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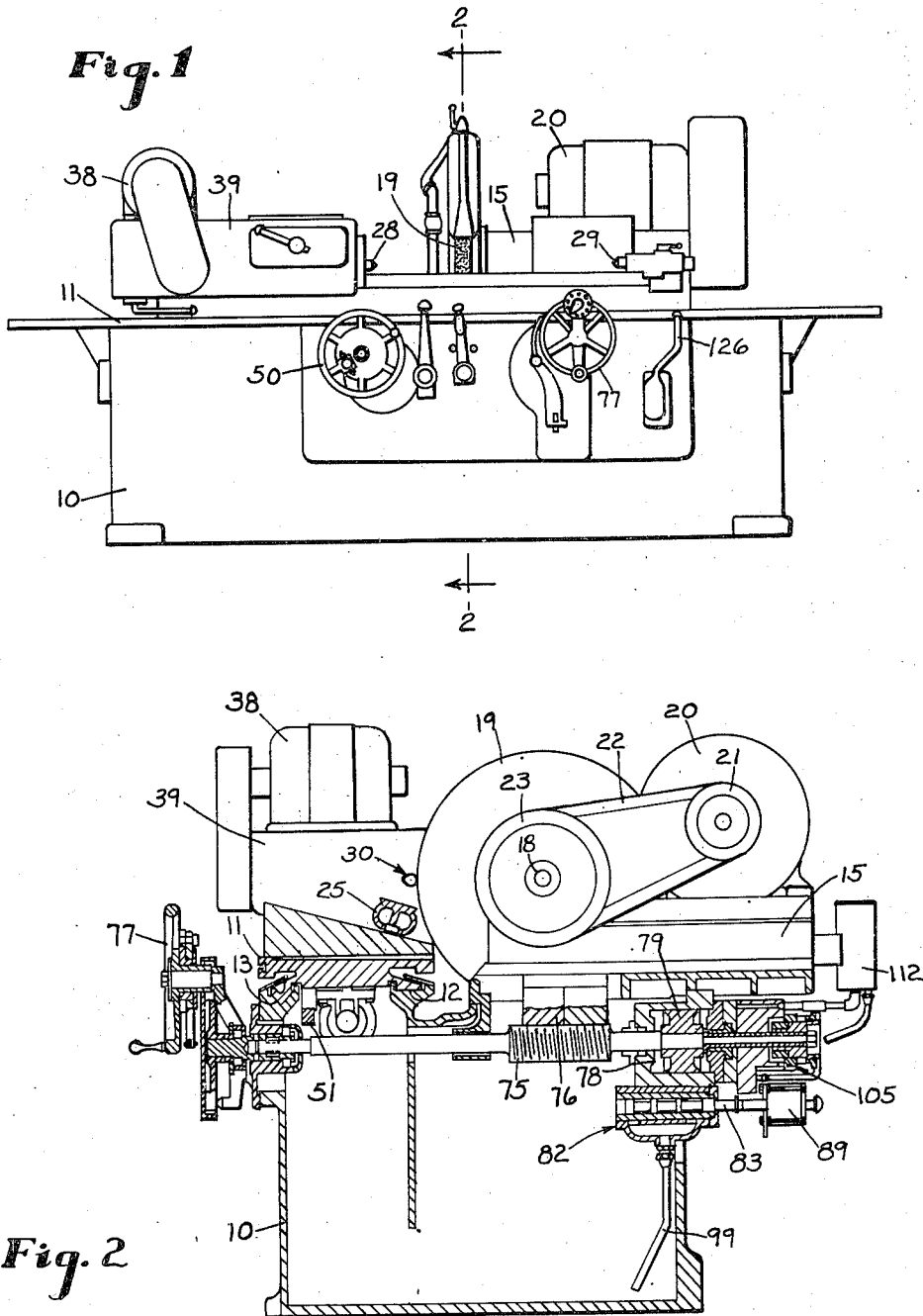
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2,460,744

