(No Model.) 3 Sheets—Sheet 1.

H. R. FAY.

ENGINE VALVE.

No. 541,605. Patented June 25, 1895.

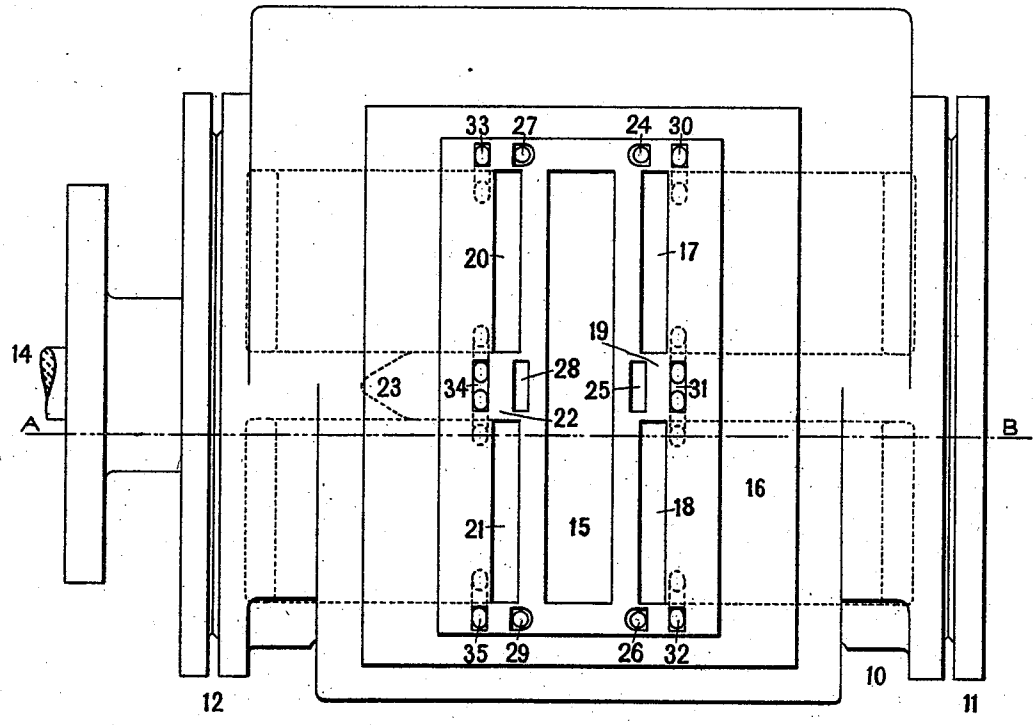

FIG. 1.

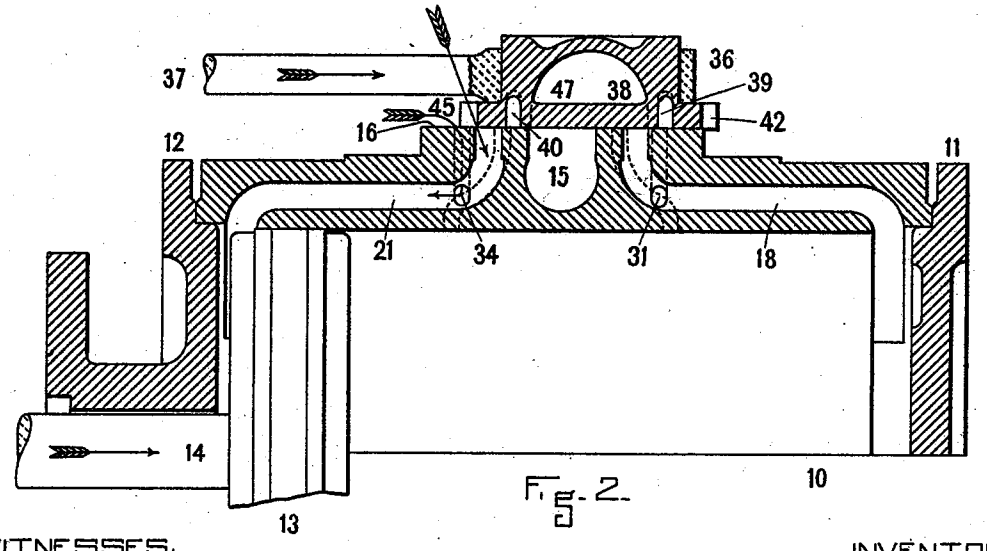

FIG. 2.

