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B. FIALA-FERNBRUGG

2,731,002

DOUBLE-PISTON, INTERNAL-COMBUSTION ENGINE

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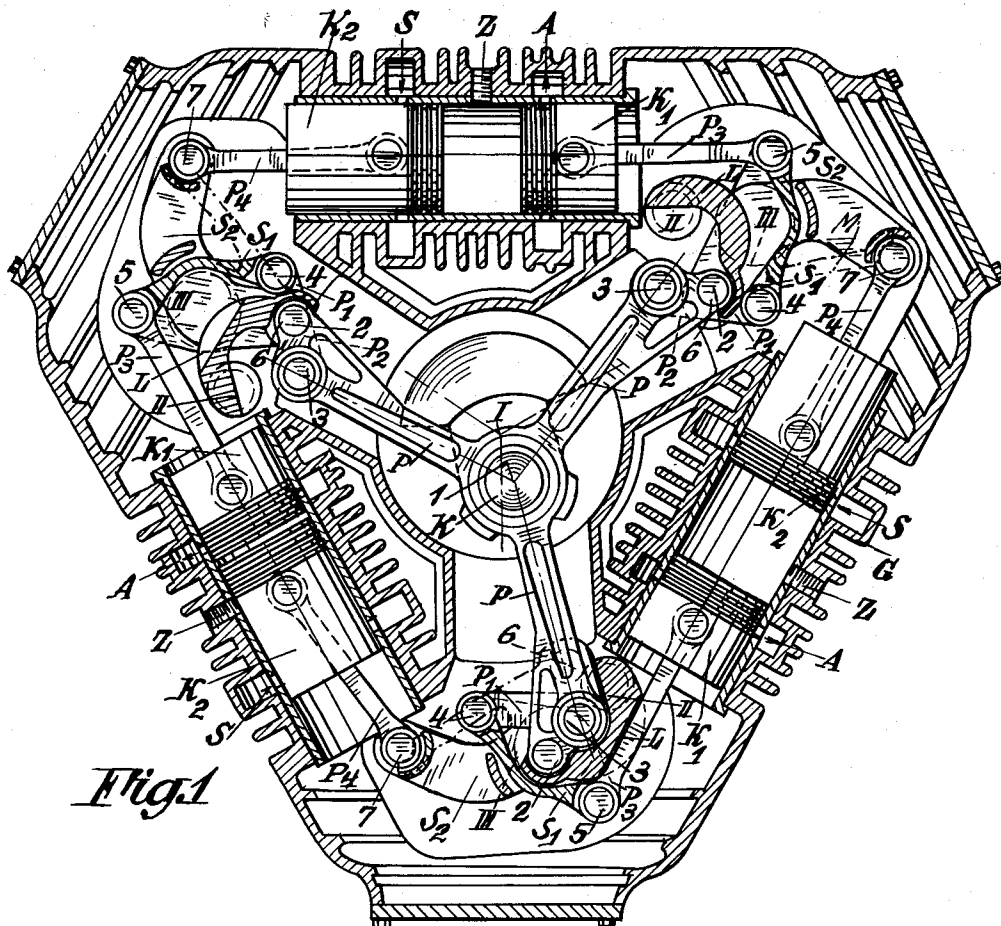
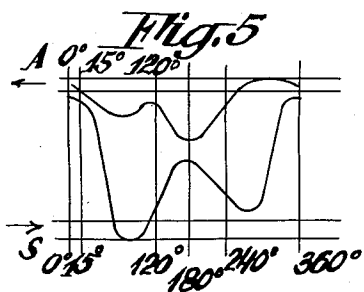


