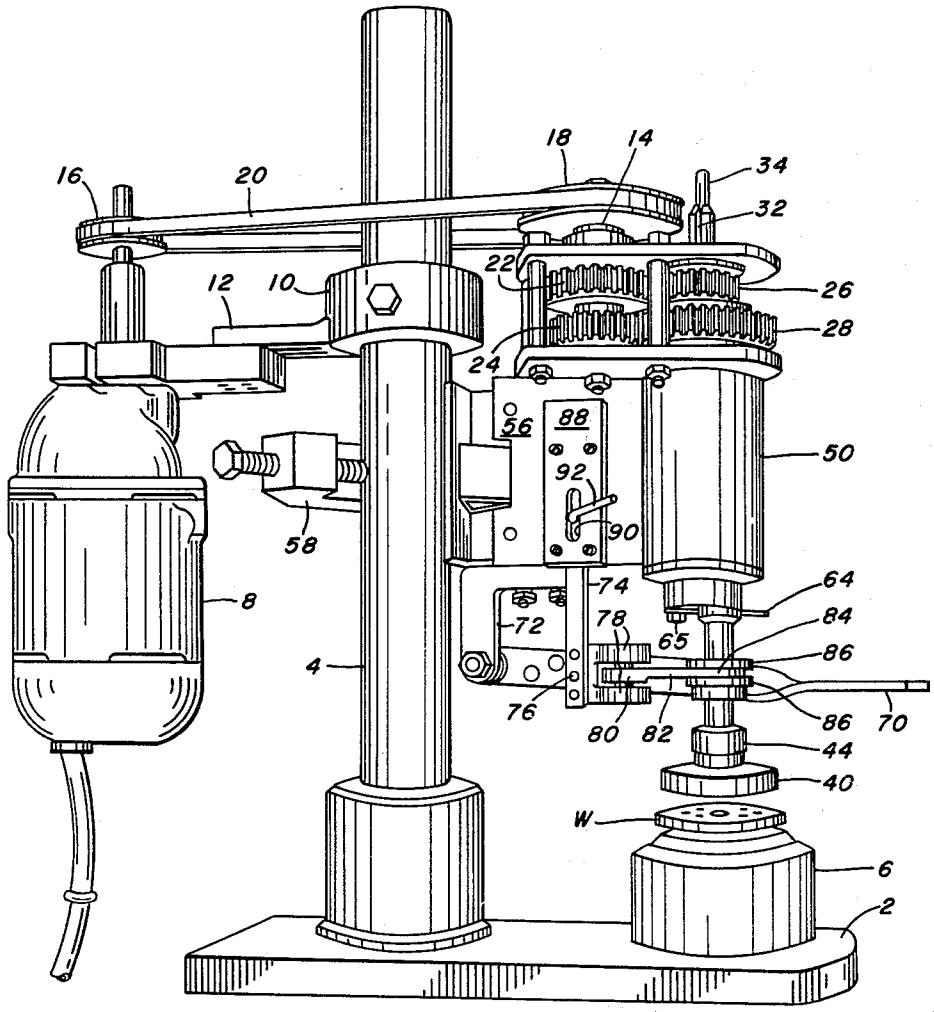
March 9, 1965 C. J. HABENICHT 3,172,241

LAPPING MACHINE

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FIG. 1.



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FIG. 2.

