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WET SLEEVE I.C. ENGINES

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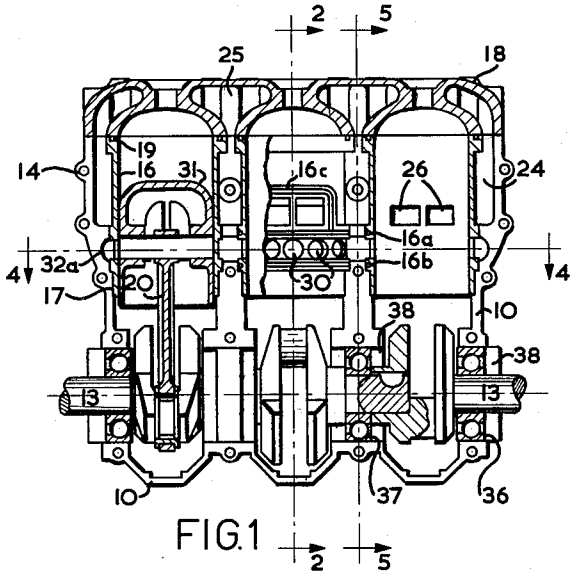



FIG.1

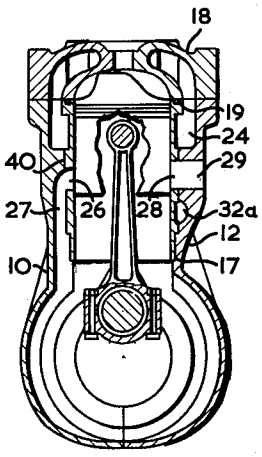



FIG.2

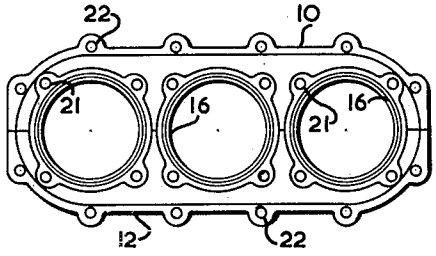



FIG.3

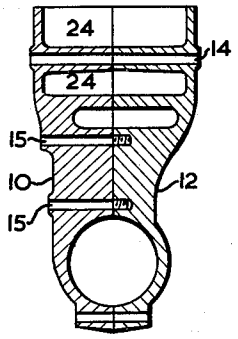



FIG.5

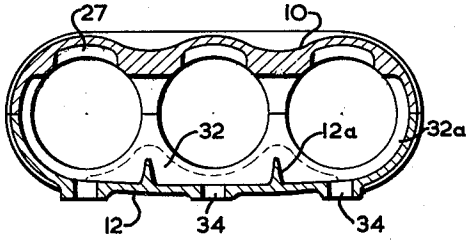



FIG.4

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# WET SLEEVE I.C. ENGINES

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6 Claims. (Cl. 123—41.72)

In wet sleeve internal combustion engines as usually constructed, each cylinder sleeve is arranged within a corresponding cored cavity in a cylinder block or body formed as a single casting. Each cylinder cavity is enlarged at the required position to form a water jacket space which surrounds the sleeve and is closed at its inner periphery thereby, so that the cooling liquid is in direct contact with the outer periphery of the sleeve. The cylinder cavities are reduced in diameter at the requisite positions and these reduced portions are bored, so as to fit tightly against the corresponding portions of the sleeves when the latter are inserted axially.

Now the object of this invention is to provide improvements in the construction of I.C. engines of the wet sleeve type.

Accordingly, the invention includes an internal combustion piston engine of the wet sleeve type having a cylinder block or body comprising at least two laterally opposed separable sections which meet in the longitudinal plane containing the axis of the cylinder or of each of them, at least one open-ended cylinder sleeve enclosed between the said sections and a removable cylinder head detachably secured to the outer ends of the sections and closing the outer end of the said sleeve.

Thus the invention is applicable to multi-cylinder engines of the "straight" or "in-line," V and opposed cylinder types and in such engines as normally constructed, the aforesaid meeting plane of the cylinder block sections also contains the axis of the crank shaft.

From the preceding description, it will be apparent that the adjacent inner surfaces of the sections of the cylinder blocks are formed with aligned cavities to receive the cylinder sleeves and that the latter are clamped between and sealed to the said sections.

An important feature of the preferred form of the invention resides in the construction wherein each cylinder sleeve is axially slidable within the divided cylinder block and is separately clamped tightly against the cylinder head, thereby to form a gas-tight seal therebetween.

A wet sleeve engine, comprising a divided cylinder block or body as above described, provides advantages in production and assembly. Thus as will hereinafter appear, the sections of the divided block may be moulded without separate cores and the cylinder sleeves may be assembled to the pistons and connecting rods before the said sleeves are arranged and clamped between the sections of the block.