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(No Model.) 3 Sheets—Sheet 2.

H. R. FAY.

ENGINE VALVE.

No. 541,605. Patented June 25, 1895.

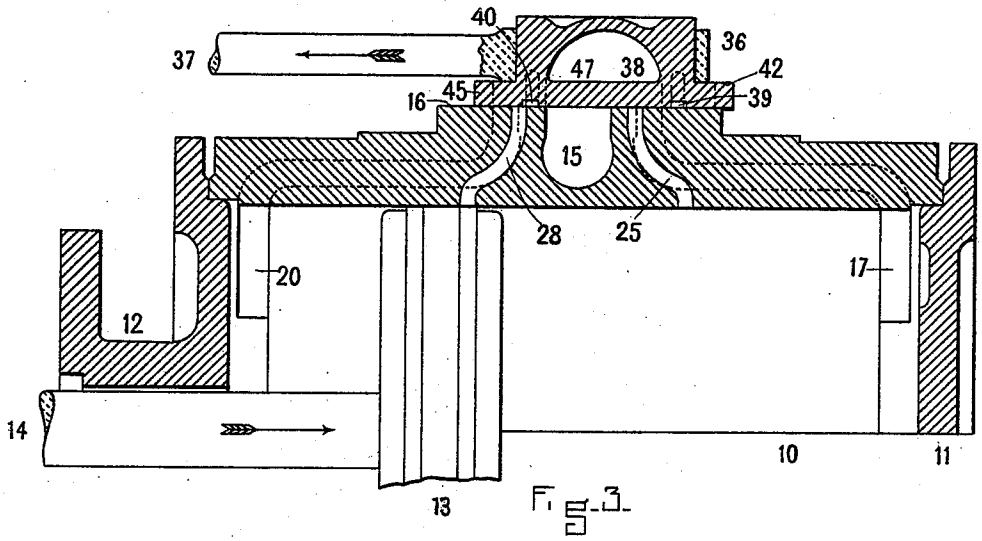

Fig. 3.

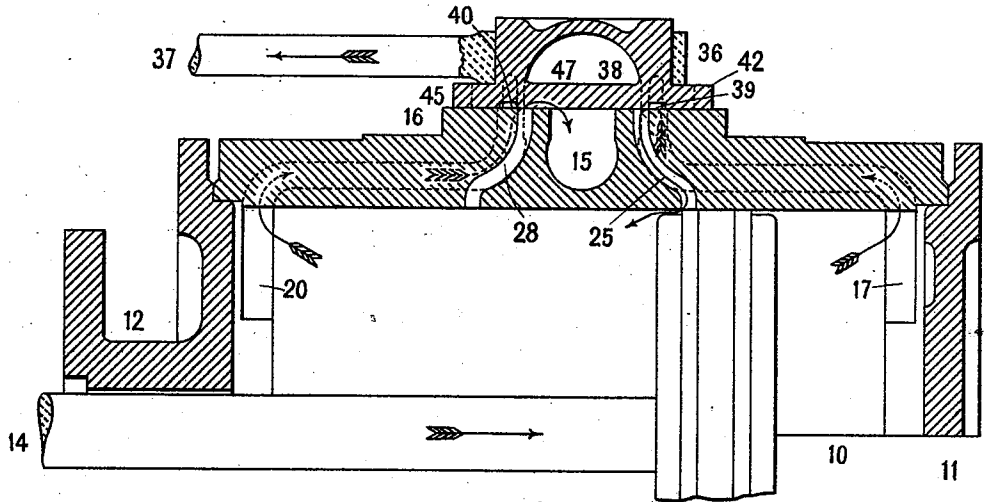

Fig. 4.

