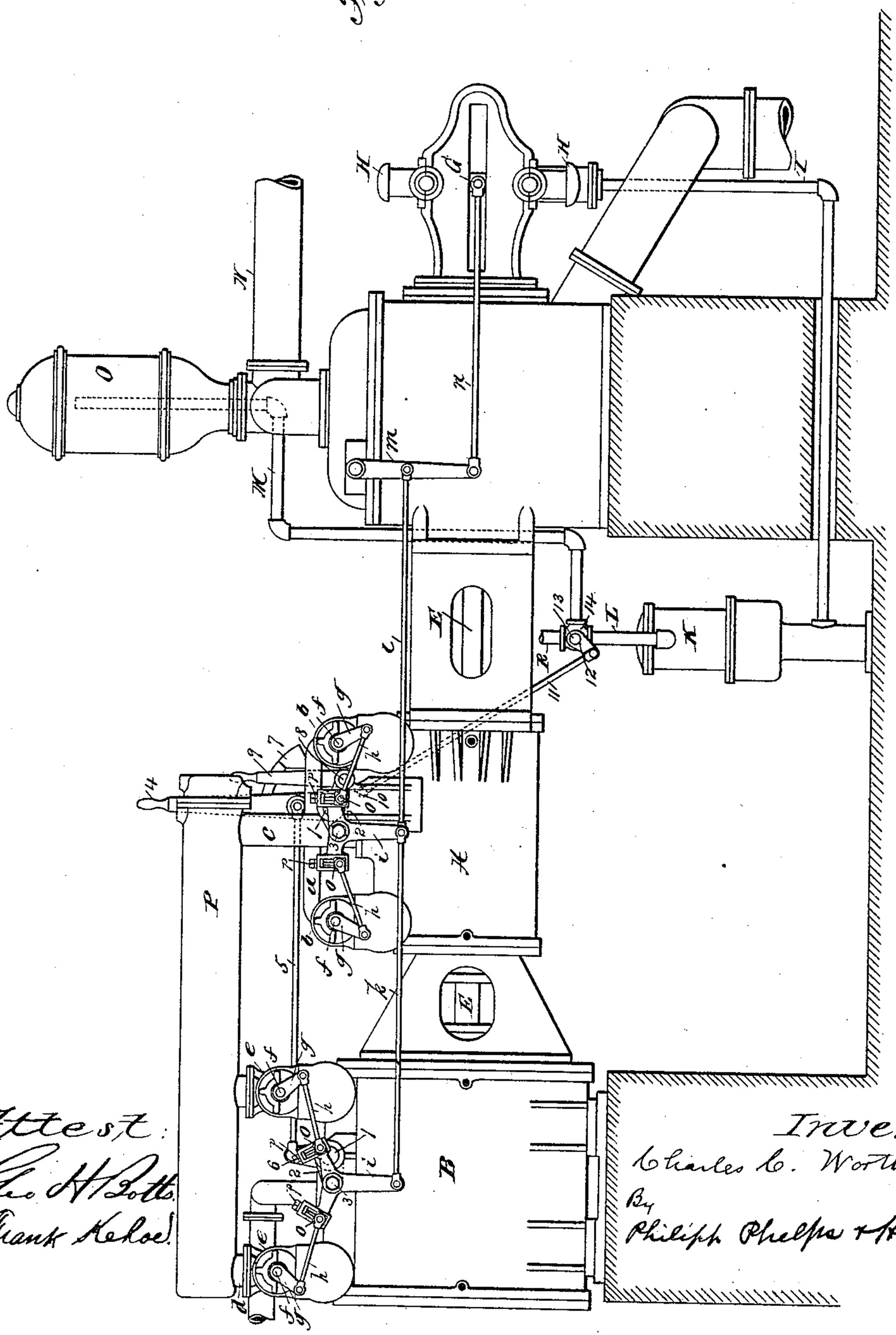
(No Model.) 5 Sheets—Sheet 1.

C. C. WORTHINGTON.

CUT-OFF GEAR FOR STEAM ENGINES.

No. 451,147. Patented Apr. 28, 1891.

Fig. 1.



Attest:
Geo. H. Bolte.
Frank Keloe.

Inventor
Charles C. Worthington
By
Philipp Phelps & Horey
Attys.

(No Model.) 5 Sheets—Sheet 2.

C. C. WORTHINGTON.

CUT-OFF GEAR FOR STEAM ENGINES.

No. 451,147. Patented Apr. 28, 1891.

