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(54) **Method and apparatus for machining bores.**

(57) A thin workpiece bore wall separating the bore from an adjacent internal passage is machined with a tool expandable against the wall while the adjacent passage is fluid pressurized to exert a pressure on the thin wall counter to the distorting force exerted by the expandable tool on the wall during machining. Bore geometry is thereby improved.

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METHOD AND APPARATUS FOR MACHINING BORES

FIELD OF THE INVENTION

The present invention relates to the machining of a bore in a workpiece and, in particular, to the machining with an expandable tool of a thin wall defining a bore in a workpiece and separating the bore from an adjacent passage.

BACKGROUND OF THE INVENTION

In the manufacture of engine blocks for vehicles, the cylinder bores are subjected to a honing operation to provide bore dimensions within very close tolerances. In the past, the maintenance of bore dimensions within the required tolerance range has sometimes been difficult especially when the cylinder block is designed and cast to have relatively thin walls separating the bores from adjacent coolant passages primarily for weight reduction purposes. This difficulty has been compounded when the cross-section of the wall varies considerably from one location to another as a result of engine design considerations or core shift when casting the engine block. During honing, the honing stones are expanded radially against the bore wall to exert an abrading action thereon, a honing pressure in the range of 100 to 400 psi, typically 200-250 psi, being used. This tool expansion force has caused thin bore walls or thin portions thereof to be distorted during honing, resulting in finished bore geometry out of required tolerances.

U.S. Patent 4,117,633 issued Oct. 3, 1975 to C. L. Yother describes a honing plate attachable to the cylinder block during honing to simulate the normal operating stresses and distortions of an engine block caused

by bolt-on components such as cylinder heads and intake manifolds. Re-boring and honing are effected with the plate attached to allegedly increase the accuracy of the boring and honing operations. However, this patent does not deal with the problem of distortion of thin bore walls by the honing tool itself, in particular by the tool expansion force or pressure needed for honing engagement.

U.S. Patent 3,542,354 issued Nov. 24, 1970 to P. Fitzpatrick and U.S. Patent 3,751,050 issued Aug. 7, 1973 to I. W. Wades et al. disclose so-called workpiece chucks or fixtures for holding a cylindrical cylinder liner during a machining operation such as honing without distorting the cylinder liner. Each patent uses an expansible component to grip and hold the workpiece around its exterior in response to fluid pressure exerted on the expansible component. These patents seek to minimize distortion of the cylinder liner workpiece caused by the clamping or fixturing means.

The aforementioned prior art workers did not deal with the problems of honing thin bore walls in engine blocks or other articles wherein the honing tool itself causes distortion of the thin walls and out of tolerance bore geometry.

SUMMARY OF THE INVENTION

The present invention relates to a method and apparatus for machining a workpiece bore, in particular a thin bore wall separating a workpiece bore from another adjacent passage such as a coolant passage and the like, with a tool expandable against the thin wall wherein pressurizing means applies a fluid pressure to the adjacent passage in the workpiece during machining acting to exert a force or pressure on the thin wall counter to the distorting force of the expandable tool against the wall. Distortion of the

thin wall is thereby substantially reduced during machining to provide a more accurate machined bore geometry.

In a particularly preferred embodiment of the invention, the coolant jacket or passages of an engine block are fluid pressurized to a pressure level of for example 30 psi during honing of the cylinder bores to substantially reduce distortion of thin cylinder walls by the expansion force of the honing tool thereagainst. Considerable improvement in bore geometry has been achieved in this manner.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partial cross-sectional view through a four cylinder engine block showing the walls separating the cylinder bores #1 and #2 from adjacent coolant passages.

Figure 2 is a schematic end elevational view showing the apparatus of the invention for fluid pressurizing the coolant passages of the engine block while the cylinder bores are honed.

Figure 3 is a schematic side elevational view of the apparatus of Fig. 2.

Figure 4 is a schematic top view of the apparatus of Fig. 3.

DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 illustrates a partial cross-section through a typical engine block 10 including cylinder bores 12 defined by walls 14 having relatively thick portions 14a at the top end and relatively thin portions 14b therebelow. It is apparent that the walls 14 may vary in cross-sectional shape or dimension along their lengths. The thin walls 14b

terminate at their bottom ends in thicker support walls 15 which are not honed. As is apparent, the thin walls 14 separate the cylinder bores from adjacent coolant passages 16 formed in the engine block.

