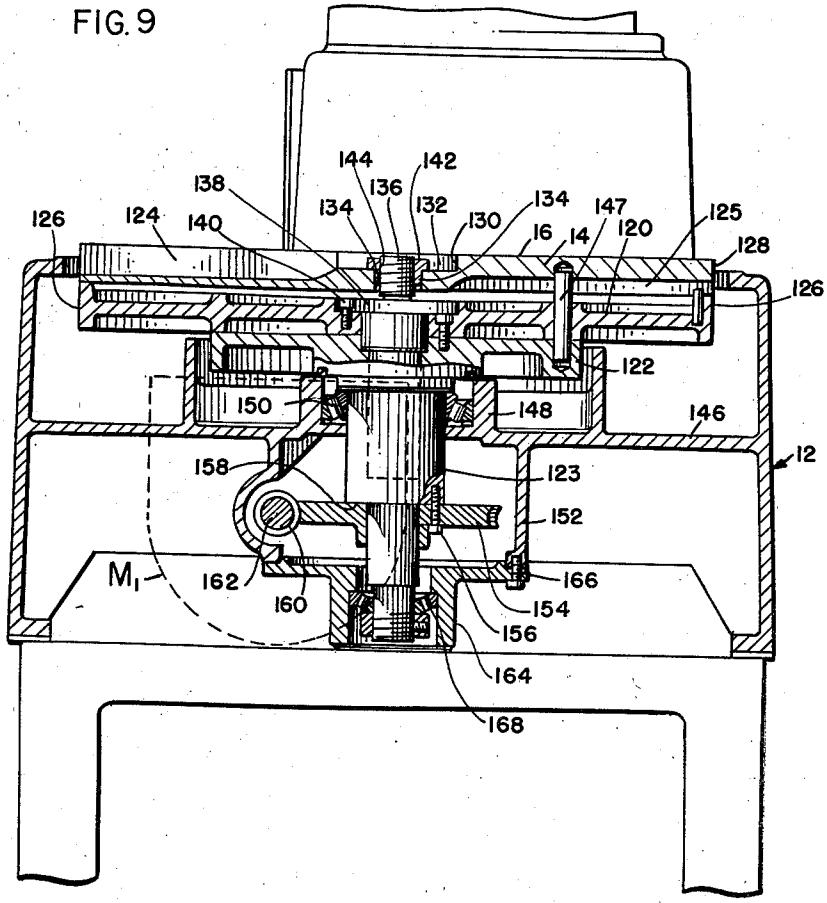
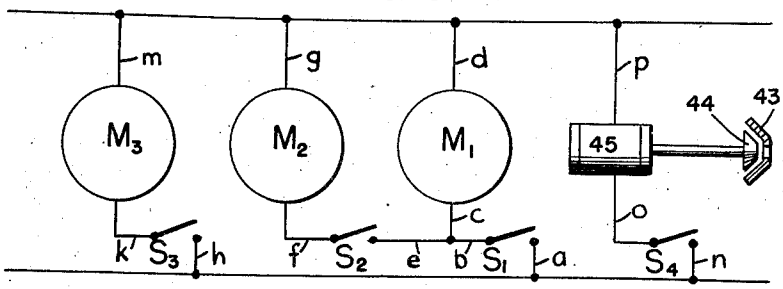


FIG. 10



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United States Patent Office 2,821,818
Patented Feb. 4, 1958

2,821,818

LAPPING MACHINE AND AUTOMATIC FEED MECHANISM THEREFOR

Harold E. McGee and Walter S. Swanson, Rockford, Ill., assignors, by mesne assignments, to Crane Packing Company, Chicago, Ill., a corporation of Illinois

Application June 18, 1954, Serial No. 437,690

6 Claims. (Cl. 51—134)

The present invention relates to lapping machines, and more particularly to an automatically operable lapping machine in which a plurality of work pieces may be successively fed into the machine to an operative lapping position, conducted through a predetermined lapping cycle during which lapping operations are performed upon the work pieces, and thereafter discharged from the machine after the lapping cycle is completed, all by a fully automatic process.

It is among the principal objects of the invention to provide a lapping machine having a rotatable lap plate associated therewith, together with a work-receiving cage operatively disposed with respect to the lap plate for conveying successive work pieces in a circular path over the lap plate from a point of reception to a point of discharge so as to lap a face on each article during a single pass of the article through the machine.

Another and equally important object of the invention, in a machine of the character briefly outlined above, is to provide a novel means for feeding the individual work pieces successively to the work-receiving cage one at a time in such a manner that there shall be no jamming of the work and so that each work piece will be assured of proper reception and orientation in the work-receiving cage preparatory to the passage of the work through the lapping cycle.

A still further object of the invention is to provide a machine of this character in which the duration of the lapping cycle may be varied at will to accommodate the requirements of different work pieces.

Yet another object of the invention is to provide an automatic machine for lapping articles which are successively introduced thereto and which embodies the lapping principles set forth in the United States patent to Bullard 2,565,590, dated August 28, 1951, for Lapping Machine.

A further object of the invention is to provide a machine of this sort for lapping circular articles in which means are provided for varying the lapping pressure of the articles against the moving lap plate while at the same time permitting induced rotation of the articles due to the unequal coefficient of friction developed between the articles and the lap plate at different eccentrically displaced regions of the lap plate.

Another object of the invention is to provide a lapping machine which is fully automatic in its operation and which includes mechanism for delivering articles out of an irregular mass and selectively depositing them in proper lapping position on the lapping surface of the lap plate in proper alignment to be lapped thereby, together with means for bodily adjusting the entire delivering means to accommodate progressive wearing of the lap plate.

