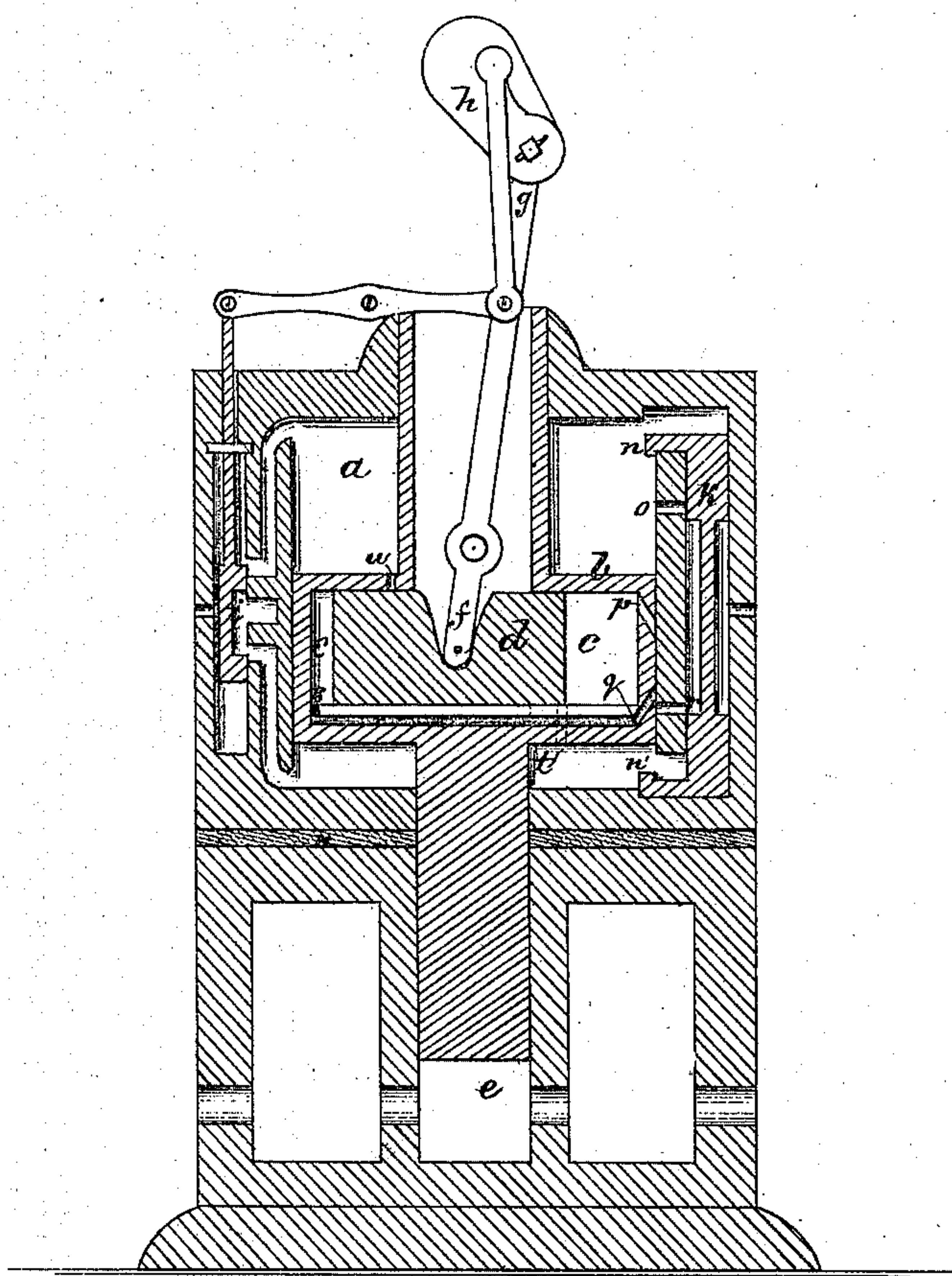


### *Reciprocating Engine.*

*Patented Mar. 15. 1870.*



Charles F. Brown.  
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Att'y.



# United States Patent Office.

JOHN S. BARDEN, OF PROVIDENCE, RHODE ISLAND.

