Feb. 7, 1967 J. L. FLITZ 3,302,250

CORE BOX AND MOLDING ASSEMBLY FOR INTERNAL COMBUSTION ENGINE BLOCKS

Original Filed Dec. 18, 1963 3 Sheets-Sheet 1

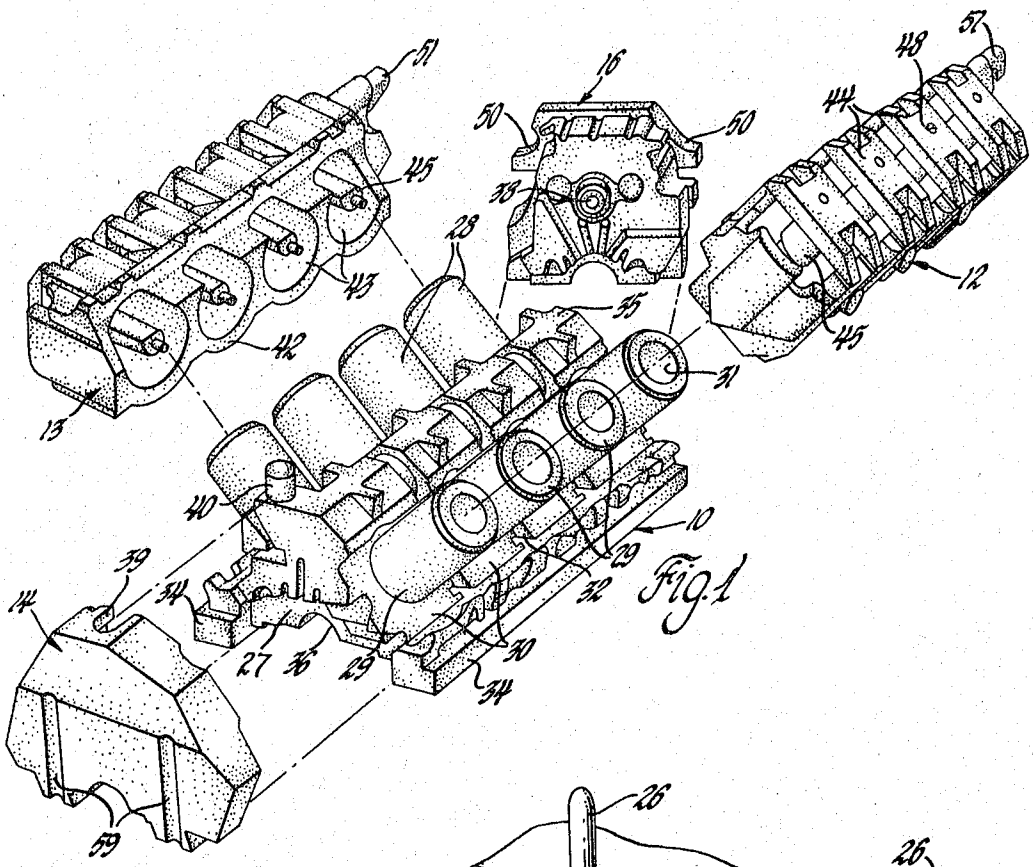

