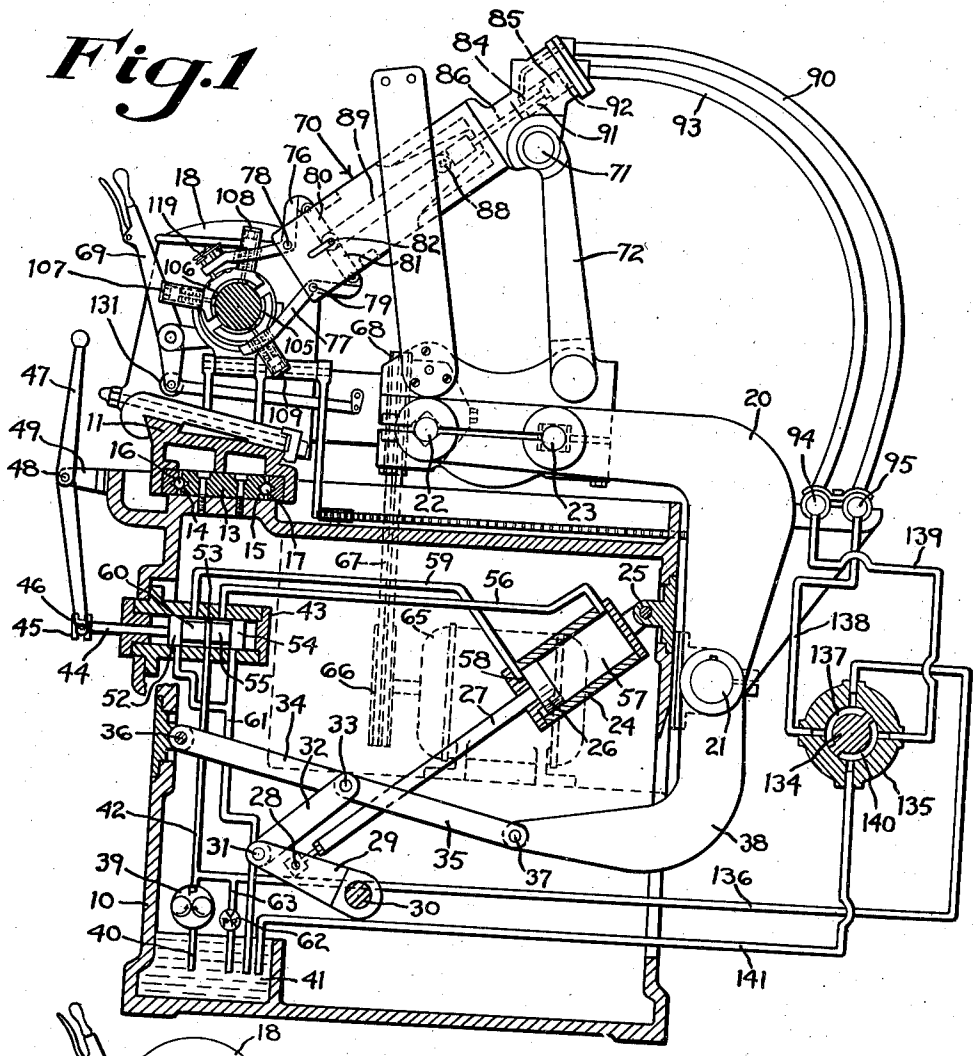
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CRANKSHAFT LAPPING MACHINE