CAMSHAFT GRINDING MACHINE

Filed June 6, 1947

4 Sheets-Sheet 1



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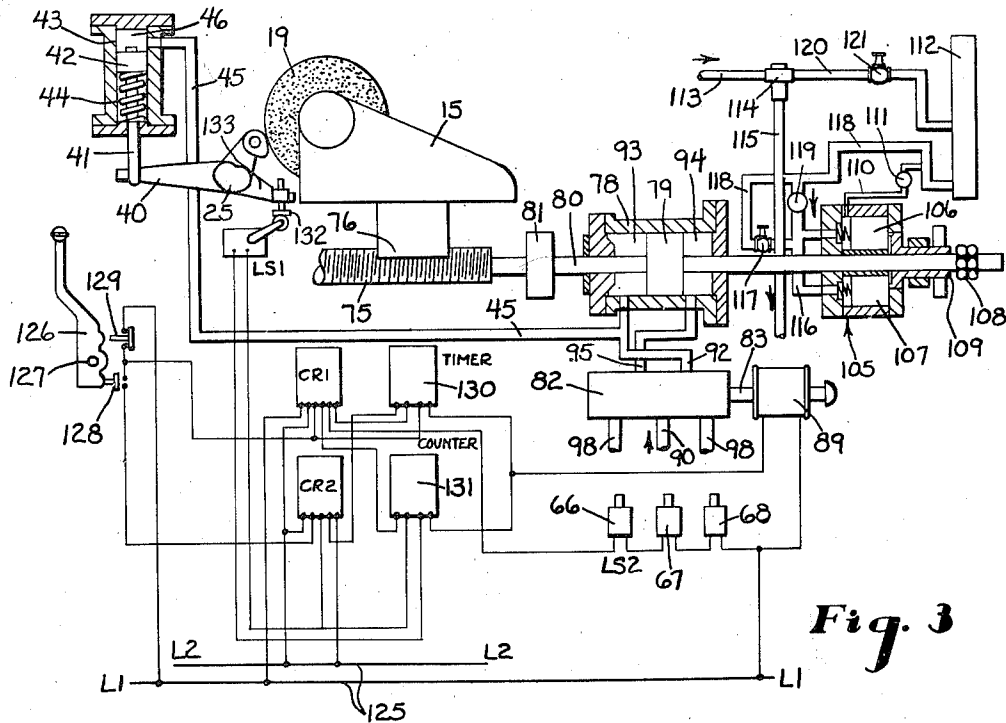


