AUTOMATIC LAPPING MACHINES

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This invention relates to improvements in automatic lapping machines.

In the copending application of Alfred F. Lichtenfeld, Serial No. 860,957, filed December 21, 1959, now Patent No. 3,050,910, issued Aug. 28, 1962, a lapping machine is disclosed which represents an improvement over lapping machines of the prior art. The present invention has features not found or suggested in the lapping machine of the copending application supra, and provides further improvements in the art of lapping machines.

Briefly, the lapping machine of the present invention produces a uniform over-all wear of the rotary lapping plate surface. This is accomplished by providing counter-rotation of the work holding pot rotating means relative to the rotation of the lapping plate. As a result, relative speed between the rotating pot and the lapping plate is minimized in the region of maximum accurate speed of the lapping plate. In addition, the radial reciprocal movement of each pot is caused to take place progressively around the circumference of the lapping plate, so that definite wear patterns on the lapping plate surface will not be established.

Other features found in the lapping machine of the present invention, relate to the arrangement of the lapping compound retaining grooves formed in the surface of the lapping plate. These grooves are sloped in the direction of rotation of the lapping plate. As a result, the lapping compound is thus more uniformly and economically utilized.

Another feature relates to the use of a rubber V-belt on the pot rotating means. Such an arrangement not only assures slip-free transmission of pot turning motion, but affords more economical maintenance of the lapping machine since the cost of replacing the V-belt is so much less than if the eccentric cam, used in the pot rotating means, was to be replaced.

In addition, a work unloading platform is provided which greatly simplifies and accelerates work unloading operations.

Finally, it will be seen that the principles of the invention may be utilized for production of accessory parts which may be conveniently applied to any standard lapping machine, or can be utilized in the design of a lapping machine to be built as a new and complete unit.

The main object of this invention is to provide an improvement in automatic lapping machines.

A more specific object is to provide an improved lapping machine wherein more uniform over-all wear of the lapping plate is achieved.

Another object is to provide an improved lapping machine wherein the lapping compound used in a lapping operation is more uniformly and economically utilized.

Still another object is to provide a pot rotating means which not only assures slip-free action, but which affords lower maintenance or replacement costs.

A further object of the invention is to provide simplified and accelerated work unloading operations.

Another object is to provide a means for unloading work from the machine which can be applied to either already built lapping machines, or which can be incorporated in the design of new machines.

These and further objects and features of the invention will become more apparent from the following description and accompanying drawings wherein:

FIG. 1 is a plan view of a lapping machine illustrating an embodiment of the invention;

FIG. 2 is an elevation view of same;

FIG. 3 is a partial section view (enlarged) generally as seen along line 3—3 in plane FIG. 1 or FIG. 2;

FIG. 4 is an enlarged section view generally as seen along line 4—4 in FIG. 1;

FIG. 5 is a section view generally as seen along line 5—5 in FIG. 4; and

FIG. 6 is a fragmentary view showing the arrangement of a surface groove as used in a lapping plate of the machine of FIG. 1.

Referring now to the drawings, the numeral 10 identifies a lapping machine incorporating the principles of the invention, which machine includes a square table top 12 having supporting legs 14 whereby the top may be supported at a convenient working height above the floor. A lapping plate 16, which is disc-like in form, is mounted for rotation upon a large radial thrust bearing 18 supported on a horizontal shelf 20 suspended below the table top 12. The lapping plate 16 projects through a hole in the table top a distance of approximately one inch above the table top. A driving motor 22 is positioned upon a suitable shelf 24 secured to the table legs 14. A gear reducer 26 may be associated with the motor 22, to reduce the speed of a first bevel gear 28 which meshes with a second bevel gear 30 secured to a vertically disposed drive shaft 32 arranged for rotation of the lapping plate 16. The rotational speed of the lapping plate may be varied by suitable motor control means, however, a speed of approximately 60 r.p.m. will be found satisfactory for most lapping operations.

