Oct. 30, 1962 G. R. COLE 3,060,915

INTERNAL COMBUSTION ENGINE

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FIG. 1.

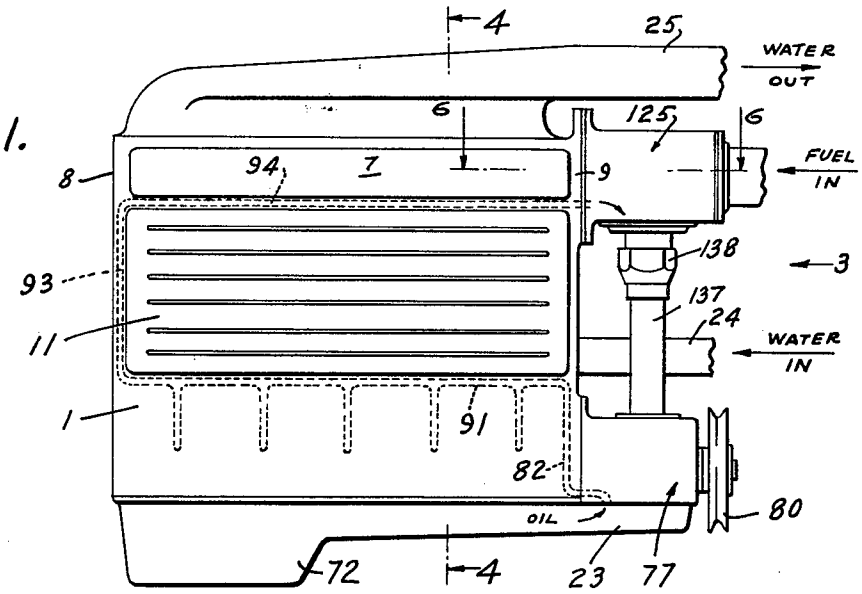
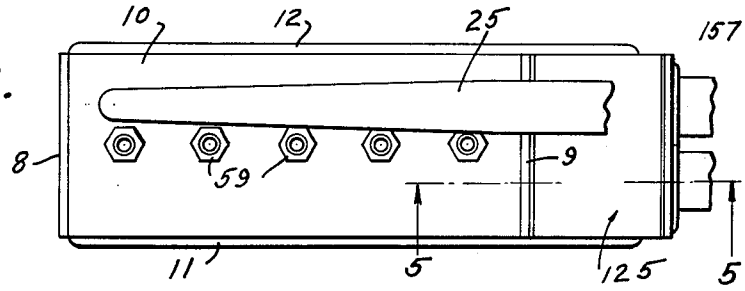


FIG. 2.



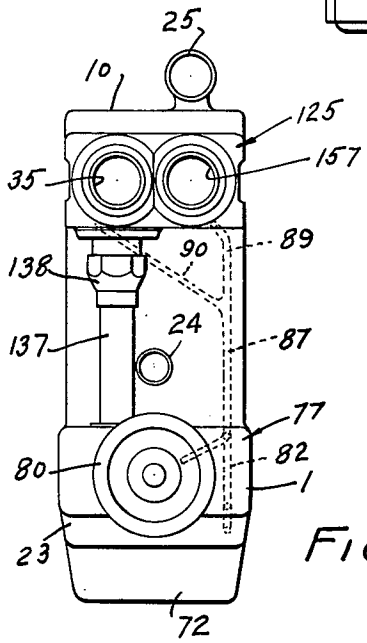


FIG. 3.

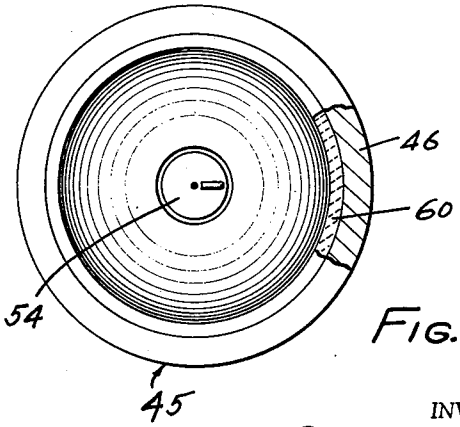


FIG. 8.

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INTERNAL COMBUSTION ENGINE

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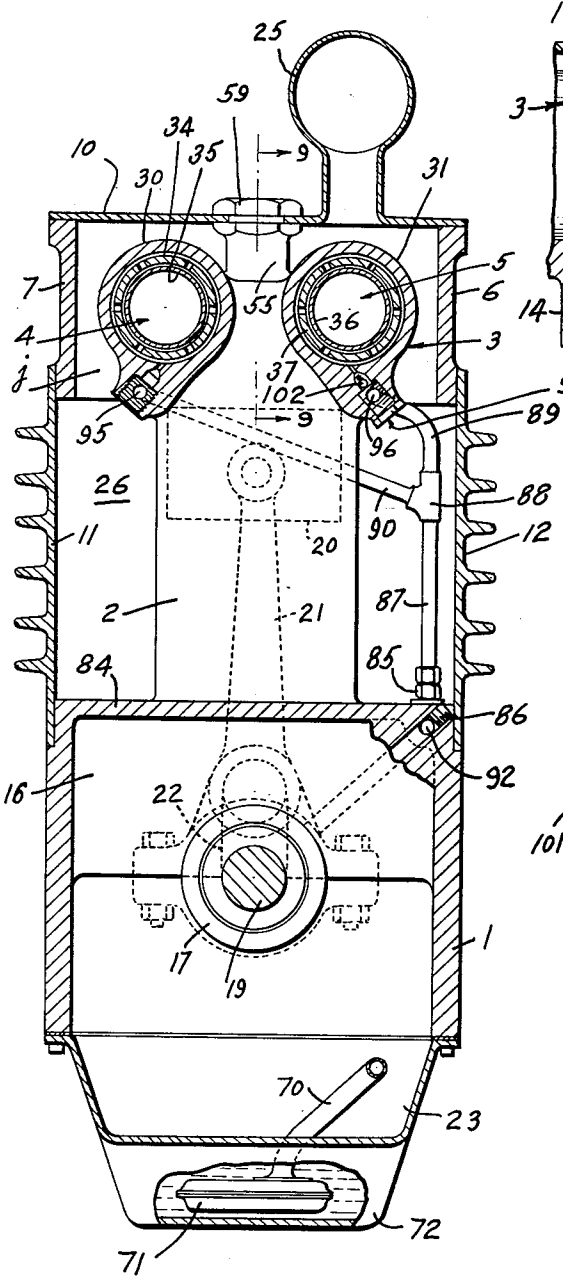


