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IMPROVEMENTS

IN

STEAM-ENGINES.

BY

JOHN HOUPT,

OF PENNSYLVANIA.

WITH DIAGRAMS.

PUBLISHED FOR THE AUTHOR BY

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1874.

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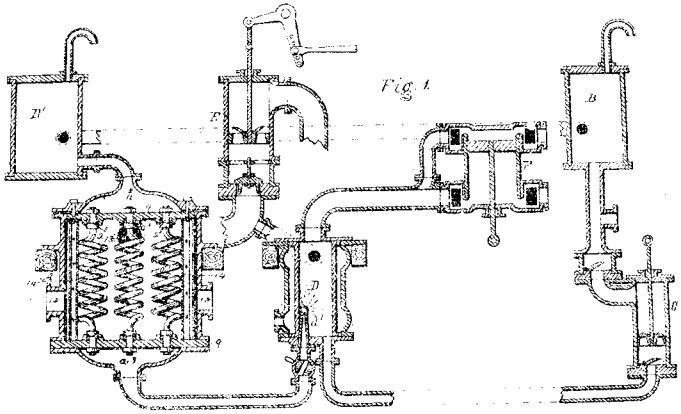
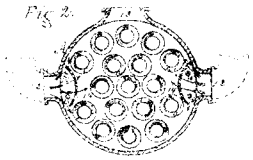




FRESH-WATER JET-CONDENSER
— FOR —
MARINE STEAM-ENGINES.

THE FRESH-WATER JET-CONDENSER,

FOR

MARINE STEAM-ENGINES,

As represented by the above Drawings,

Is simply an ordinary jet-condenser, in combination with a powerful refrigerator, for the purpose of cooling down the fresh water of condensation from the hot well of the jet-condenser, to be used over again (and again, etc.) as fresh jet-sprinkling water for the said jet-condenser, and for supplying the steam boilers with fresh water.

Explanation of Fig. 1.

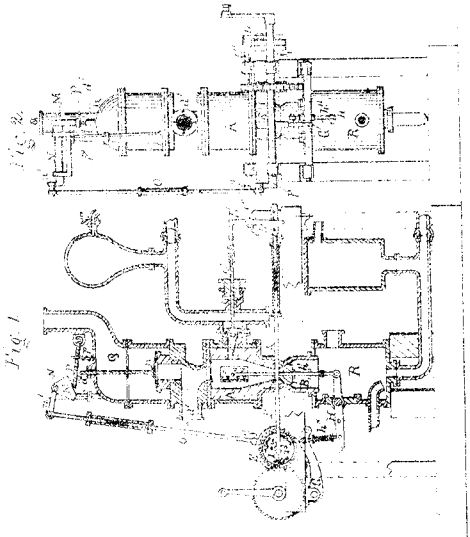
F represents the steam cylinder. D the jet-condenser. C the air-pump. B the hot well, and B′ is a fresh-water reservoir. A the refrigerator, and E the circulating-pump. For a more detailed description of the construction and operation of the fresh-water jet-condenser for marine steam-engines, see my Letters Patent of the United States, No. dated May 19, 1874.

N.B.—I will here remark that I have represented the air-pump C away off to the right of the jet-condenser D, for the purpose of bringing it out into full view, whereas, its proper place is to the left, and nearly opposite to the said jet-condenser, which will bring the hot well B in close proximity with the fresh-water reservoir B′, and the two being connected together by a short tube (instead of the long dotted lines shown in Fig. 1), consequently the reservoir B′ is supplied with fresh (warm) water from the hot well B, which is cooled down in its passage through the powerful refrigerator A, and serves as fresh, cold, jet-sprinkling water for the said jet-condenser, thereby avoiding the use of any saline jet-sprinkling water within the jet-condenser; and preserving all the condensed steam-water, as fresh, hot water, for supplying the steam boilers of marine steamers with fresh water.

J. HOUPT.

Jet Condensers for Steam Engines.

No. 156,918. Patented March 18, 1873.



WITNESSES:

Benj. Davidson

Wm. H. Morison.

INVENTOR:

John Houpt

THE SELF-CLEARING JET-CONDENSER.

Explanation of Fig. 1.

A represents the jet-condenser. B the outlet-valve at the bottom of A. C the cold-water jet-valve of A. D the auxiliary outlet-valve at the top of A. E is a cam to operate the outlet-valve B. Q the auxiliary valve-chamber above A. R the hot well. M is an oscillating cam to key down the valve D, periodically.

The principal advantage claimed for the self-clearing jet-condenser, being to produce a good vacuum in front of the steam-piston, without the aid of the air-pump, as represented by the drawings. Inasmuch as the outlet-valve B is opened and closed again by a positive movement of the cam E, at the very moment when the first part (or puff) of high-pressure exhaust steam, from the steam cylinder, reaches the *small* self-clearing jet-condenser, and thereby forcing the water of condensation and accumulated air in said condenser down through the opened outlet-valve B (with a rush), into the hot well R, below.

