

(No Model.)

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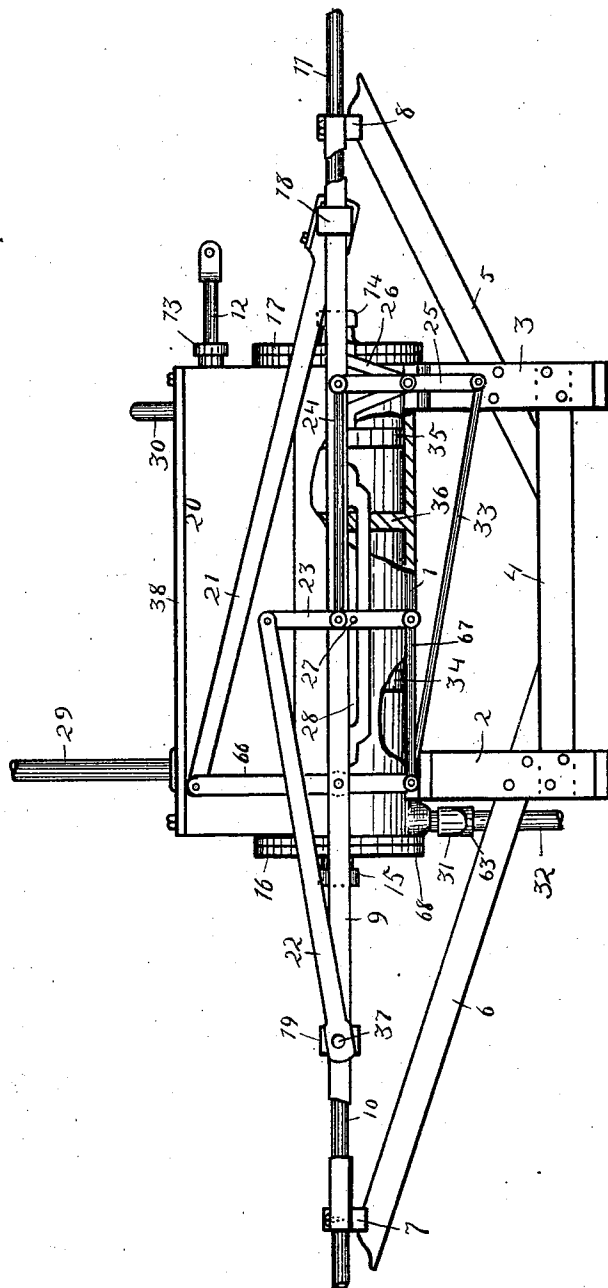
C. GARVER.

APPARATUS FOR UTILIZING EXHAUST STEAM.

No. 551,031.

Patented Dec. 10, 1895.

Fig. 1.



WITNESSES:

Charles Garver INVENTOR

Walter G. Burns  
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his ATTORNEYS.

(No Model.)

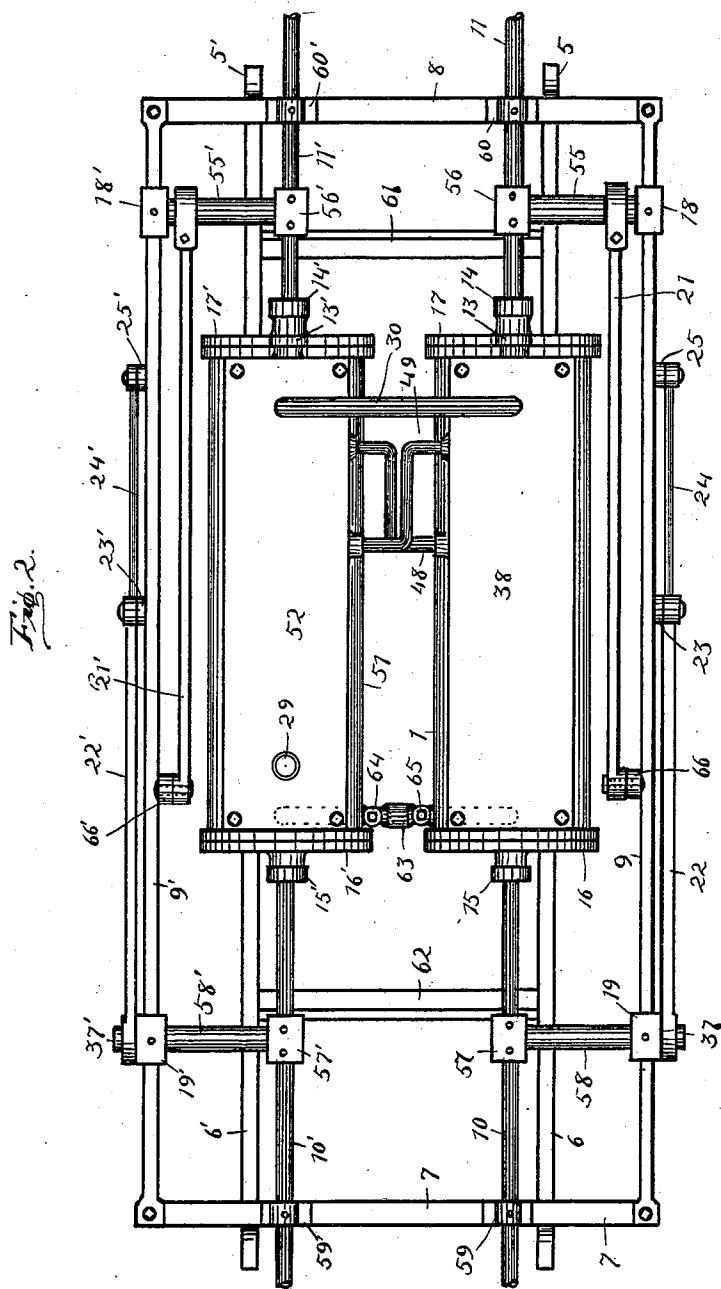
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3 Sheets—Sheet 3.

