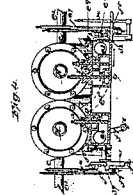
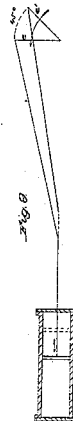
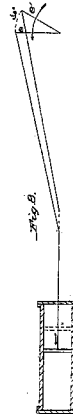
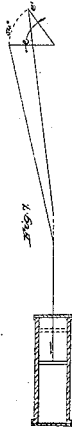
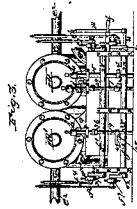
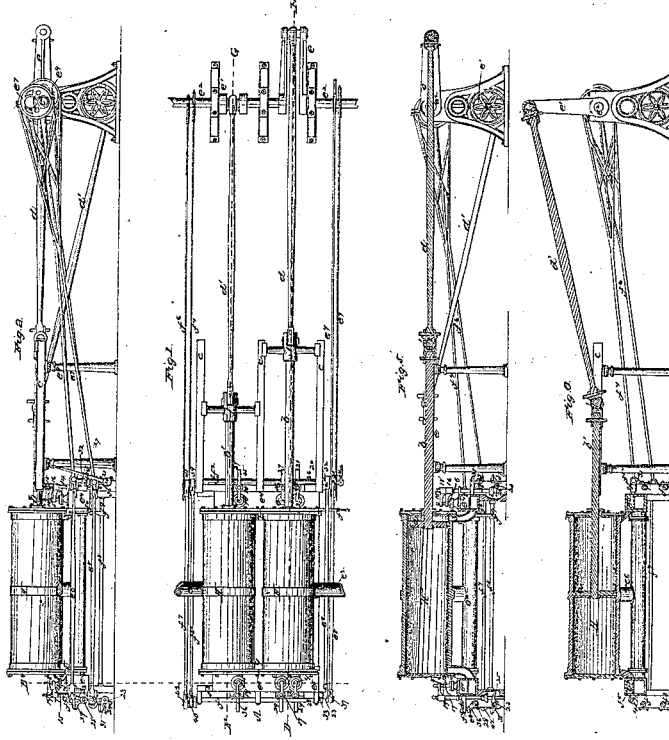


D. Barnum.

Compound Steam Engine.

N^o 4,765.

Patented Sep. 19, 1846.



Witnesses:
W. H. Russell
Samuel H. Smith

Inventor:
Daniel Barnum

UNITED STATES PATENT OFFICE.

DANIEL BARNUM, OF NEW YORK, N. Y.

DOUBLE-CYLINDER STEAM-ENGINE.

Specification of Letters Patent No. 4,765, dated September 19, 1846.

To all whom it may concern:

Be it known that I, DANIEL BARNUM, of the city, county, and State of New York, mechanical engineer, have invented and
5 made certain new and useful improvements in the mechanical arrangement, construction, application, and combination of the parts of steam-engines that are intended to work by the action of steam admitted into
10 one cylinder at a given pressure, and in the progress of the stroke or half revolution the communication with the boiler is cut off and the steam is allowed to pass into a second cylinder and work expansively, which
15 has been done before by others, but not in the manner invented by me, the first difference between my hereinafter described invention and nearly all that have preceded it being that I use two parallel and equal-
20 sized cylinders set alongside of each other; the second difference is that with these two cylinders I use only one induction steam-pipe from the boiler and one eduction-pipe from both the cylinders to the atmosphere
25 or a condenser; the third difference is that the steam is admitted by a proper induction-valve to about the half-length of the first cylinder, the induction-valve is then closed, and an expansion-valve simultaneously
30 opened from the first to the second cylinder; thus the operation of the steam, commencing at the same end of both cylinders, forms the fourth difference between my plans and those of others, and the expansion-valve is
35 sustained open, so that the steam shall act expansively during the remainder travel of the first piston and nearly the whole stroke of the second piston and shall also propel
40 the pistons both in the same direction during a large portion of the travel or stroke of each without reacting from one piston upon the other, which constitutes a fifth difference between this invention and others that
45 have preceded it; the exhaust-valve operates to exhaust both cylinders to the air or to a condenser at the same time from the same end of each cylinder to the same side pipe, and this constitutes a sixth difference between this and other plans preceding it, a
50 large portion of these ends being attained by placing the piston-rods in connection with two cranks on one main or driving shaft, which two cranks are to be placed either at right angles or at some acute or
55 lessening angle less than ninety degrees

apart, which is believed to be the seventh clear and distinct difference between these arrangements and any that have preceded them.