Fig. 1

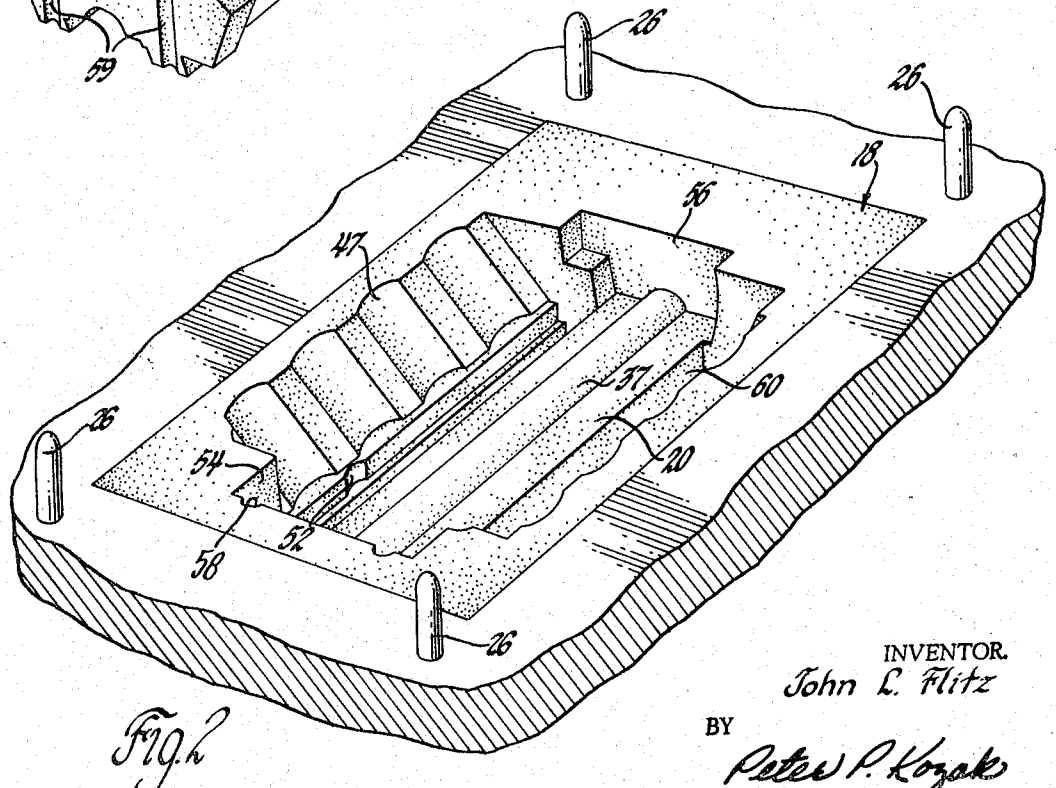

Fig. 2

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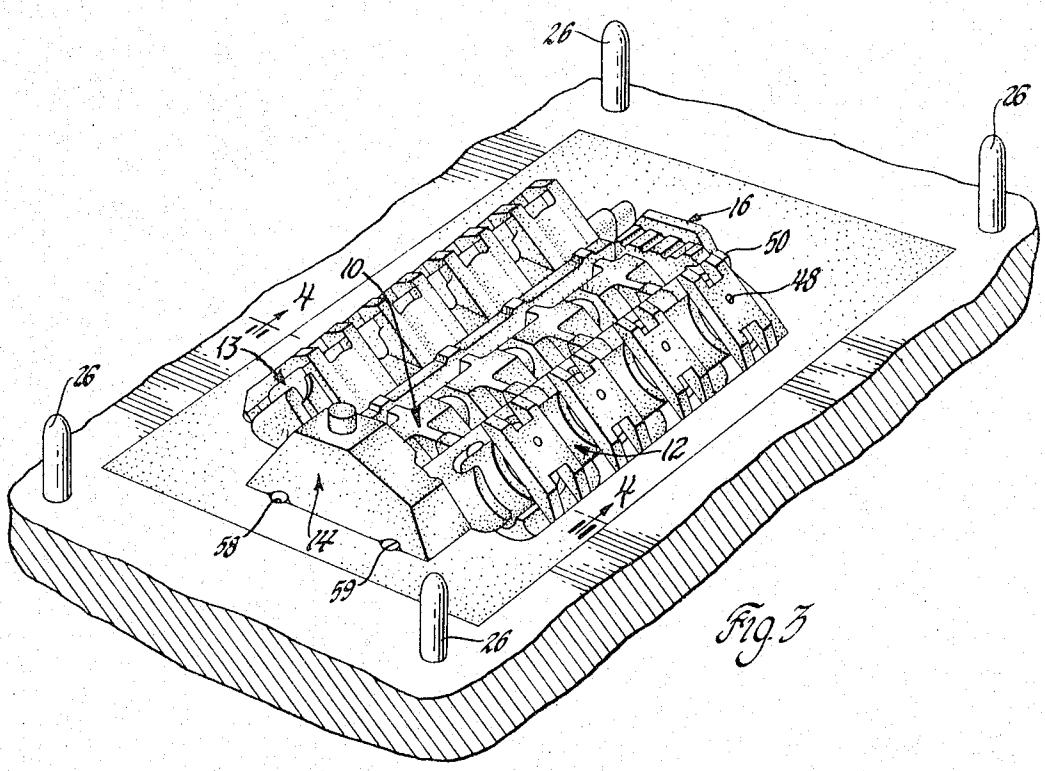

