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PATENT



SPECIFICATION

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PROVISIONAL SPECIFICATION.

**Improvements in or relating to Internal-combustion Engines.**

I, FREDERICK LAMPLUGH, M.I.A.E., Consulting Engineer, of Trafalgar House, Waterloo Place, London, S.W., do hereby declare the nature of this invention to be as follows:—

5 This invention is for improvements in or relating to internal-combustion engines and has for its object to provide a construction of such engine which is particularly suitable for aviation although it will be appreciated that the engine can be used for other purposes also.

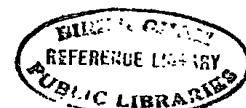
10 The engine is of the type in which the moving parts are balanced by using two oppositely moving pistons in each cylinder; according to this invention there is provided in an internal-combustion engine the combination with a pair of open-ended cylinders arranged side by side, each cylinder with two oppositely moving pistons therein, of a crank-shaft disposed in a plane transverse to the cylinders and preferably at the middle of their length, and having two cranks at 180°, and a rocking lever disposed near each end of the  
15 cylinders connected at one side of its fulcrum to the two pistons at that end of the cylinders so that the said pistons move similarly and in unison, each of the said levers being connected on the other side of its fulcrum to one of the said opposed cranks.

20 According to another feature of the invention two such combinations as above set forth are used, being so grouped as to constitute an engine in which the two cranks nearest the centre of the engine are side by side; as a consequence the engine, as to the masses of its moving parts, is completely balanced.

25 In one embodiment of the invention the engine is constructed with a suitable box-shaped frame, having bearings at each end and in a central web for the crank-shaft. On top of this frame the four cylinders are secured side by side with their axes all parallel and lying transversely of the crank-shaft. At each side of the frame there are mounted a pair of rocking levers, one such lever being allocated to and opposite the ends of each pair of cylinders. The levers are each provided with two upwardly extending arms which are connected  
30 to the pistons in the adjacent ends of a pair of cylinders, while a single downwardly extending arm is connected to one of the cranks of the crank-shaft. The two pistons at the other end of each pair of cylinders are similarly connected through a rocking lever to a crank on the crank-shaft opposed to that to which the first-mentioned pistons are connected. With this construction  
35 the pistons in each pair of cylinders approach and recede from one another as the crank-shaft rotates.

When four of the double ended cylinders are used, the eight pistons are so connected to the crank-shaft that they all reciprocate in unison, but their

[Price 6d.]



power strokes will preferably take place alternately so as to give a more uniform torque. Such an engine is particularly suitable for aviation work owing to its light weight, for although eight pistons are employed, there are only four connecting rods and cranks, since each rocking lever operates two pistons with each crank. Moreover, the moving parts of the mechanism are adequately 5 balanced.

The inlet and exhaust ports for each cylinder are formed at about the middle of its length, in the space between the two pistons. Two circumferential ports are used, and according to another feature of this invention they are controlled by a single short positively operated sleeve-valve. Preferably the sleeve-valve 10 itself is similar to that described in my earlier Patent Specification No. 39 of 1911, according to which specification the valve is operated by an external finger engaging with recesses or slots in the wall of the valve, the finger being reciprocated by a valve-rod. The sparking plug for igniting the mixture compressed between the two pistons is conveniently arranged between the inlet 15 and exhaust ports, and a suitable opening is formed in the sleeve-valve to put the pocket in which the plug lies, in communication with the combustion chamber.

Another feature of the invention consists in the operating gear for the valve, that is to say the mechanism by which the valve-rod carrying the above-mentioned finger is reciprocated. A cam-shaft is mounted parallel with and driven from the crank-shaft, and for each cylinder there are provided on it a pair of cams. Adjacent these cams there is pivotally mounted a bell-crank lever carrying a bearing roller on each arm to engage with one of the above-mentioned pairs of cams; the cams are so shaped that by their rotation they 25 rock the lever positively in opposite directions. One arm of the bell-crank lever is connected by a suitable link to the rod carrying the finger above-mentioned. Preferably the cams are so formed as to be complementary to one another, that is to say, that the rollers will always be maintained in contact with their respective cams. This construction renders the valve suitable for 30 use at high speeds, as it is found that a valve of this type, operated in one direction by a cam and in the opposite direction by springs, does not act sufficiently rapidly.

According to another feature of the invention the pivotal bearing for each of the bell-crank levers in the cam-operated gear is formed as an eccentric with a 35 suitable locking arrangement for securing it in any desired position. The object of this is to provide for adjustment of the rollers, such for example as is necessary after wear has taken place, to maintain them in contact with their respective cams.

The inlet and exhaust manifolds are conveniently mounted above the 40 cylinders, across which they extend parallel with the crank-shaft. The cylinders are preferably water-cooled, and a suitable pump for effecting circulation of the water is arranged at one end of the casing, being driven by the crank-shaft. Conveniently the driving wheel for this pump constitutes one of a train of gear-wheels by which the crank-shaft is connected to and drives 45 the cam-shaft. The magneto may be coupled to and driven by the cam-shaft in the usual manner.

