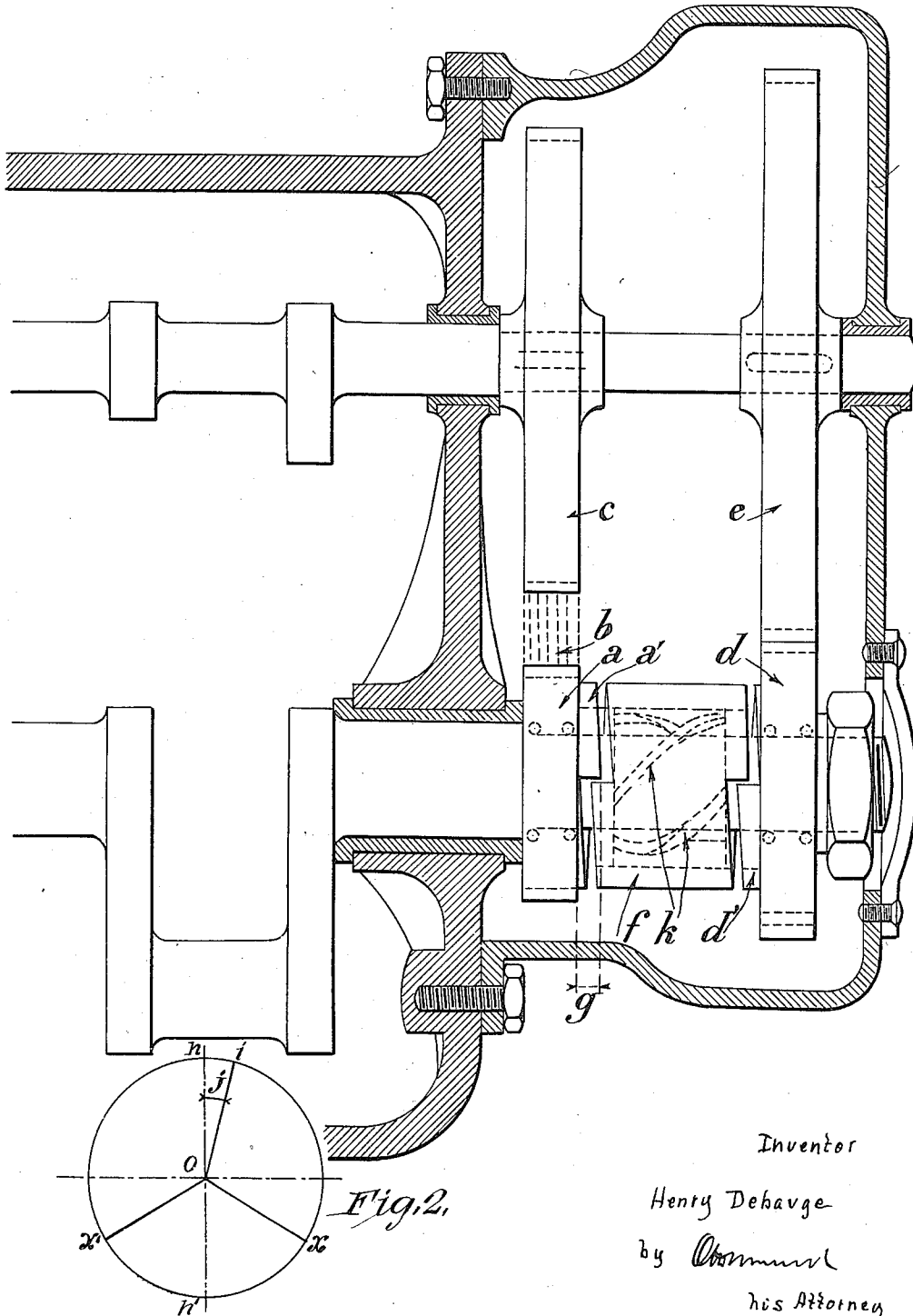


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INTERNAL COMBUSTION ENGINE.
APPLICATION FILED FEB. 10, 1919.

1,301,232.

Patented Apr. 22, 1919.

FIG. 1



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HENRY DEBAUGE, OF PARIS, FRANCE.

INTERNAL-COMBUSTION ENGINE.

1,301,232.

Specification of Letters Patent.

Patented Apr. 22, 1919.

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To all whom it may concern:

Be it known that I, HENRY DEBAUGE, citizen of the Republic of France, residing at 2 Rue de Penthièvre, Paris, in the Republic of France, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to improvements in internal combustion engines, and has especial reference to reversing mechanism for such engines.