C. GARVER.

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Fig. 3.

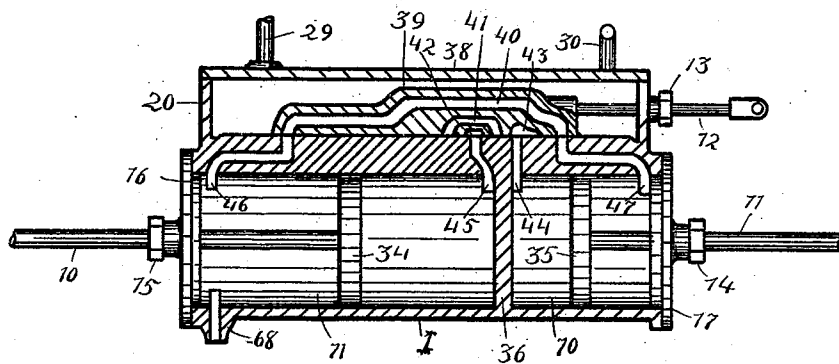


Fig. 4.

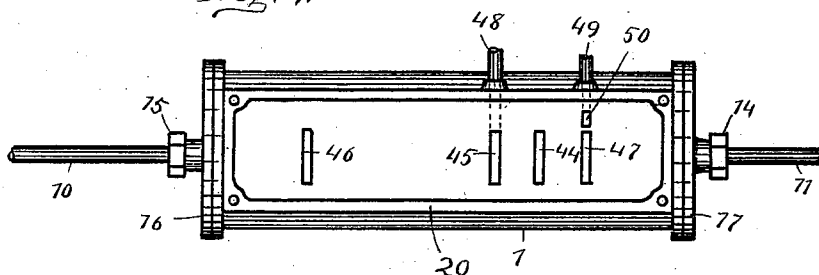
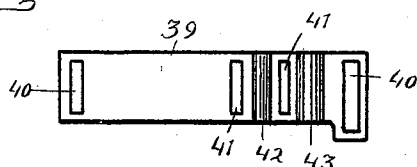


Fig. 5.



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# UNITED STATES PATENT OFFICE.

CHARLES GARVER, OF FORT WAYNE, INDIANA.

## APPARATUS FOR UTILIZING EXHAUST-STEAM.

SPECIFICATION forming part of Letters Patent No. 551,031, dated December 10, 1895.

Application filed September 18, 1895. Serial No. 562,915. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES GARVER, a citizen of the United States, residing at Fort Wayne, in the county of Allen, in the State of Indiana, have invented certain new and useful Improvements in Apparatus for Utilizing Exhaust-Steam; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to improvements in apparatus for utilizing the exhaust-steam of steam-engines by returning the same to the boiler.

The object of my invention is to provide a practical, convenient, and efficient means of economical construction for returning the exhaust-steam of either stationary or locomotive engines to the boiler without loss or waste, thereby effecting a great economy of fuel and water, the greatest loss of heat when my improvement is employed being that by radiation from the surface of the boiler.

