March 26, 1940. D. A. WALLACE 2,195,052

LAPPING APPARATUS

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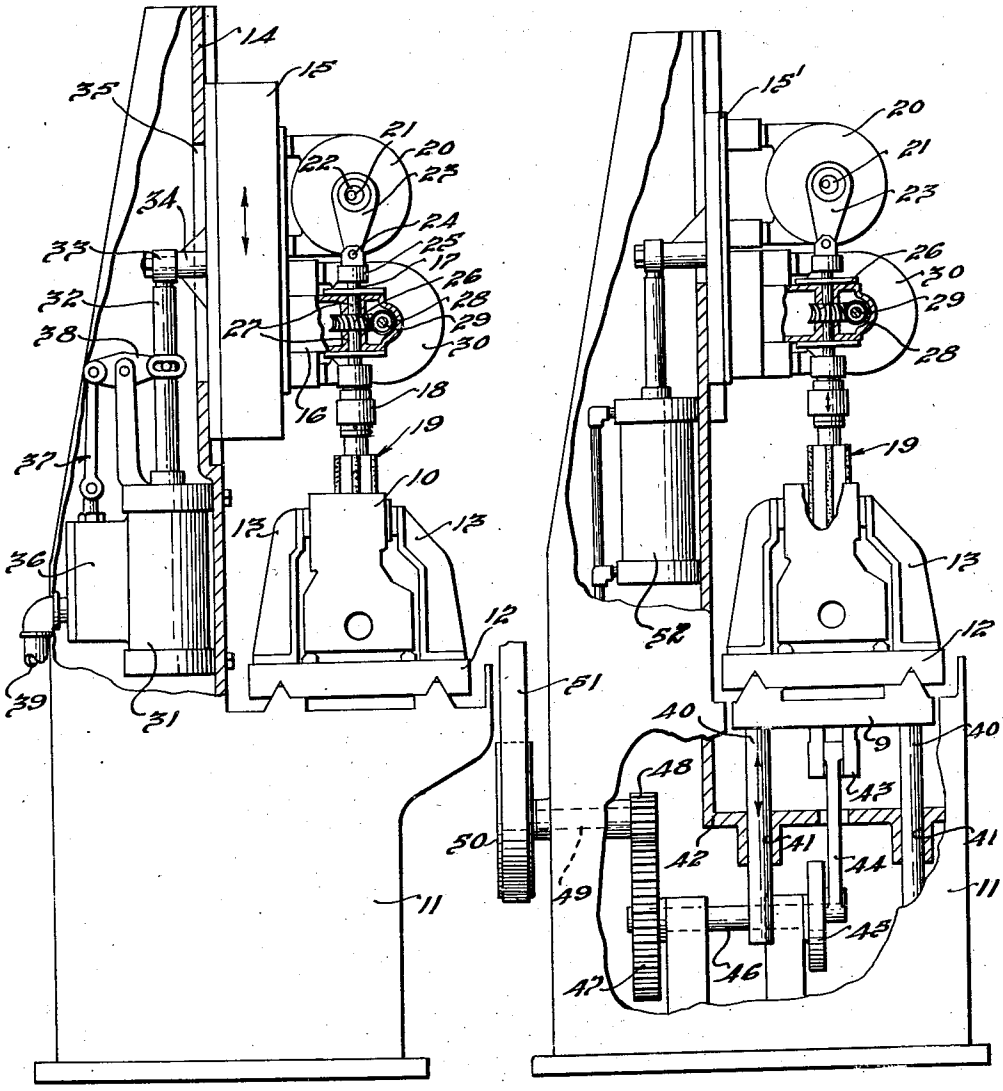

FIG. 1.

FIG. 2.