FIG. 4.

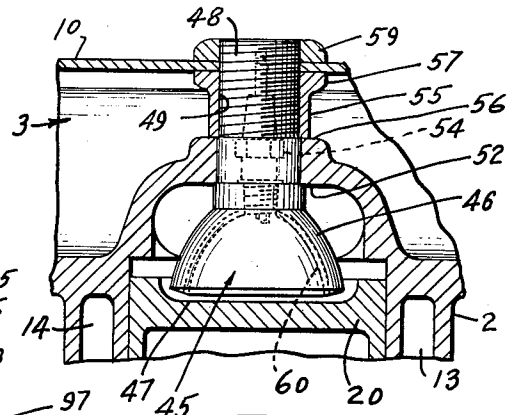


FIG. 9.

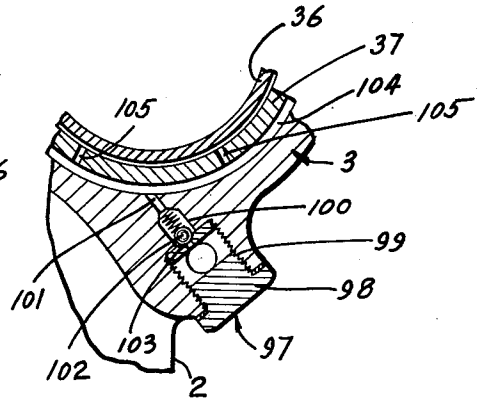


FIG. 10.

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INTERNAL COMBUSTION ENGINE

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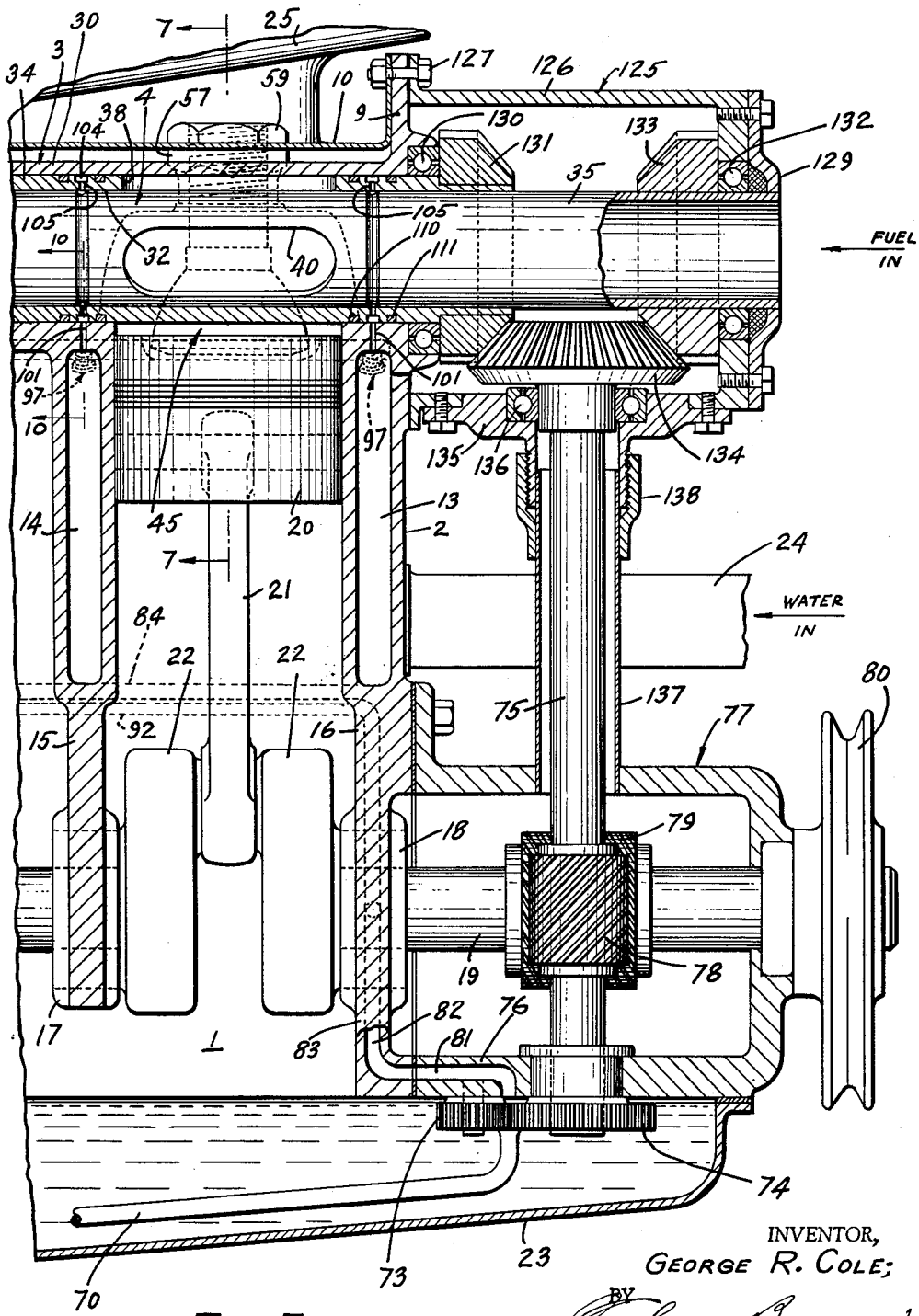