Fig. 1



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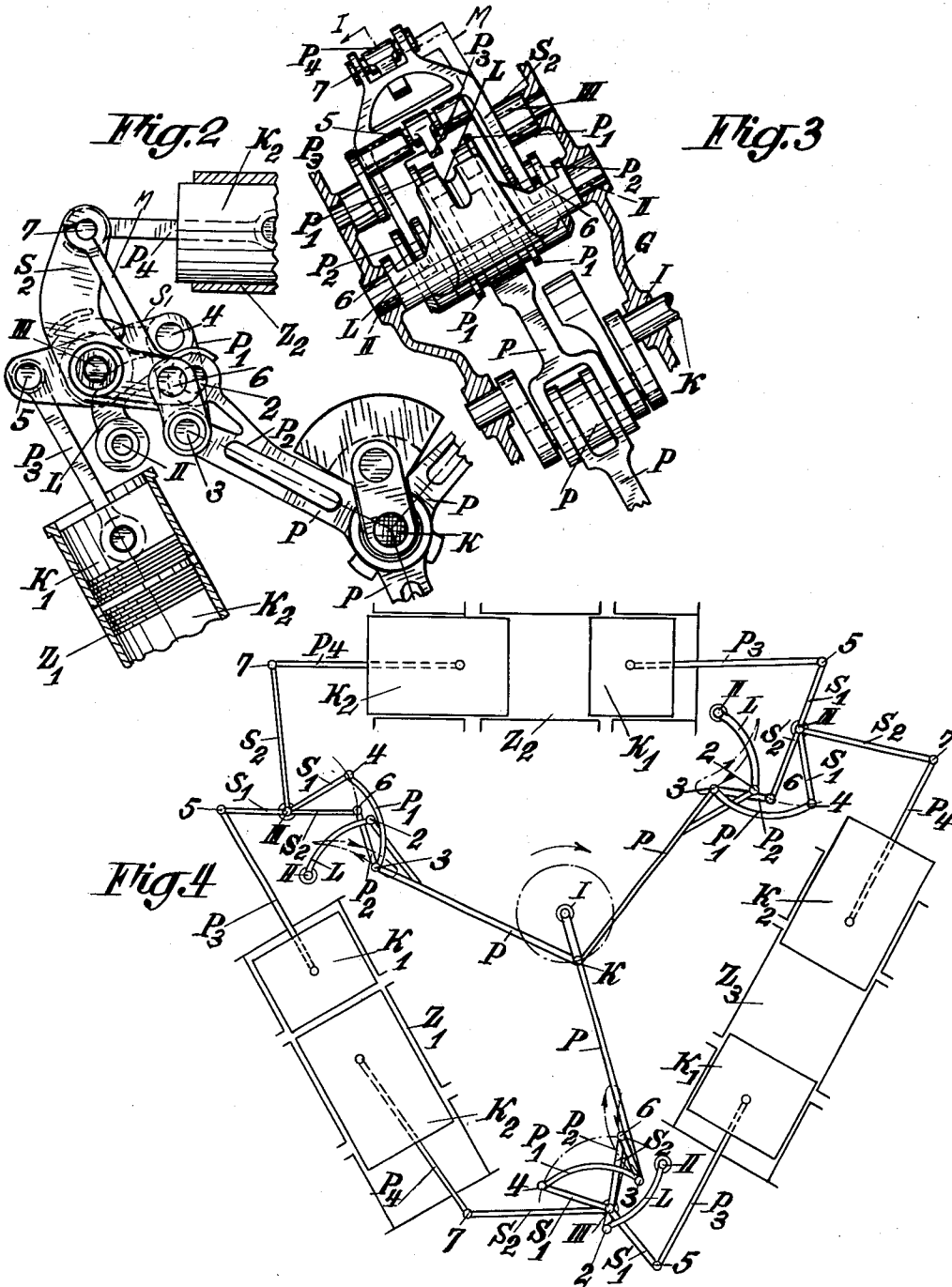
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Fig. 6

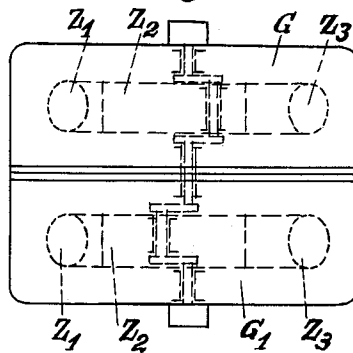
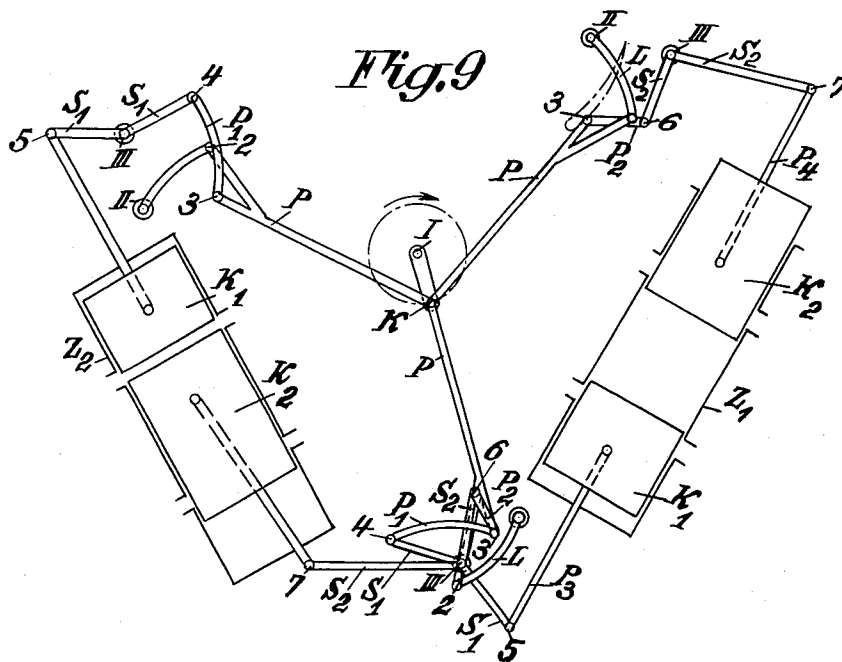


