Nov. 23, 1943. W. F. PIOCH ET AL 2,334,954

ARBOR

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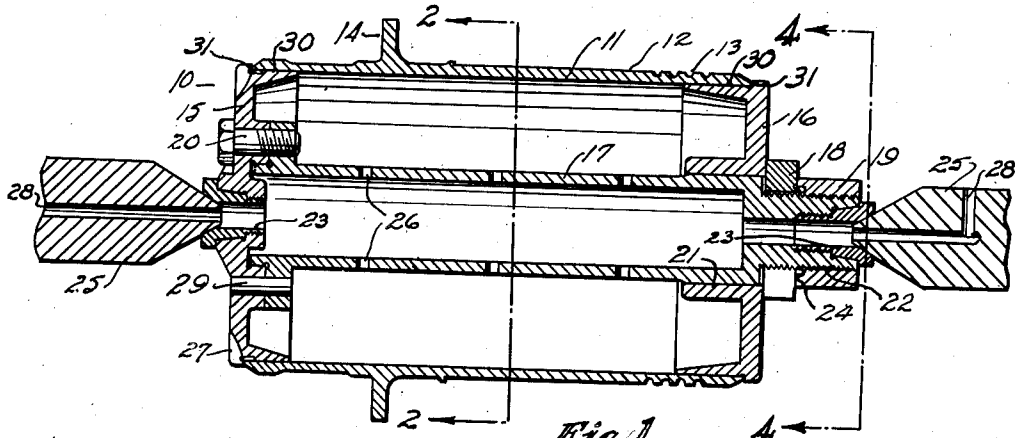


Fig. 1

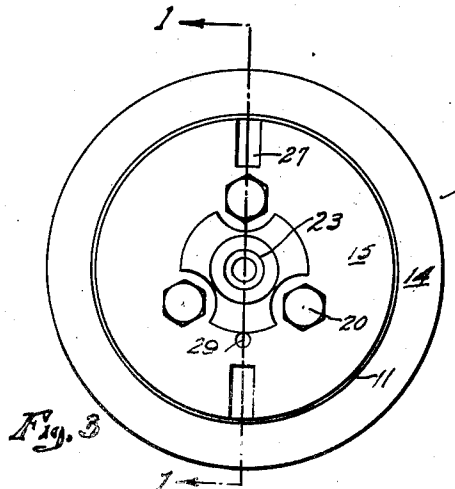


Fig. 3

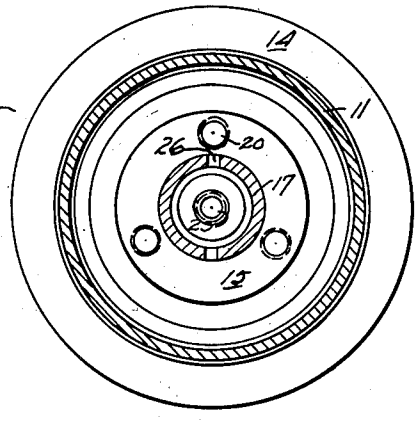


Fig. 2

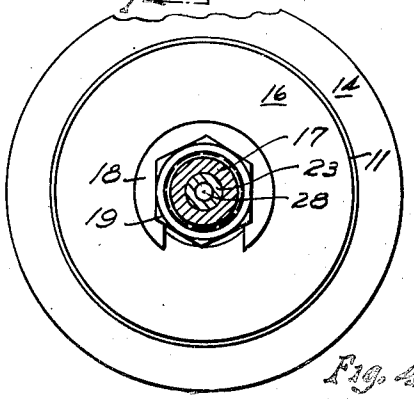


Fig. 4

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ARBOR

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4 Claims. (Cl. 51—237)

The object of this invention is to provide a fixture to facilitate final finishing of thin-walled machine parts, particularly those parts whose dimensions are held to close tolerances.

Another object of this invention is to provide means for absorbing the heat generated by grinding operations on hollowwork.

Difficulties have continually come up in final machining operations, such as grinding, whenever work having comparatively thin walls was to be finished accurately and expeditiously. Hollow, cylindrical objects in certain sizes can be successfully finished by using centerless grinders, or by setting the work up on mandrels or arbors of either the solid or expansion types. But these methods require extreme care to prevent overheating, vibrations, chatter, and other undesirable conditions known to those acquainted with the art. The above conditions prevented heavy or accurate cuts being taken on hollow, thin-walled articles. Thus the amount of metal to be removed from an article was limited; and even when comparatively light cuts were taken, accuracy could not be maintained within prescribed limits required for precision work.

