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N. S. HUMES

2,680,939

INTERNAL GRINDING MACHINE

Filed May 27, 1952

2 Sheets-Sheet 1

Fig. 1.

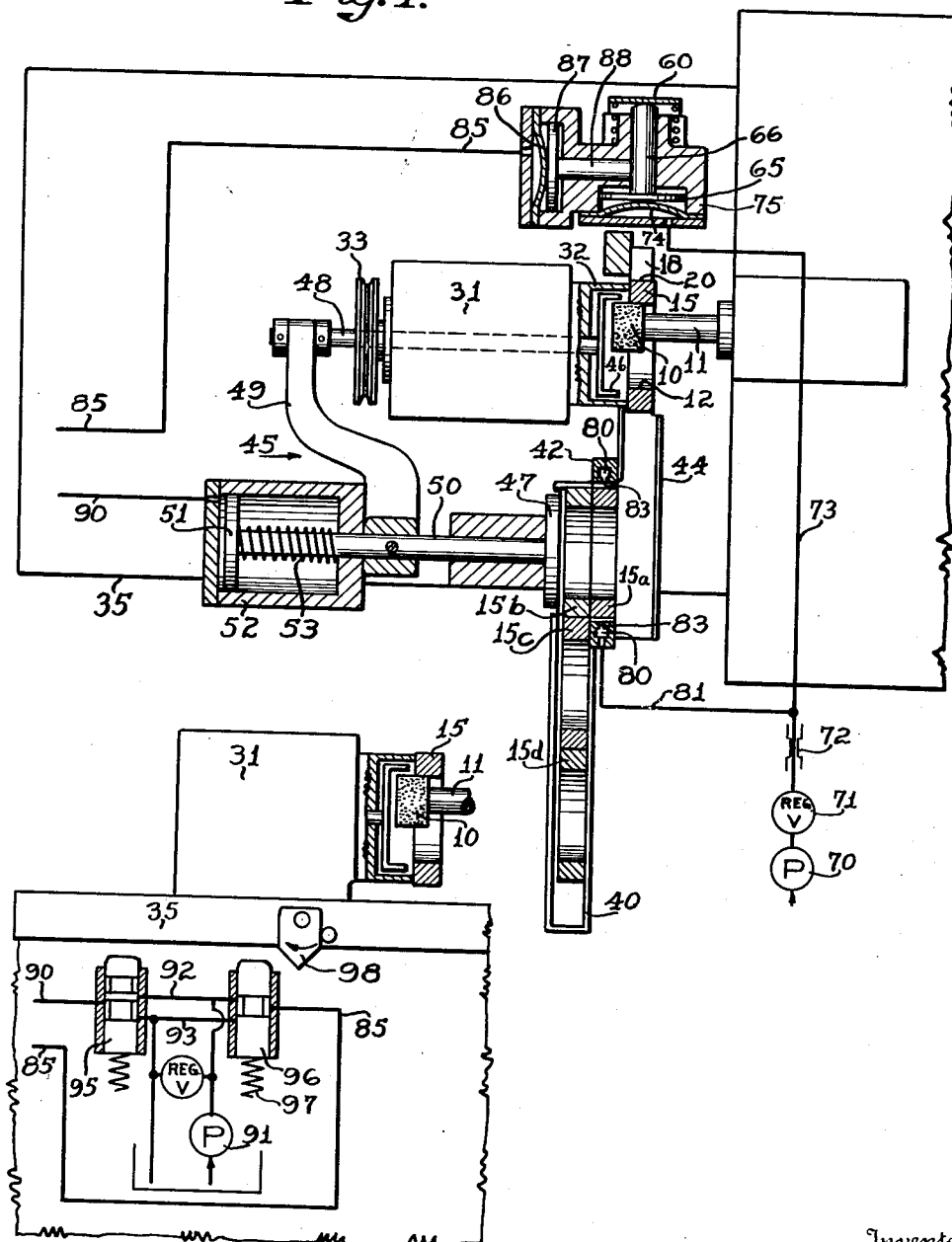


Fig. 2.