Fig. 3

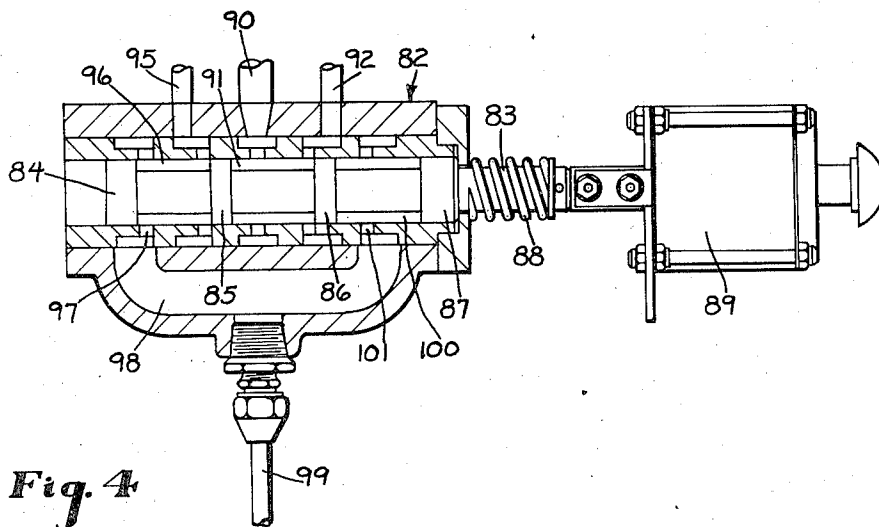


Fig. 4

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Fig. 6

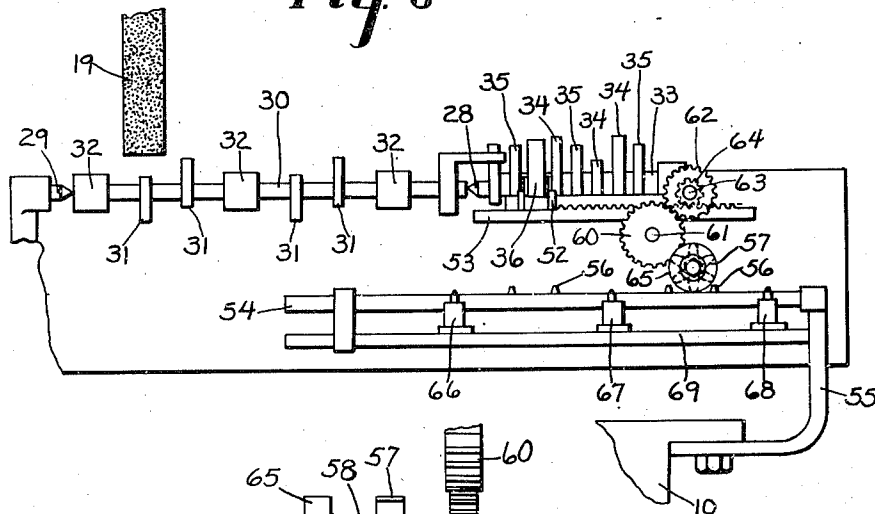


Fig. 7

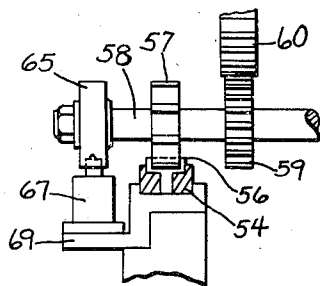
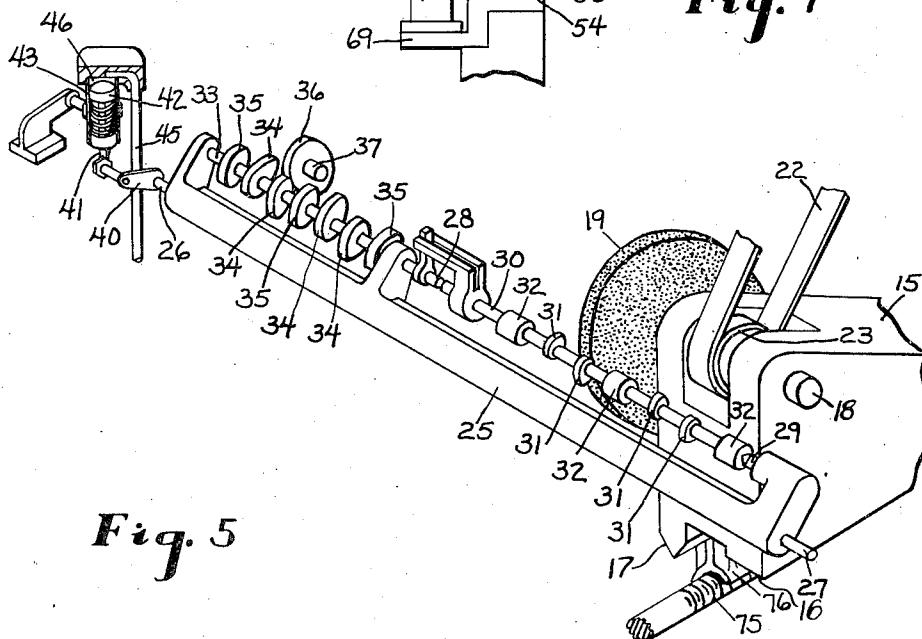


Fig. 5



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Fig. 9

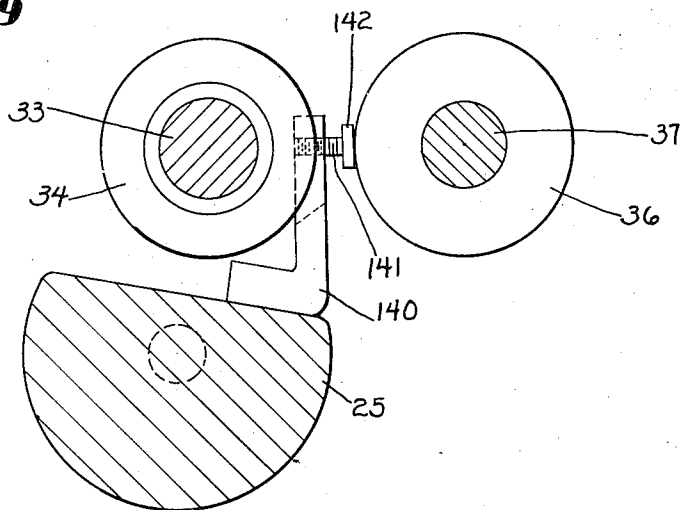
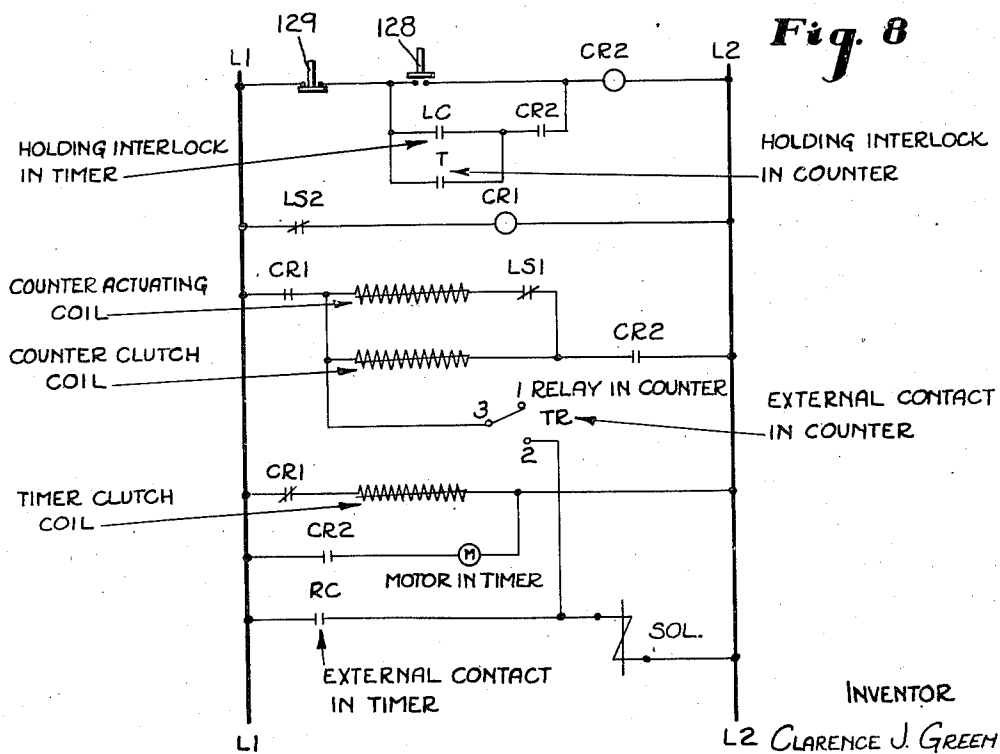


