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J. J. M. BERTRAND ET AL

INTERNAL COMBUSTION ENGINE WITH CYLINDERS ARRANGED IN TWO OPPOSITE LINES

Original Filed April 20, 1922

Fig. 1

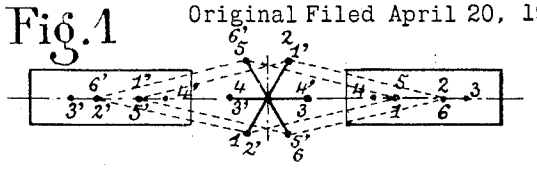


Fig. 2

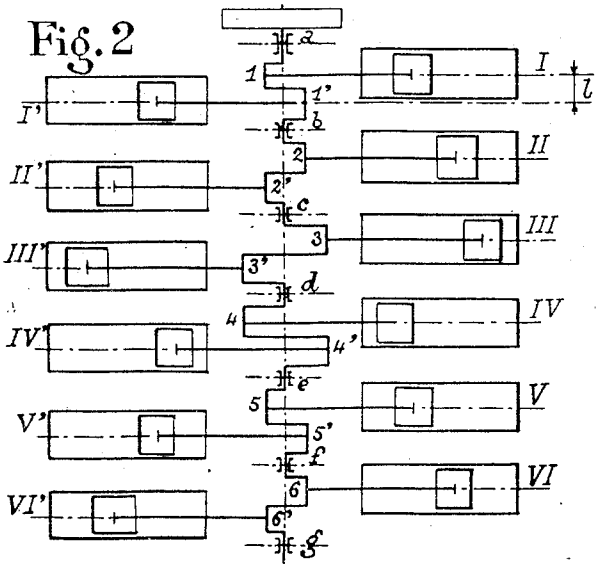


Fig. 3

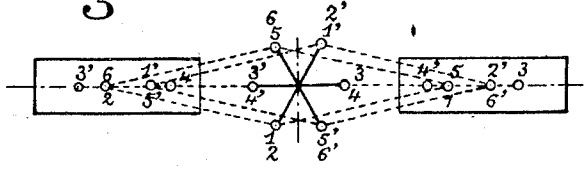
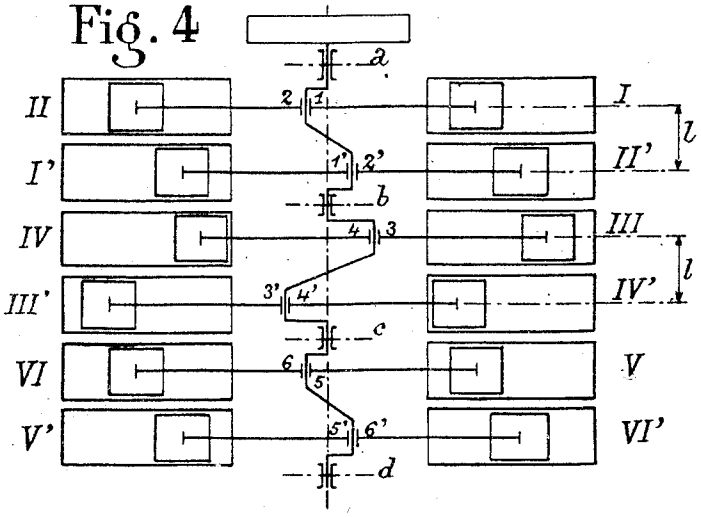


Fig. 4



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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE WITH CYLINDERS ARRANGED IN TWO OPPOSITE LINES.

Original application filed April 20, 1922, Serial No. 555,734, and in France May 13, 1921. Divided and this application filed November 30, 1926. Serial No. 151,790.

This invention relates to four stroke explosion engines or internal combustion engines with $4p$ cylinders (p being a number greater than 1) of the kind described of our copending application Serial No. 555,734 which consists substantially in the combination of p elementary four cylinder engines of known type in each of which the four cylinders are placed in two opposite lines and have all their axes parallel to a single direction. In this engine, the cranks of each group of four cylinders are in the same plane, all the cranks shafts of the various groups of four cylinders are identical and the various radial planes of the cranks of the groups of four cylinders are equally displaced relatively to one another.

Individually, each of these four cylinder engines is unbalanced, but the combination of engines so obtained is balanced and gives numerous advantages as pointed out in our hereinabove mentioned co-pending application Serial No. 555,734.

According to the present invention an engine with $4p$ cylinders arranged in two opposite lines with their axes parallel, and in which the cranks of each group of four cylinders lie in a single plane, all the crank shafts of the various groups of four cylinders are identical and arranged in p planes displaced equally to one another, is made by means of an odd number ($p=2m+1$, m being a number greater than zero) of elementary four cylinders engines and in the said engine the elementary cranks shafts are angularly displaced one the another by $\frac{360°}{p}$.

In each group of four cylinders, the rods of the pistons of two opposed connected cylinders can act on the crank shaft of any useful manner, i. e. at two diametrically opposite points—and, then in each group of four cylinder the crank shaft has the known form with three or four cranks—or at the same point and, in this last case, in each group of four cylinders, the crank shaft has the known form with two cranks.