The ideal construction must be:

1. Extremely simple, strong and mechanically practical:
2. Absolutely automatic:
3. Strictly infallible:
4. One doing mathematically equal work in both directions:
5. Of general application.

The invention has for its object an arrangement designed with a view to fulfilling these desiderata.

It consists essentially in means for effecting the reversal of the crank-shaft only, the other members, such as the cam-shaft, magneto, pumps, etc., retaining their normal direction of rotation, the essential feature of the invention being a driving-gear for the cam-shaft which will act in both directions. Further, any motor already constructed can be easily transformed.

The factors to be considered for this purpose are as follows:—

1. It must be noted that the cam-shaft being regulated by the piston and by nothing else, it is immaterial whether the crank-shaft rotates to the right or to the left; in descending the piston will suck in and it will always exhaust in reascending, if the valves are properly timed. The cam-shaft retaining its direction of rotation, the strokes of the cycle succeed each other in their normal order. The necessity immediately presents itself of a direct and a reverse drive for the cam-shaft, the two drives being totally independent of each other, but having their points of initiation of operation symmetrical at any moment on each side of the line of the dead points.

2. The action of the cams not being effected along the line of the dead points, but with advances and retardations permanently regulated, the advance and retardation on the left should be reproduced at the same angles as on the right. For this it is suf-

ficient to allow the crank-shaft to become unkeyed from the admitted angle, during its idle rotation toward the point symmetrical with its stopping point. This angle of unkeying on release is therefore invariable, while the symmetrical point, on the contrary, varies with the stopping point.

Finally there remains then to be established:

1. A direct drive of the cam-shaft:
2. A reverse drive of this shaft:
3. A member driving the one or the other:
4. The symmetrical points of initiation of operation:
5. A member permitting the unkeying or release of the crank shaft.

In the accompanying drawing a form of construction of the invention is illustratively exemplified.

Figure 1 is a view in section of the driving-gear of the cam-shaft.

Fig. 2 is a diagram relating to the unkeying or release of the crank-shaft.

A pinion *a* mounted on the crank-shaft, directly drives the cam-shaft by means of a chain *b* and the sprocket *c*.

Spaced from the pinion *a* a pinion *d* is mounted on the crank-shaft and engages with a wheel *e* on the cam-shaft, which gives a reverse drive.

The two pinions *a* and *d* are loose on the crank-shaft, whereas the wheels *c* and *e* are fixed on the cam-shaft. Consequently the two pinions always rotate in opposite directions and, if the crank-shaft drives the pinion *a* to the right, and the pinion *d* to the left, the cam-shaft rotates to the right, the pinion not driven by the crank-shaft rotating loosely on the latter and in the reverse direction.

This first point attained, there remains the driving of these pinions by the motor shaft.

For this purpose they each have on their surfaces facing each other a helicoidal claw *a'* and *d'*, cut in the same direction on both pinions but only allowing a drive in the opposite directions owing to their opposite mounting.

If therefore, the crank-shaft is provided with a nut *f* carrying claws corresponding to the claws *a'* and *d'* and capable of sliding longitudinally on and during the rotation of the crank-shaft, in one direction or the other, the drive can be effected in either direction.

Upon a change of rotation the helicoidal

inclines push each other back owing to the inertia of the cam-shaft, and of the pinion: the clutching of the nut or sleeve f is effected on the other pinion, the first becoming free again. The amplitude of movement of the sleeve should therefore equal the depth g of a claw.

Since the pinions rotate in opposite directions, their claws always occupy symmetrical points on each side of their starting point which is the line of the dead points.

Consequently the crank-shaft, stopped at any time at x for instance (Fig. 2) during suction, then started in the opposite direction passes idle through the angle x . o . x until it encounters the claw of the pinion d which is exactly at x^1 . At this moment only the cam-shaft starts again in the former direction through the action of the reverse drive from d .

There will be a back flow into the carbureter from x to h , then suction again from h into x^1 . The cam-shaft is therefore found to be keyed or adjusted to the left at the same angle that it was adjusted to the right, as well as all parts integral with it (magnetos, pumps, etc.,) and the rotation is secured as previously.

But heretofore the release of the operation of the cams in relation to the line of the dead points has not been taken into account. In going backward the motor would therefore have a very bad efficiency, the advance of sparking causing loss of speed, the retardation of the admission hindering advance, etc.

It will in the first place be laid down as a principle that one point of the cam-shaft being keyed, so are all the others, including the magneto. Then one can take as a basis the opening of the admission, as one could any other time, closing of exhaust, advance of the ignition, etc.