Other objects and advantages of the invention, not at this time enumerated, will become more readily apparent as the nature of the invention is better understood.

In the accompanying six sheets of drawings forming a part of this specification a preferred embodiment of the invention has been shown.

In these drawings:

Fig. 1 is a fragmentary perspective view of a lapping machine constructed in accordance with the principles of the present invention.

Fig. 2 is a fragmentary top plan view of the lapping machine shown in Fig. 1.

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 2 in the direction indicated by the arrows.

Fig. 4 is an enlarged fragmentary sectional view taken substantially along the horizontal plane indicated by the line 4—4 of Fig. 1.

Fig. 5 is a side elevational view of the structure shown in Fig. 4 with the addition of a work feed hopper employed in connection with the present invention.

Fig. 6 is a sectional view taken substantially along the line 6—6 of Fig. 4.

Fig. 7 is a sectional view taken substantially along the line 7—7 of Fig. 4.

Fig. 8 is a sectional view taken substantially along the line 8—8 of Fig. 4.

Fig. 9 is a fragmentary sectional view taken substantially centrally through certain lap plate driving mechanism employed in connection with the invention, and

Fig. 10 is a circuit diagram for the machine.

In all of the above described views, similar characters of reference are employed to designate similar parts throughout.

General description

Referring now to the drawings in detail, and in particular to Fig. 1, briefly, the present lapping machine involves in its general organization a table-like framework structure 10 including a table portion 12 in the form of a casting which constitutes a machine base and which rotatably supports a circular lap plate 14 having a lap surface 16 in the form of an annulus. The space above the lap plate 14 is allocated so as to provide two work lapping zones designated generally at L1 and L2 (Figs. 1 and 2) and a lap conditioning zone C. A dressing tool in the form of a circular conditioning ring 22 (see also Fig. 3) is disposed at the conditioning zone C and is adapted to float freely on the surface of the lap with its peripheral regions overhanging both the inner and outer peripheral edges of the lap annulus while at the same time being restrained against revolution about the axis of rotation of the lap. This dressing tool or conditioning ring serves, in a manner that will be made clear presently, to dress the surface 16 of the lap and maintain a desired convex, concave or plane surface.

At each of the lapping stations L1 and L2 there is positioned a rotatable work-receiving cage assembly 24 adapted to receive small articles of work such as are indicated at *w* and conduct the articles over the surface of the rotating lap in an arcuate path through the lapping zone from a work-receiving station R (Figs. 2 and 4) to a discharge station D approximately 300 angular degrees removed from the work-receiving station. Conditioning operations at the conditioning zone C and lapping operations at the two lapping zones L1 and L2 are adapted to take place simultaneously in accordance with the principles set forth in the above mentioned patent to Bullard, 2,565,590.

The work-receiving cages 24 and the lap plate 14 are driven from a common source of power which is preferably an electric motor M1 (Fig. 9) suitably mounted beneath the table portion 12 of the machine framework 10. Work pieces *w* successively introduced into the work-receiving cage 24 at the receiving station R are conducted in an arcuate path extending around the lapping zone L1 and L2 as the case may be and are ultimately

discharged after 300° path of travel over the surface of the lap at the discharge station D.

Positioned adjacent each lapping zone L1 and L2 is an adjustable shelf 26 having an inner edge 27 (Figs. 6, 7 and 8) which is substantially contiguous with the outer periphery of the lap, the shelf being vertically adjustable so that its height may be varied to maintain its upper surface at precisely the level of the lap surface 16. The work pieces are fed from a rotatable hopper H (Fig. 5) associated with a hopper-type feed mechanism of conventional design and the individual work pieces are fed by gravity along a loading chute 28 from whence they are placed on the shelf member 26 and are thereafter moved horizontally on the shelf into a series of confining pockets 30 provided for them in the peripheral regions of the cage 24.

In order to assist the action of gravity in feeding the work pieces along the shelf member 26 and toward the work-receiving cage 24 a continuously operable feed belt mechanism designated in its entirety at 29 (Fig. 5) and including an endless feed belt 31 designed to frictionally engage the work pieces *w* is suspended from the underneath side of the shelf 26. The feed belt 31 has a straightaway portion which operates within a slot provided in the shelf 26 in alignment with a row of work pieces being deposited upon the shelf and is adapted to frictionally engage these work pieces and impel them radially inwardly toward the work-receiving cage 24. Thereafter the work pieces *w* are slid, so to speak, by the rotating portion of the cage assembly 24 onto the upper surface 16 of the lap plate 14 to commence the 300° lapping cycle. The lapped work pieces *w* adjacent the discharge station D are returned from the surface 16 of the lap plate 14 to the shelf plate 26 and are allowed to fall by gravity through a circular discharge opening 32 (Fig. 5) from whence they fall into a discharge chute 33.

The supporting and driving mechanism for the work-receiving cages 24 as well as the supporting mechanism for the conditioning ring 22 is carried in a superstructure designated in its entirety at 34 (Figs. 1 and 2) and suitably supported in elevated spaced relation from the base or table portion 12.

Means are provided for distributing a vehicle containing an abrasive grit over the rotating lap surface 16 and, toward this end, a tank or receptacle 36 is supported above the base 10 at one side of the lap plate 14 and has disposed therein agitator mechanism (not shown), the central shaft or spindle 38 of which projects upwardly above the tank and is driven through a suitable gear reduction mechanism 40 from an electric motor M2 suitably supported on a platform 42 mounted on the tank 36. The liquid contained within the tank 36 and in which the particles of grit are held in suspension is adapted to flow outwardly through a discharge orifice 43, having a shut-off valve 44 (Fig. 10) associated therewith and the opening and closing movements of which are conducted by means of a solenoid 45. From the orifice 43, this grit laden fluid will flow along a flexible wire 46 leading from the orifice to a point adjacent the conditioning ring 22. The free end of the wire 46 may bear lightly against the conditioning ring 22 so that the grit laden fluid will be conducted to the conditioning ring and from thence be distributed over the surface of the rotating lap plate as the latter passes beneath the conditioning ring 22. A housing 48 mounted on the base 10 serves to support the agitator tank 36 as well as to contain certain electrical control instrumentalities associated with the machine and the nature of which will be made clear presently.

