

Jan. 12, 1971

R. P. KOZIARA
CASTING AND MACHINING OF AN INTERNALLY
PORTED AND PASSAGED CYLINDER HEAD

3,553,808

Filed March 21, 1969

4 Sheets-Sheet 1

FIG. 1.

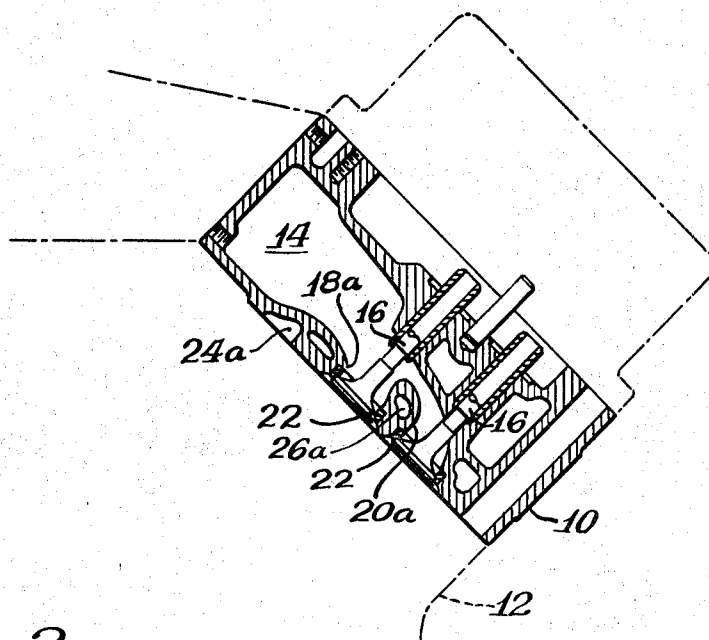
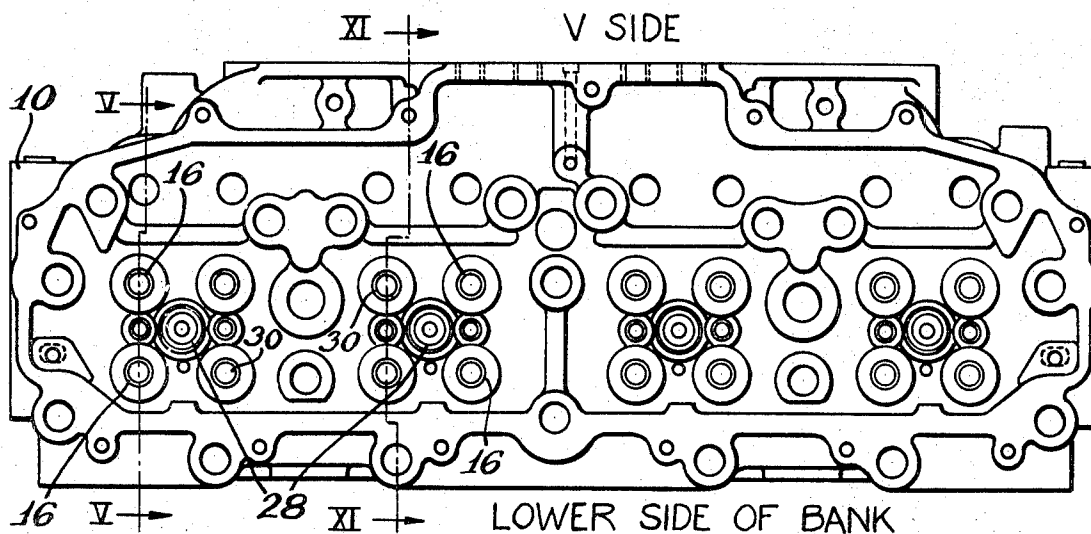


FIG. 2.



Inventor:
Robert P. Koziara
By *John W. Saines*
Atty.

Jan. 12, 1971

R. P. KOZIARA
CASTING AND MACHINING OF AN INTERNALLY
PORTED AND PASSAGED CYLINDER HEAD

3,553,808

Filed March 21, 1969

4 Sheets-Sheet 2

FIG. 3.