The auxiliary valve D, on the top of the condensing chamber A, is now keyed down firmly by the oscillating cam M, until the first puff, or high-pressure exhaust steam, has forced the accumulated water and air down into the hot well. Then the outlet-valve B is immediately closed, while the exhaust steam is still pressing the air downwards. And the pressure of the oscillating cam M on the auxiliary outlet-valve D has been removed, which now opens freely and allows the remainder of the high-pressure exhaust steam to pass out through the auxiliary outlet-valve, *chamber*, and *tube* Q into the open air (or into the furnace chimney, to prevent any cold air from striking back into the condenser).

I will further remark here, that I propose having a very small self-clearing jet-condenser, and having that thoroughly *cleared* of its water of condensation and *accumulating air*, at every puff of high-pressure exhaust steam from the steam cylinder, down through the outlet-valve at the bottom of the condenser, into the hot well, and then closing the said outlet-valve again (by a positive movement of the cam), while the exhaust steam is still pressing the air downwards into the hot well, and then allowing the remainder of the high-pressure exhaust steam to pass upwards, through the yielding auxiliary outlet-valve at the top of the condenser, and thence by the pipe Q into the furnace chimney, thereby preventing any cold air from striking back into the jet-condenser, as aforesaid. And now having the small self-clearing jet-condenser perfectly cleared of water and air, and filled with pure exhaust steam from the steam cylinder (which is expanded to a little above the pressure of the atmosphere). Consequently there will be but little cold, jet-sprinkling water required to produce the desired vacuum in front of the steam piston, which said cold-water jet is now admitted into the condenser by the cold-water jet-valve C, through the side of the said condenser; and by this means I claim to produce a cheaper and better vacuum in front of the steam piston (without the aid of an air-pump) than can be done by the ordinary jet-condenser in connection with the cumbersome device of an air-pump attached.

For a more detailed account of the construction and operation of the self-clearing jet-condenser, see my Letters Patent of the United States, No. 136,918, dated March 18, 1873, in the latter part of this book.

PREFACE.

THIS book relates principally to an improved Condensing-Apparatus for Marine Steamers, whereby a powerful Refrigerator or Surface-Cooler is used to cool down the fresh water coming from the Hot Wells, to be used over again and again as Cold Condensing-Water in the Jet-Condenser, thereby avoiding, in Marine Steamers, the use of any Saline Water in the Jet-Condenser.

The frontispiece shows a comparatively large Refrigerator in connection with the Hot Well and the Jet-Condenser, for the small class of Marine Steamers; but for the larger Marine Steamers, where space is not so important, I propose to divide the Exhaust Steam and condense a large portion of it in various different apartments, or partially Self-Clearing Surface-Condensing cases, and thereby drawing off the main portion of the Exhaust Steam directly from the Steam-Cylinder into the said partially Self-Clearing Surface-Condensers, and thus relieving the Jet-Condenser from a large

portion of its work in the condensation of the Exhaust Steam, substantially as represented by my "Compound Condensing-Apparatus for Marine Steamers," in the latter part of this book.

This book also relates to the construction and operation of my Self-Clearing Jet-Condensers for Land and Fresh-Water Engines, and to various other improvements in Steam-Engines generally.

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Letters Patent No. 97,923, dated December 14, 1869, Self-Acting Hydraulic Jet-Condenser 20

No. 5.

Letters Patent No. 102,005, dated April 19, 1870, Reissue No. 3999, dated May 31, 1870, Self-Clearing Jet-Condenser 24

No. 6.

Letters Patent No. 105,457, dated July 19, 1870, Self-Clearing Primary Jet-Condenser in combination with a Secondary and Tertiary Condensers, together with an apparatus for forcing Hot Air (at intervals) into a capacious chamber over the Hot Well of the Primary Jet-Condenser, for the purpose of producing an additional quantity of vapor to be condensed by the Tertiary Condenser, and thereby to supply the boilers of Marine Steamers with an abundance of fresh water 29

No. 7.

Letters Patent No. 109,616, dated November 29, 1870, A comparatively small Primary Jet-Condenser with an Air-Pump attached, in combination with a Tertiary Condenser, together with a Secondary Chamber or Evaporator to produce an additional amount of vapor to compensate for the loss of that portion of steam which is condensed by the Saline Jet-Spray in the Primary Jet-Condenser, and a supplementary furnace and boiler to aid in supplying the main Steam-Generator with fresh water when occasion may require it 37

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Letters Patent No. 111,937, dated February 21, 1871, A Compound Steam-Engine which relates to the combination of a plurality of Low-Pressure Engines, with a Primary High-Pressure Steam-Cylinder, having a Steam-Dividing, Self-Clearing Jet-Condenser and a Superheater between 42

No. 9.

Letters Patent No. 115,208, dated May 23, 1871, A Compound Steam-Engine with High- and Low-Pressure Steam-Cylinders in combination with a Superheater of the Exhaust Steam from the High-Pressure Cylinder and an apparatus for forcing Hot Air into the said Superheater 46

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Letters Patent No. 116,312, dated June 27, 1871, The Waste Exhaust Steam-Jacket and Jet-Spray Cooling-Apparatus for my Self-Clearing Jet-Condenser 49

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Letters Patent No. 124,359, dated March 5, 1872, Exhaust Steam-Engine and Force-Pump 52

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Letters Patent No. 131,351, dated September 17, 1872, Late Improvement on Self-Clearing Jet-Condenser 55

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Letters Patent No. 136,917, dated March 18, 1873, A comparatively large Surface-Cooler and Exhaust-Steam Expander in combination with a Secondary and Tertiary Surface-Condenser . . . 60

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Letters Patent No. 144,203, dated November 4, 1873, Compound Condensing Apparatus for Marine Steamers, having a Fresh-Water Jet-Condenser (for producing the vacuum in front of the Steam-Piston) in combination with a plurality of partially Self-Clearing Surface-Condensers, for saving the condensed Steam-Water of the Exhaust Steam, pure fresh water for supplying the Steam-Boilers. 67

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JOHN HOUPT.