It is well known, that double engines have
60 been made to act, with either equal, or unequal cylinders, upon cranks set at opposite points, in the same line, with valves and openings, that pass the steam from the top of the first piston, to the bottom of the second, and, vice versa, and threefold engines,
65 having cranks more than ninety degrees apart, have been used, and marine engines, with cranks set at ninety degrees apart, each operated by a separate and unconnected cylinder, are in common use, yet no one of
70 these operates in the manner herein proposed, the nearest approach to which has been made, by Mr. Belcher, of New York city, who made an engine with two cylinders, and pistons operating on a pair of
75 right angled cranks, the valves set to admit the steam from the boiler, only when the first crank had passed upward, or downward, to an angle of forty five degrees, and
80 at one hundred and thirty five degrees, passing the steam, expansively, from the first, to the second cylinder, to the end of the stroke of the first piston, and thus making
85 the second piston carry the first crank past the dead centers, each piston traveling, without steam operating on it, during the first quarter of each stroke. All these, and
90 many other modifications of steam engines, for the same end, are variant from my invention, and improvements, by not acting
95 in so direct concert, to produce an expansive, direct, and continuous action, of the steam in the same direction, on both pistons, through the relative positions of the cylinders and cranks, and the arrangement, and
100 combination, of the acting parts, for which I seek Letters Patent of the United States, the said improvements, being collectively entitled "Barnum's double acting successive
105 expansion and condensing steam engine" are substantially and constructively set forth, in the following descriptive specification, and shown in the drawing, annexed to, and making a substantive part hereof,
110 wherein—

Figure 1, is a general plan of a double cylinder steam engine, fitted with these improvements, as in place for use; Fig. 2, is a like elevation of the same, Fig. 3, is an ele-

vation, seen at the end A, of Figs. 1, and 2. Fig. 4, is a cross sectional elevation, through the line B, C, Figs. 1, and 2. Fig. 5, is a longitudinal sectional elevation, through the line D, E, Fig. 1, and Fig. 6, is a like section, through the line F, G, Fig. 1, the cranks being in opposite positions, to those shown in Fig. 5. The other figures are separately, and consecutively referred to, and the same letters and numbers, and other specific marks of reference apply to the like parts, in all the several figures.

H, H', are the cylinders, supported in any usual or convenient manner; *a*, *a'*, are the pistons, *b*, *b'*, are the piston rods, jointed to cross heads 1, 1, set in slides *c*, *c*, and connected by rods, or pitmen, *d* and *d'*, to two cranks, *e* and *e'*, shown at acting at right angles to each other, on *e*², the main shaft, through which the power operates; the other parts being in the position they will take, when the two cranks are in the position shown in the drawing; *e*³, is the induction steam pipe, from the boiler, opening, at the fore end, into the steam and valve chest *e*⁴, and at the back end, into the steam and valve chest *e*⁵, these, again, are connected to the ends of the education steam pipe *e*⁶, having a branch, either running to a condenser, or to the atmosphere. The valve chest *e*⁴, contains the induction steam valve 2, opening to the steam port 3, at that end of the cylinder H, near this is the expansion steam valve 6, opening from the cylinder H, to the cylinder H', by the passage way 7, partly shown by dotted lines at 9, in Fig. 4, which, being the back end of the cylinders, the corresponding way, at the fore end, will be in reverse, or handed, to that in Fig. 4; next is the exhaust steam valve 10, opening from the cylinder H', to the exhaust pipe *e*⁶, by a way not shown in the drawings, but which will be understood, by reference to the exhaust way 13, in Fig. 4, in the same manner, as the steam ways 7, and 9. The valve chest *e*⁵, at the back end of the cylinder, contains the induction steam valve 4, and steam port 5, expansion steam valve 8, and steam way, or port 9, with the exhaust steam valve 12, and way 13, (before referred to) 14, is the lifting rod and adjustable arm, to the valve 2, with a lifting foot to the toe of the rock shaft beneath, and 15 is the like rod, arm, and foot, to the valve 4.

16, and 17, are the lifting rods, and adjustable arms, to the valves 6, and 8, but are each fitted with one lifting, and one sustaining foot,—18, and 19, are the like rods, and arms, to the valves 10, and 12, each also with one lifting, and one sustaining foot.

