# PATENT SPECIFICATION

Application Date: Sept. 18, 1919. No. 23,028/19. 165,861
,, ,, Dec. 15, 1919. No. 31,397/19.
One Complete Specification Left: June 15, 1920.
Complete Accepted: July 11, 1921.

## PROVISIONAL SPECIFICATION.

No. 23,028, A.D. 1919.

### Improvements in or relating to Reciprocating Engines.

We, VICKERS LIMITED, of Vickers House, Broadway, Westminster, in the County of London, and Sir JAMES MCKECHNIE, K.B.E., Director of Vickers Limited, aforesaid, of Naval Construction Works, Barrow-in-Furness, in the County of Lancaster, do hereby declare the nature of this invention to be as follows:—

This invention relates to reciprocating engines, such as internal combustion or steam engines, of the type employing opposed pistons in a common cylinder and connected to a common crank shaft.

According to this invention a pair of cylinders each carries a pair of oppositely acting pistons with a common working space between them, the said pistons being connected to the ends of a pair of rocking levers placed at opposite ends of the cylinders and each connected at one end through a link to a connecting-rod driving the crank of the engine shaft. The end of the connecting-rod may be guided by a slide working in a guide in the engine casing between the two cylinders, which are placed on each side of the crank shaft, or if the links connecting the rod to the rocking levers are constructed as a single member extending from one lever to the other, this member may be made sufficiently strong to withstand the side stresses which are then borne by the trunnions of the rocking levers.

The links between the levers and the connecting-rod are subjected both to tension and compression, but compression may be avoided by connecting the opposite ends of the rocking levers by a tension rod independent of the connecting-rod. The working strokes of the two cylinders alternate, the pistons in one cylinder performing their inward stroke while the other pistons are on their outward stroke.

An internal combustion engine of the ordinary type of say, 300 to 400 brake horse power, single cylinder, would require water cooled pistons, but with this arrangement cylinders of sufficiently small diameter can be utilised so as to develope the same horse power and render water cooling of their pistons unnecessary, and for the powers above this oil cooling might be adopted, and only water cooling would be required for larger cylinders of say, over 12″ diameter for two-stroke engines, or over 17″ diameter for four-stroke engines.

Dated this 18th day of September, 1919.

HASELTINE, LAKE & Co.,
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55, Liberty Street, New York City, U.S.A.,
Agents for the Applicants.

## PROVISIONAL SPECIFICATION.

No. 31,397, A.D. 1919.

### Improvements in or relating to Reciprocating Engines.

We, VICKERS LIMITED, of Vickers House, Broadway, Westminster, in the County of London, and Sir JAMES MCKECHNIE, K.B.E., Director of Vickers Limited, aforesaid, of Naval Construction Works, Barrow-in-Furness, in the County

of Lancaster, do hereby declare the nature of this invention to be as follows:—

This invention relates to reciprocating engines, such as internal combustion or steam engines, of the type employing opposed pistons in a common cylinder and connected in common to a crank shaft. In the Provisional Specification of our Application for Patent No. 23,028, dated 18th September, 1919, we have described a duplex engine of this type, in which the pistons of the two cylinders are connected to a pair of rocking levers at opposite ends of the cylinders, the levers themselves being connected by a link or links driving the shaft through a connecting rod. The present invention relates to various improvements or modifications in this construction of engine.

According to one of the modifications the rocking levers at each end of the cylinders are double and a pair of links is provided, one at each side of the cylinders, a cross pin connecting the two links at the middle and providing for the attachment of two connecting rods driving a pair of cranks on the crank shaft. The cross pin and the ends of the connecting rods may be attached to one side of the link, the crank shaft being correspondingly displaced from the centre line of the engine.

We may also employ a single connecting rod and crank for two pairs of cylinders placed side by side, the pin of the connecting rod passing through the centre of the rocking lever links belonging to the engine unit on each side of the rod. This arrangement is preferably employed with two pairs of links and corresponding rocking arms for each unit.

As in the construction described in the Provisional Specification No. 23,028 of 1919 already referred to, the link connecting the rocking levers may be guided or it may be left unguided, since the side stresses are found to be comparatively small, and even if the link is made in two parts it may not be necessary to provide a guide for the jointed centre.