Lubrication of the engine is effected by means of any suitable form of pump; in the preferred construction a rotary pump is mounted below the crank-shaft to draw oil from a sump, formed by the casing of the underside of the frame of 50 the engine, the pump being driven by skew gears from the cam-shaft. The sump is situated on the centre line of the engine, and the shaft extending from the cam-shaft to the pump is therefore inclined.

When the engine is to be used for aviation purposes, it is preferred to mount the propeller on a short shaft carried in suitable roller and ball-thrust bearings 55 at the end of the engine-frame, above the crank-shaft. The crank-shaft is connected to the propeller-shaft by gearing which is adjusted to reduce the

speed of the engine to a speed suitable for the propeller. The other end of the crank-shaft may be provided with any suitable form of dog clutch for connection with a shaft carrying the starting handle.

5 Various modifications may be made in the precise details of construction without departing from the spirit of this invention as hereinbefore described. Thus for example other forms of valve may be used on the engine although the sleeve-valve above described is preferred; similarly other forms of valve-operating gear may be used. Many of the details of mechanical construction, method of lubrication and so forth, have not been described for they are such  
10 as are known to those skilled in the art and need not be set forth in detail.

Dated, this 27th day of March, 1916.

BOULT, WADE & TENNANT,  
111 & 112, Hatton Garden, London, E.C.,  
Chartered Patent Agents.

15 **COMPLETE SPECIFICATION.**

**Improvements in or relating to Internal-combustion Engines.**

I, FREDERICK LAMPLOUGH, Consulting Engineer, of Trafalgar House, Waterloo Place, London, S.W., do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described  
20 and ascertained in and by the following statement:—

This invention is for improvements in or relating to the valves and valve-operating gear of internal combustion engines of the type in which there is a combination with a sleeve-valve of operating gear therefor, comprising a bell-crank lever, a bearing-roller on each arm thereof, a cam-shaft embraced by  
25 said lever and having a cam for each roller, the cams being so shaped as by their rotation to rock the lever positively in both directions, and a link connecting, directly or indirectly, one arm of the lever to the valve to be operated. The cams may be so formed relatively to one another as always to be in contact with their respective rollers whatever may be the relative angular  
30 position of the bell-crank lever.

According to this invention, the axial bearing of the bell-crank lever is formed with an eccentric to permit adjustment of the rollers into contact with their respective cams, such adjustment being required, for example after wear  
35 has taken place.

The above-described valve and valve-gear are particularly suitable for use with an engine having open-ended cylinders and two pistons reciprocating therein, the valve taking the form of a short sleeve disposed about the middle of the length of the cylinder. Another feature of the invention accordingly  
40 comprises the combination with such an engine of the valve and valve-operating gear as above set forth.

In the accompanying drawings,

Figure 1 is an elevation looking along the axes of the cylinders partly in section on the line 1—1 of Figure 2 and partly is section on the line 2—2 of  
45 Figure 2;

Figure 2 is a section on the line 3—3 of Figure 1;

Figure 3 is an end elevation of the engine looking along the axis of the crank-shaft, and

Figures 4 and 5 show details of the valve operating gear.

Like reference characters indicate like parts throughout the drawings.

50 Referring to Figures 1—3, the engine is constructed with a suitable box-shaped frame A having bearings A<sup>1</sup> at each end and also in a central web A<sup>2</sup> for the crank-shaft B. On top of this frame four cylinders C C<sup>1</sup> C<sup>2</sup> C<sup>3</sup> are secured side by side with their axes all parallel to one another and lying transversely of the crank-shaft.

At each end of the cylinders a spindle D is secured on the frame and it carries a pair of rocking levers, one lever being allocated to each pair of cylinders as shown more clearly in Figure 1. The levers comprise sleeves E, two upwardly extending arms E<sup>1</sup> and two downwardly extending arms E<sup>2</sup>. The arms E<sup>1</sup> are situated opposite the ends of two of the cylinders and are coupled by connecting rods E<sup>3</sup> to the pistons therein as shown in Figure 2, while the arms E<sup>2</sup> receive between them and engage a connecting rod E<sup>4</sup> connected to one of the cranks B<sup>1</sup> of the crank-shaft B. Considering the pair of cylinders C C<sup>1</sup>, the rocking lever at one end is connected to a crank B<sup>1</sup>, while the rocking lever at the other end is connected to the crank B<sup>2</sup> which is at 180° from the crank B<sup>1</sup>.

The pistons in the cylinder C<sup>2</sup> C<sup>3</sup> are similarly connected to two cranks B<sup>3</sup> B<sup>4</sup> of the crank-shaft B, this pair also being 180° apart. The two cranks B<sup>2</sup> B<sup>3</sup> which are adjacent one another at the middle of the crank-shaft are arranged side by side.

