2 Sheets—Sheet 1.

J. McCRACKEN.

COMPOUND ENGINE.

No. 183,770. Patented Oct. 31, 1876.

Fig. 3.

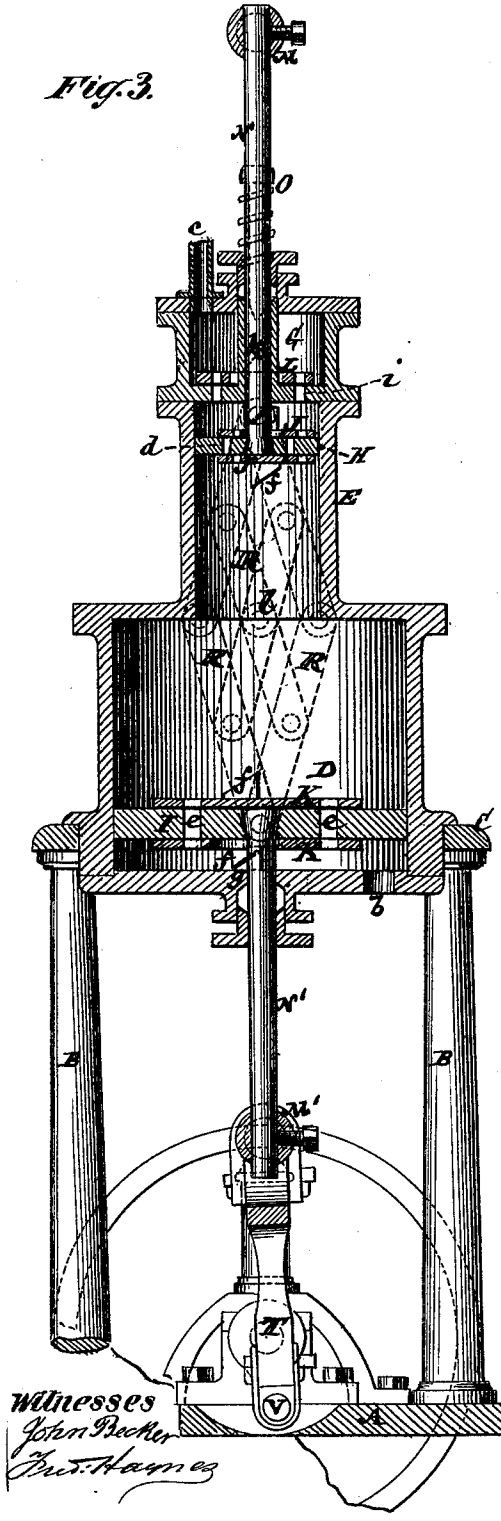
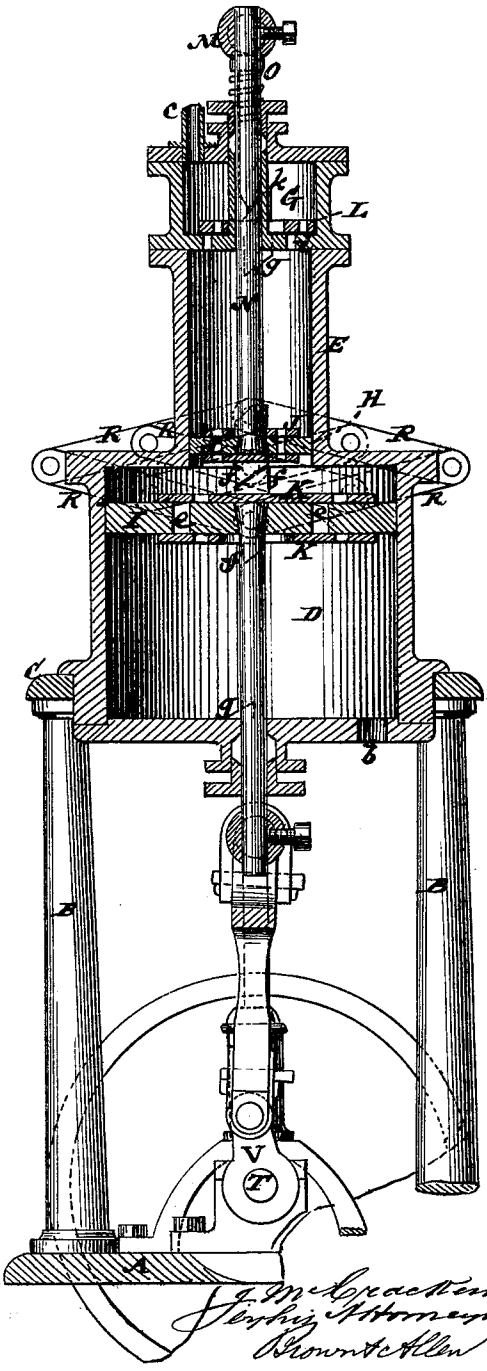