Fig. 8



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2,460,744

CAMSHAFT GRINDING MACHINE

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Application June 6, 1947, Serial No. 752,978

5 Claims. (Cl. 51—101)

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The invention relates to grinding machines, and more particularly to a camshaft grinding machine.

One object of the invention is to provide a simple and thoroughly practical camshaft grinding machine. Another object of the invention is to provide a camshaft grinding machine which is arranged to grind all of the cams and main bearings on a camshaft. Another object is to provide an automatically actuated mechanism to control the duration of the cam and bearing grinding operations. Another object is to provide an electric counter mechanism to control the duration of the cam grinding operation, and an electric timer to control the duration of the bearing grinding operation.

A further object is to provide an automatic control for the electric counter and timer which is arranged so that when the grinding wheel feed is initiated, the counter or timer are rendered operative depending upon whether a cam or a bearing is positioned for a grinding 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 this invention:

Fig. 1 is a front elevation of the improved camshaft grinding machine;

Fig. 2 is a cross sectional view, on an enlarged scale, through the machine, taken approximately on the line 2—2 of Fig. 1, showing the work head and the wheel head in elevation;

Fig. 3 is a combined hydraulic and electrical diagram of the wheel feeding mechanism and the controls therefor;

Fig. 4 is a longitudinal sectional view, on an enlarged scale, through the solenoid actuated feed control valve;

Fig. 5 is a diagrammatic perspective view showing the operative relationship of the various mechanisms;

Fig. 6 is a fragmentary rear view, showing the master cam roller indexing mechanism;

Fig. 7 is a fragmentary view, on an enlarged scale, of the star wheel and dog bar and other associated parts of the master cam roller indexing mechanism;

Fig. 8 is an electric wiring diagram of the

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electrical controls for the wheel feeding mechanism; and

Fig. 9 is a fragmentary sectional view, on an enlarged scale, of a modified construction for use in positioning the rock bar for a bearing grinding operation.

A camshaft grinding machine has been illustrated in the drawings having a base 10 which supports a longitudinally movable work table 11 on the usual flat way 12 and V-way 13. The base 10 also supports a transversely movable wheel slide 15 which is mounted on the usual flat way 16 and V-way 17 for a transverse adjustment toward and from the work supporting table 11. The wheel slide 15 rotatably supports a grinding wheel spindle 18 in suitable bearings (not shown). The wheel spindle 18 carries a grinding wheel 19 which is arranged to present a peripheral cylindrical grinding face to the work piece for a grinding operation. The grinding wheel 19 and its supporting spindle 18 may be driven by means of an electric motor 20 mounted on the upper surface of the wheel slide 15. A pulley 21 is mounted on the motor shaft and is connected by a driving belt 22 with a pulley 23 mounted on the wheel spindle 18.

The work table 11 serves as a support for a rock bar 25 which is supported on trunnion studs 26 and 27 (Fig. 5). The trunnion studs 26 and 27 are supported in bearings (not shown) which are fixedly mounted on the table 11. The rock bar 25 is provided with a head stock center 28 and a foot stock center 29 rotatably to support a camshaft 30. The camshaft 30 is provided with a plurality of integral cams 31 and bearings 32 to be ground.

In order to generate predetermined contours on the cams 31, a master camshaft 33 is rotatably supported on the rock bar 25 in axial alignment with the centers 28 and 29. The shaft 33 serves as a support for a plurality of master cams 34 and a plurality of master bearings 35. A rotatable master cam roller 36 is slidably mounted on a rotatable shaft 37 which is rotatably supported in bearings fixed relative to the table 11.

The master cam roller 36 is arranged so that it may be indexed longitudinally in timed relationship with the indexing movement of the table 11 so that when the table 11 is indexed longitudinally to position a cam 31 or a bearing 32 opposite the grinding wheel 19, the master cam roller 36 will be automatically indexed to a position opposite the master cam 34 or the master

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bearing 35 corresponding to the cam or bearing to be ground.