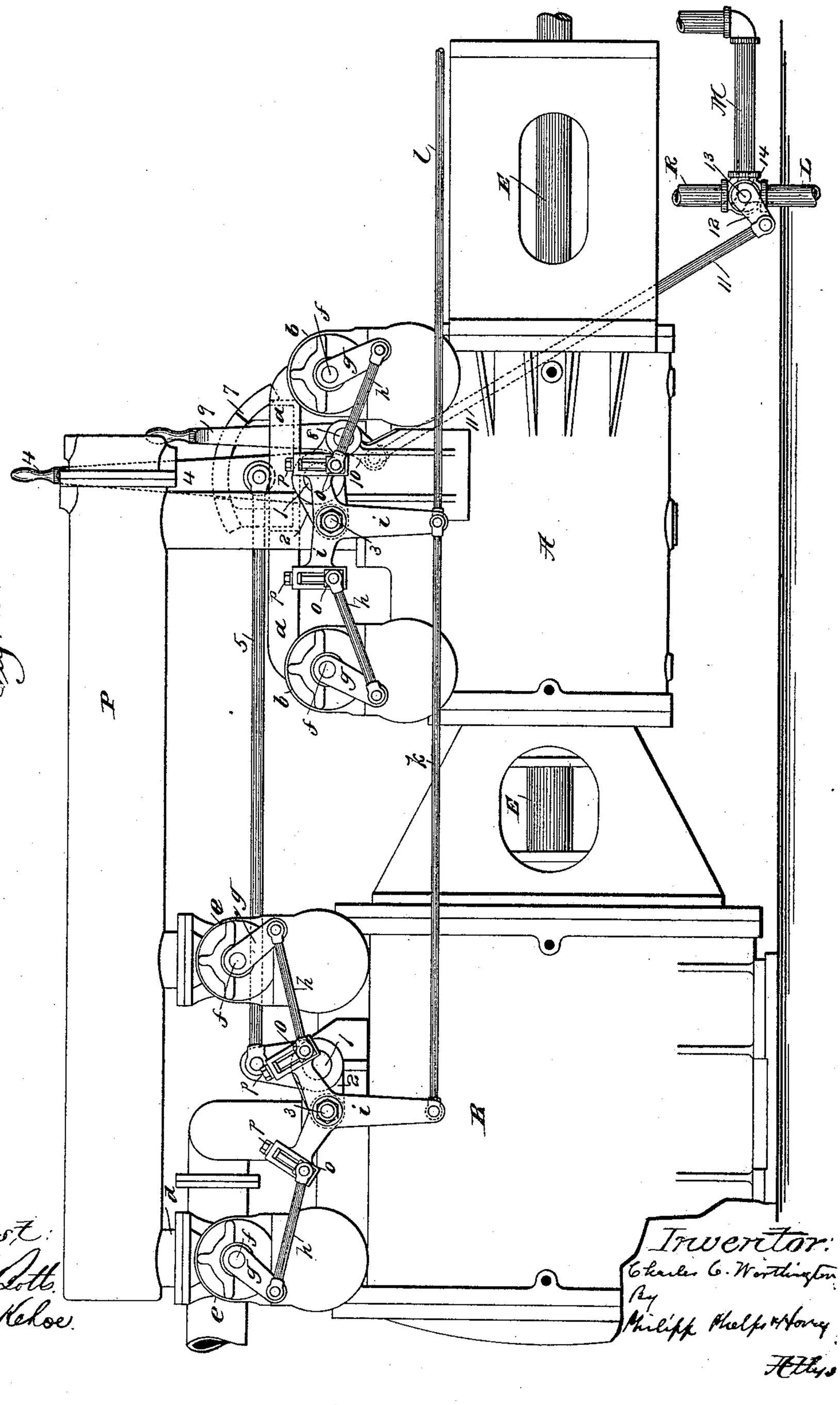


Fig. 2.

Attest:
Geo. H. Lott.
Frank Keloe.

Inventor:
Charles C. Worthington
By
Philipp Phelps & Honey
Attys

(No Model.) 5 Sheets—Sheet 3.

C. C. WORTHINGTON.

CUT-OFF GEAR FOR STEAM ENGINES.

No. 451,147. Patented Apr. 28, 1891.