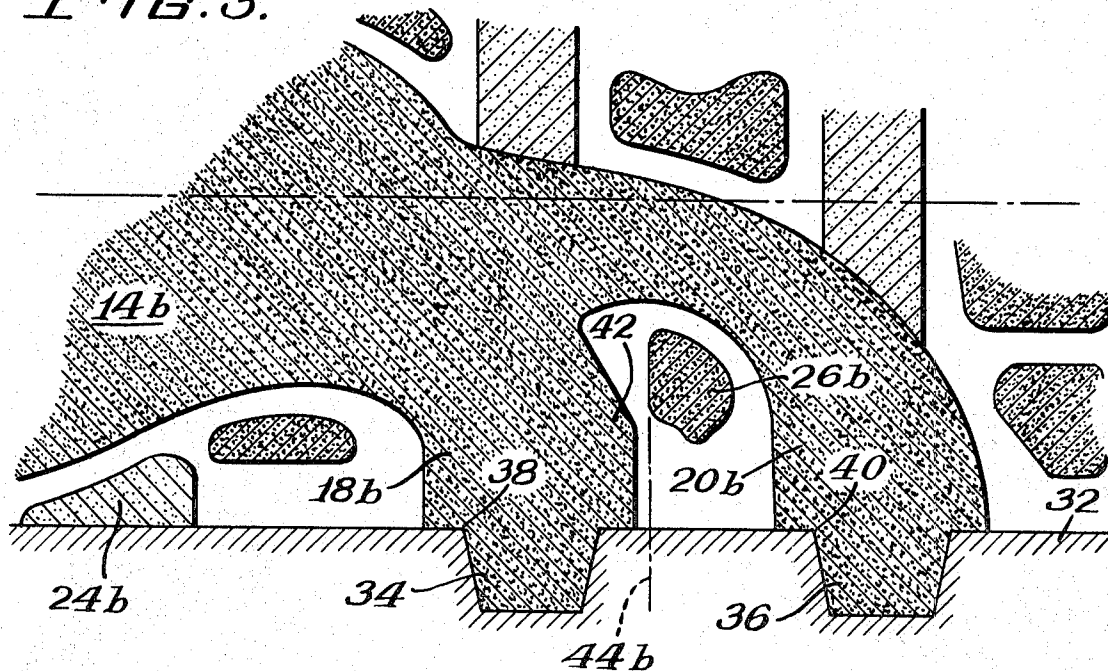
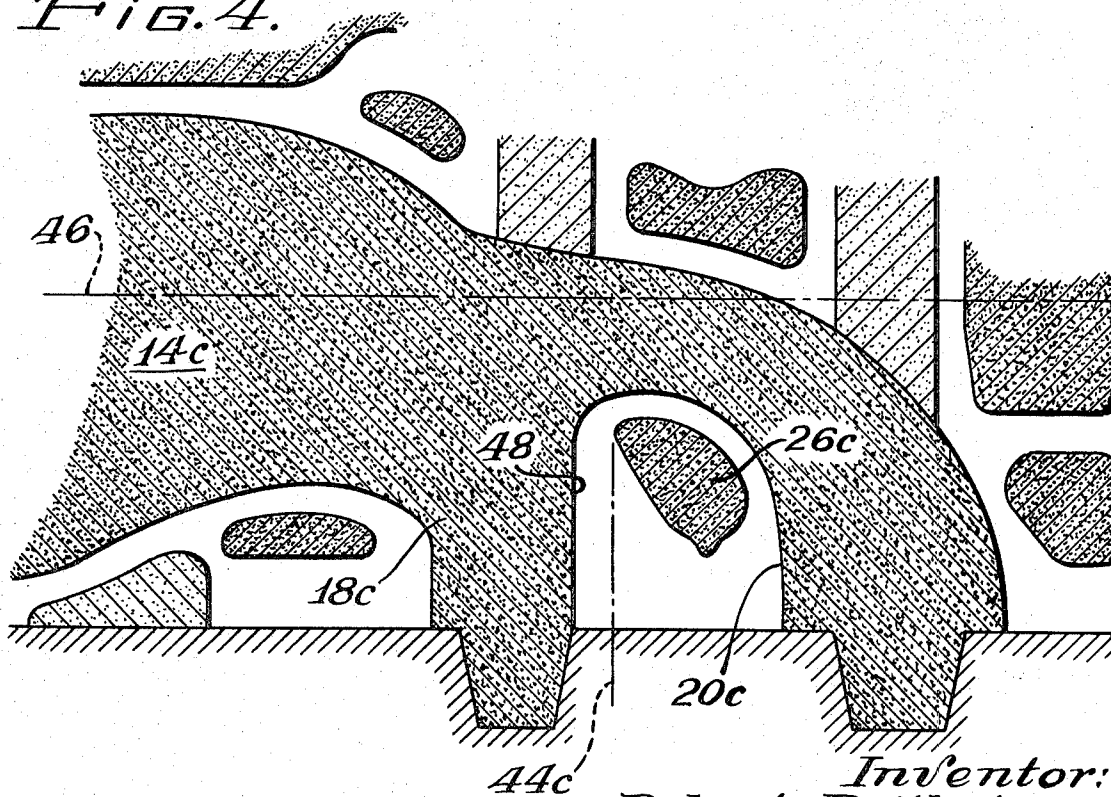


FIG. 4.