Fig. 3

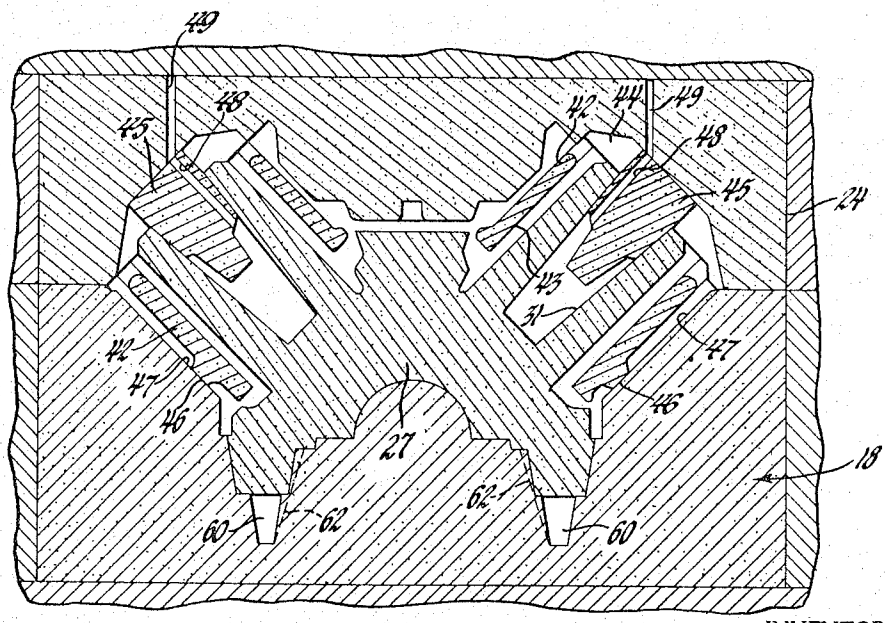

Fig. 4

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Original Filed Dec. 18, 1963 3 Sheets-Sheet 3

