

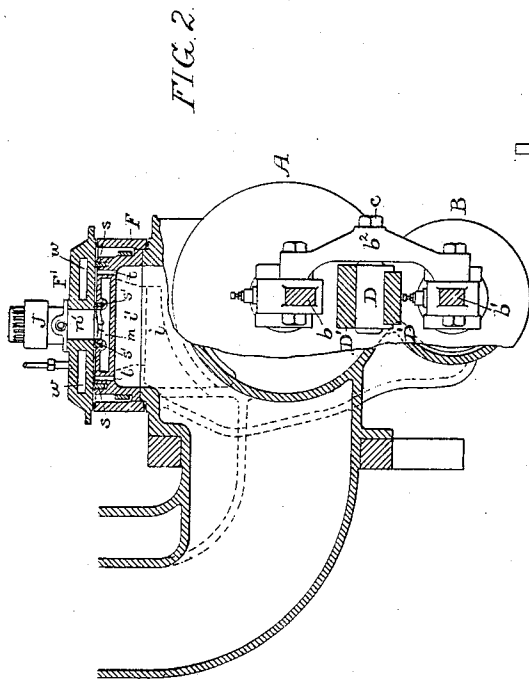
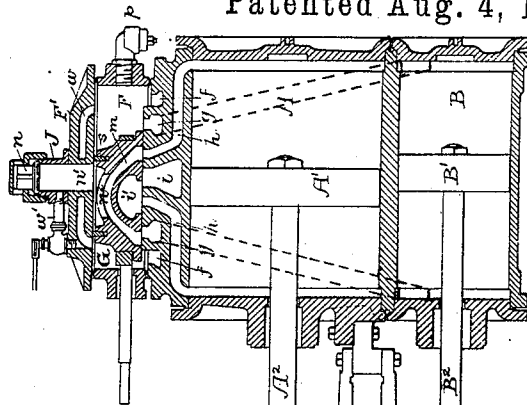
(No Model.)

2 Sheets—Sheet 1.

H. D. DUNBAR.
COMPOUND ENGINE.

No. 565,335.

Patented Aug. 4, 1896.



Witnesses:

R. Schleicher.
Will O. Barr

Inventor:
Henry D. Dunbar
by his Attorneys
Houson & Houson

(No Model.)

2 Sheets—Sheet 2.

H. D. DUNBAR.
COMPOUND ENGINE.

No. 565,335.

Patented Aug. 4, 1896.

FIG. 3.

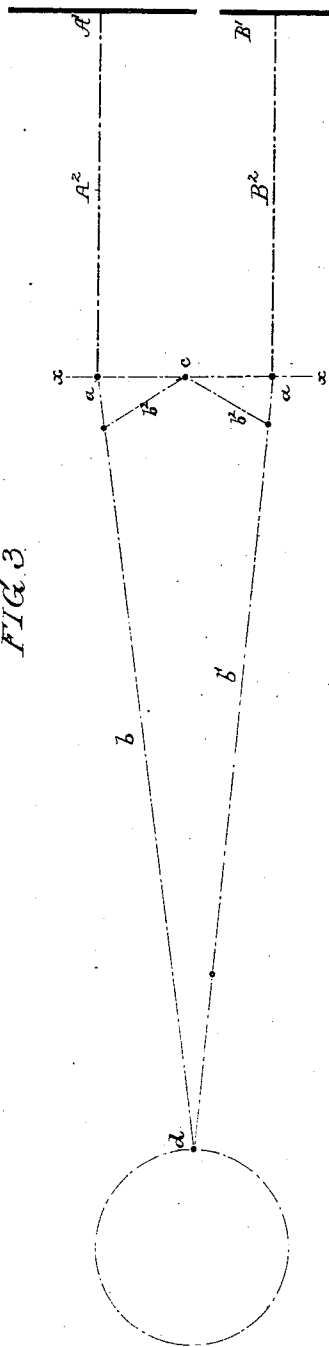
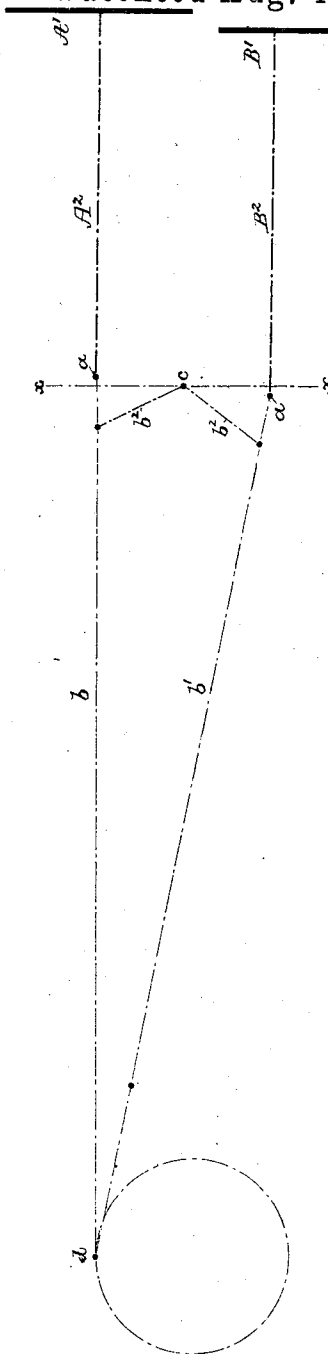