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ENGINE VALVE.

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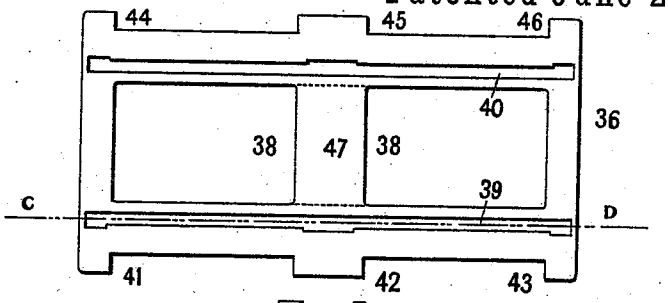

Fig. 5.

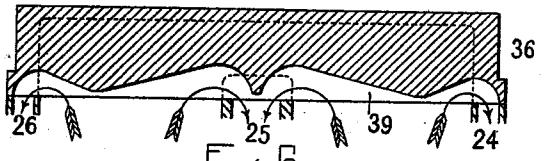

Fig. 6.

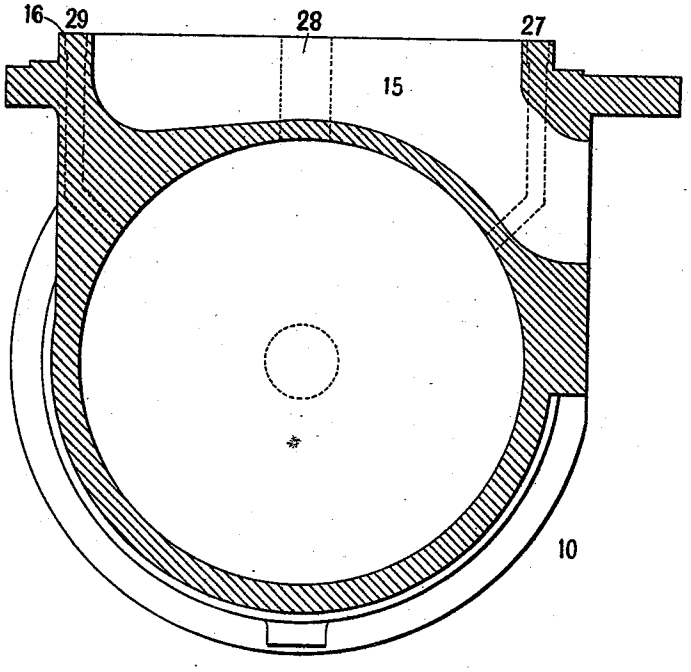

Fig. 7.

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UNITED STATES PATENT OFFICE.

HENRY ROLAND FAY, OF BOSTON, MASSACHUSETTS.

ENGINE-VALVE.

SPECIFICATION forming part of Letters Patent No. 541,605, dated June 25, 1895.

Application filed March 23, 1895. Serial No. 542,982. (No model.)

To all whom it may concern:

Be it known that I, HENRY ROLAND FAY, a citizen of the United States, residing at Boston, in the county of Suffolk and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Engine-Valves, of which the following is a specification.

My invention relates to improvements in engine-valves, and it is designed as an improvement, in part, on my engine valve as secured to me by United States Letters Patent No. 494,194, dated March 28, 1893.

It has for its object the special construction and arrangement of the extra cylinder and valve ports. In an engine-valve, the greater the outside lap, the wider (as a rule) may be the groove, or extra valve port. In most locomotives, the outside lap is only sufficient to permit the construction of a groove or extra valve port of about one half inch in width having a limited cross-sectional area. Therefore, when it is desired to have the extra cylinder ports of considerable cross-sectional area, it is essential, that they and the grooves, or extra valve ports, should be constructed and arranged, substantially as shown in the drawings and as hereinafter described, in order that the relieved compression may pass freely from the admission port, through the groove, or extra valve port, into and through the extra cylinder ports, and then into the bore of the cylinder.