My improvement consists of a pair of double cylinders connected with each other and with the exhaust-port of the steam-engine upon which it is mounted and provided at each end with proper pistons, one pair of the said pistons being driven by the working engine and the other pair being actuated by a system of levers connected with the said driving-pistons.

In the accompanying drawings, in which similar figures of reference indicate corresponding parts throughout the several views, Figure 1 is a side elevation of my improvement, showing the arrangement of the piston-actuating levers, one of the cylinders being cut away in parts to show the relative arrangement of the diametric partition, and also showing the pistons in their respective working chambers. Fig. 2 is a plan of the same, showing the connections between the cylinders and the arrangement of the levers. Fig. 3 is a longitudinal vertical section of one of the cylinders, showing the inlet and outlet ports therefor and the slide-valve in position thereon. Fig. 4 is a plan of one of the said

cylinders with the steam-chest removed. Fig. 5 is a bottom plan of the slide-valve.

The twin cylinders 1 and 51 are of the same dimensions and exactly alike in construction and are rigidly connected and fixed upon proper supporting-standards 2 and 3 at or near the ends thereof, Fig. 1, which are braced by the cross-pieces 4. To the central portion of the said standards 2 and 3 are rigidly fixed the oblique brackets 6 and 5, respectively, adapted to support the respective piston-rods in the manner hereinafter described. The said cylinders 1 and 51, arranged in parallel relation, are provided at their forward ends with proper heads 17 and 17', respectively, and at their rear ends with the respective heads 16 and 16', and are each provided with a steam-chest 20, containing a slide-valve 39, provided with the longitudinal steam-passages 40 and 41, Fig. 3, and the transverse recesses 42 and 43, Fig. 5. The forward end of the said slide-valve is provided with an operating-stem, whose forward end is so connected with the working engine as to receive motion therefrom, and which passes through the forward end of the steam-chest and the adjacent packing-box 13.

The two steam-chests 20 are connected by the cross-pipe 30, so that the boiler-pressure is always the same in each.

In the top of the chest 20 of the cylinder 1 is secured the outer end of the return-pipe 29 to the boiler, Figs. 1 and 3. The said cylinders are divided into two unequal chambers by a diametric partition 36, so arranged therein that the forward chamber 70 is but one-half the length of the rear chamber 71, for the purpose hereinafter specified. The said chamber 70 is provided at the top thereof with the steam-ports 44 and 47, adapted to register simultaneously with recess 43 and the forward end of the longitudinal channel 40 of the slide-valve 39, and is also provided with a movable piston 35, rigid on the rear end of the piston-rod 11, loosely mounted in a stuffing-box 14 on the cylinder-head 17. The piston-rods 11 and 11' are connected to and driven by the working engine in any proper manner. The rear chamber 71 of the said cylinder is provided at its upper face with the steam-ports 45 and 46, adapted to

register simultaneously with the recess 42 and the rear end of the steam-channel 40 of the said slide-valve, respectively, and is also provided with a movable piston 34, rigid on the forward end of the piston-rod 10, which is loosely mounted in a proper stuffing-box 14 on the cylinder-head 15. The said chamber 71 is also provided with an inlet-port 68 for the exhaust-steam from the working engine, which is conducted thereto by the exhaust-pipe 32, having a T-pipe 63 upon the outer end thereof leading to the said inlet-port 68 of the respective cylinders, and is provided with the check-valves 64 and 65.

The internal construction and arrangement of the cylinder 51 is in all respects identical with that of the cylinder 1, above described. The said cylinders are connected by the pipes 48 and 49, and the said steam-chests are connected by the cross-pipe 30.

The system of levers by which the piston-rod 11 is connected with the piston-rod 10 is duplicated in connecting the said piston-rod 11' with the said piston-rod 10', and is arranged as follows: A rectangular frame, whose length is approximately double that of its width and composed of the end pieces 7 and 8 and the sides 9 and 9', is rigidly fixed upon and supported by the oblique brackets 5 and 5' and 6 and 6'. The end piece 7 has proper bearings 59 and 59' for the respective piston-rods 10 and 10', Fig. 2, and the end piece 8 has proper bearings 60 and 60' for the piston-rods 11 and 11'. The shafts 55 and 55' have their inner ends apertured to receive the piston-rods 11 and 11', respectively, to which they are rigidly secured, and their outer ends 18 are also perforated to receive the sides of the said frame, on which the said ends are adapted to slide.

