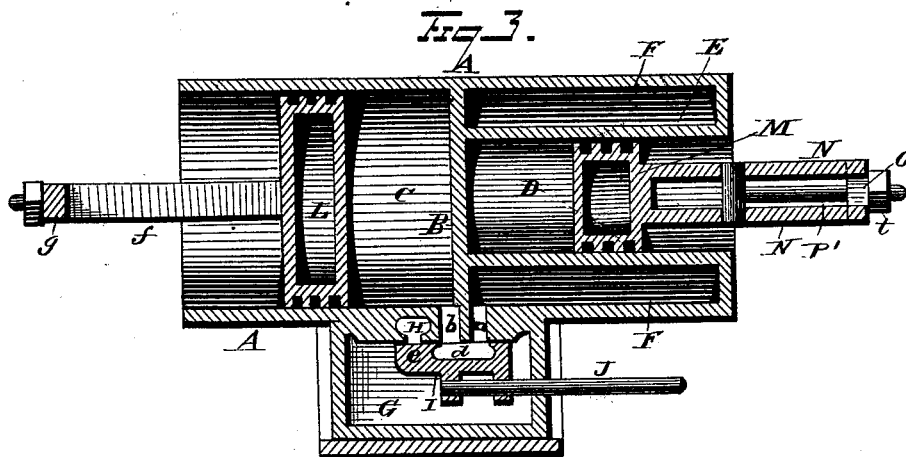
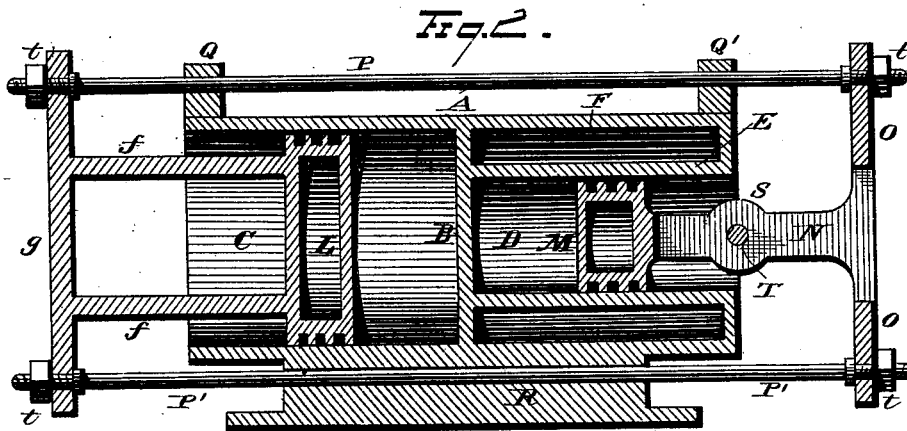
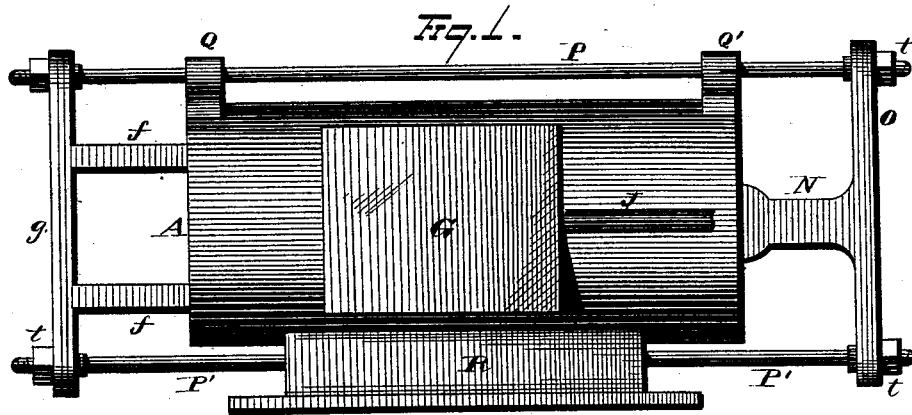


W. J. F. LIDDELL.
Compound Engine.

No. 220,160.

Patented Sept. 30, 879.



WITNESSES
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UNITED STATES PATENT OFFICE.

WALTER J. F. LIDDELL, OF CHARLOTTE, NORTH CAROLINA.

IMPROVEMENT IN COMPOUND ENGINES.

Specification forming part of Letters Patent No. **220,160**, dated September 30, 1879; application filed February 26, 1879.

To all whom it may concern:

Be it known that I, WALTER J. F. LIDDELL, of Charlotte, in the county of Mecklenburg and State of North Carolina, have invented certain new and useful Improvements in Compound Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to an improvement in compound engines, the object being to provide a compound engine of simple and durable construction, of small initial cost, and one that shall be adapted to be used as a portable as well as a stationary engine.

Heretofore portable engines have been constructed on the high-pressure principle, and as the cylinders are necessarily of limited diameter, an undue waste of steam was the result of the employment of such engines. This excessive and expensive waste of steam is avoided by the use of compound engines; and by my improved construction this form of engine is rendered as specially adapted for use as a portable engine, as well as for the ordinary uses of this class of engines.