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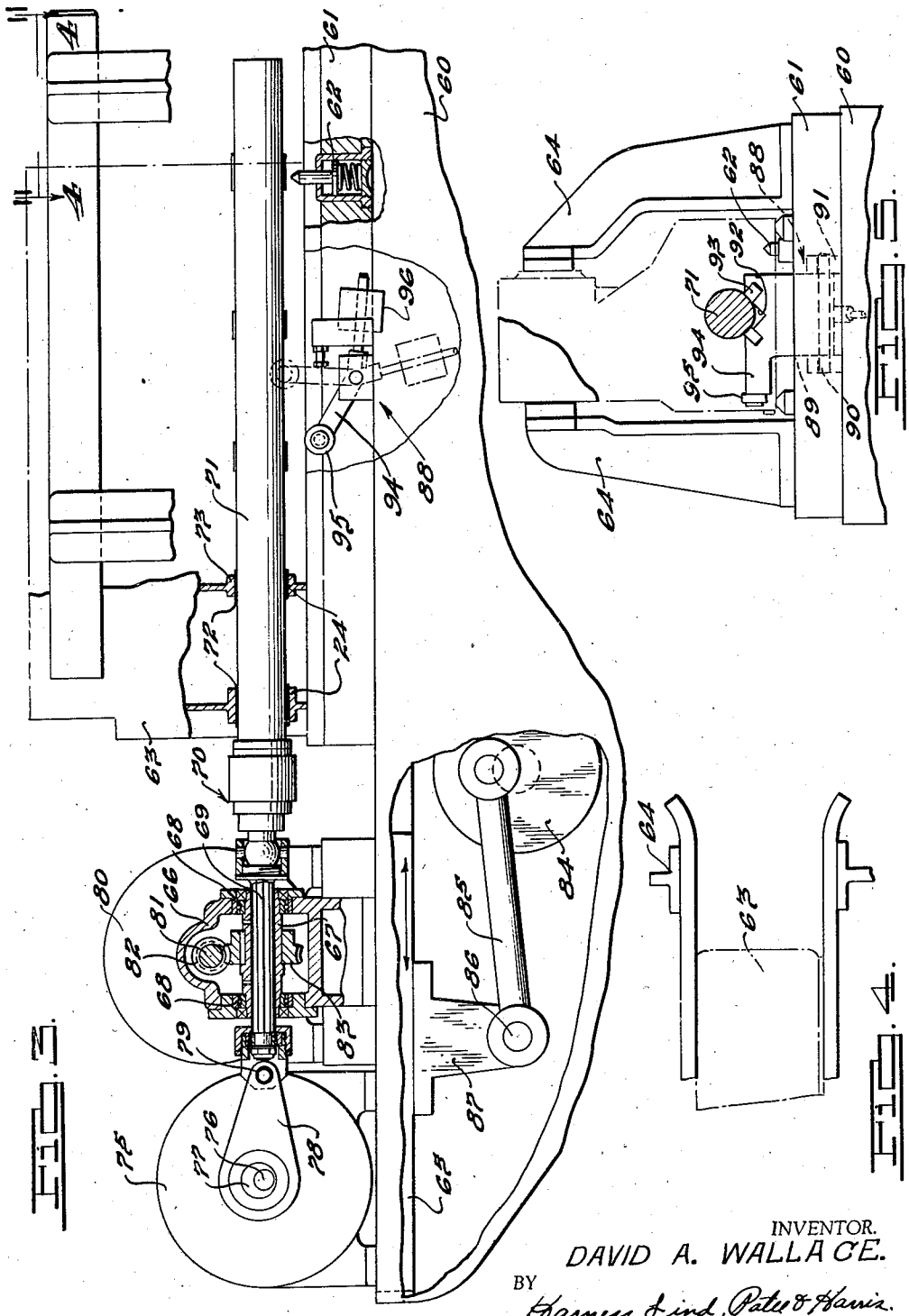

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2,195,052

LAPPING APPARATUS

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2 Claims. (Cl. 51—34)

This invention relates to an improved apparatus for lapping the surfaces of cylindrical bores and for accurately bringing the latter to true cylindrical contour and is a further development of my co-pending applications, Serial No. 91,851 and Serial No. 111,011, filed July 22, 1936 and November 16, 1936, respectively.

One of the main objects of the invention is to provide between the surface of a bore being lapped and a lapping element, a relative movement which is a resultant of a number of different simultaneous component of relative movements of the lapping element and the work.

Another object of the invention is to produce relative movement of this character between a lapping element and an internal cylindrical bore surface being lapped which is the resultant of so many components that even during repeated application of the working element to the work surface, no isolated areas or particles of the lapping element will be repeatedly applied to the same increment of area of the work.

A further object of the invention is to provide apparatus of this character which moves the lapping element rotatively while simultaneously reciprocating the same throughout a relatively long course at one speed, and throughout a comparatively shorter course at a correspondingly higher speed.

A further object of the invention is to provide a lapping device of this kind which is so manipulated during operation as to form the surface surrounding a bore, such as a cylinder bore wall or bearing surface to true cylindrical contour.

An illustrative embodiment of the invention is shown in the accompanying drawings, in which:

Fig. 1 is an end elevational view, partly in section, of a lapping machine embodying the invention.

Fig. 2 is a view similar to Fig. 1 but showing a modified form of the invention.