FIG. 4.



Witnesses:
R. Schleicher
Wm. O. Penn.

Inventor:
Henry D. Dunbar
by his Attorneys
Howson & Howson

UNITED STATES PATENT OFFICE.

HENRY D. DUNBAR, OF HARTLAND, VERMONT, ASSIGNOR OF ONE-HALF TO
OLIVER P. DUNBAR, OF NORWALK, OHIO.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 565,335, dated August 4, 1896.

Application filed May 20, 1896. Serial No. 549,926. (No model.)

To all whom it may concern:

Be it known that I, HENRY D. DUNBAR, a citizen of the United States, and a resident of North Hartland, Vermont, have invented certain Improvements in Compound Engines, of which the following is a specification.

My invention relates to that class of compound engines in which the high and low pressure cylinders are placed side by side or one above the other and the two piston-rods are connected to the same crank-pin; and the invention relates especially to that form of such engine which is shown in my Patent No. 502,956, dated August 8, 1893, and in which the structure connecting the two piston-rods to the crank-pin is in the form of a rigid triangular frame connected at the apex to the crank-pin and at the base to the piston-rods.

One object of my invention is to so modify the construction of this triangular frame as to provide for the use of a central slide and guide instead of the top slide and guide of the patented structure, a further object of the invention being to provide for the ready admission of air to the low-pressure cylinder when the steam is cut off and the engine is running by gravity or momentum, and a still further object being to provide simple means for admitting live steam to both cylinders when more than the ordinary amount of power is required, as, for instance, in starting a heavy train. These objects I attain in the manner hereinafter set forth, reference being had to the accompanying drawings, in which—

Figure 1 is a view, partly in section and partly in elevation, of sufficient of a compound engine of the locomotive type to illustrate my invention. Fig. 2 is a transverse section of the same partly through the cylinders and valve-chest and partly through the connecting-frame and slide-bearing. Fig. 3 is a diagram illustrating the position of the pistons, piston-rods, and connecting-frame when the crank-pin is on the center and the pistons are at one end of the stroke; and Fig. 4 is a diagram illustrating the position of the parts when the crank-pin is at the top mid-point of the throw and the pistons are at half-stroke.