It will be seen that in this four-cylinder engine there are eight pistons and they are so connected to the crank-shaft that they all reciprocate in unison; the engine is preferably worked on a four-stroke cycle and the power strokes are arranged to take place alternately so as to give a more uniform torque.

The inlet and exhaust manifolds F F<sup>1</sup> respectively are conveniently mounted above the cylinders across which they extend parallel with the crank-shaft B. The cylinders are water-cooled, the jackets being indicated at G. A positive circulation of the water is effected by a pump G<sup>1</sup> which is driven from the crank-shaft by means of gears H H<sup>1</sup>. These two gears are used as part of a train including the gear-wheel H<sup>2</sup> to drive the magneto and cam-shaft in the usual manner. These accessories and the gear-train for driving them are conveniently mounted on the frame at one end as shown most clearly in Figure 3.

Lubrication of the engine is effected by any desired form of pump which is preferably gear-driven from the cam-shaft and is so situated as to draw oil from a sump formed by the casing on the under side of the frame of the engine.

When the engine is to be used for aviation purposes, it is preferred to mount the propeller on a third shaft J carried in suitable roller bearings J<sup>1</sup> on an extension of the frame A. Ball thrust bearings J<sup>2</sup> are also provided to take up the end-thrust. The shaft J carries a gear J<sup>3</sup> meshing with and driven by the gear J<sup>4</sup> secured on the end of the crank-shaft B. This gearing permits the propeller to run at a speed different from that of the engine so that the speeds may be chosen to obtain the highest efficiency from both the propeller and the engine. The other end of the crank-shaft B is provided with a dog-clutch or equivalent connection B<sup>5</sup> for connection with a shaft B<sup>6</sup> carrying the starting handle for the engine.

The inlet and exhaust manifolds F F<sup>1</sup> are each provided with connecting passages F<sup>2</sup> by which they communicate with the cylinders, the connection being made at about the middle of the length of the cylinders. The cylinders are of smaller diameter at the middle of their length as shown in Figure 2 and the inlet and exhaust ports F<sup>3</sup> F<sup>4</sup> extend circumferentially, round such reduced portion. These ports are controlled by the single short sleeve-valve K which is positively operated. The sleeve-valve itself is preferably similar to that described in my earlier Patent Specification No. 39 of 1911. According to this specification, the valve is operated by an external finger engaging recesses or slots in the wall of the valve, the finger being reciprocated by a valve-rod. The sparking plug for igniting the mixture is conveniently arranged between the inlet and exhaust ports, and a suitable opening K<sup>1</sup> is formed in the valve K to put the pocket K<sup>2</sup>, in which the plug lies, in communication with the combustion chamber of the cylinder.

An important feature of the invention consists in the operating gear for the valve, that is to say, the mechanism by which the valve-rod K<sup>3</sup> connected to the sleeve K is reciprocated.

The cam-shaft L is shown in Figure 2 and is rotated as above-mentioned by the gearing H H<sup>1</sup> H<sup>2</sup> from the crank-shaft. This cam-shaft L is mounted parallel with the crank-shaft and there are provided on it a pair of cams for each cylinder. Figure 4 shows two cams L<sup>1</sup> L<sup>2</sup> for one of the cylinders, and adjacent them there is pivotally mounted a bell-crank lever having arms M N. Each arm carries a roller M<sup>1</sup> N<sup>1</sup> respectively and as will be seen by reference to Figure 5, the arms M N are conveniently duplex with the rollers mounted between them. The rollers M<sup>1</sup> N<sup>1</sup> are spaced apart longitudinally of the shaft L so that one of them bears on each cam, and the cams are so shaped that by their rotation they rock the lever M N positively in both directions.

One arm M of the bell-crank lever is connected by a suitable link K<sup>4</sup> with the valve-operating rod K<sup>3</sup>.

Preferably the cams L<sup>1</sup> L<sup>2</sup> are so formed as to be complementary to one another, that is to say, that the rollers M<sup>1</sup> N<sup>1</sup> will always be maintained in contact with their respective cams. This construction renders the valve suitable for use at high speeds, for it is found that a sleeve-valve of this type operated in one direction by a cam and in the opposite direction by springs, does not act sufficiently rapidly.

According to another feature of the invention, the bell-crank lever M N is mounted eccentrically on its spindle L<sup>3</sup>, and means are provided for securing it in any desired position on the eccentric. The object of this is to provide for adjustment of the rollers towards and away from the cams, so that they can be adjusted and maintained in contact with the cams after wear has taken place.

It is to be understood that no claim is made to the general construction of the engine hereinbefore described insofar as it relates to the arrangement and disposition of the cylinders, pistons, rocking levers and crank-shaft, but the valve-gear hereinbefore described is particularly suitable for such an engine when used, for example on aircraft, on account of the light weight and reliability. It will be appreciated that each valve controls the equivalent of two cylinders so that the weight of the valve-operating gear is considerably less than would be required in an eight-cylinder engine of other types giving the same output of power, for in such other types each cylinder would require its own valves and valve-gear.