Fig. 1.



Witnesses
John Becker
Fred. Haynes

J. McCracken
per his Attorneys
Brown & Allen

2 Sheets—Sheet 2.

J. McCRACKEN.

COMPOUND ENGINE.

No. 183,770. Patented Oct. 31, 1876.

Fig. 2.

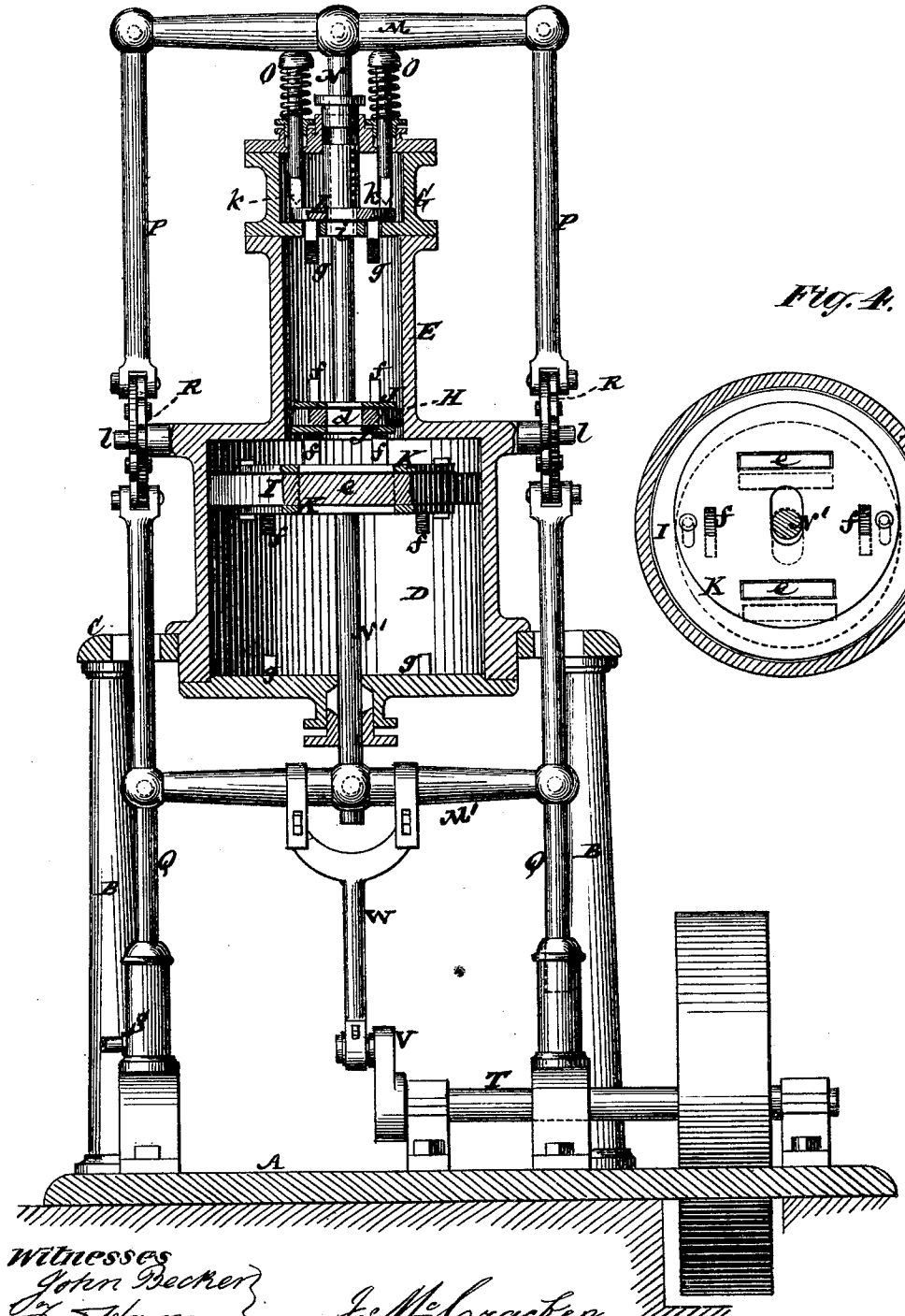


Fig. A.

Witnesses
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Fred Haynes

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by his Attorneys
Brown & Allen

UNITED STATES PATENT OFFICE.

JAMES McCRACKEN, OF BLOOMFIELD, NEW JERSEY.

IMPROVEMENT IN COMPOUND ENGINES.

Specification forming part of Letters Patent No. **183,770**, dated October 31, 1876; application filed February 14, 1876.

To all whom it may concern:

Be it known that I, JAMES McCRACKEN, of Bloomfield, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Compound Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, which forms part of this specification.

This invention relates to compound engines in which the steam or other impelling agent, after it has performed its duty upon a piston of given area in one cylinder, is utilized in an expanded form upon a piston of larger area in another cylinder. It more especially relates, however, to that description of such compound engines in which the pistons are organized to alternately diminish and increase the cylinder-space between them, and which have applied to them a valve or valves that cause said pistons to move alternately in equilibrium, thereby, although only obtaining driving force from either piston successively, doing away with that back or reactionary pressure of the steam or other impelling agent on either piston which is incidental to compound engines of a different description.