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Fig. 1



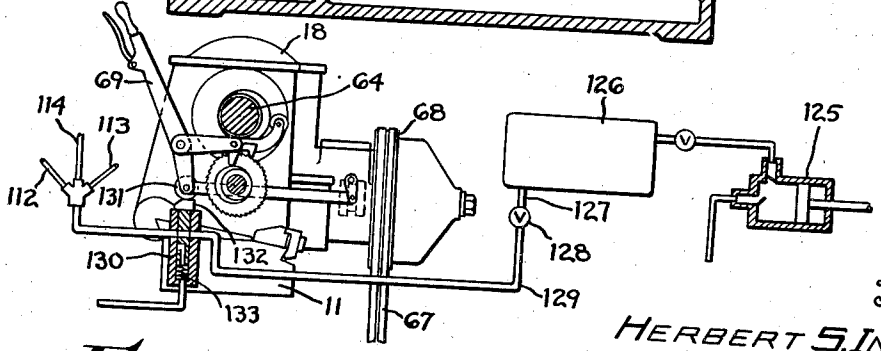


Fig. 4

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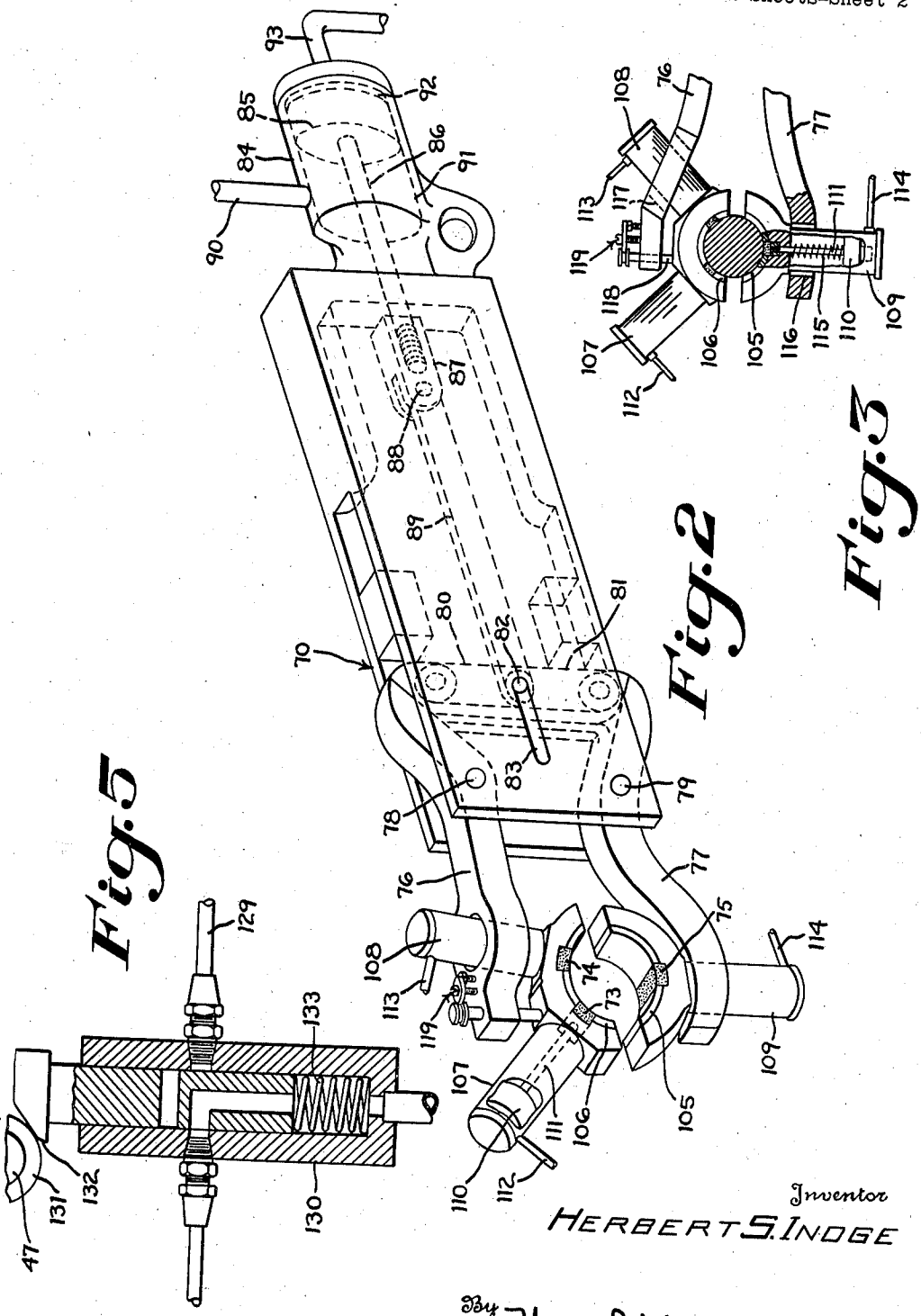


Fig. 2

Fig. 3

Fig. 5

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CRANKSHAFT LAPPING MACHINE

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Application January 12, 1940, Serial No. 313,590

3 Claims. (Cl. 51—161)

The invention relates to abrading machines, and more particularly to a crankshaft lapping machine.

