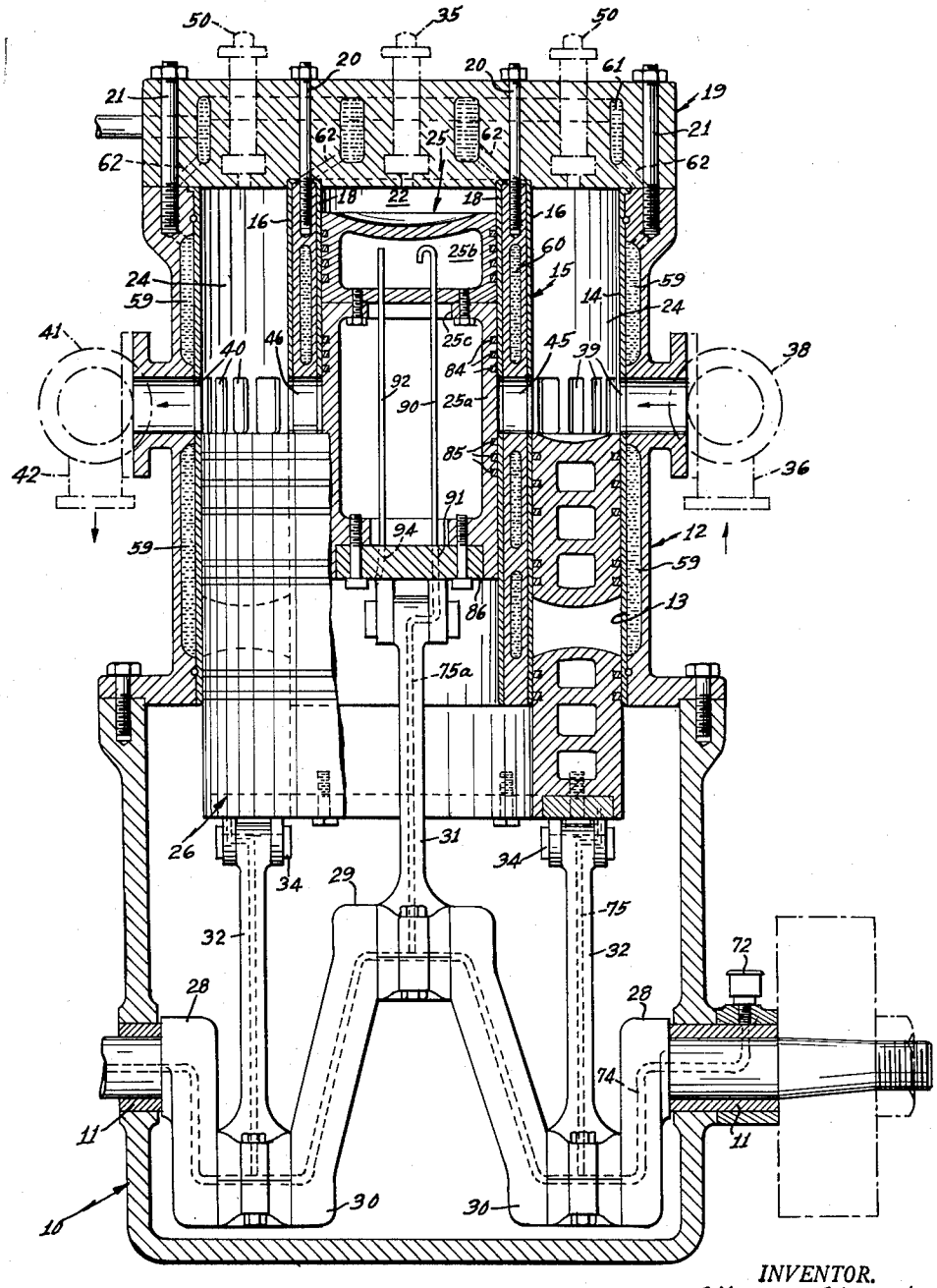
Feb. 14, 1956 W. WATERVAL 2,734,494

MULTICYLINDER ENGINE

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Fig. 1