IMPROVEMENT IN SURFACE-CONDENSERS.

Fig. 1.

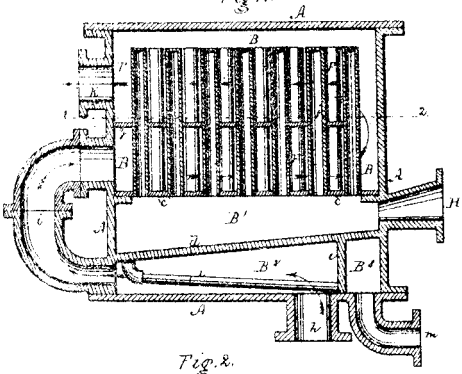
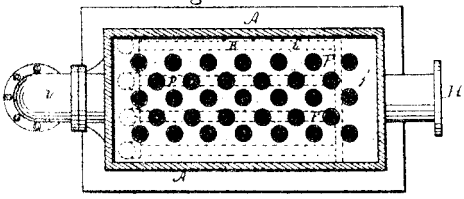


Fig. 2.



Witnesses:

John White,

Louis Boswell.

Inventor:

John Houpt.

IMPROVEMENTS IN STEAM-ENGINES.

No. 1.

Letters Patent No. 88,960, dated April 13, 1869.

IMPROVEMENT IN SURFACE-CONDENSERS.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springfield, Bucks County, Pennsylvania, have invented an Improvement in Surface-Condensers; and I do hereby declare the following to be a full, clear, and exact description of the same.

My invention consists of a surface-condenser, constructed and arranged as fully described hereafter, in which, by the employment of a number of vertical tubes, closed at their upper ends, and of a certain arrangement of chambers, I am enabled to overcome the objections arising from the contraction and expansion of the tubes in ordinary condensers, and to effect a more thorough and rapid condensation of steam.

In order to enable others skilled in the art to make and use my invention, I will now proceed to describe its construction and operation, reference being had to the accompanying drawing, which forms a part of this specification, and in which—

Figure 1 is a longitudinal vertical section of my improved surface-condenser, and

Figure 2, a sectional plan view of the same, on the line 1-2, Fig. 1.

The apparatus consists of a case A, made in the present instance of cast-iron, the interior of which is separated into four compartments, B, B^1, B^2, and B^3, by the horizontal, inclined, and vertical partitions, *c*, *d*, and *e*, the upper compartment, or water-space B, containing a cluster of vertical tubes, F.

The lower ends of the latter are secured in the usual manner to the partition-plate *c*, and are open and communicate with the steam-space B^1, but the upper ends of the said tubes are closed, and are free to contract or expand without loosening or causing the joints at their lower ends to leak.

The cold water, which is caused to circulate among the tubes F, is first admitted to the apparatus through a pipe, *h*, into one end of the compartment B^2, passing entirely through the latter and through a pipe, *i*, before it enters the upper water-space B.

In the latter there is a partition, *j*, which causes the cold water to first flow towards the opposite end of the compartment, and to consequently circulate among the lower ends of all the tubes, and then to flow in a contrary direction above the partition and around the upper ends of the tubes, until it finally reaches the pipe *k*, through which it passes from the apparatus. (See arrows in Fig. 1.)

H is the pipe through which the exhaust steam is admitted to the compartment B^1, and *i* are inclined tubes, forming a communication between the compartments B^1 and B^2, and intended for carrying off the water formed by condensation of the steam.

A pipe, *m*, communicating with the bottom of the compartment B^3, leads to the air-pump.

The operation of my improved condenser is as follows:

Cold water is forced through the compartments B^2 and B as above described, and the necessary vacuum is maintained within the tubes F, and the steam-spaces with which they communicate, by means of the air-pump, as usual.

The exhaust steam is admitted to the compartment B^1 through the pipe H, and immediately fills the vertical tubes F, which, as before described, are entirely surrounded by the water passing through the chamber B.

The steam is rapidly condensed by contact with the cold surfaces of these vertical tubes, and the water formed drops from the same on to the inclined partition *d*.

Flowing to the rear end of the partition, by reason of its inclination, the water enters the inclined tubes *i*, and in passing through the same towards the compartment B^3, is cooled by the water contained in the chamber B^2.

It will be understood that the air-pump, with which the pipe *m* is connected, draws off this condensed steam, and acts in the usual manner in preserving a vacuum within the apparatus.

The advantages possessed by the above condenser over ordinary surface-condensers may be enumerated as follows:

First, in ordinary condensers, the tubes, which are generally placed in a horizontal position, are open at each end, and are so secured to rigid plates that they are not permitted to expand or

contract, the joints consequently becoming loosened and leaky, and the operation of the apparatus imperfect.