The action of the inlet-valve is effected after the high dead point, as l at an angle j generally of ten degrees.

Therefore the crank-shaft re-starting in the reverse direction, must be able to recover these 10 degrees and take 10 more to the left of the high dead point, that is, 20° of idle movement, before again driving the cam-shaft; and that in all cases.

Helicoidal keys k of suitable pitch are provided internally on the driving sleeve f , and these keys engage suitably pitched threads of a screw keyed to the crank-shaft between the pinions a and d . Coöperation between the keys k and the threads of the screws will not only cause the longitudinal displacement of this sleeve during reversal of rotation, but will also effect the release in the reverse direction of the crank-shaft which rotates without driving the cam-shaft during the longitudinal displacement of the sleeve.

The sleeve f drives the pinions a and d al-

ternately according to the direction of rotation.

Under these conditions the screw having a pitch such that 20° make an advance equal to the depth of a claw, these 20° are always acquired in one direction to the other by the crank-shaft during the time which the sleeve takes to move through this distance. And this in all cases, as the course of the sleeve is equal to the depth of a claw and invariable, whatever may be the angle to be passed through by the crank-shaft in order to return to the point symmetrical with its stopping point.

This driving-gear appears therefore to be the simplest possible. The members are obviously incapable of getting out of order and durable because they work without shocks. The automatic action is absolute, as is evident from the above statement.

No failure in engagement can take place, since a claw only leaves its pinion in order to engage with the opposite pinion.

Any backward movement of a pinion is corrected in the reverse direction by the other. The free claws rotate in the direction contrary to their clutching, therefore no accident is to be feared in this connection.

The efficiency of the motor is insured by the mathematical adjustment of the two shafts in all cases.

Further, it is evident that the application of this arrangement to any motor is very simple and presents no difficulty.

The force of attraction or repulsion of the screw on the sleeve tends to press the latter hard on the driven pinion, thereby insuring an unerring connection exempt from shocks.

Evidently any point of the cycle can be taken as basis, but it is essentially necessary that at the initial mounting the shafts be keyed for such point, all the claws being in line with the high dead point. The pitch of the screw is then determined by the depth of the claw in functions of the angle made by the selected point with the high dead point. There are, therefore, as many screws possible as points on the cycle.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an explosive engine, the combination with a crank shaft, of a cam shaft, spaced pinions mounted loosely on the crank shaft, means for locking either of said pinions to its shaft, a pinion fixed on the cam shaft and meshing with one of the pinions on the crank shaft, a second pinion fixed on the cam shaft, and a flexible driving connection between said last mentioned pinion and the other pinion on the crank shaft.

2. In an explosive engine, the combination with a crank shaft, of a cam shaft, comple-

mental interengaging means on said shafts for driving one from the other in a reverse direction, complementary means on said shafts out of engagement with each other to drive one shaft from the other in the same direction, means for connecting said last mentioned complementary means together, and means for rendering either complementary means operative.

3. In an explosive engine, the combination with a crank shaft, of a cam shaft, spaced pinions mounted loosely on the crank shaft, a sleeve slidable on the crank shaft between said pinions to lock either thereof to its shaft, a pinion fixed on the cam shaft and meshing with one of the pinions on the crank shaft, a second pinion fixed on the cam shaft, and a flexible driving connection between said last mentioned pinion and the other pinion on the crank shaft.

4. In an explosion motor the combination of a crank-shaft, a cam-shaft parallel with said crank-shaft, a first pinion loose on the crank-shaft, a first pinion keyed on the cam-shaft and engaging with said loose pinion, a second loose pinion on the crank-shaft, a second pinion keyed on the cam-shaft, a transmission member connecting said second pinions so that they rotate in the same direction, a thread formed on said crank-shaft

between the pinions carried by it, a coupling-nut screwing on said thread, and claws on the opposite ends of said nut and on the corresponding surfaces of the pinions carried by the crank-shaft.

5. In an explosive engine, the combination of a crank shaft, a cam shaft, means for driving one shaft from the other in the same direction, means for driving one shaft from the other in a reverse direction and means under the control of the crank shaft only for automatically varying the relative angular position of the cam shaft and crank shaft, when the crank shaft is started in a reverse direction.

6. In an explosive engine, the combination of a crank shaft, a cam shaft, means for driving one shaft from the other in the same direction, means for driving one shaft from the other in a reverse direction, both of said means embodying a common coupling device, and means under the control of the crank shaft only for automatically moving the coupling device to either of its operative positions when the rotation of the crank shaft is reversed.

In testimony whereof I have signed my name to this specification.

HENRY DEBAUGE.