It also has for its object, not only the relieving of compression and counter-pressure within engine cylinders; but also the increasing of the steam admission port area, especially on short points of cut-off and at the commencement of the opening of a steam admission port by its valve. This increase of admission port area is arrived at independently of the action of the so called "Fay ports" or the extra cylinder and valve ports. Nevertheless, by reason of adapting the valve to the extra cylinder and valve ports, I am thereby enabled to readily construct and operate the extra steam admission ports.

Figure 1 is a full plan view of a locomotive-cylinder with steam-chest and valve removed in order to show the extra cylinder and the extra admission ports. Fig. 2 is a vertical sectional view on line A B of Fig. 1 with the valve in section, the direction of the movement of the valve and piston being indicated by means of arrow, illustrating by means of arrows steam admission through admission and extra admission ports. Fig. 3 is a vertical central sectional view of the cylinder and valve, showing the relative positions of piston and valve at short points of cut-off, the direction of travel of both piston and valve being indicated by means of arrows. Fig. 4 is a vertical central sectional view of the cylinder and valve, showing the relative positions of both piston and valve at point of release, the direction of travel of both piston and valve being indicated by means of arrows, the path of the relieved compression being shown by arrows. Fig. 5 is an inverted plan of the valve, and Fig. 6 is a sectional view of the valve on line C D of Fig. 5 and a portion of the valve-seat, the path of the relieved compression from the admission-ports through one of the extra valve-ports into one set of the extra cylinder-ports being indicated by arrows. Fig. 7 is a cross-sectional view of the cylinder, showing by means of dotted lines the course of the extra cylinder-ports from the valve-seat to the cylinder-bore.

In the drawings the locomotive cylinder 10, is provided with the following: Front head 11; back head 12; piston 13, having piston rod 14; and exhaust port 15, all of which are of ordinary construction and arrangement. The cylinder is also provided with the following: Valve seat 16; front admission ports 17 and 18, which are separated by means of the front admission port bridge 19; back admissions ports 20 and 21, which are separated by means of the back admission port bridge 22. These back admission ports may be united into one back admission port if desired, in the manner represented by dotted lines 23, in Fig. 1. So also, may the front admission ports be united into one front admission port. The set of front extra cylinder ports, comprising the ports 24, 25, and 26, start from the valve seat 16, between the admission ports and the exhaust port, and extend to the cylinder bore; and in the same manner, the back set of the extra cylinder ports, comprising the ports 27, 28, and 29, start from the valve seat 16, between the back admission ports and exhaust port, and enter the cylin-

der bore. The front set of extra admission ports, comprising the ports 30, 31, and 32, start at a point on the valve seat 16, near the front admission ports, and extend to the front admission port or ports 17 and 18, without entering into or interfering in any way, with the front set of extra cylinder ports. So also, in the same manner, the back set of extra admission ports, comprising the ports 33, 34, and 35, start at a point on the valve seat, near the back admission ports, and extend to the back admission port or ports 20 and 21, without entering into or interfering with, the back set of extra cylinder ports.

The valve 36, having the valve rod 37, is provided with the following: Exhaust cavity 38; front groove, or extra valve port 39; back groove, or extra valve port 40; the front set of lugs, comprising the lugs 41, 42, and 43; the back set of lugs, comprising the lugs 44, 45, and 46; and the exhaust cavity bridge 47.

The exhaust cavity bridge 47 is made for the purpose of preventing the blowing of the steam from the center extra cylinder ports into the exhaust port and also for protecting the valve seat.

In applying my invention, I have evolved the following general formulæ, by the observance of which, my device may be understandingly applied. These formulæ must of course be varied more or less in order to best adapt my invention to the various kinds and styles of engines.