One object of the invention is to provide a crank lapping machine which will more effectively lap and finish a plurality of crankpins or bearings on an automobile crankshaft. A further object of the invention is to provide a crankshaft lapping machine in which a plurality of lapping elements are arranged to engage a pin or bearing to be lapped at spaced intervals. Another object of the invention is to provide a crank lapping machine in which the crank lapping arm is provided with a plurality of independently spaced lapping elements which are yieldably maintained in engagement with the work piece to be lapped. A further object of the invention is to provide an improved crank lapping machine having a plurality of spaced, independent, pressure controlled lapping elements for engaging a work piece at spaced intervals above its periphery. A further object of the invention is to provide a lapping arm having a plurality of pneumatically controlled lapping elements for engaging the work piece at a plurality of spaced positions at predetermined pressures. 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 the improved crankshaft lapping machine;

Fig. 2 is a fragmentary perspective view, on an enlarged scale, of the crank or bearing lapping arms and the actuating mechanism therefor;

Fig. 3 is a fragmentary detail view, partly in section, showing the lapping head on the arm shown in Fig. 2;

Fig. 4 is a fragmentary constructional and diagrammatic view, showing the headstock controlling mechanism and the pneumatic pressure control for the lapping elements; and

Fig. 5 is a fragmentary cross sectional view through the air controlled valve for controlling the application of pneumatic pressure to the lapping elements.

A crankshaft lapping machine has been illustrated in the drawings comprising a base 10 which supports a longitudinally reciprocable work supporting table 11. Table ways are provided between the base 10 and the table 11 which in the preferred form are of an anti-friction type. The base 10 is provided with a plate 13 which is fixedly mounted on the base 10 and is provided on its opposite edges with parallel V-shaped grooves 14 and 15 which serve as inner raceways for a pair of spaced rows of anti-friction balls 16 and 17, respectively. A cage (not shown) is provided between the races to space the balls 16 and 17 longitudinally as desired. This construction forms an anti-friction way between the table 11 and the base 10 whereby the table together with a headstock 18 and a footstock (not shown) may be readily reciprocated during the lapping operation.

The arrangement of the headstock and footstock and associated parts is substantially identical with that shown in my prior Patent No. 2,166,009 dated July 11, 1939, to which reference may be had for details of disclosure not contained herein.

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 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 journalled in suitable 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 a slide which supports a plurality of lapping arms to be hereinafter described.

The lapping arm assembly supported by the arms 20 is arranged so that they 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 an inoperative position, a fluid pressure mechanism is provided comprising a fluid pressure cylinder 24 which is pivotally connected by means of a stud 25 with the base 10 of the machine. A piston 26 is slidably mounted within the cylinder 24 and is connected to one end of a piston rod 27. The other end of the piston rod 27 is connected by a stud 28 with a rock arm 29 which is pivotally supported on a shaft 30 within the

base 10 of the machine. The arm 29 is provided with a stud 31 which is connected to one end of a link 32. The other end of the link 32 is connected by a stud 33 with the adjacent ends of a pair of toggle levers 34 and 35. The toggle lever 34 is connected at its other end by means of a stud 36 with the base 10, and the toggle lever 35 is connected by a stud 37 with an arm 38 which is fixedly mounted on the rock shaft 21. The assembly above described is arranged to rock the shaft 21 together with the arms 20 and all of the crankpin and bearing lapping arms together with their supporting and actuating mechanisms either into or away from an operative position. Levers 29, 32, 34 and 35, as shown in full lines in Fig. 1, are in an operative position to hold the arm 38 and the arms 20 together with the entire lapping arm assembly in an operative position. When a lapping operation has been completed, fluid under pressure is admitted to the cylinder 24 to cause the piston 26 and the piston rod 27 to move toward the right (Fig. 1) so as to shift the lever mechanism above described to rock the arm 38, the rock shaft 21, together with the arms 20, in a clockwise direction (Fig. 1) to move the entire lapping arm assembly to an inoperative position.