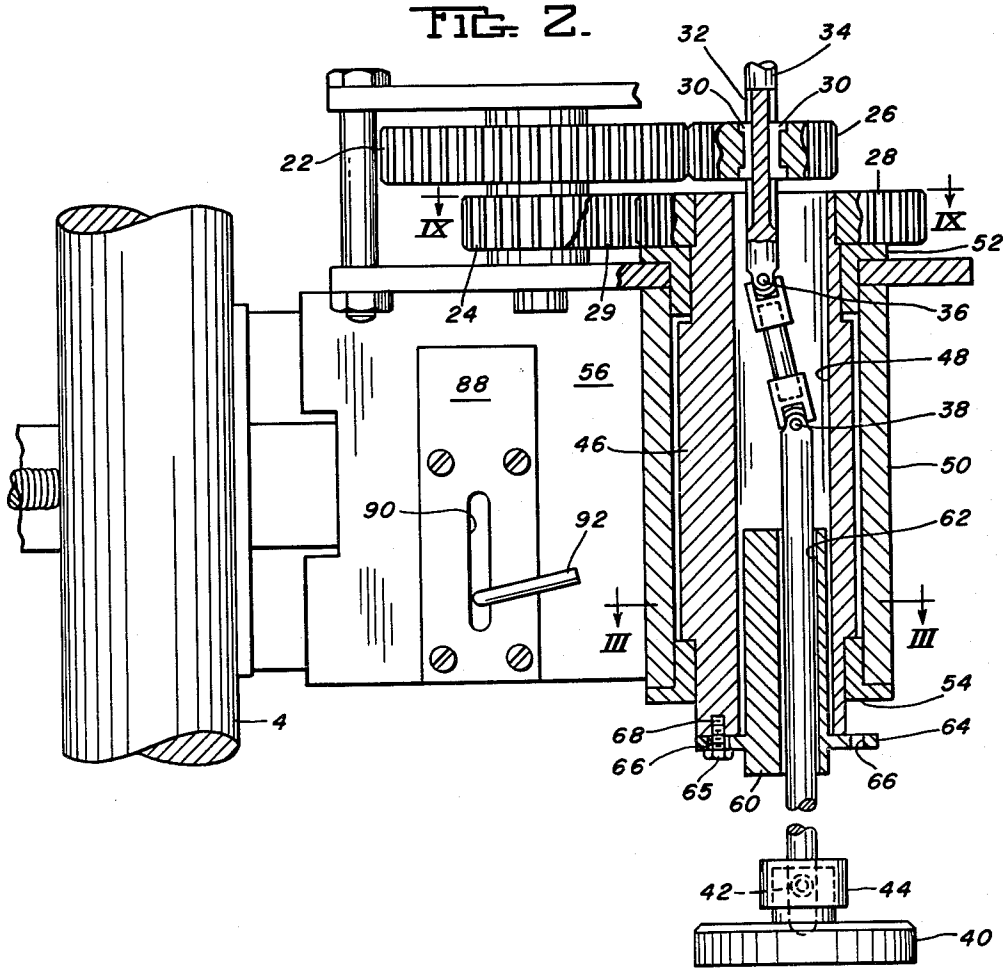


FIG. 4.

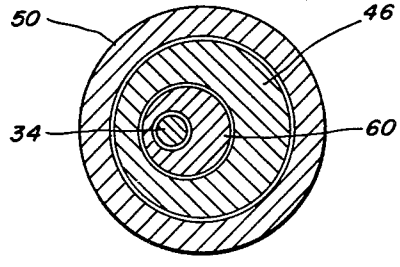
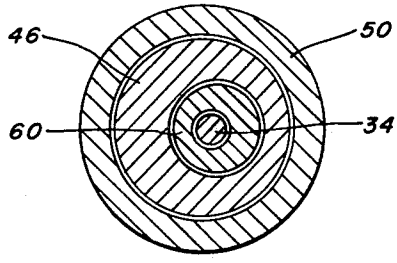


FIG. 3.



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FIG. 5.

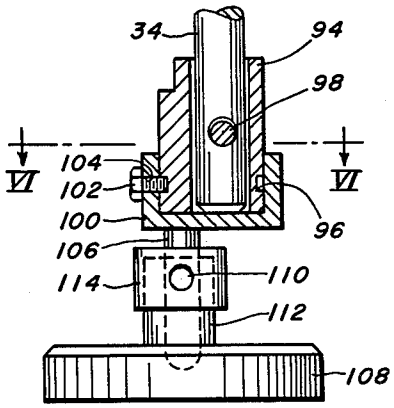


FIG. 8.

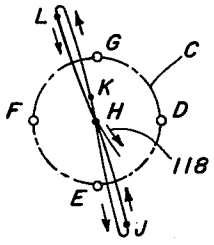


FIG. 6.

