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H. S. INDGE

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LAPPING MACHINE

Filed July 21, 1930

3 Sheets-Sheet 1

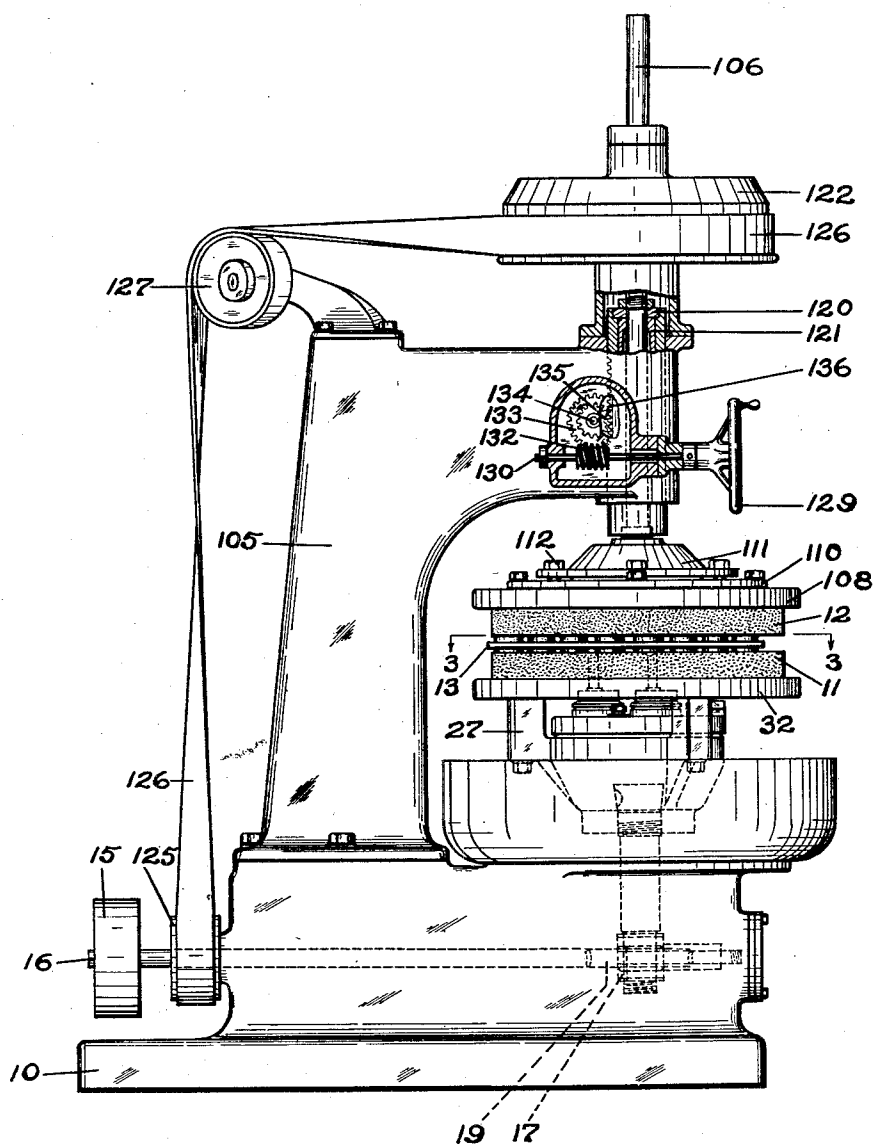


FIG. 1

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3 Sheets-Sheet 2

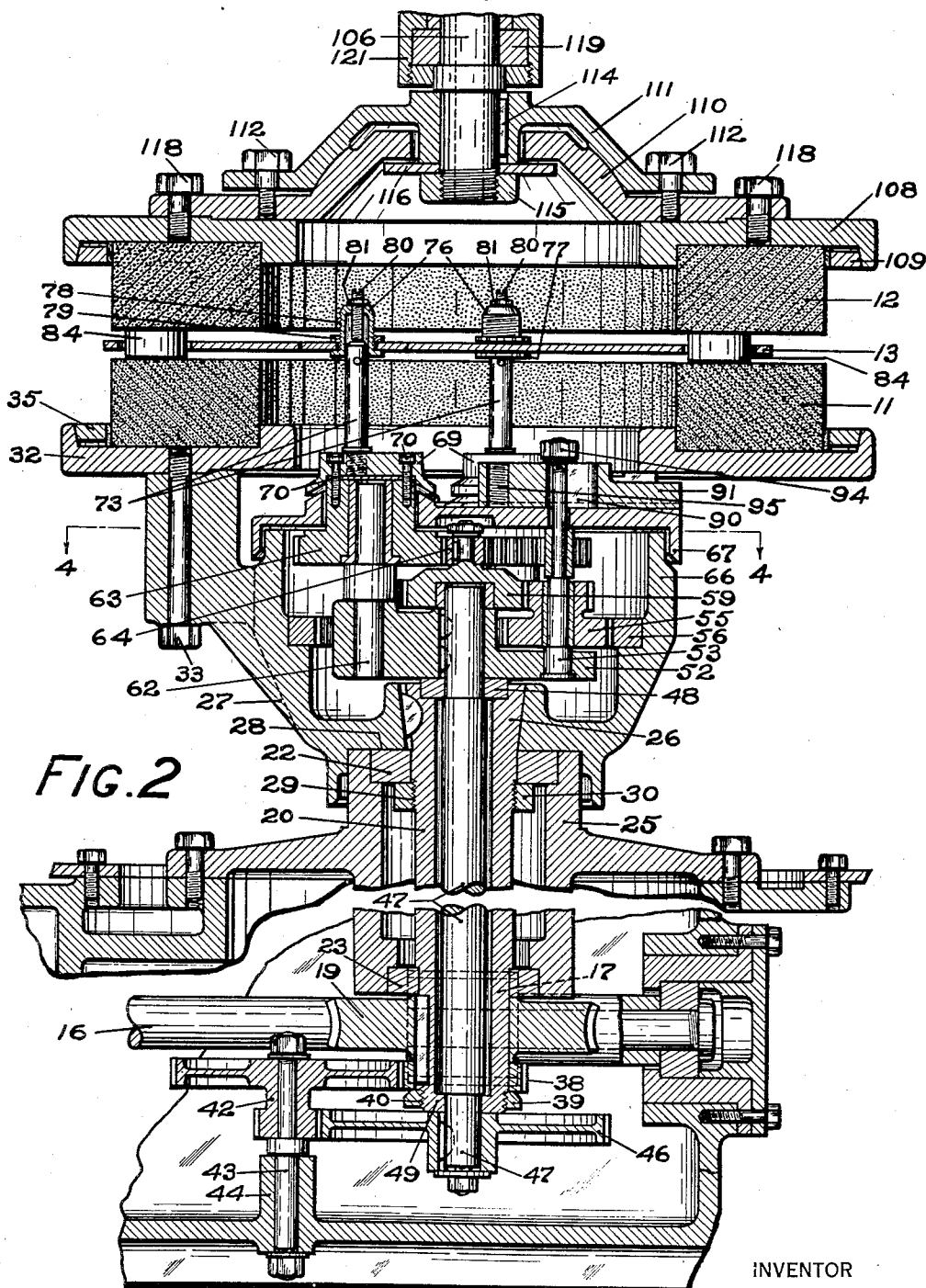


FIG. 2

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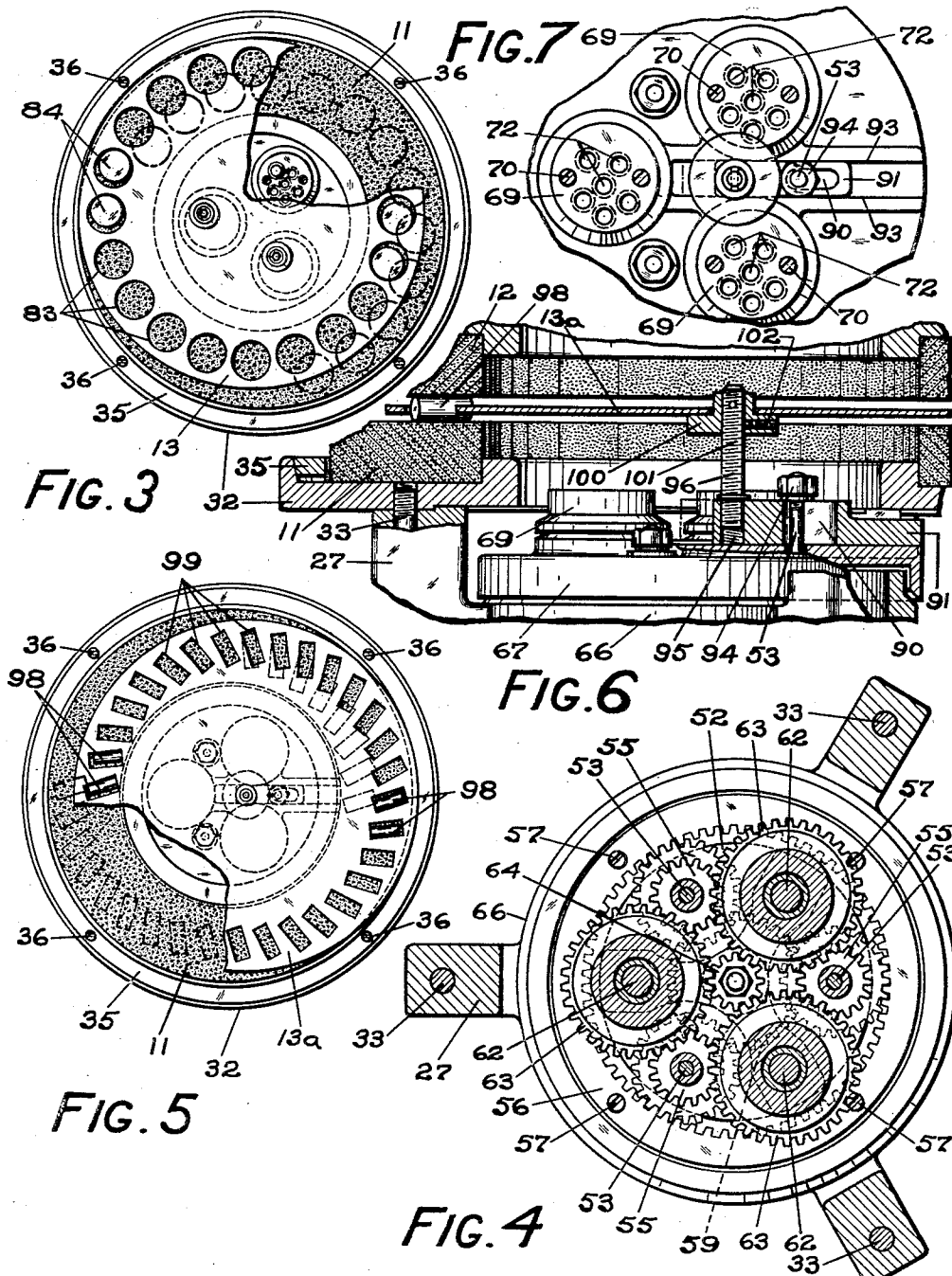
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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

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LAPPING MACHINE

Application filed July 21, 1930. Serial No. 469,367.

This invention relates to that type of grinding machinery commonly known as lapping machines and especially to a machine adapted to simultaneously and precisely lap duplicate surfaces on a multiplicity of similar work pieces which may be either flat or cylindrical in shape.