Inventor:
Robert P. Koziara
By John W. Saine
Atty.

Jan. 12, 1971

R. P. KOZIARA
CASTING AND MACHINING OF AN INTERNALLY
PORTED AND PASSAGED CYLINDER HEAD

3,553,808

Filed March 21, 1969

4 Sheets-Sheet 3

FIG. 5.

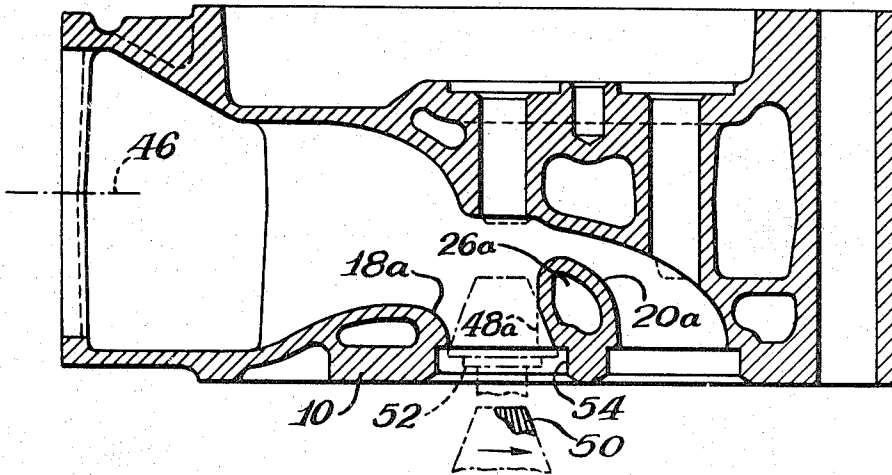


FIG. 6.

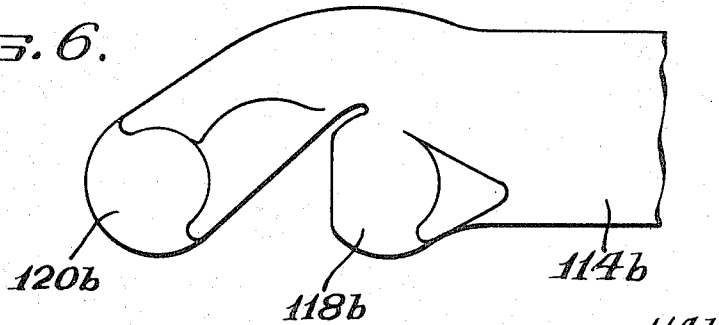


FIG. 7.

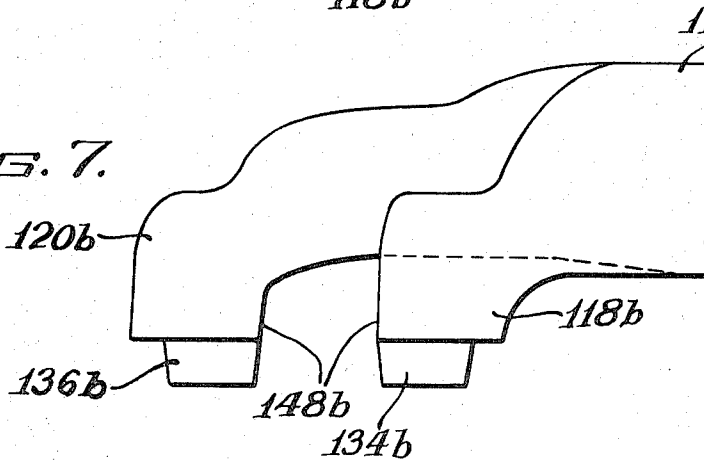
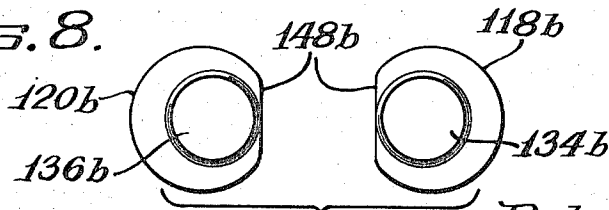


FIG. 8.