A suitable mechanism is provided yieldably to maintain the master cams 34 and the master bearings 35 in engagement with the master cam roller 36 during a grinding operation and to separate the master cams and bearings from the roller during a table indexing movement. The rock bar 25 is provided with an arm 40 which is connected to the end of a piston rod 41. A piston 42 is mounted on the upper end of the piston rod 41 and is slidably supported within a cylinder 43. A compression spring 44 surrounds the piston rod 41 and is interposed between the piston 42 and an end cap at the lower end of the cylinder 43. The compression spring 44 normally serves to maintain the master cams 34 or the master bearings 35 yieldably in engagement with the master cam roller 36 during a grinding operation. When it is desired to index the table 11 longitudinally to position a new cam 34 or bearing 32 in operative relationship with the grinding wheel 19, fluid under pressure is admitted through a pipe 45 into a cylinder chamber 46 to cause a downward movement of the piston 42 which serves to rock the rock bar 25 in a counterclockwise direction (Figs. 3 and 5) to separate the master cams and bearings from the master cam roller 36 during a table indexing movement.

The table 11 may be traversed longitudinally by a manually operable traverse mechanism comprising a hand wheel 50 which is operatively connected to a train of gears (not shown) with a rack bar 51 depending from the underside of the table 11 (Fig. 2). This mechanism is substantially identical with that shown in the prior United States Patent No. 1,783,755 to C. G. Trefethen, et al., dated December 2, 1930, to which reference may be had for details of disclosure not contained herein.

An automatically operated indexing mechanism is provided for indexing the master cam roller 36 longitudinally in timed relationship with the indexing movement of the work table 11, so that when the table is indexed to position a cam 31 or a bearing 32 into operative position relative to the grinding wheel 19, the master cam roller will be automatically positioned opposite the corresponding master cam 34 or master bearing 35. This mechanism comprises a yoke 52 which is fixedly mounted on a slidably mounted rack bar 53. A dog bar 54 is supported by a bracket 55 which is fixed relative to the base 10 (Fig. 6). The dog bar 54 supports a plurality of adjustable dogs 56 which are arranged in the path of a star wheel 57. The star wheel 57 is mounted on a rotatable shaft 58 which carries a gear 59 meshing with a gear 60 on the stud 61. The gear 60 meshes with a gear 62 carried by a shaft or stud 63. The shaft 63 also supports a gear 64 which meshes with the rack bar 53. It will be readily apparent from the foregoing disclosure that when the table 11 is moved longitudinally a corresponding movement is imparted to the star wheel and the gear train above described. When the star wheel moves into engagement with one of the dogs 56 on the dog bar 54, a rotary motion is transmitted to the gear train to transmit a longitudinal indexing movement to the rack bar, the yoke 52 to index the master cam roller 36 longitudinally. The dogs 55 are adjustably positioned on the dog bar 54 to correspond with the spacing of the cams 31 on the shaft 30 so that when the table is indexed to position any one of the cams 31 or a grinding

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operation, the master cam roller 36 will be indexed into operative with the corresponding master cam 34.

In order to control the grinding cycle while grinding a bearing 32 on the camshaft 30, a roller 65 is mounted on the left hand end of the shaft 58 (Fig. 7). The roller 65 is arranged in the path of a plurality of limit switches 66, 67 and 68 which are supported on a bar 69 which is fixedly mounted on a bracket 55. When the table 11 is indexed longitudinally to position one of the bearings 32 for a grinding operation, the roller 65 will engage the corresponding limit switch so as to render an electrical control mechanism to be hereinafter described operative to control the grinding feed on the bearing to be ground. The limit switches 66, 67, and 68 are spaced on the bar 69 to correspond with the spacing of the bearings 32 on the camshaft 30 to be ground. There is one limit switch for each bearing on the camshaft 30. In the present case there are three bearings to be ground and consequently there are three limit switches 66, 67, and 68. If a shaft to be ground has more than three bearings to be ground, then additional limit switches are provided on the bar 69.

A suitable wheel feeding mechanism is provided for controlling the feeding movement of the grinding wheel during the grinding of cams 31 and bearings 32 on the camshaft 30. This feeding mechanism comprises a rotatable feed screw 75 (Figs. 2 and 3) which meshes with or engages a half nut 76 depending from the underside of the wheel slide 15. A manually operable feed wheel 77 (Figs. 1 and 2) is provided for manually rotating the feed screw 75 to impart a transverse movement to the wheel slide 15.