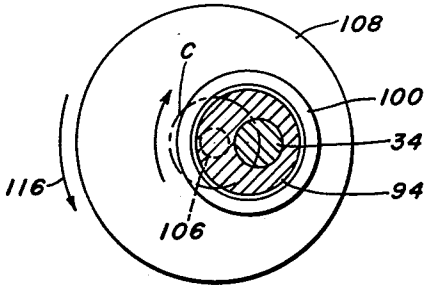


FIG. 7.

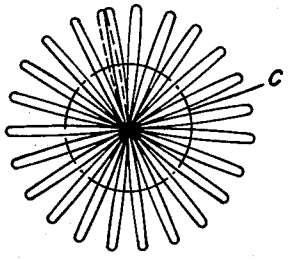
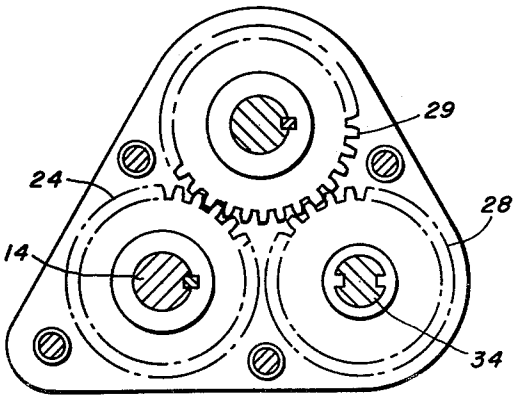


FIG. 9.



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LAPPING MACHINE

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Filed Feb. 15, 1963, Ser. No. 258,874
3 Claims. (Cl. 51—120)

The present invention relates generally to lapping machines and more particularly to an improved lapping machine for reconditioning or renewing flat surfaces of metal objects.

Although not restricted thereto, the apparatus of the invention is especially suitable for reconditioning valves and valve seats and in such use it will be described.

As is known, the compressed air systems of diesel locomotives contain a large number of valves and valve seats and it is usually necessary to dismantle these compressed air systems approximately every six months so that the valves and valve seats can be reconditioned by lapping or polishing to remove scratches, wear spots, pits, and other surface irregularities. Prior to my invention this lapping process was carried on manually using a metal disk with an abrasive powder to cut or polish the valve and valve seat. This manual lapping method was excessively time consuming and consequently uneconomical, for example, four brake valves of a typical diesel engine compressed air system required five hours per valve for reconditioning and nine compressor valves of the system required two hours each for surface renewal.

It is, accordingly, the primary object to my invention to provide a power-operated lapping machine having a novel spindle arrangement including an outer spindle having an eccentric bore, a stub shaft having an eccentric bore fitted into and rotatable with the outer spindle, and a lapping spindle journaled in the eccentric bore of the stub shaft whereby the stub shaft can be rotatably adjusted relative to the outer spindle to enlarge or diminish the orbit of the gyratory path of travel of the lapping spindle.

As a corollary to the above object, it is a further object of my invention to provide in a spindle arrangement of the character described, unique mounting means for attaching the stub shaft to the outer spindle whereby the stub shaft can be readily and easily mounted in any one of several rotatably adjusted positions.

It is another object of my invention to provide a power-operated lapping machine having a novel spindle arrangement including an outer spindle having an eccentric bore, a stub shaft having an eccentric bore fitting into and rotatable with the outer spindle, a lapping spindle journaled in the eccentric bore of the stub shaft but geared to rotate in the opposite direction, and a lapping disc eccentrically fixed to the lapping spindle.

It is a further object of my invention to provide a lapping machine as set forth in the object immediately above which provides an improved lapping motion over the action of other lapping machines, which motion more nearly approaches the modified figure-eight pattern of hand lapping.

These and other objects will become more apparent after referring to the following specification and attached drawings, in which:

FIGURE 1 is a perspective of the lapping machine of the invention;

FIGURE 2 is an enlarged partial sectional view;

FIGURE 3 is a horizontal sectional view taken along the line III—III of FIGURE 2 showing the path of gyration of the lapping spindle of the invention in broken lines;

FIGURE 4 is a horizontal sectional view similar to FIGURE 3 but showing the lapping spindle positioned 180 degrees from the position shown in FIGURE 3 and the path of gyration of the lapping spindle in broken lines;

FIGURE 5 is a partial vertical sectional view showing a modified embodiment of the invention;

FIGURE 6 is a horizontal sectional view taken along the line VI—VI of FIGURE 5;

FIGURE 7 is a schematic view showing the pattern described by the center of the lapping disc of the modified embodiment of the invention shown in FIGURE 5 during its operation;

FIGURE 8 is a schematic illustration of the relative movements of the lapping disc and lapping spindle of the modified embodiment of the invention; and

FIGURE 9 is a cross-sectional view taken along the line IX—IX of FIGURE 2.