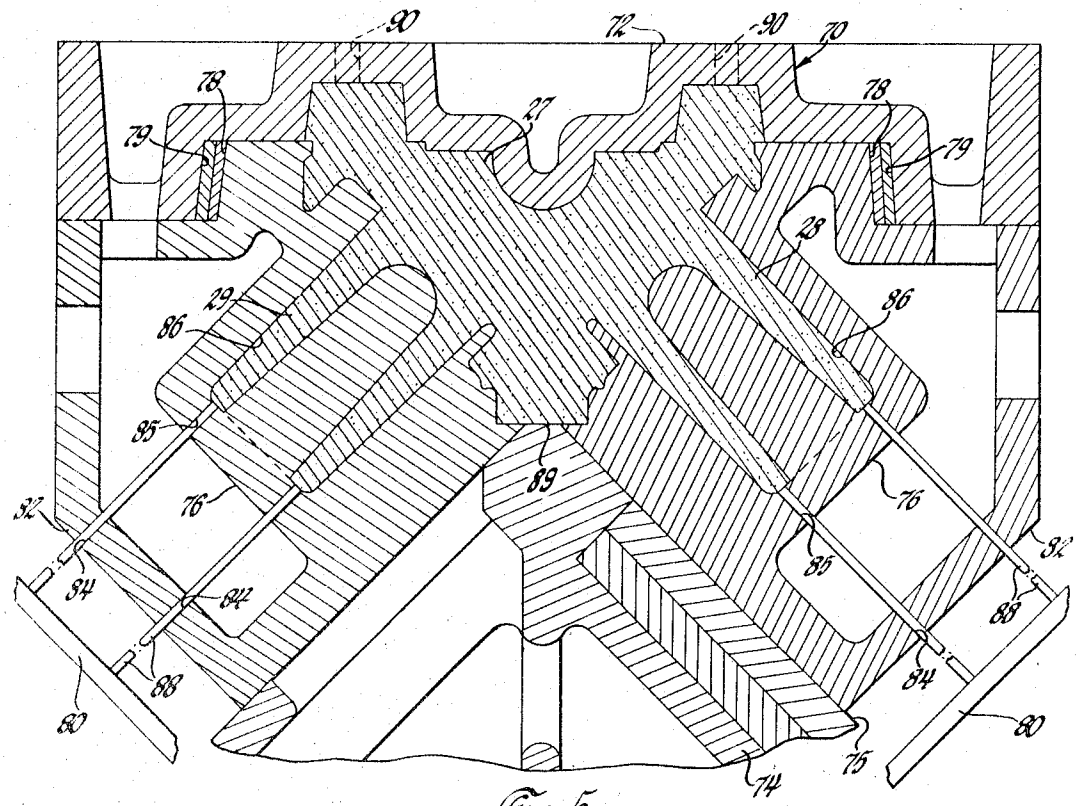

Fig. 5

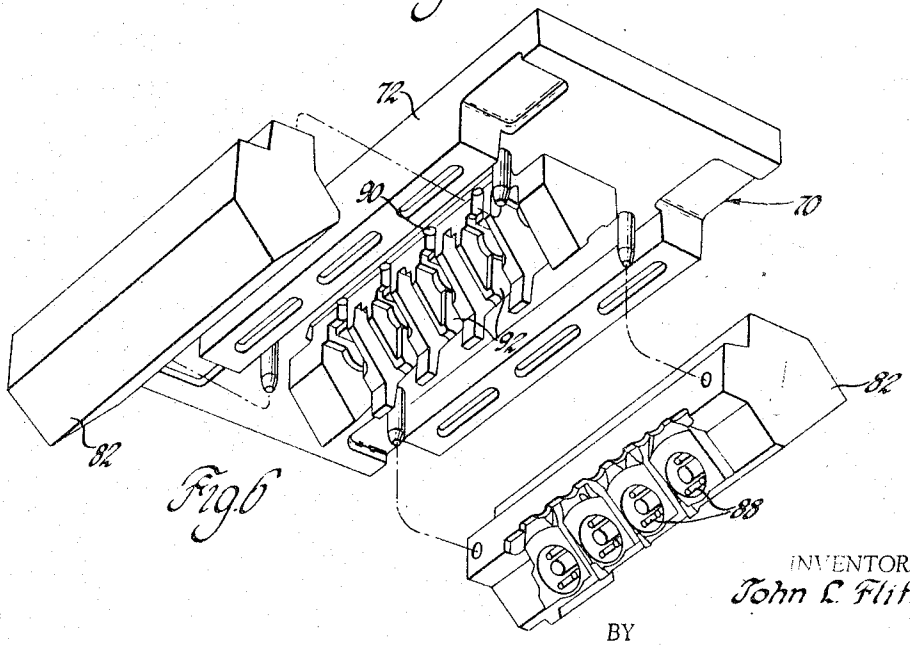

Fig. 6

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3,302,250

CORE BOX AND MOLDING ASSEMBLY FOR INTERNAL COMBUSTION ENGINE BLOCKS

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Original application Dec. 18, 1963, Ser. No. 331,442, now Patent No. 3,264,693, dated Aug. 9, 1966. Divided and this application Apr. 27, 1966, Ser. No. 545,747
5 Claims. (Cl. 22—13)

This is a division of the patent application S.N. 331,-442, filed December 18, 1963, now Patent No. 3,264,693.

This invention relates to sand casting internal combustion engine blocks, and more particularly to a core box for making an improved core arrangement whereby such engine blocks may be more accurately formed than before.

Cast iron engine blocks are made in sand molds which are formed in metal flasks by ramming both the cope and the drag half with green sand around a pattern. The two flask halves are then assembled together after removal of the patterns to establish a mold cavity which generally defines the exterior surface configurations of the engine block. Baked sand cores are supported in spacial relationship within the cavity by wires, core print projections, or the like to define the interior surfaces of the block.

Some of the more undesirable aspects of sand casting come from the sand cores which are required to define interior spaces of the engine block. To form a block as many as twenty such cores may be required, some cores being glued together and assembled with others until the required interior shape is formed. Naturally a slight misalignment due to a shifting of sand cores being glued will be carried over as an error into the finished casting. Furthermore, such interior cores often require the use of support rods or chaplets to locate them in the mold and to prevent them from being floated out of position due to the buoyancy of the molten iron. These chaplets are intended to become an integral part of the casting, but if the bond is defective the casting may leak.

Core setting is also a major problem. In simple castings, the cores may be located by the core prints in the drag half of the mold, but in more complicated coring arrangements some sort of transfer fixture that prepositions the core assembly prior to placing it in the mold is required.

In the past, cast iron blocks required considerable machining and were relatively heavy units, not only due to the weight of cast iron, but also due to the thick walls required to achieve a structurally sound part.

The weight factor in the present day automobile has become such a sore point that lighter engine blocks have become attractive; hence there has been a shift recently to emphasize the light weight metals, such as aluminum alloys, which may be pressure die cast. Such a process does not require sand cores and inherently overcomes many of the defects heretofore plaguing the sand molding process. However, die casting of aluminum alloys, or similar light metals, has its problems too due to the high cost of equipment and the troublesome metallurgical properties of these metals; hence the most recent trend is now a shift back towards cast iron for making engine blocks.