First. One half of stroke of piston minus cut-off, expressed in inches travel of piston, minus distance between center of piston and center of packing ring (or if only one wide packing ring, minus one half of width of wide ring less one half inch) equals distance between center of extra cylinder port at its point of entrance into cylinder bore from vertical center line of cylinder.

Second. The distance from inner edge of admission port to vertical center line of cylinder and valve seat, minus one half of diameter of extra cylinder port, equals distance between the center of extra cylinder port at its starting point at valve seat and vertical center line of cylinder and valve seat. Each extra cylinder port at starting point on valve seat is to be squared out on a line with inner edge of admission port. The diameter of each extra cylinder port in side wall is to be as great as possible leaving at least three-sixteenths of an inch stock on side wall, each side of extra cylinder port, at starting point.

Third. The distance between squared inner edges of end cavities of groove is to be equal to the distance between inner edges of admission ports, plus twice inside lap of valve (or minus twice the inside clearance of valve). (The squared inner edge of each end cavity should reach extra cylinder port when exhaust takes place on opposite end.)

Fourth. The distance from outside edge of groove to outside edge of valve must be greater than the width of admission port.

Fifth. The width of groove in valve must be less than the distance from line of exhaust port to extra cylinder port in valve seat.

Sixth. The depth of the gooove should be less at its center than at its sides.

Seventh. Area of groove should be greater than the area of the extra cylinder port with which it connects.

Eighth. Each lug on valve is to have one eighth inch outside lap over extra cylinder port when the valve is at its full travel.

Ninth. Extra admission ports to open at the same time as main admission port.

The operation of my device is as follows: In Fig. 2, the piston is shown at the beginning of its stroke, and the valve is represented as admitting steam into the back end of the cylinder, the direction of travel of both piston and valve being indicated by means of arrows, and it will be observed that steam is being admitted, as indicated by arrows, into the back end of the cylinder through admission ports 20 and 21, and the extra admission ports 33, 34, and 35. It will be noticed that a greater area, at short points of cut-off, or during the beginning of steam admission, will be obtained by the combined area presented at the early opening of the admission and the extra admission ports, than would be obtained under the same early opening, if there were no extra admission ports and no admission port bridge. Therefore, under these conditions, a higher initial pressure would be obtained in the cylinder by the use of my device, than would be obtained in the same cylinder not provided with my device. The back set of lugs 44, 45, and 46, are so made that they will prevent, respectively, the uncovering of the extra cylinder ports 27, 28, and 29, when the valve is at its full travel. The extra admission ports 33, 34, and 35, are so located, that they will be uncovered or opened by the lugs 44, 45, and 46, respectively, at the same instant, that the admission ports 20 and 21, are uncovered or opened by the valve.

In Fig. 3, the piston and valve are represented in their correct relative positions at point of cut-off, the direction of travel of both piston and valve, being indicated by arrows. It will be observed, that the back set of extra cylinder ports, 27, 28, and 29, have their point of entrance into the cylinder, at such a point, that they will be covered by the piston at short points of cut-off, this construction being to prevent the blowing over, at short points of cut-off, of the steam admission into the cylinder on the other or opposite side of the piston.

In Fig. 4 the piston and valve are represented in their correct relative positions at point of release, the direction of travel of both piston and valve being indicated by arrows, the path of the released compression, being represented by means of arrows, from the front end of the cylinder, through admission ports 17 and 18 into the extra valve port 39 and from this extra valve port 39 through the

extra cylinder ports 24, 25, and 26 (in the manner as shown by arrows in Fig. 6) into the back end of the cylinder on the opposite side of the piston, from which it passes into the exhaust cavity 38 and exhaust port 15 through admission ports 20 and 21.