Dated this 15th day of December, 1919.

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Agents for the Applicants.

## COMPLETE SPECIFICATION.

### Improvements in or relating to Reciprocating Engines.

We, VICKERS LIMITED, a company registered under the laws of Great Britain, of Vickers House, Broadway, Westminster, in the County of London, and Sir JAMES MCKECHNIE, K.B.E., Director of Vickers Limited aforesaid, of Naval Construction Works, Barrow-in-Furness, in the County of Lancaster, a subject of the King of Great Britain, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to reciprocating engines, such as internal combustion or steam engines, of the type employing oppositely acting pistons in a common cylinder with common working space and driving a crank shaft through a pair of interconnected rocking levers belonging to the pistons of a pair of cylinders.

According to this invention the crank shaft is driven by a connecting rod attached to a cross link connecting opposite sides of the opposing rocking levers. This arrangement allows the crank shaft or shafts to be placed clear of the cylinders so as to economise the space occupied by the cylinders while obtaining a high degree of balancing due to the opposing stresses at each cylinder. The end of the connecting rod may be guided by a slide working in a guide in the engine casing between the two cylinders or, if the links connecting the rod to the rocking levers are constructed as a single member extending from one lever to the other, this member may withstand the comparatively small side stresses, which are then borne by the trunnions of the rocking levers.

The links between the levers and the connecting rod are subjected both to tension and compression, but compression may be avoided by connecting the opposite ends of the rocking levers by a tension rod independent of the connecting rod. The working strokes of the two cylinders alternate, the pistons in one cylinder performing their inward stroke while the other pistons are on their outward stroke,

In order that the said invention may be clearly understood and readily carried into effect we will now describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a sectional elevation of a construction of internal combustion engine embodying this invention, and

Figures 2 to 5 are diagrammatic elevations of a series of modifications of the engine.

A, A are the cylinders. B, $B^1$ are the top and bottom pistons, a pair of pistons working in each cylinder. C, $C^1$ are the top and bottom rocking levers connected to the pistons by the connecting-rods *b*. D is the link connecting crosswise the opposite ends of the top and bottom levers C, $C^1$. E is the crank shaft. F is the connecting-rod driving the shaft E.

Referring to the arrangement shown in Figure 1, the cylinders A are shown symmetrically placed on each side of the crank shaft E, to the crank pin *e* of which is secured the outer end of the connecting-rod F, the upper or inner end of which is provided with the crosshead *f* on the cross pin *d* of the link D. The crosshead is shown with the slipper bars $f^1$ sliding between guides *g* on the engine casing G, so that any side stresses which may arise are taken by the guides and the engine casing on the frame $G^1$, which is mounted on the base $G^2$, the latter carrying the bearings $g^1$ for the shaft E.

The lower lever $C^1$ is pivotally mounted on trunnions *c* carried by the frame $G^1$ and the upper lever C is mounted on trunnions $c^1$ carried by the bracket or upper frame $G^3$ which is connected to the base $G^2$ by the tie rods $g^2$. The upper arm of the link D is shown as larger than the lower arm and if the crosshead *f* is guided as shown the two arms of the link should be separate and both pivoted at the pin *d*. The pistons B, $B^1$ are shown unsymmetrically placed in their cylinders A so that the exhaust ports $a^1$ leading to the exhaust outlet $a^2$ at the upper end of the cylinders are uncovered before the inlet ports $a^3$ leading from the air inlet $a^4$ at the lower end of the cylinder.

The engine operates on ordinary two stroke lines, but the flow of gases is, as is in the known opposed piston type of engine, always in the same direction, the air entering at one end of the space and the gases exhausting at the other. The use of a connecting-rod for driving the shaft enables a very compact form of engine to be designed, with the cylinders close together and the crank shaft in any position that may be desirable.

In the modification shown diagrammatically in Figures 2 and 3 the rocking levers C, $C^1$ at each end of the cylinders A are double (see Figure 3) and a pair of links D is provided, one at each side of the cylinders, the cross pin *d* connecting the two links at the middle and providing for the attachment of two connecting-rods F driving a pair of cranks *e* on the crank shaft E. The cross pin and the ends of the connecting-rods may be attached to one side of the link as shown in Figure 2, the crank shaft E being correspondingly displaced from the centre line of the engine.