A fluid pressure system is provided to control the admission of fluid under pressure to the cylinder 24. A motor driven fluid pressure pump 39 within the base 10 of the machine draws fluid through a pipe 40 from a reservoir 41 within the base 10 and passes fluid under pressure through a pipe 42 to a control valve 43. The valve 43 is of a balanced piston type having a valve stem 44 which is provided at its outer end with a spool-shaped member 45 and is connected to a control lever 47 by means of a pair of diametrically opposed studs or pins 46 mounted on a yoked end of the control lever 47. The control lever 47 is pivotally supported on a stud 48 which is carried by a bracket 49 fixedly supported on the front of the base 10 of the machine. A plurality of valve pistons 52, 53 and 54 are formed integral with the valve stem 44. Fluid under pressure passing through the pipe 42 enters a valve chamber 55 located between the valve pistons 53 and 54 and passes out through a pipe 56 into a cylinder chamber 57 to cause the piston 26 to move toward the left (Fig. 1) to shift the lapping arm supports 20 in a counterclockwise direction (Fig. 1) to position the crankpin and bearing lapping arms in an operative position. During the admission of fluid under pressure to the cylinder chamber 57, fluid is exhausted from a cylinder chamber 58 at the other end of the cylinder 24, through a pipe 59, a valve chamber 60 located between the valve pistons 52 and 53, and out through a pipe 61 which exhausts into the reservoir 41. A fluid pressure relief valve 62 is connected by a pipe 63 with the pipe line 42 and serves to by-pass excess fluid under pressure if the pressure within the pipe line 42 for any reason increases over the desired and predetermined operating pressure.

After a lapping operation has been completed, the control lever 47 is rocked in a counterclockwise direction to shift the valve 43 into a reverse position so that fluid under pressure from the pump 39 passing through the pipe 42 enters the valve chamber 60 located between the valve pistons 52 and 53 and passes out through the pipe 59 into the cylinder chamber 58. The admission of fluid under pressure to the cylinder chamber 58 causes the piston 26 and the piston rod 27 to move toward the right (Fig. 1), which movement serves through the lever mechanism above described to rock the arm 38, the rock shaft 21, and the arms 20 so as to move the entire lapping arm assembly in a clockwise direction (Fig. 1) to an inoperative position with the lapping arms out of engagement with the crankshaft being lapped. During this movement, fluid within the cylinder chamber 57 exhausts through the pipe 56, through the valve chamber 55, and through the pipe 61 into the reservoir 41.

Headstock

The headstock 18 is provided with a rotatable spindle 64 which is supported in suitable bearings within the headstock frame. The headstock is substantially identical to that shown in the prior patent to Indge and Hulbert No. 2,092,734 dated September 7, 1927, to which reference may be had for details of disclosure not contained herein. The headstock spindle may be rotated from any suitable source of power, such as an overhead belt drive or a self-contained electric motor. In the preferred construction, an electric motor 65 is mounted within the base 10 and is provided with a driving pulley 66 which is connected by a multiple V-belt 67 with a pulley 68 on the headstock 18. The pulley 68 is drivingly connected to rotate the headstock spindle 64 in a manner substantially the same as that shown in the above-mentioned U. S. Patent No. 2,092,734. A manually operable control lever 69 is provided to facilitate starting and stopping the headstock spindle 64 as desired to control the lapping cycle.