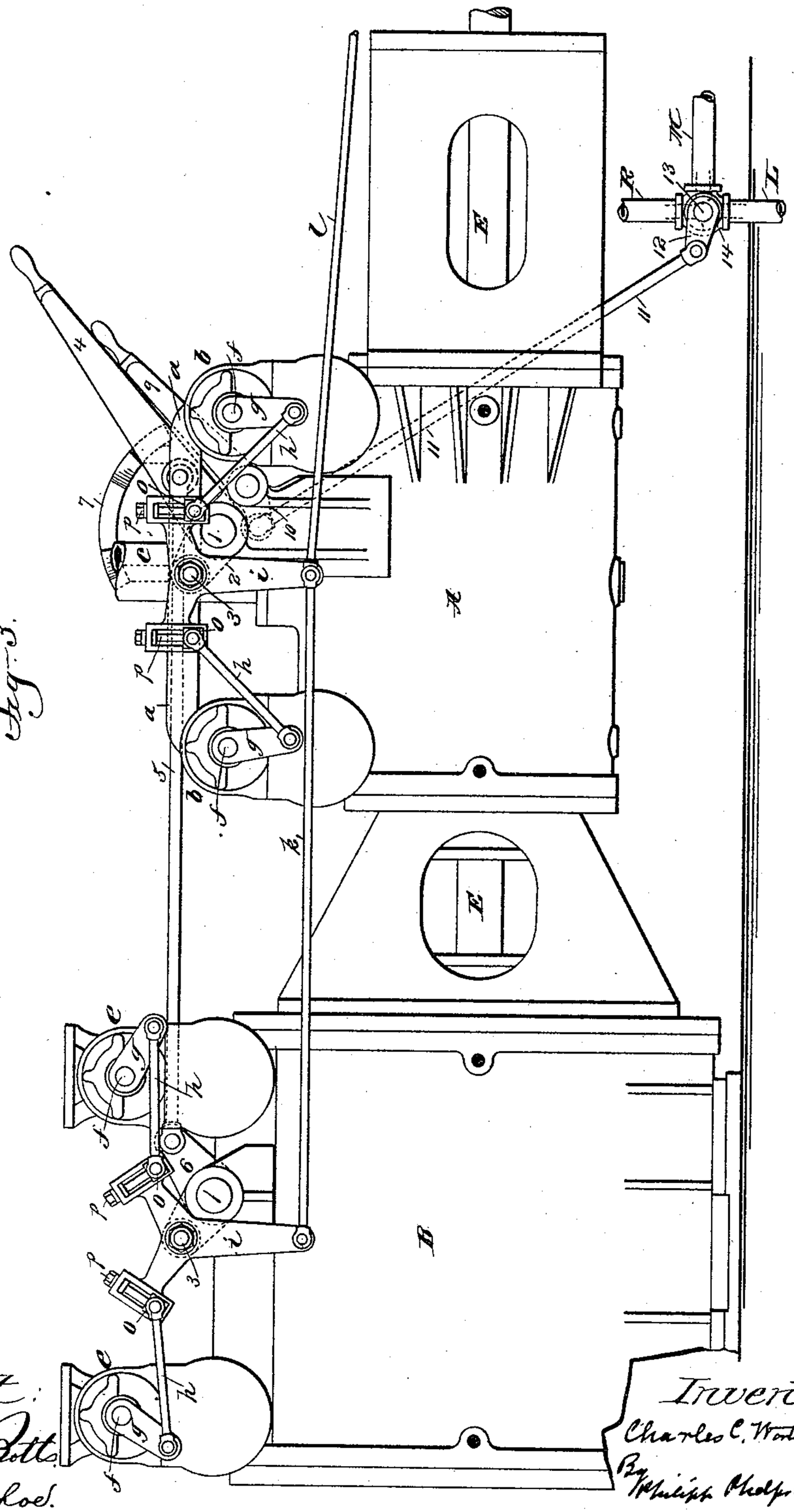


Fig. 3.

Attest:
Geo. H. Bott.
Frank Meloe.