FIG. 5.

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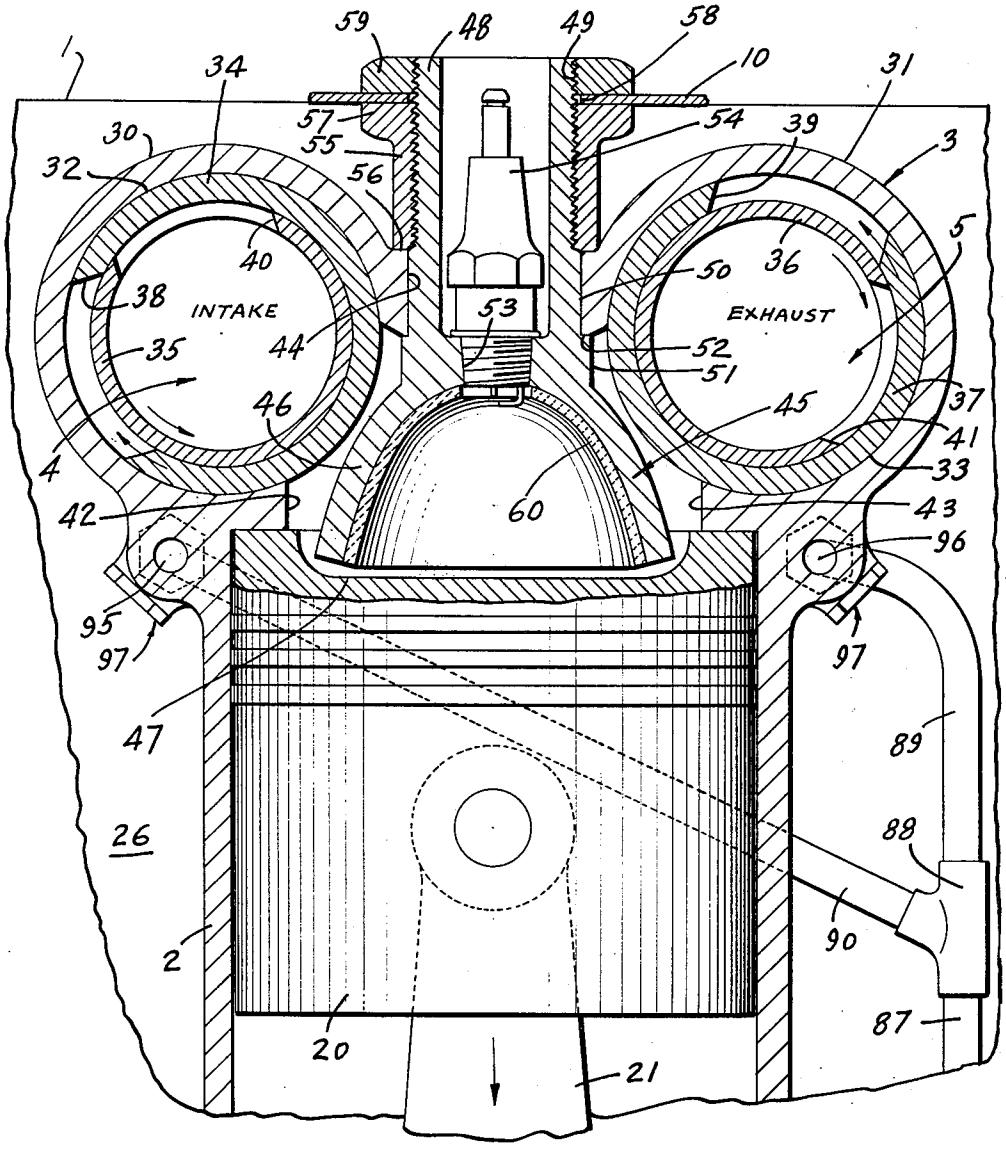


FIG. 7.

