Nov. 4, 1941. H. S. INDGE 2,261,902

LAPPING MACHINE

Filed Oct. 5, 1940 2 Sheets-Sheet 1

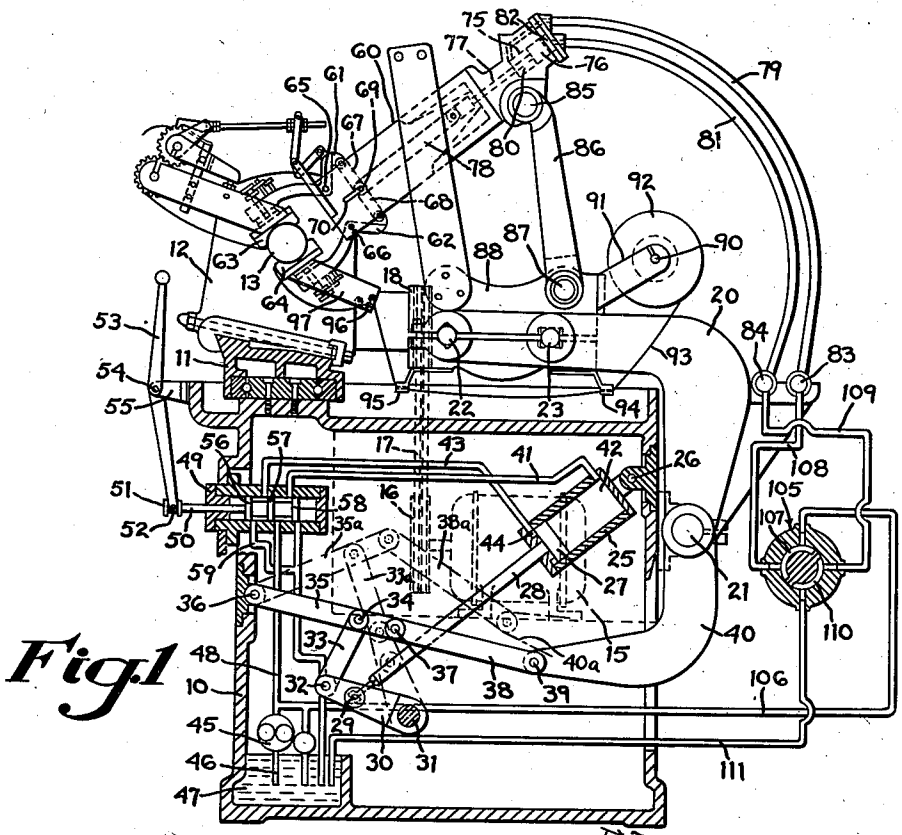


Fig. 1

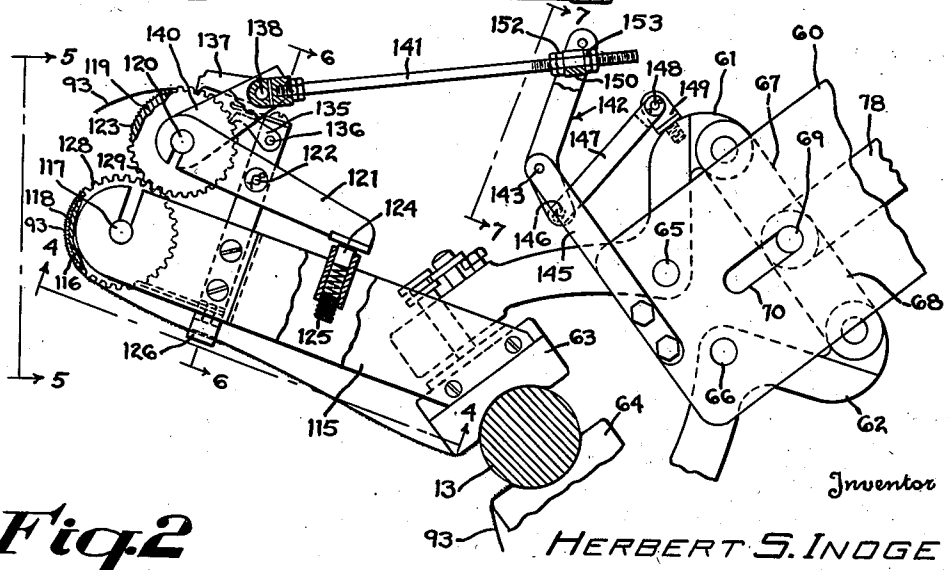


Fig. 2

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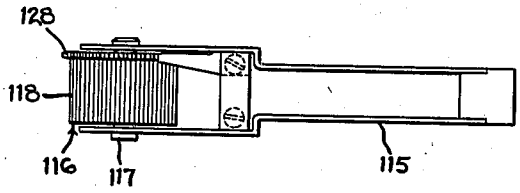