It will be noticed, referring particularly to Fig. 6, that by reason of the construction and arrangement of the extra cylinder and valve ports I am able to use an extra valve port having a very small average cross-sectional area, compared with the area of the set of extra cylinder ports, through which the relieved compression may freely pass, in four directions as indicated by arrows, without impairing the operating efficiency of the device, and at the same time, by reason of the peculiar construction of the extra cylinder port, the valve is not materially weakened by the cutting of the groove, whereas the valve would be materially weakened if the cross-sectional area of the groove were made equal to the area of the set of extra cylinder ports.

In my description of the operation, I have described the operation of one end of the cylinder only; but it is obvious that both ends of the cylinder being alike, the operation of one end of the cylinder will be the same as the opposite or other end.

My invention is very simple and very efficient. The cost of its application will be very slight, and there will be no maintenance expenses, as the device becomes a permanent fixture to the engine, reducing the counter-pressure and at the same time improving the admission and expansion of the steam. It also possesses many valuable economic features, which perhaps may best be stated by referring to the subject of indicator diagrams taken from engines fitted with my improved valve.

An indicator diagram taken from an engine in practical operation fitted with my improved valve, shows the following interesting and valuable features: First, the compression line, after exhaust valve closure, is considerably lowered; second, the expansion line at point of diagram or near the end of the expansion line (after exhaust valve closure on other end of cylinder or on opposite side of piston) is raised; third, the back pressure line is lowered. Each of these three features result in an increase of the area of the diagram. The first feature is caused by the opening of the extra cylinder and valve ports and simply relieving the compression. The second feature is caused by the relieved compression as it passes over to the opposite side of the piston. The cause of the third feature may be stated as follows: The steam compressed is saturated steam, and when, in relieving compression, it is forced around the piston, it performs duty as a jet condenser, condensing the steam, thereby reducing the back pressure by lowering the exhaust line. This condensing effect does not take place until after the exhaust has reached a pressure below the compression pressure, and in a locomotive cylinder until the exhaust has served its draft purposes. This reduction of back pressure is an extremely valuable feature. It is of course not correct to expect much of a back pressure reduction where but little back pressure exists, as in a stationary engine. Nevertheless, diagrams taken from a stationary engine, fitted with my valve, show not only a reduction of back pressure, but a slight vacuum, and these results were obtained from such a stationary engine having a free exhaust.

The amount of water contained or held in the volume of wet or supersaturated steam in a locomotive cylinder at the time of exhaust closure is very large. D. K. Clark deduced from his experiments on "Expansive Working of Steam in Locomotives" that: "The quantity condensed by the cylinder walls amounted to from eleven to forty-two per centage of the whole of the steam admitted." Add to this per-centage, the per-centage of entrained water, which according to Zeuner's tests amounts to from seven and one-half to fifteen per centage, and also the water produced by doing work, and it will be found, at least in locomotive practice, that the compression volume released (in operation) by my valve, consists of water, mostly or largely, which is at a low temperature, and this water becomes extremely effective in condensing the exhaust steam of back pressure. This operation results in an additional or fourth feature, namely: this water of low temperature being out of the way, when steam at high pressure is admitted, a better initial pressure is insured.

By reason of the action of the extra steam admission ports a better initial steam line may be obtained, and this fifth valuable feature is of great economic importance especially in connection with the development of power by high speed engines.

My invention possesses many minor valuable features or advantages, among which may be classed the following: Smaller clearance space can be made; higher speed can be obtained, by reason of reducing excessive resistance in front of the piston especially when cutting off at short points of cut-off; and a saving of the general wear of engine (by giving a smooth working engine) and especially in the wear of valve and seat, which has been proved in use, by reason of the valve keeping down on its seat, and not being forced off its seat by excessive compression, giving good steaming qualities, as steam cannot blow under the valve to exhaust port; and an engine will do the same work at shorter points of cut-off.

My valve can be applied to all engines using single slide valves of either piston or flat type.