Inventor.
Charles C. Worthington
By Philipp Phelps & Honey
Attys

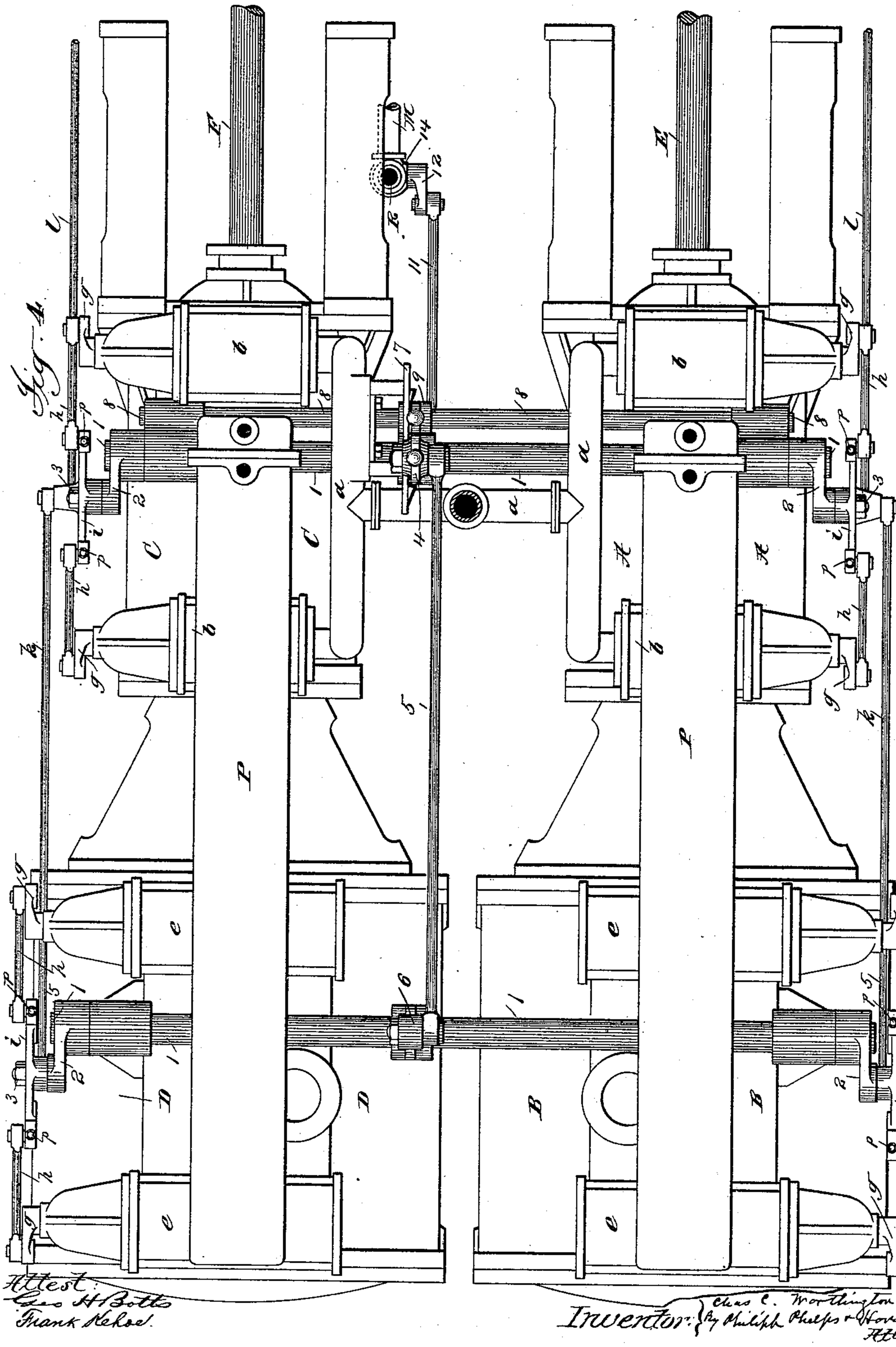
(No Model.) 5 Sheets—Sheet 4.

C. C. WORTHINGTON.

CUT-OFF GEAR FOR STEAM ENGINES.

No. 451,147. Patented Apr. 28, 1891.

Fig. 4.



Attest:
Geo. H. Botts
Frank Mekee.

Inventor: Chas. C. Worthington
By Philipp Phelps & Hovey
Attys

(No Model.) 5 Sheets—Sheet 5.

C. C. WORTHINGTON.

CUT-OFF GEAR FOR STEAM ENGINES.

No. 451,147. Patented Apr. 28, 1891.