The lapping plate 16 is formed with a plurality of radially arranged grooves, or slots 34 on the upper surface, which, as best seen in FIG. 6, have parallel side walls disposed at an angle of approximately 45° relative to the surface of the lapping plate, and extend in the direction of rotation thereof. The number and dimensions of the slots 34 may vary depending upon size of the lapping plate, however, in the embodiment illustrated wherein the diameter of the lapping plate 16 is approximately two feet, it was found that twelve slots having a width of approximately one-eighth inch and a depth of approximately one-quarter inch, produced satisfactory results in lapping items of diversified size. The slots 34 function as reservoirs for lapping compound during lapping operations. The sloping arrangement of the slots 34, will be found to provide dispensing of the lapping compound as needed for most effective lapping operations. Regarding type of lapping compounds, such are of course, well known, and selection may easily be made by those skilled in the art for any given type of work to be performed by the lapping machine.

A recess 36 is formed in the upper surface of the lapping plate 16 for receipt of the flange 38 having an integrally arranged projection, or shaft 40 extending upwardly therefrom. The flange 38 is removably secured within the recess 36 by fastening means, such as bolts 42, so that the axis of the shaft 40 coincides with the axis of the lapping plate 16.

An epicyclic gearing arrangement is provided which includes an inner driving gear 44 keyed to the shaft 40, an outer driven gear 46, and a plurality of equi-angularly disposed pinions 48, which transmit driving rotary movement from the driving gear 44 to the driven gear 46. The pinions 48 are rotatably mounted upon shafts 50 which project from a disc 52 supported upon a bushing 54 surrounding the shaft 40 and in engagement with the flange 38. A keeper rod, or arm, 56 is affixed at one end to the disc 52, the other end of the rod being anchored to the table top 16. The rod 56 is bent to provide clearance with work carrying pots, as will later be ap-
It will be seen that such an arrangement maintains the disc 52 against rotation thus rendering the pinion shafts 50 stationary so that the drive gear 44 may transmit rotary motion to the driven gear 46 via the pinions. It is pointed out that the difference in number of gear teeth between gears 44 and 46, causes differential motion therebetween. By careful selection, certain differential ratios may be obtained which is desirable for reasons more fully understood hereinafter. A gear ratio of 48 teeth on the gear 44, to 75 teeth on the gear 46, will be found satisfactory as a differential ratio.

An eccentric lapping pot cam, or driving wheel assemble blage 58, which has an elliptical peripheral shape, is arranged for mounting to the driven gear 46. Toward this end, and as best seen in FIG. 4, a lower ring member 60 is rigidly secured, as by press-fitting, to the driven gear 46, while an upper ring member 62 is affixed to the lower ring member 60, by fastening means such as bolts 64. The edges of the ring members 60 and 62 are formed to provide a peripheral recess, or groove 64, adapted to snugly receive a V-belt 66, which is formed of rubber, or equivalent high friction material. The upper ring member 62 is secured to a thrust bearing 68, which is mounted upon the shaft 40 above the driving gear 44.

It will be seen, that the thrust bearing 68 supports the driving wheel assembly 58, as well as the driven gear 46. A cover piece 70, including a thrust bearing 72, is affixed to the shaft 40 by a fastening means, such as a bolt 74, whereby the driving wheel assembly 58 is maintained in operative position.

A plurality of lapping pots 76, four in number being shown, which are of ring-like form, are positioned upon the lapping plate 16, which pots have an outside diameter less than the radial distance between an edge of the driving wheel assembly (at minor axis) and an edge of the lapping plate, as best seen in FIG. 1. It is to be noted that the major axis of the driving wheel is such that maximum radial distance movement of a pot 76 will not allow overlay of the pot inner diameter relative to the edge of the lapping plate 16.

Pot holding means in the form of a stationary arm 78, and an axial reciprocally arranged arm 80, are provided for each pot 76. The arms 78 and 80 each have a wheel, or roller 82 and 83 pivotally affixed to an end thereof, which are in rolling engagement with a pot. In such manner, three moving point contacts are made upon each pot, one contact being made by the belt 66, and the other two by the rollers 82 and 83. The movable arm 80 is slidably mounted in a holder 84 secured to the table 12, and has a compression spring 86 which constantly urges the wheel 82 at the end of the arm, against the side of a pot 76.

It will be seen that the arrangement above described, causes a radially reciprocal movement of each pot while it is rotated counter-clockwise about its axis. Since rotation of the lapping wheel 16 is likewise in a counter-clockwise direction, the relative rotational movement between the pot and the lapping wheel will be minimum toward the edge of the lapping plate, while said movement will be maximum toward the lapping pot driving wheel 58. Such relative movement contributes to more uniform wear of the surface of the lapping plate 16, because relative rotational movement between the pot and the lapping plate is minimized at the region of greatest peripheral speed of the latter. The situation would be just the reverse if the rotational direction of the driving wheel assembly 58 and the lapping plate was the same.

