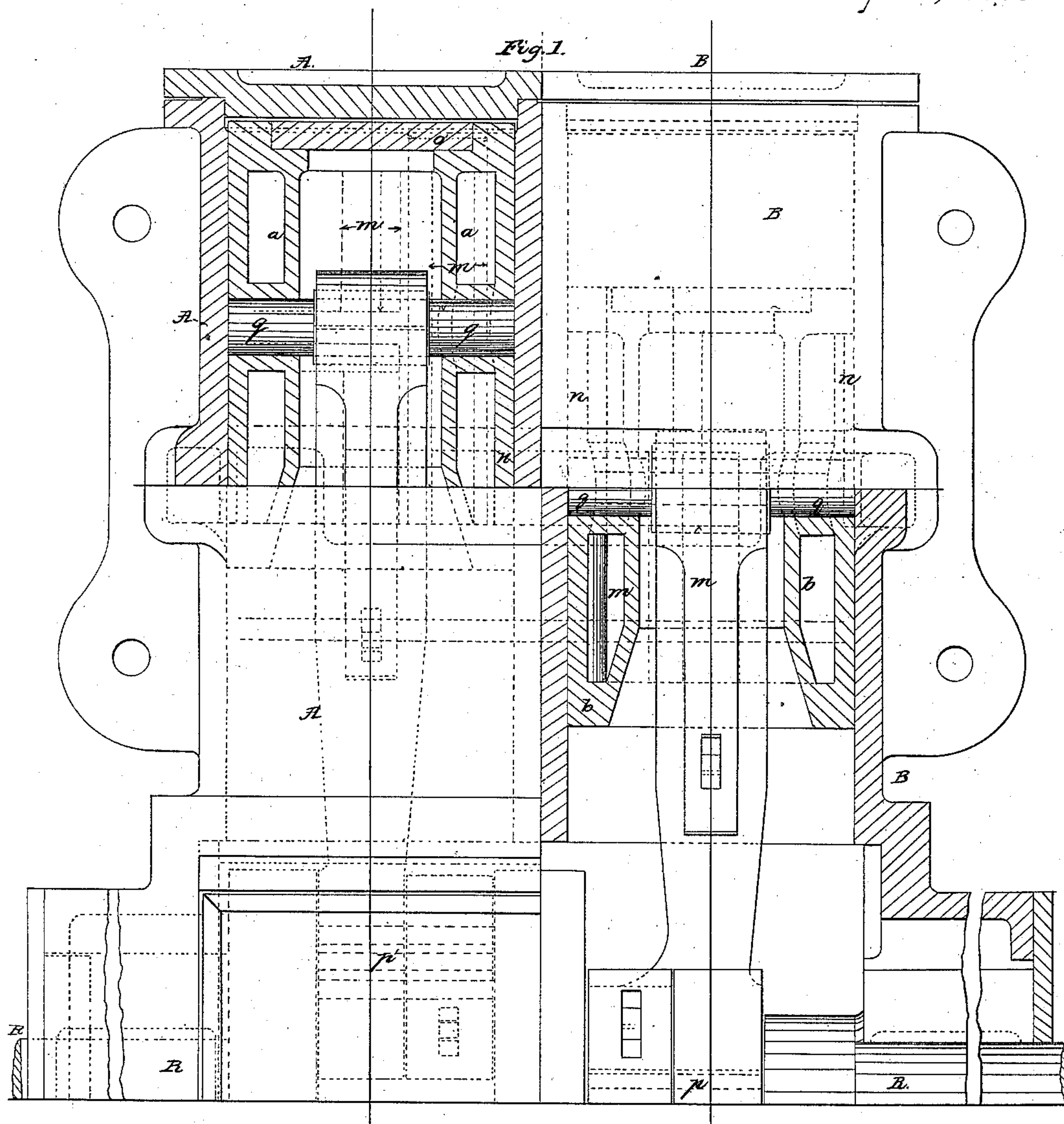


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*Nº 54,906,*

*Patented May 22, 1866.*



*Inventor:*

Jos. L. Coombs  
 Attest

Wm. Chas. & Hicks

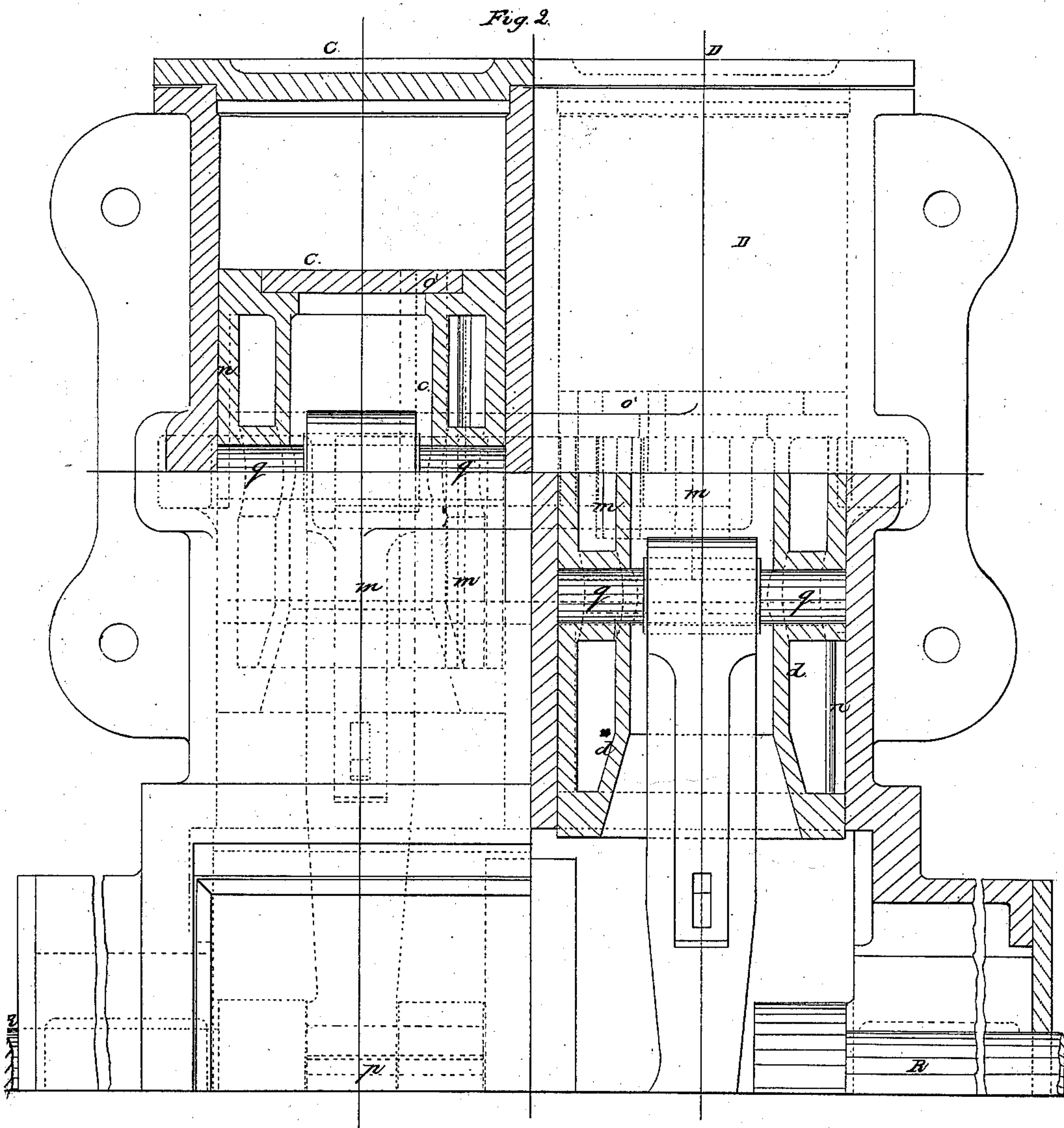
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W. C. Hicks,

*Reciprocating Steam Engine,*

No 54,906,

*Patented May 22, 1866.*



*Witnesses:*

Jos. L. Coombs  
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*Inventor:*

Wm Cleveland Hicks.