Fig. 3 is a longitudinal side elevational view, partly in section, of a lapping device showing a further embodiment of the invention.

Fig. 4 is a fragmentary, horizontal view taken on the line 4—4 of Fig. 3.

Fig. 5 is a fragmentary end elevational view showing the apparatus illustrated in Fig. 3, as viewed from the right in that figure.

In Fig. 1 of the drawings is illustrated apparatus which is particularly adapted for lapping of the cylinder walls of an internal combustion engine cylinder block 10 in accordance with the invention. The apparatus shown in this figure comprises a base portion 11 having a substantially horizontal work supporting table 12 which is provided with upwardly extending jaws 13 for properly positioning a cylinder block to be operated upon. The base 11 of the lapping machine has an upstanding support 14 on which a vertically reciprocable carriage 15 is slidably mounted. Mounted on the carriage 15 is a combined bearing and gear housing member 16 in which a shaft 17 is rotatably and axially shiftably mounted. The shaft 17 has a coupling member 18 on its lower end by which a lapping tool 19 may be detachably connected to it. The lapping element 19 preferably conforms in details and construction to the lapping tool shown in Figs. 6 to 10 and hereinafter more clearly described, but any suitable bore lapping tool may be used for this purpose.

Mounted on the carriage 15 above the upper end of the shaft 17 is an electric motor 20 which is provided with a shaft 21 on which an eccentric 22 is mounted. Operatively associated with the eccentric 21 is a connecting rod 23 which is pivotally attached at 24 to the upper end of the shaft 17 by a coupling member 25. A worm gear 26 is disposed in the combined bearing and housing 16 and is splined on the shaft 17 and held against movement axially thereof by thrust bearing members 27. The teeth of the gear 26 are meshed with a worm 28 non-rotatably fixed on the shaft 29 of a motor 30, or other suitable driving means. The motor 20 reciprocates the shaft 17, and the lapping tool 19 carried thereby, throughout a relatively short stroke and at a comparatively high speed while the motor 30 simultaneously rotates the shaft 17 and the lapping tool 19. The rotary movement of the lapping tool 19 is about an axis which is predetermined to establish the axis of the cylinder bore in which the tool operates and the reciprocatory movement produced by the motor 20 is parallel to this axis.

The shiftable carriage 15 may be reciprocated bodily during operation of the motors 20 and 30 by an air cylinder 31 mounted on the support 14 and provided with a piston (not shown) and piston rod 32 which is pivotally attached at 33 to a post 34 fixed to the carriage 15. The post 34 extends through a vertical slot 35 formed in the support 14. Steam, or compressed air or other suitable fluid medium under pressure may be supplied to the respectively opposite ends of the cylinder 31 alternately by a valve chest 36 having valve mechanism (not shown) therein of the type conventionally used in reciprocating

steam engines. The valve mechanism is operated in timed relation with the piston movement by valve gearing, generally designated by the numeral 37, which is operatively connected at 38 to the piston rod 32. Fluid medium under pressure may be supplied to the valve chest 36 by the supply pipe 39.

The stroke of the piston rod 32 is preferably predetermined so as to reciprocate the carriage 15 and all of the mechanism carried thereby, including the lapping tool 19, throughout a substantially longer stroke and at a comparatively slower speed than the stroke and speed respectively of the reciprocatory movement produced by the motor 20. Reciprocatory movement of the tool 19 by the cylinder 31 preferably occurs at a rate varying from 50 to 250 reciprocations per minute while the tool is reciprocated by the motor 20 at a rate of from 500 to 1000 reciprocations per minute. These two modes of reciprocatory movement occur simultaneously during rotation of the tool at a rate varying from 150 R. P. M. to 300 R. P. M. The foregoing speeds of operation are only illustrative and may be varied.