Fig. 9



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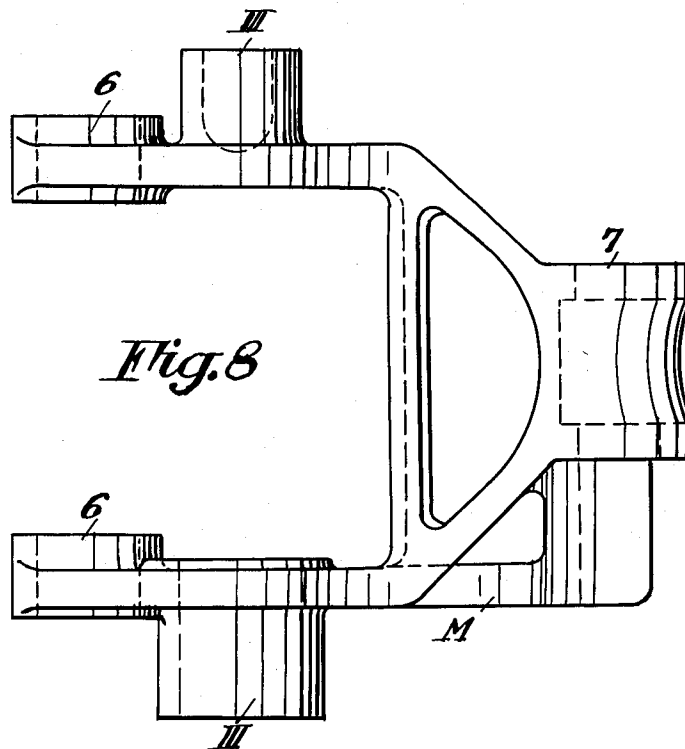
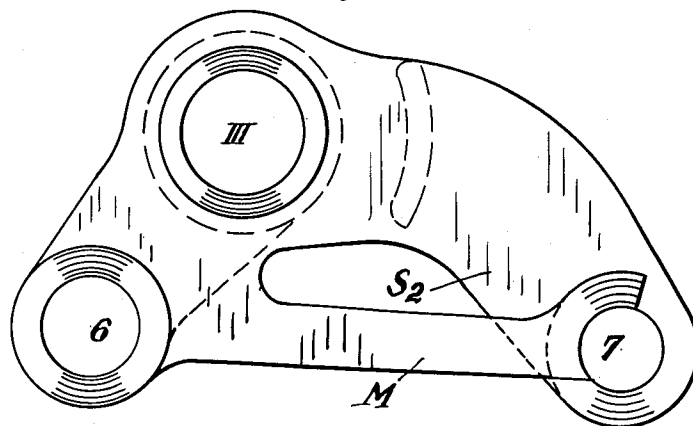
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Fig. 7



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DOUBLE-PISTON, INTERNAL-COMBUSTION ENGINE

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Claims priority, application Austria March 12, 1951

9 Claims. (Cl. 123—51)

This invention relates to a double-piston, internal-combustion engine controlled by the working pistons.

Double-piston, internal-combustion engines are known, in which the intake and exhaust ports are controlled by the working pistons themselves and in which the cycle of a four-stroke engine, comprising intake, compression, ignition, expansion, and exhaust of products of combustion, is performed during only one turn of the crank. The known devices of this type use cycloidal crank linkage, or a normal crank linkage and a cycloidal crank linkage.

Moreover, it is known to arrange in double-piston engines, performing a four-stroke cycle during one turn of the crankshaft, a rocker-lever drive for the pistons, but only where a special control member is provided to control the exhaust and intake.