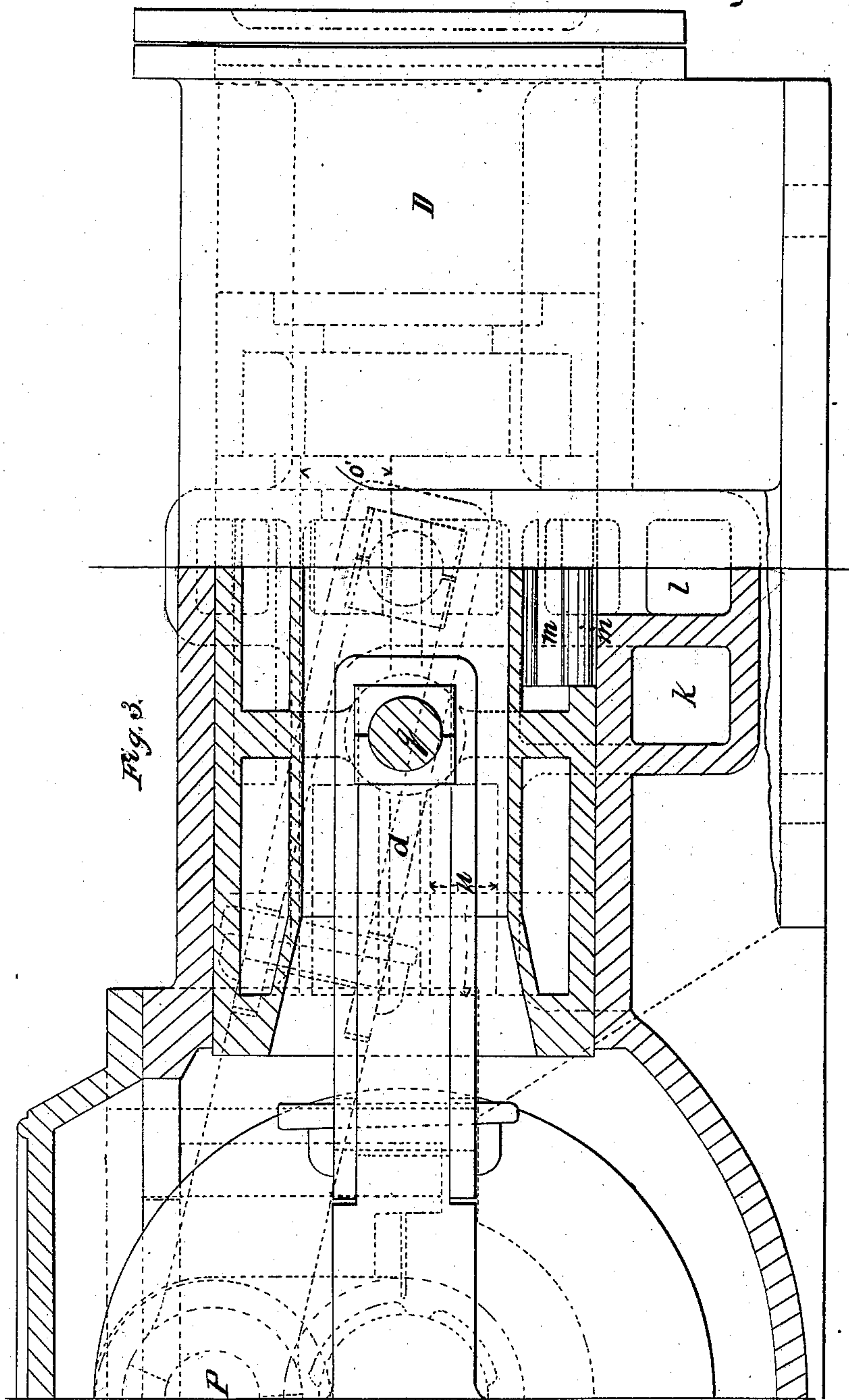


W. C. Hicks,

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No 54,906,

Patented May 22, 1866.



Witnesses: Jos. L. Coombs  
Attest

Inventor:  
Wm. Cleveland Hicks

W. C. Hicks,

Sheet 4-6 Sheets.

Reciprocating Steam Engine,