In my condenser full provision is made for the contraction and expansion of the tubes, by securing them at their lower ends only, and permitting to their upper closed ends the slight motion due to these causes.

A second advantage arising from the employment of vertical tubes closed at their upper ends is, that a more thorough circulation of cold water can be maintained about them than with horizontal tubes, and that the condensation and cooling of the water formed are more thorough and rapid, inasmuch as the steam, which rises to the top of each tube, has to return through the same tube before it can again reach the chamber B^1.

The vertical tubes also possess an advantage over those placed in any other position, when the condenser is used in connection with marine engines, as the water of condensation is less likely to be directed into improper channels by the motions of the vessel; and to still further aid the air-pump, by directing the water towards it, the partition *d* and tubes *l* are somewhat inclined, as before described.

I claim as my invention, and desire to secure by Letters Patent—

1. The arrangement, in a surface-condenser, of vertical tubes F, open at their lower ends but closed at the top, substantially as herein described.

2. The vertical tubes F, closed at the top, in combination with chambers B, B^1, B^2, and B^3, arranged in respect to each other and to the tubes, and communicating as set forth.

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

JOHN HOUPT.

Witnesses:

JOHN WHITE,

LOUIS BOSWELL.

No. 2.

Letters Patent No. 90,265, dated May 18, 1869; Reissue No. 4374, dated May 9, 1871.

IMPROVEMENT IN STEAM-ENGINES.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Steam-Engines, of which the following is a specification.

Nature and Objects of the Invention.

My invention consists of apparatus, hereinafter fully described, for superheating and equalizing the pressure of the exhaust steam of a high-pressure steam-engine, to be again used in driving a second engine.

Description of the Accompanying Drawing.

Figure 1 is a sectional elevation of apparatus constructed according to my invention, and

Figure 2, a sectional plan view of the same on the line 1-2, Fig. 1.

General Description.

A A represent the side walls of a furnace, between which are the usual grate-bars, *a*, and resting upon the top of this furnace, directly over the fire-place, is an upright cylindrical casing, B, closed at the top, and furnished with a pipe, *b*, Fig. 2, through which the smoke and other products of combustion can pass to the chimney.

A cylindrical reservoir, C, of a diameter less than that of the casing B, is suspended within the latter in such a position that its curved bottom, *c*, shall be in close proximity to the fire, and so that an annular space, *d*, shall intervene between its sides and the said casing.

John Houpt's improvement in Steam Engines.

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Reissued May 9 1871

Fig. 1

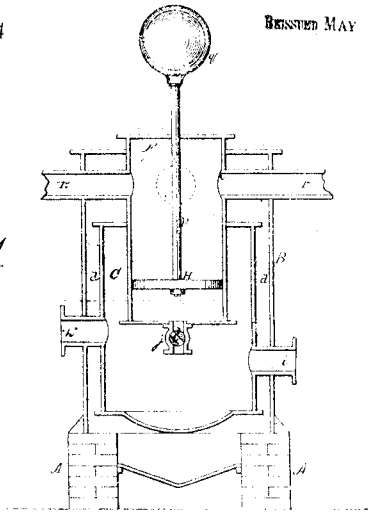
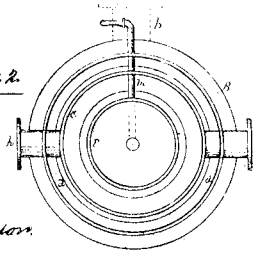


Fig. 2.



Witnesses
Ray Morrison
Wm. H. Morrison

Inventor
John Houpt

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Two pipes, *h* and *i*, pass through the outer casing B, at points about opposite to each other, and communicate with the interior of the reservoir C, for a purpose described hereinafter.

F is a cylinder, which is contained partly within the reservoir C and partly within the casing B, it being closed at the top but open at the bottom, where there is a pipe, *j*, provided with a valve or stop-cock, *l*, which is operated from without the casing by a rod, *m*, Fig. 2.

A piston, H, is arranged to slide freely within the cylinder F, its rod *p* passing through the upper end of the said cylinder, and having secured to it a weight, *q*.

Two pipes, *r r*, open at their outer ends, communicate with the interior of the cylinder F, at a point above the casing *c*, and may, if desired, be provided with suitable cocks, or with valves opening outward.

The operation of the apparatus is as follows:

The exhaust steam of a high-pressure engine, which it is desired to use a second time in driving a low-pressure condensing-engine, is admitted into the reservoir C, through the pipe *h*, and passes from the same through the pipe *i*.

As the exhaust steam is received directly from the engine in a series of puffs of varying pressure, it is essential that this pressure should be equalized before it is permitted to pass from the reservoir.

It is also necessary, in order to prevent the partial condensation of the steam, and consequent lowering of the pressure, that the reservoir should be effectually heated; for which purpose it is placed over the furnace A, and entirely surrounded by the heated gases, etc., arising from the same.

This plan also enables me to superheat the steam, if desired.

As the steam within the reservoir has free access to the interior of the cylinder F, through the opening in the cock *l*, it will, as its volume increases, have a tendency to raise the piston H; which, however, actuated by its ball, *q*, will bear downward with a pressure proportionate to the weight of the said ball, and will thus maintain the steam at an even pressure, providing always that there be a sufficient quantity of steam to slightly raise the piston H.