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MULTICYLINDER ENGINE

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Fig. 2

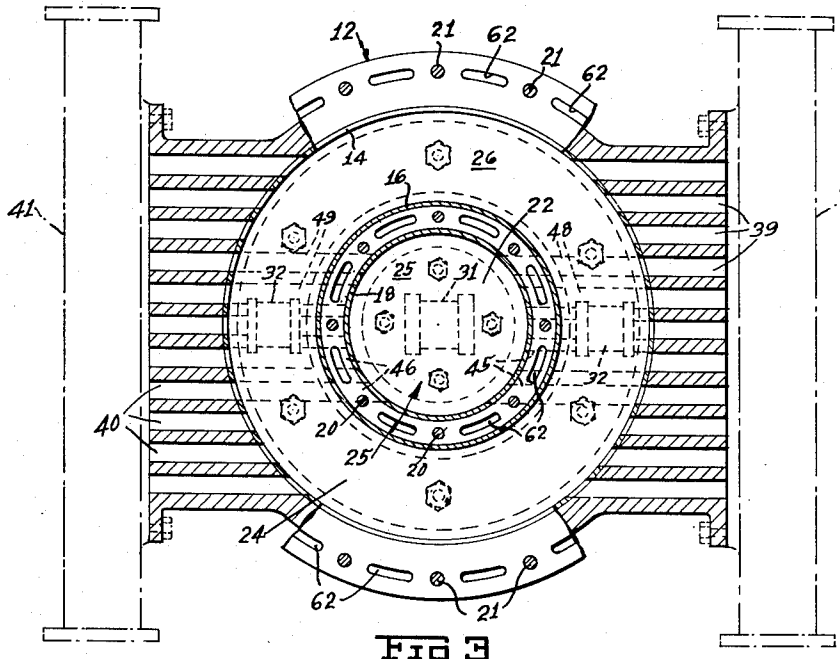
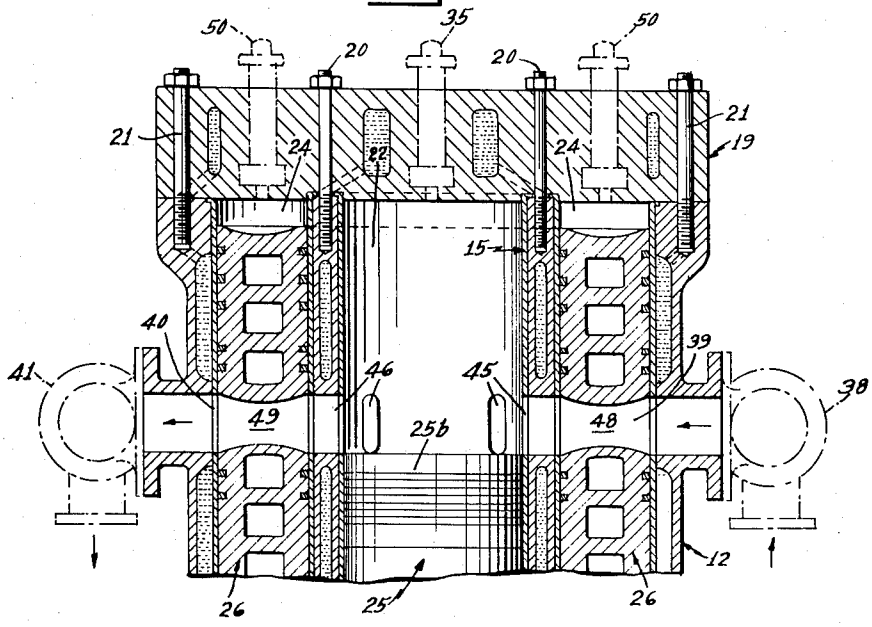


