(No Model.) 2 Sheets—Sheet 1.

A. D. LINN.

COMPOUND ENGINE.

No. 375,077. Patented Dec. 20, 1887.

Fig. 1

ON LINE X—X

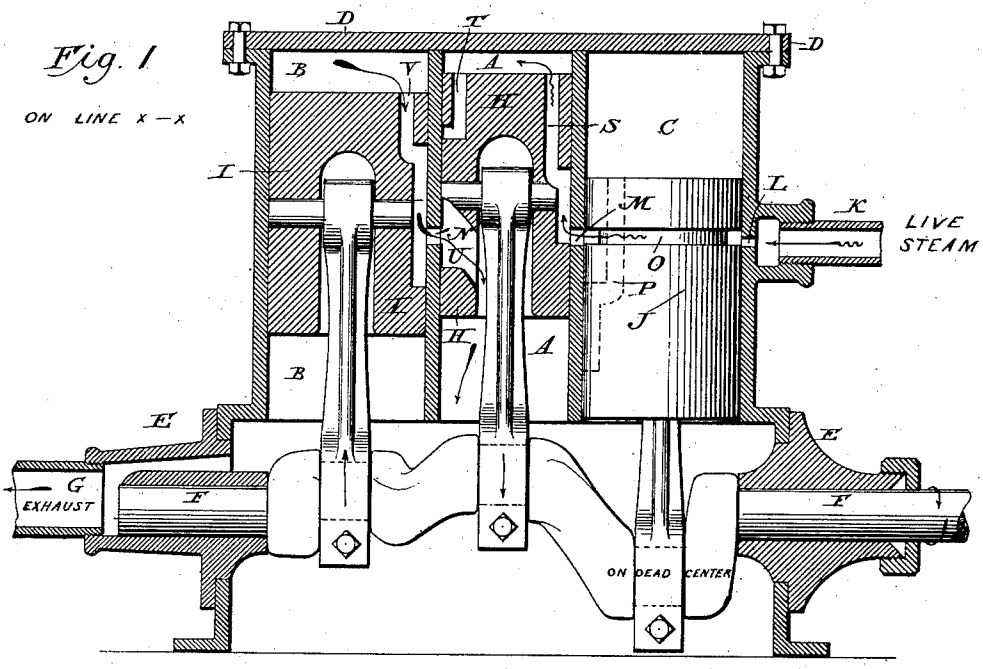
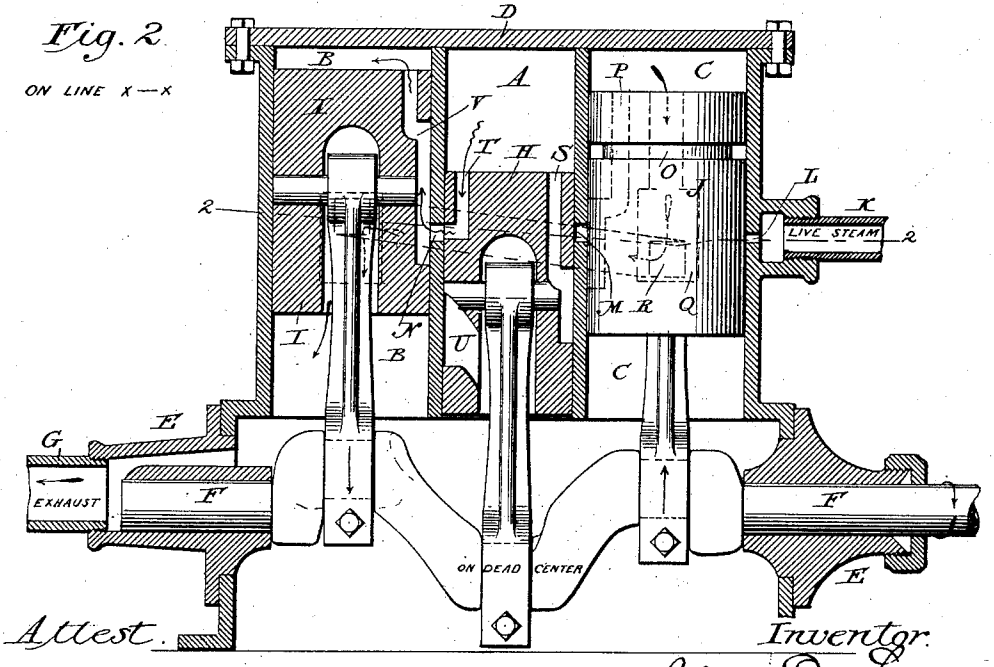


Fig. 2

ON LINE X—X



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By his Atty

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(No Model.) 2 Sheets—Sheet 2.

A. D. LINN.

COMPOUND ENGINE.

No. 375,077. Patented Dec. 20, 1887.

Fig. 3.

ON LINE X-X

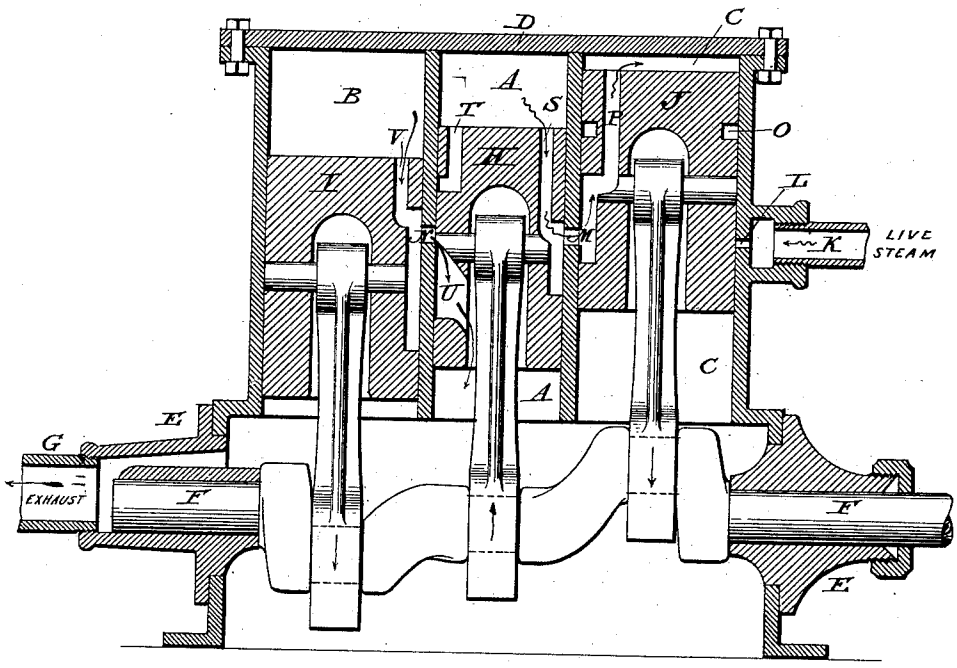


Fig. 4

ON LINE 2-2

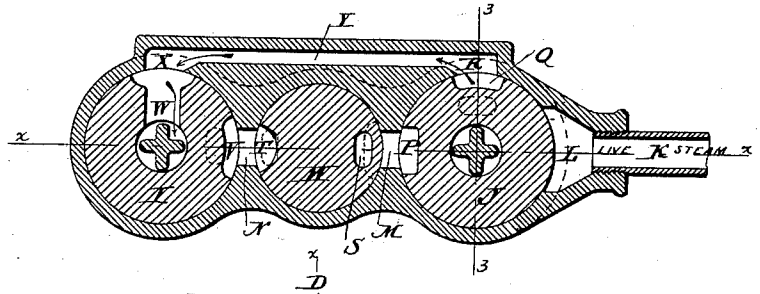
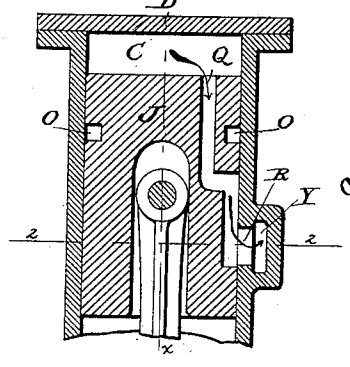


Fig. 5.

ON LINE 3-3



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UNITED STATES PATENT OFFICE.

ALLEN D. LINN, OF RACINE, WISCONSIN, ASSIGNOR TO THE RACINE HARDWARE MANUFACTURING COMPANY, OF SAME PLACE, AND THOMAS KANE, OF CHICAGO, ILLINOIS.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 375,077, dated December 20, 1887.

Application filed June 24, 1886. Renewed June 1, 1887. Serial No. 239,969. (No model.)

To all whom it may concern:

Be it known that I, ALLEN D. LINN, of Racine, in the county of Racine and State of Wisconsin, have invented certain Improvements in Compound Engines, of which the following is a specification.

The particular aim of my invention is to provide a compound engine which shall be simple and compact, and in which the several pistons shall wholly and directly control the flow of the steam.

It consists, essentially, in the combination of a high-pressure cylinder and piston and two low-pressure cylinders and pistons of greater diameter, the respective cylinders and pistons being provided with ports formed and arranged in such manner that steam is delivered first into the high-pressure cylinder, thence in part into one of the low-pressure cylinders, and thereafter from the high-pressure into the second low-pressure cylinder, the steam being discharged directly from each of the low-pressure cylinders independently of the other.

In the accompanying drawings, Figure 1 represents a vertical longitudinal section on the line *x x* of Fig. 4 through my engine, with the high-pressure piston at the beginning of its downward or active stroke. Fig. 2 is a similar view with the low-pressure piston on the left at the beginning of its downward stroke. Fig. 3 is a similar view with the second low-pressure piston on the right at the beginning of its stroke. Fig. 4 is a transverse section on the line 2 2 of Fig. 2. Fig. 5 is a vertical cross-section on the line 3 3 of Figs. 2 and 4.

Referring to the drawings, A represents a high-pressure cylinder, and B and C two low-pressure cylinders lying on opposite sides thereof and parallel therewith, their sectional areas being much greater than that of the high-pressure cylinder. The three cylinders are preferably formed complete in one casting, as shown in the drawings, their principal ends being closed by a cap-plate, D, bolted thereto, and their lower ends left open and secured to a hollow casting, E, which serves the threefold purpose of a supporting-base, a bearing for the crank-shaft F, and a chamber to receive the exhaust-steam, which may escape through a pipe, G, applied at one end, or through any other appropriate outlet. In the respective cylinders I mount elongated pistons H, I, and J, which are connected by pitmen to the respective cranks of the horizontal shaft F, these cranks being arranged at an angle of one hundred and twenty degrees to each other.

The cylinder C is provided with a pipe, K, supplying live steam, and with a port, L, through which the live steam enters the side of the cylinder midway of its height. A second port, M, leads from the opposite side of this cylinder directly into the cylinder A, which in turn communicates at its opposite side by a port, N, directly with the cylinder B.

The piston J is provided with a circumferential groove or port, O, in such position that when the piston approaches the limit of its downward movement this groove will form a communication between the live-steam port L and the port M, as shown in Fig. 1, allowing the steam to pass directly through the port M to the high-pressure cylinder A. The piston J is also provided with a port, P, extending downward through its top and emerging on the side next to cylinder A, as plainly shown in Figs. 1, 3, and 4. It is further provided on the rear side with a port, Q, extending downward through its top and emerging from one side in line with the exhaust-port R, extending through the rear side of the cylinder, as shown more particularly in Figs. 4 and 5.

The high-pressure piston H is provided with a port, S, extending downward through its top and emerging on the side next to the cylinder C, also with a second port, T, passing downward through its top and opening outward from the side next to cylinder B, and also with a third exhaust-port, U, extending inward from its side next to the cylinder B, and downward through its lower end where it communicates with the base-chamber.

The low-pressure piston I is provided with a port, V, passing downward through its top and opening through its side adjacent to cylinder

A. This piston is also provided at the rear side with an exhaust-port, W, opening through its lower end and through its side midway of its height, or thereabout. A port, X, is formed in the rear side of the cylinder B in line vertically with port W, and its port X is connected by a cross-passage, Y, on the outside of the cylinders, with the exhaust-port R of the cylinder C, before alluded to.