Fig.4

Fig.5 Fig.6 Fig.7

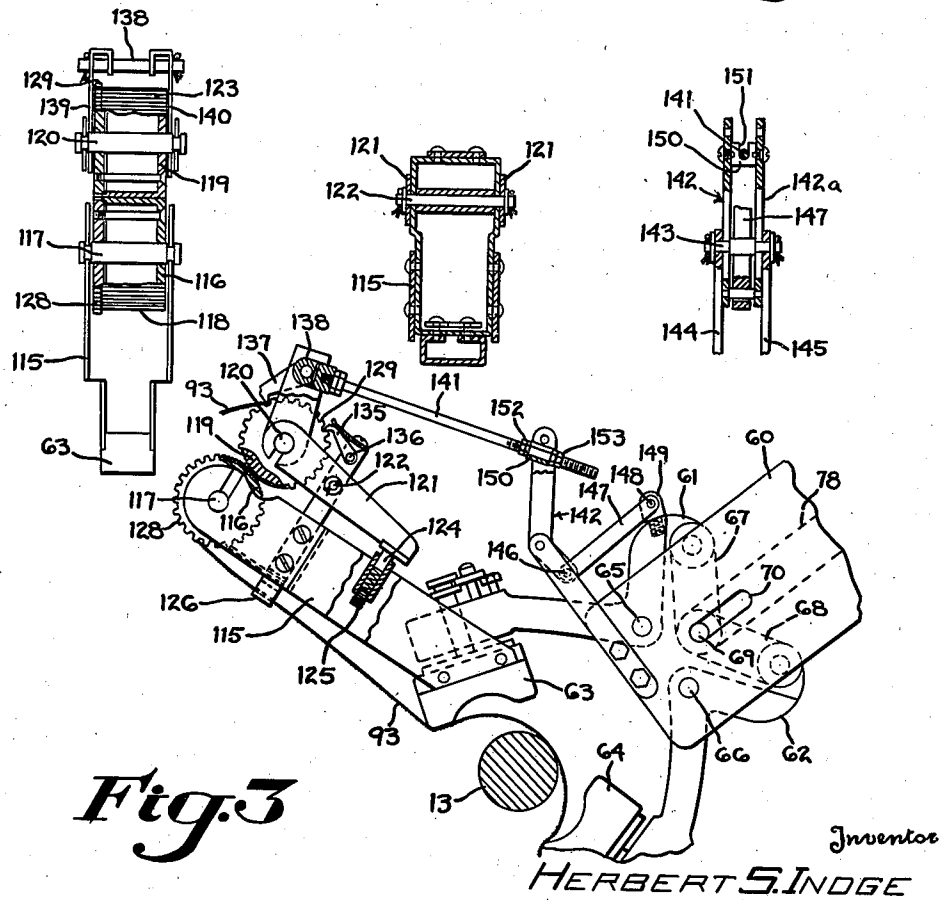


Fig.3

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UNITED STATES PATENT OFFICE

2,261,902

LAPPING MACHINE

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Application October 5, 1940, Serial No. 359,921

2 Claims. (Cl. 51—73)

The invention relates to lapping machines, and more particularly to a lapping machine for lapping the crankpins and bearings of an automotive crankshaft.

One object of the invention is to provide an improved lapping machine for lapping crankpins, main bearings and the like. A further object of the invention is to provide an improved hydraulically operated, toggle actuated lapping arm. A further object of the invention is to provide an improved lapping arm in which a flexible abrasive lapping element is employed which is automatically fed after each lapping operation to provide a fresh abrading surface for the next operation.