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INTERNAL COMBUSTION ENGINE

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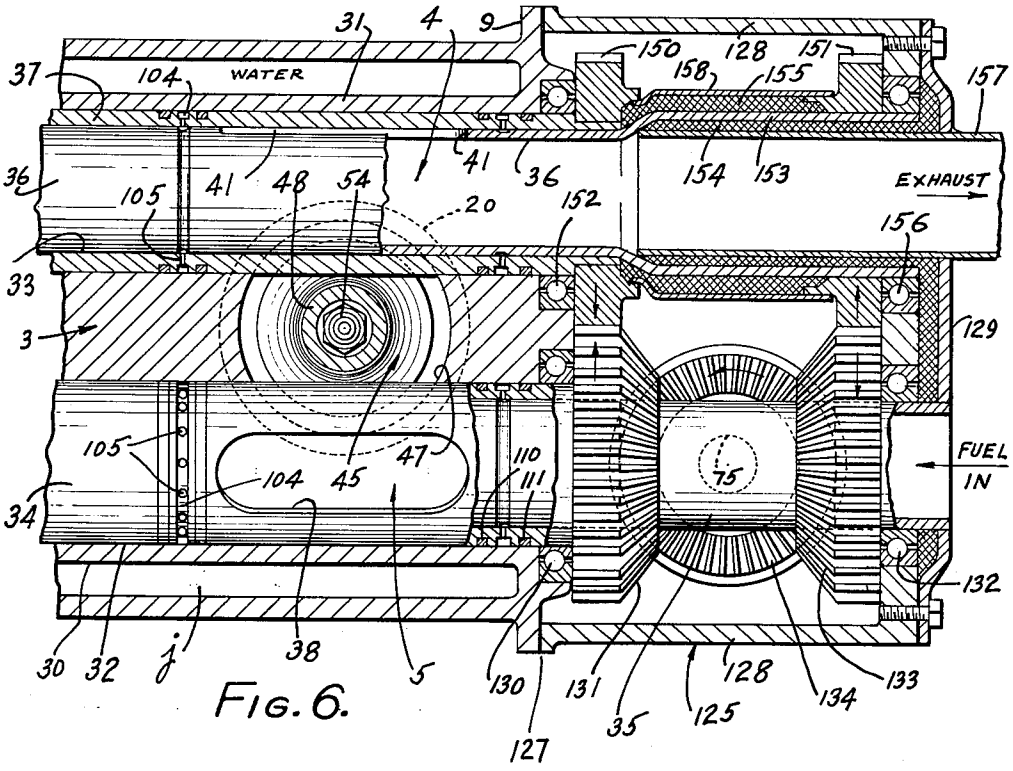


FIG. 6.

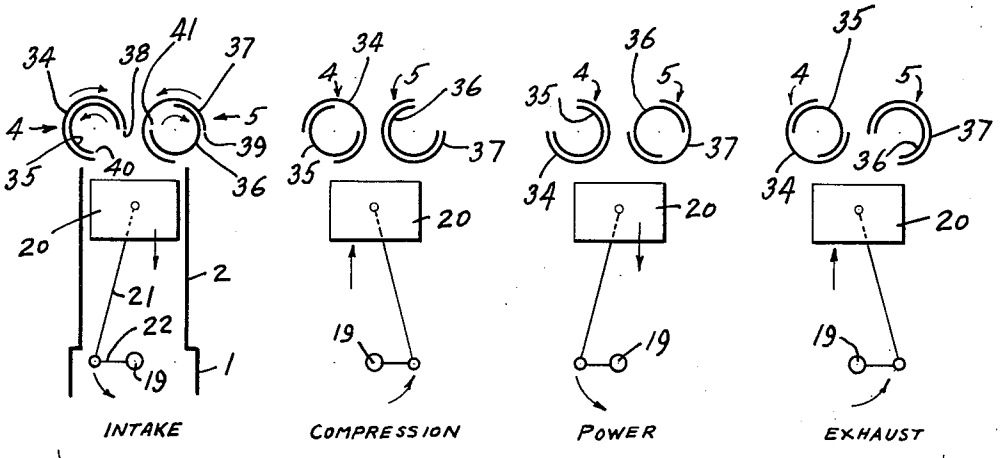


FIG. 11.

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United States Patent Office 3,060,915 Patented Oct. 30, 1962

3,060,915

INTERNAL COMBUSTION ENGINE

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Filed June 8, 1959, Ser. No. 818,783
2 Claims. (Cl. 123—59)

The present invention relates to internal combustion engines and specifically to a valve construction therefor.

An object of the invention is the provision of an internal combustion engine designed for die casting substantially in one piece without the necessity of a separate removable cylinder head. With respect to this object, it may be pointed out that the conventional internal combustion engine generally used in automotive practice employs poppet valves which are so treated as to be hard faced and require hardened surfaces on which to seat which precludes the use of die cast metal for the body of the engine. Furthermore, poppet valve construction requires many parts to be assembled and adjusted, all of which is obviated by the present invention. Thus another object of this invention is to greatly simplify and reduce the cost of the engine construction.

Another object is to provide an improved valve construction for internal combustion engines and wherein the valve operation for both intake and exhaust is not subject to pitting, easily assembled, overhauled and repaired and which is readily accessible.

A further object is the provision of an improved firing chamber for each cylinder of the engine and which firing chamber assures against warpage due to heat of the valve mechanism of the present invention.

A further object is the provision of a novel sealing means for the valve mechanism and which effectively prevents gas under pressure from escaping between cylinders.

The inventor is aware that prior investigators have proposed rotary valve mechanism for both the intake and the exhaust to and from the cyinder or series of cylinders of an internal combustion engine. Difficulties have been encountered however in that heat tends to warp the valve sleeves or tubes resulting in a binding engagement with the valve casing. Proper timing of the valves has likewise been a factor. With the present invention I have so arranged the valve mechanism that no binding occurs, that the parts are properly lubricated at all times and that the timing of the valves is positive and exact.