We may also, as shown in Figures 4 and 5, employ a single connecting rod F, and crank *e* for two pairs of cylinders $A^1$ placed side by side, the pin $d^2$ of the connecting rod F passing through the centre of the rocking lever links D belonging to the engine unit on each side of the rod. This arrangement is preferably employed, as shown, with two pairs of links D and corresponding rocking arms C, $C^1$ for each unit. As already described the ends of the levers C, $C^1$ opposite to the link connections may be connected together by a tension rod so as to avoid subjecting the link D to compression but this auxiliary connection is not necessary.

An internal combustion engine of the ordinary type of say, 300 to 400 brake horse power, single cylinder, would require water cooled pistons, but with this arrangement cylinders of sufficiently small diameter can be utilised to develope the same horse power and render water cooling of their pistons unnecessary, and for the powers above this oil cooling might be adopted, and only water cooling would be required for larger cylinders of, say, over 12″ diameter for two-stroke engines, or over 17″ diameter for four-stroke engines.

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. A reciprocating engine, in which each one of a pair of cylinders carries a pair of oppositely acting pistons with a common working space between them, and connected to the ends of a pair of rocking levers placed at opposite ends of the cylinders and the crank shaft is driven by a connecting rod attached to a cross link connecting opposite sides of the opposed rocking levers.

2. A reciprocating engine as claimed in Claim 1, in which the end of the connect-

ing rod attached to the link is guided in guides belonging to the engine casing.

3. A reciprocating engine as claimed in Claim 1, in which the connecting rod to the crank shaft is attached to the link at or near the middle of the latter and without guiding of the rod, the side stresses being taken by the said link.

4. A reciprocating engine as claimed in Claim 1, in which two pairs of cylinders are employed with two pairs of rocking levers the links of which are connected by a common cross pin driving the connecting rod of the crank shaft.

5. A reciprocating engine of the opposed piston type having its parts arranged and adapted to operate substantially as hereinbefore described with reference to any one of the examples illustrated in the accompanying drawings, for the purpose specified.

Dated this 15th day of June, 1920.

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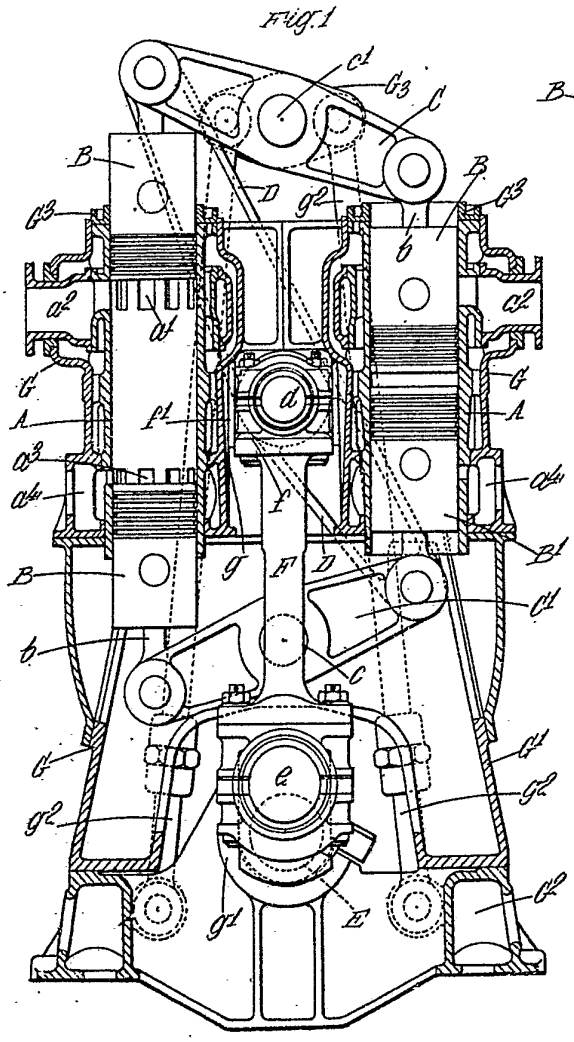


FIG. 1.