The lapping apparatus illustrated in Fig. 2 is in many respects similar to that shown in Fig. 1 and corresponding parts are designated by the same numerals. In this form of the invention the work table 12 is disposed on a carriage 9 vertically, reciprocably mounted on the base portion 11 of the lapping machine by guide rods 40 which are slidably mounted in passages 41 formed in a shelf structure 42 disposed below the work support table. Provided on the lower side of the carriage 9 are a pair of spaced ears 43 to which the upper end of a connecting link 44 is pivotally attached. The lower end of the connecting link 44 is pivotally secured to a crank member 45 carried by a horizontally disposed shaft 46 which is provided at its left end, as viewed in Fig. 2, with a gear 47. The teeth of the gear 47 are meshed with a pinion 48 carried by a vertically spaced horizontal shaft 49 which is journalled in bearings provided in the base structure 11. The shaft 49 has a pulley 50 on its external end which is operatively connected by a belt 51 with an electric motor, or other suitable driving means (not shown). Rotation of the pulley 50 by the belt 51 causes the work table 12 to be vertically reciprocated throughout a substantially long stroke and at a comparatively low speed relative to the tool 19 which is simultaneously rotated, as set forth in the description of Fig. 1, by a worm gear 26 which meshes with a worm 28 carried by the shaft 29 of the electric motor 30. The lapping tool 19 is also reciprocated throughout a relatively shorter stroke and at a comparatively faster speed by the connecting rod 23 which is operated by the eccentric 21 of the shaft of a motor 20. The motors 20 and 30 and the combined bearing and housing 16 are carried by a vertically shiftable carriage 15' which may be raised and lowered by an air cylinder 52 for the purpose of facilitating removal and replacement of a cylinder block, or other piece of work to be operated upon, from the work table 12.

In the operation of the lapping apparatus embodying the form of the invention shown in Fig. 2, the relative speeds of the reciprocatory movements and rotative movements are substantially the same as those set forth in the description of the apparatus shown in Fig. 1.

In Fig. 3 of the drawings is illustrated a lapping apparatus embodying the invention which is particularly adapted to simultaneously lap a plurality of axially aligned spaced internal cylindrical surfaces such as the main bearings of an internal combustion engine. This apparatus comprises a base structure 60 on which is mounted a work support table 61 having spring pressed detents 62 mounted therein and arranged to register with and fit into apertures formed in the lower edge portions of a cylinder block, diagrammatically illustrated at 63, in order to bring the cylinder block into a predetermined position on the work table 61. Mounted on the work table 61 are upstanding spaced jaws 64 which are adapted to engage opposite lateral side portions of the cylinder block 63 in order to firmly hold the latter in position thereon to receive the lapping operation.

A horizontal carriage 65 is slidably mounted on the left end portion of the base structure 60, as viewed in Fig. 3, and is so constructed and arranged as to be capable of reciprocation in the general direction of the length of the base 60. Mounted on the shiftable carriage 65 is a combined bearing and housing member 66 in which a tubular spindle 67 is rotatably supported by bearing 68. A shaft 69 is splined and slidably mounted in the interior of the tubular spindle 67 and is provided at its right end, as viewed in Fig. 3 with a coupling member, generally designated by the numeral 70, by which a lapping tool 71 is attached thereto. The lapping tool 71 may be of conventional construction but it preferably conforms to the multiple, expansible lapping tool structure illustrated in Figs. 6 to 10, inclusive, hereinafter more fully described. Provided on the lapping tool 71 are axially spaced series of circumferentially arranged lapping elements 72 of which each series is adapted to operate upon one of the main bearings 73, respectively, of the internal combustion engine cylinder block. During lapping of these bearings, the bearing caps 74 thereof are bolted in place to present continuous internal, cylindrical surfaces to the action of the lapping elements.

The shaft 69 and tool 71 attached thereto is adapted to be reciprocated in the direction of its axis throughout a comparatively short stroke and at a relatively high speed by a motor 75 having a shaft 76 on which is provided an eccentric 77. The eccentric 77 operates upon a connecting rod 78 associated therewith which is pivotally attached at 79 to the left extremity of the shaft 69, as illustrated in Fig. 3. The shaft 69 and associated lapping tool 71 are rotated during reciprocatory movement thereof by a motor 80 having a shaft 81 on which is mounted a worm 82 that meshes with a worm gear 83 fixed on the exterior of the tubular spindle 67. The lapping tool 71 is also caused to reciprocate in the direction of its axis throughout a longer stroke and at a comparatively slower speed by a crank member 84 which is operatively connected with the shiftable carriage 65 by link 85. The left end of the link 85, as viewed in Fig. 3, is pivotally attached at 86 to a bracket 87 mounted on the lower side of the shiftable carriage 65. The crank 84 may be driven by an electric motor or by any suitable driving means (not shown).