A machine of this general type has been utilized heretofore for lapping either the parallel flat surfaces of such articles as piston rings, metal disks and the like, or articles of cylindrical shape, such as automotive wrist pins as well as similar articles which require a high finish within extremely narrow limits of accuracy. In such machines, a multiplicity of duplicate work pieces are placed within a work positioning or work retaining cage which guides them through a combined rotating, sliding and eccentric break-up motion while in engagement with the two opposed metal laps charged with abrasive, one or both of which may be fixed against rotation. It has often been the practice in such machines to rotate the lower lap and the work cage at different rates of speed and to permit the upper lap to rest upon the work by the force of gravity. Owing to the increased popularity of lapped automotive parts and the exacting demands of the machine industry for accurately finished moving parts, this type of lapping machine has been found too slow in its operation and consequently expensive to use. The metal laps frequently lose their form and have to be removed from the machine for a truing and recharging operation which is expensive and involves considerable loss of time as well as effort on the part of the operator.

The present invention relates to an improvement over this prior type of lapping machine and has for its primary object the provision of a lapping machine in which rotating abrasive wheels are used to lap a multiplicity of duplicate work pieces with extreme precision and great rapidity, and in which the work pieces are moved through a constantly changing path relative to the two rotating wheels and the rates of movement are such that the operative surface of each lap may be utilized efficiently and the abrading

action imparted to the work by each lap will be substantially identical.