With the above mentioned and other objects in view, the invention consists of the novel and useful provision, formation, construction, association and relative arrangement of parts, members and features all as shown in a certain embodiment in the accompanying drawings, described generally, and more particularly pointed out in the claims.

In the drawings:

FIGURE 1 is a fragmentary side elevation of an internal combustion engine embodying the invention;

FIGURE 2 is a top plan view of the engine shown in FIGURE 1;

FIGURE 3 is an end elevation of the engine shown in FIGURE 1 looking in the direction of the arrow 3;

FIGURE 4 is a fragmentary sectional view on the line 4—4 of FIGURE 1 and on an enlarged scale;

FIGURE 5 is a fragmentary, partially sectional view taken on the line 5—5 of FIGURE 2 and on an enlarged scale;

FIGURE 6 is a fragmentary sectional view on the line 6—6 of FIGURE 1 and on an enlarged scale;

FIGURE 7 is a fragmentary sectional view on the line 7—7 of FIGURE 5 and on an enlarged scale;

FIGURE 8 is a fragmentary, partially sectional bottom plan view of an auxiliary firing chamber member used in the practice of the invention, and shown in FIGURE 7 in vertical transverse section immediately above the engine piston;

FIGURE 9 is a fragmentary sectional view taken on line 9—9 of FIGURE 4 and on an enlarged scale;

FIGURE 10 is a fragmentary sectional view on an enlarged scale on the line 10—10 of FIGURE 5; and,

FIGURE 11 diagrammatically illustrates successive cycling of the valve sleeves during intake, compression, power and exhaust strokes of a piston in a cylinder.

Referring now to the drawings and specifically to FIGURES 1 to 4 inclusive, I have provided an engine design which includes a crank case 1, a cylinder block 2, and a cylinder and valve head 3 all cast in-block, which head 3 is provided with valves, shown at 4 and 5. The construction may be termed a valve in the head structure, the valves of which are of the rotary type to distinguish the valves from the well-known poppet and sleeve types. I prefer in casting the present cylinder block, cylinder head and crank case to provide side and end walls 6, 7, 8 and 9, the side walls of which are spaced from the cylinder and valve head portions shown at 3 which provide the water jacket *j* for the cylinder head and valves particulraly when the side and end walls are covered by a closure plate 10. This closure plate is held to the side and end walls in any suitable manner such as by cap screws or by other means of attachment but the preferred method is by means of compression between the lock nut 59 and the elongated nut 55 shown in FIGURE 7. I provide finned plates at 11 and 12 which extend between the side walls 6 and 7 and the sides of the crank case 1 which plates are held in any desired manner to provide as between said plates and the cylinder block, a water jacket 26 which is in direct communication with the jacket *j*. Preferably in the casting of the cylinder block and crank case as well as the cylinder head, I cast at the same time end plates to which the side panels 11 and 12 are secured. I may, if desired, use separate plates for this portion. As is customary in engine construction, the cylinders of the cylinder block are separated which leaves a space between cylinders as shown in FIGURE 5 at 13 and 14, with solid portions immediately below the cylinder portions as shown at 15 and 16, which are part of the crank case casting, and which carry bearings 17 and 18 for the crank shaft 19. As shown in FIGURE 5 a piston 20 is within the cylinder together with the connecting rod 21 connected to a crank shaft throw 22. As shown in FIGURE 4, an oil pan 23 connects with the crank case 1 for the purpose of holding oil and directing the oil to the crank shaft bearings and for pumping the oil from an oil sump to various portions of the engine as hereinafter detailed. In addition to the various features of the engine so far set forth, I have provided an inlet pipe 24 for water to pass from a radiator into the jackets 13 and *j* with an outlet pipe or manifold 25 returning to the radiator. The usual water pump may be incorporated, or the water circulation may be of the thermo-syphon type.

So far as detailed, I utilize as a feature of my invention the fact that the crank case, cylinder block with the cylinders and the cylinder head which also includes the valves, are cast in-block. Preferably the casting may be of a light metal such as aluminum, aluminum alloys, magnesium and magnesium alloys.

The cylinder head is so cast as to provide a pair of oppositely positioned, substantially parallel and longitudinally extending valve head casings 30 and 31 having cylindrical bores 32 and 33, the said casings extending substantially the full length of the cylinder block. Within the bores 32 and 33 are pairs of concentric tubes or sleeves 34 and 35 in one instance and 36 and 37 in a second instance. One set of tubes, to wit: 34 and 35

are here designated as the intake valve structure while the other pair of concentric telescopic tubes **36** and **37** are designated as the exhaust valve structure. As shown in FIGURE 7, the outer tubes **34** and **37** are each provided with segmental ports **38** and **39**. These ports are elongated as shown in FIGURE 5 and a port like **38** and **39** is provided for each cylinder of the engine. The inner valve tubes **35** and **36** are provided with ports **40** and **41** which are adapted to register with the ports **38** and **39** during a certain sequence of operation of the valves. The ports **40** and **41** subtend the same arc as the ports **38** and **39** and are of equal length. The number of ports **40** and **41** will depend upon the number of cylinders to the engine. As shown in FIGURE 5 the length of the ports for both the inner and outer tubes for the intake and for the exhaust valves is substantially equal to the inner diameter of a cylinder and further considering FIGURES 5 and 7 for a single cylinder, the cylinder head is so cast as to provide elongated ports at **42** and **43** subtending an arc equal to or greater than the degree of arc for the ports **38** and **39**. The ports **42** and **43** communicate with the top of the cylinder.