The machine framework

Referring now to Fig. 1, the machine base 10 may be in the form of a relatively large casting providing a horizontal upwardly facing table top 56 and depending sides 58. At each end of the machine a leg casting including a pair of legs 60 and a transverse supporting strut 62 serves to maintain the base 10 at a suitable working elevation from the floor or other supporting surface. The superstructure 34 forms a part of the machine framework and is in the form of a box-like gear housing including a flat top plate 64 (see also Fig. 3) which is generally of rectangular design and from which there depends a peripheral apron 66 secured in position on the plate 64 by means of screws 68. A bottom plate 69 extends across the bottom of the apron 66 and completes the box-like housing. The superstructure 34 is supported above the level of the table top 56 on a pair of vertically adjustable posts 70 having reduced upper ends 72 which extend into a pair of bosses 74 one of which is formed on an ear 75 carried by the apron 66 and the other of which is formed on an extension 76 likewise carried by the apron 66, the ear and apron being positioned at opposed diagonal corners of the superstructure 34. A set screw 77 serves to secure the upper end of each post 70 in position with its respective boss 74. The lower end of each post 70 slidably extends into a vertical bore 78 (Fig. 3) provided in the base casting 10. The lower end of the post 70 is threaded as at 80 and a knurled adjusting collar 82 threadedly received on the post 70 rests upon the table portion 56 and is provided for the purpose of effecting vertical adjustment of the post 70 and consequent vertical positioning of the superstructure 34 as a whole. The superstructure 34 is provided for the purpose of supporting certain variable drive mechanism designated in its entirety at 84 shielded by a guard plate 85 and by means of which the operative work-impelling mechanism associated with the work-receiving cage devices 24 may be driven.

At the front of the machine and at one side thereof a pair of vertically extending guide strips 90 are secured as by welding to adjacent sides 58 of the machine base 10 in spaced relationship. Each pair of strips provides therebetween a vertical guideway for a vertically adjustable block 92 which is generally of rectilinear configuration. Each block 92 is formed with a plurality of slots 94 therein. A stud 96 carried by the base 12 projects through each slot 94 and is adapted to receive thereon a clamping nut 98, the various clamping nuts serving to maintain the blocks 92 clamped to the base 10 in any desired position of vertical adjustment.

Projecting horizontally outwardly and centrally from each of the blocks 92 is an inverted U-shaped channel member 100, the inner end of which is welded to the block 92. The outer regions of each channel member 100 serve to support thereon a vertical standard 102 (Fig. 5) which forms the supporting structure for one of the feed hoppers H. Suitable studs 104 serve to anchor the standard 102 in position on the channel member 100. One of the feed hoppers H is designed to accommodate the lapping zone L1 by supplying work pieces *w* to the work-receiving cage 24 thereof and the other hopper is designed to similarly accommodate the feeding of work pieces to the lapping zone L2.

Each shelf member 26 is adjustably supported from the block 92 by means of a pair of threaded support rods 106 (Figs. 1 and 5), the lower ends of which are anchored in the block 92 and the upper ends of which extend through openings 108 provided in the shelf member 26. Adjusting nuts 110 and 112 on the rods 106 above and below the shelf member respectively serve to secure the latter in any desired position of adjustment.

From the above description it will be seen that the adjustment for the shelf member 26 provided by the nuts 110 and 112 may be an initial adjustment which serves to locate the shelf relative to the hopper H. This adjustment, having once been made, is a permanent one and, thereafter, by loosening the nuts 98 on the studs 96, the entire feed mechanism including the hopper H, its chute 28, the shelf member 26 and the friction drive mechanism 31 may be adjusted vertically bodily as a unit, the

purpose of such adjustment being to maintain the upper plane surface of the shelf **26** in register with the plane of the lap surface **16** as the latter becomes worn.

The lap plate and its supporting and driving mechanism

Referring now to Figs. 3 and 9, the lap plate **14** proper forms part of a lap plate assembly including a rotatable platen or lap plate supporting plate **120** and a bed plate **122**, the latter being in the form of a flange provided on a drive shaft **123**. The lap plate **14** is capable of being adjusted so that the working surface **16** thereof may be rendered substantially flat, concave or convex and toward this end it may be constructed along the principles set forth in the patent to Roshong, 2,597,187, dated May 20, 1952, for an Adjustable Lap, although other types of lap plates or lap plate assemblies are capable of use in connection with the present invention.

The present lap plate **14** is circular and is made of cast iron of the grade commonly known as "Meehanite." Both the upper and lower surfaces of the plate are formed with grooves **124** and **125** respectively (Fig. 9) which extend substantially radially of the plate and which are substantially perpendicular to the upper and lower faces thereof. The grooves **124** and **125** extend more than half way through the plate and are staggered with respect to one another thus resulting in a generally corrugated plate section. A lapping plate of this character will have a slight amount of resilience even though it is constructed of cast iron. It is this resilience which is relied upon to distort the lapping face **16** of the plate to either convex or concave form as may be desired. The lap plate **14** rests upon the supporting plate **120** and the peripheral regions of the plate **14** bear against a circular peripheral rib **126** provided on the supporting plate **120**. The central region of the lap plate **14** is thus suspended above the plate **120**. The lap plate **14** is initially formed with a slightly dished shape so that the lap surface **16** thereof is slightly convex. Thus slight convexity of the upper lapping surface or annulus **16** is not apparent from the present drawings inasmuch as the actual deviation from flatness in a lap plate which is twenty-four inches in diameter is only a few hundredths of an inch.