A further object of the invention is to provide an automatically actuated positive feed for a flexible abrasive lapping element. Another object of the invention is to provide an automatically actuated paper feeding mechanism including a pair of positively actuated, spring-pressed feed rollers which are actuated automatically at the end of each lapping operation. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the mechanical features of the invention,

Fig. 1 is a cross sectional view through a lapping machine, showing the improved lapping arm together with a diagrammatic illustration of the hydraulic control and actuating system;

Fig. 2 is a fragmentary side elevation, on an enlarged scale, of a lapping arm having the lapping element and parts shown in an operative position for a lapping operation;

Fig. 3 is a similar fragmentary side elevation, on an enlarged scale, of one of the lapping arms, such as shown in Fig. 2, with the lapping elements and supporting parts in an inoperative position;

Fig. 4 is a fragmentary detail view of the lower abrasive paper feed roll, taken approximately on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary front elevation of the lapping arm shown in Fig. 2, taken approximately on the line 5—5, showing the abrasive paper feed roll broken away and shown in cross section;

Fig. 6 is a fragmentary cross-sectional view, taken approximately on the line 6—6 of Fig. 2; and

Fig. 7 is a fragmentary detail view, taken approximately on the line 7—7 of Fig. 2, having parts broken away and shown in section to more clearly illustrate the construction.

A lapping machine has been illustrated in the drawings comprising a base 10 which supports a longitudinally reciprocable table 11. Table ways are provided between the base 10 and table 11 which in the preferred form are of an anti-friction type substantially the same as shown and described in my prior U. S. Patent No. 2,166,009 dated July 19, 1939, to which reference may be had for details of disclosure not contained herein. The table 11 serves as a support for a headstock 12 and a footstock (not shown) which serve as a rotatable support for a work piece 13.

The headstock 12 is preferably driven by an electric motor 15 which is mounted on the base 10. The motor 15 is provided with a multi-grooved pulley 16 which is connected by multiple V-belts 17 with a multi-grooved pulley 18 which is operatively connected to rotate the headstock spindle (not shown) in a manner substantially the same as that disclosed in my prior U. S. patent above referred to.

Lapping arm support

It is desirable to provide a movable support for a plurality of crankpin and bearing lapping arms so that they may be simultaneously and rapidly moved into an operative or an inoperative position, as desired. A pair of spaced supporting arms 20, only one of which has been illustrated in the drawings (Fig. 1), are mounted on a rock shaft 21 which is supported in bearings on the rear of the machine base 10. The arms 20 are provided with horizontally extending portions which are connected by two spaced bars 22 and 23 which serve as slide bars or ways for supporting a plurality of lapping arms to be hereinafter described.

The lapping arm assembly supported by the arms 20 is arranged so that it may be automatically moved to and from an operative position to facilitate loading of crankshafts into the machine and removing them therefrom after a lapping operation has been completed. In order to move the entire lapping arm assembly to and from an operative position, a fluid pressure mechanism is provided including a fluid pressure cylinder 25 which is pivotally connected by means of a stud 26 with the base 10 of the

machine. A piston 27 is slidably mounted within the cylinder 25 and is connected to one end of a piston rod 28. The other end of the piston rod 28 is connected by a stud 29 with an arm 30 pivotally mounted on a shaft 31 within the base 10. The arm 30 is provided with a stud 32 which is connected to one end of a link 33. The link 33 is connected by a stud 34 with a toggle lever 35. One end of the toggle lever 35 is pivotally connected to a stud 36 which is fixedly supported on the base 10 of the machine. The other end of the toggle lever 35 is connected by a stud 37 with a toggle lever 38. The opposite end of the toggle lever 38 is connected by a stud 39 which is carried by the lower end of an arm 40. The arm 40 is fixedly supported on the rock shaft 21.

When fluid under pressure is admitted through a pipe 41 into a cylinder chamber 42, the piston 27 is moved downwardly into the position illustrated in Fig. 1, which serves through the toggle levers 35 and 38 to position the arm 40 and the arms 20 in the position illustrated in Fig. 1. After a lapping operation has been completed, fluid under pressure is admitted through a pipe 43 into a cylinder chamber 44 to move the piston 27 upwardly toward the right, which movement shifts the toggle levers 35 and 38 into the position illustrated in dotted lines 35*a* and 38*a*, which movement swings the arm 40 into position 40*a*. This movement of the arm 40 serves to rock the shaft 21 to swing the arms 20 together with the entire lapping arm assembly in a clockwise direction to an inoperative position.