Referring more particularly to the drawings reference numeral 2 designates a base having an upright support 4 and a work holder 6 thereon. An electric motor 8, which is mounted on the support 4 by means of a collar 10 and attached supporting bars 12, drives a shaft 14 through pulleys 16 and 18, and a drive belt 20 trained around the pulleys.

Two gears 22 and 24 are keyed to the shaft 14. Gear 22 is in mesh with and drives a gear 26, while gear 24 drives gear 28 through an intermediate pinion 29, as best shown in FIGURE 9, so that gear 28 rotates in the direction opposite to the direction of rotation of gear 26. Gears 26 and 28 are arranged in such a manner that gear 28 rotates somewhat more slowly than gear 26. For example, while gear 26 makes one revolution, gear 28 may make 0.92 revolution in the opposite direction. As best shown in FIGURE 2, gear 26 has two keys 30 which fit into longitudinal keyways 32 formed in the outer peripheral surface of a lapping spindle 34. This arrangement permits the spindle 34 to slide vertically while still engaged by the gear 26.

Spindle 34 is divided into an upper shaft and a lower shaft connected by universal joints 36 and 38. A metal lapping disk 40 is loosely pivoted on the lower end of the spindle 34 by means of a pin 42 which passes through aligned holes in the spindle 34 and disk 40. A retaining ring 44 fits over the pin 42. The ring 44 can be raised along the spindle to permit removal of the pin 42 and replacement of the lapping disk 40.

The gear 28 is keyed to the upper portion of an outer spindle 46 which has an eccentric longitudinal bore 48 therethrough. The lapping spindle 34 extends through the eccentric bore 48. The outer spindle 46 is enclosed in a bearing sleeve 50 and is journaled in bearings 52 and 54 disposed in the top and bottom, respectively, of the bearing sleeve. The bearing sleeve 50 is welded or otherwise rigidly connected with a frame 56 which in turn is rigidly mounted on the upright support 4 by a clamp 58.

An adjusting sleeve in the form of a stub shaft 60 having a longitudinal eccentric bore 62 extending therethrough is fitted in the bottom end of the bore 48 of the outer spindle 46. The lower shaft of the lapping spindle 34 is journaled in the eccentric bore 62 of the stub shaft 60. The lower end of the stub shaft projects below the bearing sleeve 50 and is provided with a peripheral flange 64 having a plurality of holes 66 spaced therearound. The stub shaft 60 is connected with the outer spindle 46 by means of a bolt 65 which passes through one of the holes 66 in the peripheral flange 64 and is threaded in a tapped hole 68 in the bottom of the outer spindle 46. Thus, the position of the stub shaft can be rotatably adjusted to enlarge or diminish the gyrational path of travel of the lapping spindle by removing the bolt 65 and turning the stub shaft to shift the eccentric bore 62 so that the desired gyrational path of travel is obtained. After the stub shaft has been adjusted in desired position the bolt 65 is inserted through the hole 66 in registry with hole 68. This arrangement renders the apparatus of the

invention capable of processing a wide range of sizes of workpieces.

A handle **70** is provided for raising and lowering the spindle assembly. One end of the handle is pivoted on a fix support **72** which is attached to and depends from the rigid frame **56**. At a point intermediate its length the handle **70** is also pivotally connected to a vertical bar **74** by a pin **76** which projects laterally from the handle and fits into a hole in the bar.

Two spaced bearings **78** are welded or otherwise rigidly connected with the bar **74** for supporting one end **80** of a guide bar **82**. The other end **84** of the lever bar **82** loosely engages the lapping spindle **34** between a pair of flanges **86** attached to the lapping spindle.