The cylinder head is provided with a plurality of bores **44**, one bore for each cylinder, with end bore **44** coaxial with the axis of the cylinder to receive an auxiliary combustion chamber member designated generally as **45**. This combustion chamber member **45** includes a concavo-convex or cup-like portion **46** positioned in part within the top of the cylinder and adapted to be received in a depression **47** of the piston when the piston is in the position shown in FIGURE 7. The top of said concavo-convex portion **46** is provided with a tubular extension **48**, the external surface of which is threaded at **49** and non-threaded and enlarged in external diameter at the portions **50** and **51**. This tubular extension is adapted to be passed through the bore **44** in the cylinder head and to shoulder at **52** on the cylinder head, due to the difference in diameter of the portions **50** and **51** to make a gas-tight seal at this point. A threaded bore is provided at **53** for receiving the threaded shank of a spark plug **54** in such a manner that the electrodes are received within the cavity of the member **45**. A nut **55** is secured to the threads **49** and abuts the shoulder **56** of the cylinder head so as to hold the auxiliary combustion chamber member **45** securely to the cylinder head. The nut **55** is provided with an annular end flange **57** and the top plate **10** is provided with a bore **58** to allow passage therethrough of the tubular extension **48**, with a further nut **59** carried on the threads **49** whereby the top plate **10** may be secured between the nut **59** and the flange **57**, as shown in FIGURE 7. The diameter of the bore of the tubular extension **48** is sufficient to allow ready insertion therein of the spark plug **54** for threaded connection at **53** with the combustion chamber members.

I have found it convenient to cover the concave surface of the member **45** with heat resistant material **60**. Alumina is a satisfactory material to use for lining, although it is obvious that other lining material or none at all may be utilized, as the shape of member **45** tends to contain the extreme heat of the explosion. As I have previously pointed out, I have been describing a single cylinder having a piston therein together with the means for igniting an explosive mixture through the medium of the spark plug **54** for driving the piston downwardly within the cylinder on the power stroke. Other cylinders and pistons would be similarly arranged as would the arrangement for intake of combustible gases and the exhaust of spent gases.

Before describing the timing mechanism for the valves, I call attention to the oiling system and wherein an oil tube **70** communicates with a filter **71** positioned in the lowest part of the oil sump, being the portion **72** of the oil pan **23**. The said tube **70** is adapted to have oil drawn therethrough by a gear type oil pump shown within the oil pan at **73** and **74**, the gear **74** being driven by shaft **75** suitably journalled in the bottom wall **76** of a gear box **77**. Shaft **75** carries spiral gear **78** which meshes with spiral gear **79** carried on an extension of the crank shaft **19**, which crank shaft, as shown, passes through the gear box and outwardly thereof and carries a pulley wheel **80**. This pulley wheel **80** through the medium of a belt usually drives a fan, a generator and other devices associated with the motor. The bottom wall **76** of the gear box may be bored as shown at **81** which bore communicates with the outlet of the gear pump, with the bore **81** in turn communicating with bore **82** which extends through the crank case wall **83**. As shown best in FIGURE 4, the top wall **84** of the crank case is bored to receive a fitting **85** which communicates with the bore **82**, the bore **82** being plugged at one end as shown at **86**. The fitting **85** secures an upstanding oil pipe **87** positioned within the water jacket and adjacent to side **12**. Pipe **87** is provided with a Y-connector **88**. The Y-connector in turn secures two further pipes **89** and **90**. As shown in FIGURE 1, the direction of the flow of oil is indicated by dotted lines **91**, thus the flow from pipe **70** is either through a bore in the top wall **84** of the crank case as indicated at **92** or if such a bore is impractical due to the size and length of the engine, then by means of a main oil pipe having branch pipes leading to the bearings such as **17** and **18** and continuing to one end of the engine as indicated by the dotted lines at **93**, at which point there are provided pipes **87**, **89** and **90**, as shown in FIGURE 4. The dotted lines at **94** indicate a drilled hole for one side of the engine, the hole being in the combination cylinder head and valve head block. There are, as shown in FIGURE 4, two of said drilled holes as indicated at **95** and **96**, both of which as stated, extend lengthwise of the valve and cylinder head block. Adapted to be positioned on either side of the cylinders and preferably in the space between adjacent cylinders, as shown for instance at **13** and **14** in FIGURE 5, are back pressure valves designated generally as **97** and shown in FIGURE 5 and detailed in FIGURE 10. These devices are adapted to assure proper lubrication of the intake and the outlet valves. Valve **97** includes a cap-type nut **98** in screw threaded engagement with the threads of an enlarged bore **99** projecting at an angle into the valve and cylinder head block and which bore communicates with the reduced diameter bore **100** and a further reduced diameter bore **101** leading to the area included between the bore of the valve casing and the periphery of the outermost tubular valve whether it is intake or exhaust. Passage of oil through the bores **100** and **101** is regulated by a spring pressed ball check valve **102**, the ball of which engages a seat **103**, the seat being in communication with the area included between one side of the nut **98**, the threaded bore **99** and said seat with the oil bore **95** or **96**. Hence, a certain amount of pressure in the oil line will open the ball check valve and allow passage of oil through bores **102** and **101**. Oil passed through the bores **95** and **96** if excessive, will flow toward the front of the engine and be redirected to the oil sump. As shown in FIGURE 1, this returned oil is passed into a gear box designated generally as **125**. The bore **101** communicates with an annular groove **104** in the periphery of the tube **34** in one instance and **37** in the other instance, there being a plurality of radial bores **105** passed through said tubes **34** and **37** and in each instance communicating with an annular groove **104** whereby oil directed through the bore **101** will be received in the annular groove **104** and in turn then directed through the radial bores **105** to lubricate the contacting surfaces between tubes **34** and **35** in one case, and **36** and **37** in a second case. As previously pointed out, there are a plurality of annular grooves **104** in spaced apart relationship on both of the tubes **34** and **37** and on diametrically positioned sides of each cylinder as shown in FIGURE 5. In addition, I have provided in the periphery of tubes **34**