A fluid pressure system is provided for controlling the admission of fluid under pressure to the cylinder 25. A motor driven pump 45 within the base 10 of the machine draws fluid through a pipe 46 from a reservoir 47 within the base 10 and forces fluid under pressure through a pipe 48 to a reverse or control valve 49. The valve 49 is a balanced piston type valve having a valve stem 50 which is provided at its outer end with a spool-shaped member 51 and is connected by means of a pair of diametrically opposed studs or pins 52 mounted on a lower yoke-shaped end of a control lever 53. The control lever 53 is pivotally supported by means of a stud 54 on a bracket 55 which is fixedly supported on the base 10 of the machine. A plurality of valve pistons 56, 57 and 58 are formed integral with the valve stem 50. Fluid under pressure passing through the pipe 48 enters a valve chamber located between the valve pistons 57 and 58 and passes outwardly through the pipe 41 into the cylinder chamber 42 to move the piston 27 downwardly into the position shown in Fig. 1 to move the lapping arm assembly into an operative position. During the downward movement of the piston 27, fluid within the cylinder chamber 44 is exhausted through the pipe 43, through a valve chamber located between the valve pistons 56 and 57, and out through an exhaust pipe 59 into the reservoir 47.

After a lapping operation has been completed and it is desired to move the lapping arm assembly to an inoperative position, the manually operable control lever 53 is moved in a counterclockwise direction to shift the valve pistons 56, 57 and 58 so that fluid under pressure passing through the pipe 48 enters a valve chamber located between the valve pistons 56 and 57 and passes outwardly through the pipe 43 into the cylinder chamber 44 to cause an upward movement of the piston 27. This upward movement of the piston 27 shifts the toggle levers 35 and 38 together with the arm 40 into the dotted line positions 35*a*, 38*a* and 40*a* to rock the shaft 21 together with the arms 20 and the entire lapping assembly in a clockwise direction into an inoperative position. During this movement, fluid within the cylinder chamber 42 is exhausted through the pipe 41, through the valve chamber located between the valve pistons 57 and 58, and passes outwardly through the exhaust pipe 59 into the reservoir 47.

Lapping arms

In order that all of the crankpins and main bearings on the crankshaft 13 may be simultaneously lapped, a plurality of crankpin and bearing lapping arms are provided which correspond in number with the crankpins and bearings to be lapped. As illustrated, only one of the lapping arms has been shown. For details of arrangement of the plurality of lapping arms, reference may be had to my prior U. S. Patent 2,166,009 above referred to. A side elevation of a lapping arm 60 is shown in Fig. 1. The lapping arm 60 as well as all of the other lapping arms are each provided with a pair of pivotally mounted lap supporting arms 61 and 62 which are provided at their operative ends with partially cylindrical lap supporting blocks or elements 63 and 64, respectively. The arms 61 and 62 are pivotally supported by studs 65 and 66 on the lapping arm 60. The other ends of the arms 61 and 62 are connected by a pair of toggle levers 67 and 68 which are connected together at their inner ends by means of the stud 69 which slides in elongated slots 70 formed in the side plates of the lapping arm 60. When the toggle levers 67 and 68 are in a straight-line position, as indicated in Fig. 1, the lap supporting members 63 and 64 are maintained in an operative position to hold the abrasive or lapping elements in operative contact with the work piece 13.

The lap supporting arms 61 and 62 are arranged to be moved toward and away from an operative position by means of a hydraulically operated mechanism comprising a fluid pressure cylinder 75 which is mounted on the upper end of the lapping arm 60. A piston 76 is slidably mounted within the cylinder 75 and is connected to one end of a piston rod 77. The other end of the piston rod 77 is connected by means of the link 78 with the stud 69 which is pivotally connected to the toggle levers 67 and 68, respectively. It will be readily apparent from the foregoing disclosure that when the piston 76 is moved downwardly, that is, toward the left (Fig. 1), the piston rod 77 and the connecting link 78 will be moved also in a downward direction toward the left, which serves to unlock the toggle levers 67 and 68 and thereby to rock the lap supporting arms 61 and 62 together with the lap supporting elements 63 and 64 to an inoperative position out of engagement with the bearings of the crankshaft 13 to be lapped.