Fig 3



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Fig. 4

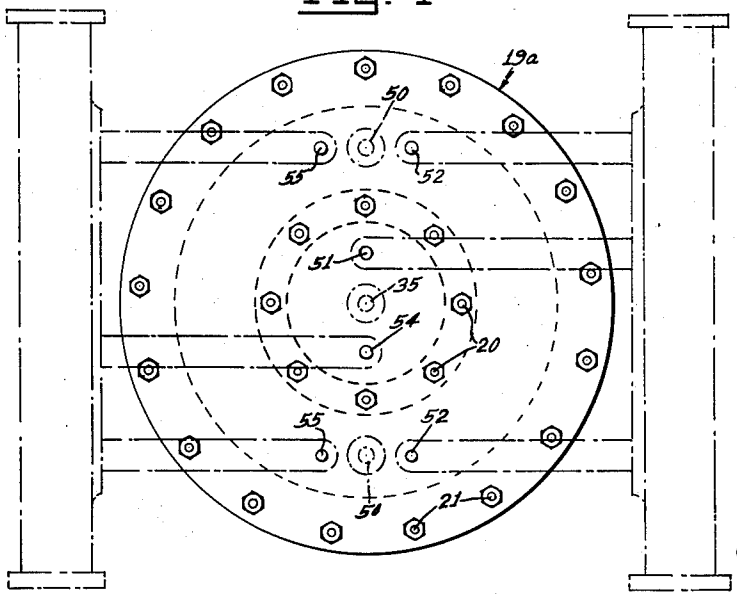


Fig. 4a

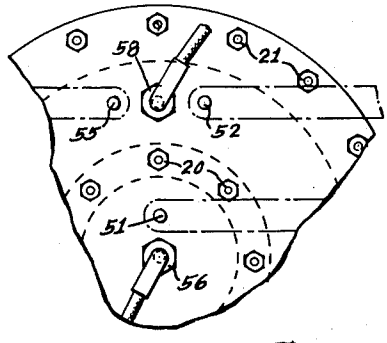


Fig. 6

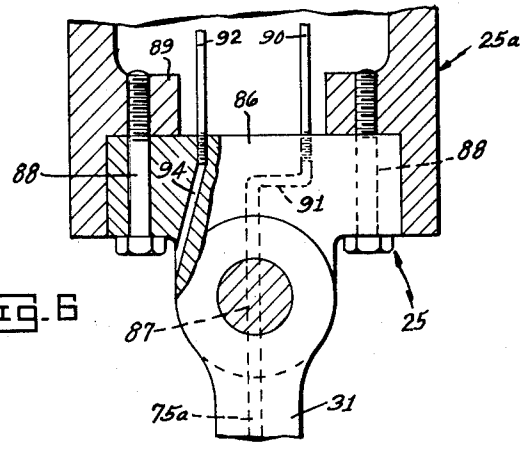
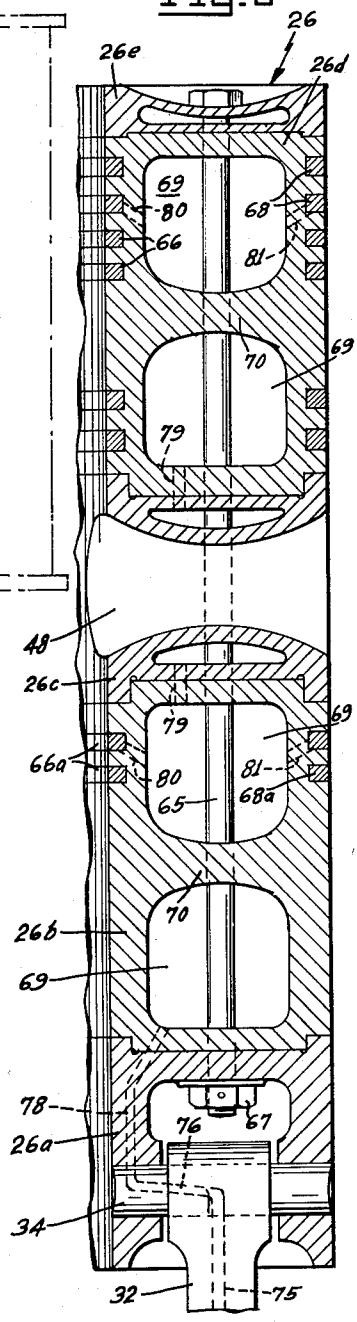


Fig. 5



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United States Patent Office 2,734,494 Patented Feb. 14, 1956

2,734,494

MULTICYLINDER ENGINE

William Waterval, Brooklyn, N. Y.