Inventor:
Robert P. Koziara
By John W. Haines
Atty.

Jan. 12, 1971

R. P. KOZIARA
CASTING AND MACHINING OF AN INTERNALLY
PORTED AND PASSAGED CYLINDER HEAD

3,553,808

Filed March 21, 1969

4 Sheets-Sheet 4

FIG. 9.

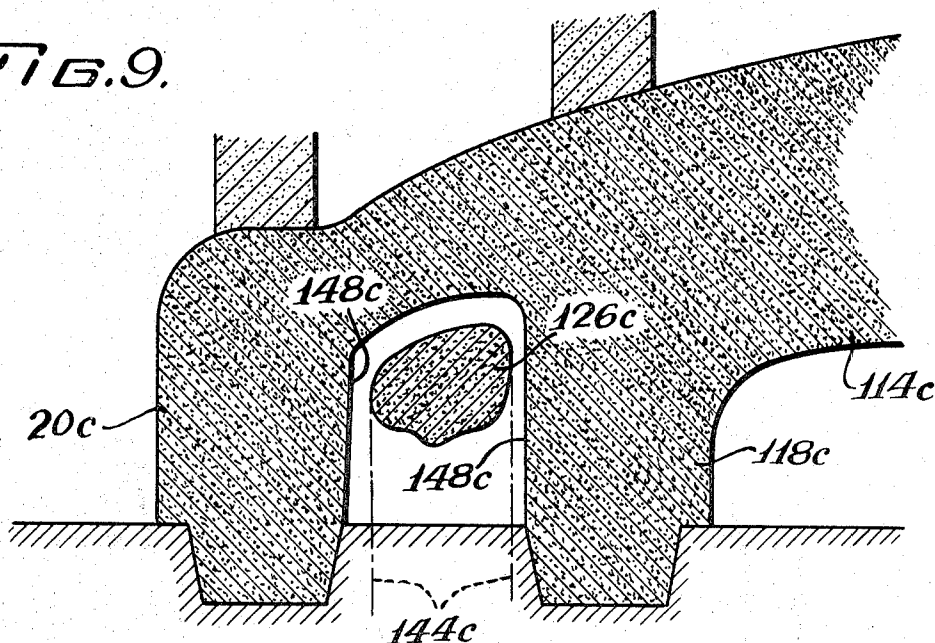


FIG. 10.

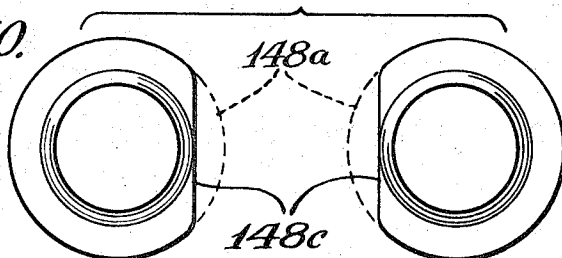
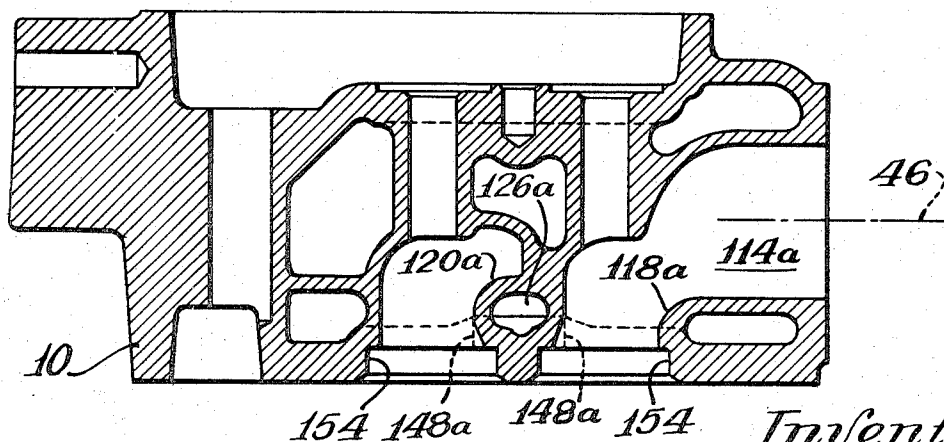


FIG. 11.



Inventor:
Robert P. Koziara
By John W. Isaines
Atty.