With this and other objects in view, as will be apparent to one skilled in the art, this invention resides in the features set forth in the specification and covered by the appended claims.

In accordance with this invention, I have provided a lapping machine having two opposed abrasive laps, and preferably wheels of bonded abrasive grains, which are rotated at different rates and preferably in opposite directions while in operative engagement with a multiplicity of duplicate work pieces. If it is desired to lap the two opposed parallel surfaces of a multiplicity of flat work pieces, they are mounted within a work cage which is driven through a composite motion of rotation and gyration at such a rate that the work pieces retained therein are moved through a progressively changing path and receive an identical lapping action upon each of the surfaces being lapped. If it is desired to lap the peripheral surfaces of a multiplicity of cylindrical work pieces they are mounted within a work cage which is so arranged that it is freely rotatable about an eccentrically driven centering member, thus permitting the cylindrical work pieces to roll upon the lapping surfaces at a differential speed and also imparting a sliding action of the work pieces between the laps at the same time. Means are provided whereby the irregular path of the work pieces may be controlled and adjusted to different sizes of work. The gyratory motion of the work cage is usually so regulated that each work piece comes in contact with the entire operative surface of each of the laps before the completion of the lapping cycle, thereby causing an even wear upon the laps and making a truing of their operative surfaces rarely necessary.

Referring to the drawings which illustrate one embodiment of the invention and in which like reference numerals indicate like parts:

Fig. 1 is a vertical elevation partly in section showing the assembled lapping machine;

Fig. 2 is a sectional view showing the relative position of the laps and the work and associated driving mechanism during the lapping operation when the machine is adapted for flat lapping;

Fig. 3 is a fragmentary view taken approximately along the line 3—3 of Fig. 1;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 2;

Fig. 5 is a view similar to Fig. 3 but showing a work cage adapted to hold cylindrical work; and

Figs. 6 and 7 show the mechanism for supporting and driving a work cage adapted for cylindrical work.

Referring more particularly to the embodiment of this invention as illustrated, the lapping machine may be constructed in its general aspects similar to the machine disclosed in the United States patent to Indge No. 1,610,527 and this machine as herein illustrated comprises a base 10 adapted to support a lower lap 11 and an upper lap 12 between which is arranged a work guiding member or work cage 13. Both the upper and lower laps rotate, preferably in different directions. A composite motion of rotation and gyration is imparted to the work cage which causes the work pieces retained therein to move through a so-called eccentric break-up motion along a progressively changing path which may be regulated as desired.

Power may be supplied to the machine in any convenient manner, such as by a belt arranged to rotate a pulley 15 keyed to a shaft 16 journaled in the base 10 of the machine and arranged to rotate both the upper and lower laps as well as to transmit an irregular motion to the work cage. A worm 17 is fastened to the shaft 16 in such a position that it is constantly enmeshed with a worm wheel 19 keyed to a vertical sleeve 20 rotatably supported by bearings 22 and 23 secured within a hub 25 bolted to the base of the machine. The upper end of the sleeve 20 has a tapered head 26 and a spider member 27 is accurately fitted and keyed thereto. This spider member has a bearing surface 28 adapted to fit exactly against the top of bearing 22 and hub 25 and thereby support sleeve 20 and its associated parts in correct vertical position. To further secure said sleeve in correct vertical position, a threaded portion 29 is provided thereon just below the bearing 22 and a bearing nut 30 is locked in light contact with the under side of bearing 22 so that the sleeve will be free to rotate without any end-wise movement. A driving plate 32 is firmly mounted upon the spider 27 and secured there-to by bolts 33. The lower lap 11, which is illustrated as an annulus of ceramic bonded abrasive grains made like a grinding wheel, is firmly gripped by the driving plate and maintained as an integral part thereof by means of a retaining ring 35 fastened

to the driving plate by means of screws 36. Thus any rotary motion applied to pulley 15 is transmitted through shaft 16 and worm 17 to worm wheel 19, sleeve 20, spider member 27 and driving plate 32 to rotate the lower lap 11.