While the indicated movement of the lapping plate 16 and driving wheel assembly 58, has been indicated as counterclockwise and clockwise respectively, obviously such rotational directions could be reversed, if so desired, with equally good effect. In such event, it will, of course, be necessary to have a reverse slope on the grooves 34, as well as a reversal of the fixed and movable holding arms 78 and 80.

It will also be seen that the tooth ratio of the drive gear 44 and driven gear 46, is such as to cause a progressive change in relative movement of each pot upon the lapping plate during rotation of the lapping plate. With the gear ratio specified, i.e., 48 teeth on gear 44, and 75 teeth on gear 46, the lapping plate must make twenty-five revolutions before a radial movement of a pot in a given pattern on the lapping plate will reoccur. Such action also contributes to more uniform wear of the lapping surface of the lapping plate 16.

It will be understood, of course, that work pieces 87 to be lapped are placed in each pot 76, and a weighted cover (not shown) may be placed in the pot to press the work pieces downwardly upon the lapping plate.

For convenience in unloading each pot 76 after completion of a lapping operation, one or more platforms 88 may be provided between adjacent pot holding arms 78 and 80. Each platform has a curved inner edge 90, with a radius slightly greater than that of the lapping plate, whereby the platform will be closely positioned adjacent the peripheral edge of the lapping plate 16, and a pair of legs 92 arranged to engage holes 94 formed in the table top 12, as well as a pair of legs 96, which rest upon the table top. The top of the platform 88 is a slight distance below the top of the lapping plate 16, as best seen in FIG. 3. In unloading a pot after completion of a lapping operation, the pot is slid upon the platform whereupon the work pieces 87 will be deposited thereupon.

From the foregoing it will be seen that the described embodiment will satisfy all of the objectives set forth hereinbefore. Attention is directed to the fact that the disclosed embodiment may be conveniently applied to most types of lapping machines now in commercial use. The principles thereof could be used to design a machine wherein further simplification can be realized. Toward such end, the counter-rotation of the driving wheel assembly 58 relative to the lapping wheel 16, as required for attainment of certain objectives, could be effected by a secondary shaft extending axially through the lapping wheel, which secondary shaft may be driven directly by the motor means 22.

The foregoing description has been given in detail without thought of limitation since the inventive principles involved are capable of assuming other forms without departing from the spirit of the invention or the scope of the following claims.

What is claimed is:

1. A lapping machine including in combination, a lapping plate arranged for rotary movement in a given direction, a pair of arm members arranged for rolling contact engagement with a lapping pot when the latter is placed in operative position upon the lapping plate, one of said arm members being resiliently urged into contact with a lapping pot, an eccentric cam positioned for engagement with the lapping pot and adapted to cause rotary movement of the lapping pot, and means to rotate the eccentric cam in a direction opposite to that of the lapping plate during a lapping operation.

2. A lapping machine according to claim 1, wherein said means for rotation of the eccentric cam comprises a differential gear assembly including an inner gear mounted for rotation with the lapping plate, an outer gear rotatably supported by a central shaft secured to the lapping plate, and at least one pinion mounted upon a shaft and positioned for engagement with the teeth of the inner gear and the teeth of the outer gear, and holding means to restrict the pinion shaft against movement in any direction.

3. A lapping machine according to claim 2, wherein said holding means includes a disc which is rotatably mounted upon the central shaft and which is arranged to support said pinion shaft, and a rod rigidly affixed at one
end to said disc and adapted to be anchored at the other end against movement.

4. A lapping machine according to claim 3, wherein the eccentric cam has an elliptically shaped peripheral surface.

5. A lapping machine according to claim 4, wherein a friction material is arranged upon the peripheral surface of the eccentric cam.

6. A lapping machine according to claim 5, wherein said friction material is a rubber belt.

7. A lapping machine according to claim 1, wherein a table top is arranged about the peripheral surface of the lapping plate and at a given distance below the surface of the lapping plate, and at least one movable platform is provided upon the table top, which platform has an inner edge adjacent the periphery of the lapping plate, said platform being arranged so that the surface thereof is slightly below the surface of the lapping plate.

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