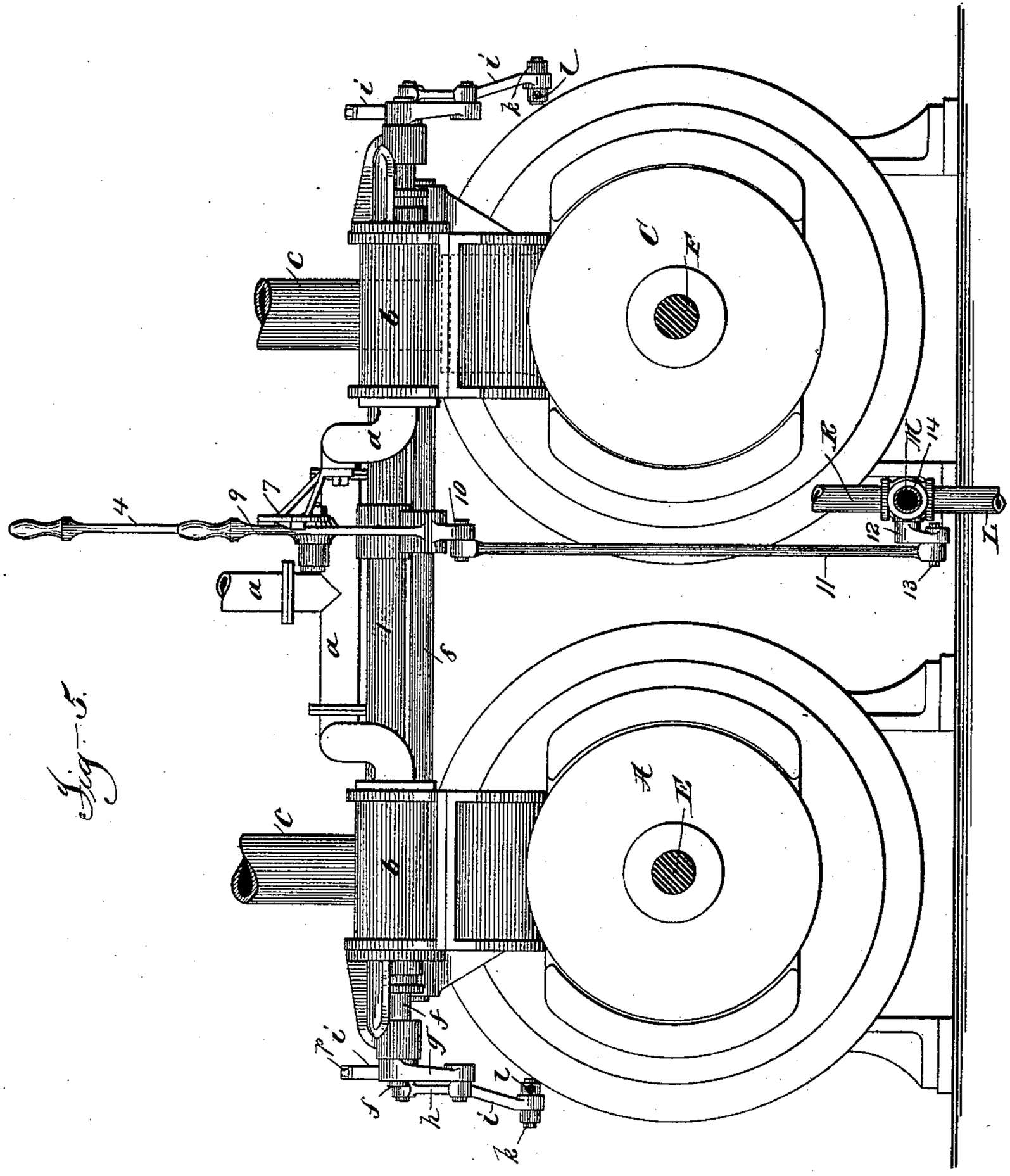


Fig. 5.

Attest:
Geo. H. Bolte.
Frank Kehoe.

Inventor:
Charles C. Worthington
By Philipp Phelps & Hovey
Attys

UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

CUT-OFF GEAR FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 451,147, dated April 28, 1891.

Application filed July 23, 1890. Serial No. 359,638. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Cut-Off Gears for Steam-Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to cut-off valves for steam-engines, and is of general application in all classes of engines in which steam is used expansively and in which it is desirable at any time to throw the cut-off valves out of operation, so that steam shall be admitted to the cylinder throughout the entire stroke. The improvements constituting this invention are intended especially for use, however, in that class of engines known as "direct-acting duplex engines," in which the steam of the main cylinder or cylinders is cut off after the engine has made a part of its stroke, and in which one or more compensating cylinders and pistons are used for each side of the engine, which act in opposition to the main piston or pistons during the first part of the stroke and in conjunction therewith during the last part of the stroke. Examples of engines of this class are shown in United States Letters Patent Nos. 292,525, 309,676, 332,857, 341,534, 401,401, and 422,680, heretofore granted to me. In pumping-engines of this class it is often desirable to throw the cut-off valves out of operation, so that the steam may be admitted throughout the entire stroke. At the same time the compensating cylinder or cylinders must be rendered inoperative, in order that the uniform action of the engine may be preserved and the damage which might result from the force produced by the joint action of the steam late in the stroke and of the compensating cylinders be prevented.

It is the principal object of my invention to provide a simple and convenient means for quickly changing the position of the cut-off valves, so that they shall not operate to cut off the steam at all or shall operate only late in the stroke.

Further objects of my invention are to provide means for quickly rendering the compensating cylinder or cylinders inoperative and to provide a construction by which the cut-off valves cannot be thrown out of operation while the compensating cylinders are operative.

With these objects in view my invention consists in various constructions and combinations of parts, all of which will be described in the specification, and pointed out in the claims.

