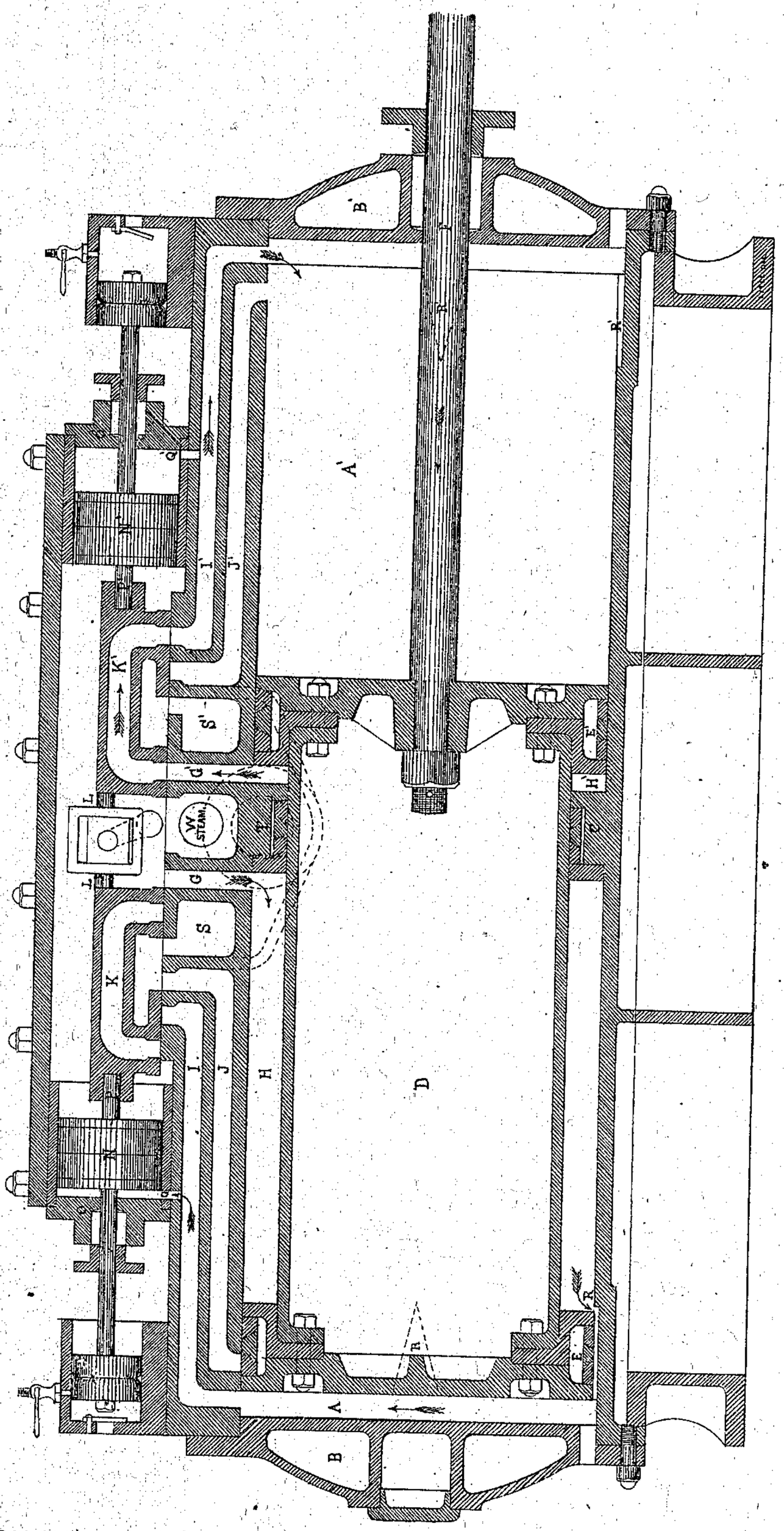
W. M. HENDERSON.

DIRECT ACTING COMPOUND ENGINE.

No. 105,941. Patented Aug. 2, 1870.



WITNESSES.

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WILLIAM M. HENDERSON, OF PHILADELPHIA, PENNSYLVANIA.