In Figs. 1 and 2, A represents the low-pressure cylinder, and B the high-pressure cylinder,

of the engine, A' B' representing, respectively, the low-pressure and high-pressure pistons and A² B² the low-pressure and high-pressure piston-rods. The usual heads at the outer ends of the piston-rods are connected by pivot-pins *a* to a triangular frame comprising the upper member *b*, the lower member *b'*, and the short connecting member *b²*, all of these members being rigidly secured together at their meeting points, and the outer end of the member *b* having the usual bearing-box for receiving the crank-pin *d* of the driving-wheel. The member *b²* of the triangular frame is pivoted by means of a pin *c* to a slide D, which is adapted to guides D', projecting forwardly from the cylinder-head structure and occupying a position midway between the upper and lower piston-rods A² B². By thus pivoting the connecting member of the triangular frame at its center I am enabled to employ the central slide and guides instead of the guide above the upper piston-rod, as in my patented structure, so that the front end of each piston-rod is comparatively close to the rigid guide, and is therefore more effectively guided.

This construction implies, as did the former one, a slight differential movement of the pistons, the three pins *a a* and *c* being vertically in line with each other when the crank-pin is on the center and the pistons are at the end of the stroke, as shown in Fig. 3, the upper pin *a* being in advance of the vertical line *x* through the pin *c* and the lower pin *a* in the rear of said line when the crank-pin is at the lower mid-position, as shown in Fig. 1, and a condition of affairs the reverse of that shown in said Fig. 1 being the result when the crank-pin is at the upper mid-position, as shown in Fig. 4. This provision for independent movement of the upper and lower piston-rods, however, is not a disadvantage, but is, as set forth in my former patent, attended with certain advantages in carrying the crank-pin over the centers. The ends of the member *b²* of the triangular frame are offset or carried forwardly beyond the central pivot of the same to such an extent that the three pins are directly in line vertically when the pistons are in either extreme position. Hence the arcs of circles traversed by the upper and

lower pins *a a* do not deflect the latter materially from horizontal lines, and there is no objectionable vertical play of the piston-rods in their stuffing-boxes and no injurious twisting strain upon either of the pistons.

In engines of the class to which my invention relates an objectionable thumping or pounding frequently occurs owing to the formation of a partial vacuum in the low-pressure cylinder when steam is cut off and the engine is running down a grade or by momentum. This objection I overcome by providing an air-inlet valve for the low-pressure cylinder independent of that which supplies air to the high-pressure cylinder when the steam is cut off.

The chamber within the steam-chest *F* is in communication with the steam-supply pipe through channels *f*, the combined induction and eduction passages for the high-pressure cylinder being shown at *g*, the combined induction and eduction passages for the low-pressure cylinder being represented at *h*, and the main exhaust-passage at *I*, this being the usual construction.

The valve *G* is a sliding *D*-valve having the ordinary exhaust-chamber *i'*, but having also a passage *m*, which serves to convey steam from one or other of the passages *g* to the opposite passage *h*, so that steam is exhausted from one end of the high-pressure cylinder into the opposite end of the low-pressure cylinder, in order that the pistons of both cylinders may be driven in the same direction.

On the top of the steam-chest cover *F'* is a small chest *J*, containing a check-valve *n*, opening inwardly, this chest *J* communicating, through an opening *n'* in the cover *F'* and through an opening *n''* in the back of the valve *G*, with the passage *m* of the latter.

When the engine is running under ordinary conditions, steam under pressure from the passage *m* of the valve *G* enters the valve-chest *J* and closes the valve *n* against its seat, so that no escape of steam therefrom is permitted, but when the steam has been cut off and the engine is running down a grade or by momentum, and the movement of the piston *A'* causes partial vacuum in that end of the cylinder *A* which is in communication with the passage *m* of the valve *G*, the valve *n* will open and permit air to enter the cylinder *A* through the valve-chest *J*, openings *n'* *n''*, and passage *m* of the valve *G*, so as to overcome the objectionable thumping or pounding due to the creation of this partial vacuum in engines as at present constructed.

Under the same conditions of working, air is supplied to the valve-chest *F*, and thence to the high-pressure cylinder *B*, by means of the usual air-valve *p* at one end of said valve-chest.