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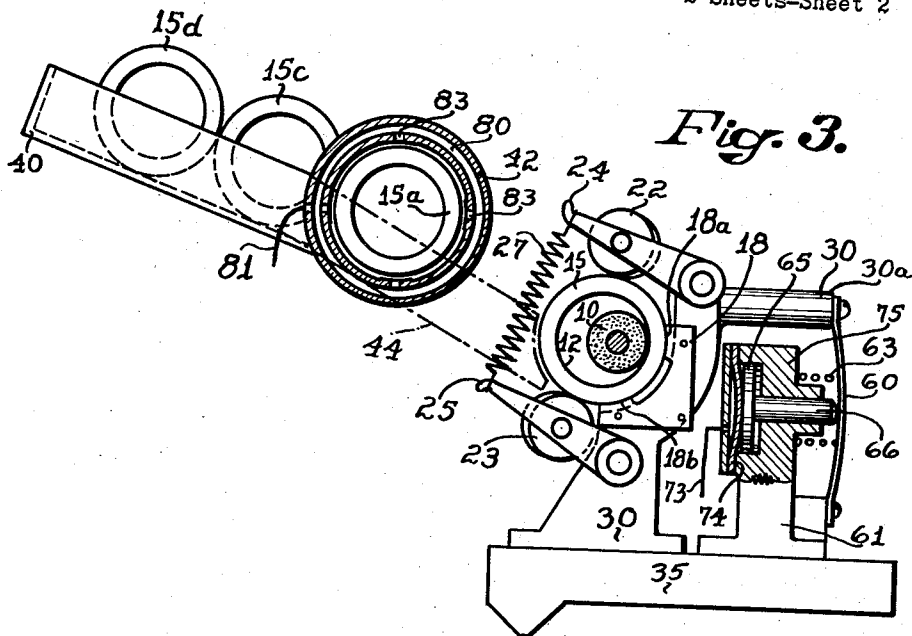


Fig. 6.

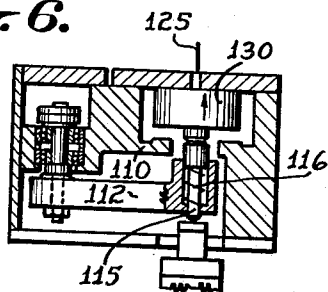
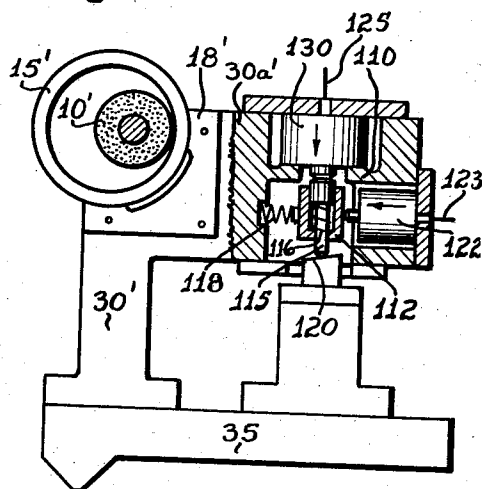


Fig. 4.

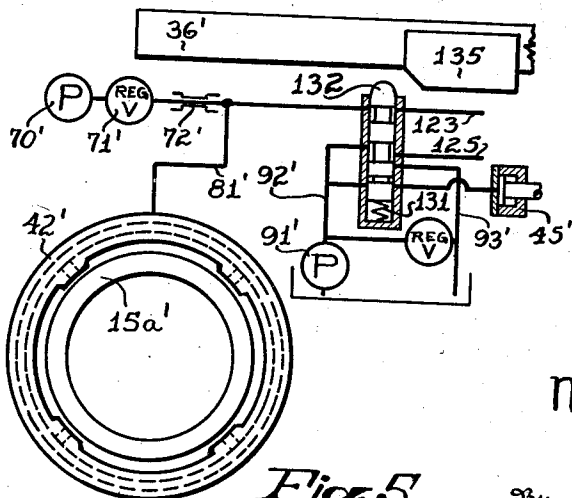


Fig. 5.