Figs. 2-4 show an apparatus for use in the invention comprising a simulated cylinder head 20 adapted to be bolted to the engine block. To this end, the head includes a plurality of holes 22 for receiving standard bolts (not shown) and a bottom surface 24 to rest against the top surface 26 of the engine block and close off the coolant passages in known manner where the passages open to the top surface 26. A resilient gasket 28 is interposed between head surface 24 and block surface 26 to provide a fluid pressure tight seal therebetween. The head 20 also includes a plurality of bores 30 coaxially aligned with the cylinder bores 12, the head bores 30 being slightly greater in diameter than the cylinder bores to allow entry of the honing tools 34 to the cylinder bores for the honing operation. Honing tools used in the method of the invention are commercially available and include a plurality of abrasive stones 35 or an abrasive sleeve expandable radially outward by various means such as tapered arbors, to engage and contact the bore wall at a selected honing pressure to effect honing, usually in the range of 100 psi to 400 psi, typically 200 psi to 250 psi.

The apparatus also includes a cover 36 bolted over the water pump opening 38 in the front side of the engine block. A resilient gasket 40 is placed between the cover 36 and engine block to provide a fluid pressure tight seal therebetween. In addition, all other side or lateral openings 44 in the engine block extending to the coolant jacket or passages are plugged fluid pressure tight by expandable plugs 46 or other means.

To introduce fluid pressurizing means such as pressurized liquid or gas into the coolant jacket including passages 16, a conduit 50 is attached to the engine block at the engine temperature thermocouple opening 52. Of course, the conduit is connected to a suitable source 54 of pressurized fluid such as pressurized liquid or gas. Honing trials using the above-described apparatus were carried out using air pressure of 30 psi introduced into the coolant passages 16 from a conventional pressurized air source and using a pressure regulator 56 in the air supply conduit 50 to the block 10. The coolant used in the honing operation could also be used as the pressurized fluid (from source 54).

Table I shows the roundness deviation of bores in a 4-cylinder automobile cast iron engine before honing by the invention and afterwards. Honing was carried out using an expandable honing tool with 9 abrasive stones of 230 grit with approximately 200 psi hone pressure during a 33-second honing stage followed by a hone pressure of approximately 80 psi during a 5-second run-out stage. Roundness measurements were taken with a commercially available "Talyrond" gage at the top, center and bottom of each cylinder bore in known fashion.

TABLE I

		DEVIATION ROUNDNESS (BEFORE) (ten thousands of inch)	DEVIATION ROUNDNESS (AFTER) (ten thousands of inch)
Bore #1	Top	1	½
	Center	3	1½
	Bottom	8	4
Bore #2	Top	5	0
	Center	13	0
	Bottom	12	1
Bore #3	Top	2	1
	Center	7	1
	Bottom	12	0
Bore #4	Top	2	1
	Center	6	1
	Bottom	3	1

It is apparent that a marked improvement in bore roundness is achieved by the honing method of the invention. The increased out-of-roundness of bore #1 relative to the other bores is attributable to the greater thickness of portions of the cast wall defining this bore (see Fig. 1) compared to the other bores. Bore #1 would correspond to the first bore at the front of the engine. The roundness of bore #1 was nevertheless considerably improved by the honing method of the invention. The present invention is especially effective in improving roundness of bores with the relatively thinner cast walls such as walls associated with the inner bores #2 and #3 and, depending on engine block design, rear bore #4.

While there have been described what are considered to be certain preferred embodiments of the invention, other modifications, additions and the like may occur to those skilled in the art and it is intended to cover in the appended claims all such modifications as fall within the spirit and scope of the invention.

We Claim:

1. A method for machining a bore in a workpiece wherein a thin workpiece wall defines the bore and separates it from an adjacent passage and the like comprising engaging an expandable tool against the wall for machining purposes and fluid pressurizing the adjacent passage to reduce distortion of the wall by the expandable tool.

2. The method of claim 1 wherein the passage is pressurized with liquid.

3. The method of claim 1 wherein the passage is pressurized with gas.

4. A method for honing a cylinder bore in an engine block wherein a thin bore wall separates the cylinder bore from an adjacent coolant passage in the block comprising engaging an expandable honing tool in abrading contact with the wall for honing same and fluid pressurizing the adjacent coolant passage to reduce distortion of the wall by the honing tool.

5. An apparatus for machining a bore in a workpiece wherein a thin workpiece wall defines the bore and separates it from an adjacent passage, comprising a means adapted for releasable attachment to the workpiece to seal the passage in fluid pressure tight manner, means for introducing fluid pressure into the sealed passage during machining and tool means expandable against the wall and movable relative thereto to effect machining, whereby the fluid pressure in the passage acts counter to any distorting force exerted on the wall by the expandable tool means to reduce distortion thereof during machining, providing a closer tolerance bore geometry.

6. The apparatus of claim 5 wherein the passage sealing means includes a tool-receiving bore providing access of the tool means to the workpiece bore.

7. The apparatus of claim 5 wherein the means for introducing fluid pressure to the passage includes a conduit connected in fluid flow relation to the passage and a source of fluid pressure.