Lapping arm

A plurality of crankpin and bearing lapping arms 70 are provided, one arm being provided for each crankpin and main bearing on the shaft to be finished. Each of the lapping arms 70 is pivotally supported on a stud 71 which is in turn supported on the upper end of an arm 72. The lapping arms 70 each carry on their forward ends a plurality of lapping elements 73, 74 and 75. The lapping elements 73, 74 and 75 are supported by a pair of pivotally mounted lap supporting arms 76 and 77. The arms 76 and 77 are pivotally supported by studs 78 and 79, respectively, on the lapping arm 70. The other ends of the arms 76 and 77 are connected by a pair of toggle levers 80 and 81 which are connected together at their inner ends by means of a stud 82 which slides within elongated slots 83 (Fig. 2) formed in the side plates of the lapping arm 70. When the toggle levers 80 and 81 are in a straight line position (Figs. 1 and 2), the lap supporting arms 76 and 77 are maintained in an operative position with the lapping elements 73, 74 and 75 in operative contact with the crankpin or bearing to be lapped. In the preferred construction, the lapping arms 70 are arranged to be automatically actuated to shift the lapping elements into and away from an operative position in engagement with the work piece to be lapped.

A fluid pressure mechanism is provided for actuating the toggle levers 80 and 81, comprising a cylinder 84 having a piston 85 slidably mounted therein. The piston 85 is connected to one end of a piston rod 86. The other end of the piston rod 86 is provided with a block 87 which is connected by means of a stud 88 with a link 89, the other end of which is connected to the stud 82. When fluid under pressure is admitted through a pipe 90 into a cylinder chamber 91 to move the piston 85 toward the right into the position illustrated in Fig. 2, the

toggle levers 80 and 81 are moved into a straight-line position to locate the lapping elements 73, 74 and 75 in operative engagement with a work piece. During this movement, fluid is exhausted from a cylinder chamber 92 through a pipe 93.

Similarly, when fluid under pressure is admitted through the pipe 93 into the cylinder chamber 92, the piston 85, piston rod 86, and the link 89 are moved toward the left (Fig. 2) which serves to shift the toggle levers 80 and 81 from the full line positions (Fig. 2) which serves to rock the lap supporting arms 76 and 77 to move the lapping elements 73, 74 and 75 to an inoperative position. Pipes 90 and 93 are preferably flexible pipes or tubes to facilitate a swinging movement of the arms 70 during a lapping operation. The pipes 90 and 91 are connected to a pair of manifolds or pipes 94 and 95, respectively, which extend longitudinally between the arms 20 at the rear of the machine to provide a readily accessible means whereby any number of lapping arms 70 may be provided on the machine.

It is desirable that the lapping arm 70 be so arranged that the arms for lapping or finishing a crankpin may readily follow the movement of the crankpin during its revolution. As illustrated in the drawings, a lower crankpin or bearing engaging shoe 105 is provided having a partial internal cylindrical surface which is arranged to mate with and engage the lower portion of a work piece, such as a crankpin or main bearing. Similarly, an upper crankpin or bearing engaging shoe 106 is provided, having a partial internal cylindrical surface for engaging the upper surface of the work. The shoes 105 and 106 are in turn supported by the lap supporting arms 77 and 76, respectively. When the arms 77 and 76 are positioned as shown in Fig. 2, the shoes 105 and 106 serve to support the end of the lapping arm so that as the crankshaft to be lapped is rotated and the crankpin is revolved during said rotation, the arm will readily follow the crank motion so that the lapping elements 73, 74 and 75 will be maintained uniformly in contact with the surface to be lapped. The members 105 and 106 serve to take up any thrust due to movement of the work piece, thus leaving the abrading or lapping elements to perform only their abrading or lapping operation.

The shoes 105 and 106 may be locked in a rigid operating position on the work by means of the toggle levers 80 and 81. In order to facilitate alignment of the shoes 105 and 106 with the periphery of the crankpin or main bearing as they are moved into an operating position, a floating connection is preferably provided between said shoes and the arms 77 and 76, respectively.

