

UNITED STATES PATENT OFFICE.

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COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 534,193, dated February 12, 1895.

Application filed January 6, 1894. Serial No. 496,992. (No model.) Patented in England April 22, 1892, No. 7,647.

To all whom it may concern:

Be it known that I, AUGUST VON BORRIES, a subject of the King of Prussia, residing at 15 Herrenstrasse, Hanover, in the Empire of Germany, have invented Improvements in Compound Engines, (for which Letters Patent have been obtained in Great Britain, No. 7,647, dated April 22, 1892,) of which the following is a specification.

This invention of improvements in compound engines has reference to the valve apparatus used in such engines whereby they can be worked, at will, either as compound engines or as non-compound engines.

In my United States patent dated December 26, 1893, No. 511,581, I have described a construction of valve apparatus for the purpose mentioned in which the connecting passage between the high and low pressure cylinders, a high pressure exhaust port, and a steam passage by which live steam can flow at a reduced pressure to the steam chest of the low pressure cylinder, are controlled by intercepting exhaust, and auxiliary steam reducing valves which are moved in one direction to close the connecting passage and open the exhaust and live steam passages, when the engine is to work as a non-compound engine, by the pressure of live steam admitted to one end of a cylinder fitted with a piston connected with the said valves, the valves being automatically moved in the opposite direction to open the connecting passage and close the exhaust and live steam passages, when the engine is to work as a compound engine and the supply of live steam to the live steam passage is cut off, by reason of the pressure of the steam in the low pressure steam pipe on the valve controlling the connecting pipe between the high and low pressure cylinders being then unbalanced by the pressure of live steam on the said piston. Now my present invention has reference to improvements in or relating to valve apparatus of this and similar kinds, and it has for its object to effect each of the above mentioned movements of the valves by the action of fluid pressure at the will of the engine driver, so as to thereby obviate any liability that may arise of the said valves not automatically

moving into position for working compound, by reason of the pressure on the low-pressure side of the engine falling too low from any cause, as for example owing to the steam supply having been cut off and the engine allowed to run empty for some time, after previously working as a non-compound engine. For this purpose I connect the said valves to a piston arranged to work in a cylinder to each end of which motive fluid is or may be admitted at will, the arrangement being such as to form a double acting or differential fluid-pressure motor under the control of the engine driver. The said cylinder may be separate from the chamber through which live steam passes to the auxiliary steam reducing valve, or it may form part of such chamber as in the example hereinafter described.

In the accompanying drawings, Figures 1 and 2 show partly in longitudinal central section and partly in elevation, valve apparatus constructed according to this invention, Fig. 1 showing the valves in position for working the engine to which they are applied as a compound engine, while Fig. 2 shows the valves in position for working the engine as a non-compound engine.

A is the valve case formed with a passage B, B' arranged to form part of the connecting pipe or receiver B² between the high and low pressure cylinders, and with another passage C in communication with a high pressure exhaust pipe C'.

D is a combined exhaust valve and intercepting valve adapted to control an exhaust port or passage E between the passages B B' and C, and also the communication between the high and low pressure cylinders through the said passage B B'.

F is a piston arranged to work in a cylinder F' that is secured to one side of the valve case A and is provided with live steam inlets G, G' at its inner and outer ends respectively.

H, H' is a rod of two diameters connecting the valve D with the piston F and working through a plate I separating the passage B, B' from the cylinder F'. This rod serves as a steam reducing valve that serves to prevent live steam flowing to the low pressure cylinder until the valve D is fully open as shown

in Fig. 2, at which time the part H of the rod of smaller diameter will extend through the hole in the said plate I and leave an annular opening I' for the passage of live steam to the end B' of the said passage B, B', whence it can flow, at a reduced pressure, to the low pressure cylinder.

J and J' are pipes connecting the steam inlets G G' respectively with the high pressure steam supply pipe K for the high pressure cylinder L.

N is a valve case formed with three passages N¹ N² N³ communicating respectively with the steam inlet G', the live steam pipe J', and the external atmosphere.

O is a valve that is held in the position shown in Fig. 1 by the pressure of live steam thereon, when the engine is working as a compound engine, so as to open communication between the passages N¹ and N² and close the passage N³.

P is a lever arranged to act against the stem O' of the valve O and connected to a rod Q whereby the engine driver can move the said valve from the position shown in Fig. 1 to that shown in Fig. 2 when it is desired to work the engine as a non-compound engine. In the latter case, the outer end of the piston will be subjected only to the pressure of the external atmosphere so that the steam acting upon its inner end will readily move it and the connected valves from the positions shown in Fig. 1 to those shown in Fig. 2 thereby closing the communication between the high and low pressure cylinders and opening the exhaust port E and also the annular steam passage I' so that live steam can then flow from the pipe J by way of the inlet G, and inner end of the cylinder F' into the pipe B' at the low pressure side of the valve D, at a reduced pressure, and thence to the steam chest of the low pressure cylinder. In the former case both ends of the piston F will be subjected to the pressure of live steam entering by the inlets G G' but since the outer end is of greater area than the inner end, in consequence of the rod H H' being connected thereto, the pressure on the former will exceed that on the latter with the result that the piston and connected valves will be moved by such excess of pressure from the position shown in Fig. 2 to that shown in Fig. 1, whether there be any steam pressure in the passage B' B² leading to the low pressure cylinder or not.

In the example shown the valve O is a disk valve operated in one direction by the steam

pressure and in the opposite direction by the lever, but it will be obvious that other types of valves or cocks can be used if desired for the purpose mentioned, and be operated in each direction by a rod or lever under the control of the engine driver. The relative areas of the inner ends of the valve D and piston F subjected to live steam pressure, should be such that the total pressure of the live steam on the piston F will equal that of the steam at lower pressure on the valve D so that the reducing valve H H' will be caused to automatically vary the supply of steam through the opening I' in accordance with variation of the pressure in the passage B' B² as fully explained in my said former specification.

As will be obvious a double acting or differential fluid pressure motor such as described may be used in conjunction with various arrangements of intercepting valve for changing the working of compound engines from compound to non-compound and vice versa whether exhaust and auxiliary steam reducing valves be combined therewith or not.

What I claim is—

The combination of the high pressure exhaust, the passage to the low pressure cylinder, valve D for controlling the communication between the exhaust and said passage, cylinder F', a valved connection between the same and the passage to the low pressure cylinder, live steam pipe J leading to the inner end of the cylinder, similar pipe J' connected to its outer end, valve O normally closing the outer end of the cylinder to the outer air, the valve being so held by the pressure in pipe J', a mechanism for moving said valve to close pipe J' and open the cylinder to the outer air, the single piston F in cylinder F' for operating valve D and of such areas at its ends as to subject its outer end to greater pressure than its inner end, whereby said piston will be held normally at the inner end of the cylinder with valve D so held as to have the engine work compound, substantially as shown and described.

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

AUGUST VON BORRIES.

Witnesses:

HEINRICH ZEIHNER,

KARL DAMMANN,

Both of Hanover.