Application September 28, 1954, Serial No. 458,894

5 Claims. (Cl. 123—52)

This invention relates to multicylinder engines and particularly to two cylinder or two piston motor units and more particularly engines having co-axial pistons with one piston within the other.

Objects and advantages of my invention include a great saving of space and a better balance of the engine, when in operation, so as to reduce vibration.

Another object of the invention is to provide a piston having a greater freedom from stresses when in operation.

The accomplishment of these and other objects, as will be later understood, is achieved in my two piston engine or motor which, briefly stated, includes a jacket portion having two coaxial round combustion chambers therein which are separated from each other by an annular liner or partition. The two chambers are provided with inner and outer pistons which are connected to a common crank shaft so as to be about 180° out of phase with each other.

In the accompanying drawing showing, by way of example, several of many possible embodiments of the invention,

Figure 1 is a longitudinal diametric sectional view of one form of the engine.

Figure 2 is a plan of the jacket portion with a liner forming the inner wall of the outer chamber.

Figure 3 is a fragmental diametric sectional view of the pistons in a different position from that shown in Figure 1, the diametric section being angularly slightly displaced from that of Figure 1.

Figures 4 and 4*a* are a plan and a fragmental plan respectively of the cylinder head of a modified form of the invention.

Figure 5 shows details of the outer piston and,

Figure 6 shows details of the inner piston.

The invention is shown in connection with a two cycle motor in Figure 1 and includes a housing **10** having shaft bearings **11** generally similar to a conventional two cycle motor construction, although the housing need not be gas tight for the same reason that most conventional two cycle motors are gas tight, since the two cylinder motor of the invention does not lend itself to making use of the crank case as a compression or pump chamber.

On the housing there is mounted an exterior, generally cylindrical, jacket or jacket member **12** having a cylindrical liner **13** provided with an inner smooth wall or wearing surface **14**. Within the jacket is disposed, coaxially therewith, an annular partition **15** likewise having smooth outer and inner walls or wearing surfaces **16** and **18**, the partition being secured to a cylinder head **19**, in turn secured to the jacket member. Any suitable means may be used for both securing means, such as bolts **20** and **21**.

The partition serves to divide the resultant structure into an inner or core chamber **22** and an outer or annular chamber **24**. Disposed in the respective chambers are a core piston **25** and an annular piston **26**.

A crank shaft **28** disposed in the bearings **11** is provided with three cranks, the middle crank **29** being displaced 180° from the two outer cranks **30** of equal throw. A middle connecting rod **31** connects the inner or core piston to the middle crank **29** in the usual manner while two outer connecting rods **32** connect the outer cranks to the annular piston at portions along a diameter of the piston **26** parallel to the shaft axis as shown at wrist pins **34**.

The throw of crank **29**, not necessarily, but preferably, is about equal to that of cranks **30**, and if so, it is desirable that the cross sectional area of the two pistons be equal.

Figure 1 shows the motor with the annular piston **26** expelled to extreme downward position, and with the core piston giving about maximum compression, and about at the time for fuel to be injected through the injector **35**. With the parts of the motor in the position as shown, intake air is forced into the annular chamber, by means (not shown) connected to the inlet pipe **36** and manifold **38** secured alongside one side of the jacket, through inlet ports **39** to purge exhaust gases out through exhaust ports **40**, exhaust manifold **41** and the exhaust pipe **42**. The inlet and purged gases pass over the end or top of the outer piston, for the latter is now clear of the ports.

Upon explosion or burning of the contents of the core chamber **22**, the core piston **25** is expelled to a position shown in Figure 3 where it uncovers crossing ports **45** and **46** (heretofore, in the described cycle, having been covered by the core piston **25**) through the partition **15**, the crossing ports being more or less opposite the inlet and exhaust ports. As the core piston was being expelled, the annular piston **26** was being forced into the chamber **24**, covering ports **39**, **40**, **45** and **46**, to compress the fresh gas charge. When the piston **25** is at about its outermost position, the piston **26** is at about its innermost position and with diametric crossing ducts **48** and **49**, provided through the mid portion of the annular piston, more or less in registry with the inlet and crossing ports **39** and **45** and with the exhaust and crossing ports **40** and **46**. This action permits inlet gas to enter, through the jacket, the annular piston and partition, into the core chamber **22**, purging and expelling burnt gases as it enters. Almost simultaneously, fuel is injected into the annular chamber by way of the injectors **50**.