The object of the cock *l* is to so regulate the passage of steam into the cylinder F as to prevent it from raising the piston too suddenly.

If steam should continue to enter the reservoir, without being at the same time drawn off from the same, through the pipe *i*, the pressure would not be increased, as the piston H would gradually rise to such a point as to permit the surplus steam to pass off through the pipes *r r*.

In this way all liability to accident arising from an increase of pressure in the reservoir is prevented.

It should be understood that the pipe *h* is provided with a valve opening toward the reservoir, so that there shall be no back pressure from the latter to interfere with the operation of the first or high-pressure engine.

Instead of having a separate furnace to heat the reservoir, the same result might be attained by causing the heated products of combustion from the boiler-furnace to pass through the casing B, and around the said reservoir.

Claims.

I claim as my invention—

1. A steam-reservoir, provided with inlet and outlet-pipes, *h* and *i*, communicating with a cylinder, in which is a weighted piston, H, and surrounded by a casing or jacket, B, through which heated products of combustion are arranged to pass, all substantially as hereinbefore described.

2. A pipe, *r*, arranged in respect to the cylinder F and its piston, as specified.

3. In the described combination of steam-cylinders of high and low pressure, and apparatus for superheating, a supplemental cylinder with piston, in combination with said superheater, whereby a varying amount of steam can be retained at an even pressure, substantially as set forth, to be again used for driving a second engine.

JOHN HOUPT.

Witnesses:

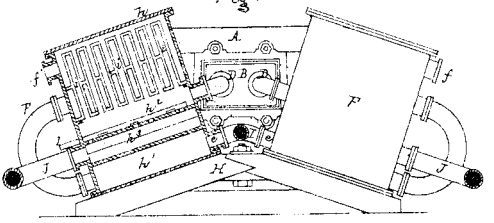
BENJ. MORISON,

WM. H. MORISON.

JOHN HOUPT

IMPROVEMENTS IN CONDENSING STEAM ENGINES.

Fig. 1.



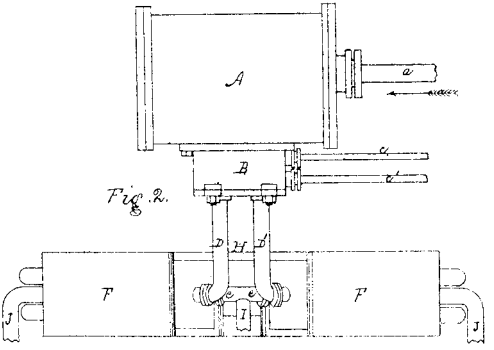


Fig. 2.

Witnesses:
Wm A Steel.
John Parker

Inventor:
John Houpt

No. 3.

Letters Patent No. 90,266, dated May 18, 1869.

IMPROVED CONDENSING STEAM-ENGINE.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springfield, County of Bucks, State of Pennsylvania, have invented certain Improvements in Condensing Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the same.

My invention consists in the combination, with a single steam-cylinder, of condensers, which are arranged to operate as hereafter described, so that while the engine can be driven at a higher rate of speed, and with a higher pressure of steam than has heretofore been considered practicable with condensing-engines, each condenser shall have sufficient time to cool and to perform its duty effectively.

In order to enable others skilled in the art to make and use my invention, I will now proceed to describe its construction and operation, reference being had to the accompanying drawing, which forms a part of this specification, and in which—

Figure 1 is a side elevation, partly in section, of a portion of a steam-engine with my improvements, and

Figure 2, a plan view of the same.

A represents a steam-cylinder, of which *a* is the piston-rod; B, the steam-chest; and *c*, the valve-rod.

Besides the usual slide-valve, there is, within the steam-chest, a second, which is so operated by a rod, *c'*, driven by an eccentric on the main shaft of the engine, that it shall direct the exhaust steam from one end of a cylinder into a pipe, D, and from the opposite end of the cylinder into a similar pipe, D'.

The former of these pipes communicates with the steam-space of a condenser, F, and the latter pipe with a condenser, F', both condensers being, in the present instance, secured in inclined positions upon a suitable base, H, in close proximity to each other.

The supply of cold water for the condensers is furnished from a single pipe, I, through branches *e e*, this water, after having performed its duty, passing off through pipes *f f*.

The water of condensation is drawn off through the pipes J J, which lead to the air-pump.

The condensers shown in the drawing are similar to that for which Letters Patent were allowed to me on the 16th day of November, A.D. 1868, the interior of each of them being separated into water-chambers, h and h^1, a steam-space, h^2, and a chamber, h^3, for the collection of the water of condensation before it is drawn off by the air-pump.

Vertical or inclined tubes, *i i*, closed at their upper ends, are contained in the water-chamber h, and communicate with the steam-space h^2, and the partition between the latter and the chamber h^3 is perforated with a number of holes, which can be opened or closed by means of a valve, *j*, operated in any suitable manner, the object of the said valve being to debar all steam from the chamber h^3 until it is properly condensed.