No. 54,906,

Patented May 22, 1866.

Fig. 4

Witnesses:

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A. P. Hoke

Inventor:

Wm. Cleveland Hicks



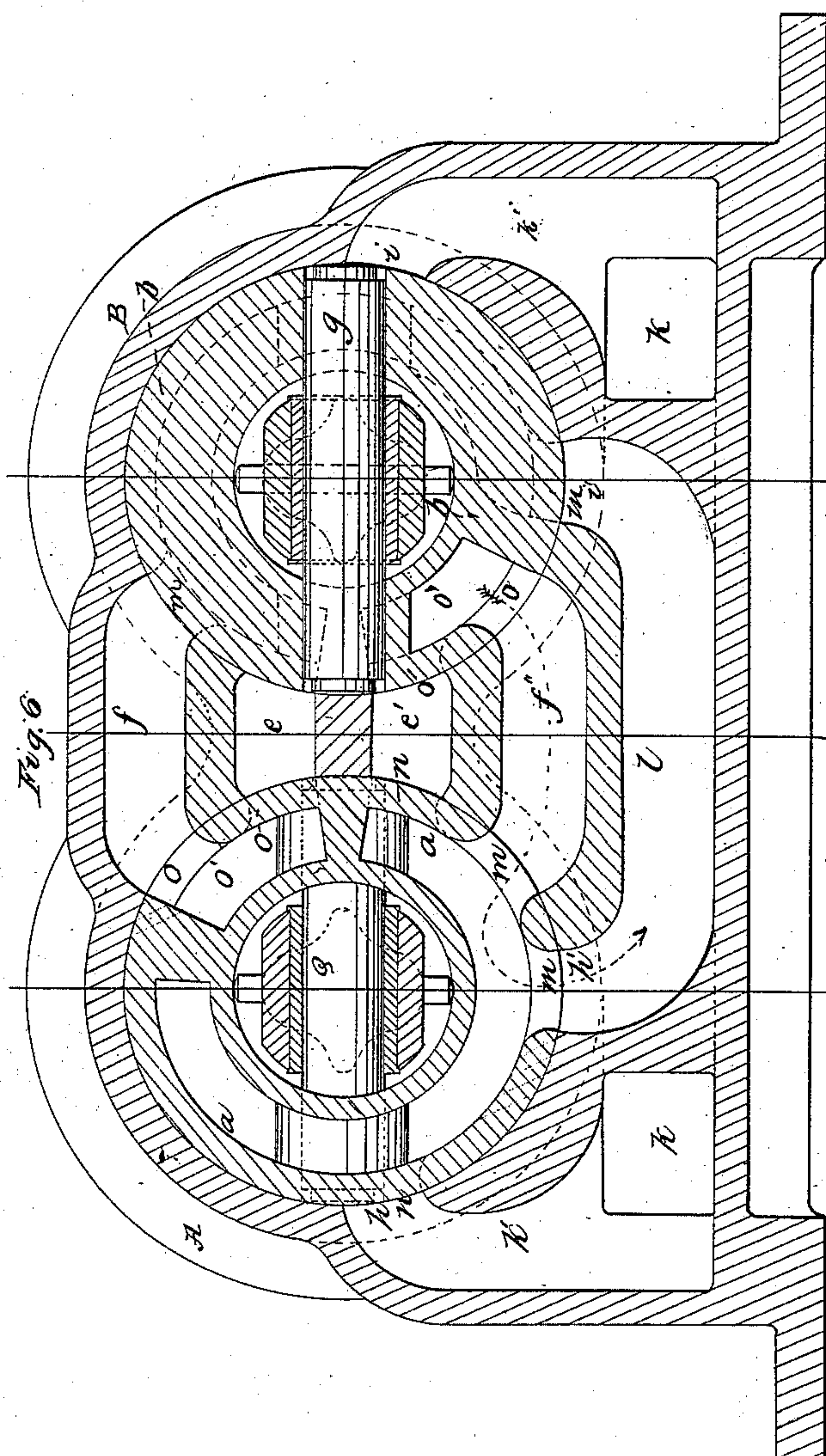
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W.C. Hicks,