The invention is applicable to two-stroke and four-stroke electric ignition engines and also to compression ignition engines. In the case of a four-stroke engine, the cylinder block preferably comprises three laterally opposed sections, viz. two outer sections and an intermediate section, the latter having one of its faces disposed in the aforesaid longitudinal plane contatining the cylinder axes and having its other face parallel thereto and containing the axis of the cam shaft.

According to a preferred form of the invention, each section of the cylinder block is formed integrally with



a corresponding section of a crank case to form a combined cylinder and crank case block. That is to say, the crank case also is formed in two laterally opposed sections which meet in a plane which contains the axis of the crank shaft and the axis of the cylinder, or of each of them, and each crank case section is formed integrally with the corresponding cylinder block section, whereby further advantages in manufacture and assembly are obtained. Thus the crank shaft, crank shaft bearings, connecting rods, pistons and cylinder sleeves may be assembled together, before being enclosed between the opposed sections of the combined cylinder and crank case block.

In the accompanying drawings:

Figure 1 is a view in longitudinal section showing the preferred construction of two-stroke engine according to the invention,

Figure 2 is a view in sectional end elevation taken on the line 2—2 of Figure 1,

Figure 3 is a view in plan with the cylinder head removed,

Figure 4 is a view in sectional plan taken on the line 4—4 of Figure 1, and

Figure 5 is a view in sectional end elevation taken on the line 5—5 of Figure 1.

The wet sleeve engine shown in the drawings comprises three cylinders arranged in line and the engine has a combined cylinder and crank case block consisting of two laterally opposed cast sections **10** and **12** formed with finished mating faces which meet in that plane which is common to the axes of the cylinders to the axis of the crank shaft **13**. The block sections are detachably secured together by a plurality of bolts **14** and **15**.

Each cylinder consists of a separate sleeve or liner **16** which is open at each end and is clamped between the block sections **10** and **12** and the outer ends of the cylinders are closed by a common detachable head **18**. The inner end of each cylinder sleeve abuts against and is located by an annular shoulder **17** formed in the block and each cylinder is fitted with a piston **31** which is coupled to the respective crank pin by a connecting rod **20** in the usual way. The engine is water cooled, for which purpose, water jacket spaces **24** are formed in the cylinder block about the outer portions of the cylinder sleeves and these jacket spaces communicate freely with jacket spaces **25** in the cylinder head.

An inlet port **26** formed in the wall of each cylinder sleeve is in register with the outer end of a corresponding inlet passage **27** formed in the section **10** of the cylinder block and communicating at its inner end with the corresponding portion of the crank case. These passages **27** are arranged centrally in the respective semi-cylindrical cavities in the block section **10**, so that they face the plane of separation of the sections as shown in Figure 4.

Each cylinder sleeve is also formed with an exhaust port **28** which is diametrically opposed to the respective inlet port **26** and which registers with a corresponding exhaust passage **29** formed in the section **12** of the cylinder block.

A circumferentially extending series of holes **30** provided in each cylinder sleeve, below the inlet and outlet ports therein, admit the combustible mixture to the corresponding compartment of the crank case. These holes **30** thus collectively form the "third port" of the cylinder and are so arranged as to be uncovered by the respective piston **31** when the latter is located at the outer end of the cylinder. The holes **30** in the three cylinder sleeves communicate freely with a common inlet space **32** formed in the cylinder block and partly by arcuate grooves **32a** which extend around portions of the two outer cylinder sleeves as shown in Figures 1, 2 and 4.

Preferably, a separate carburetor is provided for each cylinder, in which case an inlet passage **34** is arranged opposite to each cylinder as shown in Figure 4 and it has been found advantageous to provide the section **12** of the cylinder block with inwardly projecting webs **12***a* which serve as baffles between the adjacent pairs of inlet passages **34**.

The crank shaft is mounted in anti-friction bearings **36** and **37**. The intermediate bearings **37** may be of the split type, but preferably, they comprise conntinuous rings and for this purpose, the crank shaft comprises three separate coaxial sections which are secured together as shown at the right of Figure 1 after the bearings **37** have been attached.

Each compartment of the crank case is sealed around the crank shaft by suitable seals **38**. Thus a seal is arranged on each side of each intermediate bearing **37** and a similar seal is arranged at the outer side of each of the end bearings **36**. Thus the explosive mixture is independently compressed in each crank case compartment as the respective piston **31** is moving inwardly.