In order to move the wheel slide rapidly to and from a grinding position and to automatically control the feed thereof during grinding, a hydraulically operated mechanism is provided comprising a cylinder 78 which is fixed relative to the base 10. The cylinder 78 contains a slidably mounted piston 79 which is connected to a double end piston rod 80. The left hand end of the piston rod 80 is connected by means of a coupling 81 with the right hand end of the feed screw 75. The coupling 81 is arranged so that the feed screw 75 may be rotated without imparting a rotary motion to the piston rod 80.

A feed control valve 82 is provided for controlling the admission to and exhaust of fluid from the cylinder 78. The valve 82 is preferably a piston type valve comprising a valve stem 83 having formed integral therewith valve pistons 84, 85, 86 and 87. A compression spring 88 serves normally to maintain the valve stem 83 in its right hand end position as illustrated in Fig. 4. A push-type solenoid 89 is provided to shift the valve stem 83 toward the left when it is desired to initiate a forward feeding movement of the grinding wheel 19. Fluid under pressure from a pump (not shown) is passed through a pipe 90 into a valve chamber 91 located between the valve pistons 85 and 86. In the position of the valve 82 (Fig. 4) fluid under pressure entering the valve chamber 91 passes through a pipe 92 into a cylinder chamber 93 to cause the piston 79 together with the feed screw 75 and wheel slide 15 to move toward the right (Fig. 3) to move the grinding wheel 19 to a rearward or inoperative position. During this movement, fluid within a cylinder chamber 94 may exhaust through a pipe 95 into a valve chamber 96 located between the valve pistons 84 and 85 and pass out through a port

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97, a passage 98, and a pipe 99 into the reservoir contained within the base of the machine.

When the solenoid 89 is energized to shift the valve stem 83 into its left hand end position, fluid under pressure passing from the pipe 90 into the valve chamber 91 passes out through the pipe 95 into the cylinder chamber 94 to cause the piston 79 to move toward the left (Fig. 3) to move the grinding wheel 19 rapidly toward the work piece to be ground. During this movement of the grinding wheel 19, fluid within the cylinder chamber 93 may exhaust through the pipe 92, through a valve chamber 100 located between the valve pistons 86 and 87 and pass out through a port 101, through the passage 98 and the exhaust pipe 99 into the reservoir.

In order to slow down the rapid approaching movement of the grinding wheel 19, a dash pot feed regulator is provided comprising a pair of diametrically opposed dash pot pistons 106 and 107. A rearwardly extending portion of the piston rod 80 is provided with an adjustable nut 103 which is arranged to engage the right hand end of a collar 109. The rapid approaching movement of the wheel continues until the nut 108 engages the collar 109 and starts movement of the dash pot pistons 106 and 107 toward the left (Fig. 3). Fluid from the dash pot cylinders is exhausted through a pipe 110 and a needle valve 111 into a reservoir 112. A pipe 116 is also connected to the left hand end of both of the dash pot cylinders to control the exhaust of fluid through a second needle valve 117 and a pipe 118 into the reservoir 112. During the initial movement of the dash pot pistons 106 and 107 toward the left, the exhaust of fluid from both of the dash pot cylinders is controlled by the setting of needle valves 111 and 117 to produce a shoulder grinding or a rough grinding feed. After the dash pot pistons close the port at the end of the pipe 110, the exhaust of fluid is thereafter controlled by valve 117 which is set to produce a slower or finish grinding feed.

In order to maintain sufficient fluid within the reservoir 112, fluid under pressure from the pump (not shown) is conveyed through a pipe 113, and a relief valve 114 which is set to pass a relatively low pressure fluid through the relief valve 114. Excess fluid under pressure entering the relief valve 114 is returned through a pipe 115 into the reservoir. A pipe 120 connects the relief valve 114 with the reservoir 112. A control valve 121 is provided in the pipe line 120. Compression springs are provided within the dashpot cylinders to return the dashpot pistons 106 and 107 toward the right into an inoperative position when the wheel slide 15 and grinding wheel 19 are moved rearwardly to inoperative positions. In order to facilitate the passage of fluid through pipe 118 to fill the dash pot cylinder chambers, a check valve 119 is provided which opens to allow rapid passage of fluid to bypass around the needle valve 117, rapidly to fill the dash pot cylinder chambers.

A modified construction has been illustrated in Fig. 9 for controlling and positioning the rock bar 25 during a bearing grinding operation. As shown and described above cylindrically shaped master bearings have been provided for locating the rock bar relative to the master cam follower roller 36 during a bearing grinding operation. During the bearing grinding operation there is no rocking movement of the bar 25 but it is merely necessary to position the bar in a fixed

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position and to maintain it in this position during the grinding of the bearings 32 on the camshaft 30. As illustrated in Fig. 9, the rock bar 25 may be provided with a plurality of brackets 140 which are fixedly mounted on the upper surface of the rock bar 25 and spaced thereon to correspond with the main bearings 32 on the camshaft 30 to be ground. An adjusting screw 141 is mounted on the upper end of the bracket 140. The adjusting screw 141 is provided with an enlarged head 142 having a plane surface which is arranged to engage the periphery of the master cam roller 36 to position the rock bar 25 during a bearing grinding operation. It will be readily apparent from the foregoing disclosure that the adjusting screw 141 may be adjusted precisely to adjust the position of the rock bar 25 relative to the master cam roller 36 in setting up the machine for a grinding operation.