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INTERNAL GRINDING MACHINE

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9 Claims. (Cl. 51-103)

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This invention relates to internal grinding machines and particularly to work sizing in connection with machines of the centerless type.

In the art of refining inner surfaces of round workpieces by the application of an internal grinding wheel or other similar finishing tool, it is usual to locate the work, that is to fix the center of the workpiece with respect to the wheel by holding one of its outer peripheral surfaces against a work support which bears a predetermined fixed spaced relation to the grinding tool.

In grinding certain types of workpieces, it is necessary to support the piece directly in line with the force exerted by the tool on the work in order to avoid deflections in the workpiece and consequent errors in sizing. The work support may be either a rotatable roll, or a flat or concave surface, the latter conforming to the outer peripheral support surface of the workpiece and against which the workpiece is held by pressure rolls or other means while its inner surface is being refined.

Since it is the primary function of a fixed work support of the general type discussed to fix the centers of successive workpieces in the same spot with respect to the final position of the grinding tool surface, it is desirable also to arrange such a fixed work support so that appreciable variations (in terms of modern tolerances) in the outside diameters of support surfaces of successive workpieces will be compensated for with the result that the center of each workpiece will always be located at the same point with respect to the working surface of the tool and this is the primary object of the present invention.

Essentially the invention comprises means to change the position of a fixed work support with respect to the grinding tool for each successive workpiece to the extent that the outside radius of the workpiece varies from that of the previous workpiece and in response to such variation.

In the drawings:

Fig. 1 is a partial plan view partly in section of the mechanism of the invention.

Fig. 2 is a front elevation and partly schematic view of fluid pressure and control means for the mechanism of Fig. 1.

Fig. 3 is an end elevation view of the mechanism of Fig. 1.

Fig. 4 is an end elevation view of a modification.

Fig. 5 is a front elevation and partly schematic view of fluid pressure and control means for the mechanism of Fig. 4.

Fig. 6 is an end elevation view of some of the mechanism of Fig. 4.

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Referring to Figs. 1 to 3, an internal type grinding wheel or other finishing tool 10 on a spindle 11 is mounted to be driven from a fixed head (not shown) to refine an inner surface 12 of a workpiece 15. The workpiece is supported, while being ground, by a fixed work support 13 having concave surfaces 13a and 13b in contact with a preformed outer peripheral workpiece surface 20. The finished inside diameter of the inner surface 12 is determined in the usual manner by the position of the center of rotation of the workpiece which in turn depends upon the position of the outer workpiece surface 20 with respect to the final position of the surface of the grinding tool 10 at the finish of the grinding operation. The workpiece being ground is held against the support 13 by a pair of pressure rolls 22 and 23 mounted on pivoted arms 24 and 25 which are urged together to force the rolls against the work by a spring 27. The arms 24 and 25 and also the work support 13 are carried on a resilient member 30 which is mounted on a work head sliding table 35. A workhead 31 including a back plate 32 against which the workpiece abuts is also mounted on the table 35. The workpiece 15 may be urged against the back plate by the rolls 22 and 23 which are in a skewed position for this purpose. The workpiece is driven by the back plate 32 through a pulley 33 to which the back plate is fast.

A magazine 40 is arranged to feed a succession of workpieces 15a, 15b, 15c, 15d, first to an air gage 42 and then through an offset chute 44 to the work support 13 when the work table 35 has been retracted from the grinding tool 10.