Letters Patent No. 100,841, dated March 15, 1870.

## IMPROVEMENT IN STEAM-ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, JOHN S. BARDEN, of Providence, in the county of Providence, and State of Rhode Island, have invented certain Improvements in Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the construction and operation of the same, reference being had to the accompanying drawing and letters of reference marked thereon, which drawing represents a vertical section of steam-cylinder with piston, steam-valves, crank, &c., embodying my invention.

The object of my invention is to avoid the loss of steam and power in reciprocating steam-engines by the passage of the crank over the dead centers, thus making the steam-engine more efficient and regular in its motion.

My invention consists in a piston provided with a cylindrical cavity, within which a second piston moves transversely to the direction of motion of the first piston.

It further consists in connecting the second piston with a double-armed lever, the fulcrum of which being attached to and moving with the first piston in such manner that when the crank approaches one of the dead centers, by the admission of steam into the cavity of the first piston, the second piston is set in motion, carrying the short arm of the lever with it, while the other arm throws the crank over the dead center.

It further consists in an automatic valve arrangement, by which, through the motion of the first piston, steam is admitted into the cavity for propelling the second piston and exhausted therefrom.

It also consists in so connecting a pump with the steam-cylinder that the latter forms, with the pump-barrel, air and valve-chambers, one casting, a stratum of non-conducting material like zinc being interposed between the steam and water apartments to prevent a too rapid condensation of the steam, also extending a portion of the first piston or piston-rod of the steam cylinder in the pump-barrel, thus producing a steam-pump of great simplicity and at little cost.

In the drawings—

*a* is the inside of the steam-cylinder, with piston *b*, cavity *c*, and second piston *d*.

The piston *b* is provided with cylindrical projections, the upper one of which extends through the piston-head, acting as in ordinary trunk-engines. The lower one, which may be solid, passes into the pump-barrel *e*, and forms there a piston for the latter.

Within the upper cylindrical projection is attached the fulcrum of a double-arm lever, of which the shorter arm, *f*, extends into a cavity provided for it in the piston *d*, the long arm, *g*, being attached to the crank-pin of crank *h*.

The steam-valve *i* is attached, operated, and ar-

ranged in the usual manner, and at the opposite side of the cylinder is another steam-chest, in which operates the automatic valve *k*, for admitting steam into the cavity of piston *b*, which latter, when nearly completing its upward stroke, comes in contact with the projection *n* of valve *k*, and thus raises the latter and opens steam communication through port *o* and passage *p*, in the cavity of piston *b*.

The steam now propels piston *d*, and with it the portions *f* and *g* of lever and crank *h*, over the dead center.

The piston *d*, when near port *o*, has opened the aperture *u*, thus allowing the steam at that portion of the cavity to exhaust into the cylinder *a*, and from there into the exhaust of the latter.

After the piston *d* has started and covered again the aperture *u*, there may be some steam left in that portion of the cavity, but of too small density and force to resist effectually the action of live steam on the other side of piston *d*.

The piston *b*, at the down-stroke, acts against the projection *n'* of valve *k*, moving the latter and establishing steam communication between the further end of cavity and valve *k*, by means of port *r* and passage *g*, while the steam on the opposite side of piston *d* exhausts through aperture *t* into the lower portion of steam-cylinder, &c.

It will be observed that the double-arm lever is placed within an open cylindrical projection of piston *b*, thus allowing the air to circulate in and around the moving parts of the lever, and preventing friction from undue expansion of the working parts.

Having thus fully described my invention,

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination of hollow piston *b* with piston *d*, in the manner and for the purpose substantially as described.

2. The pistons *b* and *d* in combination with vibrating lever and crank *h*, in the manner and for the purpose specified.

3. The cylinder *a* and piston *b*, in combination with piston *d*, valves *i* and *k*, steam-inlets *o* *r*, and exhaust-ports *u* *t*, in the manner and for the purpose set forth.

4. The steam-cylinder *a*, in combination with pump-barrel *e*, stratum of non-conducting material *y*, constructed in the manner and for the purpose as above described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN S. BARDEN.

Witnesses:

CARROLL D. WRIGHT,  
CHARLES F. BROWN.