A work driving motor 38 is mounted on a work head casing 39 (Fig. 1) which is operatively connected to rotate the master camshaft 33 and the camshaft 30 to be ground. The driving connections between the motor 38 and the master camshaft 33 are identical with that shown in the prior United States Patent No. 2,194,434 to Herbert A. Silven dated March 19, 1940, to which reference may be had for details of disclosure not contained herein.

An electrical control apparatus is provided including a source of power, as indicated by a pair of power lines L1 and L2 (Figs. 3 and 8). A control lever 126 is pivotally supported on a stud 127 on the front of the base 10. When the lever 126 is moved in a counterclockwise direction (Fig. 3), a cycle start switch is closed to start a grinding cycle by energizing the solenoid 89. If it is desired to stop the grinding cycle at any time during a grinding operation, the control lever 126 may at any time be moved in a clockwise direction (Fig. 3) to open a cycle stop switch 129. The closing of the cycle start switch 128 serves through a pair of control relays CR1 and CR2 to energize the solenoid 89 so as to shift the control valve 82 to initiate an infeeding movement of the grinding wheel 19. The control relays CR1 and CR2 serve to render either an electric timer 130 or an electric counter 131 operative to control the duration of a bearing or a cam grinding cycle respectively. A normally closed limit switch LS1 (Figs. 3 and 8) is actuated by an adjustable screw 132 carried by an arm 133 on the rock bar 25. Each time the rock bar is rocked during a cam grinding operation, that is, once during each rotation of the master camshaft and the camshaft being ground, the switch LS1 is opened to impart an impulse to the counter 131. After a predetermined number of rotations of the camshaft 30 being ground, that is, after a predetermined number of impulses of the counter 131, the solenoid 89 is deenergized thereby releasing the compression of the spring 88 which shifts the control valve 82 into a reverse position to move the grinding wheel 19 rearwardly into an inoperative position and thereby to terminate a cam grinding operation.

When the table 11 is indexed to position one of the bearings 32 for a grinding operation, the roller 65 is moved to actuate and open one of the limit switches (LS2—Fig. 8) 66, 67, or 68 (Fig. 6). Opening of one of the limit switches serves to render the timer 130 operative to control the grinding cycle so that the solenoid 89 remains energized for a predetermined time interval. After a predetermined time interval has elapsed,

the timer 130 operates to break a circuit so as to deenergize the solenoid 89 thereby allowing the released compression of the spring 88 to shift the valve 82 into a reverse position to move the grinding wheel 19 rearwardly to an inoperative position, and thereby to terminate a bearing grinding operation.

While the limit switches (LS2—Fig. 8) 66, 67 and 68 remain closed, the timer is rendered inoperative and the counter 131 operative to control a cam grinding cycle.

Operation

The operation of the improved camshaft grinding machine will be readily apparent from the foregoing disclosure. Assuming the various adjustments to have previously been made, a camshaft 30 having a plurality of cams 31 and bearings 32 to be ground is mounted on centers 28 and 29. The rotation of the grinding wheel driving motor 20 and the work driving motor 38 are started. The manually operable traverse wheel 50 is rotated to index the table 11 so as to position either a cam 30 or a bearing 32 to be ground in an operative position opposite the grinding wheel 19. During the table indexing movement, the master cam roller 36 is automatically indexed into operative relation with the master cam 34 or master bearing 35 corresponding to the cam 31 or bearing 32 to be ground. The control lever 126 is then rocked in a counterclockwise direction (Fig. 3) to close the cycle start switch 128. Closing switch 128 serves to energize the solenoid 89 to shift valve stem 83 into an extreme left hand position to initiate a rapid approaching movement of the grinding wheel 19 toward the cam 31 or bearing 32 to be ground. The rapid approaching movement of the grinding wheel 19 continues until the nut 108 engages the sleeve 109 after which the dash pot pistons 106 and 107 slow down the rapid approaching to a slow grinding feed. At the same time the cycle start switch 128 is closed, either the electric timer 130 or the electric counter 131 is rendered operative depending upon whether a bearing 32 or a cam 31 is to be ground. The grinding operation continues for either a predetermined time interval or a predetermined number of impulses of the counter after which the solenoid 89 is deenergized to release the compression of the spring 88 which shifts the valve 82 into a reverse position rapidly to move the grinding wheel 19 to a rearward or inoperative position. The table 11 may then be indexed to position the next cam 31 or bearing 32 into a grinding position after which the grinding cycle is repeated until all of the cams 31 and bearings 32 have been ground.