This re-evaluation of the cast iron block has been possible primarily through recent improvements in core assembly techniques and mold and core castings which allow more accurate, thin walled castings to be made. The former technique is disclosed in United States Patent 2,783,510, Dolza et al. In Dolza et al., the conventional methods of coring a V-type cylinder block were rendered obsolete by his advance which contemplates making the

projections and depressions embracing the interior surfaces of the block so that a single core may be employed for each crankthrow compartment and associated cylinder cavity, the crankcase-barrel core units being formed in a core box the parting line of which would be in an imaginary plane passing transversely through the block and generally through the axes of the cylinders. In other words, in the past where a separate core was required for each cylinder barrel and crankthrow area, the crankcase and barrel cores may be formed according to Dolza et al. in one piece while lying on their sides in a core box having a horizontal parting line through the center. A plurality of such crankcase and barrel core units, depending on the number of cylinders in the engine, can then be assembled, one behind the other, in the drag half of the mold with the various cooperating core elements arranged around them, thus greatly reducing the number of cores required and simplifying the procedure of core setting. The core setting step may be even further improved by the technique shown in the United States Patent 2,768,-414, Dolza, where a metal tray is used to prearrange the crankcase-barrel cores.

Due to the elimination of a great many core pieces and more accurate means for core setting, the accuracy of iron blocks has improved and the cost has been reduced. Following the trails blazed by Dolza in his patents, the present invention makes a significant contribution and improvement which it is believed makes sand casting even more advantageous for the manufacture of vehicle engine blocks.

In accordance with the present invention, a one piece crankcase-barrel core for all of the crankthrow and cylinder barrel spaces in the block is provided which comprises the basic core unit of an interfitting core assembly. The crankcase-barrel core unit is formed in a novel multi-part core box including a plurality of fixed and relatively movable sections adapted to define a core mold cavity when in the closed position and having blow tubes for introducing a core sand mixture into the cavity under air pressure and vents for exhausting the cavity. The movable sections include a cover section with projections or blades adapted to be withdrawn from the core interior to render inner adjacent surfaces thereof exposed for cooperation with surfaces in the mold cavity to define the bulkhead and bearing structure of the engine block and a reciprocative barrel section for forming the barrel core portions movable relative to the cover section along the axes of the barrel core portions of the crankcase-barrel core unit.

Additional features and objects of this invention will be made clear by reference to the following detailed description and drawings wherein:

FIGURE 1 is an exploded perspective view of the one piece crankcase-barrel core showing it and other cores used to form a V–8 cylinder block for an internal combustion engine and the relationship of these cores with each other in accordance with the present invention;

FIGURE 2 is a perspective view of the drag and drag half of the mold shown ready to receive the core assembly in FIGURE 1;

FIGURE 3 is a perspective view of the drag shown in FIGURE 2 with the core assembly in place;

FIGURE 4 is a sectional view taken along the line 4—4 of FIGURE 3 through the mold with the cope in place showing the spacing of the core assembly in the mold;

FIGURE 5 is a sectional view of the core box for making the one piece crankcase-barrel core shown in the closed position; and

FIGURE 6 is an exploded perspective view of the movable core box sections.

Referring to FIGURES 1–4, a five-piece baked sand

core assembly is provided which includes a unitized crankcase-barrel core **10**, right and left water jacket cores **12** and **13**, a rear end core **14**, and a front end core **16**. The core assembly is positioned in the casting cavity of the drag half of the sand mold **18** shown in FIGURE 2 and having a bottom wall in which is formed a longitudinally extending elongated portion **20** which directly supports the crankcase-barrel core **10** and rear and front cores **14** and **16**. The portion **20** is positioned to support the core assembly in spacial relationship within the mold cavity when the flask is closed and is formed along with the drag half of the mold in the conventional manner by ramming green sand around a pattern having the shape of the drag cavity which defines the lower exterior walls of the block. After the drag half of the mold **18** has been rammed, the cope half **24** shown in FIGURE 4, is likewise rammed with green sand about a pattern forming the cope cavity defining the upper exterior block walls. The core assembly **10**, **12**, **13**, **14**, and **16** is then positioned in the drag cavity as shown in FIGURE 3 whereupon the cope half of the mold **24** is assembled closing the mold, proper positioning of the cope and drag being insured by the flask pins **26** for purposes of illustration, the pins **26** are shown at each corner of the drag and are to be received in holes at each corner of the cope, however, in practice, a metal flask of more conventional design would be used. With the flask closed as viewed in FIGURE 4, it is ready to receive molten metal to start the casting process.