My invention consists in the peculiar construction and combinations of parts, as will hereinafter be described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of my improved compound engine. Fig. 2 is a vertical section, and Fig. 3 is a horizontal longitudinal section, of the same.

A represents the cylinder, of any desired size, which is provided with a partition, B, which is either bolted in place or cast solid with the cylinder.

Within the cylinder A, and on opposite sides of the partition B, are two steam-cylinders, C and D, the former being of a diameter equal to that of the main cylinder A, and is termed the "low-pressure cylinder," while the latter is surrounded by a jacket, E, constituting an intervening space, F, around the cylinder, which space is filled either with live or exhaust steam to prevent sudden cooling and condensation

of the steam, the smaller cylinder, D, being termed the "high-pressure cylinder."

G is a valve-chest, located immediately over the central partition, B. Ports *a b*, respectively located on opposite sides of partition B, connect the valve-chest with the high and low pressure cylinders D and C.

In the valve-seat *c* is formed an exhaust-port, H, which leads to the atmosphere, or to the jacket surrounding the high-pressure cylinder, or to a condenser, as may be desired.

I represents a valve, provided with a valve-rod, J, by means of which it is actuated. Valve I is constructed with a steam-passage, *d*, and an extended face, *e*, the latter of sufficient length to cover the exhaust-port, and the former to span the ports *a b* leading to the two cylinders. A steam-pipe may connect with the valve-chest for supplying steam thereto; but the steam-induction pipe is preferably connected with the cylinder to supply live steam to the annular space around the high-pressure cylinder, from whence the steam is conveyed to the valve-chest, and from thence supplied to the high and low pressure cylinders.

L is the piston located in the low-pressure cylinder, and M the smaller and high-pressure piston, which may be made hollow, as shown in the drawings, and provided with any desired form of piston-packing; or the pistons may be made solid, but preferably are constructed of cup-shape form, with the recessed portions facing the outer ends of the respective cylinder.

To the outer surface of the low-pressure piston L is attached the bars or braces *f*, the outer ends of which are connected by a cross-bar, *g*. The high-pressure piston M has secured to the outer face thereof, or formed solid therewith, the parallel plates N, having a centrally-slotted cross-bar, O, connected with the outer ends thereof.

P P' are connecting-rods, which are attached to the cross-bars *g* and O, the rod P being supported in bearings Q Q', attached to the ends of the cylinder A, while the rod P' extends through the base-support R of the cylinder, and is guided thereby. The plates N are enlarged at S, and a journal, T, attached to the same. The inner end of the connecting-rod

is attached to the journal T, in close proximity to the piston M. The extent of movement of the pistons can be readily regulated by means of the adjusting-nuts *t* on the ends of the rods P P'.

The operation of my improved engine is as follows: The throttle-valve governing the flow of steam from the boiler to the engine being opened, steam flows into the valve-chest. When the valve is moved to the left, the port *a* leading to the high-pressure cylinder is uncovered, and the port *b* connected through the valve with the exhaust-port. Steam enters the high-pressure cylinder between its piston and the partition B, and forces the piston outwardly or toward the outer end of its cylinder. As the high and low pressure pistons are connected with each other, and move in unison, the low-pressure piston moves at the same time toward the partition B, the confined steam between the piston and partition B escaping through the passages leading to the exhaust. When the high-pressure has reached the limit of its outward stroke the valve is moved toward the right, connecting the ports *a b* through the valve, and closing the exhaust-port. This position of the valve allows the steam that has done its work in the high-pressure cylinder to escape into the low-pressure cylinder and operate against the face of the large piston contained therein to force it outward to the end of its stroke.

The two pistons may be of any desired relative size or area best suited to effectually utilize the exhaust-steam of the high-pressure cylinder in doing effective work in the low-pressure cylinder. The valve being again

shifted, the live steam enters the small cylinder, and the steam in the large cylinder escapes through the exhaust-port, from whence it may be conveyed to the jacket surrounding the high-pressure cylinder, or to a condenser, or to the atmosphere, as may be desired. The jacket around the high-pressure cylinder serves to prevent undue condensation of steam therein, and also serves to materially strengthen the central partition, B.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a compound engine, the high and low pressure cylinders, formed within a single cylinder and separated by a partition, the high-pressure cylinder surrounded by a jacket, the inner ends of which connect with the central partition, substantially as set forth.

2. In a compound engine, the combination, with a high and low pressure cylinder formed within a single cylinder and separated by a partition, of the ports *a b* and exhaust-port, and a valve provided with an extended face for governing the exhaust-port, substantially as set forth.

3. In a compound engine, the combination of the high and low pressure pistons, of rods P P', plates N, enlarged at S, journal T, and slotted cross-bar O, substantially as set forth.

In testimony that I claim the foregoing I have hereunto set my hand this 12th day of February, 1879.

WALTER J. F. LIDDELL.

Witnesses:

HENRY A. SEYMOUR,

FRANK O. MCCLEARY.