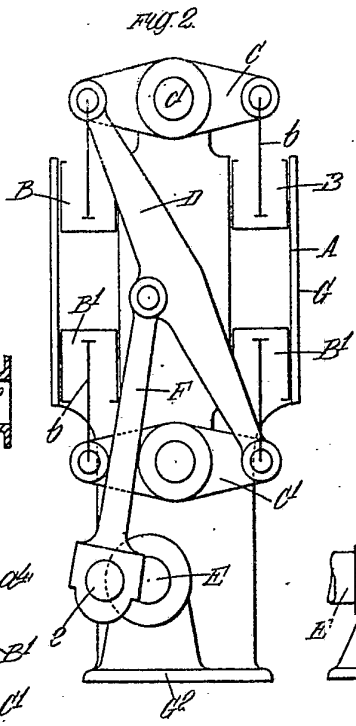


FIG. 2.

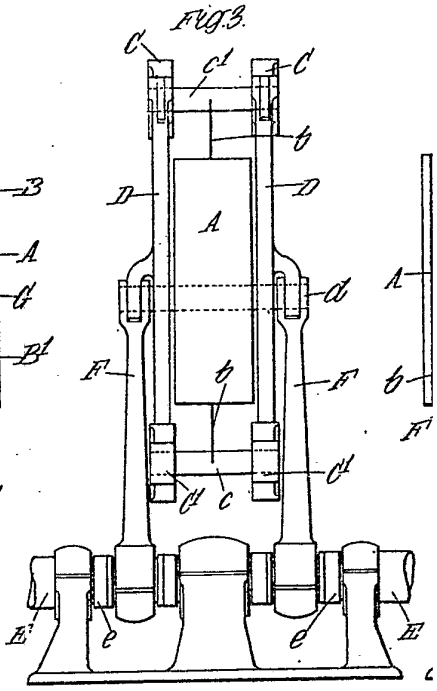
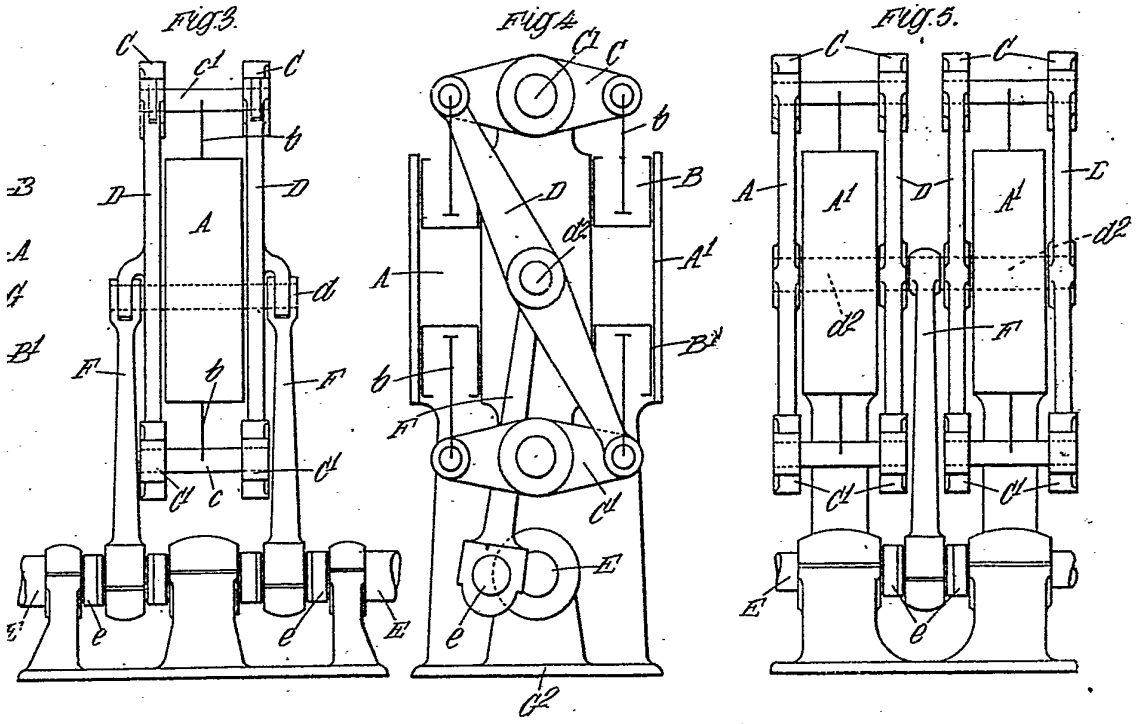


FIG. 3.