During rotation of the lower lap, the work cage 13 is moved through an irregular path. A gear 38 is keyed to sleeve 20 and maintained in position just below worm wheel 19 by a nut 39 screwed onto a threaded portion 40 on the lower end of the sleeve. A cluster gear 42, rotatably mounted on a stud 43 supported within a hub 44 of the base, is constantly in mesh with gear 38 on sleeve 20 and gear 46 which is fastened to a spindle 47 journaled within the sleeve 20 in bearings 48 and 49. At the upper end of the spindle, a head 52 is fastened so that it may rotate therewith and within the spider member 27.

The head 52 is provided with three studs 53 equally spaced from each other and equidistant from the spindle 47 about which they revolve. Upon each one of these three studs 53 is rotatably mounted a cluster gear 55, said gears being so positioned that they are constantly in mesh with an internal ring gear 56 secured to the spider member 27 by screws 57 as shown in Fig. 4, this spider being rotated with the lower lap. Each of these three cluster gears 55 also is constantly in mesh with a pinion 59 mounted for free rotation upon the upper end of the spindle 47. Three other studs 62 are fixedly supported by the head 52 equidistant from each other and also equidistant from the spindle 47 about which they revolve. Gears 63 are rotatably mounted, one upon each of the studs 62 in such positions as to be constantly in mesh with a pinion 64 concentric with and fixed to rotate with pinion 59.

A casing 66 forms an integral part of the spider member 27 and provides a container for a lubricant in which the gears may rotate. A cover 67 is provided to prevent dust and foreign matter from coming in contact with the moving parts and thereby causing wear. A cap 69 is fastened by screws 70 to the hub of each one of the three gears 63 so that it will rotate concentric therewith. Each cap has several duplicate tapped holes 72 located in various positions within its upper face. Work cage supporting and driving studs 73 are screwed into one of the threaded holes in each cap in corresponding positions and each stud has an adjustable supporting member at its upper end arranged to position and drive the work cage 13 between the two laps.

To adjustably support the work cage relative to the two opposed laps so that it will not contact therewith, I provide supporting heads 76 arranged to slidably fit over each one of the work cage driving studs 73. Each of these supporting heads has a flanged portion 77 arranged to engage the under side of

the work cage 13 and a threaded portion 78 over which a nut 79 may be screwed to engage the top face of the work cage. An adjusting screw 80 is threaded into the upper portion of each supporting head and engages the top of each stud 73 respectively. Thus the machine operator may turn each of these adjusting screws and accurately position his work cage between the opposed laps and then lock the screws in position by tightening a lock nut 81 against the top of each supporting head.

The work cage for flat lapping in my preferred construction comprises a metal disk or plate having a multiplicity of circular holes 83 within which flat work pieces 84 may be loosely retained. Three holes are also provided within which the supporting heads 76 may be secured. Thus when the lower lap rotates, a combined motion of rotation and gyration is transmitted to the work cage since rotation of pulley 15 transmits a similar motion of rotation through shaft 16, worm 17, worm wheel 19, gears 38, 42 and 46 to rotate spindle 47 and head 52 which carries the three work cage driving studs supported by gears 63 upon studs 62 fixed to the head 52.

During the rotation of spindle 47 and head 52 secured thereto, studs 73 revolve each about its own central support or stud 62, since the gear train comprising gears 38, 42 and 46 has been so selected that sleeve 20 and spindle 47 supported therein rotate at different rates. This different rate of rotation causes the three cluster gears 55 carried by studs 53 to roll upon ring gear 56 and to transmit rotary motion to the three gears 63 through the pinions 59 and 64 which are fastened together. Stud 73 which carry the work cage rotate with gears 63 and revolve eccentrically in synchronism about studs 62. These studs 62 are revolved slowly about the axis of the central spindle 47, and at the same speed. Consequently, the motion of revolution of studs 62 is compounded with the motion of revolution of stud 73 and thereby causes the work pieces in the cage to travel with a compound gyrating and revolving motion. By changing the position of the studs 73 the amount of eccentric motion imparted to the work cage during its rotation may be varied for different types and sizes of work.