1

3,553,808

CASTING AND MACHINING OF AN INTERNALLY PORTED AND PASSAGED CYLINDER HEAD

Robert P. Kobiara, Arlington Heights, Ill., assignor to International Harvester Company, Chicago, Ill., a corporation of Delaware

Filed Mar. 21, 1969, Ser. No. 809,351

Int. Cl. B23p 15/00, 13/00

U.S. Cl. 29—156.7

6 Claims

ABSTRACT OF THE DISCLOSURE

Cylinder head coring to provide internal ports and water passages therein, and a method combining the steps of casting-in metal to form the head casting, and machining of the casting thereafter. An intake or exhaust passage with dual ports is cast intentionally with at least one imperfect port only partially completed at the end. More specifically, it is by provision of no back draft on one of the legs of the port core, that it becomes possible to design an adjacent water passage which is materially enlarged in cross section yet, at the same time, the resulting cored port is imperfect because incomplete as indicated. However, the port is readily completed by enlarging it with a machining operation, insuring satisfactory porting and affording at the same time a separate water passage of appreciable size located thereadjacent.

This invention relates to cast cylinder heads for internal combustion engines, of the kind arranged with a head passage having dual ports, and with a water passage in the head passing between the dual ports of the head passage. Actually, the cylinder heads of the engine hereof are formed with two such head passages per cylinder of the engine, namely, an intake and an exhaust passage, whereof the dual ports of the intake passage are inlet ports and the dual ports of the exhaust passage are outlet or exhaust ports from the cylinder.

Cast heads having a head passage with dual ports included in the design are, according to past practice, cast about a coring assembly wherein the water passage core which is intermediate the dual ports is severely restricted in dimension, particularly width, by the fact that the back draft of at least that core leg for one of the head ports adjacent the water passage core must not encroach too close to the vertical projection of the water passage core or else the two cores will interfere when being positioned in the coring assembly. It has therefore been the practice to allow the adjacent portion of the core leg to follow along an acute vertical angle productive of back draft and at the same time productive of streamlining of the port, and to prevent interference by narrowing the water passage core sufficiently that the back draft area will not encroach upon the vertical projection of the narrowed water passage core. A streamline port used as an inlet provides high swirl.

So intake port water passage cores and exhaust port water passage cores hitherto have possessed, at the least, very small width or very small width and height dimensions and, in cases where a substantial height of cross section has been provided, the core has possessed a width to height ratio less than unity. The disadvantage is a small volume of water and a restricted water flow where needed in the head, which are a problem under high output engine conditions. That is to say, it is a disadvantage having a water passage which must be designed tall and slender as viewed in cross section, simply to make it accommodate dual ports astraddle thereof.

2

The foregoing problem is either substantially eliminated or materially reduced by the present core assembly, casting, and machining procedure for engine cylinder heads as will now be explained in detail. Features, objects, and advantages are either specifically pointed out or will become apparent when, for a better understanding of my invention, reference is made to the following description taken in conjunction with the accompanying drawings, which show a certain preferred embodiment thereof and in which:

FIG. 1 is a partially phantom end view, with the parts broken away and in section, of a V8 diesel engine embodying the cylinder head coring assembly and casting and machining method according to the present invention;

FIG. 2 is a top plan showing of the cylinder head, with the upper side in face view;

FIGS. 3 and 4 are views in correspondence to FIG. 1, FIG. 3 showing cores as employed in a conventional coring arrangement for casting the head and FIG. 4 showing the present improved coring arrangement for casting the head shown in FIG. 1;

FIG. 5 corresponds to FIG. 1, but shows the head only, viewed while being machined in one of the final operations prior to assembly onto the engine;

FIGS. 6, 7 and 8 are top plan, side elevation, and bottom plan views respectively of an exhaust port core;

FIGS. 9 and 10 are side elevational and bottom plan views of the coring for an exhaust passage, as if FIG. 9 had been taken along the section line XI—XI of FIG. 2; and

FIG. 11 is a transverse cross sectional view taken along the lines XI—XI of FIG. 2 and showing the resulting exhaust passage in the head.

More particularly as shown in FIGS. 1 and 2 of the drawings, a head 10 on one bank of a V8 diesel engine 12 is provided for four of the cylinders, and has the No. 1 cylinder intake passage 14 typical for all cylinders. The passage 14 includes therein a pair of simultaneously operable, spaced apart and parallel intake valves 16. The heads of the valves 16 control downturned dual legs 18a and 20a (FIG. 1) of the passage 14, the legs having mouths in the bottom deck opening into the aligned cylinder, not shown, so as to provide two inlet ports for the cylinder.