and 37 annular grooves having packing rings therein as shown in FIGURE 5 at 110 and 111. The position is such that the packing rings are situated on opposite sides of the oil groove but not in communication with such groove. These rings 110 and 111 prevent any by-pass between the several cylinders.

The gear box shown at 125, see FIGURE 5, in the present instance, is at the forward end of the motor block and the said motor block together with the valve and cylinder head is so constructed as to provide for ready attachment of the top wall 126 of the gear box in the manner shown at 127 and to likewise secure the side and front wall 128 and 129 respectively. As shown, the intake tube 34 is supported by bearings 130 in suitable races in the front wall of the cylinder block and said tube has mounted thereon a bevel gear 131. The tube 35 terminates inwardly of the front wall 129 of the gear box and is supported by bearings 132. A bevel gear 133, is carried on the tube 35. Bevel gears 131 and 133 are keyed or otherwise secured to their respective outer and inner tubes so that rotation of the bevel gears produces rotation of said tubes. The shaft 75 extends into the gear box and carries a bevel gear 134, the teeth of which are in mesh with the teeth of the bevel gears 131 and 132. The bottom wall 135 of the gear box which is detachable from the box is provided with suitable bearings 136 for the shaft and bevel gear 134. The surrounding casing 137 for shaft 75, is held by means 138 to a fitting on wall 135. The arrangement is such that oil return is directed into the gear box, see FIGURE 1 at 94, so that the bevel gears within said gear box may be lubricated and likewise provide lubrication of the bearings 130, 132 and 136 and gears 78 and 79. The gear box 125, see FIGURE 6, is of extended width so as to enclose gears 150 and 151 for rotating the exhaust tubes. Thus gear 150 is suitably keyed or otherwise secured to an end of the outermost exhaust tube 37 where it is received within the gear box with said tube suitably supported by bearings designated generally as 152, with the inner exhaust tube 36 flared slightly and enlarged as to diameter at 153 being jacketed internally and externally with tubular insulation 154 and 155. A gear 151 is secured thereto by keying so that rotation of gear 151 will produce rotation of said tube 36. The portion 153 of tube 36 is supported by bearings 156. A portion of the customary fixed exhaust pipe is shown at 157 and extends outwardly through the front wall 129 of the gear box. To encase the insulation 155, I have provided a metal covering 158. This covering extends between the gears 150 and 151 but is free to rotate oppositely from gear 150. As shown in FIGURE 6, the gear 150 is in mesh with the gear 131 and gear 151 is in mesh with gear 133 with the direction of rotation of the various gears in accordance with the arrows applied thereto.

The present engine may be cast in block. By this is meant that there are no inaccessible voids or pockets requiring cores which must be destroyed in order to be removed from the casting.

Without attempting to detail the design, the die or mold, it would be accomplished generally as follows: Each cylinder bore with that portion of the cylinder head and crank case adjacent to that cylinder would be formed by a mold or die consisting of at least three parts, each extending from the bottom to the top of the interior of the casting. Preferably these three or more segments are tapered or wedge shaped with relation to one another in such a manner that the center segment may easily be withdrawn when the casting is complete, and the other segments then be moved into the space vacated by the first segment thus allowing these segments to clear and be removed from the necessary ribs, returns, fillets and other required contours of the crank case, webs or bearing supports. It will be noted that the interior of the cylinder head is shaped so as to make this possible even to the point that appropriately shaped portions of the top of these segments form the communication openings between the cylinder head interior and the valve tube interiors.

It will be further noted that the front and back ends of the engine body are flat without ribs or projections so as to simplify the casting procedure. Thus the mold forming the exterior surface of these parts is simply a flat plate to which other portions of the mold to form the exterior of the engine can be easily mated. The top of the exterior of the engine is formed by a mold which follows the contour of the tops of the various cylinders and extending half way down the exterior curved surfaces of the valve housing tubes, at the same time forming approximately half the inside surface of the side members 6 and 7. This top mold should interlock with the center segment of the cylinder interior mold by means of a projection, preferably slightly tapered extending either upwardly or downwardly through the opening 50 which subsequently will receive the neck of the auxiliary firing member 45 and mating with a cavity provided for it in the mating piece. Additional parts of the mold to complete the exterior of the engine casting are as follows: two longitudinal sections, symmetrical from the center line of the engine to form the lower half of the valve housing tubes, the lower portion of the side members 6 and 7 and the upper part of the cylinder exteriors, removable from the completed casting by dropping down to clear the side members then withdrawing to either side. Two additional longitudinal sections similarly symemtrical at the center would then suffice to form the lower portion of the cylinder exterior, also the top and sides of the crankcase exterior. Finally, the exterior mold of the engine is completed by two additional members designed to mold the exterior of the side members 6 and 7 and to join top and side members of the mold. These last two can be used to transfer any desired lettering or data to the side members 6 and 7.