Referring in more detail to FIGURE 1, the crankcase-barrel core unit shown is adapted for use in casting a 90° eight cylinder internal combustion engine. Obviously the type of engine or the number of cylinders is not a limitation to this invention, and the concepts hereof can be readily adapted by modifying the core assembly for use in making a V–6 or even an inline engine block. The core **10** being for a V-type engine has a plurality of alinged core body portions **27** of generally triangular shape appropriate to define the crankthrow areas below the engine cylinders. The engine cylinders are cored by the integrally formed barrel core portions **28** and **29** projecting from the triangular side walls **30** of the body portions **27** forming left and right inclined parallel rows. In this case, the left barrel core portions **28** are arranged in a V-fashion at 90° to the right barrel core portions **29**. The barrel core portions have conical bores **31** the function of which will be described hereinafter. The body portions **27** are not separate units but are formed together as a unitary member having generally vertically extending recesses bounded by inner adjacent laterally extending transverse surfaces **32** and being joined locally at the corners by the longitudinally extending leg portions **34** on either side at the bottom and by the cam shaft gallery core portion **35** at the top. The inner adjacent walls or surfaces **32** of the body portions **27** cooperate with the slab **20** in the drag half of the mold **18** to define the bulkhead and bearing structure of the engine block. Accurate portions **36** at the bases of the body portions **27** mate with the longitudinally extending crown **37** of the slab **20** to confine the molten metal within the spaces between the adjacent body portions **27**. When the main core **10** is assembled with the end cores **14** and **16**, the end walls of the outer core body portions **27** will be spaced from the inner walls of the end cores by core projections such as **38** on the front core **16**, this projection forming the cam shaft opening in the front wall of the block. A similar projection (not shown) on the rear core **14** is also provided. The spacing between the cores **10**, **14**, and **16** will be sufficient to define the end walls of the block while the triangular side walls **30** of the body portions **27** will form the interior right and left bank walls of the upper crankcase region through which the cylinders open. The rear core **14** has a recess **39** which partially surrounds the vertical projection **40** on the core **10** being spaced sufficiently therefrom to form a distributor boss in the top of the block.

The water jacket cores **12** and **13** are assembled over the barrel portions **28** and **29** of the core **10** and include generally cylindrical body portions **42** having interior cylindrical walls **43** which are of larger dimension than the barrel portions **28** and **29** so that when arranged in coaxial relationship therewith there will be a radial spacing between them. This radial spacing, which conforms to the engine cylinder barrels, is established by virtue of the core straps **44** and depending posts **45** which mate with the conical bores **31** of the barrel core portions as best seen in FIGURE 4. A fit of the posts and bores is reached when the tops of the barrel core portions abut against the undersurface of the straps **44** automatically locating the water jacket cores in spacial relationship with respect to the crankcase-barrel core unit **10**. A core locating function is also performed by the core bosses **46** which project from the lower sides of the cylindrical portions **42** and bear against the inclined green sand walls **47** of the drag. These bosses form openings in the finished casting that are closed by sheet metal plugs in the well-known manner. Passages **48** opening at the top of the straps **44** extend down into the posts **45** opening at the other end within the bores **31** to vent the core **10** through passages **49** in the cope.

This arrangement of locating the water jacket cores for a V-type engine core assembly is a departure from the past practice taught, for example, by the Dolza et al. patent. There a plurality of metallic spacer sleeves are used to properly space the water jacket cores from the barrel core portions. These sleeves are preferably slightly conical in shape and their smallest internal diameters are somewhat smaller than the outside diameter of the barrel portions. Thus when the spacer sleeves are assembled over the barrel portions, the outward taper of their inner surfaces prevents their sliding downward on the barrel portions to an excessive extent with the result that their lower edges are spacially separated from the sloping side surfaces of the body portions of the crankcase-barrel cores. When the spacer sleeves are securely in position around the barrel portions, the two water jacket cores are placed over the sleeves and the barrel portions so that the latter protrude completely through the openings formed by the cylindrical body portions of the water jacket core. After assembly of the cores in the drag, the spacer sleeves are then removed since the positioning of the water jacket cores with respect to the barrel core portions is now maintained by core prints in the mold.

In the present invention, the need for metallic spacer sleeves is eliminated, and instead this function is performed by the integrally formed core straps **44** and posts **45**. It may be appreciated that the radial spacing of the water jacket core is extremely critical since a slight misalignment will cause a thin metal region to form between the cylinder barrel and the water jacket possibly resulting in a crack in the cylinder wall during operation leading to total engine failure. With the present water jacket positioning, the posts **45** extend far enough into the barrel bores **31** to give stability to the whole water jacket core along the axis of the cylinder barrels during the casting process which was not the case in the past practice where the metallic spacer sleeves were removed prior to metal being poured. In that arrangement while the metal was being poured, the positioning of the water jacket cores depended primarily upon the core prints formed in the drag when ramming the sand around the pattern. It might be appreciated that slight pattern wear in the area of these core prints may cause a considerable error to be introduced with the result that the water jacket cores would be allowed to float out of position slightly. Also the use of a large number of metallic chaplets to reduce the tendency of the cores to float has been common practice.