The annular lap surface **16** has an outer periphery **128** and an inner periphery **130**, the latter existing by virtue of a central well or depression **132** in the upper surface of the lap plate. The plate **14** is formed with a central opening **134** therethrough through which there projects upwardly a threaded stud **136** formed on a circular plate **138** which is secured by means of studs **140** to the upper face of the lap plate supporting plate **120**. A clamping nut **142** threadedly received on the stud **136** has a flange portion **144** which bears against the bottom of the recess **132**. Adjustment of the nut **142** is utilized to control the contour of the lap surface **16** and it will be seen that as the nut **142** is tightened or drawn downwardly on the threaded stud **136**, the lap plate **14** will be distorted and the annular lap surface **16** will change its contour progressively from convex shape to concave shape, the surface passing through an intermediate condition wherein it is perfectly flat or planar. The means for altering the contour of the lap plate just described forms no part of the present invention and reference may be had to the above mentioned patent to Roshong for a full description of this feature which is only an incidental disclosure herein.

Still referring to Figs. 3 and 9, the lap plate assembly including the lap plate proper **14**, supporting plate **120** and bed plate **122** which is integral with the driving shaft **123** are all supported from a generally horizontal web **146** integrally formed with the base casting **12**. A pin **147** extends through the plate **120** and projects into the lap plate **14** and bed plate **122** to drivingly connect these parts for movement in unison. The web **146** is formed with a central hub portion **148** which carries a tapered roller bearing assembly **150** for rotatably supporting the shaft **123** and its integrally formed bed plate **122**. A generally cylindrical apron **152** depending centrally from the web **146** encloses a gear reduction drive assembly mechanism including a worm gear **154** secured as at **156** to a shoulder **158** provided on the shaft **123**. The worm gear **154** meshes with a worm **160** carried on a worm shaft **162** operatively connected to the driving motor M1 which is suitably suspended within the hollow casting **12**. A bearing cap **164** is bolted as at **166** to the end face of the apron **152** and serves to guide the lower end of the shaft **123** by means of a suitable roller bearing assembly **168**.

The work-impelling mechanism

Referring now to Figs. 2, 3 and 4, the work-impelling mechanism for moving the work across the face of the lap plate **14** during the lapping cycle includes the work-receiving cage assemblies **24** at the lapping zones L1 and L2 respectively. These assemblies are substantially identical in construction and therefore a description of one of them will suffice for the other. Each assembly involves in its general organization a generally circular work-impelling plate **170**. The plate **170** as seen in Fig. 4 is provided with a series of closely spaced peripheral notches or recesses **172** therein, which recesses in combination with other structure subsequently to be described, provide the previously mentioned work-receiving pockets **30** in which the work pieces *w* are adapted to be confined during their approximately 300° arcuate path of travel through the lapping zone from the receiving station R to the discharge station D. The plate **170** is suspended slightly above the level of the lap surface **16** as shown in Fig. 3 and it is secured by means of screws **174** to the lower end of a spindle **176** rotatably journaled as at **178** in a sleeve **180** which is welded in an opening **184** provided in the previously mentioned supporting plate **69** associated with the superstructure.

Surrounding the circular plate **170** and spaced from the periphery thereof is a retaining or confining ring **186**. This ring **186** is suspended from the superstructure **34** by means of a pair of suspension rods **188** (Fig. 3) the lower ends of which are secured in ears **189** formed on the ring **186** and the upper ends of which are secured by means of adjusting nuts **190** from a pair of laterally extending ears **192** (Figs. 1, 2 and 3).

It is to be noted from an inspection of Figs. 2 and 4 that the work-receiving pockets **30** exist by virtue of the generally semicircular recesses or notches **172** provided in the periphery of the plate **170** and by virtue of the stationary confining ring **186**. Since the plate **170** is adapted to be continuously rotated at a rate of rotation commensurate with the lapping cycle, the pockets **30** provided for the work pieces in the peripheral regions of the cage structure **24** are in the nature of traveling or moving pockets which, by their movement, carry the individual work pieces in an arcuate path through the lapping zone from the receiving station R to the discharge station D which is 300° removed from the receiving station.

In order to admit the work pieces *w* from the loading chute **28** associated with the feed hopper H into the pockets **30** successively as these pockets traverse the receiving station R, a gate opening **200** (Fig. 8) is provided in the stationary ring **186** in alignment and register with the chute **28** at the receiving station R. This gate opening **200** is in the form of a rectangular slot which is provided in the underneath surface of the ring **186**, the slot being of a height slightly in excess of the thickness of the articles *w* undergoing feeding. As shown in Figs. 5 and 6, the articles *w* carried by the chute **28** in the forward regions thereof are moved onto the upper surface of the shelf **26** and thereafter they are carried under the influence of the driving belt **31** associated with the impelling mechanism **29**. These articles are then fed into the opening **200** from whence they will be deposited one at a time in successive pockets **30** as these pockets move into register with the opening.