20, is the lower rock shaft, at the fore end of H, with an outer toe 21, to lift the steam valve 2, and an inner toe 22, to sustain the

expansion valve 6. 23, is the lower rock shaft, to the back end of H, with an outer toe 24, to lift the induction valve 4, and an inner toe 25, to sustain the expansion valve 8, these rock shafts are moved, by the eccentric and rod *e*⁷, from the shaft *e*², to the crank 30, on the rock shaft 20, and a connecting rod *e*⁸, from the crank 30, to the crank 31, on the shaft 23, all so timed, that the lifting the valves 2, or 4, closes the valves 6, or 8, and the contrary, thus the closing the valves 2, or 4, to shut off the steam, at any portion of the stroke to which they are set, brings up the opposite toe, to sustain the expansion valves 6, or 8, until the reverse motion again raises, and opens, the induction steam valves 2, or 4, the expansion valves closing, until again lifted by the following means: The rock shaft 26, at the fore end of the cylinder H, has a toe 27, to lift the expansion valve 6, and a similar rock shaft 28, has a toe 29, to lift the expansion valve 8, and these rock shafts are moved, by the second eccentric and rod *e*⁸, going from the shaft *e*², to the crank 32, on the rock shaft 26, and a second connecting rod *e*, *o*, from the crank 32 takes a similar crank 33, on the rock shaft 28, and the motions of these parts are timed so, that the expansion valves 6, or 8, shall be lifted, at the instant the induction steam valves 2, or 4, are closed, the further movements of these parts, would close the expansion valves too soon, but the toes 22, and 25, on the rock shaft 20, and 23, take the duty of sustaining them, as before described, until the steam valves are lifted again. The starting bar 34, gives the means of working by hand, as usual.

The exhaust valves are worked as follows: The upper rock shaft *f*, at the fore end of the cylinder H', has a toe 35, set to lift the exhaust valve 10, and the rock shaft *f'*, at the back end, has a toe 36, to lift the back exhaust valve 12, these parts are moved by the third eccentric and rod, *f*¹, from the shaft *e*², to the crank 39, on the rock shaft *f*, and the third connecting rod *f*², from the crank 39, to the crank 40, on the shaft *f*, these lift the valves, only; the lower rock shaft *f*², at the fore end of the cylinder H', has a toe 37, to sustain the valve 10, and the lower rock shaft *f*³, at the back end, has a toe 38, to sustain the exhaust valve 12, and these parts are moved, by the fourth eccentric and rod *f*³, taking the crank 41, on the shaft *f*², and the fourth connecting rod *f*⁴, from the crank 41, to the crank 42, on the shaft *f*³, these parts are so timed, that the shafts *f*, and *f'*, lift the valves, by the toes 35, or 36, at the moment after the piston *a*, has arrived at the opposite end of the cylinder H, and is so far in the return, that the two cross heads are nearly in the same cross line, at which time

the exhaust valve opens, and allows the exhaust of the steam to commence, momentarily after the fresh induction of steam, upon the opposite side of the piston *a*, but before the fresh steam entering, has carried the piston *a*, more than about one tenth of the stroke, and so prevents any reaction, or compression, between the steam that is finishing its work, and the steam that is commencing its work, and the lower rock shafts *f*², *f*³, and toes, 37, and 38, sustain the valves 10, and 12, until the piston *a*, has returned the given portion of the stroke, at which the expansion is to begin from the cylinder H, to H'. When the valves 10, or 12, are closed, and the expansion valves 6, or 8, are opened, to act as before described. By these arrangements of the parts, and their consequent action, the induction steam pipe, and induction valves, act in the usual way, to admit and cut off the steam, the second valve, at each end of the cylinders does the duty of an expansion valve, between the cylinders, and of an exhaust valve to the first cylinder, while the third, or only extra valve, beyond what would be used with one cylinder, passes the steam away, by one exhaust side pipe, which is believed to be a new feature, in double cylindered engines.

The placing the cranks at a right angle with each other, or at some acute angle or less than a right angle, makes the pistons move very closely together, so as to receive the steam, acting expansively, to move them both in the same direction, during a large portion of the stroke of each, and the steam that is allowed to escape, or in other words, is thrown away, in common high pressure expansive engines, is, by these arrangements, compelled to do an amount of duty, that it is believed will add materially to the effect produced, by its expenditure, while, by the actions of the parts, the steam, thus expended, may be run into a condenser, through the same eduction way from each cylinder, which may be considered a new feature, in double cylindered engines, and will allow the operation of a vacuum, behind both the pistons, that will more than compensate the power expended on the air pump, to empty the condenser, and will thus add to the effective power of the engines, at the same time removing the annoyance, caused by the noise of the escape steam, in any situation, but importantly so, in passenger steam boats.