Preferably the fuel of each injector **50** for the outer chamber is proportioned to that of the feed for the inner chamber injector **35** so that the same amount of fuel is fed to each chamber. The injectors **50** are preferably spaced the same circumferential distance apart to distribute the impact of the explosion and prevent canting of the outer piston. One injector over each rod **32** is satisfactory.

While the description above has shown the embodiment of co-axial pistons, one within the other, in connection with a two cycle diesel motor, many other embodiments are possible. For instance, the invention may take the form as shown in Figure 4 for use in a four cycle engine. In this form all the above mentioned ports may be omitted, as well as the crossing ducts, and the head **19***a* provided, in known manner, with head inlet valves **51** and **52** for the core and annular chambers respectively, and similarly, with exhaust valves **54** and **55**.

Of course when the motor is constructed for either two or four cycle operation, spark plugs **56** and **58** may replace the injectors **35** and **50** if the inlet gases carry the fuel. All valves may be timed by the usual means such as by a timely operated cam shaft and overhead rocker arm (not shown).

The usual valves (not shown) for starting by use of compressed air and for safety may be provided in the cylinder head **19**.

For cooling the motor I may provide passageways **59** in the jacket and **60** in the partition for a circulating cooling fluid, and similar passageways **61** in the head **19**. Some passageways **62** in the head may connect those of the jacket and partition.

While in Figures 1 and 3 the outer piston **26** is shown in a general manner, I prefer that the piston be made up of four annuli as shown in Figure 5, namely: **26***a*, **26***b*, **26***c*, **26***d* and an annular cap **26***e* stacked one upon the other in the order given, and secured together by tie rods **65**. The first, **26***a*, is the skirt portion of the piston to which the connecting rods **32** are attached as at **34**. The third, **26***c*, is provided with the passageways **48** and the second and fourth, **26***b* and **26***d*, each carry inner and outer rings **66** and **68** respectively. The annuli **26***b*, **26***c* and **26***d* are preferably provided with large voids **69** to reduce weight, leaving strut portions **70** between voids to give strength to the annulus.

The pistons may be lubricated by forcing lubricant into a crank shaft bearing **11** as at **72** from whence it flows through a passageway **74** in the shaft, thence via a similar passage **74**, **75**, **76**, **78** through the connecting rod **32**, the wrist pin **34** and the skirt **26***a*. Registering ducts **79** in adjacent annuli enable the oil to pass into substantially all parts of the piston, especially around the exhaust ports **49**, from whence it may flow through oil holes **80** and **81**, to inner rings **66** and outer rings **68**, with suitable check valves (not shown) to prevent the explosions from blowing oil out of the system.

It is to be understood that the core piston may be lubricated in a like manner and that similar passageways may be provided in both connecting rods so that there may even be a circulation of oil in the outer piston with a flow in through one rod and out the other.

Since the lower portion of the annular piston **26** cooperates in the confining of gases in chamber **22** it is preferable that, say, annulus **26***b* be provided with particular inner and outer rings **66***a* and **68***a*. For similar reasons the core piston is provided with head piston rings **84** and skirt piston rings **85**.

It will be realized that the outermost annulus **26***a* of the outer piston is in fact a piston cross head and may be separated from the other annuli of the piston by removing the nut **67** from the tie rod **65**. This feature is especially beneficial if the inner piston **25** is provided with a skirt portion **25***a* having a removable cross head **86** secured thereto as by bolts **88**, either fast on internal abutments **89** on the skirt portion, or extending the length of the cylinder as tie rods as shown in Figure 5 in the event a composite inner piston is desired. By having the cross heads bolted to the pistons the assembly and dismounting of the engine for repairs is greatly facilitated.

A portion of the oil in the crank shaft duct may be diverted to cool the core piston through a duct **75***a* in the connecting rod **31**.