As a full understanding of the improvements constituting the invention can best be given by an illustration and a somewhat detailed description of an engine embodying the same, such a description will now be given, reference being had to the accompanying drawings, in which my invention is shown as applied to a duplex direct-acting pumping-engine of the class shown and described in my Letters Patent above referred to.

Referring to said drawings, Figure 1 is a side elevation of the engine embodying my improvements. Fig. 2 is a side elevation of the steam end of the engine on an enlarged scale, showing the parts in the position they occupy when the engine is used as a high-duty engine, the steam being cut off before the end of the stroke and economized. Fig. 3 is a similar view of the engine as a low-duty engine, the steam being admitted throughout the stroke. Fig. 4 is a plan view of the steam end of the engine as a high-duty engine, and Fig. 5 is an end elevation looking to the left in Figs. 2 and 4.

The engine consists of the four steam-cylinders A B and C D, these cylinders being arranged in pairs, the cylinders A B forming one side of the engine and C D the opposite side, the cylinders A C being high-pressure cylinders and B D low-pressure cylinders. The pistons E F for the respective sides of the engine are extended through the water end of the engine and are connected outside the water end to cross-heads G, and are acted upon by compensating cylinders and pistons H in the manner usual in this class of construction. The compensating cylinders H are supplied with motor-fluid from a pipe I, communicating with an accumulator K of the general construction shown in my patents, Nos. 341,534 and 422,680, previously referred

to, the pressure in which is produced by means of a pipe L, communicating through a pipe M directly with the force-main N or preferably, as shown, with an air-chamber O, connected thereto.

The steam is supplied to high-pressure cylinders A C through induction-pipes *a*, communicating with steam-chests *b*, and is exhausted through exhaust-pipes *c* to exhaust-tanks P, from which the steam passes to low-pressure cylinders B D through induction-pipes *d* and steam-chests *e*, the steam being exhausted from the low-pressure cylinders to a condenser or to the open air, according to the class of engine.

It will be understood that the main induction and eduction valves on each side of the engine are operated from the opposite side, and that these valves are of the construction shown in my patent, No. 401,401, above referred to, these valves and their operating parts being omitted for clearness of illustration, as they constitute no part of the present invention.

The cut-off valves are of the construction shown in my patent, No. 401,401, above referred to, and are operated by the same means, as follows: Referring to one side of the engine, the high-pressure cut-off valves operate in the steam-chests *b* and the low-pressure cut-off valves in the steam-chests *e*, and are provided with stems *f*, which project outward and to which are connected crank-arms *g*, which in turn are connected by means of links *h* to a pair of T-levers *i*, the operating-arms of which are connected by means of a link *k*. These T-shaped levers *i* thus connected are operated through a rod *l*, pivotally connected to a rock-arm *m*, which in turn is connected by a rod *n* to cross-head G outside the water end of the engine. The links *h*, preferably, are not connected directly to the T-levers *i*; but the arms of the levers are slotted to receive sliding blocks *o*, to which the links are connected and which are moved in the slotted arms by means of the screw-bolts *p*, so that the cut-off valves may be adjusted to any position desired relative to the cut-off ports. The construction on the opposite side of the engine is the same.

The operation of the parts thus far described is fully set forth in my patent, No. 401,401, and need not be described herein, it being understood that the piston on each side of the engine, by means of a cross-head G and the intermediate connections above described, operates the T-levers *i* on its side of the engine so as to shift the cut-off valves and cut off the steam at the desired point in the stroke.

The present invention includes improvements in this construction by which the cut-off valves may readily be shifted to such a position that while operated by their respective pistons, they shall not close the ports and cut off the admission of steam, and by which the pressure in the compensating cylinders shall always be removed, so that they shall not affect the operation of the engine when the cut-off valves are out of operative position.

The parts constituting my invention will now be described.

Mounted transversely of the engine are rock-shafts 1—a rock-shaft for each pair of cylinders and their cut-off valves—these rock-shafts being provided with crank-arms 2 on each side of the engine, on which are carried the T-levers *i*, these levers being pivotally connected to the crank-arms 2 by means of studs 3. One of the rock-shafts (shown in the present construction as that next the water-end of the engine) is provided with a lever-arm 4, forming a handle by which the rock-shaft is operated, and a link 5 connects this handle with a crank-arm 6 upon the other rock-shaft, so that the operation of the handle rocks both the shafts 1 and their crank-arms 2, and thus raises or lowers both the T-levers *i* on each side of the engine. The lever 4 moves over a segment 7, mounted upon any convenient part of the engine, and the lever or segment may be provided with any suitable devices for holding the lever in any desired position.