While the inherent weight of the articles *w* may be relied upon to establish the necessary degree of lapping pressure between the bottom surfaces of the articles and the upper lapping surface **16** of the lap plate **14**, auxiliary pressure applying means such as has been shown in Figs. 6, 7 and 8, may be employed if desired. This pressure applying means is in the form of a series of weights **202** which are adapted to rest on the upper surface of each article *w* during substantially the entire lapping cycle, i. e. its path of travel through the lapping zone. The weights **202** are preferably in the form of cylindrical members having flat bottom surfaces **204** and generally rounded upper surfaces **206**. A threaded suspension pin **208** is threadedly received centrally in each weight **202** and is provided with a shouldered head **210** carried in an opening **212** provided in a suspension spring **214** which is in the form of a flat leaf spring. Each leaf spring **214** has one end region thereof seated in a recess **216** provided in the upper surface of the circular plate **170** at the peripheral regions thereof. The various leaf springs **214** are clamped in position by means of a clamping ring **218** which overlies the various springs **214** and which is held in position on the plate **170** by anchoring screws **220**. The outer or free region of the spring **214** overlies a peripheral recess **222** formed in the circular block **170** and these outer regions of the spring are normally biased upwardly against the lower end of a series of adjusting screws **224** which extend through the clamping ring **218**. Thus by rotating the adjusting screws **224** to a predetermined position of adjustment, the springs **214** may be brought to such positions that their respective weights **202** rest solely by the action of gravity on the work pieces *w*. To make this possible the shouldered head **210** of each pin **208** is so designed that the spring **214** will have a slight clearance between the body portion of the weight **202** and the shoulder afforded by the head **210**. If additional lapping pressure is required on the work pieces *w* the adjusting screws **224** may be threaded downwardly through the ring member **218** to exert a predetermined degree of pressure on the springs **214** to distort the latter and cause the same to bear downwardly on the weights **202** and in turn cause the latter to exert an added degree of pressure on the upper surfaces of the articles *w*.

Still referring to Figs. 6, 7 and 8, the stationary ring **186** which surrounds the work-impelling plate **170** is formed with an elevated land surface **226** immediately above the gate opening **200**, this land surface **226** having inclined ramp surfaces **228** and **230** at each end thereof. Except for the provision of the land surface **226** and ramp surfaces **228** and **230** in the vicinity of the opening **200** which increases the vertical thickness of the ring **186** in the region of the gate opening, the remaining portions of the ring are of the same uniform vertical thickness.

The two ramp surfaces **228** and **230** constitute in effect cam surfaces adapted to be engaged by the extreme free or outer end regions of the various leaf springs **214** so that when the springs move into the vicinity of the receiving zone R the forward ends thereof will become elevated to cause the pressure applying weights **202** to be lifted above the level of the gate opening and allow the work pieces to be passed through the gate opening and into the work-receiving pocket **30** associated with each individual spring **214**.

Referring now to Figs. 1 and 8, and considering only the lapping zone L1, it will be seen that inasmuch as the work-impelling plate **170** rotates in a counterclockwise direction as indicated by the arrow in Fig. 2, the outer ends of the springs **214** which approach the receiving station R travel around the circumference of the confining ring **186** and are slightly spaced as indicated at **232** above the upper surface of the ring **186**. As soon as the spring **214** moves into the limited arcuate zone presented by the thickened portion of the ring at the receiving station R, the end of the spring engages the inclined ramp **228** and rides upwardly as indicated in Fig. 6. The spring thus engages the shoulder head **210** of the pin **208** and raises the latter upwardly, thus bodily lifting the weight **202** so that its underneath surface **204** moves to a position above the plane of an article *w* received in the pocket **30** at the receiving station R. The outer end of the spring continues to travel over the horizontal flat surface **226** of the ring **186** and when the spring becomes aligned with the vertical plane of the opening **200**, the leading article *w* contained in the chute **28** is slid, so to speak, through the opening **200** so that it becomes nested within the pocket **30** beneath the weight **202**. As soon as the article has been deposited in the pocket **30** it is constrained to move circumferentially of the work cage **24** and, as the outer end of the spring **214** rides downwardly on the ramp surface **230**, the weight **202** is deposited on the upper surface of the article *w* as previously described so that during its subsequent 300° path of travel through the lapping zone L1 it will be held against the upper face of the lap annulus **16**. During this passage of the article through the lapping zone an induced rotation about its own vertical axis will take place due to frictional engagement between the article and the moving lap surface therebeneath. Since the weight **202** resting on the article is, in effect, by the provision of the shoulder pin head **210**, pivotally suspended from the spring **214**, the weight itself may rotate and thus will offer no hindrance to rotational movement of the article. Thus the lapping principles clearly set forth in the above mentioned patent to Bullard, 2,565,590, are preserved during the entire lapping cycle.

It is to be noted from an inspection of Fig. 6 that the work-confining ring **186** in the vicinity of the receiving zone R overlies the outer peripheral edge **128** of the lap plate **14** and overlies the inner region of the shelf **26** and also that the circular work-impelling plate **170** similarly overlaps and overlies the lap plate and shelf **26** respectively so that work pieces *w* which are projected through the gate opening **200** and are thus received in a pocket **30** at the receiving station are wholly contained on the upper surface of the shelf **26**. These work pieces are subsequently, upon continued rotation of the work-impelling plate **170**, caused to slide over the face of the shelf **26** and become transferred to the lap plate **14** at the commencement of the lapping cycle. Toward the end of the lapping cycle when the work pieces have progressed through the lapping zone L1 they are again transferred from the lap plate **14** back to the upper surface of the shelf **26** in the vicinity of the discharge station D and, at such a time as they are brought into vertical register with the discharge opening **32** (Fig. 5), they will fall through this opening by gravity and travel down the chute **33** to a point of discharge.