Referring now to Fig. 1, at a suitable point upon the inner face of the side 9 is pivotally mounted in an upright position the lever 66, whose upper end is approximately twice the length of the lower end. To the upper end of the said lever 66 is pivotally connected the rear end of the lever 21, whose forward end is loosely mounted on the shaft 55. At a suitable point on the side 9 of said frame is a fixed depending bracket 26, in the lower end of which is pivotally mounted the vertical lever 25, which is pivotally connected at its lower end by the rod 33 to the lower end of the lever 66. The upper end of the said lever 25 is pivotally connected to the forward end of the horizontal rod 24, carrying at its rear end the pivotal lever 23, provided with a guide-pin 27 for the longitudinal guiding-slot 28 in the side 9. The lower end of the lever 23 is pivotally connected to the lower end of the said lever 66 by the rod 67, and the upper end thereof is pivotally connected to the forward end of the lever 22, whose forward end is pivotally mounted upon the outer end of the shaft 58, as seen at 37.

The object of the levers is to impart to the

piston-rods 10 and 10' just twice as much motion as is given the piston-rods 11 and 11', whereby the piston 34 at each stroke passes over twice the distance passed over by the piston 35. This is effected as follows: Operating the piston-rod 11 in any proper manner from the working engine will operate the oblique lever 21, secured to the same shaft 55, which in turn operates the vertical lever 23 through its connection lever 66 and rod 67, which gives a to-and-fro motion to the lever 22 and the shaft 58 and consequently to the piston-rod 10 and the piston 34.

It will be seen that each movement of the said lever 66 actuates not only the vertical lever 23 by means of the short rod 67, but also actuates the lever 25 by means of the rod 33, which is pivoted on the fixed bracket 26, and is connected to the said lever 23 at its center by the pivoted horizontal rod 24, which under the impulse of the lever 25 is adapted to drive the lever 23 backward and forward on the side 9 a distance equal to that covered by the piston 35. This gives a double motion to the lever 22 and also the piston-rod 10, to which it is rigidly connected, and carries the piston 34 over twice the distance covered by the piston 35, which thereby gives room in the chamber 71 for the exhaust-steam, presently to be described. It is obvious that the said levers may be variously arranged to move the said piston-rods 10 and 10' over double the distance covered by the said piston-rods 11 and 11' without departing from the spirit and scope of my invention.

The manner of returning the exhaust-steam to the boiler by the employment of my improvement is, briefly stated, as follows: As the pistons 34 and 35 are driven forward simultaneously, the exhaust-steam enters the rear portion of the chamber 71, behind the piston 34, at the port 68, and at the same time the forward movement of the piston 35 expels the steam in the forward end of the chamber 70, forcing one half of it out through the port 47 and the passage 40 into the rear end of the said chamber 71, while the other half of the charge passes out at 47 and down through the port 50, which does not open directly into the cylinder, but into the passage 40, by which it communicates with the port 47, and thence passes into the rear chamber 71 of the outer cylinder 51 through the pipe 49, Fig. 2. At the same time the portions of the chambers 70 and 71 adjacent the partition 36 are open to boiler-pressure from the steam-chest 20 through the transverse passages 42 and 43, registering with the ports 45 and 44, respectively, Fig. 3, thereby equalizing the pressure upon both sides of the said pistons, and all that is necessary in operating them is to overcome their weight and the friction of the working parts. As the said pistons 34 and 35 move forward simultaneously in their respective chambers to the limit of their stroke, the slide-valve 39 will reach the

limit of its movement in the opposite direction, thereby uncovering the port 47 for the reception of steam from the steam-chest 20. The said pistons being now at the limit of their forward movement, they begin their return movement, and the slide-valve moves simultaneously in the opposite direction, thereby causing the steam-passage 41 to register with the steam-ports 44 and 45, which permits the compressed steam in the chamber 70 to escape into the forward portion of the chamber 70, while at the same time the forward end of the chamber 70 is supplied with fresh steam from the steam-chest 20 through the port 47, registering with the transverse passage 43, thus equalizing the pressure on the piston 35, and at the same time the port 46 is uncovered and the exhaust-steam in the rear end of the chamber 71 admitted by the port 68 will thus, upon the return of the piston 34, be forced out into the steam-chest 20 through the port 46, the check-valve 65 preventing its return through the port 68; but prior to this, and at the time when the said slide-valve upon its forward movement reaches the point seen in Fig. 3, one half of the steam in the forward portion of the chamber 70 of the cylinder 51, the actions of whose pistons is alternating with that of the pistons 34 and 35 of the cylinder 1, enters the forward portion of the chamber 71 through the pipe 48, the steam-passage 42, and the port 45.