Reciprocating Steam Engine,

No. 54,906,

Patented May 22, 1866.



Witnesses:

Jos. L. Leavelle

A. Pollock

Inventor:

Wm. Cleveland Hicks

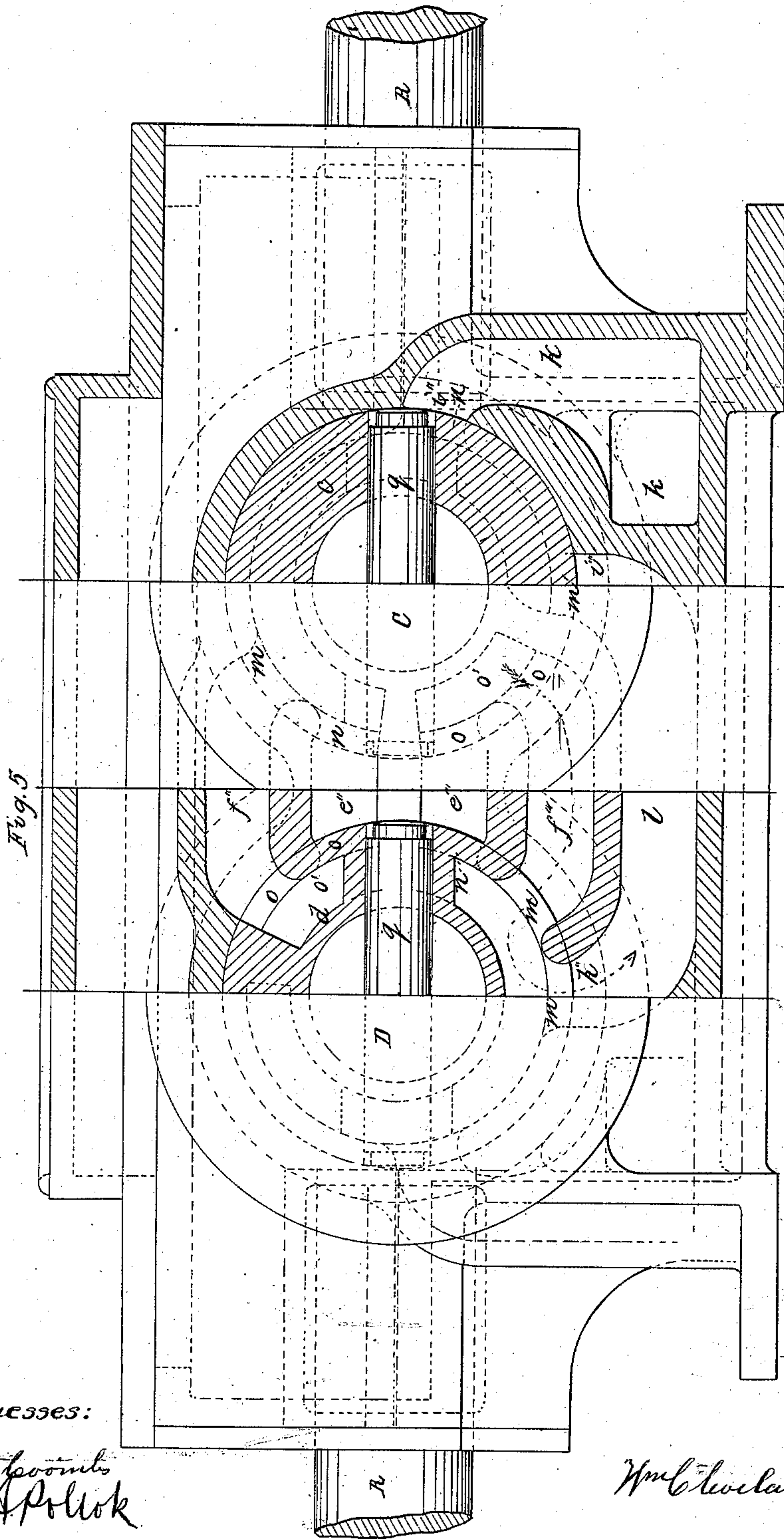
W. C. Hicks,

Sheet 6-6 Sheets.

Reciprocating Steam Engine,

No 54,906,

Patented May 22, 1866.



Witnesses:

Jos A. Coombs  
A. Pollok

Inventor:

Wm Cleveland Hicks



# UNITED STATES PATENT OFFICE.

WILLIAM CLEVELAND HICKS, OF NEW YORK, N. Y.

## IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. 54,906, dated May 22, 1866.

*To all whom it may concern:*

Be it known that I, WILLIAM CLEVELAND HICKS, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Steam-Engines; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, in which—

Figures 1 and 2 of Plates 1 and 2 are plan views, partly in horizontal section, of an engine constructed in accordance with my said invention, the plane of section passing through the center of the cylinder, each figure indicating one of the two pairs of cylinders which constitute an engine complete. Figs. 3 and 4 of Plates 3 and 4 are front elevations, partly in vertical section, of the same, the plane of section passing through the center of the cylinder, each figure indicating one of the pair of cylinders opposite each other. The sectional views show the arrangement of the pistons in opposite cylinders at full stroke—i. e., the crank being on the center. Fig. 5 of Plate 5 is an end view of the engine, partly in vertical section, the plane of section passing through the center of ports, so as to show the two contiguous cylinders with the pistons at full in the one and at half stroke in the other cylinder. Fig. 6 is a vertical transverse section of the same through the center of ports, showing the two contiguous cylinders with their pistons at full in the one and at half stroke in the other cylinder.

This invention relates to that class of steam-engines in which pistons of suitable form and arrangement perform also the offices of valves and cut-off, dispensing not only with these contrivances, but also with the whole array of valve-rods, eccentrics, rock-shafts, packing-boxes, slides, levers, cross-heads, and external attachments of every kind which they necessitate—that is to say, to that class of steam-engines which in one type or form has been patented to me on the 21st day of February, 1865.

The object of this invention is the arrangement of this steam-engine so as to admit of better adaptation to locomotive, steamboat, and many other purposes for which the upright engine, or the engine in which the cylinders are arranged crosswise or radiating from a common center, is less applicable.

Another object of this invention is to give the engine greater stability or steadiness and to effect a saving in the use of steam.

To this effect my invention consists in the general arrangement of parts, subordinate, however, to the principle and subject-matter of my patent of February 21, 1865, before named.

In the arrangement four cylinders are employed, the pistons in which receive the pressure of the steam or other fluid in one direction only, or are what is called "single-acting."