The bar **74** is slidably held against the frame **56** by a plate **88** having an elongated vertical slot **90** therethrough. A locking pin **92** passes through the slot **90** and is threaded through a hole in the bar **74**. The pin **92** can be turned to bear against the frame **56** to hold the bar **74** and the entire spindle assembly in a raised position.

In operation, a valve W to be lapped is placed in the work holder **6** which is approximately centered under the outer spindle **46**. The bolt **65** is removed and the stub shaft **60** is turned to such a position as to cause the lapping spindle **34** to gyrate in a path suitable for the size workpiece to be processed. For best results the lapping disk should extend slightly beyond the edge of the workpiece as the disk revolves. If the lapping disk describes too great a circle during its gyration it will wear the article unevenly and tend to round the edges thereof. After the stub shaft has been properly adjusted, the bolt **65** is again inserted through the flange **64** and threaded into the tapped hole **68** in the bottom of the outer spindle **46** to secure the stub shaft in position. The motor **8** is then started and locking pin **92** is turned to release it from engagement with the frame **56** and allow the spindle assembly to be lowered so that the lapping disk **40** makes contact with the workpiece to be lapped. The weight of the spindle assembly is sufficient to insure good contact and an efficient lapping operation. The rounded lower end of the lapping spindle **34** (see FIGURE 2) provides even pressure on the workpiece through the lapping disk **40**, and the gyratory movement of the lapping disk insures uniform coverage of the entire area of the surface of the workpiece and prevents the formation of high or low spots.

In the modified embodiment of my invention, as shown in FIGURES 5, 6, 7 and 8, a sleeve **94**, having an eccentric bore, and a plurality of holes **96** circumferentially spaced around its lower end portion, is fixed to the lower end of the spindle **34** by means of a pin **98** which passes transversely through the sleeve and the spindle. A cup-shape cap **100** is adjustably attached to the bottom end of sleeve **94** by means of a bolt **102** which passes through a hole **104** in the cap **100** and fits into one of the holes **96** in the sleeve **94**. A stub shaft **106** depends from the cap **100** eccentrically thereto. A metal lapping disk **108** is loosely pivoted on the lower end of the shaft **106** by means of a pin **110** which passes through aligned holes in the shaft **106** and the upwardly-projecting hollow hub **112** of the disk **108**. A retaining ring **114** fits over the pin **110** and can be raised along the shaft **106** to permit removal of the pin **110** and replacement of the lapping disk **108**.

In the modified embodiment of the invention, the maximum eccentricity of the center of bore **62** in stub shaft **60** (and the corresponding axis of the lower end of spindle **34**) with respect to the center of rotation of outer spindle **46** is equal to the maximum eccentricity of the axis of shaft **106** with respect to the axis of the lower end of the spindle **34**. This arrangement is necessary so that the center of the lapping disk **108** will pass through the center of the workpiece, as will become apparent. In addition, as cap **100** is rotated 180 degrees from the position shown in FIGURES 5 and 6, the center of shaft **106** should coincide with the center of the lower end of spindle **34**.

In the operation of the modified embodiment of my invention, assuming that the stub shaft **60** and cap **100** are each adjusted for maximum eccentricity and lapping disk **108** is centered over the workpiece, when the motor **8** is started, outer spindle **46** will rotate clockwise, moving the axis of the lower end of spindle **34** in the clockwise path C shown in broken lines in FIGURE 6. Simultaneuosly, spindle **34** will rotate about its own axis in the opposite direction, swinging lapping disk **108** in a circular counterclockwise path, as indicated by the arrow **116**, relative to the axis of the lower end of spindle **34**. The resultant actual path of the center of lapping disk **108** will be as shown in FIGURES 7 and 8. That is, as the center of the lower end of spindle **34** moves from point D to points E, F, and G, the center of the lapping disk **108** moves from point H to points J, K, and L, in a figure-eight pattern. When the lower end of spindle **34** has moved back to the starting point D, disk **108** will have moved back through the center of the circle C and will be started on the next loop, as indicated by arrow **118**. As rotation continues, the center of disk **108** will form the complete pattern shown in FIGURE 7. The extent of lead of disk **108** over the lower end of spindle **34** and thus the number and spacing of the loops will be determined by the angular velocity of gear **26** over the angular velocity of gear **28**. It will be noted that if gear **26** turns more slowly than gear **28**, the motion of disk **108** will lag the motion of the lower end of spindle **34**, but a similar loop pattern will be developed.