When the condensers are arranged as above, their operation is as follows:

The valve connected with the rod c' is so operated that when the piston of the engine is moving in the direction of the arrow, the exhaust steam shall pass from the cylinder to the pipe D, and thence to the condenser F, which produces a vacuum in front of the piston, as usual. Then, as the motion of the piston is being reversed, the first pipe D is closed, and the exhaust steam from the opposite end of the cylinder permitted to pass through the pipe D′ into the second condenser F′, the condenser F becoming, in the mean time, perfectly cooled, and ready for a second charge of steam when the piston is again reversed.

It will be evident that an engine, when thus provided with two condensers, arranged to work alternately, can be driven at a much greater rate of speed, and with a more perfect condensation than usual; but as each condenser has to receive a full charge of steam from its own end of the cylinder, it must be of the same capacity as though but a single condenser were employed.

It should be here understood, although I have described a specific kind of surface-condenser, that jet-condensers, or any of the well-known condensers, whether tubular or not, may be used in carrying out my invention.

When more than two condensers are used, their operation may be as follows:

The valve in the passage to one of the condensers should be opened just before the crank of the engine reaches the dead-centre, in order that this condenser may reduce the pressure of the steam in its own end of the cylinder. Then, as soon as the crank has

passed the dead-centre, and just as the motion of the piston is being reversed, the valve of the first condenser is closed, and that of the second condenser, at the same end of the cylinder, opened, the latter condenser receiving the remainder of the charge of steam, and producing the required vacuum in front of the piston.

The other pair of condensers operates in a similar manner in exhausting the steam and producing a vacuum at the opposite end of the cylinder, when the piston is again reversed.

When an abundant supply of fresh water can be obtained, and two jet-condensers are employed, an engine can be worked with a high pressure of steam by arranging the said condensers to receive the exhaust steam from both ends of the cylinder in the same manner that each pair of surface-condensers, above described, received the steam from one end only of the cylinder.

The jet-condenser will thus perform double the duty of the surface-condensers, but this is rendered practicable on account of their more rapid operation and cooling.

The object of thus passing the steam from each end of the cylinder into two condensers, is to enablethe pressure and temperature of the steam before the piston to be reduced by the first condenser, while the second condenser, having but little steam to withdraw and condense, forms a much more perfect vacuum in the cylinder than is usually obtained.

It will be evident, without further description, that by the employment of several condensers instead of one, as heretofore, an engine can be driven at a higher rate of speed, and with a higher pressure of steam than usual, while each condenser will have sufficient time to cool and to perform its duty properly.

I claim as my invention, and desire to secure by Letters Patent—

In combination with a single steam-cylinder, a plurality of condensers, arranged to operate substantially as described, for the purpose specified.

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

JOHN HOUPT.

Witnesses:

JOHN WHITE.

HARRY SMITH.

No. 4.

Letters Patent No. 97,923, dated December 14, 1869.

IMPROVEMENT IN CONDENSERS.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, County of Bucks, State of Pennsylvania, have invented an Improved Condenser for Steam-Engines, etc.; and I do hereby declare the following to be a full, clear, and exact description of the same.

My invention consists of a jet-condenser, so constructed and operating that the condensing-water and condensed steam shall be carried off by gravity alone, while all particles of air shall either pass off with the water or be exhausted from the condenser by means of a small air-pump, all of which is fully described hereafter.

In order to enable others skilled in the art to make and use my invention, I will now proceed to describe its construction and operation, reference being had to the accompanying drawing, which forms a part of this specification, and in which—

Figure 1 is a vertical section of my improved condenser, in the simplest form;

Figure 2, a sectional view of a modification of my invention, in which the condensing-water has to be raised to a certain height before performing its duty; and

Figure 3, another modification, to be used when but a small supply of condensing-water can be obtained.

Similar letters refer to similar parts throughout the several views.

Before proceeding to describe my invention, it will be well to state that its object is to effect economy in the condensation of steam, by dispensing, either wholly or in part, with the air-pump, as an adjunct to jet-condensers.

It may be also mentioned, that the apparatus is intended to be used mainly in mountainous or hilly country, where a regular

John Houpt

Improved Condenser for Steam Engines etc.

Fig. 2.

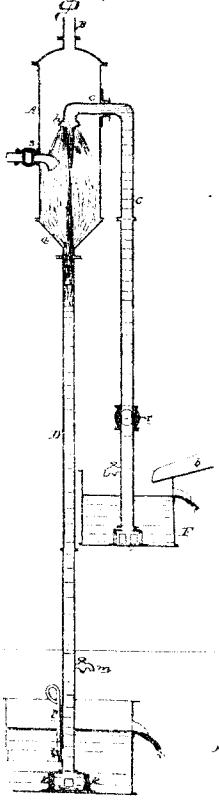


Fig. 1.

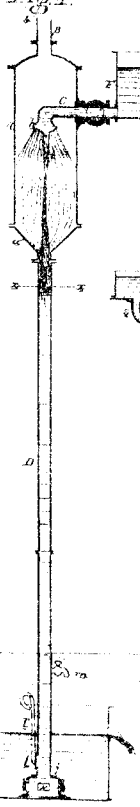
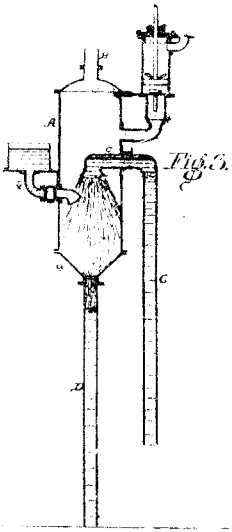


Fig. 3.