The invention consists in an arrangement of the exhaust-steam outlet in a compound engine of the special description above referred to, in or near the rear end of the larger cylinder—that is, back of the piston working therein—such end of said cylinder otherwise being of a closed construction. By this improvement, when connecting said exhaust-steam outlet with a condenser, both the large and small pistons obtain successively the full benefit of the vacuum on their one side, subject to pressure of steam on their other side, thus adding to the power of the engine besides, or in addition to, doing away with reactionary force or back pressure of the steam on either piston.

The engine may either be an upright one or occupy any other suitable position, and either be single or double—that is, with either one large and one small cylinder, or with two or more small cylinders, and a corresponding number of large cylinders and pistons to match. Furthermore, the cylinders may either be arranged one above the other, side by side, or be otherwise disposed in relation with each other, and various means be employed for mechanical connection of the pistons; also, any suitable kind of valve and valve-gear may be used, and the engine either be a direct or indirect acting one, to give rotary motion or not, as desired.

These and other changes may be made without departing from the novel character or distinguishing features of my invention; but it will here be described under one form of application only, including a novel and advantageous combination with the pistons of a compound engine, operating as hereinbefore described, of valves and ports applied directly to both the small piston and large piston of the engine, whereby not only clearance is reduced or avoided by the shortening of the ports, but whereby also large ports and a free passage for the steam, likewise a quick or ready exhaust therefor, are obtained.