To facilitate an independent regulation of the pressure of the lapping elements on the surface of the work being lapped or finished, a fluid pressure mechanism is provided, comprising fluid pressure cylinders 107, 108 and 109 which extend radially with respect to the lapping elements 73, 74 and 75, as well as radially relative to the crank or bearing to be lapped. Each of the cylinders 107, 108 and 109 contains a slidably mounted piston 110 which is connected by means of a piston rod 111 with the lapping elements 73, 74 and 75, respectively. Fluid under pressure, such as pneumatic pressure, is supplied through a pipe 112 into the cylinder chamber above the piston 110 to exert a pressure on the lapping element 73. Similarly, pressure may be simultaneously admitted through pipes 113 and 114 to the cylinders 108 and 109, respectively, to apply a definite and predetermined pressure to the lapping elements 74 and 75, respectively, to maintain the lapping elements in operative lapping engagement with the work piece. It will be readily apparent from the foregoing that the thrust of the crankpin on the lapping arm 70 is taken entirely by the shoes 105 and 106, respectively.

A spring 115 surrounds each of the piston rods 111 and is interposed between the piston 110 and the members 105 and 106, respectively, and serve to maintain the lapping elements in an inoperative position. The cylinders 107 and 108 are fixedly supported by the shoe 106 and the cylinder 109 is fixedly supported on the shoe 105. The cylinder 109 passes through a clearance aperture 116 (Fig. 3) formed in the lap supporting arm 77 and serves to provide a floating movement of the shoe 105 as the lap supporting arms 76 and 77 are moved into an operative position. The cylinder 108 passes through a clearance aperture 117 in the lap supporting arm 76. The shoe 106 together with the cylinders 107 and 108 supported thereby are carried by a stud 118 which is adjustably mounted for adjustment in a vertical direction by means of a screw adjusting mechanism 119, thus forming a self-aligning support for the member 106 so that when the lap supporting arms 76 and 77 are moved into an operative position, the shoe 106 may readily align itself with the crankpin or bearing surface to be finished. It will be readily apparent from the foregoing disclosure that the abrading or lapping elements 73, 74 and 75 are arranged so that they do not take any of the thrust of the crank or the movement of the lapping arm but are independently controlled and serve only as lapping elements to lap and finish the predetermined portions of the work piece.

In order to supply fluid under pressure, such as compressed air, to apply the desired lapping pressure to the elements 73, 74 and 75, a suitable compressed air apparatus may be provided. Connection may be made to the standard compressed air line which passes through most modern manufacturing plants or, if desired, a compressed air unit may be provided either adjacent to or within the base of the machine, comprising an air compressor 125 (shown diagrammatically in Fig. 4). Air is forced under pressure by the compressor 125 into a compression tank or chamber 126 which is connected by means of a pipe 127 and a pressure control valve 128 to a pipe 129 which connects with the pipes 112, 113 and 114 simultaneously and uniformly to apply equal and predetermined pressures to the lapping elements 73, 74 and 75, thus producing a uniform lapping or abrading action by each of the lapping elements.

To facilitate automatic operation of the pressure control device, a control valve 130 is mounted in the pipe line 129. The valve 130 is arranged to be actuated by means of a roller 131 supported at the lower end of the headstock control lever 69 so that when the control lever 69 is moved into the full line position (Fig. 4) to start rotation of the work at the beginning of a lapping cycle, the roller 131 acting upon a cam face at the upper end of the valve 130, will depress the valve into the position illustrated in Fig. 4 to admit fluid under pressure through the pipe 129 to apply the desired operating pressures to the lapping elements 73, 74 and 75. The valve 130 is normally held in an up position by means of a

spring 133 in which position the fluid or compressed air within the pipe 129 is cut off so that the released compression of the springs 115 will maintain the lapping elements 73, 74 and 75 out of operative lapping engagement with the pin or bearing being finished.

Fluid under pressure from the pump 39 within the base 10 of the machine passes through the pipe 42 and through a pipe 136 to a manually operable control valve 135. The valve 135 is preferably a rotary type valve having a valve rotor 134 rotatably supported within the valve casing. Fluid under pressure passing through the pipe 136 passes through a valve chamber 137 formed in the valve rotor 134 and is forced out through a pipe 138 which connects with a pipe or manifold 95 extending longitudinally of the machine. The manifold 95 is connected by means of flexible pipes with the hydraulic actuating mechanism for the lapping arms 70 (only one of the pipes and arms having been illustrated in the present case). Fluid under pressure within the manifold 95 passes through a flexible pipe or conduit 90, into a cylinder chamber 91, to move the piston 85 upwardly into the position shown in Fig. 1.