Witnesses { Wm. Ashtel. John Fisher

J. Houpt
by his Atty.
J. Hollinger

supply of running water, having from thirty to fifty feet fall, can be obtained, although it can be used advantageously in the upper story of a building, or, in fact, in any situation of a proper height, to which a sufficient head of condensing-water can be conducted.

On reference to Fig. 1 of the drawing—

A represents the condensing-chamber, consisting, in the present instance, of an upright cylindrical vessel, with which communicates, at the top, the exhaust-pipe B of the engine.

The pipe C, by which the condensing-water is conducted to the apparatus, passes through one side of the vessel A, and to the funnel-shaped bottom *a* of the latter is connected the upper end of a vertical tube, D, through which the condensing-water, the condensed steam, and all particles of air are carried off from the apparatus, as described hereafter.

One end of the tube *c* is connected to a tank, F, into which a constant stream of water is conducted by a spout, *b*, and the opposite end of the said tube, within the condensing-vessel, is bent abruptly downward, as shown in the drawing, and terminates in a rose, *h*, from the centre of which projects a tapering nozzle, *i*.

The lower end of the tube D also projects into a tank, H, filled with water, and in order to prevent this water from rising through the tube into the condensing vessel, when a vacuum is produced within the latter, it is necessary that the said tube should be of greater length than the height of a column of water which would be forced upward through the same by the pressure of the atmosphere; in other words, the length of the tube must exceed thirty-four feet.

At the lower end of the tube D is a valve-chest, *j*, which is furnished with four hinged valves, *k*, opening outward into the tank; and on one side of the tube, above this valve-chest, but beneath the water-line in the tank, is an opening, covered by a sliding-valve, *l*, which is operated by means of the rod *l'*.

There is also, on the tube D, a cock, *m*, for a purpose described hereafter.

The operation of the apparatus is as follows:

Before admitting steam, the cock *r*, in the pipe C, is closed, and the cock *m* and valve *l* of the tube D opened, steam from the exhaust-pipe B being then blown through the chamber A and tube D, for the purpose of driving out the air.

When the air has been entirely expelled, the cock *m* is closed, and the cock *r* opened, water then flowing through the pipe C, and passing from the rose *h* into the condensing-chamber, in a number of fine jets, while a stream of water is projected with considerable force from the nozzle *i* directly into the tube D, to which the air and water are guided by the funnel-shaped end of the chamber.

These jets of water will immediately condense the steam contained in the apparatus, when, a vacuum being formed, water will be forced from the tank H through the valve-opening *l*, and up into the tube D, to the point represented by the line *x–x*, Fig. 1, or, in other words, to a height of about thirty-three feet, the valve *l* being then closed.

As each puff of exhaust steam enters the condensing-chamber, it will force whatever air has accumulated in the same downward, and through the cold-water jets, the latter immediately condensing the steam, and forcing the same, together with the air, into the tube D, the volume and force of the jets, and of the stream from the nozzle *i*, being sufficient to thoroughly mix the water and air in the tube, and to prevent the air from again rising into the condensing chamber, it consequently passing downward with the water to the lower end of the tube, and escaping through the valves *k*.

It will be understood, that when the water has once risen in the tube D to the height shown by the line *x–x*, it is maintained at that point by the supply of condensing-water and condensed steam, the surplus water passing into the tank H through the valves *k*, which will open when the pressure of the column of water in the tube exceeds that of the atmosphere, or when it rises above the line *x–x*.

It will be evident, without further description, that a condenser, constructed and operating as above described, will possess the advantages over the ordinary jet-condenser, of maintaining as good or a better vacuum, at less expense, and without taxing the engine for a portion of its power to drive an air-pump.

When a plentiful supply of condensing-water can be obtained, but at a height somewhat less than that of the condensing-chamber, it will be necessary to construct the apparatus as shown in Fig. 2.

In this case, a vacuum is first produced, after blowing through, by means of what I term a "primer," being merely a short tube, *s*, terminating in a rose, and communicating with an adjacent tank. After producing the desired vacuum, the pressure of the atmosphere will be sufficient to cause a constant stream of water to rise through the tube *c* and into the condensing-chamber.

In other cases, where the supply of water is limited, and barely sufficient to condense the steam, the apparatus may be constructed as seen in Fig. 3, the nozzle *i* being, in this case, dispensed with, and a small air-pump being attached to the condenser, for the purpose of exhausting the air from the same; but it should be understood, that even in this case the condensing-water and the condensed steam are carried off through the tube D, so that the power required to drive the air-pump amounts to but little.

The valves *k*, at the lower end of the tube D, are not essential to the perfect working of the apparatus, their object being to prevent the sudden fluctuations of the height of the water in the tube, in the intervals between the admission of each puff of steam and its condensation.

Although I have described my invention as applied to a steam-engine only, it will be evident that it can be advantageously employed in connection with sugar-boilers' vacuum-pans, and for other useful purposes.