To the rear of the rock-shaft 1, which carries the handle 4, is mounted a shaft 8, provided with or on which is mounted a lever-handle 9 directly in line of and behind the handle 4, so that the handle 4 cannot be moved without carrying rearward with it the handle 9. This shaft 8 may be a rock-shaft and have a crank-arm, or, as shown, the sleeve carrying the handle 9 may be provided with a crank-arm 10, which is connected by a rod 11 to a crank-arm 12, secured to the stem 13 of a valve or cock 14, controlling the connection between the air-chamber O and the accumulator.

The pipe M, as previously described, connects with the accumulator through a pipe L, and a waste-pipe R communicates with the chamber of cock 14, through which same chamber connection is made between the pipes M and L. The openings in this valve-chamber are controlled by a two-way plug, this plug operating either to close the waste-pipe R and connect the pipe M and pipe L leading to the accumulator, in which case the pressure of the air-chamber is transmitted to the accumulator, or to be shifted to such a position as to close the pipe M and open the connection between the accumulator-pipe and the waste-pipe, thus allowing the air or other fluid to pass out from the accumulator and removing the pressure from the compensating cylinders.

The operation of the parts described is as follows: In the position of the parts as shown in Fig. 2 the engine operates as a high-duty engine, and the cut-off valves are operated through the T-levers *i* and the connections to the pistons to cut off the steam at or about the middle of the stroke, as is usual in this class of engines. In this position of the parts

the cock 14 closes the waste-pipe R, and the pipe M connects with the accumulator, as shown in dotted lines, the pressure of the air-chamber thus being transmitted through the accumulator or to the compensating cylinders H. When the engine is changed quickly from a high-duty to a low-duty engine, it is essential that the compensating cylinders shall not be operative at such a point in the stroke that the power from the compensating cylinders and from the steam admitted to the cylinder at the end of the stroke shall be combined, as the force produced by such combined action will produce irregular action and too great a strain upon the engine. If the cut-off valves and compensating-cylinders are thrown out of operation simultaneously, there is a slight chance that this change may be made at such a point in the stroke as to bring the force of the compensating cylinders on one or the other side of the engine into co-operation with that of the increased pressure of the steam allowed to enter at the end of the stroke. This, however, could occur only during the stroke being made by the engine at the time the cut-off valves are thrown out of operation, as the compensating cylinders must be out of action on the next stroke. In changing from a high-duty to a low-duty engine therefore the lever 9 will first be moved to the position shown in Fig. 3, by which movement the crank-arm 12 is operated so as to shift the cock 14 to close the pipe M, connecting the air-chamber and accumulator, and open the connection between the accumulator and the waste-pipe R, as shown in dotted lines in the same figure, thus allowing the air or fluid to pass out of the accumulator and removing the pressure from the compensating pistons. The compensating cylinders having thus been thrown out of operation, the lever 4 will then be thrown to the rearward over the segment 7 and the parts on both sides of the engine will assume the position shown for one side in Fig. 3, in which the levers *i* are raised by the crank-arms 2, by which they are carried, and the cut-off valves are thereby shifted into such positions that, although operated by the connections with their respective pistons, they do not close the ports in the steam-chests to cut off the supply of steam.

In changing from a low-duty to a high-duty engine it is desirable that the cut-off valves should be thrown into operative position before the compensating cylinders are rendered operative, since if the compensating cylinders and cut-off valves are thrown into operation simultaneously the piston on one or the other side of the engine might be at that point of its stroke in which the cut-off valves would not operate to cut off the steam sufficiently early during that stroke, and in addition the compensating cylinders would exert their pressure upon the piston. The lever 4, therefore, will first be moved forward over the segment 7 from the position shown in Fig. 3 to that shown in Fig. 2, when the cut-off valves on both sides of the engine will be shifted to their operative positions. The cut-off valves having thus been thrown into operation, the lever 9 will then be moved forward, so as to shift the cock 14 into position to close the discharge-pipe R and open the connection between the air-chamber and the accumulator, when the pressure of the air-chamber will again be transmitted through the accumulator to the compensating cylinders and the latter be rendered operative. If the operator neglect to throw out the compensating cylinders before the cut-off valves in changing from a high to a low duty engine, it will be seen that the handle 4 must come in contact with the handle 9 and throw out the compensating cylinders. In changing from a low to a high duty engine, likewise the movement of the lever 9 to throw in the compensating cylinders must also shift the lever 4 and throw in the cut-off valves. It will thus be seen that I provide a simple and convenient device by which the cut-off valves and the compensating cylinders may be thrown out of operation, and by which the cut-off valves cannot be thrown out of operation without rendering the compensating cylinders inoperative, and on the other hand the compensating cylinders cannot be thrown into operation while the cut-off valves are out of operative position. The danger of damage to the engine through carelessness of the operator in neglecting to throw out the compensating cylinders when changing from a high to a low duty engine, or throwing in the compensating cylinders before the cut-off valves in changing from a low to a high duty engine, is thus avoided.