The outline, or skeleton Fig. 7, shows the cranks *e*, *e'*, at an acute angle of 54 degrees, the Fig. 8, the same, at 30 degrees, and the Fig. 9, at 45 degrees apart, and are merely introduced, to show, by the position taken by the center of the crank pins and cross-heads, the place, that the piston will occupy, relatively to each other, when the cranks

are placed at any of those angles, the relative positions, and movements, of the other acting parts, being timed to act proportionately the same, as herein before described.

The cylinder H, may be made to work alone, by the following means: Beneath the cylinder H', a longitudinal shaft *f*³, has a toe 43, at the back end, and a similar toe, not seen in the drawing, at the fore end. each of these toes act beneath a corresponding foot, in the exhaust valve rods, to set them open, by the attendant drawing a slide rod *f*, *o*, in the direction of the arrow near it, and bringing, in the same direction, a crank *f*^o, on the shaft *f*³, thus lifting the exhaust valves 10 and 12, and leaving the valves 6, and 8, to do only the duty of exhaust valves to the cylinder H, no steam, in this case, passing so as to operate in the cylinder H', but going direct, through the expansion and exhaust ports and valve chests, to the air, or condenser, but it is here proper to notice, that the upper eccentric rod *e*^o, must be disengaged from the crank 32, when the cylinder H, is worked alone.

The arrangements are shown in the drawings, as fitted to horizontal cylinders, this mode having especial reference, in my mind, to the largest steam boats of the western waters; but it will be manifest, that these arrangements can be equally made available, in either vertical or inclined engines, by any competent mechanic, and it will also be seen, that any of the cut off valves, or throttle valves, or other valves now commonly used, between the side pipe and cylinders, or boilers, may equally be used, with my improved arrangements above described, and it will be also manifest, that in working steam, of very high pressure, it may be, sometimes, advisable to use a second or expansion cylinder, of larger area than the first, which may be done, without any really mechanical departure from the arrangements herein described, as applicable to two cylinders of equal size.

Having, in the commencement of this specification, set forth the general differences, between these arrangements, and those that have preceded them, it will be understood, that I do not claim to have originally invented an expansively acting steam engine, neither do I claim to have invented any of the parts, herein described, as used by me, for these purposes, the whole of them having been long well known, and in general use, neither do I claim the application of two cylinders, with a pair of cranks, irrespective of an application arrangement for the admission of the steam from the first cylinder with the second at the half stroke (more or less) of the first piston, but

I do claim as new and of my own inven-

tion and desire to secure by Letters Patent—

1. The mode of constructing and arranging two steam cylinders side by side with steam passages from one to the other direct at each end in combination with valves so arranged and operated as to admit the steam from the boiler into one cylinder only—and from that one into the same end of the other cylinder at the half stroke—(more or less) of the piston of the first cylinder—substantially as described and shown.

2. I claim as new, the mode of working the expansion and exhaust valves, distinguished from the working of all other valves, they each being opened, by the toe of one rock shaft, in advance of the regular or usual period—the one, at the proper time to allow the steam to pass into the second cylinder, to act by expansion, and the other, at the proper time to prevent the compression of steam, or reaction between the two pistons—from which toes the valves are each taken, by a toe of another rock shaft, for the purpose of being sustained, and kept open, the requisite length of time, for the attainment of the ends sought, as described and shown.

3. I claim as new, the arrangement for disconnecting the two cylinders, by simply opening the two exhaust valves to the sec-

ond cylinder, and unlocking the eccentric, which works the expansion valves, between the two cylinders, when the first cylinder is used, as a single engine, worked in the ordinary way, or by hand, for the purpose of reversing the motion, or stopping, or starting the engine, as described and shown.

4. I claim the arrangement, and application, of the several parts with each other, which I have above described, and set out, as new, in combination with a pair of cranks, which are attached to one main or driving shaft, set to a right angle or either more, or less than a right angle, with each other, for the purpose of working the pistons of the two cylinders, in the same direction, by the primary, and expansive action, of the steam, and exhausting to the air, or a condenser, forming a vacuum, each working by one channel, from the same end of the two cylinders, at the same time, substantially as described, and shown.

In witness whereof I have hereunto set my hand in the city of New York this day the nineteenth of February one thousand eight hundred and forty-six.

DANIEL BARNUM. [L. s.]

Witnesses:

W. SERRELL,
LEMUEL W. SERRELL.