Valve seat inserts 22 are press fitted into counterbores in the mouths of the ports so as to receive the heads of the intake valves 16. Molded-in water jacket depressions 24a and cored-in lower water jacket passages such as the passage 26a are transverse in the head 10 to the intake passage 14 at varying levels in the head 10 and are separated from the intake passage by an appropriate thickness of the cast metal.

In FIG. 2, that portion of the head central to each cylinder includes an injector nozzle 28, and further includes the valves arranged in a ring around the nozzle with the intake valves 16 adjacent one another and with two exhaust valves 30 adjacent one another for each cylinder.

CONVENTIONAL CORING—FIG. 3

In the illustrated coring system, heretofore conventionally used in casting cylinder heads for V8 engines, it will be noted that the water jacket sand 24b has a size to form water jacket depressions of desired width and height and rests directly on the base slab of green sand 32 in the lower half (drag half) of the mold. The lower water jacket cores, the specific one bearing a reference numeral being the water passage core 26b, are supported at a lower elevation than the upper cores in well known manner within the drag.

3

An intake passage core **14b** has the downturned legs **18b** and **20b** thereof straddling the lower water passage core **26b**. Depending core print projections or core locators **34** and **36** on the legs engage corresponding core prints or depressions **38** and **40** formed in the green sand **32** of the base slab in the drag.

Although it may appear at first that the so-called back draft portion **42** of the leg **18b** of the dual legs might encroach on the water passage core **26b**, upon closer inspection it will be seen that the vertical projection line **44b** of the core **26b** is clear at all points outside of the back draft portion **42**. The clearance keeps the water passage core **26b** from interfering when the intake passage core **14b** is brought straight down thereover with the legs **18b** and **20b** of the latter astraddle of the water passage core **26b**.

Consequently, the metal to be cast in will be rather thick in portions because the width to height ratio of the core **26b** is only about 0.8. The upper part of the core **26b** is foreshortened in the leftward direction as viewed in FIG. 3, despite the fact that some of the volume of the resulting metal wall should desirably be relegated to becoming volume of a cooling water passage.

When the just described lower water passage core **26b** employed in a conventional coring arrangement is compared with the lower water passage core in accordance with the present coring invention, the advantages of the latter in its capacity at cooling are at once apparent.

IMPROVED CORING—FIG. 4

In the illustrated coring system, according to my invention, the intake passage core **14c**, the downturned dual legs **18c** and **20c** thereon, and the lower water passage core **26c** are essentially "negatives" of their corresponding passages and dual ports as shown in FIG. 1. The water passage core **26c**, again, is spatially related within and between the downturned dual leg ends. The parting line between the drag and the upper half (cope half) of the sand mold is indicated at **46**. The drag flask and the cope flask which confine the sand in the mold are not shown.

The water passage core **26c** has its vertical projection line **44c** again free from interference, but the core **26c** is changed as viewed in FIG. 4 by being extended farther to the left than before so as to have approximately a 1.0, or higher, width to height ratio. Therefore, the water volume is increased and the change brings about a significantly large increase of surface area of the resulting water passage, compared to the conventional passage.

The change is due to the elimination of back draft on the leg **18c** so that, at the inlet port end, the leg is not essentially circularly cross sectioned. Instead, the leg **18c** has a pronounced flat **48** thereon by which the port when cast is misshapen with a chordal deformity partially occluding it. The particular leg **18c** is the intermediate or second leg, transversely oriented on the core **14c** between the first leg **20c** at one end and the opposite end of the core **14c**.

RESULTANT CASTING—FIG. 5

The port is cured of its intentional misshapeness by machining out the deformity portion **48a** in the casting with a rotary cutting tool having a frusto conical cutter **50** at the head. The rotating cutter **50** is advanced into the cutting position indicated by the broken lines **52** and, in the desired way, the cutter enlarges the outline of the mouth of the second inlet port **18a** making it generally round, all around, and providing to the head port passage streamlining. The unwanted metal is in the malformed shape of a segment of a right circular frusto-cone, bounded at the radially inner side by a hyperbolical conic section.

The apex cone angle of the frusto conical cutter **50** is about 45°, the cutter removing the flat chordal portion **48a** at a corresponding acute vertical angle of about 22½°. 75

4

The cutter is shown schematically, and in actual practice would probably be a compound tool which, while so cutting, would preferably be at least rough machining the concentric valve seat counterbore necessary to be provided. Such counterbore, following the finish machining thereof whenever it occurs, is shown at **54**.