The feed belt mechanism

The motor driven feed belt mechanism **29** (Fig. 5) which includes the friction feed belt **31** is in the form of a unitary assembly suspended from the underneath side of the shelf **26**. This assembly includes a pair of side plates **240** and **242** between which there are rotatably mounted a pair of pulleys including a driving pulley **244** and a driven pulley **246**, the latter being capable of longitudinal adjustment toward and away from the pulley **244** as indicated by the pin and slot connections **248**. The previously mentioned friction drive belt **31** extends over the two pulleys and its upper straightaway portion operates in a slot **250** (Fig. 4) provided in the shelf **26** immediately below the feed chute **28** and in the vicinity of the gate opening **200**. The upper surface of the straightway portion of the belt extends slightly above the upper surface of the shelf **26** and the bottom wall of the chute **28** is formed with an elongated clearance opening **252** therein into which the moving straightaway portion of the drive belt may extend to enable the belt to come into contact with the underneath faces of the first few leading work pieces *w* contained within the chute.

The moving belt thus normally tends to impel these first few work pieces *w* forwardly toward the gate opening **200** so that when one of the pockets **30** becomes aligned with the gate opening the leading work piece *w* in the chute will be forceably impelled into the pocket. At this time the penultimate work piece *w* will bear against the work piece which has been deposited in the pocket **30** and the friction belt **31** will slide beneath the underneath surface of the few work pieces with which it comes into contact until such time as a succeeding pocket has moved into register with the gate opening **200** and an additional work piece is released from the chute **28**. The driven pulley **244** is mounted on a drive shaft **254** operatively connected by a continuously driven driving motor M3 suitably supported between the side plates **240** and **242**.

The feed hopper and chute mechanism

The feed hopper H and its associated chute **28** by means of which work pieces *w* are uniformly and successively fed onto the surface of the shelf **26** for subsequent movement through the gate opening **200** and into the receiving pockets **30** of the work-receiving cage assembly **24** forms no part of the present invention and no claim is made herein to any novelty associated with the same. This hopper and chute construction are preferably of the type manufactured by the Detroit Power Screwdriver Company of Detroit, Michigan, and shown in the United States Patent to Bailey, No. 2,350,486, dated June 6, 1944, and reference may be had to this patent for details of the disclosure not herein made. It is deemed sufficient for purposes of clarifying the present invention to state that the hopper H and its associated chute **28** may be adjusted vertically by the simple expedient of vertically adjusting the supporting member **100** upon which the hopper H is mounted so that from time to time as the lap plate **14** becomes worn the shelf **26** may be brought to the level of the lap surface **16** while at the same time the hopper and chute mechanism will be moved bodily with the shelf **26** so that there will be no disturbing of the initial hopper and chute adjustment relative to the shelf **26**.

The variable speed driving mechanism for the work cage assemblies

Referring now to Figs. 1, 2 and 3, the spindles **176** which support the circular work-impelling plate associated with the two work-receiving cages **24** at the lapping zones L1 and L2 respectively are adapted to be driven from the lap plate driving motor M1 through an extension of the lap plate drive shaft **123**. The extension just referred to is in the form of a shaft **260** in alignment with the threaded stud **136** and the lower end of which is operatively connected to the stud by a pin and sleeve connection **262**. The shaft **260** is rotatably journaled as at **264** in the lower plate **69** of the superstructure **34**. The shaft **260** projects upwardly through the upper plate **64** of the superstructure and carries at the upper end the driving element or pulley **266** of the variable speed driving mechanism **84** which is preferably in the form of a conventional Reeves variable speed drive mechanism having an adjusting knob **267** associated therewith. The driven pulley **268** of the variable speed drive mechanism **84** is carried on a vertical shaft **270** which is rotatably journaled in bearings **272** and **274** provided in the upper and lower plates **64** and **69** respectively of the superstructure **34**. The shaft **270** carries a pinion **276** which meshes with a large gear **278** mounted on a shaft **280** rotatably journaled in the plates **64** and **69**. The shaft **280** carries a small pinion **282** which meshes with a gear **284** rotatably supported on the shaft **270**. The gear **284** forms one element of a spool gear assembly including a small gear **286** and this latter gear meshes with a pair of gears **288** and **290** each rotatably mounted on a short stub shaft **292** carried by the plate **69**. The gear **288** meshes with a large gear **294** carried at the upper end of the spindle **176** of the circular work-impelling plate **170** at the lapping station L1. The gear **290** (Fig. 2) meshes with a gear **296** carried at the upper end of the spindle **176** associated with the work-impelling plate **170** at the lapping station L2. From the above description it will be seen that the two work-impelling plates **170** are adapted to be driven in common from the lap plate shaft extention **260** through a power train which includes the variable speed mechanism **84** and gears **276**, **278**, **282**, **284** and **286**, the power train thereafter dividing through the gears **288** and **290** to drive the gears **294** and **296** respectively associated with the two work-impelling plates **170**.

From the above description it will be seen that the work-impelling plates **170** associated with the two work-receiving cages **24** are adapted to be driven in the same direction and at the same uniform rate of speed, i. e. in a counterclockwise direction as viewed in Fig. 2. The rate of turning movement of these plates **170** is materially less than the rate of turning movement of the lap plate **14** and the variable speed drive mechanism **84** may be adjusted to vary the ultimate rate of rotation of the plates **170** within predetermined limits. The specific gear ratios involved are not essential to the present invention and, for illustrative purposes, it is stated that in the case of a lap plate **14** which is maintained at a constant rotation of fifty-eight revolutions per minute, the variable speed drive mechanism **84** should be capable of causing rotation of the two work-impelling plates **170** within the limits from 0.145 revolution per minute minimum to 1.160 revolutions per minute maximum. When the power train and its variable speed control mechanism are thus designed, the lapping cycle for each of the work pieces *w* may be varied from approximately one minute minimum to ten minutes maximum.