The invention is distinguished from prior art by the feature of using only the working pistons as control members, in conjunction with a linkage interposed between the crankshaft and the working pistons and consisting only of connecting rods, links, and rocker levers.

In the accompanying drawings a three-cylinder engine embodying the invention is shown by way of example, in Fig. 1 in a cross-sectional view, whereas

Fig. 2 shows a gearing without casing, and

Fig. 3 shows the same in a side view.

Fig. 4 is a diagrammatic view of the rods and rocker levers, and

Fig. 5 a time-displacement curve of the piston motion.

Fig. 6 shows, on a reduced scale, the combination of two axially aligned engines of the type shown in Fig. 1. Figs. 7 and 8 are two different views of a rocker lever.

Fig. 9 is a diagrammatic view of a modified embodiment.

The example shown consists of a motor having three working cylinder liners, the axes of which lie in a common plane and are inclined against each other by 120 deg. Each cylinder liner has an intake and an exhaust port and inside each liner two pistons move partly in the same and partly in opposite senses. One of said pistons controls the intake port, the other the exhaust port. In the subsequent description of the linkage the pivots mounted in the casing G are designated with Roman numerals, the other joints with Arabic numerals, and the connecting rods, links and rocker levers are designated with letters.

A one-throw crankshaft K, mounted in the crankshaft bearing I of the crankcase G, operates a main connecting rod P, which at the pivot 2 is attached to a link L rotatable about bearing II in the engine casing G. The main connecting rod P carries a pivot 3, to which the intermediate connecting rods P₁ and P₂ are attached. The intermediate connecting rod P₁ is attached by means of the pivot 4 to the two-armed rocker lever S₁, to the pivot 5 of which the piston connecting rod P₃ is attached, which moves in the cylinder Z₁ the exhaust-controlling working piston K₁. The rocker lever S₁ is mounted in a bearing III in the crankcase G. The intermediate connecting rod P₂ connects the pivot 3 of the main connecting rod P to

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the two-armed rocker lever S₂, to the pivot 6 of which it is attached. The rocker lever S₂ operates through the pivot 7 the piston connecting rod P₄ moving in the cylinder Z₂ the working piston K₂ controlling the intake. In the embodiment shown the rocker levers S₁ and S₂ are coaxial, for example.

The linkage may be so dimensioned that the piston motion corresponds to the time-displacement curve shown in Fig. 5. The subsequently indicated measures and angles are given only by way of example. The times corresponding to the degrees of the angular movement of a crank are entered as abscissae, and the piston displacement between the exhaust port A and the intake port S are entered as ordinates.

It is assumed that in the working cylinder liner the control edges of the intake and exhaust ports are spaced by 71 mm. About 15 deg. after the 0-deg. point of the crankshaft turn the exhaust-controlling working piston K₁, at a distance of 2.5 mm. from the intake-controlling working piston K₂, closes the exhaust port A. Both pistons move toward the intake port S, which is opened by the intake-controlling working piston K₂ at 72 deg. of the crank turn when the exhaust-controlling working piston K₁ has passed beyond the exhaust port by 17 mm. and has closed the same already. During a time corresponding to 72 deg.—15 deg.—57 deg. of the crank turn, the residual gases corresponding to a piston spacing of 2.5 mm. expand to a piston spacing of 56 mm. whereby negative pressure is set up. By the resulting expansion and cooling an internal cooling is accomplished which directly influences the oil film adhering to the inside of the cylinder. At 72 deg. of the crankpin turn the induction mixture, or only air, enters the cylinder and expands too. When the intake-controlling working piston K₂ has fully opened the intake port S, it moves towards the exhaust port A, as well as the exhaust-controlling piston K₁, which is reversed 4 mm. before the exhaust slot A and without having opened the exhaust port moves back toward the intake port. When the exhaust-controlling piston K₁ is at a distance of 4 mm. from the exhaust port A the intake-controlling working piston K₂ has passed the intake port S at 120 deg. of the crank turn and closes between the two working pistons K₁ and K₂ an intake volume corresponding to a piston spacing of 68 mm. Now the two working pistons move toward each other until at 180 deg. of the crank turn they reach the compression position when they are 10 mm. apart. The ignited gas mixture expands between the two pistons moving apart, the exhaust-controlling piston K₁ opening the exhaust port from 267 deg. to 375 deg. of the crank turn, whereas the intake-controlling piston K₂ reaches its outermost point in the expansion stroke 5 mm. before the intake port S without opening the same, and subsequently during the exhaust stroke moves towards the exhaust port, after it has enclosed together with the exhaust-controlling piston a maximum expansion volume corresponding to a spacing of 71.5 mm. Thereafter, at a crank turn of 360 deg., a new working cycle begins.