If the operator desires to lap cylindrical work pieces, such as automotive wrist pins and the like, this machine may be quickly and easily adapted to accurately lap such work, as shown in Fig. 6. For lapping cylindrical work pieces, it has been found necessary to support the work cage so that it may freely and eccentrically rotate relative to the two opposed laps, thereby subjecting the work pieces to a combined rolling and sliding action between the laps for an

even abrading action. To accomplish this, I have made that one of the three studs 53 which is shown in Fig. 2 long enough to extend out through the cover 67 and through a slotted portion 90 in a member 91 which is slidably mounted on ways 93 upon cover 67. A nut 94 is screwed onto a threaded portion on the end of the elongated stud 53 and engages the top of member 91, clamping it firmly in any preadjusted position upon the ways 93. A threaded portion 95 is provided in one end of the member 91 so that a work cage centering stud 96 may be removably screwed therein.

When the machine operator desires to lap cylindrical work pieces, he removes the cage 13 adapted for flat lapping and unscrews each of the driving studs 73, whereupon he may mount stud 96 in member 91. A work cage 13a adapted to hold a multiplicity of cylindrical work pieces 98 within slotted portions 99 is rotatably mounted upon a hub 100 which is arranged to be screwed up and down a threaded portion 101 of stud 96 to adjust the work cage so that it may freely rotate between the two opposed laps without engagement therewith. When the hub 100 has been adjusted to the proper height, it may be locked in position by any convenient means, such as a set screw 102. The eccentricity of the work cage 13a may be easily regulated by loosening the nut 94 and sliding member 91 toward or from the axis of the laps. Thus the work cage will be free to rotate at a differential speed in the direction of the faster rotating lap as well as being driven through an eccentric motion about the axis of the laps.

A rotatable upper lap 12 of substantially the same size and structure as the lower lap is supported above the lower lap by a frame 105 mounted upon the base of the machine and also supports a feeding mechanism therefor. In order to permit rotation of the upper lap a spindle 106 is rotatably supported within the frame 105 and is provided with a head 108 to which the upper lap is firmly secured by a retaining ring 109. The head 108 is supported and driven by ball and socket members 110 and 111 which may be firmly secured together by screws 112 or which if loosened may be free to float within one another and thereby permit the upper lap to adapt itself to the upper surface of the work pieces and freely float thereupon. Member 111 is secured to spindle 106 by key 114 and nut 115 which engage member 111 through washer 116. Member 110 is firmly fastened to the head 108 by screws 118. Shaft 106 is journaled in bearings 119 and 120 within sleeve 121 in the frame 105. A pulley 122 is slidably keyed at the upper end of spindle 106 and is maintained in constant driving engagement with a pulley 125

keyed on the shaft 16, by a belt 126 which passes over idler pulleys 127.

To facilitate adjustment of the laps relative to the work, the upper lap is mounted so that it may be moved vertically toward and from the lower lap. To accomplish this, the sleeve 121 is slidably mounted within frame 105. A hand wheel 129 is secured to a shaft 130 mounted for rotation within bearings in the frame 105. A worm 132 is fastened upon shaft 130 and so positioned that it will be constantly in mesh with a worm wheel 133 which is fastened to rotate with a cross shaft 134 supported for rotation in suitable bearings in frame 105. A pinion 135 is also secured to cross shaft 134 and in such a position as to be constantly in mesh with a rack 136 cut within the face of sleeve 121. Thus rotation of the hand wheel 129 in either direction will rotate the worm 132, worm wheel 133 and pinion 135 causing the upper lap to move toward or from the lower lap.

The operation of this machine will be readily apparent in view of the construction as previously described. For the lapping of flat work as illustrated in Figs. 2 and 3, duplicate work pieces, which in the present instance are shown as metal disks 84, are each placed within one of a plurality of holes 83 in the work cage 13. The operator then turns hand wheel 129 to lower the upper lap 12 until it rests upon the work pieces by the force of gravity, after which the machine may be placed in operation by rotating pulley 15 with any suitable source of power. The studs 73 are so positioned within the various holes 72 that the eccentric travel of the work cage will carry each work piece across the entire width of the two opposed annular lapping surfaces during the lapping cycle and thereby cause the laps to wear away evenly. Each of the screws 80 is adjusted and locked in position so that the work cage 13 will be substantially parallel to the opposed lap surfaces and out of contact therewith.