My invention is of special value as applied to compound engines for the reason that compression, commencing at receiver pressure

in high pressure cylinder, combined with the greater area of low pressure cylinder, causes excessive compression. The clearance space can be cut down, which will give economical results.

In the sets of extra cylinder ports, the center port, which may be located at either side of the longitudinal center line of the valve seat, by reason of its considerable area, is the principal extra cylinder port, and the small extra cylinder ports in the side walls, if, for any reason, owing perhaps to the peculiar construction of an engine cylinder, it may be considered advisable, either one or both of the small ports may be dispensed with without greatly or seriously affecting the economical operation of the device.

In applying my invention, especially to the many kinds and styles of stationary engines now in the market, it should be fully understood, that many modifications of my invention will have to be made in order to adapt it in the best manner, to produce the results sought to be obtained, as hereinbefore set forth; but in every modification or adaptation, the essential feature is the passing of the relieved compression from one end of the cylinder, around the piston, to the other end of the cylinder.

In order to make the best adaptation of my device to a stationary engine of a standard construction having its steam ports on the side of the cylinder and having its valve adapted to operate these ports, the weight of the valve being carried on a horizontal plane slide, I employed the following adaptation: The extra cylinder ports, instead of starting from the valve seat, started from the slide, and the extra valve ports were so designed as to operate in connection with the extra cylinder ports, and compression release was accomplished by the relieved compression passing from one end of the cylinder through the extra valve port and then through the extra cylinder port around the piston, into the other end of the cylinder, entering the cylinder bore at a point near the bottom of the cylinder. I have given this particular adaptation of my device simply to show one of the almost numberless modifications or adaptations of my invention, by means of which, compression release is accomplished, the principle of operation being substantially as herein described and claimed.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an engine, the cylinder provided with the extra cylinder ports 25 and 28 their starting points at the valve seat being located at or near the longitudinal center line of and between the side walls of the valve seat, in combination with the valve provided with the extra valve ports 39 and 40 each extra valve port being constructed, substantially as described, in order that the relieved compression may pass freely from the admission port, passing through the extra valve port in two different directions approaching a common center into and through the extra cylinder port, and then into the bore of the cylinder, for the purpose of relieving compression, substantially as set forth.

2. In an engine, the cylinder provided with the extra cylinder ports 25 and 28, their starting points at the valve seat being located between the side walls of the valve seat, and the valve provided with the extra valve ports 39 and 40, in combination with the extra steam admission ports 31 and 34, substantially as described.

3. In an engine, the cylinder provided with the extra cylinder ports 25 and 28 having their starting points at the valve seat, located between the side walls of the valve seat, and the extra cylinder ports 24 and 26, and 27 and 29 having their starting points at the valve seat located in the side walls of the valve seat, in combination with the valve provided with the extra valve ports 39 and 40 each extra valve port being constructed substantially as described, in order that the relieved compression may pass freely from the admission port, passing through the extra valve port in four directions into and through the extra cylinder ports, and then into the bore of the cylinder, for the purpose of relieving compression, substantially as set forth.

4. In an engine, the cylinder provided with the front and back sets of extra cylinder ports and the valve provided with the extra valve ports 39 and 40 in combination with the front and back sets of extra admission ports, substantially as and for the purposes set forth.

5. In an engine, the cylinder provided with the extra cylinder and the extra admission ports in combination with the valve provided with the extra valve ports, and having the sets of lugs, and exhaust cavity bridge, substantially as set forth.

6. In an engine, the cylinder provided with the extra cylinder ports and the valve provided with the extra valve ports by means of which, in relieving compression, the released compression passes from one end of the cylinder, around the piston, to the other end of the cylinder, in combination with the extra steam admission ports, substantially as described.

7. In an engine, the cylinder provided with the extra cylinder and the extra admission ports in combination with the valve provided with the extra valve ports, and having the sets of lugs, and exhaust cavity bridge, substantially as set forth.

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

HENRY ROLAND FAY.

Witnesses:

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CHARLES L. ELLIS.