I would here observe that the pistons opposite to each other may be rigidly connected, in which case the two pistons together constitute virtually and in effect but one largely-recessed piston, which receives pressure of steam alternately in front and in rear, and is thus, as it were, double-acting. In the annexed drawings these are shown arranged in two pairs, parallel to each other. They are hollow and open at their inner ends, and having a crank-shaft in the center.

The four cylinders are marked in the drawings A, B, C, and D. The cylinders which are contiguous are connected with each other by two steam-channels, *e* and *f*, one of which, *e*, is for direct steam, and the other, *f*, for the exhaust, although in reversing the engine *e* becomes the exhaust and *f* the steam-passageway. The pistons are cylindrical, and take up sufficient space to lap over the openings of the steam-channels *e* and *f* where those enter the cylinders.

In the sides of the piston channels or recesses are cut proper to meet the steam-passages when the piston is moved along the cylinder, so that they shall stand over their openings.

It is to be understood that the valve does not operate the steam for its own cylinder, but always for the cylinder next adjoining it. Thus the valve in the cylinder A regulates the flow of steam to and from the cylinder B, and, vice versa, the valve in the cylinder B regulates the flow of steam to and from the cylinder A, so that there is reciprocal action in these two cylinders.

It will be seen that in this arrangement there is no necessary connection between the two pairs of cylinders opposite each other, but that they are or may be independent in their action, except so far as they are connected or coupled together on the same crank-shaft.



It will be understood, also, that the two cylinders C and D are arranged in precisely the same manner as described with reference to cylinders A and B, they and their pistons being provided with channels and recesses to regulate the flow of steam to and from each other in like manner.

There are six openings into each cylinder—viz., *e* and *f*, leading from *b* to *a*, and *e'* and *f'*, leading from *a* to *b* on the inner sides, and so likewise for the other two cylinders and lying in the same plane. The other two openings enter on nearly opposite sides of the cylinder, at an angle to those first named, and as shown by *h h'* and *i i'* in cylinders A and B.

The opening *h*, as also the similar opening *i* in the other cylinder, lead to one common receiving-pipe for the admission of steam, as shown at *k*, Figs. 3, 5, and 6, *k'* being the branch pipe for connecting the two contiguous cylinders with it. The openings *h' i'* also lead in like manner to one common exit-pipe, *l*.

At *n m* are recesses on one side of the valve or piston. One of these, *n*, passes round one-half (more or less) of the circumference of the cylinder alternately on the upper and under side, while *m* extends between two openings on the opposite end of the piston. It will be thus seen that when the piston *a*, for instance, has moved along so that the channel *n* stand opposite *e'*, it will also be over the opening *h*, so that steam will pass at once into the cylinder B. The same is also true of *m*; for when that recess is opposite *f'* it will also stand over the opening *h'*, and the steam can flow out of the cylinder B, as shown.

On the opposite side of the piston there is another opening for receiving and discharging the steam according to the working of the valve in *a*. This opening is seen at *o*, and extends through the narrow channel *o'* up and through the piston, thus communicating with the steam-space between the piston and the head of the cylinder. As shown, it overlaps the two ports *e* and *f'*, and acts in that respect like an ordinary slide-valve.

The crank-shaft is placed in the opening in the frame at the inner ends of the four cylinders, as seen at *p*, that being the crank-pin. Four connecting-rods, each attached to one of the four pistons, are joined to the crank-pins. As the cranks on the shaft are at right angles to each other, there is necessarily always one or two pistons in action upon the crank, so that when any pair of pistons which stand opposite to each other are at the end of their strokes the other two will be at the half of their stroke. Thus the piston *b* is at half-stroke moving toward the crank, *c* is also at half-stroke retreating from the crank, and *a* and *d* at the extremity of their respective strokes. Now it is when the pistons are at half-stroke that the valves begin to operate upon the steam for the adjoining cylinder, either to admit or exhaust the steam, as may be required.