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

1. The combination with the valve-operating bell-crank lever in an engine of the kind defined of an eccentric mounting for the lever-pivot to permit adjustment of the levers (or their rollers) into contact with their respective cams.

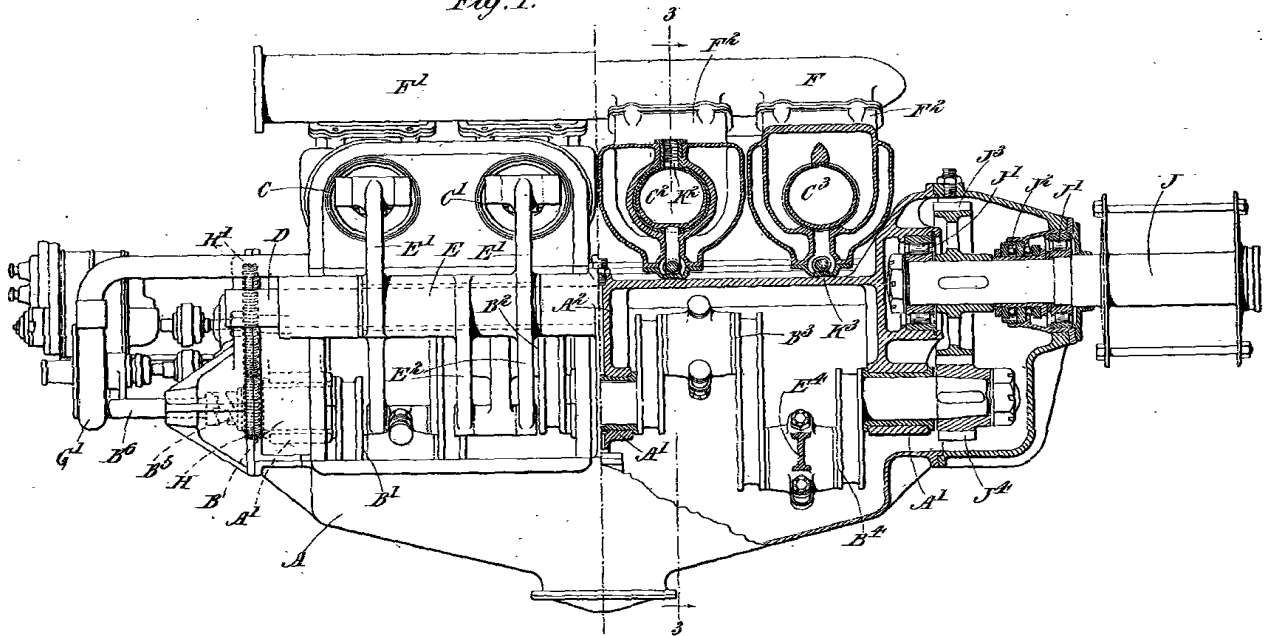
2. In an internal combustion engine the combination with the cylinder open at both ends and having a pair of oppositely moving pistons therein of a single sleeve-valve at the middle of the length of the cylinder and operating mechanism therefor as set forth in claiming-clause No. 1.

3. The improved valve-operating gear for a sleeve-valve in an internal combustion engine as described or as illustrated in the accompanying drawings.

Dated this 27th day, of September, 1916.

BOULT, WADE & TENNANT,  
111 & 112, Hatton Garden, London, E.C.,  
Chartered Patent Agents.