As illustrated in the drawing and described above, the table 11 is indexed manually by rotation of the hand traverse wheel 50. If desired the table 11 may be indexed automatically in a manner similar to that disclosed in the prior United States patent to Herbert A. Silven, No. 2,194,434 dated March 19, 1940, to which reference may be had for details of disclosure not contained herein.

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 camshaft grinding machine having a transversely movable rotatable grinding wheel, a longitudinally movable table, a rock bar on said table, a master camshaft rotatably supported on said rock bar, a plurality of spaced master cams and master bearings on said shaft, a headstock and a footstock center on said rock bar in axial alignment with the master camshaft rotatably to support a camshaft having a plurality of spaced cams and bearings to be ground, a slidably mounted rotatable master cam roller on said table, an electric counter actuated by oscillation of the rock bar which is rendered operative when a cam is in an operative grinding position to control the duration of a cam grinding operation, and an electric timer which is rendered operative when a bearing is in an operative grinding position to control the duration of a bearing grinding operation.

2. In a camshaft grinding machine having a transversely movable rotatable grinding wheel, a longitudinally movable table, means including a hydraulic piston and cylinder to move said wheel transversely in either direction, a solenoid actuated control valve therefor, a rock bar on said table, a master camshaft rotatably to rock said bar, a plurality of spaced master cams and master bearings on said shaft, a headstock and a footstock center on said rock bar in axial alignment with the master camshaft rotatably to support a camshaft having a plurality of spaced cams and bearings to be ground, a table-indexed slidably mounted master cam roller on said table, an electric counter actuated by oscillation of the rock bar which is rendered operative when a cam is in an operative grinding position to actuate said solenoid valve to cause a rearward movement of the grinding wheel to an inoperative position after a predetermined cam grinding operation, and an electric timer which is rendered operative when a bearing is in an operative grinding position to actuate said solenoid valve to cause a rearward movement of the grinding wheel to an inoperative position after a predetermined bearing grinding operation has been completed.

3. In a camshaft grinding machine having a transversely movable rotatable grinding wheel, a longitudinally movable table, means including a piston and cylinder to move said wheel transversely in either direction, a solenoid actuated control valve therefor, means including a manually operable switch to actuate said solenoid to initiate a forward feeding movement of the grinding wheel, a rock bar on said table, a master camshaft rotatably supported on said rock bar, a plurality of spaced master cams and master bearings on said shaft, a headstock and a footstock center on said rock bar in axial alignment with the master cam rotatably to support a camshaft having a plurality of spaced cams and bearings to be ground, a slidably mounted rotatable master cam follower on said table, an electric counter actuated by oscillation of the rock bar which is rendered operative when a cam is in an operative grinding position to actuate said solenoid valve after a predetermined cam grinding operation to cause a rearward movement of the grinding wheel to an inoperative position so as to control the duration of a cam grinding operation, and an electric timer which is rendered operative when a bearing is in an operative grinding position to actuate said solenoid valve to cause a rearward

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movement of the grinding wheel to an inoperative position after a predetermined bearing grinding operation so as to control the duration of the bearing grinding operation.

4. In a camshaft grinding machine having a transversely movable rotatable grinding wheel, a longitudinally movable table, a rock bar on said table, a master camshaft rotatably supported on said rock bar, a plurality of spaced master cams and bearings on said shaft, a headstock and a footstock center on said rock bar in axial alignment with the master camshaft rotatably to support a camshaft having a plurality of spaced cams and bearings to be ground, a table-indexed slidably mounted master cam roller, an electric counter, a limit switch actuated by oscillation of said rock bar to actuate said counter to control the duration of a cam grinding operation, a plurality of limit switches, one of said limit switches being arranged to be actuated when the camshaft is moved longitudinally to position a bearing for grinding, and an electric timer rendered operative by said switches to control the duration of the bearing grinding operation.

5. In a cam grinding machine having a transversely movable rotatable grinding wheel, a longitudinally movable table, a rock bar on said table, a master camshaft rotatably supported on said rock bar, a plurality of spaced master cams on

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said shaft, a headstock and a footstock center on said rock bar to support a camshaft having a plurality of spaced cams and bearings to be ground, a rotatable slidably mounted master cam roller on said table, means including a dog bar having a plurality of adjustable dogs and a star wheel to index the master cam roller in timed relation with the table indexing movement, a plurality of spaced adjustably mounted screws on said rock bar located between said master cams which are spaced to correspond with spaced bearings on the camshaft to be ground, said screws being arranged to engage said roller when a main bearing is in a grinding position, a plurality of spaced limit switches actuated in timed relation with said star wheel, and an electric timer rendered operative by said limit switches to control the duration of a bearing grinding operation.

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