To eliminate these causes of poor castings and to facilitate core setting in the invention, the dependency on green sand core prints is reduced and the use of chaplets is also reduced. For example, the front end core **16** has core print recesses **50** on opposite sides thereof to receive the core projections **51** formed on the ends of the water jacket cores. Hence there is no problem of trying to match green sand core prints in the drag up with separate core projections when setting the core assembly where in the past, a number of core projections were seated in the drag and had to be aligned individually when placing the core assembly. Proper longitudinal positioning of the core assembly **10**, **12**, **13**, **14**, and **16** in the drag **18** is insured by the core print **52** in the green sand on the left side of the drag wall which cooperates with a small projection (not shown) on the left leg **34** of the crankcase-barrel core **10** to locate the entire core assembly with respect to the drag cavity, the recesses **54** and **56** in the drag being shaped to receive the end cores **14** and **16** respectively. The flask pins **26** serve to locate the cope over the drag; and with the flask in the closed position, as shown in FIGURE 4, ready to receive molten metal, it is seen that the straps **44** engage surfaces in the cope to prevent floating of the cores during casting.

Spruce openings **58** (not shown) extend from the top of the flask down through the cope and drag, cooperating in the drag with channels **59** in the back side of the rear core **14** and the channels **58** in the drag **18** to open into the longitudinal runners **60** formed in the drag below each leg **34** of the crankcase-barrel core **10**. As seen in FIGURE 4, gates **62** on the inner edges of the runners **60** open upwardly into the spaces between adjacent body portions **27** and between the end cores **14** and **16** and core **10** permitting molten metal to rise into the mold cavity at the engine bulkhead and end wall locations. The gate and runner system is rammed up with the green sand of the drag.

As taught by the Dolza et al. patent, separate crankcase-barrel core units for a V-type engine block are arranged one behind the other in the drag, being mutually spaced from one another by integrally formed core projections which engage the rear surface of the immediately preceding crankcase-barrel core thereby defining the lower surfaces of the engine bulkheads. These crankcase-barrel cores must be separately formed lying on their sides in a core box having a parting line in a plane passing horizontally through the center. Since the core box opens in a direction normal to this plane and each crankcase-barrel core is a separate unit, it is possible therefore to form the bulkhead bottom surface core projections on the sides of the body portions normal to the parting line.

It is important to note that in the present invention the crankcase-barrel core **10** is a one piece construction in which each bulkhead of the engine is defined in the space between adjacent body portion **27** and the green sand of the rammed portion **20** in the drag. A core box of the type used to form the separate crankcase-barrel core units in Dolza with the parting plane passing generally through the axes of the cylinders could not be used to manufacture the core **10** for the reason that a plurality of body portions and integral barrel portions **27**, **28**, and **29** are all joined together as a unit, one behind the other in aligned fashion.

To deal with the problem of manufacturing an integrated crankcase-barrel core such as that shown in FIGURE 1, I have developed the novel core box illustrated in FIGURES 5 and 6 which includes a plurality of core box sections, some of which are movable with respect to others which are fixed; the movable sections moving relative to each other and to the fixed sections to define a closed cavity of the configuration of the core **10** as shown in FIGURE 5.

Referring to FIGURE 5, the core box **70** is shown in the closed position and includes a vertically movable cover section **72** positioned above a fixed base section **74** which provides a surface **75** to support obliquely slidable barrel forming side sections **76** and a mold surface **89** for forming a portion of the camshaft gallery core portion **35**. The side sections **76** have longitudinal bearing surfaces **78** which mate with complementary bearing surfaces **79** on the cover section in the closed position to lock the movable sections in a closed position. Stripper plates **80** fixed to the base section **74** extend parallel to the back surfaces **82** of the side sections **76** and are spaced therefrom sufficiently to be out of range when the side sections are moved to the open position. The back surfaces **82** have a plurality of ports **84** which are aligned with ports **85** in the tops of the barrel forming molds **86**. The aligned ports **84** and **85** are adapted to receive ejection pins **88** mounted on the fixed stripper plates **80**. Blow tubes **90** formed in a cover section **72** communicate with the sand hopper of a standard core blowing machine for introducing the core sand mixture into the mold cavity under air pressure, filling the cavity with tightly packed core sand. The air pressure is exhausted through air vents (not shown) in the right and left barrel molds and the base section. As seen by inspection, the core **10** is formed upside down in the core box which may then be shuttled over gas burners heating the core box and core sand mixture to the baking temperature. After baking, the core box is opened by raising the cover section **72** and retracting right and left barrel forming sections **76** relative to the ejection pins **88** which are stationary and extend into the barrel forming molds **86** as shown in FIGURE 6.