It is well-known that certain articles can be considerably distorted even by the relatively small forces imposed in grinding operations. Distortion of the work may be permanent such as bending, or temporary such as springing, but in either case accuracy and quality of the work is greatly reduced. Overheating by grinding is, of course, detrimental to many parts and especially to the aircraft cylinders described herein as it may burn or partially draw the temper of the metal.

To remedy such conditions, grinding operations have, therefore, been restricted to a slow and tedious process. Numerous and very small cuts were required to produce satisfactory or even passable work.

After much experimental work on various mandrels and arbors, it was found that the arbor described in this specification and shown in the drawing has overcome most of the former disadvantages.

Figure 1 is a sectional view of the arbor on which is mounted an aircraft-engine cylinder, taken on the line 1—1 of Figure 3.

Figure 2 is a transverse section of the arbor and cylinder mounted between centers of a grinding machine taken on line 2—2 of Figure 1.

Figure 3 is an elevation of the left-hand end of the arbor.

Figure 4 is an elevation of the right-hand end of the arbor on the line 4—4 of Figure 1.

Referring to Figure 1 the assembled arbor 10 is shown with an aircraft-engine cylinder 11 in position for the grinding operations. Surface 12 and threaded portion 13 and flange 14 must be finish-ground to allow subsequent mounting of the usual pressed-fit cooling fins on surface 12 and cylinder head on threads 13. Flange 14 must be ground true, to permit correct installation of cylinder on crankcase in respect to the pistons.

The assembled arbor 10 consists of end plates 15, 16, hollow shaft 17, the U washer 18, and nut 19. Shaft 17 is rigidly attached to end plate 15 by means of studs 20 and is dowelled to it by dowell 29. Shaft 17 has the machined surface 21 upon which the plate 16 is slidably received and the thread portion 22. Both end plate 15 and shaft 17 have hollow centering bushings 23 completing a passage through the arbor. Both end plates have a circumferential finished surface 30 and a rim 31, the surfaces 30 having an appreciable extent longitudinal of the arbor.

In operation the unit is assembled by positioning cylinder 11 on surface 30 of plate 15 and bearing against the rim 31 thereon. End plate 16 is slipped over surface 21 and surface 30 and rim 31 of plate 16 are engaged with the work. The U washer 18 is placed and the end plates are drawn together by tightening the nut 19 which covers the projections 24 on the U washer 18 and locks it in place.

The purpose of the U washer 18 is to permit speedy assembly and disassembly of the unit since the nut 19 need only be loosened to allow the U washer 18 to be removed from shaft, and since the nut 19 is smaller than the aperture in end plate 16, the end plate may be removed while the nut 19 remains on shaft. When the nut 19 is drawn up, the arbor components and the work are rigidly secured together in the proper position for insertion in the cylinder. The extended support afforded by the end plates has been found to be most important in obtaining machining accuracy and proper location of the work.

The assembled unit may be mounted on the centers of a grinder or any machine whose operations require turning of the work. The centering bushings are hardened to yield long life and accurate alignment of the work in respect to the line of centers. However, if the bushings do wear, they are removable and may easily be replaced.

In Figure 1 the assembled arbor and cylinder is shown mounted between centers 25 of a grinding machine, the driving means not being shown as any conventional design is satisfactory. These centers differ from regular centers as they have

been drilled as at 26 to provide means for admitting fluid under pressure to the interior of the work. Thus, the work mounted on this arbor may be subjected to an internal pressure by injecting a fluid such as water or oil through one center into the hollow shaft. The hollow shaft 17 is provided with holes 26 to allow an even distribution of fluid throughout the enclosed space and continuous flow of fluid will remove heat incident to machining operations. The end plate 15 is provided with slots 27 into which a dog or other driving means may be inserted to revolve work at desired speeds.

The particular cylinder shown in Figure 1 is the type employed on Pratt and Whitney radial aircraft engines. These cylinders have a diameter of about 6 inches, a length of about 10 inches, and a wall thickness of only about one-eighth of an inch. It is this thin-wall section that has made the grinding operations particularly difficult. Prior to this invention grinding of these cylinders was slow and tedious, for whenever heavier cuts were attempted, the work would chatter, flutter, heat, and distort.

Chattering and fluttering under pressure of the grinding wheel occurred even though the work was as rigidly mounted as ingenuity could contrive. To eliminate these undesirable conditions wheel pressures had to be reduced while various slower cutting or softer wheels replaced the faster cutting wheels. This was necessary since the vibrations causing such chattering or fluttering seemed to originate by reason of the thin walls of the cylinder which had a tendency to spring slightly under pressure of the wheel. Moreover, excessive heating and distortion of the work were common under fast cutting conditions. Continuous support did not cure the tendency toward vibration evidently because the amplitude was so small that the mandrel to be effective would have to have precise surface contact throughout which is not feasible in production work.