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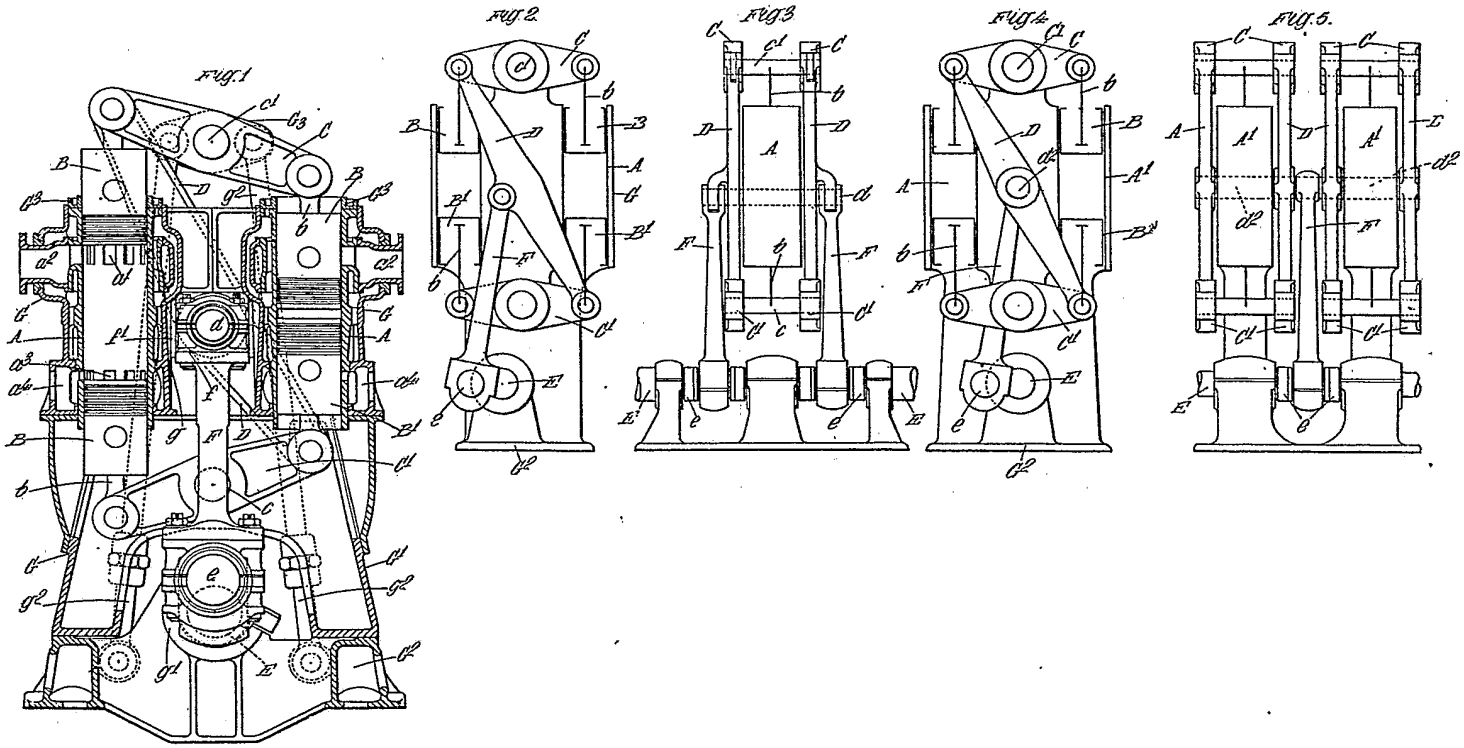


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