The speed of gear **26** should be at least three or four percent greater, and may range up to fifty percent or more greater, than the speed of gear **28**. However, the difference in speed should not be such that the angular advantage of gear **26** over gear **28** can be evenly divided into 360 degrees; e.g., 10% or 36 degrees, 5% or 18 degrees, etc. In such case the lapping disk **108** and lower end of spindle **34** would return to the starting point after a certain number of loops, and the pattern would be exactly repeated. To prevent an exact repetition, it is necessary that the gear ratio be somewhat uneven, such as 1.09 to 1, 1 to 0.92 (as mentioned above), etc. With the latter gear ratios, the center of the lapping disk **108** will describe the second series of loops slightly offset from the first series, as shown by broken lines in FIGURE 7. Thus, the series of figures eight described by the lapping disk **108** will progress around the workpiece, providing complete and uniform coverage of the entire area of the surface and preventing the formation of high or low spots.

For best results, the lapping disk **108** should extend slightly beyond the edge of the workpiece at its extreme limit of movement. If the disk describes too large a pattern, it will wear the workpiece unevenly and tend to round the edges thereof. To decrease the movement of the disk for smaller workpieces, the bolt **65** is removed and stub shaft **60** is turned through an angle (up to 180 degrees) that will cause the lower end of spindle **34** to revolve in a path suitable for the size workpiece to be processed. After the stub shaft **60** has been properly adjusted, the bolt **65** is again inserted through the flange **64** and threaded into the tapped hole **68** in the bottom of the outer spindle **48** to secure the stub shaft **60** in position. In order that the center of the lapping disk **108** will pass through the center of the workpiece surface and again describe the figure-eight pattern, bolt **102** must also be removed and cap **100** turned through an angle corresponding to the angle through which the stub shaft was turned in the opposite direction, after which bolt **102** is re-inserted through one of the holes **104** and fitted into one of the holes **96** in the sleeve **94**.

The apparatus of the invention performs the lapping operation more uniformly and in a much shorter time than was possible heretofore by prior manual lapping

methods. Through the use of the apparatus of the invention it is possible to recondition or lap a brake valve from the compressed air system of a diesel locomotive in 15 minutes whereas the same operation required five hours when done by hand lapping and a compressor valve from the system, which required two hours for lapping by the old method, can now be reconditioned in approximately ten minutes. The spindle and adjusting sleeve arrangement of the apparatus of the invention makes it possible to uniformly process articles in a wide range of sizes with one machine.

While two embodiments of my invention have been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. In a lapping machine including a vertical bearing sleeve, and an outer spindle journaled in said sleeve for rotation in one direction therein, said outer spindle having an eccentric longitudinal bore therethrough, the improvement therewith of a stub shaft journaled in said bore and projecting below said sleeve, said shaft having an eccentric longitudinal bore therethrough, a lapping spindle journaled in the bore of said stub shaft for rotation therein the direction opposite to the direction of rotation of said outer spindle and projecting at its lower end below said stub shaft, a sleeve having an eccentric bore fixedly mounted on the lower end of said lapping spindle for rotation therewith, and a lapping disk depending from said last-named sleeve, said disk being horizontally disposed with its vertical axis eccentric to the vertical axis of said lapping spindle, the maximum eccentricity of the longitudinal axis of said bore of said stub shaft with respect to the center of rotation of said outer spindle being equal to the maximum eccentricity of the vertical axis of said disk with respect to the vertical axis of said lapping spindle.

2. Apparatus as defined by claim 1 characterized by said stub shaft having a peripheral flange adjacent its lower end, and means securing said flange to the lower end of said outer spindle.

3. Apparatus as defined by claim 1 characterized by said sleeve mounted on said lapping spindle having a cap removably mounted on the lower end thereof, said disk being mounted on said cap.

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