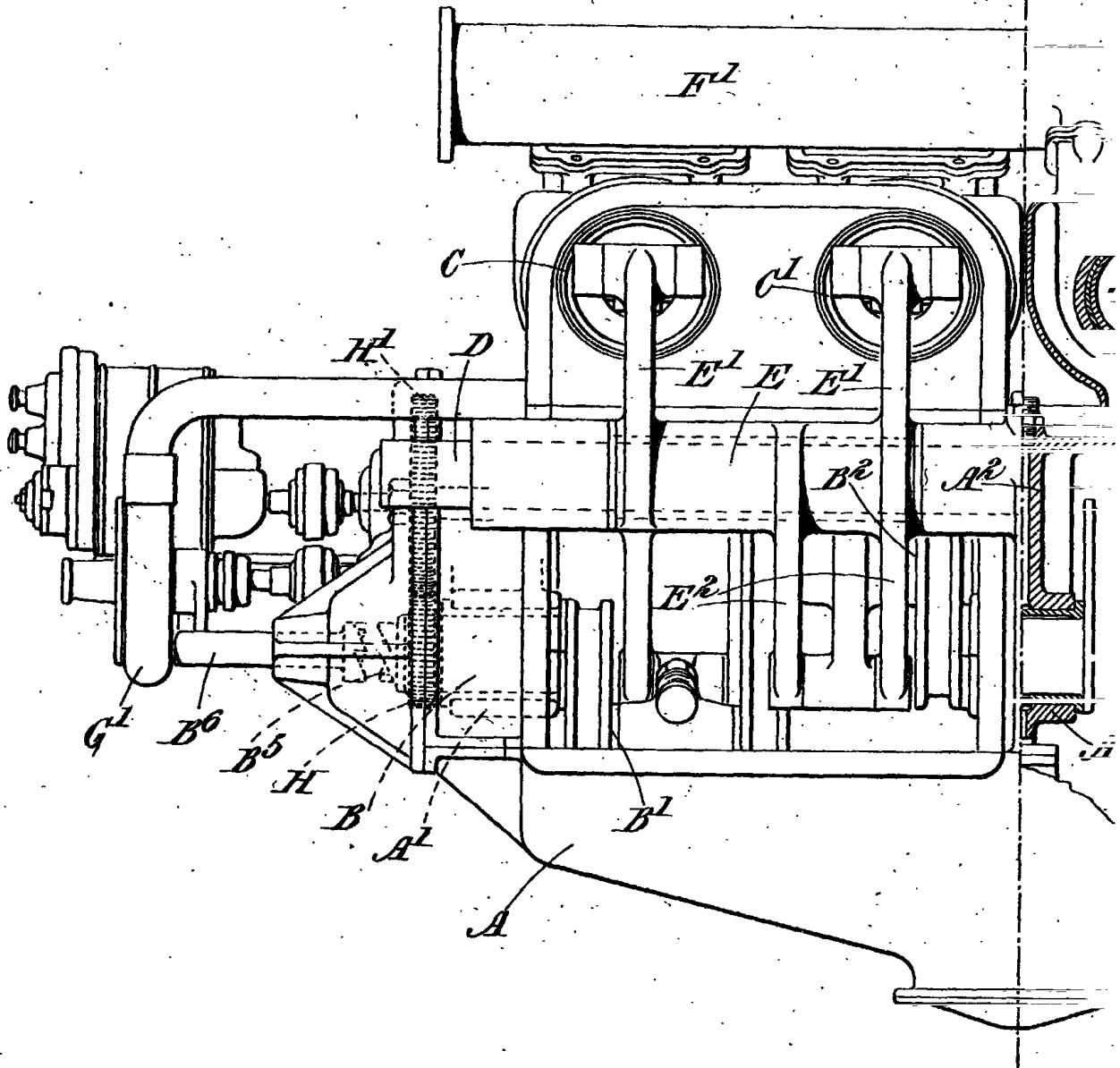
Fig. 1.



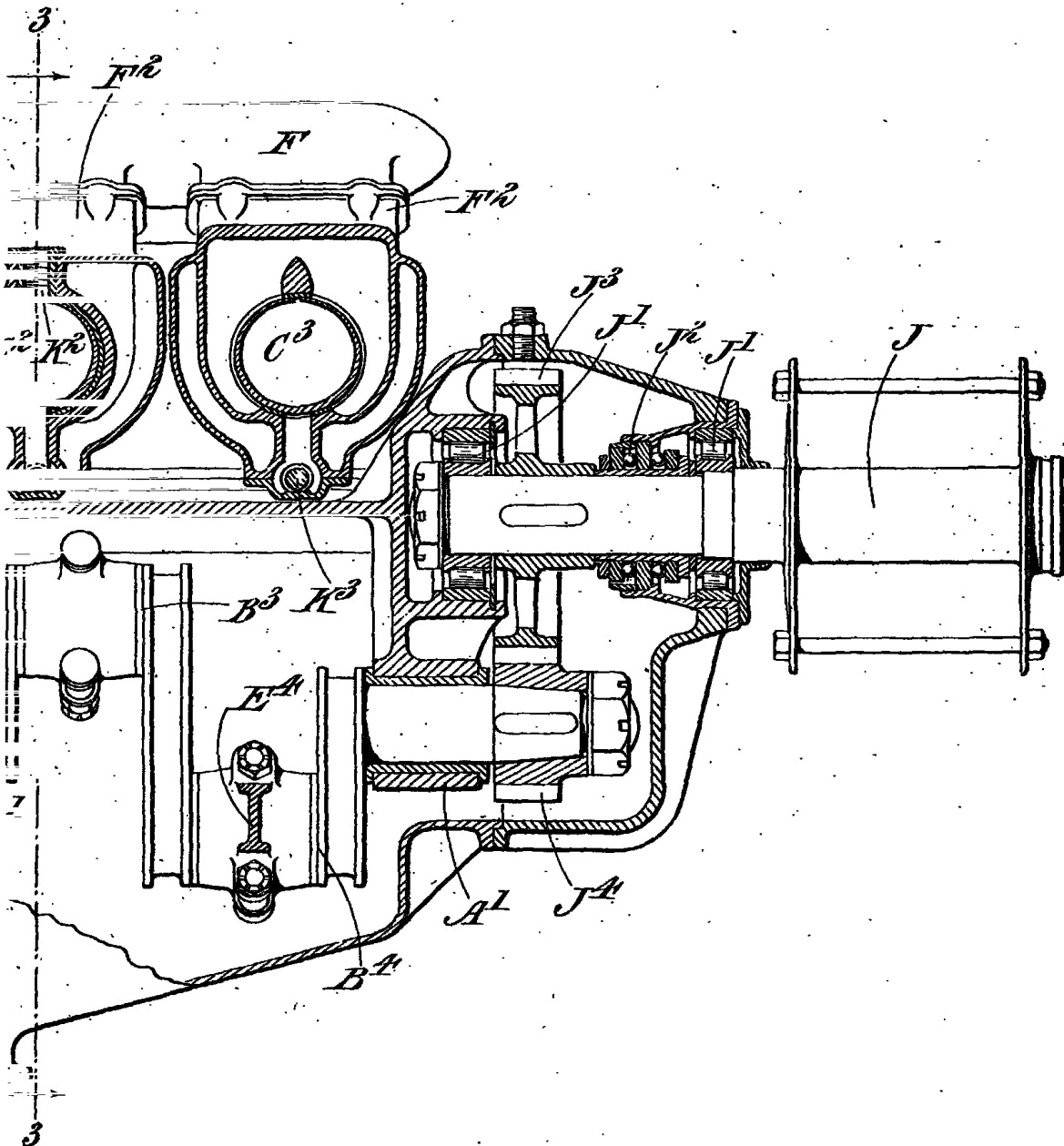
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Fig. 1.