The relative positions of the movable core box sections are best shown in FIGURE 6 where the barrel forming side sections **76** have been moved downwardly and outwardly relative to the top section **72** which has been previously raised vertically. Of course to closed the box, the sequence is merely reversed; that is, the side sections are first moved to the closed position and then the cover section is lowered.

The core box projections on the cover section **72** form the interior spaces of the main core **10** and include the blades **92** which define the core spaces between the body portions **27**, such spaces forming the bulkhead and bearing regions of the engine block. The point here is that no core projections can be allowed on the inner adjacent surfaces **32** of the main core **10** since this would interfere with the pulling of the blades **92** from between such surfaces. In addition, some redesigning of the engine bulkhead construction is necessary in order to take into account the fact that there must be sufficient draft in the surfaces **32** in order to pull the blade projections.

In other words, the inner adjacent side surfaces **32** must open downwardly and outwardly with respect to a transverse plane which is the plane of the cross section in FIGURE 5 but passing generally through the center of the bulkhead spaces. This is one way of saying that these surfaces must be free of any projections or pockets and re-entrant angles which would otherwise prevent the pulling of the core box projections. With the design of the engine accordingly modified, as dictated by the foundry practice disclosed here, it is now possible to join the core body portions and barrel core portions into a one piece crankcase-barrel core unit.

Having now described the invention in its preferred embodiment and in sufficient detail to allow the same to be practiced, it is intended that obvious changes may be made, such as modifying the invention to accommodate engine blocks having a different number of cylinders or the like, without deviating therefrom as defined in the appended claims.

I claim:

1. A multi-part core box adapted for use in making a sand core of the type suitable for use in casting the interior crankcase and cylinder barrel surfaces of a V-type internal combustion engine frame,

said core having a crankcase forming body portion

which supports integrally formed barrel core portions projecting therefrom in inclined V-fashion, said core box including fixed and relatively movable core box sections cooperating in a closed position to define said core mold cavity, means associated with one of said sections for admitting a core sand mixture under fluid pressure into the cavity, said movable sections comprising:

a movable cover section having molding projections thereon for forming the core surfaces of the body portion used for defining the bulkhead surfaces of the engine frame; and

obliquely movable side sections mutually closable with said cover section having mold cavities therein for forming said barrel core portions.

2. A multi-part core box adapted for use in making a sand core of the type suitable for forming the interior crankcase and cylinder barrel surfaces of a cast V-type internal combustion engine frame, said core having integrally formed triangular body portions being locally spaced apart to expose inner adjacent side surfaces thereof, said body portions supporting integrally formed barrel core portions projecting from the triangular side surfaces thereof in inclined V-fashion, said core box including fixed and relatively movable sections cooperating in a closed position to define said core mold cavity, means for introducing a core sand mixture under fluid pressure into the mold cavity associated with one of said sections, said movable sections comprising:

a vertically movable cover section having molding projections thereon for forming said inner adjacent side surfaces of the core body portions used for defining the bulkhead surfaces of the engine frame; and

downwardly and outwardly movable side sections having mold cavities therein for forming said barrel core portions, said side sections being movable in the axes of said barrel core portions between closed and open cavity portions with respect to the vertical displacement of said cover section.

3. Claim **1** wherein said movable cover section includes opposed inwardly facing bearing portions and said obliquely movable side sections each include an outwardly facing bearing portion which is adapted to mate with the said inwardly facing bearing portions whereby said obliquely movable side sections are locked in place by said cover section when the said movable portions are in a closed position.

4. A multi-part core box adapted for use in making a sand core of the type suitable for use in casting the interior crankcase and cylinder barrel surfaces of a V-type internal combustion engine frame, said core having a crankcase forming portion which supports integrally formed barrel core portions projecting therefrom in inclined V-fashion and a camshaft gallery forming core portion,

said core box including fixed and relatively movable core box sections cooperating in a closed position to define said core mold cavity,

said fixed core box section including a mold surface for defining a portion of said camshaft gallery core portion,

said movable sections comprising a movable cover section having molding projections thereon for forming the core surfaces of the body portion used for defining the bulkhead surfaces of the engine frame and obliquely movable side sections supported by said fixed portion mutually closable with said cover section having mold cavities therein for forming said barrel core portions.

5. Claim **4** wherein said fixed core box section and said obliquely movable side sections cooperate to define said gallery core portion.

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