In order to support the free end portion of the tool 71 during insertion thereof into the bearings 73 of the cylinder block which is moved leftwardly on the work support table 61 during the tool inserting operation, a pivotal support generally designated by the numeral 88 is mounted

on the base 60, as illustrated in Fig. 5. The support 88 comprises a plate 89 pivotally mounted at 90 upon ears 91 carried by the base 60. Formed in the upper edge portion of the plate 89 is a notch 92 for receiving the tool 71. Spaced rollers 93 having peripheries substantially aligned with the side walls of the notch 92 are rotatably mounted on the plate 89, as illustrated in Fig. 5, in order to provide rolling contact between the support and the tool. The plate 89 is provided with an outwardly extending arm 94 on the extremity of which is rotatably mounted a roller 95 which is adapted to engage the left end of the cylinder block 63, during movement of the latter toward the left end of the lapping apparatus as the tool 71 is inserted into the bearings 73. Engagement of the cylinder block with the roller 95 turns the support 88 in a counter-clockwise direction, as viewed in Fig. 3, to bring the plate 89 into an inoperative position after a substantial portion of the free end part of the tool 71 has been inserted through the first one or two or more bearings of the cylinder block. The support 88 is normally urged upon its pivot 90 in a clockwise direction by a weight 96.

The reciprocatory movement produced by the motor 75 and crank 84 respectively, may be predetermined both in length of stroke and speed to any desired relationship. The reciprocation of the tool caused by reciprocatory movement of the shiftable carriage 65 is of a longer stroke and slower speed than the reciprocatory movement of the tool produced by the motor 75 and its eccentric. The speed of the shorter reciprocating stroke may vary from 500 reciprocations per minute to 1000 reciprocations per minute and the speed of the longer reciprocating stroke may vary from 50 reciprocations per minute to 250 reciprocations per minute, it being understood that during both modes of simultaneous reciprocatory movement of the tool, the latter is rotated preferably at the speed of 150 R. P. M. a minute to 300 R. P. M.

During lapping operations of the foregoing character, the internal cylindrical surfaces of the bores operated upon are brought to an accurate cylindrical contour and the surfaces are polished to a mirror-like finish. The relative movement produced between the surfaces of the work operated upon and the lapping element is a resultant of a plurality of different components which assures removal of the machining formed ridges of the surface operated upon without producing scratches or repeatedly bringing isolated portions, or hard particles of the lapping surfaces of the lapping element into engagement with the same increment of area of the work. Relatively small and light lapping elements may be used upon work having surfaces of much greater dimensions while assuring equal application of the lapping surfaces to all portions of the work surface. This is accomplished by not only reciprocating the lapping element relative to the lapping tool throughout one stroke, preferably of a speed approaching a vibratory order, but by producing relative reciprocatory movements between the work and the tool throughout substantially longer strokes and at a comparatively slower speed. The combined reciprocations of the lapping elements at relatively high speed throughout a comparatively short stroke and at lower speed throughout a longer stroke, assures removal of metal and particles of the lapping elements from between the grains of the latter, which preferably comprise stone, and thereby maintains the working surfaces of the lapping elements in a clean, efficient cutting condition. The lapping elements may comprise artificial or natural stone or any suitable lapping or polishing material.

All speeds of relative rotative and reciprocatory movements of the work and lapping elements set forth herein are illustrative only and may be varied in accordance with the dimensions of the work and other characteristics thereof.

Although but several specific embodiments of the invention are herein shown and described, it will be understood that various changes in the size, shape and arrangement of parts may be made without departing from the spirit of my invention.

What I claim is:

1. Apparatus for lapping the cylinder bore of a cylinder block comprising a base structure, relatively reciprocable work and tool supports on said base structure, a lapping tool reciprocably and rotatively mounted on said tool support having an axis of rotation substantially parallel to its path of reciprocatory movement and to the path of relative reciprocatory movement of said work and tool supports, means for drivingly simultaneously reciprocating at a speed of substantially a vibratory order and rotating said tool relative to said tool support and for producing relative reciprocation between said tool support and work support at a lower speed than that of the reciprocation of said tool relative to said tool support but at a substantially faster speed than that conventionally employed in feeding successively adjacent portions of a piece of work to a tool, and means on said work support for positioning the cylinder bore of a cylinder block in axial alignment with said tool.

2. Finishing apparatus including a base structure, a pair of supports on said base structure, one being linearly shiftable with respect to the other in a predetermined course, an abrading tool rotatively and linearly shiftably mounted on one of said supports for rotation about an axis extending substantially parallel to said course and reciprocation in a substantially parallel course, said abrading tool being operatively engageable with a piece of work on the other of said supports, means for rotating said tool relative to its support and with respect to said work, and means for drivingly producing reciprocative abrading movements of said tool relative to its support at a rate of a substantially vibratory order and for simultaneously drivingly producing relative reciprocative abrading movements of said supports at a lower rate of a substantially higher value than that conventionally employed in feeding successively adjacent portions of a piece of work to a tool.

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