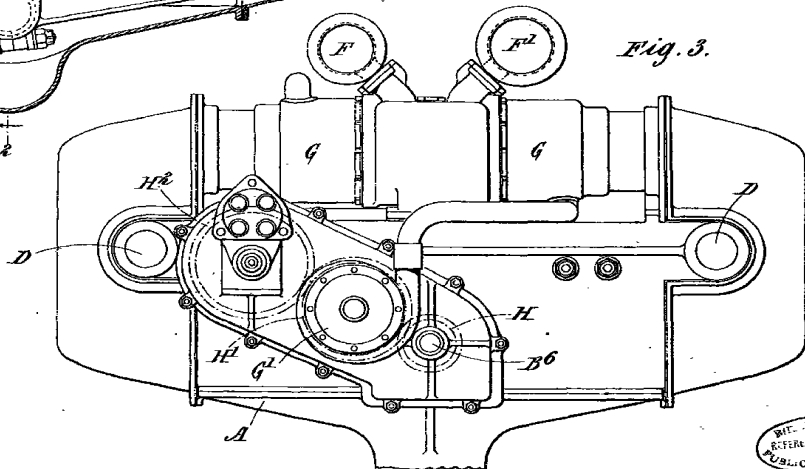
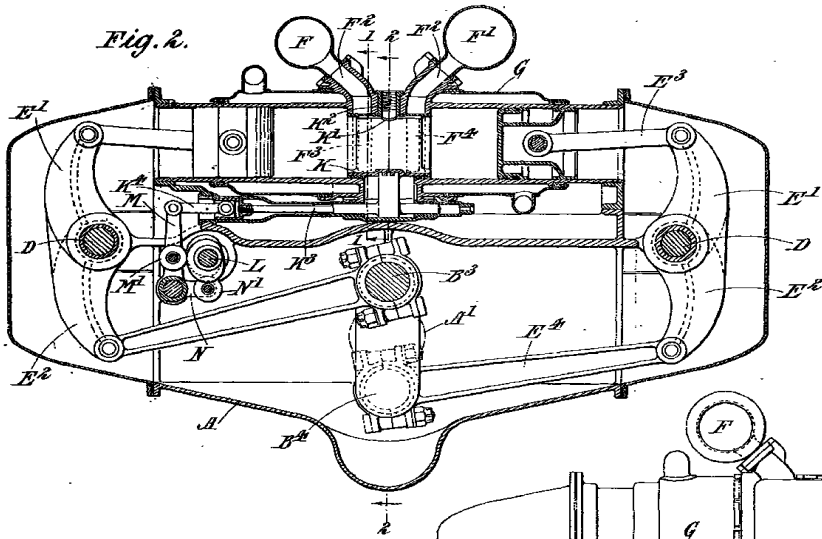