Thereafter, the insert **22** (FIG. 1) is forced into place to a point into the counterbore **54**, up to the acute vertical angle of the streamlining therein. The insert lines the counterbore mouth portion adjacent the acute vertical angle to provide smoothness to the recess in the deck. Accordingly, the insert is of internally curved formation in the axial direction to afford a curved formation for the radial inside of the streamlining of the port.

The water passage **26a** is disposed noninterferingly transversely of the head passage between the dual ports of the latter and between the latter and the deck. The acute vertical angle of streamlining of the leg or port **18a** extends to or past, or at least very close to, a point of intersection with the vertically projected position **44a**, not shown, of the water passage, such point falling between the water passage **26a** and the deck.

Under more stringent conditions, my invention applies with more pronounced advantage. The more stringent conditions occur in an exhaust passage with dual ports. Less streamlining of the dual exhaust ports is required and the volume in the water passage is desirably maximized because of the higher heat dissipation required.

EXHAUST PORT MODEL—FIGS. 6, 7 AND 8

The model shown is suitable for checking the pattern equipment for the exhaust ports, and the portion **114b** generally corresponds to the exhaust passage core. The intermediate and the first or extreme downturned leg ends **118b** and **120b**, respectively, have flat leg portions **148b**. Each such leg portion **148b** is a corresponding "negative" to an unwanted, generally vertical flat chordal portion which results, in the casting, across that side of the mouth of the resulting exhaust port opening which is adjacent the other exhaust port opening.

The respective portions **134b** and **136b** on the model have a conventional 5° draft angle, and correspond to the longitudinally extending core print projections or core locators customary on the ends of the actual exhaust passage core which is placed in core prints in the mold.

EXHAUST PASSAGE CORE—FIGS. 9 AND 10

The actual exhaust passage core in the mold has the flats **148c** adjacent and confronting the intervening water passage core **126c**. The resulting casting has an unwanted chord **148a** across one side of the mouth of each generally circular exhaust port opening, the chord substantially equally to the length of a diameter of said circular exhaust port opening.

The flats **148c** of the legs **118c** and **122c** provide foreshortening in the malformed way desired with respect to the vertical projection lines **144c** of the water passage core **126c**. The core **126c** in two embodiments contemplated had respective width to height ratios slightly in excess of 1.2:1 and 1.3:1.

CASTING—FIG. 11

After or during two operations with a cutter, not shown to remove the unwanted chordal portions **148a** from, and to streamline, the respective ports **118a** and **120a** of the head **10**, the head is counterbored at **154** and exhaust valve seat inserts, not shown, are installed.

The procedure is much the same as with the intake passage casting previously described. An apex angle on the cutter head of 45° is satisfactory, and removal of the unwanted chordal portion **148a** is at an acute vertical angle of about 22.5°. A large intervening water passage **126a** results.

The actual casting of the head is conventional. Into the mold, I cast in, about and along with water passage

5

core of each passage, a water passage with a cross sectional width to height ratio of at least approximately unity. I simultaneously cast in, about and along the head port cores for exhaust and intake, head ports each with adjacent downturned leg ends of which at least one is foreshortened on that portion adjacent the vertically projected position of the water passage core.

In the assembly of the drag half of the sand core beginning at the bottom level, the green sand provided is a mixture of sand and active clay, and the water jacket sand immediately thereupon is either an oil sand or it includes among other things a furfural binder. The lower water jacket passage cores, including furfural for example as the binder therein, are placed in position engaging the base slab of green sand, the head port cores are placed thereover, and the upper water jacket passage cores (not shown) are then placed in position at an upper level.

The effective omission of back draft, leaving an incomplete port later completed as herein taught, directly results in increased capacity of the water passage cooling between the dual ports of each had passage. Also, back draft elimination on the port core simplifies making the latter because it eliminates the need for loose pieces in the port core box.

In operation, each head passage dependent upon whether its function is admission or exhaust either effects reception or effects discharge through an open back end spaced apart laterally from the cylinder served thereby. In both cases, the generally sloping head passages illustrated each extend from its open back end at an angle downwardly and across the cylinder at one side thereof (FIG. 2), terminating at the anterior end in an open recess in the deck. Intermediate the open back and anterior ends, the passage has a second open recess in the deck, providing the second one of the dual ports for the cylinder.

Irrespective of the direction of flow therethrough, each of the head passages and its first streamline port are arranged adjacent the side wall of the cylinder served thereby with an outer side wall of the head passage and an outer side point of the first port substantially tangent to the cylinder. Similarly, in plan view, the head passage and its second streamline port are arranged with an outer side wall and side point of the respective passage and port, respectively, being substantially tangent to the cylinder. Dual porting, such as the foregoing, materially simplifies the head, both from standpoint of manufacture and from standpoint of operation.