When fluid under pressure is passed through a flexible pipe 79 into a cylinder chamber 80, the piston 76 will be moved upwardly to move the toggle levers 67 and 68 into the position shown in Fig. 1 to move the lapping element into operative engagement with the work piece 13 for a lapping operation. Similarly, when fluid is admitted through a flexible pipe 81 into the cylinder 75 to cause a downward movement of

the piston 76 toward the left (Figs. 1 and 2), the toggle levers 67 and 68 will be unlocked to move the lapping elements to an inoperative position. Each of the lapping arms 60 is provided with an independent fluid operated piston and cylinder mechanism for independently actuating each of the lapping elements.

A pair of longitudinally extending pipes or manifolds 83 and 84 are provided for supplying fluid under pressure to the flexible pipes 79 and 81, respectively, to a plurality of spaced lapping elements. The lapping arm 60 is pivotally connected by means of a stud 85 which is supported on a pivotally mounted arm 86. The arm 86 is pivotally supported by means of a stud 87 on a supporting member 88. The supporting member 88 is in turn adjustably supported on the guide rods 22 and 23, respectively. The supporting member 88 may be adjusted longitudinally relative to the rods 22 and 23 to position the arm 60 in the desired location for lapping a predetermined portion on the work piece.

A flexible abrasive paper or cloth is preferably utilized as a lapping medium. Each of the lapping arms 60 is provided with a separate strip of continuous abrasive paper or cloth which wraps around the crankpin or main bearing to be lapped and is held in position thereagainst by the lap supporting members 63 and 64.

A rod 90 is supported by a pair of brackets 91 (only one of which is shown in Fig. 1) and serves as a support for a reel 92 of flexible abrasive paper 93. The abrasive paper 93 passes through guides 94 and 95 which are fixedly mounted on the under side of the supporting member 88 and pass through a series of rollers 96 carried by a bracket 97. The bracket 97 is in turn supported on the lap supporting arm 62. The abrasive paper, as above described, wraps around the crankpin 13 and is supported by the lap supporting members 63 and 64.

A manually operable control or reverse valve 105 is provided for controlling the admission to and exhaust of fluid from the cylinder 75. Fluid under pressure from the pump 45 passes through a pipe 106 into a valve chamber 107 and in the position illustrated in Fig. 1 passes out through a pipe 108, through the manifold 83, and through the flexible pipe 79, into the cylinder 75 to move the piston 76 upwardly into the position shown in Figs. 1 and 2. During this movement fluid within the lower cylinder chamber is exhausted through the flexible pipe 81, the manifold 84, a pipe 109, through a valve chamber 110 and an exhaust pipe 111, into the reservoir 47. When the valve 105 is shifted into a reverse position, that is, the valve rotor shifted ninety degrees, fluid under pressure passing through the pipe 106 will pass through the pipe 109, the manifold 84, the flexible pipe 81, into the cylinder chamber 82, to cause a downward movement of the piston 76.

The operation of this improved lapping machine will be readily apparent from the foregoing disclosure. A work piece 13, such as an automotive crankshaft, is placed in position for rotation by the headstock 12 and the footstock (not shown). The work rotation is then started and the control lever 53 is moved in a clockwise direction into the position shown in Fig. 1 to move the valve pistons so as to admit fluid under pressure through the pipe 41 into the cylinder chamber 42 to move the lapping arm assembly supported by the arms 20 into an operative position. After the lapping arms have moved to an operative position, the manually operable control valve 105 is then shifted into the position illustrated in Fig. 1 so as to admit fluid under pressure through the flexible pipe 79 to cause an upward movement of the piston 76, thus moving the abrasive lapping element into operative lapping engagement with the work piece 13.

As the lapping operation proceeds, the pressure is increased until the toggle levers 67 and 68 reach a straight-line position, as indicated in Fig. 1, after which the lapping operation proceeds. After the work piece has been lapped to the required and predetermined extent, the control valve 105 is shifted into its reverse position to admit fluid under pressure through the flexible pipe 81 to cause a downward movement of the piston 76 which in turn serves to break the toggle 67—68, thereby moving the lap supporting members 63 and 64 into an open or inoperative position. After the lapping element has been moved to an inoperative position, the control lever 53 may then be rocked in a counter-clockwise direction so as to admit fluid under pressure through the pipe 43, into the cylinder chamber 44, to cause an upward movement of the piston 27 which operates through the lever mechanism above described to rock the shaft 21 and the arms 20 to swing the entire lapping arm assembly to an inoperative or loading position, after which the lapped work piece may be removed from the machine and replaced with a new work piece to be lapped. As above explained, the machine may be readily equipped with one or more of the lapping arms 60 arranged at spaced intervals along the slide bars 22 and 23 in a manner similar to that shown in my prior U. S. Patent No. 2,166,009 above referred to.