An ejector mechanism indicated at 45 has a part 46 operating to the right as viewed in Fig. 1 to push a finished workpiece 15 out of the grip between the rolls 22 and 23 and the support 13 and another part 47 operating also toward the right as viewed to push a workpiece 15b into the air gage 42. The workpiece 15b in turn pushes an abutting workpiece 15a out of the air gage into the chute 44 where it rolls down into the support 13 ready for a successive grinding operation. The ejector part 46 is fast on a rod 48 extending through the workhead 31 independently of the back plate 32 and its driving pulley 33 (the shaft connecting the back plate 32 and pulley 33 being hollow and not shown). The rod 48 is connected to an offset arm 49 on a piston rod 50 on one end of which is mounted the ejector part 47 and on the other of which is a piston 51 operating in a cylinder 52 toward the right as shown under fluid pressure and toward the left under force of a spring 53.

The support member 30 being resilient, as stated, means are provided according to the invention to position the member 30 and the work support 18 with respect to a pre-determined position of the surface of the grinding tool 10. Referring particularly to Fig. 3, a leaf or bow 60 extends between the upper end 30a of the support member 30 and a base member 61 on the table 35. The central part of the bow 60 is preloaded to the right by a spring 63 and further pressure exerted to the right against the center of the bow 60 bends the resilient support member 30 to the right and hence moves the work support 18 away from the grinding tool 10.

Means are provided thus to move and position the work support 18 away from the tool 10 when a workpiece having a larger outside diameter is to be ground, and to allow the support 18 to be positioned closer to the tool 10 for a smaller workpiece, thus fixing successive workpiece centers at the same point with respect to the tool surface. For this purpose a piston 65 and rod 66 are provided to operate in the base 61 and to abut and move against the bow 60. Air under pressure generated by a pump 70 (Fig. 1) passing through a regulating valve 71, a restriction 72 and a conduit 73 is admitted to work against a diaphragm 74 and the piston 65 in a cylinder 75 in which the piston 65 operates. The amount of pressure in the line 73 determines the amount of movement to the right of the piston 65 and bow 60 and hence the amount of movement of the workpiece support 18 away from the tool 10. This in turn is determined by the size of a workpiece 15a in the air gage 42.

The air gage 42 has a circumferential air chamber 80 to which air is admitted from the line 73 through a branch line 81 and from which air is blown through peripheral jets 83 against the workpiece 15a being measured by the gage 42. The larger the workpiece 15a, the less air escapes through the jets 83, the greater the pressure in the line 73 and the more the work support 18 is moved to the right away from the tool 10. The work support 18 is thus positioned between grinding cycles to accommodate a succeeding workpiece 15a in the gage just before the workpiece 15a is moved into the chute 44 to replace the workpiece 15 which has been finished.

Fluid pressure means are provided to lock the piston rod 66 and support 18 in place for the next grinding operation once their position has been determined by the size of the workpiece 15a in the gage 42. For this purpose fluid under pressure in a line 85 acts against a diaphragm 86, a piston 87 and a piston rod 88 forcing the latter against the piston rod 66 to hold it in a fixed position. After the piston 66 establishes the position of the work support 18 and is locked in place by the piston 88, fluid pressure in a line 90 operates the piston 51 to eject the finished workpiece 15 and to send the succeeding workpiece 15a from the gage into the chute 44. The line 90 is then exhausted, withdrawing the part 46 and allowing the workpiece 15a to roll into the support 18 ready to be ground.

Fluid under pressure is supplied by a pump 91 (Fig. 2) to a pressure line 92. An exhaust line 93 is also provided. The lines 85 and 90 are each opened successively to the pressure and exhaust lines 92 and 93 by operation of valves 95 and 96. These valves are in turned operated successively by a pivoted dog 98 on the table 35 when the latter moves away from the wheel 10 to the left as seen in Fig. 2.