It will be seen that if the recess *n* in the valve

in cylinder A is just ready to lap the channel *e'* and cover the opening *h*, thus admitting steam at once to the cylinder B in the rear of its piston, this channel will be kept open until the piston in A has completed its stroke and returned back to the half-stroke, for then the piston *b* will have completed its stroke and be ready to return. It must therefore be allowed to exhaust its steam. The recess *m* will now have come to the opening *h'* and *f'*, thus at once exhausting the steam, for the two half-strokes of the piston in A are just equal to the whole stroke of the piston in B. The piston *b* acts in like manner for the valve for the cylinder A. The piston in the latter is returning for a new stroke, and is accordingly exhausting its steam, the channel *f* is accordingly put in connection with the escape-passage *h'* through the recess *m*, as shown, and the same operation takes place for the cylinders C and D. Thus it will be understood that in each cylinder there is contained a piston which operates as a valve to admit and exhaust the steam to and from the next adjoining cylinder.

In steam-engines constructed in the manner described there may be combined with the arrangement of valve shown an ordinary **D** slide-valve or other reversing-valve in a steam-supply chamber, whereby the starting, stopping, and reversing of the engine may be effected.

In Figs. 1 and 2 and in Figs. 3 and 4 are views, respectively, in plan and elevation (shown partly in dotted lines) of the mode of attachment of the connecting-rods to the cranks of the crank-shaft and to the pistons.

The crank-shaft R is arranged centrally in relation to and in the same planes of the four cylinders. It is provided with two cranks arranged at right angles to each other.

To the crank-pin *p* are attached the connecting-rods of the pistons *b* and *c*, while to the crank-pin *p'* are secured the connecting-rods of the pistons *a* and *d*. The other end of the connecting-rod is attached to a pin, *q*, traversing the piston at both sides, but turned so as to present a flush finish with the general surface of the piston. This, although an important feature in the construction of my engine, offering, as it does, the most efficient connection that can be applied, is not essential to the general arrangement described, as other connections may be used with good effect.

The operation is as follows: Steam being admitted through *k*, the piston-valve *j* is drawn so as to allow it to flow through *k*, whence it will pass by the branch pipes *k' k'* to each of the cylinders A, B, C, and D. The piston *a* is just at the end of its return stroke and in the position ready to receive steam. The position of the recess *n* of the valve in cylinder B is just at the edge of the port or opening into the channel *e*, and likewise at the steam-aperture *i*. So soon as the said recess passes these openings a continuous channel is at once formed, and the steam flows through *o* into the cylin-



der A in rear of the piston, and accordingly drives the latter toward the crank. At the same time that the piston in A is receiving the effect of the steam admitted through the cylinder B the piston in A is performing the office of regulating the flow of steam into and from B. The piston in this latter cylinder, having performed its stroke, is exhausting its steam, and it will be seen by the direction of the arrow flowing back through  $f'$ ,  $m$ , and  $h'$  to the final discharge  $l$ . The face of the narrow channel  $o'$  forms a cut-off by lapping over the port in  $e'$  as soon as the piston has performed one-half its stroke, in which position it is shown in cylinder B. This lap may be made adjustable as to length by a sliding piece, so as to regulate the expansion to any degree required.

Several variations can be made in this engine. It is not necessary that the channels  $f$  and  $e$  be separate. They may be included in one and may terminate in the cylinders in the

rear of the pistons, so as to omit the passage  $o$  and  $o'$ .

Steam has been described as the fluid used for the motive power; but water, gas, or other fluid may be employed, and the engine also be employed as a pump.

Having thus described my invention and the manner in which the same is or may be carried into effect, I claim—

The arrangement of the cylinders, valvular pistons, and steam admission and exhaust passages, substantially as herein described, to operate in the manner and for the purposes set forth.

In testimony whereof I have signed my name to this specification before two subscribing witnesses.

WM. CLEVELAND HICKS.

Witnesses:

E. L. COOK,

C. M. RAYMOND.