By utilizing two rotating abrasive laps, I have found it practicable to reduce the speed of rotation of the work cage to a relatively slow rate as compared with machines of previous constructions. This slow rotation of the work cage permits the fast rotating abrasive lap to continuously and positively rotate each work piece within the work cage as it travels along its irregular, ever changing path and thus prevents the likelihood of excessive or uneven wear upon either the lap or the work pieces. In the preferred form of my invention, as illustrated, it has been found practicable to rotate the lower lap at approximately 113 R. P. M. in a counter-clockwise direction and the upper lap at approximately 97 R. P. M. in a clockwise direction. The work cage is usually rotated in the direction of the faster lap at approximately one-half the difference of the two opposed laps when

lapping flat work pieces. Thus the rate of rotation of the work cage in the present instance is 8 R. P. M. counter-clockwise. In machines of the previous constructions wherein one of the laps was fixed, it was found necessary to rotate the work cage at a much higher rate of speed. The centrifugal force caused by this excessively high rate of work cage rotation tended to throw the work pieces against the side of the work cage and create sufficient friction to prevent the work pieces from rotating within the cage properly during the lapping operation. Such a condition tended to leave abrading marks upon the work pieces and to wear them away at an uneven rate, thus seriously impairing the accuracy of the work being lapped.

Whenever it is desired to accurately finish cylindrical work, such as automotive wrist pins and the like, this machine may be quickly adapted to lap such work by removing the work cage 13 adapted for flat lapping and removing the cage driving pins 73, whereupon the stud 96 may be screwed into member 91 and the work cage 13a adapted for cylindrical work may be mounted thereupon as illustrated in Figs. 5 and 6. Since the work cage 13a is freely rotatable upon the adjustable hub 100, it may be positioned so that the cylindrical work pieces 98 retained therein will be free to rotate at a differential speed between the two opposed laps. During the rotation of the work cage, the centering pin 96 moves it through an eccentric motion which may be easily regulated by loosening nut 94 and sliding the member 91 on the ways 93 so that each work piece will travel across the entire width of the two annular lapping surfaces during the lapping cycle thus causing an even wear on both laps.

Bonded abrasive laps are used in this machine, since they not only abrade the work at a faster rate than do the metal laps charged with abrasive as used in prior machines, but also may be employed continuously until too thin for further usefulness. It is necessary to true the lapping surfaces only when they become unevenly worn and this rarely occurs unless the machine has had abusive treatment.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A lapping machine comprising two opposed laps and a work cage supported therebetween, a rotatable spider arranged to support one of the laps, a head mounted concentric with the spider and rotatable relative thereto, means to rotate said head and spider at different rates of speed, pinions rotatably mounted upon said head and spaced from its axis so as to revolve therewith, driving pins arranged to engage said work cage, each of said driving pins being eccentrically mounted upon one of said rotatable pinions, a ring gear arranged to rotate with said spider, and gears carried

by said rotatable head which engage the ring gear and said pinions and cause the work cage to move through a composite motion of rotation and gyration.

5 2. A lapping machine having two horizontally opposed rotatable annular laps of bonded abrasive grains, and a rotatable work cage interposed therebetween which is arranged to move a multiplicity of work pieces between
10 the opposed lapping faces, means for freely supporting the upper lap whereby it may accommodate itself to the top work surfaces, means for maintaining the cage operatively associated with the laps but out of abrading
15 contact therewith, mechanism to rotate said laps at high speeds in opposite directions, the rates of which are slightly different, and means to gyrate the work cage rapidly while causing it to rotate very slowly at a speed ap-
20 proximately half the difference between the speeds of the laps and in the direction of the faster rotating lap, whereby each work piece will be caused to follow an ever-changing path and move through a combined rotation
25 and rapid sliding motion over the entire operative surface of both of the opposed laps.

3. A lapping machine comprising two horizontally opposed rotatable concentric laps of bonded abrasive grains and a freely rotatable
30 work cage eccentrically mounted relative to the laps and arranged to maintain a multiplicity of work pieces interposed therebetween, mechanism to rotate both laps rapidly in opposite directions and at slightly different
35 rates, means for freely supporting the upper rotatable lap whereby said lap may accommodate itself to the top work surfaces, means to support the work cage out of contact with both laps and mechanism associated with the
40 lap rotating means adapted to revolve the work cage center rapidly about the axis of the laps and cause the work pieces to slide axially at a rapid rate as they roll rapidly along a progressively changing path over the entire sur-
45 face of both of the opposed rotating lap faces, the work cage being rotated slowly about its axis whereby the centrifugal force acting axially on the work pieces is minimized.

Signed at Worcester, Massachusetts, this
50 18th day of July, 1930.

HERBERT S. INDGE.

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