There is also combined with said valves, and a main valve for admitting the impelling fluid to the small cylinder, novel means for automatically operating the valves without having recourse to outside valve-gear. Again, the invention consists in a novel and advantageous connection of the small and large pistons of the engine by means of rods, crossheads, and interposed cross levers or bars, whereby the proper relative action of the pistons is insured in a simple and practical manner to make available their effective actions.

Having thus explained the object or objects and nature of the invention, it will now be described with reference to the accompanying drawing.

Figures 1 and 2 are vertical sections, in planes at right angles to each other, of a compound engine, under one form or modification, with the invention applied, and showing the engine-pistons in both views in like relation with each other as regards their strokes. Fig. 3 is a further vertical section of the same, with the pistons in different relation with each other as regards their stroke, to change their respective actions as affected by the shifting of the valves which control them. Fig. 4 is a transverse section of the

larger cylinder, and inverted or back view of its piston with attached valve.

A is a bed-plate, on which are mounted columns B B, that serve to carry a table, C. This table C supports the larger or low-pressure cylinder D of an upright single-acting compound engine, and which has its smaller or high-pressure cylinder E mounted in concentric relation with and upon the larger cylinder.

Supposing the engine to be a condensing one, as usual in all or most compound engines, the larger cylinder D has the exhaust-steam outlet *b* connected with a condenser, said outlet being at what may be termed the rear end of the cylinder D—that is, back of the piston I, as distinguished from arranging it to connect with the space between the pistons—or in front of the pressure side or face of the piston I. This exhaust-steam outlet *b* is the only opening in the rear end of the cylinder D, which end is otherwise of a closed construction, or has no inlet for either steam or air.

Mounted upon the smaller cylinder E is a steam-chest, G, to which steam at its higher pressure is admitted by a pipe, *c*. The cylinder E is in free communication at its bottom with the cylinder D at its top. H is the piston of the cylinder E, and I the piston of the cylinder D. These pistons are each fitted with a valve or valves, arranged to control ports *d e* through them. Said valves may be of any suitable description; but they are here shown as slotted slide-valves J K, arranged to operate on both or opposite sides of the pistons, and as opened and closed respectively, and in proper relation with each other, by means of inclined projections *f g* upon said valves, and on or at the outer ends of the two cylinders. Said pistons H and I approach each other simultaneously, and recede from each other simultaneously. As they approach each other—that is, when the piston H reaches the end of its bottom stroke, and the piston I the end of its top stroke—the inclines *f* on the upper face of the valve K, coming in contact with the inclines *f* on the under side of the valve J, cause the valve K to close the ports *e* through the pistons I, and the valve J to open the ports *d* through the piston H, as shown in Figs. 1 and 2. Said valves remain in these positions till the pistons reach their extreme receding positions from each other, when the valve K is moved by its lower inclines *f* coming in contact with the inclined projections *g* on the bottom of the cylinder D to open the ports *e* in the piston I, and the valve J is moved by its upper inclines *f* striking the inclined projections *g* at the upper end of the cylinder E to close the ports *d* in the piston H, as shown in Fig. 3 of the drawing. The valves J and K retain these changed positions until the pistons again approach each other. The inclined projections *g* at the upper end of the cylinder E are here shown as attached to a slide-valve, L, in the steam-chest G, which valve is moved when the valve J is closed for the purpose of admitting steam by ports *i* to the top of the piston H. This valve L is closed at or toward the end of the down-stroke of the piston H by a cross-head, M, on the piston-rod N striking spring-tappets O, which, pressing against upper inclines *k* on the valve L, close the latter, and said valve keeps closed till the piston H again reaches the end of its top stroke.

Of course, these several valves need not operate in the precise timely relation here specified for them, but may be more or less changed in such respect to prevent steam blowing through the engine, and to avoid impairing of the vacuum.