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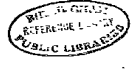
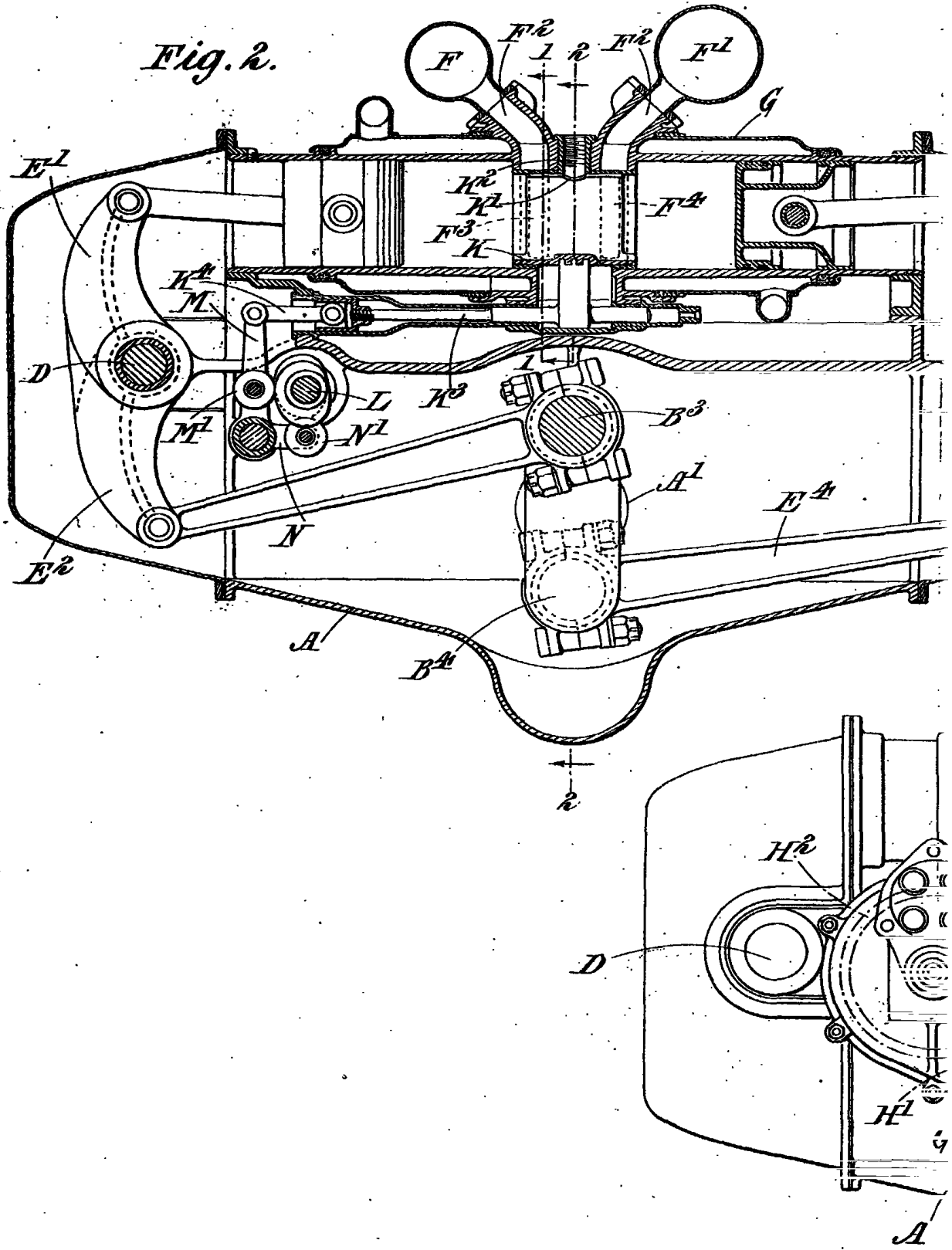


Fig. 2.