As shown by way of example in Fig. 1, three working cylinders are arranged around the crankshaft bearing I so that the three axes of the cylinders lie in a plane normal to the axis of the crankshaft bearing and form an equilateral triangle, through the center of gravity of which passes the axis of the crankshaft bearing I. The thus defined three-cylinder, double-piston engine operates from a crankshaft throw through three main connecting rods P, by means of the link-and-rocker lever linkage, in each of its three cylinders an exhaust-controlling working piston K₁ and an intake-controlling working piston K₂, which open and close the exhaust ports A and intake ports S, respectively, in accordance with the piston time-displacement curve, so that the piston motion

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in a cylinder, during one turn of the crankshaft, has the characteristics of a double-piston, four-stroke engine with an internal cooling stroke. By the arrangement of the cylinder axes of the polygonal motor in an equilateral triangle, a mutual phase displacement of the working cycle in three cylinders by 120 deg. of the piston time-displacement curve is obtained.

Generally speaking the further development of the invention, comprising the special linkage, resides in that in a one-throw, polygonal, double-piston engine having N cylinders, the crankshaft drives from one throw through N main connecting rods and N link-and-rocker-lever linkage the pistons of N cylinders arranged in a polygon having N angles, with a phase displacement of $360:N$ deg. between two adjacent cylinders

In one-cylinder, double-piston engines the two pistons of the cylinder liner drive a single-throw crankshaft arranged laterally of the cylinder liner and having an axis intersecting the cylinder axis at right angles, by means of a main connecting rod and a link-and-rocker-lever linkage.

The in-line engine (Fig. 6) results from an analogous in-line arrangement of N cylinders having two pistons each along a crankshaft having N throws.

The invention may be embodied in water- or air-cooled carburetor engines, fuel injection engines, diesel engines, or semi-diesel engines, also with injection of water.

The application of the linkage according to the invention enables the construction of a novel type of motor: the polygonal motor having a central, one-throw crankshaft.

Embodied in a polygonal motor having a central crankshaft this motor is the most compact type of motor, requiring the least space.

Having no gears, the motor may be constructed in the simplest and most reliable manner, from the engineering viewpoint. Moreover, its mechanical efficiency is favorable because no eccentrics, known for their poor efficiency, are required.

By the application of the linkage according to the invention a time-piston displacement curve of the exhaust-controlling piston may be obtained with which a much larger intake displacement is obtained during the intake stroke than is possible in conjunction with a cycloidal crank linkage or a crank linkage with a special member for controlling exhaust and intake. The increased intake displacement, in conjunction with the delayed opening of the intake port, leads to a most thorough internal cooling by the expansion of the inflowing fresh gases or air.

As shown in Figs. 7 and 8, a connecting member M is provided at the two-armed rocker levers S_2 to interconnect the respective pivots 6, 7 and thus to prevent resonant vibration of the arms of the rocker levers. A corresponding member is preferably provided on rocker lever S_1 for connecting the pivots 4, 5.

I claim:

1. An internal-combustion engine having a plurality of working cylinder liners with intake and exhaust ports and with two pistons for each working cylinder, one of said pistons controlling the intake port, the other of said pistons controlling the exhaust port, the engine comprising, moreover, a casing forming a frame for the working cylinder liners and a crankshaft, said crankshaft rectangularly intersecting the axes of the working cylinder liners outside said liners and having a crankpin, a separate main connecting rod attached to said crank pin, and means operatively connecting said main connecting rod to the exhaust controlling piston of a cylinder liner, and to the intake controlling piston of another cylinder liner of said cylinder liners to transmit motion to said crankshaft and to move the piston of each of said liners during a full crank turn toward each other, once for exhausting the burnt gases and once more for compressing the

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charge, and to move the pistons apart twice, for setting up negative pressure after the intake of the fresh mixture and for expansion after ignition, one of said approaches taking place after one piston has opened the exhaust port, the second approach taking place after the other piston, with a large spacing from the first one, has opened and closed the intake port after the closing of the exhaust port, said means comprising a linkage associated with each main connecting rod and composed of a link, rocker levers and intermediate connecting rods, one of said links and one of said rocker levers being supported in the casing.