If it be desired to adjust the valves so that the throw-off shall not render the cut-off valves entirely inoperative, but shall cause them to operate at a late point in the stroke, they may either be adjusted by means of the bolts *p* and sliding blocks *o*, by which also an accurate adjustment of the valves for their correct operation in either a high or a low duty engine may be secured, or the segment 7 may be provided with a plurality of retaining devices for the lever 4, so that the latter may be held at different points upon the segment and the valve be moved to positions intermediate between their normal positions and that of inoperativeness.

It is obvious that many modifications may be made in the construction shown by one skilled in the art without departing from my invention, and that the improvements constituting the invention are applicable in other classes of engines than that shown. While I have shown an accumulator between the air-chamber and the compensating cylinders, it will be understood that this may be omitted and that the pressure upon the compensating pistons may be transmitted directly

from any suitable source of power other than the air-chamber or force-main, as well understood in the art.

What I claim is—

1. The combination, with a steam-cylinder and its cut-off valves, of an oscillating lever connected to and operating said valves, connections between said lever and a moving part of the engine for oscillating the lever, a movable member on which said lever is mounted, and means for varying the position of said member to carry the lever into position to render the valves operative or inoperative, substantially as described.

2. The combination, with a steam-cylinder and its cut-off valves, of an oscillating lever connected to and operating said valves, connections between said lever and a moving part of the engine for oscillating said lever, a rock-shaft having a crank-arm on which said lever is mounted, and means for rocking said shaft to render the valves operative or inoperative, substantially as described.

3. The combination, with the steam-cylinders A C and their cut-off valves, of an oscillating lever for each cylinder, by which the cut-off valves are operated, connections between said levers and moving parts of the engine for oscillating the levers, movable members on which said levers are mounted, and means for simultaneously varying the position of said members to carry the levers into position to render the valves operative or inoperative, substantially as described.

4. In a duplex engine, the combination, with the cylinder or cylinders on each side of the engine and their cut-off valves, of an oscillating lever or levers at each side of the engine, by which the cut-off valves are operated, connections between said lever and moving parts of the engine for oscillating the levers, movable members on which said levers are mounted, an operating-handle, and connections between said operating-handle and movable members, whereby the shifting of the handle varies the position of said members to carry the lever on each side of the engine into position to render the valves operative or inoperative, substantially as described.

5. In a duplex engine, the combination, with the cylinder or cylinders on each side of the engine and their cut-off valves, of an oscillating lever or levers at each side of the engine, by which the cut-off valves are operated, connections between said levers and moving parts of the engine for oscillating the levers, a rock-shaft for each pair of cylinders, extending transversely of the engine and provided with crank-arms on which said levers are mounted, an operating-handle, and connections between said operating-handle and the rock-shafts, whereby the movement of the handle rocks the shafts to carry the valves on both sides of the engine into operative or inoperative position, substantially as described.

6. In a direct-acting engine, the combination, with the steam cylinder or cylinders and its or their cut-off valves, of a compensator or compensators, connections between a moving part of the engine and the cut-off valves for operating the latter, an operating-handle, and connections whereby the movement of the handle in one direction throws out of operation both the cut-off valves and compensators, substantially as described.

7. In a direct-acting engine, the combination, with the steam cylinder or cylinders and its or their cut-off valves, of a compensator or compensators, connections between a moving part of the engine and the cut-off valves for operating the latter, an operating-handle, and connections whereby the movement of the handle in one direction throws into operation both the cut-off valves and compensators, substantially as described.

8. In a direct-acting engine, the combination, with the steam cylinder or cylinders and its or their cut-off valves, of a compensator or compensators, connections between a moving part of the engine and the cut-off valves for operating the latter, and operating-handles and connections for throwing in and out of operation the cut-off valves and compensators, respectively, said parts being so arranged that the movement of the cut-off handle for throwing the valves out of operation renders the compensators inoperative and the movement of the compensator-handle to return the compensators to action throws the cut-off valves into operation, substantially as described.

9. In a direct-acting duplex engine, the combination, with a steam cylinder or cylinders on each side of the engine and their pistons and cut-off valves, of a compensator or compensators at each side of the engine, connections between moving parts of the engine and the cut-off valves for operating the latter, an operating-handle and connections for throwing the cut-off valves on both sides of the engine in and out of operation, and an operating-handle and connections for rendering the compensators on both sides of the engine operative or inoperative, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHAS. C. WORTHINGTON.

Witnesses:
B. W. PIERSON,
LOUIS R. ALBERGER.