The outer end of each cylinder sleeve **16** is independently secured to the cylinder head **18** by a plurality of longitudinally extending stud bolts **21**, while the head is secured to the outer ends of the sections of the divided block or casing by a separate set of stud bolts **22**. Thus each cylinder sleeve is located between the respective finished surface on the head and the aforesaid annular shoulder **17** at the inner end of the sleeve, but the latter is not bolted or otherwise directly secured to the divided block. Consequently, each cylinder sleeve is free to slide axially through a small distance, whereby it may be pulled tightly against the head by the stud bolts **21** and a neoprene O ring **19** or other suitable sealing member is arranged in an annular groove in the outer end of the sleeve in order to form a gas-tight seal with the head.

It is necessary also to form fluid-tight seals around each cylinder sleeve and between the adjacent fluid spaces **24**, **27**, **29** and **32**. For this purpose, each sleeve **16** is formed with spaced circumferential collars **16***a* and **16***b* arranged respectively above and below the holes **30** therein and is also formed with integral projecting surrounds **16***c* which are of inverted U shape when viewed from the side as in Figure 1. These surrounds extend around the inlet and exhaust ports **27** and **29** and merge at their lower ends into the adjacent collar **16***a*. The outer surfaces of the collars and surrounds are machined for engagement with coacting machined faces in the cylinder cavities of the divided block and the said collars and surrounds are formed with grooves **39** to receive sealing rings and strips **40**, e.g. neoprene O rings and strips. The lower collar **16***b* of each sleeve may however, be omitted if desired, as it has been found that it is not necessary to provide sealing rings between the holes **30** and the respective crank case compartments.

From the preceding description and the accompanying drawings, it will be understood that each section **10** and **12** of the combined cylinder and crank case block consists of one-half of the cylinder block and the corresponding half of the crank case which is integral therewith. Each section is formed with a more or less semi-cylindrical cavity for each cylinder sleeve and these cavities are enlarged and merged to form the connected water jacket spaces **24** and the common inlet space **32**. Likewise, each cylinder cavity is provided centrally with a groove which extends lengthwise of the cylinder and forms the respective inlet passage **27**. Also, as will be best understood from Figure 4, the several cavities are so formed and arranged that the moulds in which the sections are cast are formed without the use of separate cores. This not only greatly simplifies the moulding operation, but also ensures greater accuracy in the location of the internal cavities.

After the mating faces of the sections are finished, these sections are bolted together, after which, the cylinder cavities and the crank shaft bearings are machined.



In order to assemble the engine, the bearings **36** and **37**, the seals **38** and the connecting rods **20** are fitted to the crank shaft after the pistons are attached to the rods. Each cylinder sleeve **16** is then independently fitted to the respective piston and the sealing rings and strips **40** are arranged in the sealing grooves in the exterior of each sleeve.

The sub-assembly, comprising the cylinder sleeves, pistons, connecting rods and crankshaft with its bearings and seals is then laid in one of the sections of the combined cylinder and crank case block, after which, the other section is placed in position and is bolted to the first-mentioned section. If desired, the mating faces of one of these sections may be formed with grooves to receive O section or other suitable sealing members.

Finally, the sealing rings **19** are arranged in the annular grooves in the outer ends of the cylinder sleeves and the common cylinder head **18** is secured in position by the bolts **21** and **22**, the former of which pull the sleeves into sealing engagement with the coacting sealing faces on the head.

The engine is thus particularly simple to assemble and also to dismantle for service or repairs and it has been found that effective seals between the several fixed components may be formed as above described.

The invention is not limited to two cycle engines, as it is equally applicable to four-stroke engines of both the side valve and overhead valve types.

In the case of a four-stroke side valve engine, the combined cylinder and crank case block is preferably divided into three sections, of which the intermediate section and one of the outer sections abut together in the common plane of the cylinder axes as in the two-stroke engine described above. The other outer section abuts against the other face of the intermediate section in a plane disposed parallel to the first-mentioned meeting plane and passing through the axes of the cam shaft and valves.

Similarly, in the case of an overhead valve engine, the combined cylinder and crank case block is preferably also divided in a plane passing through the cam shaft axis.

A V engine, e. g. a V eight engine is equivalent in a sense to two straight four engines, and it will be apparent that for the purpose of the present invention the cylinder block comprises a minimum of three sections, viz. a central section and two outer sections which meet in the mutually inclined planes containing the axes of the opposed groups of cylinders and which intersect at the axis of the crankshaft.

I claim:

1. A multi-cylinder internal combustion engine of the wet sleeve type, comprising a cylinder block composed of at least two laterally opposed sections which meet in the longitudinal plane containing the axes of the several cylinders, a plurality of open-ended cylinder sleeves accommodated slidably within corresponding cavities formed in the inner surfaces of the cylinder block sections, the walls of the said cavities being spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces within the block and about the sleeves for a cooling fluid, the said walls being in sealing contact with the sleeves at the inner ends of the said jacket spaces, a cylinder head removably secured to the outer end of the divided cylinder block and independent means clamping the outer end of each cylinder sleeve tightly against the cylinder head thereby to form a gas-tight seal therebetween.

