July 5, 1927. 1,634,866

J. J. M. BERTRAND ET AL

INTERNAL COMBUSTION ENGINE WITH CYLINDERS ARRANGED IN TWO OPPOSITE LINES

Filed April 20. 1922 2 Sheets-Sheet 1

Fig. 1

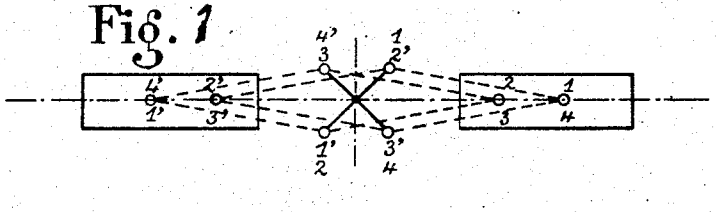
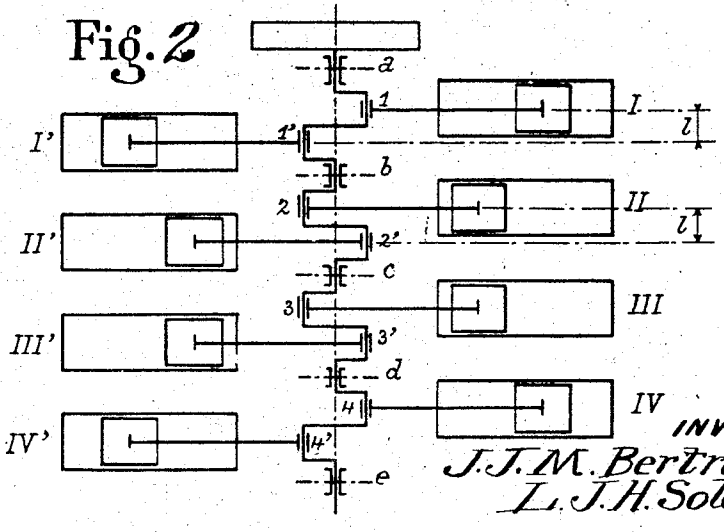


Fig. 2



INVENTORS.
J. J. M. Bertrand and
L. J. H. Solanet.
By William C. Linton
Atty.

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Fig. 3

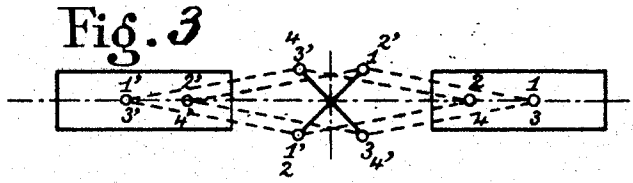
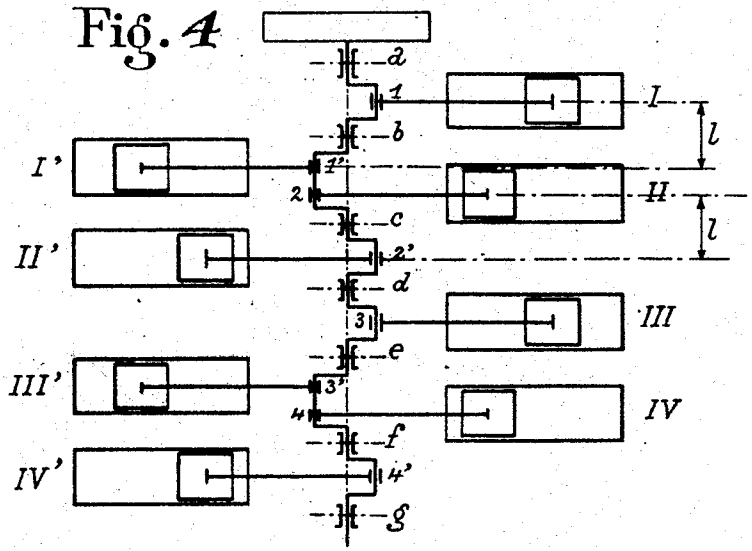


Fig. 4



INVENTORS
J. J. M. Bertrand and
L. J. H. Solanet.
By William C. Linton Atty.

Patented July 5, 1927. 1,634,866

UNITED STATES PATENT OFFICE.

JEAN JOSEPH MARIE BERTRAND AND LOUIS JOSEPH HENRI SOLANET, OF PARIS, FRANCE.

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

Application filed April 20, 1922, Serial No. 555,734, and in France May 13, 1921.

This invention relates to four stroke explosion engines or internal combustion engines with $4p$ cylinders (p being a number greater than 1); it 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 crank shafts of the various groups of 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.

Two known types of four cylinder engine can be used as an element in the said combination and give two types of engines which lie within the scope of the present invention.

Figures 1 to 4 refer to the motors of the first type.

Figures 1 and 2 show an eight cylinder engine having five bearings and eight crank pins with the crank shaft made of two plane four-throw crank shafts.

Figures 3 and 4 show another eight cylinder engine having a crank shaft made of two plane three-throw crank shafts displaced relatively to one another by 90°, the said eight cylinder engine having seven bearings.

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 distance 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.

According to the first type, an engine with $4p$ cylinders is made by means of p elementary four cylinder engines in each of which the piston-rods of two connected opposed cylinders act on the crank shaft at two diametrically opposed points and, therefore, in each of which the crank shaft has the known form with four or three cranks. Then, the elementary crank shafts are angularly displaced one to another by $\frac{180°}{p}$ when p is even and $\frac{180°}{p}$ or $\frac{360°}{p}$ when p is odd.

According to the second type, an engine with $4p$ cylinders is made by means of an odd number ($p=2m+1$; m being a number greater than zero) of elementary four cylinder engines in each of which the two connected opposed cylinders act on the crank shaft at the same point, and, therefore, in each of which the crank shaft has the known form with two cranks. Then, these various crank shafts are angularly displaced one to another by $\frac{180°}{p}$.

These engines of both types 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 simltaneously obtained in the engines at present used with six 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 carburettor only for each group of four cylinders, the simplicity of the piping, the regularity of the crank turning moment, the present invention gives particular 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 suitably 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 brack-

ets 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 l (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.

There is a possibility of making an internal combustion engines of the kind hereinabove specified by means of any number p of elementary four cylinder engines in each of which the piston rods of two connected opposed cylinders act on two diametrically opposed points of the crank shaft, the elementary crank shafts being angularly displaced one to another by 180°, as more specially described hereinafter, shown in the accompanying drawings and claimed in the appended claims. Then, the crank shaft of each elementary four cylinders engine has the known form with four or three cranks.

There is also a possibility of making an internal combustion engines of the kind hereinabove specified by means of any odd number p ($p=2m+l$, m being a number greater than zero) of elementary four cylinder engines, the various crank shafts of which are displaced one to another by $\frac{360°}{p}$. Then, these elementary four cylinders engines can be of the known type in which the piston rods of two connected opposed cylinders act on two diametrically opposed points of the crank shaft, and, therefore, in each of which the crank shaft has the known form with four or three cranks, or these elementary four cylinder engines can also be of the known type in which the piston rods of two connected opposed cylinders act on the crank shaft at the same point, and, therefore, in each of which the crank shaft has the known form with two cranks.

Besides, in the engine of the last type, i. e., with an odd number of elementary four cylinder engines, the cranks shafts of which are displaced one to another by $\frac{360°}{p}$, the center of gravity of 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 the engine with $4p$ cylinders arranged in two opposite lines. As such an engine requires only a small place it is possible to arrange it beneath the body of the vehicle and consequently at any part of the length of the vehicle; in the aeroplanes, it is possible to arrange such an engine of a great power in wings of a relatively small thickness.

The following tables sum up the explanation of the characteristics of the most used motors which can be constructed according to the present invention.

I. First type.

Number of cylinders.	Number of crank pins.	Number of groups of four-cylinder engines with plane three or four throw crank shaft.
8	6 or 8	2
12	9 or 12	3
16	12 or 16	4
20	15 or 20	5

II. Second type.

Number of cylinders.	Number of crank pins.	Number of groups of four-cylinder engines with plane two-throw crank shaft.
12	6	3
20	10	5
28	14	7

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 a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposed lines with their axes parallel, in which the cranks of each group of four cylinders lie in a single plane and all the crank shafts of the various groups of four cylinders are identical and arranged in p planes displaced equally relatively to one another.

2. An internal combustion engine comprising a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposite lines with their axes parallel, in which the cranks of each group of four cylinders lie in a single plane and the p crank shafts of the various groups of four cylinders are identical, placed end to end and displaced equally relatively to one another.

3. An internal combustion engine comprising a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposed lines with their axes parallel, in which the cranks of each group of four cylinders lie in a single plane and all the crank shafts of the various groups of four cylinders are identical and

arranged in p planes displaced equally relatively to one another and in which also the rods of the pistons of two opposed connected cylinders act on the crank shaft at two diametrically opposite points, the various identical parts of the crank shaft of the engine being displaced relatively to one another by $180°/p$.

4. An internal combustion engine comprising a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposed lines with their axes parallel, in which the cranks of each group of four cylinders lie in a single plane and the p crank shafts of the various groups of cylinders are identical, placed end to end and displaced relatively to one another by $180°/p$.

5. An internal combustion engine comprising a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposed lines with their axes parallel, in which the cranks of each group of four cylinders lie in a single plane and the p crank shafts of the various groups of cylinders are identical, placed end to end and displaced relatively to one another by $180°/p$, the rods of the pistons of two opposed connected cylinders acting on the crank shaft at two diametrically opposite points.

In witness whereof we have hereunto set our hands.

JEAN JOSEPH MARIE BERTRAND.
LOUIS JOSEPH HENRI SOLANET.