Letters Patent No. 105,941, *dated August* 2, 1870.

IMPROVEMENT IN DIRECT-ACTING COMPOUND ENGINE.

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

I, WILLIAM M. HENDERSON, of Philadelphia, State of Pennsylvania, have invented certain Improvements in Direct-Action Compound Steam-Engines, of which the following is a specification.

This invention is intended as an improvement upon the patent granted to myself by the United States Patent Office, dated April 5, 1870, No. 101,617, for an "Improvement in Direct-Action Compound Steam-Engines," the improvement referring exclusively to the mode of operating the steam-valves when it is desired to work the engines singly, and not in pairs, as set forth in the patent above referred to, the same being directly applicable to the construction of single direct-action engines, as commonly employed for pumping purposes, which engines invariably take full-pressure steam throughout the entire stroke, a consequence attendant upon the general means employed to operate the steam-valve, which is alternately reversed by a motion communicated from the steam-piston or its rod, at or about the termination of each stroke, in a variety of ways, each the subject of an individual patent. The result of the whole is identical in the one feature, that no gain from expansion can ever be obtained, a matter overlooked as of minor importance, so long as the valve can be reversed, but in reality of great significance, especially so when an engine of considerable size is required, where economy of fuel is a desideratum. In this engine the means employed to effect this end is by the use of combined high and low pressure steam-cylinders, fitted with slide-valves of a peculiar form, connected with small steam-pistons, which valves are entirely free from contact with the main pistons or rod, and moved exclusively by the fluid employed as a motive power, the valves controlling the motion of the main pistons, and said pistons controlling the necessary motion of the valves at the right time, to cause the whole to operate automatically with any degree of determined expansion, all of which will be hereafter more fully described, reference being had to the accompanying drawing, and to the letters of reference marked thereon, which shows a longitudinal section of this improvement, exhibiting the combined cylinders, with the general arrangement of the pistons, ports, and valves, and means for operating them.

A is a steam-cylinder, closed at each end by heads B B′, and divided into two equal parts by an abutment, C, formed into a stuffing-box, and packed with metallic packing-rings, as shown.

D is a hollow trunk, turned to suit the bore of this stuffing-box, its extremities fitted with piston-heads E E′, at a distance apart equal to the length of the stroke of the engine, added to the width of the central abutment, and the clearance allowed. Each piston-head of the trunk is furnished with packing-rings in the usual manner, turned to fit the bore of the cylinder A, which is about twice the usual length of single-cylinder engines, in order to permit each piston, E E′, to have the stroke determined upon.

The piston-rod F is attached to the trunk D, as shown, and passes through a stuffing-box in the front cylinder-head B′.

G G′ are ports for admitting the live steam from the steam-chest to the annular cylinders H H′, formed by the above-described combination of parts.

I I′ are transfer ports for conducting the steam from the annular or high-pressure cylinders to the low pressure cylinders A A′, and J J′ are eduction ports for exhausting the spent steam.

K K′ are two similar slide-valves, connected and moved together by a rod, L, which is furnished with a yoke, as shown, fitted with a sliding block, into which a wrist-pin of a crank-arm, M, projects; the shaft of this crank passes through a stuffing-box to the outside of the chest, where a starting-bar is connected, to move the valves by hand, when necessary.

In each end of the valve-chest is formed a small cylinder, bored true in line with each other, and fitted with steam-pistons N N′, packed with metallic packing-rings. The inner ends of these cylinders are open to the steam within the valve-chest, and consequently balance each other, being both exposed to the same pressure. The outer ends of the cylinders are closed by heads O O′, as shown. These pistons are attached to the valves K K′ by rods P P′, and constitute the mechanism by which the slide-valves are operated.

Steam-passages, Q Q′, are cut through from these small cylinders into the transfer-ports I I′, as indicated. The rods P P′ are continued through stuffing-boxes in the heads O O′, and their extremities fitted with dash-pots, to break the force of the movement of the valves, by cushioning, in any of the well-known methods.

Each slide-valve has a steam-passage or port cored through it, to establish, at the proper time, a communication between the ports G and I, for the purpose of conducting the live steam from the high-pressure to the low-pressure steam-cylinders, as before described. In other respects the faces of these valves are made to coincide with the ports over which they play.