The operation of the engine is as follows: When the pistons are in the position shown in Fig. 1, the live or high-pressure steam entering pipe K passes through port L, thence through the circumferential port O in piston J, through port M into the lower end of port S of the high-pressure piston, and, ascending through its port into the upper end of the cylinder A, it acts to depress the high-pressure piston H, the two low-pressure pistons ascending in the meantime before the high-pressure piston finishes its downward stroke, the piston J rises sufficiently to carry its port O above the ports L and M, thereby cutting off the admission of steam to the high-pressure piston and causing the contained steam to act expansively during the remainder of its stroke. As this piston completes its downward stroke, the lower end of its port T registers with the port N, which latter registers at the same time with the port V of the low-pressure piston I, whereupon the steam flows through said ports from the high-pressure cylinder into the low-pressure cylinder B, where it acts to depress the piston I. This delivery of steam to cylinder B continues until its piston I has descended through half its stroke, or thereabout, whereupon the ascent of the piston H carries its port T out of communication with port N, thus cutting off the delivery of steam to the cylinder B, the steam already admitted to the latter being confined and permitted to act expansively. At or about the time the piston I completes its descent, and while its port V is still in communication with port N, the port U of the high-pressure piston is also brought in communication with port N, whereupon the steam is exhausted from the cylinder B through the ports V, N, and U and through the lower end of cylinder A in the base-chamber. At or about the time the delivery of steam from cylinder A into cylinder B is cut off the port S of the high-pressure piston and the port P of the low-pressure piston J are brought into communication with the intermediate port, M, as shown in Fig. 3, whereupon the steam remaining in the high-pressure cylinder is delivered through said ports into the upper end of cylinder C, where it acts to depress the piston J. The delivery of steam to cylinder C is cut off just before the piston H completes its ascent. As the piston J nears the end of its downward stroke, its rear port, Q, is brought into communication with the exhaust-port R, as shown in Figs. 4 and 5, whereupon the steam is exhausted from the cylinder C through the ports Q and R into the passage Y, whence it escapes through the port X of the piston I into the base-chamber.

Having thus described my invention, what I claim is—

1. In a compound engine, the combination of a high-pressure cylinder, two low-pressure cylinders, ports between the high-pressure cylinder and each of the low-pressure cylinders, and pistons mounted in the cylinders and coupled to a common crank-shaft, said pistons provided, substantially as described, with ports for admitting steam to the high-pressure cylinder, and thence directly to the low-pressure cylinders in succession.

2. The high-pressure cylinder and the two low-pressure cylinders provided with ports L, M, N, R, X, and W, in combination with the three pistons provided with their ports O, P, Q, S, T, U, and V, as described and shown.

3. In a compound engine, the combination of a high-pressure and a low-pressure cylinder directly connected by a port in position to be constantly covered by their pistons and two pistons mounted one in each cylinder and each provided with a port opening from its working face or end through its periphery in position to register with the port between the cylinders, whereby the steam may be exhausted from the high-pressure directly into the low-pressure cylinder through their pistons.

4. In a compound engine, a high-pressure and a low-pressure cylinder directly connected by a port constantly covered by their pistons, in combination with two pistons mounted in the respective cylinders, the low-pressure piston provided with a port, V, leading from its active face through its periphery, and the high-pressure piston provided with a port, U, leading from its periphery through its rear face, whereby the low-pressure steam is exhausted through the high-pressure cylinder and piston.

5. The high-pressure cylinder A and low-pressure cylinder B, connected by port N, in combination with piston H, having ports T and U, and piston I, having port V, whereby the steam is first delivered from the high-pressure into the low-pressure cylinder, and subsequently exhausted from the latter through the open end of the former.

6. In a compound engine, two low-pressure cylinders, C B, connected by a port, R Y X, in combination with pistons T and I, mounted in said cylinders and coupled to a common crank-shaft, the piston T, provided with port Q, leading from its working-face through its side, and the piston I, provided with port W, leading from its periphery through its rear face, whereby the dead steam is exhausted from cylinder C through the open end of cylinder B.

7. In a compound engine, the high-pressure and two low-pressure cylinders, each having one end closed and without ports opening to its steam-space, and the opposite end open, in combination with the three pistons coupled to a common shaft and provided with ports co-

operating with stationary ports, substantially such as described, to direct steam into and out of the cylinders.

8. In a compound engine, a series of pistons provided, substantially as described, with ports whereby the steam is admitted to and discharged from each cylinder wholly through its own piston, in combination with cylinders provided with stationary induction and eduction ports operating in direct connection with the piston-ports, substantially as described, whereby the flow of the steam is controlled wholly by the pistons and without the assistance of movable auxiliary valves.

In testimony whereof I hereunto set my hand this 7th day of June, 1886, in the presence of two attesting witnesses.

ALLEN D. LINN.

Witnesses:
J. F. BICKEL,
E. G. DURANT.