In one form of the invention the cooling is accomplished by having the piston made up, as shown in Figure 1, of a skirt portion **25***a* having flanges **25***c*, on which a closed hollow head portion **25***b* is secured by lag bolts. An oil inlet tube **90** secured on the cross head **86** projects into the hollow of the head portion **25***b* to provide communication between the hollow and duct **75***a* via a duct **91** in the cross head **86** passing the wrist pin **87** in a conventional manner.

Oil in the hollow leaves by an overflow pipe or tube **92** projecting upwardly into the hollow, the lower portion of the tube **92** being suitably anchored as in drain duct **94** in and through the cross head **86** so that the overflow oil may fall into the crank case.

While I have shown only a two cylinder engine, it is to be understood that a plurality of such engines may have a common crank shaft and in effect produce an engine having cylinders in multiples of two.

Moreover my engine need not be used only as an internal combustion engine but also as a steam or compressed air engine, and may by modification be made to function also as a double acting internal combustion engine.

If a quantity of steam enters through the core injector **35** (suitably modified and dimensioned) the core piston will descend to the position as shown in Figure 2 and the steam may be exhausted through the exhaust (and even the intake) manifold in a manner similar to that in the "Uniflow" steam engine. On the return stroke steam enters through the outer injectors **50**.

Of course the form shown in Figure 4, with proper timing of the valves, may likewise be used on steam or air or other gas.

My multicylinder engine is especially suitable for use on high pressure gas in low temperature work, where expansion of gas is made to do useful work with an attendant cooling of the gas. This is due to the fact that the engine is quite compact and especially because the core chamber is surrounded by a cold structure and the cold exhaust gas from the core chamber passes over and through the outer piston (the one most likely to warm up when external insulation is poor).

The invention claimed is:

1. A multi-piston engine comprising inner and outer coaxial chamber members forming inner and outer round gas chambers; inner and outer pistons in said chambers respectively, said members being provided with gas inlet and exhaust ports in their longitudinal mid portions and said outer piston being provided with substantially radial crossing ducts in the mid portion thereof to selectively establish communication between the inner chamber and the exterior of the outer chamber member by registry with said ports.

2. An engine as claimed in claim 1, said pistons being about 180° apart and the outer piston acting as a valve to control the entry and exit of gas into and out of the inner chamber.

3. In combination, an exterior cylindrical wall member; an annular partition within the wall member and forming an inner chamber and an outer chamber; a cylinder head secured to the respective outer ends of the member and partition; an inner piston within the inner chamber and an outer piston within the outer chamber, and each slidable in its respective chamber; and a crank shaft connected to the pistons, said wall member being provided with inlet ports therethrough substantially inner of the inner end of the outer piston when the latter is in outmost position and on one arcuate side of the member, and with outlet ports on the other side; said partition being provided with crossing ports approximately opposite said inlet and outlet ports, said outer piston being provided with cross ducts in the middle portions thereof to register with the inlet, crossing and exhaust ports when the outer piston is in innermost position, and at which time the inner piston is outer of the crossing ports so that inlet gases may purge the inner chamber.

4. A two cycle engine comprising an exterior cylindrical jacket; an annular partition within the jacket coaxial therewith and forming a core member and an annular chamber; a cylinder head secured to the respective outer ends of the jacket and partition; a core piston within the core chamber and an annular piston within the annular chamber, and slidable in its respective chamber; a crank shaft having three cranks, the outer two of which are displaced substantially 180° from the middle crank, said outer two cranks having equal throw; a pair of outer connecting rods connecting the outer cranks and the outer end portions of the annular cylinder at a diameter thereof; a middle connecting rod connecting the middle crank to the outer end portion of the core piston; said jacket being provided with inlet ports therethrough substantially inner of the inner end of the annular piston when the latter is in outmost position and on one arcuate side of the jacket, and with outlet ports on the other side; said partition being provided with crossing ports approxi-

mately opposite said inlet and outlet ports, said annular piston being provided with diametric cross ducts in the middle portions thereof to register with the inlet, crossing and exhaust ports when the annular piston is in innermost position, and at which time the core piston is outer of the crossing ports so that inlet gases may purge the core member.

5. An engine as claimed in claim 4 wherein when said core portion is at innermost position the core piston covers the crossing ports and the annular piston is expelled past the inlet and exhaust ducts.

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