The lap plate trueing or conditioning mechanism at the conditioning station

Referring now to Figs. 2 and 3, the lap plate conditioning mechanism employed for the purpose of maintaining the upper surface of the lap plate substantially flat or slightly concave or convex as the case may be is similar in principle to the mechanism shown in the above mentioned patent to Bullard, 2,565,590, and this mechanism in the present instance includes the previously mentioned trueing tool or conditioning ring **22** which is in the form of a circular member open at both its upper and lower ends and which has a lower lap trueing or conditioning face **300**. The inner diameter of the ring 22 is preferably substantially equal to the radial width of the lap annulus **16** so that the ring **22** overhangs the outer and inner lap face peripheries **128** and **130**. The cross piece or bar **302** extends diametrically across the conditioning ring 22 and has its ends anchored by means of screws **304** to the upper surface of the ring. A stub shaft **306** projects upwardly from the center of the bar **302** and is connected by a universal coupling **308** to the lower end of a threaded rod **310**. The rod **310** projects vertically upwardly through a slot **312** provided in a web **314** formed on the extention **76** which projects laterally from the apron **66** of the superstructure **34**. The rod **310** is capable of being secured in the slot **312** at any desired degree of lateral adjustment by means of a clamping nut assembly **317**. A knob **318** carried at the upper end of the rod **310** permits the conditioning ring assembly **22**, **302** to be elevated to the surface of the lap plate **14** when desired.

From the above description it will be seen that because the wear ring **22** overhangs both the outer and inner peripheries **128** and **130** respectively of the lap annulus **16**, the inner radial width of the lap surface is operated upon. If the ring **22** is adjusted so that the extent of overhang is greater at the outside periphery **128** of the lap plate than at the inner periphery **130** it is obvious that a greater weight will be induced at the outer regions of the lap than at the inner regions thereof

so that the lap surface will be progressively worn to convex form. On the other hand, if the rod 310 is adjusted radially inwardly so that a greater degree of overhang exists at the inner periphery 130 than at the outer periphery 128, progressive wearing of the lap annulus 16 will take place in such a manner that the annulus will tend to become concave. Where the degree of overhang is substantially the same at both peripheries 128 and 130, the tendency will be for the lap annulus to become substantially flat.

The electrical control instrumentalities

The major components of the illustrated machine are the main motor M1 which drives the lap plate 14 and the work-impelling instrumentalities at the lapping zones L1 and L2; the agitator motor M2 carried on the control housing and agitator tank assembly 48, 36; the motor M3 for the feed belt mechanism 29; and the solenoid 45 which controls the operation of the valve 44 for opening and closing the orifice 43. These major components are shown diagrammatically but are not specifically described since they are of no special significance in so far as the present invention is concerned. Still other components of the control system include manually operable switches S1, S2 and S4 mounted on the control housing 48 and switch S3 which may be mounted on the plate 240 (Fig. 5) associated with the feed belt assembly 29.

These electrical control instrumentalities are shown in the circuit diagram of Fig. 10 wherein the switch S1 is shown as being disposed in a motor circuit common to the motors M1 and M2 while switch S3 is disposed in a circuit for the motor M3. Upon closure of the switch S1 a circuit will be established from one side of the powerline through lead *a*, switch S1, leads *b* and *c*, the motor M1 and lead *d* to the other side of the line thus setting the lap plate driving motor into operation. If the switch S2 is closed, closure of the switch S1 will also establish a circuit from one side of the line through lead *a*, switch S1, leads *b*, *e*, switch S2, lead *f*, the motor M2 and lead *g* to the other side of the line. Ordinarily the switch S2 will remain closed so that closure of the switch S1 will immediately set the motors M1 and M2 into operation. However, if for any reason it is desired to operate the lap plate without operating the agitator motor M2, the switch S2 may be opened. The switch S3 is disposed in the circuit for the motor M3 which drives the feed belt 31 and for convenience this switch may be mounted on the plate 240 (Fig. 5). Upon closure of the switch S3 the circuit is established from one side of the line through lead *h*, switch S3, lead *k*, motor M3 and lead *m* to the other side of the line. The switch S4 for the solenoid 45 which controls the opening and closing movements of the outlet orifice 43 for vehicle and grit is disposed in the solenoid circuit and upon closure thereof a circuit will exist from one side of the powerline through lead *n*, switch S4, lead *o*, the solenoid 45 and lead *p* to the other side of the line thus exercising the solenoid and causing the valve 44 to be withdrawn from the orifice 43.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only in so far as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

What we claim and desire to secure by Letters Patent is:

1. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation to the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations and substantially the level of the lap surface, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-receiving cage assembly comprising a stationary confining ring having its major portion overlying the lap surface and the remaining portion thereof overlapping said support at the work-receiving and discharge stations, there being a peripheral work-receiving opening through said ring above said stationary support at the work-receiving station, and a work-impelling carriage concentrically disposed within said ring, said carriage having a series of open recesses in the peripheral regions thereof, said recesses, in combination with the inner surface of said ring, defining a series of work-receiving pockets, means holding the articles in the recesses for rotation about an axis parallel with the lap axis, and means for rotating said carriage to bring said recesses successively into register with said work-receiving opening above the stationary support so as to receive articles therein through said opening and to thereafter slide said articles within said pockets from the support and transfer them to the lap surface and move the same progressively over the lap surface from the receiving station to the discharge station.

2. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation to the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations and at substantially the level of the lap surface, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-receiving cage assembly comprising a stationary confining ring having its major portion overlying the lap surface and the remaining portion thereof overlapping said support at the work receiving and discharge stations, there being a peripheral work-receiving opening through said ring above said stationary support at the work-receiving station, and a work-impelling carriage concentrically disposed within said ring, said carriage being in the form of a circular plate having a series of open circumferential spaced recesses in the peripheral regions thereof, said recesses, in combination with the inner surface of said ring, defining a series of work-receiving pockets, means holding the articles in the recesses for rotation about an axis parallel with the lap axis, and means operatively connecting said carriage and lap plate in driving relationship so as to continuously rotate said carriage and bring said recesses successively into register with said work-receiving opening above said stationary support to receive articles therein through said opening and to thereafter slide said articles within said pockets from the support and transfer

them to the lap surface and move the same progressively over the lap surface through said predetermined path of movement from the receiving station to the discharge station.

3. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines and offset from the vertical axis of the lap, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation to the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-impelling mechanism including a stationary guide member having a portion thereof overlapping said support at the work-receiving station, there being a work-receiving opening extending through said guide member at the work-receiving station, and a work-impelling carriage positioned adjacent said guide member, said carriage having a series of open recesses which, in combination with a face of said guide member, define a series of work-receiving pockets, means holding the articles in the recesses for rotation about an axis parallel with the lap axis, and means for moving said carriage to bring said recesses successively into register with said work-receiving opening to receive articles therein through said opening and to thereafter conduct said articles within said pockets progressively over the surfaces of the lap plate from the receiving station to the discharge station.

4. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation to and at the level of the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-receiving cage assembly comprising a stationary confining ring having a portion thereof overlapping said support at the work-receiving and discharge stations, there being a peripheral work-receiving opening through said ring at the work-receiving station, and a work-impelling plate of circular configuration concentrically disposed within said ring and having a series of circumferentially spaced open recesses in the peripheral regions thereof, said recesses in combination with the inner surface of said ring defining a series of work-receiving pockets, means for rotating said plate to bring said recesses successively into register with said opening so as to receive articles therein through said opening and to thereafter conduct said articles within said pockets progressively over the surface of the lap plate from the receiving station to the discharge station, and means carried by said plate and movable bodily therewith and designed for cooperation with an article disposed in each pocket for applying pressure to the article to increase its degree of frictional contact with the lap surface during movement of the article through the lapping zone, said last mentioned means including a pivoted support for the pressure applying means to permit the article to rotate about an axis parallel with the axis of the lap.

5. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation to and at the level of the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-receiving cage assembly comprising a stationary confining ring having a portion thereof overlapping said support at the work-receiving and discharge stations, there being a peripheral work-receiving opening through said ring at the work-receiving station, and a work-impelling plate of circular configuration concentrically disposed within said ring, said plate having a series of open recesses in the peripheral regions thereof, said recesses, in combination with the inner surface of said ring, defining a series of work-receiving pockets, means for rotating said carriage to bring said recesses successively into register with said work-receiving opening so as to receive articles therein through the opening and to thereafter conduct the articles within said pockets progressively over the surface of the lap plate from the receiving station to the discharge station, a support carried by said plate and having a portion thereof overlying each recess, a pressure-applying weight suspended from each support and in register with its respective recesses, said weights being adapted to receive therebeneath the articles introduced into the various recesses and to rest thereon by gravity during passage of the articles through the lapping zone to increase the degree of frictional contact between the articles and the lap surface, and means rotatable about an axis parallel with the lap axis for mounting the weight on the support.

6. In a lapping machine, a base, a lap plate mounted on said base for rotation about a vertical axis and having an upwardly presented substantially flat lap surface, means establishing a lapping zone above the lap surface in one sector of the circular lap confines, means establishing a work-receiving station and a work discharge station adjacent said lapping zone, a stationary work support positioned on one side of said lap plate and having an inner edge disposed in contiguous relation by the rotating peripheral edge of the lap surface in the vicinity of both said receiving and discharge stations, a work-receiving cage assembly adapted to successively receive articles of work from said support at said receiving zone and to transfer said articles from the support onto the surface of the rotating lap plate in lapping relationship with respect thereto and to thereafter conduct the articles through a predetermined path of movement in said zone over said lap surface and to finally restore the articles to said support at the discharge station, said work-receiving cage assembly comprising a stationary confining ring having a portion thereof overlapping said

support at the work-receiving opening formed in said ring at the work-receiving station, and a work-impelling plate of circular configuration concentrically disposed within said ring, said plate having a series of open recesses in the peripheral regions thereof, said recesses, in combination with the inner surface of said ring, defining a series of work-receiving pockets, means for rotating said plate to bring said recesses successively into register with said work-receiving opening so as to receive articles therein through the opening and to thereafter conduct the articles within said pockets progressively over the surface of the lap plate from the receiving station to the discharge station, a leaf spring secured to said plate in the vicinity of each recess and movable bodily with the plate, said spring having a portion thereof overlying the recess and having its free end overlying said ring, a weight rotatably suspended from said spring and in register with the recess, said weight in the normal position of the spring being adapted to bear downwardly against an article contained in the recess to increase the effective lapping pressure of the article on said lap plate, said ring having an upwardly presented cam surface formed thereon in the vicinity of said opening, said cam surface extending above the normal level of the free end of said spring, the free end of said spring being adapted to ride upwardly on said cam surface to flex the spring and elevate the weight carried thereby to cause the latter to clear an article introduced into the recess through said opening at the receiving zone.

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U. S. DEPARTMENT OF COMMERCE

PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,821,818 February 4, 1958

Harold E. McGee et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 13, line 39, for "surfaces" read --surface--; column 14, line 63, for "relation by" read --relation to--.

Signed and sealed this 1st day of April 1958.

(SEAL)
Attest:
KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents