

R. ESNAULT-PELTERIE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED MAY 2, 1907.

1,060,070.

Patented Apr. 29, 1913.

3 SHEETS-SHEET 1.

Fig. 1.

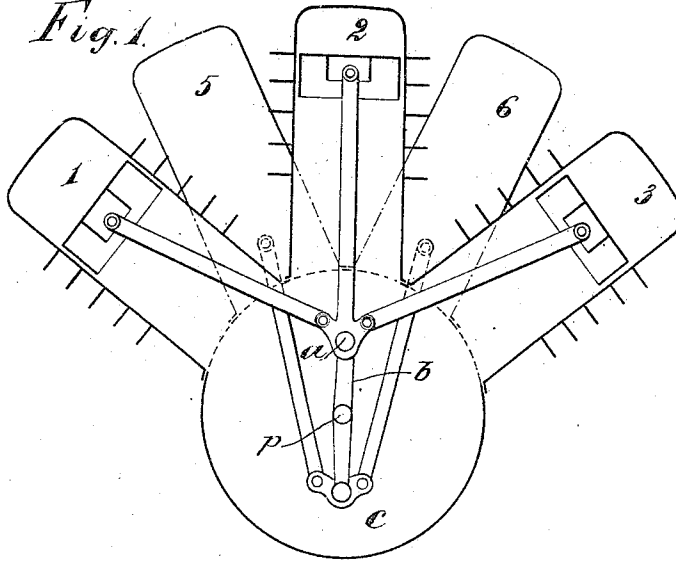
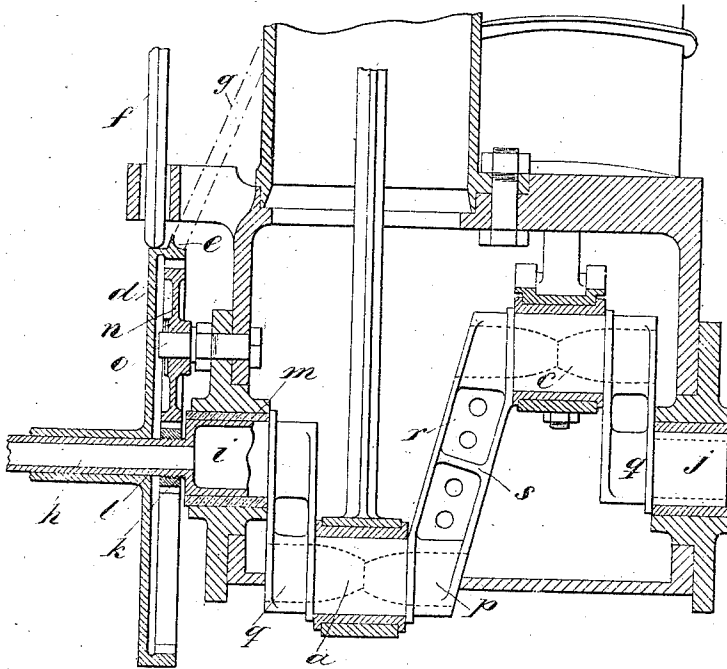


Fig. 2.



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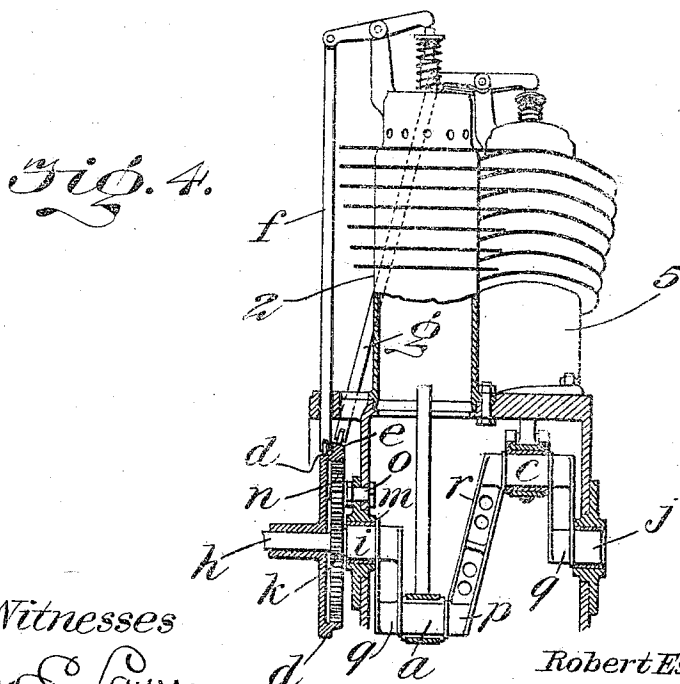
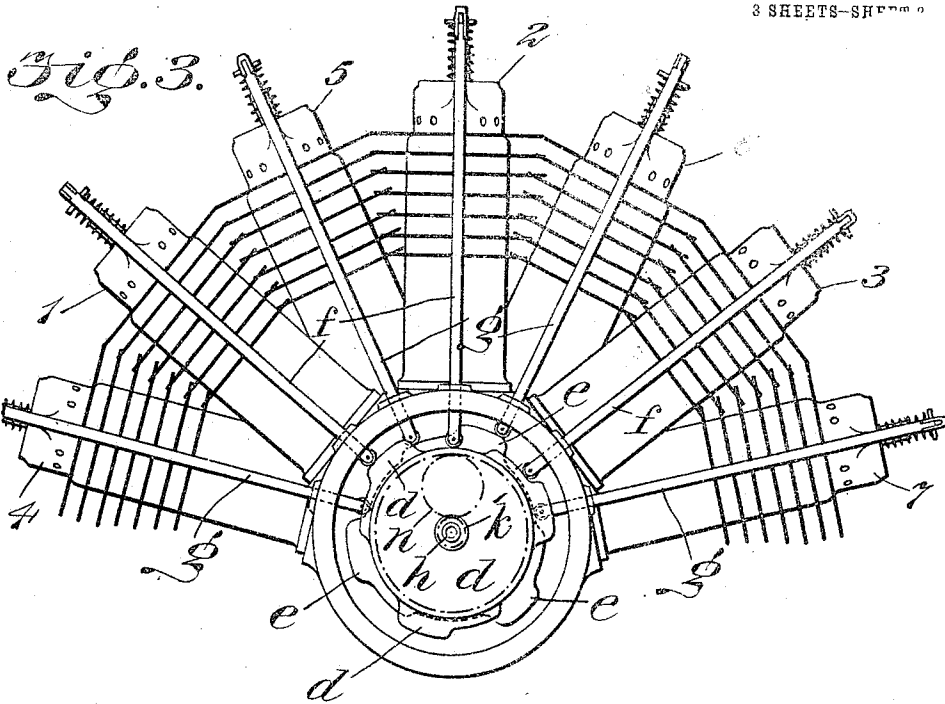
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3 SHEETS-SHEET 2



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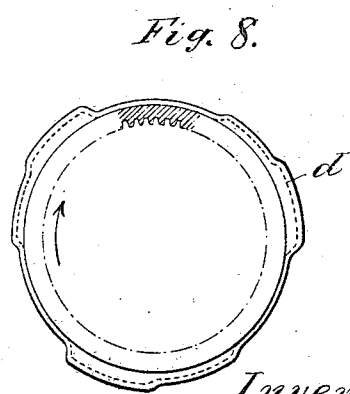
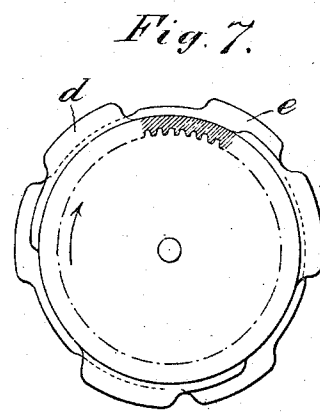
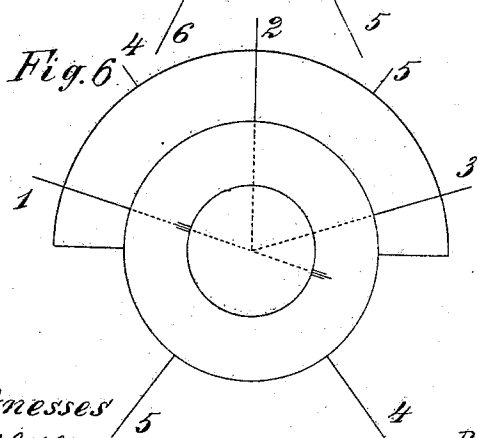
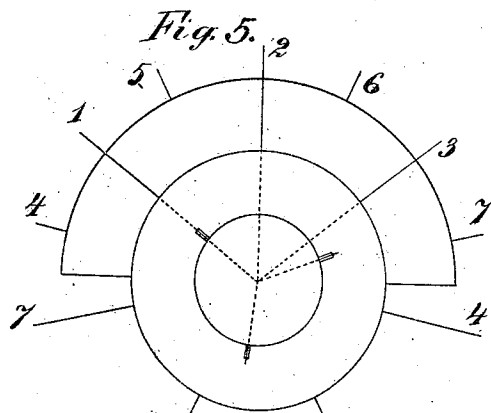
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3 SHEETS-SHEET 3.



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UNITED STATES PATENT OFFICE.

ROBERT ESNAULT-PELTERIE, OF BOULOGNE, FRANCE.

INTERNAL-COMBUSTION ENGINE.

1,060,070.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ROBERT ESNAULT-PELTERIE, a citizen of the Republic of France, residing at Boulogne, France, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to certain improvements in motors and more particularly in that class of motors wherein a plurality of cylinders are provided appropriately grouped with relation to a crank shaft operated by pistons within such cylinders and the object of the invention is to provide a motor of this general character of a simple and comparatively inexpensive nature and of a compact and durable construction presenting certain features of novelty and improvement whereby increased efficiency and greater convenience are attained in the operation and control of the motor together with a maximum of strength and lightness in construction.

The invention consists in certain novel features of the construction, and combinations and arrangements of the several parts of the improved motor, whereby certain important advantages are attained, and the device is rendered lighter, stronger, more compact and otherwise better adapted and more convenient for use, all as will be hereinafter more fully set forth.

The novel features of the invention will be carefully defined in the claims.

In order that my improvements may be the better understood, I will now proceed to describe the same with reference to the accompanying drawings, wherein I have shown one embodiment of the invention.

In said drawings, Figure 1 shows diagrammatically a side view of the motor; Fig. 2 is a transverse section on an enlarged scale through the axis of one of the front cylinders and showing the crank shaft as well as the mechanism controlling the distribution; Fig. 3 is a view in side elevation of a motor constructed in accordance with the present invention; Fig. 4 is a view partly in end elevation and partly in section of the structure shown in Fig. 3; Fig. 5 is a diagram explaining the operation of the motor in the case of a motor having seven cylinders; Fig. 6 is an analogous dia-

gram in the case of a motor having five cylinders; Fig. 7 is a face view of the cam for controlling the valves of three of the cylinders and showing the profile of the cam for controlling the valves of the four rear cylinders turned through an angle of 180° ; Fig. 8 is a face view of the cam for the control of the valves of the four rear cylinders.

The essential feature of this motor is that it comprises (see Fig. 1) an uneven number of cylinders, seven or five, 1, 2, 3, 4, 5, 6, 7, for example, forming between them equal angles of approximately $51^\circ 26$ minutes. These cylinders are not arranged in star in the same plane, for this arrangement would not allow a suitable lubrication of the lower cylinders. They are divided into two groups 1, 2, 3, and 4, 5, 6, 7, the one represented in full lines and the other in dotted lines, which groups are arranged in two parallel planes in such a manner that cylinders 7 and 4 nearest to the horizontal plane make therewith each an angle of $12^\circ 51$ minutes, and the oil cannot rise in the bottom of these cylinders. This arrangement is equivalent to that in which all the cylinders make equal angles with each other. The connecting rods operate two cranks, at an angle of 180° to each other, one corresponding with the three front cylinders and the other with the four rear cylinders.

In subsequently explaining the arrangement of the ignition with reference to Figs. 5 and 6, it will be assumed that the seven or five cylinders are in the same plane, and to realize the actual arrangement one part of the figure must be rotated through 180° relatively to the other.

As is seen in Fig. 1, the connecting rods of the cylinders 1 and 3 are jointed to the head of the connecting rod of cylinder 2, which is itself jointed to the crank pin *a* of the crank shaft *p*; so also the connecting rods shown in dotted lines of the rear cylinders 4, 5 and 7 are jointed to the head of the connecting rod of cylinder 6, which is itself jointed to the crank pin *c*.

Each cylinder is provided with a single double valve of any existing type having two unequal lifts, which acts alternately as admission and exhaust valve.

All seven valves are controlled by a sin-

gle cam turning in the direction opposite to that of the motor shaft and at least at one sixth of the speed.

If it is assumed, for greater simplicity, that all the cylinders are in one plane (see Fig. 5); it is necessary that all the cylinders operate at equal intervals in order that the motive couple may be as regular as possible, and it is necessary moreover that for every two revolutions of the motor all the cylinders should operate at least once, and no more.

If the motor turns in the direction of the hands of a watch (see Fig. 5) and the cylinders are numbered from 1 to 7 starting from the left hand, the cylinders ought to act, in order to satisfy the foregoing conditions, in the order 1, 3, 5, 7, 2, 4, 6. The cam which turns in the opposite direction will encounter them in the order 7, 6, 5, 4, 3, 2, 1. It is necessary that when the cam shall have turned from cylinder 7 to cylinder 6, the motor shall equally have turned from cylinder 7 to cylinder 6. In thus turning it has passed by the axes of the cylinders 2 and 4 and in consequence has described an angle of

$$6 \cdot \frac{2\pi}{7}$$

During this time the cam has described the angle

$$\frac{2\pi}{7}$$

It has therefore turned at one sixth of the speed of the motor and in the opposite direction. But, as in turning from cylinder 7 to cylinder 6 the motor passes by the cylinders 2 and 4, the cam must have its bosses or cam faces equidistant (Fig. 7 showing the whole profile), that is, spaced apart by angles of 120° . When the motor turns from cylinder 7 to cylinder 2 it describes an angle equal to

$$2 \cdot \frac{2\pi}{7}$$

and the cam which turns in the opposite direction at one sixth of the speed describes an angle equal to

$$\frac{2}{6} \cdot \frac{2\pi}{7}$$

It follows from this that the distance between each two consecutive bosses or cam faces should be equal, as is indicated in the diagram for cylinders 1 and 3, namely

$$\frac{2}{6} \cdot \frac{2\pi}{7} + \frac{2}{7} \cdot 2\pi = \frac{2\pi}{3}$$

that is to say 120° . But in reality it must not be forgotten that the cylinders are divided into two groups turned in relation to each other through 180° . This is why the cam should be doubled, the two cams

being turned through 180° relatively to each other. Thus there are two adjacent cams *d, e* (Figs. 7 and 8) controlling the rods *f g* (Fig. 2) respectively of the corresponding valves and these cams, cut in the same piece as shown in Fig. 2 or bolted together, will be turned together.

In the case of the motor having five cylinders, three of the cylinders may be placed on one side and two on the other, and the cylinders will be at angles of approximately 72° to each other. The rear cylinders will also be turned through 180° relatively to the front cylinders, and their connecting rods will work a crank turned through 180° relatively to the crank of the three front cylinders.

The diagram of the distribution is shown in Fig. 6.

As before, if the cylinders are numbered from left to right they operate in the order 1, 3, 5, 2, 4, and the cam which turns in the opposite direction in the order 5, 4, 3, 2, 1. It will be necessary then that while the cam is turning from cylinder 5 to cylinder 4 the motor should turn from cylinder 5 to cylinder 4. It will thus have described an angle equal to

$$\frac{4}{5} \cdot 2\pi,$$

while the cam will have only described an angle

$$\frac{2\pi}{5}$$

It must in consequence turn at one fourth of the speed of the motor and in the opposite direction. The bosses or cam faces of the cam are in this case 180° apart.

When the motor turns from cylinder 1 to cylinder 5, it passes by the axis of cylinder 3 which will give in its turn the motive power. In arriving at this cylinder, an angle equal to

$$2 \cdot \frac{2\pi}{5},$$

but on the other hand the cam will have turned through an angle equal to

$$\frac{2}{4} \cdot \frac{2\pi}{5},$$

and the distance between the two bosses of the cam should be

$$\frac{2}{4} \cdot \frac{2\pi}{5} + 2 \cdot \frac{2\pi}{5} = \pi,$$

that is to say 180° . In this particular case there is also need to turn the cam for the rear cylinders through 180° in relation to the cam for the front cylinders, but this is useless since the bosses of the two cams would coincide.

It is obvious that the above remarks may

be applied generally for the distribution of poly-cylindrical star-formed motors of which the lower cylinders are turned through 180° and placed above the horizontal plane passing through the axis of the shaft in a plane parallel to the upper cylinders and in which two groups of cylinders each work a crank, these cranks being turned in relation to each other through 180° .

The ignition may be produced by accumulators and controlled by a cam like that for the distribution. It may also be produced by a magneto-electric machine. In this latter case the speed of the rotation of the magneto-electric machine should be $1\frac{1}{2}$ that of the motor, for the magneto-electric machine having a maximum negative or positive wave at each half turn ought to turn π times while the motor turns

$$2 \cdot \frac{2\pi}{7}$$

times, an arrangement which allows the utilization of any ordinary magneto-electric machine. If the latter is a high tension machine there must be added a distributor which at each half revolution sends the current into the appropriate cylinder.

The double cam d, e is mounted free on a shaft h which is a prolongation of the axis of the trunnions i and j of the crank shaft p , and is turned by the intermediary of a toothed wheel n mounted free on a pin o fixed on the cylinder frame, which toothed wheel engages with an annular rack on the cam d , and on the other hand with a pinion k held on the hollow shaft which is a prolongation of the trunnion i on which shaft the double cam d, e turns.

The crank shaft carries two crank pins a and c displaced through 180° relatively to each other; a is driven by the three front cylinders 1, 2 and 3, and c by the four rear cylinders 4, 5, 6, 7. This shaft has no bearing at its middle; the two extreme arms q as well as the transverse arm r are made of double T-section, and the middle arm r has at its middle a small strengthening web s which ties the two lateral webs. The crank pins a and c are hollow, the interior being shaped to offer suitable resistance to the bending moments.

The trunnions i and j are also hollow, and as the strain upon them is comparatively feeble they can be of lighter section than the crank pins.

The fly wheel, not represented in the drawing, and which need not be very heavy by reason of the uniform distribution of the power, is keyed on the shaft by the side of the four cylinders. The various masses may be balanced by hollowing suitably the surface of the fly wheel in order to remove its weight at an appropriate place.

The head of each cylinder carries the

single admission and exhaust valve as well as the corresponding ducts which are carried on its upper face. The said head serves also as a support for the brackets carrying the pivots of the control levers of the valves, and it is at this part that the air necessary for cooling enters, as has been already explained.

The framework is of aluminium, and has the form required for receiving the seven cylinders which are imbricated among themselves in such a manner as to reduce further the bulk of the motor.

Having thus described the nature of my said invention and the best means I know of carrying the same into practical effect, I claim:—

1. An internal combustion engine having an uneven number of cylinders in two parallel groups, the cylinders of each group being arranged to make equal angles with each other, a shaft having oppositely set cranks with which the pistons of the respective groups are respectively connected, each of said two groups of cylinders being above a horizontal plane passed through the axis of said shaft, valve mechanism for the cylinders, a cam having cam surfaces for operative engagement with the valve mechanisms of the respective groups and means for rotating said cam in a direction reverse to the direction of rotation of the crank shaft and at a speed which is $\frac{1}{n-1}$ of the speed of said crank shaft, where n is the number of cylinders.

2. An internal combustion engine having an uneven number of cylinders in two parallel groups, the cylinders of each group being arranged to make equal angles with each other, a shaft having oppositely set cranks with which the pistons of the respective groups are respectively connected, each of said two groups of cylinders being above a horizontal plane passed through the axis of said shaft, valve mechanism for the cylinders, and a cam rotatable in a direction reverse to the direction of the crank shaft and having two sets of cam faces side by side, the cam faces of each set corresponding in arrangement with and being arranged to operate the valve mechanism of the cylinders of one of said respective groups.

3. An internal combustion engine having an uneven number of cylinders arranged in two parallel groups, the cylinders of each group being arranged to make equal angles with each other, a shaft having oppositely set cranks with which the pistons of the respective groups are respectively connected, each of said two groups of cylinders being above a horizontal plane passed through the axis of said shaft, and valve mechanism for the cylinders of the respective groups and including a single distributing cam rotata-

ble in a direction reverse to the direction of the crank shaft and having two sets of peripheral cam surfaces side by side, the cam surfaces of each set being separated at distances of 120°.

4. An internal combustion engine having an uneven number of cylinders arranged in two parallel groups, the cylinders of each group being arranged to make equal angles with each other, a shaft having oppositely set cranks with which the pistons of the respective groups are respectively connected, each of said two groups of cylinders being above a horizontal plane passed through the axis of said shaft, and valve mechanisms for the cylinders of the respective groups and comprising a distributing cam rotatable in a direction reverse to the direction of the crank shaft and having two parallel sets of cam surfaces coinciding angularly with the cylinders of the respective groups.

5. An internal combustion engine having a shaft having oppositely set cranks, an uneven number of cylinders arranged in two parallel groups each of which is above a horizontal plane passed through the axis of said shaft, the pistons of one group of cylinders being connected with one of said cranks and those of the other group being connected with the other crank of said shaft, valve mechanism including a distributing cam rotatable in a direction reverse to the direction of the crank shaft and having peripheral cam surfaces side by side and corresponding with the cylinders of the respective groups, an annular gear surface on said cam, and gearing for operating said cam from the crank shaft and comprising

a gear wheel mounted to turn and meshing with said annular gear face on the cam.

6. An internal combustion engine having a shaft having oppositely set cranks, an uneven number of cylinders arranged in two parallel groups each of which is above a horizontal plane passed through the axis of said shaft, the pistons of one group of cylinders being connected with one of said cranks and those of the other group being connected with the other crank of said shaft and valve mechanism including a distributing cam rotatable in a direction reverse to the direction of the crank shaft and having peripheral cam surfaces side by side and at angles to each other and valve rods arranged for contact upon said angular cam surfaces.

7. An internal combustion engine having a shaft having oppositely set cranks, an uneven number of cylinders arranged in two parallel groups each of which is above a horizontal plane passed through the axis of said shaft, the pistons of one group of cylinders having connection with one of said cranks while those of the other group have connection with the other crank of said shaft, and valve operating mechanism including cams having surfaces of different throw and rotatable in a direction reverse to the direction of the crank shaft.

In witness whereof I have hereunto signed my name this 18th day of April 1907, in the presence of two subscribing witnesses.

ROBERT ESNault-PELTERIE.

Witnesses:

H. C. COXE,

GABRIEL BELLARD.