Variations within the spirit and scope of the invention described are equally comprehended by the foregoing description.

What is claimed is:

1. Combined casting and machining procedure, utilized in cylinder head manufacture in a combined way to eliminate back draft on a multilegged head port core and to provide a water passage core of substantial cross sectional size in a coring assembly, said water passage core located in said assembly between the downturned leg ends of the multilegged head port core in a noninterfering manner conforming to streamlining the head port passage, said procedure characterized by the method steps of:

casting in, in the coring assembly about and along the water passage core, a water passage with a width to height ratio in cross section of at least approximately unity;

simultaneously casting in, in the coring assembly about and along the head port core, a head port with a downturned leg end foreshortened with respect to the vertically projected position of the water passage core, whereby the mouth of the resulting head port opening has an unwanted flat portion on the otherwise generally round outline thereof; and

machining out the flat portion to enlarge the outline

6

of the mouth, to make it generally round, all around, and to streamline the head port passage.

2. The invention of claim 1,

the head port comprising an intake port;

the casting characterized by casting the intake port with said downturned leg end foreshortened to the extent that the unwanted flat portion forms a chord which is across the otherwise generally round outline of the mouth of the intake port and which approximates a diameter of said generally round outline.

3. The invention of claim 1,

the head port comprising an exhaust port;

the casting characterized by casting the exhaust port with two adjacent downturned leg ends foreshortened flat with respect to the vertically projected position of the water passage core, whereby the flat portion of each forms an unwanted chord across that side of the mouth of the resulting exhaust port opening which is adjacent to the other exhaust port opening.

4. Combined casting and machining procedure utilized in cylinder head manufacture in a combined way to eliminate back draft on a multilegged head port core and to provide a water passage core of substantial cross sectional size in a coring assembly, said water passage core located in said assembly between the downturned leg ends of the multilegged head port core in a noninterfering manner conforming to streamlining the head port passage, said procedure characterized by the method steps of:

casting in, in the coring assembly about and along the water passage core, a water passage with a width to height ratio in cross section of at least approximately unity;

simultaneously casting in, in the coring assembly about and along the head port core, a head port with a downturned leg end foreshortened with respect to the vertically projected position of the water passage core, whereby the mouth of the resulting head port opening has an unwanted generally vertical flat portion on the otherwise generally round outline thereof; removing the flat portion at an acute vertical angle thereby enlarging the outline of the mouth, to make it generally round, all around, and to provide to the head port passage streamlining; and

inserting into said mouth of the head port passage and up to the acute vertical angle of the streamlining therein an annular insert which constitutes a lining for the mouth portion adjacent the acute vertical angle and is of internally curved formation in the axial direction to provide a curved formation for the inside of the streamlining.

5. The method steps claimed in 4, the annular insert characterized by being the seat for a poppet valve.

6. Combined casting and machining procedure utilized in cylinder head manufacture in a combined way to eliminate back draft on a multilegged head port core and to provide a water passage core of substantial cross sectional size in a coring assembly, said water passage core located in said assembly between two downturned leg ends of the multilegged head port core in a noninterfering manner conforming to streamlining the head port passage, said procedure characterized by the:

casting in, in the coring assembly about and along the water passage core, of a water passage with a width to height ratio in cross section of at least approximately unity;

simultaneous casting in, in the coring assembly about and along the head port core, of a head port with both downturned leg ends foreshortened where they immediately confront the vertically projected position of the water passage core, whereby the mouths of the resulting head port openings each have an unwanted generally vertical flat portion on the otherwise generally round outline thereof;

7

removal of each flat portion at an acute vertical angle
enlarging the outline of the associated mouth, to
make it generally round, all around, and to provide
to the head port passage streamlining; and
insertion, into said mouths of the respective head port
passages and up to the acute vertical angle of the
streamlining therein, of annular inserts each of which
constitutes a lining for the portion of the associated
adjacent the acute vertical angle and is of internally
curved formation in the axial direction to provide a
curved formation for the inside of the streamlining.

5

10

8

References Cited

UNITED STATES PATENTS

3,368,259	2/1968	Stevens	-----	29—156.7
3,497,937	3/1970	Willer	-----	164—76X

JOHN F. CAMPBELL, Primary Examiner
D. C. REILEY, Assistant Examiner

U.S. Cl. X.R.

29—156.4, 527.6; 164—69, 76