8. The apparatus of claim 7 wherein the source is a source of pressurized air.

9. The apparatus of claim 7 wherein the source is a source of pressurized liquid.

10. An apparatus for honing cylinder bores in an engine block wherein thin bore walls separate the cylinder bores from adjacent coolant passage in the block comprising a simulated cylinder head member releasably attachable to the engine block including a plurality of openings slightly greater in diameter than the cylinder bores to provide access to the cylinder bores, gasket means between the cylinder head member and engine block to provide a fluid pressure tight seal therebetween, means for sealing other openings to the coolant passages, means for introducing fluid pressure into the sealed passages during honing, and honing tool means expandable against a respective one of the walls and reciprocable relative thereto to effect honing, whereby the fluid pressure in the passage acts counter to any distorting force exerted on the wall by the expandable honing tool means to reduce distortion thereof during honing, providing bores with a closer tolerance bore geometry.

11. The apparatus of claim 10 wherein the fluid pressure introducing means includes a conduit connected in fuel flow relation to the passages and source of pressurized fluid.

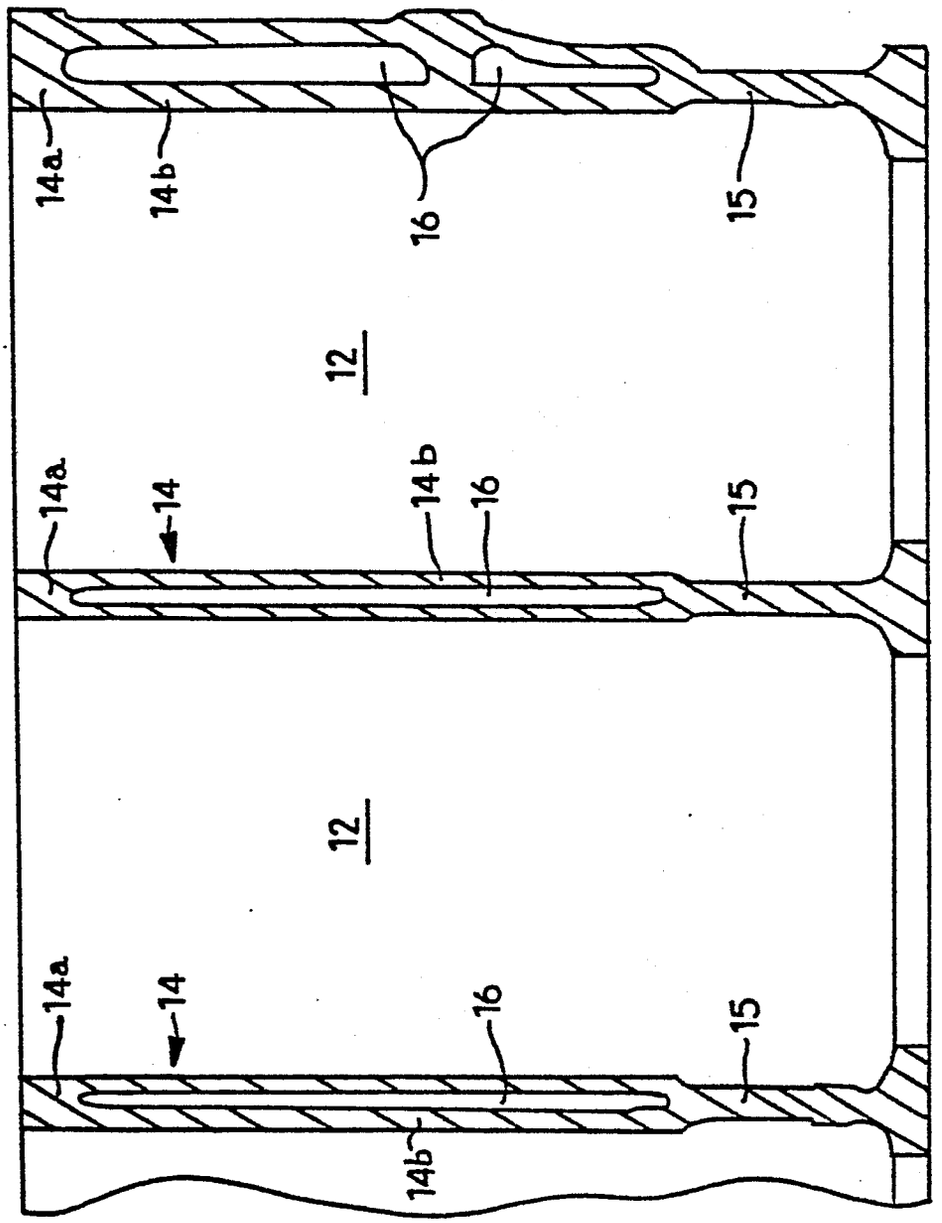


FIG. 1

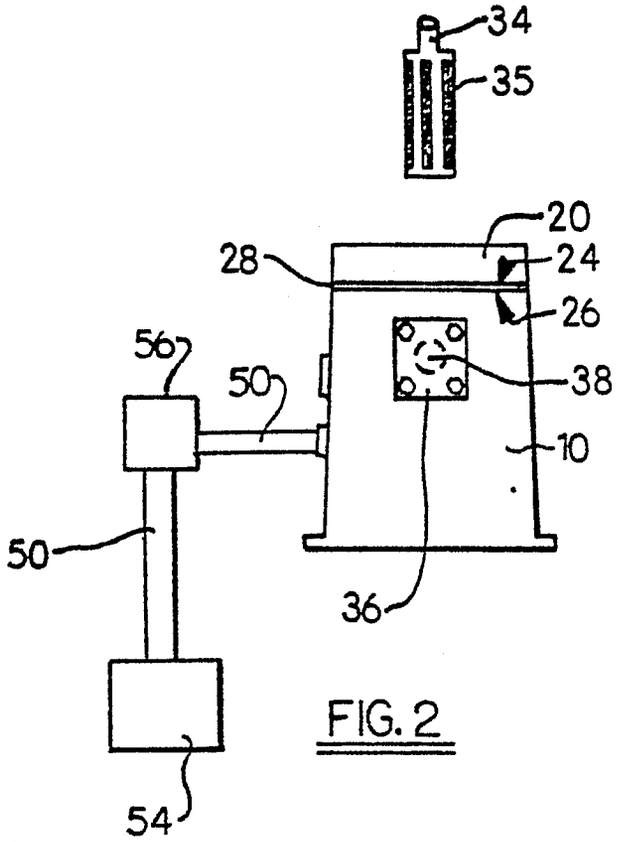


FIG. 2

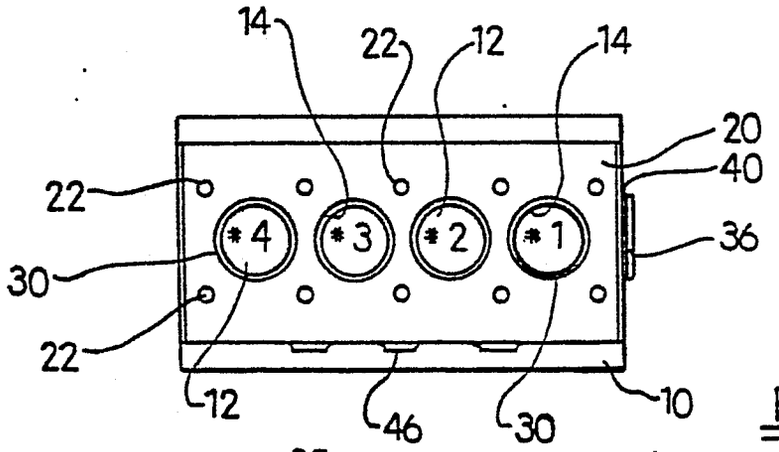
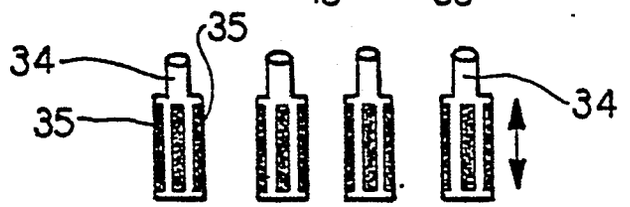


FIG. 4



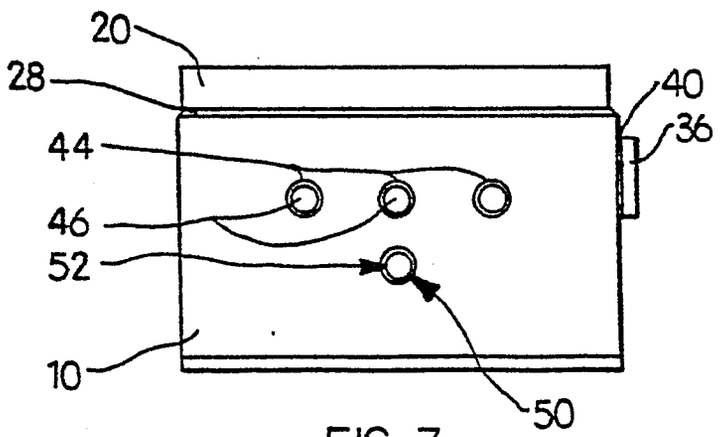


FIG. 3