During this movement, fluid within a cylinder chamber 92 exhausts through a flexible pipe 93 into a pipe or manifold 94 which extends longitudinally of the machine. Fluid exhausts from the manifold 94, through a pipe 139, a valve chamber 140 formed in the valve rotor 134, and passes out through a pipe 141 which exhausts into the reservoir 41. It will be readily apparent that in the position of the valve 135 as illustrated in Fig. 1, the lapping elements and supporting arms 76 and 77 will be moved into an operative position. When the valve rotor 134 is rotated one-quarter turn, the direction of flow of fluid under pressure will be reversed to cause the piston 85 to move downwardly toward the left (Fig. 1) to remove the supporting arms 76 and 77 into an inoperative position.

The operation of this improved crankshaft lapping machine will be readily apparent from the foregoing disclosure. A crankshaft to be lapped is placed in position on the work supporting centers of the headstock 18 and footstock (not shown). The lever 47 is then moved into the position illustrated in Fig. 1 to swing the lapping arm assembly supported by the arms 20 in a counterclockwise direction to move the lapping arm 70 into an operative position. The valve rotor 134 is then shifted into the position illustrated in Fig. 1 to admit fluid under pressure to the cylinder chamber 91 to actuate the toggle levers 80 and 81, respectively, to swing the lap engaging members 105 and 106, respectively, into operative engagement with the pin or bearing to be lapped. At the same time, the headstock control lever 69 is moved in a counterclockwise direction to start the rotation of the crankshaft to be lapped and at the same time to actuate the air controlled valve 130 to apply a definite and predetermined lapping pressure to the lapping elements 73, 74 and 75. The lapping operation may then proceed to the desired extent, after which the headstock lever 69 is again moved either manually or automatically to stop rotation of the work piece and the valve rotor 134 of the valve 135 is rotated to reverse the direction of flow of fluid under pressure to actuate the toggle levers 80 and 81, respectively, to swing the lap supporting arms 76 and 77 so as to remove the elements or members 105 and 106 from operative engagement with the work. In this position of the parts, the main control lever 47 may then be moved in a counterclockwise direction (Fig. 1) to admit fluid under pressure to the cylinder chamber 58 to cause the lapping arm assembly to be rocked to an inoperative position to facilitate removal of the finished camshaft and the insertion of a new shaft to be lapped.

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

I claim:

1. In a crankshaft lapping machine having a movable crankpin lapping arm, a pair of opposed crankpin engaging shoes, means to move said shoes into and out of engagement with a crankpin to be lapped, said shoes being arranged to take up the thrust of said lapping arm, a plurality of lapping elements movably supported by said shoes, and means to apply a uniform predetermined pressure to all of said lapping elements.

2. In a crankshaft lapping machine having a pivotally supported crankpin lapping arm, a pair of opposed crankpin engaging shoes whereby the arm is moved with the crankpin during rotation thereof, a plurality of radially movable lapping elements supported by said shoes, and means including a piston and cylinder supported on said shoes for independently moving each of said elements into operative engagement with a crankpin and maintaining them in operative contact at a uniform predetermined pressure during the lapping operation.

3. In a crankshaft lapping machine having a movable crankpin lapping arm, a pair of opposed crankpin engaging shoes, means to move said shoes into and out of an operative position, said shoes being arranged to take up the thrust of the lapping arm, a plurality of fluid pressure cylinders supported on said shoes, pistons in said cylinders, a plurality of lapping elements actuated by said pistons and arranged to be moved in a substantially radial direction into engagement with a work piece to be lapped, and means simultaneously to admit fluid under pressure to all of said cylinders to move and maintain said lapping elements in lapping engagement with the work piece at a predetermined pressure.

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