Assuming now that the parts are in position as shown in Figs. 1-3 with the valve 95 up and the fluid line 90 opened to exhaust and the ejector piston 51 in its left position, and with the valve 96 up, opening the fluid line 85 to pressure to lock the piston 66 holding the work support 15 in a fixed position while the workpiece 15 is being ground and with a succeeding workpiece 15a in the gage 42, operation of the mechanism is as follows:

After the workpiece 15 has been finished to a predetermined size, the table 35 is retracted by the usual means, i. e., moving to the left as seen in Figs. 1 and 2. The table dog 98 engages the valve 96 moving the latter down closing the line 85 to the pressure line 92 and opening it to the exhaust line 93. This releases pressure on the piston rod 88 and unlocks the piston rod 66. The piston 65 and hence the work support 18 can now assume a position with respect to the grinding tool 10 as determined by the size of the succeeding workpiece 15a being measured in the gage 42. Further movement of the table 35 to the left releases the valve 96 which moves upwardly again under force of its spring 97, again opening the line 85 to pressure to lock the piston 66 in the position which has just been established. Still further movement of the table 35 to the left causes the dog 98 to depress the valve 95 momentarily opening the fluid line 90 to pressure. This operates the ejector piston 51 toward the right and back toward the left, which ejects the finished workpiece 15 from the support 18 and sends the new workpiece 15a down to the support 18 whose position has just been established and fixed according to the size of the workpiece 15a. At the same time a new workpiece 15b is inserted in the gage 42. Now the table 35 moves back to present the workpiece 15a to the grinding tool 10, the dog 98 being inoperative during this return movement of the table 35. It is thus seen that the workpiece is measured and the support moved to accommodate its size before it reaches the position in which it is ground.

In a modified form of the invention shown in Figs. 4-6, a frame 110 is attached to the upper end 30a' of the resilient support member 30' which carries the work support 18'. Pivottally supported to swing horizontally in the frame 110 is an arm 112 which carries a vertically slidable pin 115 which is urged upwardly by a light spring 116. A spring 118 urges the swinging end of the arm 112 to the right as seen in Fig. 4 so that the pin 115 is over the high portion of a sloping cam surface 120. A bellows 122 when actuated by air pressure in a line 123 moves the arm 112 against the spring 118 moving the pin 115 toward the low portion of the cam surface 120. The pressure in the line 123 is determined by the size of a workpiece 15a being measured in an air gage 42'. A large diameter piece 15a increases the pressure in the line 123 causing the arm 112 to move over the low portion of the cam 120. Thereafter, fluid pressure in a line 125 expands a bellows 130 until the bottom of the bellows contacts the frame 110 as shown in Fig. 4. The pin 115 is thereby forced downwardly against the cam surface 120, thus forcing the top 30a' of the support member 30' and the workpiece support 18' to the left to a small degree. A smaller workpiece 15a in the gage 42' decreases the pressure in the line 123 allowing the pin 115 to move over the higher portion of the cam surface 120 so that when the bellows 130 is moved downwardly against the frame 110, the support 18' is forced further to the left

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toward the grinding tool 10'. The arm 112 is, of course, positioned by the air operated bellows 122 while the pressure is off the fluid operated bellows 130. The pin 115 is, therefore, retracted as shown in Fig. 6 and the arm is free-swinging and sensitive to slight changes of air pressure determined by the gage 42'. After fluid pressure is applied against the bellows 130, the pin 115 locks the mechanism in the established position. The slope of the surface 120 is exaggerated in the drawing and is not actually enough to cause the pin 115 to slide down it when the pressure is on the pin. Air is supplied to the bellows 122 and air gage 42' from a pump 70', through a regulating valve 71', restriction 72' and the lines 81' and 123. It is controlled by a valve 132. Fluid pressure is supplied by a fluid pump 91' to a line 92'. An exhaust line 93' is provided.

In operation, when the work table 35 moves to the left as shown in Fig. 5 away from the tool 10', a table cam 135 depresses the valve 132 shutting off the line 123 but at the pressure which was established by the gage 42' when the line 123 was open to pressure. Further downward movement of the valve 132 opens the line 125 to exhaust retracting the bellows 130 and the pin 115. The pre-established pressure in the line 123 then positions the arm 112 and the loader mechanism indicated at 45' and similar to that in Figs. 1-3 operates after which upward movement of the valve 132 under pressure of its spring 131 reopens the line 125 to fluid pressure causing downward movement of the pin 115 to its always same position, bending the support 18' toward the tool 10' in accordance with the new position of the pin 115 on the cam surface 120.