It is desirable to provide a fresh portion of abrasive paper or cloth for each lapping operation in order that a substantially uniform lapping action may be obtained on successive work pieces. To accomplish this desired result, it is desirable to provide an automatic abrasive paper feeding mechanism which will automatically and positively advance the abrasive paper by an exact and predetermined amount for each lapping operation. It is desirable to provide a paper feeding mechanism which is arranged automatically and positively to feed the abrasive paper by a predetermined amount each time the lap supporting arms 61 and 62 are opened after a lapping operation has been completed. The abrasive paper feeding mechanism is supported by a bracket 115 which is fastened to the lap supporting element 63 so that it moves to and from an operative position therewith. A roller 116 is rotatably supported by a stud 117 adjacent to the left-hand end of the bracket 115 (Figs. 1, 2 and 3). The periphery of the roller 116 is provided with a corrugated or knurled surface 118. A roller 119 is rotatably supported by a stud 120 which is in turn supported on the left-hand end of a rock arm 121. The rock arm 121 is pivotally supported on a stud 122 which is fixed relative to the bracket 115. The periphery of the roller 119 is provided with a corrugated or knurled surface 123 which is yieldably urged toward the corrugated surface 118 of the roller 116 by means of a spring-pressed plunger 124. The compression of the spring-pressed plunger 124 may be adjusted by means of a manually adjustable screw 125 so that a desired pressure may be exerted between the rollers 119 and 116.

The continuous strip of abrasive paper, which

wraps around the work piece 113 and engages the lap supporting element 63, passes through a guide 126 which is carried by the bracket 115. The abrasive paper 93 extends to the left beyond the guide 126 and wraps in a clockwise direction around the knurled peripheral surface 118 of the roller 116. The abrasive paper then passes through the adjacent knurled surfaces 123 and 118 of the rollers 119 and 116, respectively, and wraps in a counterclockwise direction around the roller 119. A gear 128 is fixedly mounted on the end of the roller 116. The gear 128 meshes with a gear 129 which is fixedly mounted on the end of the roller 119.

In order to automatically and positively index the abrasive lapping element 93 by a predetermined amount after each lapping operation, an automatic indexing mechanism is provided whereby the gears 129 and 128 may be readily indexed each time the lap supporting arms 61 and 62 are moved to an inoperative position.

A holding pawl 135 is provided to at all times hold the gear 129 against rotation in a clockwise direction. An actuating pawl 137 is pivotally supported on a stud 138. The stud 138 is in turn supported by a pair of spaced rock arms 139 and 140 which are pivotally supported on the stud 120. The stud 138 is connected by a rod 141 with a bell crank lever 142. The bell crank lever 142 is pivotally supported by a stud 143 which is fixedly supported in spaced brackets 144 and 145 (Fig. 7). The brackets 144 and 145 are fixedly mounted on the lower end of the lapping arm 60. The lower or short arm of the bell crank 142 is connected by a stud 146 with a link 147. The link 147 is pivotally connected by a stud 148 with a bracket 149 which is fixedly mounted on the lap supporting arm 61.

In Fig. 2 the lap supporting elements 63 and 64 together with the flexible abrasive lapping element 93 are shown in an operative position together with the other actuating parts thereof and with the abrasive paper feeding pawl 137 in a retracted position. When fluid under pressure is admitted to break the toggle levers 67 and 68, the lap supporting arm 61 moves in a clockwise direction, which movement is transmitted through the link 147 to rock the bell crank lever 142 in a counterclockwise direction so as to shift the rod 141 toward the left (Fig. 1) to move the pawl supporting arms 139 and 140 in a counterclockwise direction, which movement carries the paper feeding pawl 137 also in a counterclockwise direction to rotate the gears 129 and 128 in a counterclockwise and clockwise direction, respectively, to feed the abrasive forward by an exact and predetermined amount to present a portion of fresh abrasive surface for the next lapping operation. The index pawl 137 together with its actuating parts is shown in the indexed position in Fig. 3. When the lap supporting elements 63 and 64 together with their actuating parts are again moved into operative position with the next work piece to be lapped, the index pawl 137 rides idly over the teeth of the gear 129 to return the pawl 137 to its initial position (Fig. 2). During this movement the holding pawl 135 serves to prevent movement of the gear 129 in a clockwise direction.