These engines give numerous advantages and particularly with regard to the facility of the feeding of the cylinders, the simplicity of construction of the engine and the perfection of the balancing, and the said advantages are not simultaneously obtained in the engines at present used with twelve or more cylinders arranged in two opposite lines or in the known engines of the same power with four cylinders only or in the known engines with $4p$ ($p=2m+1$) cylinders arranged in various radial lines.

In addition to the various advantages already obtained in some types of engines, i. e. the possibility of using one carburetor only for each group of four cylinders, the simplicity of the piping, the regularity of the crank turning moment, the present invention gives advantages, namely:

1, the possibility of making the crank shaft by means of p parts in each of which all the cranks are arranged in the same plane, the said parts being identical, placed end to end and suitable angularly displaced relatively to one another;

2, the possibility of reducing to $p-1$ only for $4p$ cylinders the number of intermediate supporting brackets, that is to say to one bracket only between two elementary groups of four cylinders, all the intermediate brackets being taken off in each elementary group of four cylinders, and the possibility of using ball or roller bearings.

3, as a consequence of this simplification of the crank shaft, increased facility of fitting the ball or roller bearings,

4, the obtaining of the balancing by making but little call on the rigidity of the engine bed, and, therefore, the possibility of making the said engine bed lighter than the ones at present used, because by reducing the linear displacement 1 (Fig. 2) for instance, by counterelbowing the crank shaft, the inertia couples which are mutually balanced are also reduced.

5, the perfection of the balancing gives the possibility of running the motor at higher speed than ordinary motors, which allows of the construction of lighter motors than the ones at present used.

6, the very great perfection of the balancing due to the fact that the center of gravity of all the moving parts is still and the harmonica of any order are rigorously balanced.

The above advantages allow of using in any motor vehicle or aeroplane than engine with $4p$ cylinders ($p=2m+1$) arranged in two opposite lines. As such an engine requires only a small place it is possible to ar-

range it beneath the body of the vehicle and consequently at any part of the length of the vehicle; in the aeroplane, it is possible to arrange such an engine of a great power in wings of a relatively small thickness.

The following table sums the explanation of the characteristics of the most used motors which can be constructed according to the present invention.

Number of cylinders.	Number of crank pins.	Number of groups of four cylinder engines with plane two or three or four throw crank shaft.
12	6, 9 or 12	3
20	10, 15 or 20	5
28	14, 21 or 28	7

In the accompanying drawings given by way of example and acting as illustration only of the present invention:

Figs. 1 and 2 show a twelve cylinder engine having seven bearings twelve crank pins and a crank shaft made of three plane four-throw cranks shafts.

Figs. 3 and 4 a twelve cylinder engine having four bearings and six cranks, the said engine being fitted with three plane two-throw crank shafts. These three parts are assembled relatively one to another as shown in the drawings.

Besides, in each of the said engines, in each group of four cylinders, the adjacent cylinders can be put close in order to reduce the linear displacement 1 and the distances between the bearings *a*, *b*, *c*, *d* . . . can be as small as possible.

In each engine shown in the drawings, the cylinders and the corresponding parts of each cylinder are indicated with the numbers I, II, I′, II′ . . 1, 2, 1′, 2′ . . . in order to distinguish at once the various parts of an engine and so to make instantaneous the understanding of the said drawings and motors.

In these figures, the letters, *a*, *b*, *c*, *d* . . . show the bearings.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. An internal combustion engine comprising an odd number of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposite lines with their axes parallel and in which the cranks of each group of four cylinders lie in a single plane and all the cranks shafts of the various groups of four cylinders are identical and arranged in p planes displaced equally relatively to one another by $360°/p$.

2. An internal combustion engine comprising an odd number of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposite lines with their axes parallel and in which the crank shaft of each group of four cylinders lie in a single plane, the rods of the pistons of the two opposed connected cylinders acting on the said elementary crank shaft of the group at the same point, the said known elementary shaft having two cranks only, and the various sections of the crank shaft of the engine being identical and displaced relatively one to another by $360°/p$.

3. An internal combustion engine comprising an odd number of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposite lines with their axes parallel and in which the cranks of each group of four cylinders lie in a single plane, all the cranks shafts of the various groups of four cylinders are identical, arranged in p planes displaced equally relatively to one another by $360°$ p, made separately, placed end to end, and jointed together.

4. An internal combustion engine comprising an odd number of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposite lines with their axes parallel and in which the cranks of each group of four cylinders lie in a single plane, the rods of the pistons of the two opposed connected cylinders acting on the said elementary crank shaft of the group at the same point, the said known elementary crank shaft having two cranks only, the various sections of the crank shaft of the engine being identical displaced relatively one to another by $360°/p$, made separately placed end to end, and jointed together.

In witness whereof we have hereunto set our hands.

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LOUIS JOSEPH HENRI SOLANET.