2. An internal-combustion engine as set forth in claim 1, in which said linkage for transmitting the piston motion to the crankshaft comprises a piston connecting rod associated with each piston, two rocker levers each having one pivot mounted in the casing, one of said rocker levers having a second pivot mounted in the piston connecting rod of an exhaust-controlling piston, the other of said rocker levers having a second pivot mounted in the piston connecting rod of an intake-controlling piston, each rocker lever having a third pivot connected to an intermediate connecting rod, a pivot on said main connecting rod, said intermediate connecting rods being connected to said pivot of the main connecting rod to transmit motion from the rocker lever to the main connecting rod, said main connecting rod having a second pivot connected to said link, said link being pivotally connected to the casing.

3. In an internal-combustion engine as set forth in claim 1, in which the working cylinders are arranged in sets of less than three working cylinders the axes of which extend in a common plane, and which comprises a number of such sets of working cylinders and the crankshaft of which has a number of throws corresponding to the number of such sets.

4. An internal-combustion engine as set forth in claim 1, in which said linkage composed of links, rocker levers, and connecting rods comprises two-armed rocker levers, and a member interconnecting the two arms of at least one of said rocker levers to prevent resonant vibration of said arms.

5. An internal-combustion engine having arranged end to end several working cylinder liners with intake and exhaust ports and with two pistons for each working cylinder, one of said pistons controlling the intake port, the other of said pistons controlling the exhaust port, the engine comprising, moreover, a casing forming a frame for the working cylinder liners and a crankshaft, said crankshaft rectangularly intersecting the axes of the working cylinder liners outside said liners and having a crankpin, a separate main connecting rod attached to said crankpin, and means operatively connecting said main connecting rod to the exhaust controlling piston of a cylinder liner, and to the intake controlling piston of another cylinder liner of said cylinder liners and located adjacent to said first-mentioned cylinder liner to transmit piston motions to said crankshaft and to move the pistons of each of said liners during a full crank turn toward each other once for exhausting the burnt gases and once more for compressing the charge, and to move the pistons apart twice, for setting up negative pressure after the intake of the fresh mixture and for expansion after ignition, one of said approaches taking place after one piston has opened the exhaust port, the second approach taking place after the other piston, with a large spacing from the first one, has opened and closed the intake port after the closing of the exhaust port, said means comprising a linkage associated with each of said main connecting rods and composed of a link, rocker levers and intermediate connecting rods, said links and one of said rocker levers being supported in the casing, a number of N working cylinder liners having their axes extending in a common plane, said axes forming an equilateral figure having N angles.

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6. An internal-combustion engine as set forth in claim 5, in which said linkage for transmitting the piston motions to the crankshaft comprises a piston connecting rod associated with each piston, two rocker levers each having one pivot mounted in the casing, one of said rocker levers having a second pivot mounted in the piston connecting rod of an exhaust controlling piston, the other of said rocker levers having a second pivot mounted in the piston connecting rod of the intake connecting piston of an adjacent working cylinder, each rocker lever having a third pivot connected to an intermediate connecting rod, a pivot on said main connecting rod, said intermediate connecting rods being connected to said pivot of the main connecting rod to transmit motion from the rocker lever to the main connecting rod, said main connecting rod having a second pivot connected to said link, said link being pivotally connected to the casing.

7. An internal-combustion engine as set forth in claim 5, in which the working cylinders are arranged in sets of at least three working cylinders the axes of which extend in a common plane, and which comprises a number of such sets of working cylinders and the crankshaft of which has a number of throws corresponding to the number of such sets.

8. An internal-combustion engine as set forth in claim 5, in which said linkage composed of links, rocker levers and connecting rods comprises two-armed rocker levers and a member interconnecting the two arms of at least one of said rocker levers to prevent resonant vibration of said arms.

9. A four-stroke internal combustion engine comprising, in combination, a set of main cylinders having axes located in a plane, each cylinder being formed with in-

take and exhaust ports at the ends thereof; an intake port controlling piston, and an exhaust port controlling piston reciprocably mounted in each of said cylinders; supporting means supporting said cylinders; a crank shaft rotatably mounted in said supporting means and including a crank portion extending normal to the axes of said working cylinders; a plurality of main connecting rods, each main connecting rod being turnably mounted at one end thereof on said crank portion; linkage means connecting the other end of each of said main connecting rods to the intake port controlling piston of one of said cylinders, and to the outlet port controlling piston of a cylinder adjacent said one cylinder adjacent said one cylinder for moving each piston, during one revolution of said crank shaft, through two strokes and for uncovering the port associated with said piston during only one of said two strokes.

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