The interior of the valve housing tubes 4 and 5 are preferably formed by metal tubes of appropriate exterior diameter extending through openings provided for them in the front and rear plates of the engine molds. It is desirable that each of these tubes be provided with an open seam or joint, lapped but not welded, so as to permit a slight contraction of the tube as the casting metal cools.

The various oil passages in the casting may be drilled after the completion of the casting, may be cored by removable rods or tubes or formed by suitable metal tubing which is left in place in the casting. The upper and lower gear boxes are designed to be made separately, as are the various closure plates required, as these require only the simplest molding practice yet would unnecessarily complicate the main casting if made integral with it.

A refinement of the permanent molds or casting as described herewith for the body of the engine would be to link together or articulate the various separate parts of the mold so that they would be withdrawn from the completed casting in a particular order and then each part returned to its correct position in relation to the others for the next casting.

The operation, uses and advantages of the invention described are as follows:

First, it will be observed that I have provided a forced lubrication system for the tubular intake and exhaust valves which assures that said valves will at all times be permitted to rotate without the likelihood of the tubes freezing.

Secondly, I have provided a means by way of an auxiliary combustion chamber within each cylinder head which deflects heat away from that portion of the cylinder head defined as the valve head;

Thirdly, I have provided a positive timing system for timing intake, compression, power and exhaust strokes of the piston with relation to the intake tubular valves and the exhaust tubular valves, and

Fourthly, the engine may be cast enblock using a light weight metal.

In the present instance I have assumed a four cycle engine, and the various strokes with relation to turning movement of the tubular valves are illustrated in FIGURE 11. Both the intake and the outlet valves are rotated at one-half crank shaft rotation speed. Thus on the intake stroke of the piston, referring now to FIGURE 11, the ports **38** and **40** are in alignment so that combustible mixture is directed into the cylinder, the ports in the exhaust tubes **39** and **41** are diametrically positioned to close communication with the cylinder. As the piston again moves upwardly to compress the combustible mixture in the head of the cylinder and the head of the auxiliary combustion chamber, the outer and inner intake valves are moved to a position where the ports are diametrically opposite, in other words, closed so far as communication of the cylinder head is concerned. The exhaust tube ports **49** and **41** are in alignment on the same side but the remainder of the tube structure is so positioned as not to have communication with the cylinder head. When the spark plug is energized for the power stroke, the intake tube ports **38** and **40** are now in alignment but the remaining portion of the tubes close any entrance between the intake tube **35** with the cylinder head. The exhaust tubes have rotated to a position where the exhaust ports **39** and **41** are oppositely or diametrically positioned and thus communication with the cylinder head is prevented. Upon reaching the exhaust stroke of the piston, the exhaust ports **39** and **41** are in alignment on the same side and in communication with the cylinder head while the intake tubes have so moved that communication between the intake ports and the cylinder head is closed. In this manner I may time all the different cylinders by arranging the port members in said tubes to proper relationship with movement of the piston within its cylinder.

I am aware that past investigators in this particular art have had difficulty in properly oiling sleeve or tubular type valves, and likewise in preventing blow-by between adjacent cylinders. However, I have overcome this difficulty in the present construction by arranging the valve passages in a certain manner as well as providing the packing rings **111** between adjacent cylinders and their respective valve openings. I have also protected the rotating sleeves and tubes constituting the intake and exhaust valves from direct heat and the force of the explosions within the cylinders by the use of the auxiliary explosion chambers.

The various valves such as shown in FIGURE 10 prevent back pressure in the oil circulating system and carbonizing of the oil due to heat is not a factor as carbonizing aids in sealing various points where oil is directed to the valve structure.

Cooling of the engine is simple and may be accomplished in any convenient manner either by water or other liquids or by substituting suitable cooling fins for the water jackets, the engine may be air cooled.

Finally, the present engine design permits its being cast

substantially in one piece by permanent mold or by a die casting method.

I claim:

1. In an internal combustion engine construction: a cylinder block having a cylinder with a piston therein, a cylinder head cast enblock with said cylinder block, said cylinder head housing rotary intake and exhaust valves on diametric opposite portions of the cylinder of the cylinder block, and an auxiliary compression combustion chamber member concentric with the axis of the cylinder in the cylinder head between said intake and exhaust valves, and comprising a cup-like member the concave portion of which faces within the cylinder and the convex portion of which is adjacent the intake and exhaust valves to isolate the valves from direct heat and the force of the explosion within the cylinder.

2. An internal combustion engine construction having a cylinder block and valve and cylinder head cast enblock, a series of aligned, spaced-apart cylinders in said engine block adapted to house pistons for movement therein, the valve head including: two spaced apart tubular casings running the length of the cylinder block, each casing provided with an enlarged port directed toward a cylinder, pairs of concentric rotary tubes within each tubular casing, and each pair of tubes provided with elongated segmental ports adapted to register during rotation of the said tubes and likewise register with the port leading from the tubular casing to a cylinder, and means for rotating each pair of tubes in a timed sequence to provide for intake and exhaust from each cylinder, and cup-like combustion chamber members positioned between the pair of tubular casings and concentric with each cylinder, the convex sides of said cup-like combustion chamber members lying adjacent the ports between the tubular casings and each cylinder to isolate the ports from direct heat and force of explosion within each cylinder.

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1,911,917	Meyer	May 30, 1933
2,118,571	Peterson	May 24, 1938

FOREIGN PATENTS

16,445	Denmark	Oct. 9, 1906
40,645	Denmark	Aug. 7, 1928