R R′ are small V-shaped cavities arranged at each end of the bore of the cylinder A, cut down to the level of the counter-bore, the apex of the V of each pointing toward each other; these are cushioning-passages for arresting the pistons E E′ at the ends of their stroke, and at the same time are also the steam-ports for admitting the steam to the valve-pistons, to cause a reversion of the position of the slide-valves, the main pistons acting at that time as the slide-valve for the small pistons.

W is where the steam enters the chest from the boiler, and its distribution is effected as follows;

Referring to the drawing, we find the piston as hav-

ing just completed the stroke to the left. Live steam has been admitted by the port G, while the spent steam from the other side of the piston E has been exhausted through the port J into the exhaust-chamber S, thence conveyed away by a pipe, T, in the usual manner, to the condenser, or discharged into the atmosphere, as the case may be.

It will at the same time be observed that the charge of live steam from the previous stroke, after impelling the piston E′ to the right, has been transferred by the ports G′, K′, and I′, to the low-pressure cylinder A′, where it has been assisting the efforts of the live steam pressing upon the piston-head E, by exerting its expansive force upon the greater area presented by the face of the piston E′.

The effective area afforded here is reduced to that of the trunk only, as the steam, in expanding within the low-pressure cylinder, reacts with a back pressure upon the annular or high-pressure cylinder, as will be at once apparent by an examination of the action of the valve K′. This, however, does no harm; nothing is lost in consequence, and we only require to make the low-pressure cylinder somewhat larger to compensate for it.

The present position of the ports shows that the piston E has just passed over the exhaust-port J, effectually shutting off all communication between the end of the cylinder A and the condenser or atmosphere, the engine being condensing or non-condensing, and that, immediately following upon this, the inner edge of the same piston-head passes over the cushioning-passage R, permitting the live steam to flow to the greater area presented by this piston, as indicated by the arrow, thus bringing the stroke to an end. This same steam immediately rushes up the transfer-port I, and through the passage Q, to the end of piston N.

Now, by virtue of the fact that the steam contained within the cylinder A′ has become reduced by expansive working, in the proportion of the relative capacities of the annular cylinder H′ to that of the low-pressure cylinder A′, the pressure acting upon the other piston, N′, is inferior to that just admitted to piston N, consequently the slide-valves must be carried to the right by this superior force, which, changing the direction of the currents of the steam by a reversion of position of the slide-valves, the return stroke will be made, afterward to be arrested, and the valves again reversed precisely in a similar manner to that just described, which, being repeated at the end of each stroke, will cause alternate reciprocation of the pistons and valves *ad infinitum*, so long as the steam is admitted to the engine.

It is obvious that the exhaust-ports should be surely closed by the piston-heads before the established cushion-passages permit the steam to pass to the ends of the cylinders, otherwise there would be a waste of steam; as it is, no loss is entailed, as the little steam that is passed to perform the functions of arresting the piston and reversing the valve is merely an advance of the main body, which, immediately after the valve is reversed, pours over, by the port in the valve K, to continue its further service of expansion.

By arranging the V-shaped passages as described, with the apex of each pointing toward each other, the cushioning is effected in a very gradual manner, and the pistons will not be so suddenly checked, as would be the case if these passages opened abruptly.

With a further view of regulating the cushioning-ports to a greater degree of nicety, the steam might be conveyed by a closed passage, fitted with a valve, in place of the countersunk V-passage just described.

I claim as my invention—

1. In a compound engine, as described, where the opposite faces of each piston presents an unequal area, the arrangement of the passages R R′, eduction-ports J J′, and steam-passages Q Q′, or their equivalents, in combination with the main pistons E E′ and valve-pistons N N′, in such manner that the live steam, upon the completion of each stroke, will pass directly from the annular cylinders to the valve-pistons N, by the passages R and Q, for the purpose of operating the valves, as described.

2. The slide-valves, admitting the impelling agent employed to the main pistons, which, in turn, and at the proper time, become valves for controlling the action of the slide-valve pistons, the one admitting the impelling agent to the other alternately, substantially in the manner and for the purposes represented.

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Witnesses:

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