The action of the pistons in the similarly constructed and arranged cylinder 51 is identical with that above described; but their action while simultaneous is alternate to that of the pistons in the cylinder 1.

As the ordinary engine exhausts twice at each revolution, it is obvious that two cylinders are necessary, as one could not receive both exhausts, and one should always be open to receive each exhaust. It is obvious, therefore, that by the use of my improvement the exhaust-steam is readily, economically, and directly returned to the boiler, while an equalization of pressure upon the operating-pistons is uniformly maintained.

My improved levers can be readily adapted to other situations and to other purposes and uses, for which I desire to make future applications for patents.

Having thus described my invention and the manner of operating the same, what I desire to secure by Letters Patent is—

1. In an apparatus for utilizing the partly expended exhaust steam of steam engines, the combination of the cylinders 1 and 51 divided into unequal working chambers 70 and 71 for the purpose specified, having proper ports adapted to register with the steam passages of the slide valve 39 in the steam chest 20, as described, and provided at one end with the respective driving pistons 35, and at the other end with the pistons 34 actuated by a system of levers connected with and oper-

ated by the said driving pistons, in the manner described, the said cylinders being connected by the cross pipes 48 and 49 for the purpose specified, and are alternately supplied with exhaust steam by the pipe 32 and with live steam by the boiler pipe 29, and a system of levers for each cylinder operated by the said driving pistons and so arranged as to drive the said pistons 34 at each stroke over twice the space covered by the said driving pistons, all substantially as described.

2. The combination in an apparatus for utilizing the partly expended exhaust steam of steam engines, the cylinders 1 and 51 provided with steam chests 20 connected by the steam pipe 30 and a slide valve 39 channeled as shown, and divided into unequal working chambers 70 and 71, for the purpose specified, having proper ports adapted to register with the steam passages of the said valve, as described, and respectively provided with the driving pistons 35 mounted in the chamber 70, and the driven pistons 34 mounted in the chamber 71, the said cylinders being connected by the cross pipes 48 and 49 for the purpose stated, and are alternately supplied with exhaust steam by the pipe 32 and the port 68, and a system of actuating levers for each cylinder, comprising the oblique lever 21 having its forward end connected with the driving piston and its rear end connected to the lever 22 by one or more pivoted rods and levers, the forward end of said lever 22 being connected with the piston 34 and so arranged as to drive the same at each stroke over twice the distance covered by the said driving piston, all substantially as described.

3. In an apparatus for utilizing the partly expended exhaust steam of steam engines the cylinder 1 having the unequal working chambers 70 and 71, separated by the partition 36, a steam chest fixed thereon and connected with the boiler by the pipe 29, the slide valve 39 channeled as shown and provided with an operating stem 12, the said cylinder having an inlet port 68 for the exhaust steam from the working engine a series of ports arranged as shown and adapted to register with the steam channels of the said valve, and provided with the simultaneously acting pistons 34 and 35, arranged in the respective chambers, all substantially as described.

4. In an apparatus for utilizing the partly expended exhaust steam for steam engines, the combination of the steam cylinders 1 and 51, each provided with a steam chest 20 connected by a cross pipe 30, and a slide valve 39 channeled as shown and provided with an operating stem 12, the said cylinders having the working chambers 70 and 71 provided with the simultaneously acting pistons 35 and 34 respectively, a series of steam ports adapted to register with the steam channels of the said valve, and an inlet steam port 68, all substantially as described.

5. In an apparatus for utilizing the exhaust

steam of steam engines, a system of pivotally connected actuating levers, connecting the driving pistons with the driven pistons so constructed and arranged as to impart to the said driven pistons twice the motion of the said driving pistons for the purpose specified, all substantially as described.

6. A system of levers for transmitting power comprising an oblique lever 21 fixed at one end to the driving piston rod by means of the shaft 55, and pivotally connected at its other end with the oblique lever 22 by means of the

vertical levers 25, 23, and 66, and the connecting rods 24, 33, and 67, in combination with the shaft 58, the piston rod 10, and the fixed supports 2 and 3, all substantially as described.

Signed by me, at Fort Wayne, Indiana, this 6th day of September, 1895.

CHARLES <sup>his</sup> X GARVER.  
mark

Witnesses:

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WATTS P. DENNY.