2. A multi-cylinder internal combustion engine of the wet sleeve type comprising a crank shaft, a combined cylinder and crank case block composed of at least two laterally opposed sections which meet in the longitudinal plane containing the axis of the crank shaft and the axes of the several cylinders, the cylinder and crank case portions of each section being formed integrally, a plurality of open-ended cylinder sleeves slidably accommodated within corresponding cavities formed in the inner surfaces of the said sections, the walls of the said cavities being

spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces for a cooling fluid within the block and about the cylinder sleeves, the said cavity walls being in sealing contact with the sleeves at the inner ends of the said jacket spaces, a cylinder head removably secured to the outer ends of the sections of the block, and independent means clamping the outer end of each cylinder sleeve tightly against the cylinder head thereby to form a gas-tight seal therebetween.

3. A multi-cylinder internal combustion engine of the wet sleeve type comprising a crank shaft, a combined cylinder and crank case block composed of at least two laterally opposed sections which meet in the longitudinal plane containing the axis of the crank shaft and the axes of the several cylinders, the cylinder and crank case portions of each section being formed integrally, a plurality of open-ended cylinder sleeves slidably accommodated within corresponding cavities formed in the inner surfaces of the said sections, the walls of the said cavities being spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces for a cooling fluid within the block and about the cylinder sleeves, the said cavity walls being in sealing contact with the sleeves at the inner ends of the said jacket spaces, a cylinder head removably secured to the outer end of the block and longitudinally extending bolts independently securing each cylinder sleeve to the cylinder head whereby a gastight seal is formed therebetween.

4. A multi-cylinder internal combustion engine of the wet sleeve type comprising a crank shaft, a combined cylinder and crank case block composed of at least two laterally opposed sections which meet in the longitudinal plane containing the axis of the crank shaft and the axes of the several cylinders, the cylinder and crank case portions of each section being formed integrally, a plurality of open-ended cylinder sleeves slidably accommodated within corresponding cavities formed in the inner surfaces of the said sections, the walls of the said cavities being spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces for a cooling fluid within the block and about the cylinder sleeves, a sealing ring compressed between each sleeve and the adjacent portions of the divided cylinder block to define the inner ends of the respective jacket spaces, a cylinder head removably secured to the outer ends of the sections of the block, a compressible sealing ring interposed between the outer end of each cylinder sleeve and the cylinder head and longitudinally extending bolts or the like independently securing each cylinder sleeve to the cylinder head so as to compress the last-mentioned sealing ring therebetween.



5. A multi-cylinder two-stroke internal combustion engine of the wet sleeve type comprising a crank shaft, a combined cylinder and crank case block composed of at least two laterally opposed sections which meet in the longitudinal plane containing the axis of the crank shaft and the axes of the several cylinders, the cylinder and crank case portions of each section being formed integrally, a plurality of open-ended cylinder sleeves slidably accommodated within corresponding cavities formed in the inner surfaces of the said sections, the walls of the said cavities being spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces for a cooling fluid within the block and about the cylinder sleeves, the said cavity walls being in sealing contact with the sleeves at the inner ends of the said jacket spaces, each cylinder cavity in one section of the divided cylinder block being formed with a groove which extends lengthwise of the cylinder and communicates at its inner end with the interior of the crank case and at its outer end with the interior of the respective cylinder to form the inlet passage for the latter, a cylinder head removably secured to the outer ends of the sections of the block, and independent means clamping the outer end of each cylinder sleeve tightly against the cylinder head thereby to form a gas-tight seal therebetween.

6. A multi-cylinder internal combustion engine of the wet sleeve type, comprising a cylinder block comprising two laterally opposed sections which meet in the longitudinal plane containing the axes of the several cylinders, each section of the said block being shaped so that a mould therefor may be formed without the use of separate cores, a plurality of open-ended cylinder sleeves accommodated slidably within corresponding cavities formed in the inner surfaces of the cylinder block sections, the walls of the said cavities being spaced from the outer end portions of the sleeves thereby to define communicating jacket spaces for a cooling fluid within the block and about the cylinder sleeves, the said walls of the cavities being in sealing contact with the sleeves at the inner ends of the said jacket spaces, a cylinder head removably secured to the outer end of the divided cylinder block, and independent means clamping the outer end of each cylinder sleeve tightly against the cylinder head thereby to form a gas-tight seal therebetween.

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