I claim:

1. In a machine for refining an inner surface of revolution of a workpiece having an outer preformed surface of revolution and in combination a grinding tool, workpiece rotating means and support means, said support means including a support element adapted to make contact with an outside support surface of a workpiece substantially in opposition to the force applied by the tool against the work thereby to support said piece against said force during grinding, said support element being adjustably movable toward and away from the desired center of rotation of said workpiece to compensate for variations in outside diameters of said workpiece support surfaces in different workpieces and adjusting means to fix the position of said support element relative to said center of rotation of a workpiece in accordance with the diameter of its said outside support surface.

2. In a machine for refining inner surfaces of revolution of workpieces having outer preformed surfaces of revolution and in combination, a rotary tool applicable to said inner workpiece surface, means to support each said workpiece from below, means to rotate each said workpiece, and a support element arranged to make contact with said outer workpiece surface substantially opposite the force applied by the tool during grinding, said support element being automatically movable toward and away from a final position of said tool to an adjusted position and means positioning said support element with respect to said final tool position in response to the diameter of the workpiece, and thereby maintaining the centers of successive workpieces at a substantially fixed distance from said final position of said tool.

3. In the combination as set forth in claim 75

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2, means to lock said movable support element in its said adjusted position before said tool is applied to the workpiece.

4. In a machine for refining an inner surface of revolution of a workpiece, said workpiece having an outer preformed surface of revolution and in combination, a grinding tool, movable support means engaging said outer surface to fix the center of the workpiece with respect to the tool, gage means to measure the diameter of said workpiece outer surface, and means operated automatically by the gage means to locate said support means with respect to said grinding tool in accordance with said measured diameter of each said workpiece thereby compensating for variations in the diameter of each of successive workpieces.

5. In a machine for refining an inner surface of revolution of a workpiece, said workpiece having an outer preformed surface of revolution and in combination, a grinding tool, movable support means engaging said outer surface to fix the center of the workpiece with respect to the tool, gage means to measure the diameter of said outer surface, means operated automatically by the gage means to locate said support means with respect to said grinding tool in accordance with said measured diameter of each said workpiece and means to feed a succession of workpieces to said gage means and said support means.

6. In a machine for refining an inner surface of revolution of a workpiece, said workpiece having an outer preformed surface of revolution and in combination, a grinding tool, movable support means to fix the center of the workpiece, gage means to measure the diameter of an outer surface of a workpiece in the gage while another is being finished by said tool, means to eject the finished workpiece and to move the workpiece in the gage into the support means and means responsive to the gage to locate the support means relative to the tool in accordance with the measured diameter of the previously measured workpiece.

7. In the combination as set forth in claim 6, a loading chute for holding a succession of workpieces, and means associated with said chute to feed a successive workpiece into said gauge as the workpiece in the gauge is moved into said support means.

8. In a machine for refining an inner surface of revolution of a workpiece, said workpiece having an outer preformed surface of revolution and in combination, a grinding tool, resiliently mounted support means, means to fix the position of said support means at a predetermined point for locating a first workpiece radially with respect to the tool during a grinding operation, gage means measuring the diameter of a succeeding workpiece while the first is being ground, means responsive to the gage means capable of moving the support means relative to the tool prior to the grinding of the said succeeding workpiece to compensate for any variation in diameter between the said workpieces and means to fix the support means in its newly established position during the grinding of a succeeding workpiece.

9. In a machine for refining an inner surface of revolution of a workpiece, said workpiece having an outer preformed surface of revolution and in combination, a retractable grinding tool, movable support means to position the workpiece radially, gage means to measure a diameter

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of a workpiece while another is being ground, means controlled by said gage means and operating automatically in time with tool retraction to locate said support means and then to lock it in position in accordance with the said measured diameter thereby to compensate for any variation in the measured diameters of successive workpieces.

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