The valve *G* is provided on the back with suitable packing-strips *s s'* in order to prevent the access of steam to the back of the valve, thereby relieving the same from pres-

sure. The packing-strips *s* are common in this form of balanced valve, but I have added the strips *s'*, so as to cut off the opening *n''*, which leads into the chamber *m* of the valve, thereby reducing the steam-pressure on the back of the valve to a minimum.

In order to prevent steam which may leak past the packing-strips for accumulating behind the valve and within the spaces inclosed by said packing-strips, the valve has openings *t*, leading to the main exhaust-chamber *i'* from the chambers on the back of the valve.

The opposite ends of the steam-chest communicate with each other through passages *w*, formed in the cover *F'*, and one of these passages is in communication, through a valved pipe *w'*, with the chest *J*.

The valve in the pipe *w'* is normally closed, so that no opportunity is afforded for live steam to gain access to the chest *J*, but when it is desired to use live steam in the low-pressure cylinder in order to develop high power, as, for instance, in starting a heavy train, the valve in the pipe *w'* is opened, so that live steam can gain access to the chest *J*, and thence, through the passage *m* of the valve *G*, can enter the low-pressure cylinder, the latter thereby becoming, for the time, a high-pressure cylinder, the pressure in both ends of the normal high-pressure cylinder *B* being equalized.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The combination in a compound engine, of side-by-side cylinders each with piston and piston-rod, a triangular frame connected directly to the outer unguided ends of the piston-rods and to the crank, and a guided slide located between the piston-rods and carrying a pivot for the short connecting member of said triangular frame, substantially as specified.

2. The combination in a compound engine, of side-by-side cylinders each with piston and piston-rod, the triangular frame connected directly to the outer unguided ends of said piston-rods and to the crank, and a slide adapted to guides between the piston-rods, said slide carrying a pivot-pin for the short connecting member of the triangular frame and said pivot-pin being offset longitudinally in respect to the points of connection of said short member with the other members of the triangular frame, substantially as specified.

3. The combination in a compound engine, of high and low pressure cylinders, each with its piston and piston-rod, a valve-chest having a main valve for directing steam to the high-pressure cylinder, from the latter to the low-pressure cylinder, and from the latter to the exhaust, a valved air-inlet, a passage leading therefrom to the low-pressure cylinder through the main valve, and a valved pipe whereby live steam from the steam-chest can be directed into said passage and thence into

the low-pressure cylinder, substantially as specified.

4. The combination in a compound engine, of high and low pressure cylinders each with
5 piston and piston-rod, a valve-chest having a main valve with exhaust-chamber, and above the same a chamber for conveying steam from a port of the high-pressure cylinder to a port of the low-pressure cylinder, an opening from
10 this conveying-chamber to the back of the valve, a live-steam passage leading through the back of the valve-chest, and longitudinal and transverse packing-strips carried by the back of the valve and bearing against the
15 back of the valve-chest, the longitudinal packing-strips comprising inner and outer sets, the inner set being close to the passage in the back of the valve-chest whereby the steam-pressure on the back of the valve is
20 reduced to a minimum, substantially as specified.

5. The combination in a compound engine, of high and low pressure cylinders each with piston and piston-rod, a valve-chest having a
25 main valve with exhaust-chamber, and above

the same a chamber for conveying steam from a port of the high-pressure cylinder to a port of the low-pressure cylinder, an opening from this conveying-chamber to the back of the valve, a live-steam passage leading through
30 the back of the valve-chest, longitudinal and transverse packing-strips carried by the back of the valve and bearing against the back of the valve-chest, the longitudinal packing-strips comprising inner and outer sets, the
35 inner set being close to the passage in the back of the valve-chest whereby the steam-pressure on the back of the valve is reduced to a minimum, and drainage ports or passages leading from the exhaust-chamber of
40 the valve to the spaces between the inner and outer longitudinal packing-strips of the same, substantially as specified.

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

HENRY D. DUNBAR.

Witnesses:

FRANK E. BECHTOLD,
JOS. H. KLEIN.