Springs, variously applied, may, if desired, be used to open and close the valves, or to assist in doing so, and provision may or may not be made to work the steam expansively in the smaller or high-pressure cylinder, and the means generally for operating the valves may be such that there will be but little lost space between the ends of the cylinders and the faces of the pistons, and between the pistons at the extreme positions of the latter in their reverse strokes or actions.

The action is as follows: Supposing the parts to be in the position represented in Fig. 3, steam, by the open position of the valve L, is let on to the top of the smaller piston H, to move said piston downward while the larger piston I is correspondingly moving upward. During such action the valve J keeps closed and the valve K open. After this, the valve L being closed, and the pistons H and I having reached the extreme of their approach toward each other, the valve J is opened and the valve K closed. This admits the steam from the cylinder E to act upon the top of the piston I, to depress the latter while the piston H is correspondingly moving upward, the valves J and K remaining as last shifted till the two pistons reach their extreme positions apart. The action then is reversed again as regards the several valves and travel of the pistons. The opening of the valve J when the piston H reaches the end of its bottom stroke is to pass the steam previously utilized in the cylinder E to do its further duty on the piston I in the cylinder D, and the opening of the valve K, when the piston I reaches the end of its bottom stroke, is to establish communication with the exhaust or condenser while said piston is making its ascent. In this way, although only one of the pistons H I is effective at any one time, both pistons obtain the full benefit of the vacuum on their one side, subject to the pressure of steam on their other side, and said pistons, as they respectively make their non-effective strokes, move in equilibrium, or are not exposed to any counteracting force or reaction as regards pressure.

The pistons H and I are here represented as connected, so that they will work together, and move in relation with each other, as described, as follows: Each piston-rod N N′ is attached to a cross-head, M M′, which cross-

heads have side rods P Q, that are connected, respectively, at their inner ends to the opposite ends of a system or series of cross levers or bars, R, constituting a lazy-tongs frame on either side, and having fixed centers of motion, *l l*. Such cross levers or bars may either be single or double, or certain of them single and others double, to prevent racking of their joints. The side rods P Q may work in guides, and one of the rods, Q, be utilized for working the force-pump S of the engine, while the air-pump may be operated from the cross-head M′ or otherwise.

When the engine is required to give rotary motion to a shaft, T, the same may be done by a crank, V, on said shaft, and a connecting-rod, W, arranged to connect the cross-head M′ with said crank.

By arranging the valves J K, no matter how constructed, on the pistons, and the ports *d e* in the pistons themselves, to provide for passage of the steam from the small to the large cylinder, and for establishing the exhaust, with the beneficial results hereinbefore specified, of getting the advantage of the vacuum on both pistons and no reactionary pressure on either piston, clearance is reduced or avoided by reason of the shortness of the ports *d e* and large ports, and a free passage for the steam, likewise a quick or ready exhaust therefor, is obtained. A system of outside valves and ports, however, might be used without changing the general principle of action of the engine.

I claim—

1. In a compound engine having its pistons H I of different area, organized to alternately diminish and increase the cylinder-space between them, and which is provided with valves that cause said pistons to move alternately in equilibrium, the arrangement of the exhaust-steam outlet *b* in or near the rear closed end of the larger cylinder and back of the larger piston I, whereby, on connecting said outlet *b* with a condenser, both of said pistons alternately obtain the full benefit of the vacuum on their one side, subject to pressure of the steam on their opposite side without reactionary pressure or back action of the steam on either piston.

2. In a compound engine having its pistons organized to operate substantially as specified, the valves J K and ports *d e*, arranged on and in the pistons, essentially as and for the purposes herein set forth.

3. The combination, with the pistons H I and valves L J K, of the tappets O and inclined surfaces or projections *k f g*, substantially as specified.

4. The combination, with the pistons H I and their rods N N′, of the cross-heads M M′, the side rods P Q, and the interposed cross levers or bars R, working on fixed centers *l*, essentially as and for the purpose herein set forth.

JAMES McCRACKEN.

Witnesses:

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FRED. HAYNES.