Excessive heating of work is known to be detrimental as the temper may be drawn and the work distorted thereby. Normal production was greatly hampered by the speed limitations imposed until the fluid-containing arbor described herein was developed. However, these advantages are not attributable solely to cooling action because conventional coolant systems are still required.

In construction of the arbor those surfaces at which liquid seals are to be maintained must be fitted snugly. But thus far it has not become necessary to place gaskets at said surfaces even under slight line pressure or under pressures developed by centrifugal action. These pressures are not very high in most cases, since the work may be revolved as low as 200–400 R. P. M. Therefore, since the internal pressure is comparatively small, being in the range of about 2–6 lbs. per sq. in., it is doubtful that success can be entirely attributed to the pressure. However, it is believed that a combination of several conditions permits successful fast grinding operations. The combination of the internal fluid pressure, the dampening action of the fluid within the cylinder, and the lower working temperatures maintained on the internal surface of the work comparable to those obtainable on the outer surface all seem to contribute to the beneficial effects observed, particularly when the work has the thin section shown here.

The use of the fluid arbor permits faster grinding practice by use of heavier cuts and faster or harder cutting wheels. This arbor has eliminated chattering and fluttering of the work probably by dampening the vibration of the work, and has prevented distortions of the cylinder by reason of pressure of grinding wheels or heat. Excessive heating is prevented by the absorption and removal of the heat by the circulation of the fluid within the work, thus eliminating the danger of drawing the temper of the metal. It has been found that a very small flow of fluid usually suffices in removing the heat from the work efficiently. Such fluids may, of course, be recirculated if desired. Nor is it essential that the work be entirely filled with fluid although this condition, customarily, obtains.

Some changes may be made in the arrangement, construction, and combination of the various parts of the improved device and in the steps of the method thereto appertaining without departing from the spirit of this invention, and it is the intention to cover by the claims such changes as may reasonably be included within the scope thereof.

The invention claimed:

1. A holding device, of the character described, a rigid mount for thin-walled, cylindrical machine parts comprising two end plates adapted to engage opposite ends of said part and mounted on a central longitudinal shaft, clamping means on said shaft co-operating with said end plates, said clamping means including a U washer and a nut, locking means operable between said washer and said nut when said last-named two elements are in clamping position, the mounting aperture in one said end plate being larger than said nut.

2. A work-holding device for engine cylinders and like sleeves having relatively thin-wall sections, comprising, a pair of end plates, circumferential bearing surfaces conforming to the inner diameter of the workpiece to be received thereon, said surfaces being of substantial longitudinal extent, retaining rims on said plates outwardly of said surface, a central hollow shaft, one said plate secured adjacent one end of said shaft, the other said plate slidably mounted on the other end of said shaft, retaining means operable between said second plate and said shaft to fix said plates in selected relative positions, means adjacent the ends of said device to mount said device on a machine tool, and conduits on said mounting means and communicating with said shaft for the circulation of fluid therethrough.

3 A work-holding device for engine cylinders and like hollowwork having relatively thin-wall sections, comprising, a pair of end plates, inwardly extending bearing surfaces on said plates conforming to the inner surface of the workpiece, retaining rims on said plates outwardly of said surface, a central hollow shaft, one said plate secured adjacent one end of said shaft, the other said plate sildably mounted on the other end of said shaft, retaining means operable between said second plate and said shaft to fix said plates in selected relative positions, bushings adjacent the ends of said device adapted to receive tool centers, conduits extending through said bushings and communicating with the interior of said central shaft, apertures on said central shaft communicating with the interior of said workpiece whereby fluid may be introduced and retained in the interior of said workpiece through said centers, bushings and central shaft.

4. A work-holding device for engine cylinders and the like parts having relatively thin-walled sections during operations of external finish thereon, comprising, a pair of end plates, circum-

ferential bearing surfaces conforming to the inner diameter of the work pieces to be received thereof, said surfaces being of substantial longitudinal extent, a central hollow shaft mounted on said plate, retaining means to secure said plates in selected position on said shaft, means to mount said work-holding device on a machine tool, conduits in said mounting means communicating with the said shaft for the circulation of fluid therethrough, and apertures in said shaft to permit circulation of fluid therefrom to the interior of said work piece.

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