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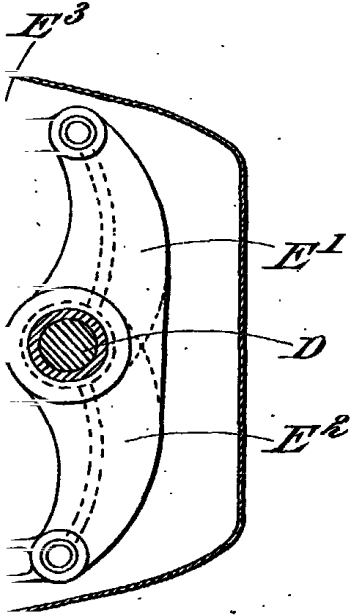
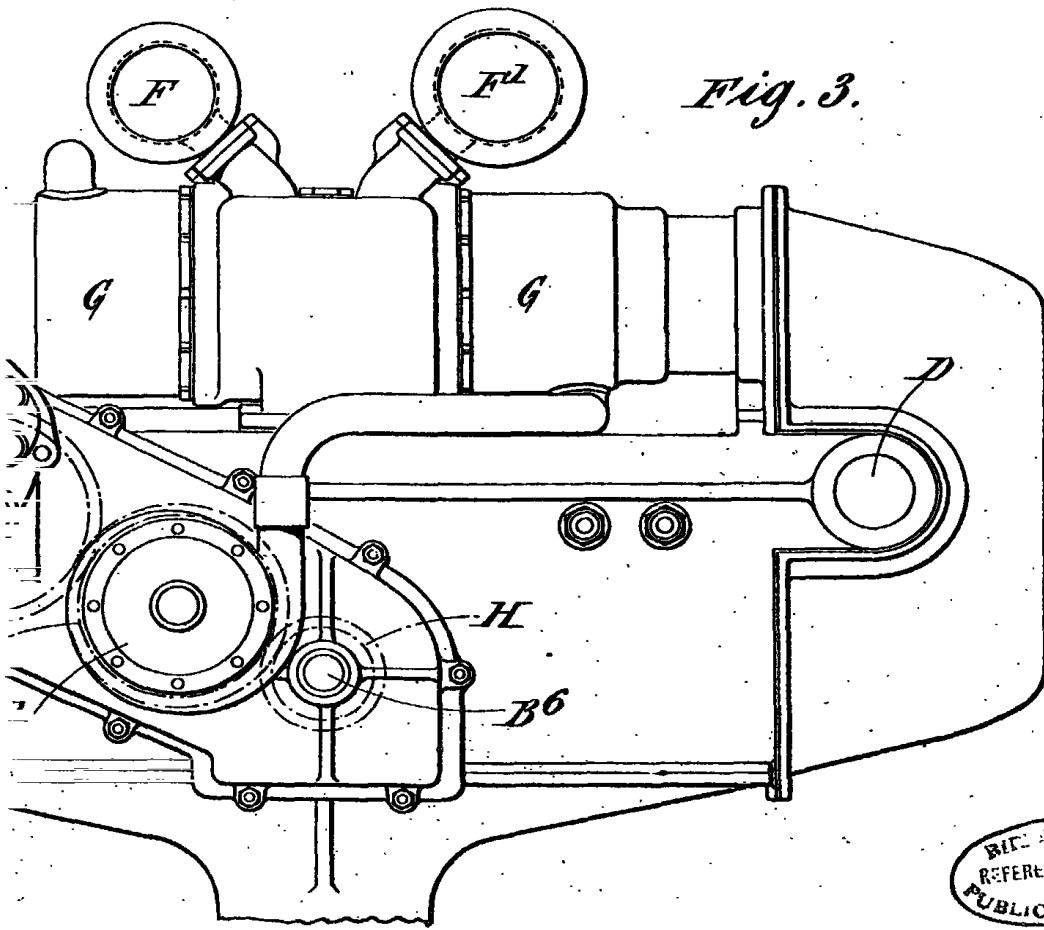


Fig. 3.



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Fig. 5.

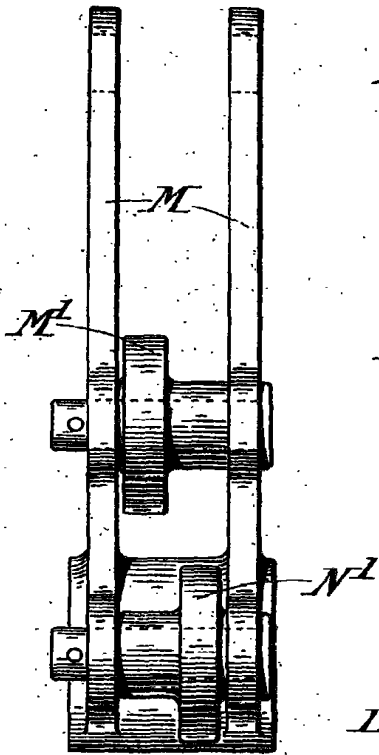
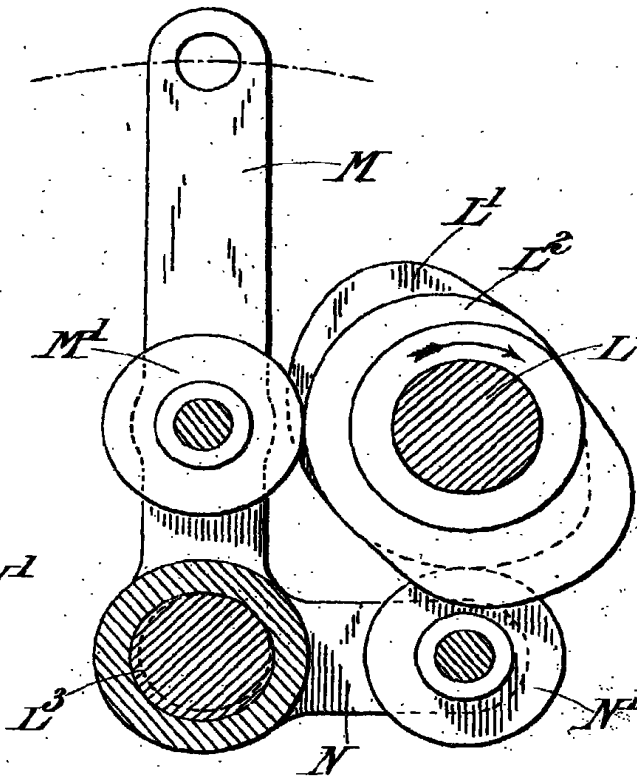


Fig. 4.



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