The rod 141 is preferably adjustably connected to the bell crank lever 142. The bell crank lever 142 is preferably formed as two spaced parts 142 and 142a (Fig. 7). The bell crank lever supports a bracket 150 which is provided with a notch 151. The notch 151 serves as a support for the threaded end of the rod 141. A pair of spaced nuts and lock nuts 152 and 153 are arranged on opposite sides of the bracket 150 (Fig. 2). By manipulation of the nuts 152 and 153, the effective length of the rod 141 may be readily varied as desired.

It will be readily apparent from the foregoing disclosure that each time the lap supporting elements 63 and 64 are moved to an inoperative position after a lapping operation has been completed, this movement will be automatically transmitted through the indexing mechanism above described positively and precisely to index the abrasive paper 93 so as to present a predetermined portion of fresh abrasive for the next successive lapping operation. By utilizing the pair of corrugated or knurled spring-pressed feed rollers, a positive indexing movement of the flexible abrasive element is assured.

The operation of this improved lapping machine will be readily apparent from the foregoing disclosure. A work piece 13, such as an automotive crankshaft, is placed in position for rotation by the headstock 12 and the footstock (not shown). The work rotation is then started and the control lever 53 is moved in a clockwise direction into the position shown in Fig. 1 to move the control valve 49 so that fluid under pressure will pass through the pipe 41 into the cylinder chamber 42 to cause a downward movement of the piston 27, thus rocking the entire lapping arm assembly supported by the arms 20 to an operative position, such as that shown in Fig. 1. The valve 105 is then shifted into the position illustrated in Fig. 1 to move the lap supporting elements 63 and 64 into an operative position to wrap the flexible abrasive paper or lapping element 93 around the periphery of the surface to be lapped.

The indexing mechanism above described having previously advanced the paper 93 by a precise and predetermined amount, the closing of the lap supporting elements 63 and 64 serves to advance the abrasive paper 93 from the supply roller 92. The lapping operation then proceeds to the desired and predetermined extent, after which the valve 105 is shifted so as to admit fluid under pressure through the flexible pipe 81 to cause a downward movement of the piston 76, which movement breaks the toggle levers 67 and 68 and moves the lap supporting elements 63 and 64 into an inoperative position away from the work piece 13. During this movement, the index pawl 137 is automatically moved in a counterclockwise direction to rotate the gear 129 in a counterclockwise direction and the gear 128 in a clockwise direction, thus advancing the abrasive paper 93 by a precise and predetermined amount to present a predetermined fresh abrasive surface for the next lapping operation. As above explained, the machine may be readily equipped with one or more lapping arms 60 arranged at spaced intervals along the supporting bars 22 and 23 in a manner similar to that shown in my prior U. S. Patent No. 2,166,009 above referred to.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the ac-

companying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a lapping arm for lapping cylindrical work pieces, a flexible strip of abrasive to loop around a work piece, a pair of opposed jaws having surfaces arranged to clamp said abrasive in abrading contact with a workpiece, means to move said jaws to and from an operative position, guiding rollers supported by one of said jaws, a pair of opposed rough-surfaced, spring-pressed rotatable feed rollers supported by the other jaw, means to adjust the relative pressure between said rollers, gearing operatively connecting said rollers, means including a pawl engageable with said gearing, and means including adjustable connections between said pawl and one of said jaws which is actuated by movement of said jaws to an inoperative position automatically to actuate said pawl and index said abrasive by a precise and predetermined amount.

2. In a lapping arm for lapping cylindrical work pieces having a flexible strip of abrasive to loop around a work piece, a pair of pivotally mounted opposed shoes to support the abrasive element in abrading contact with the work piece, a pair of toggle levers to move said shoes to and from an operative position, and an abrasive element feeding mechanism including an abrasive guiding device supported by one of said jaws, a pair of opposed rough-surfaced, spring-pressed rotatable feed rollers supported on the other jaw, said abrasive element passing between said rollers, gearing operatively connecting said rollers, means including an index pawl engageable with said gearing, means including a pivotally mounted lever which is adjustably connected to actuate said pawl, and operative connections between said lever and one of said toggle levers which is actuated automatically by movement of said toggle levers to an inoperative position automatically to actuate said pawl and feed said abrasive element a precise and predetermined amount.

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