I claim as my invention, and desire to secure by Letters Patent—

1. Chamber A, pipe D, and tubes B C, so arranged that a stream of water is forced through the said chamber, directly into the mouth of the tube D, substantially as described.

2. A rose, *h*, constructed and applied to the condenser, substantially as set forth.

3. The valves *k* and *l*, arranged at the lower end of the tube D, substantially as specified.

4. The chamber A, its tube D, and supply-pipe C, in combination with the primer *s*, as described.

5. The combination, with the tubes B, C, and D, arranged as described, of a chamber, A, having a funnel-shaped bottom, for the purpose set forth.

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

JOHN HOUPT.

Witnesses:
JOHN A. HURLEY,
LOUIS BOSWELL.

No. 5.

Letters Patent No. 102,005, dated April 19, 1870; reissue No. 3999, dated May 31, 1870.

IMPROVEMENT IN STEAM-CONDENSERS.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Condensers for Steam-Engines, of which the following is a specification.

Nature and Object of the Invention.

My invention relates, more especially, to "an improvement in condensing steam-engines," for which Letters Patent were granted to me dated the 18th day of May, 1869. The said improvement consists in the combination of a plurality of condensers with a single steam-cylinder, for the purpose therein specified, the said condensers, when more than one set are used for each end of the cylinder, acting independently of each other, but for the single purpose of producing the required vacuum in front of the piston.

My present invention, however, while it divides the exhaust steam into two portions, as required in my said patented invention, differs in this, that it produces instantly, and without the use of an air-pump, a more perfect vacuum in front of the piston, by condensing only one of the two portions of the exhaust steam, for the purpose of producing the said vacuum, while the other portion is either condensed in a separate or independent chamber over the usual hot well, as required in marine engines, or is allowed to escape from said chamber into the open air, as in stationary or land engines, where there is an abundance of fresh water to supply the boilers.

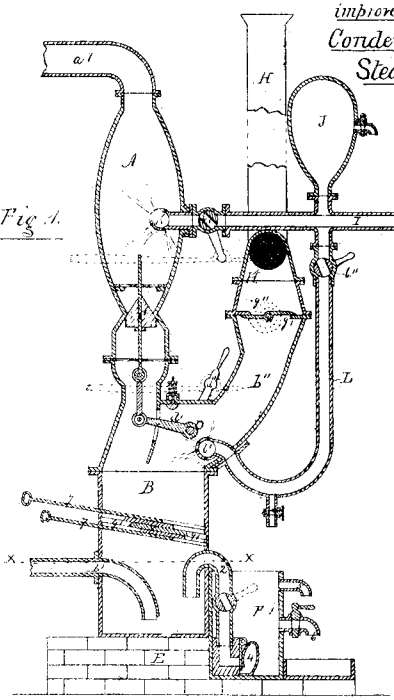
Description of the Accompanying Drawing.

Figure 1 is a vertical longitudinal central section, embodying my invention, and

Figure 2 is a sectional plan view of the lower portion of Fig. 1.

John Houpt's
improvement in
Condenser for
Steam Engines.

Fig. 1.



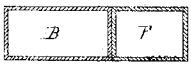


Fig. 2.

Witnesses:
Benj Morison.
Wm H. Morison.

Inventor:
John Houpt.

General Description.

A is a condensing-chamber, which is intended to be connected with the steam-cylinder of the engine, by means of the exhaust-pipe a', which is secured to its upper end.

This chamber A may be called the primary condenser, and is of the spindle form, and supported in a vertical position upon an elevated portion of the upper end of a more capacious chamber, B, which latter may be called the secondary condenser.

The lower end of the primary condenser A opens into the secondary condenser B, but is fitted with a spindle-valve, C, whereby the said opening between the two chambers A and B is periodically closed by a positive motion given to the valve by a rock-shaft, D, which passes horizontally through the upper part of the chamber B, and has a fixed arm, d', which is articulated to the lower end of the spindle of the said valve C, motion being given to the rock-shaft D by means of a lever d'', and the usual detachable connecting-rod, operated by the engine.

The secondary condenser B is a rectangular chamber, which is fixed to rest securely upon a substantial base, E, its lower portion constituting the hot well, with a pipe, b', which leads to the usual pump for supplying water to the boiler, and a siphon-pipe, 2, which passes out through the one side of chamber B, and is fitted with an adjustable hand-valve, 3, near its upper part, outside of the chamber, for the purpose of regulating thereby the height of the water in the hot well, and with a spring-valve, 4, at its lower end, for preventing an accidental return of water, the said outside portion of the siphon-pipe 2 extending down into and nearly to the bottom of an outside water-receiver or waste-well, F, which is fitted with an overflow-spout, 5, and a lowering-cock, 6.

Above the hot well water-line x, in the secondary condenser B, a pair of adjustable slides 7 7 are fitted, so that they can be moved by hand over the opposite sides of an inclined partition, 8, which has two openings, 9 9', through it, that can be either closed or varied in area by moving the slides accordingly.

The upper portion of the secondary condenser B is divided transversely by a curved upright partition, 10, which extends downward toward the middle of the partition 8, containing the slides 7 7, the arm d' in the rock-shaft D working in a roomy slot in the said partition 10.

On the rock-shaft side of the partition 10 the secondary condenser B extends in a curve upward, so as to afford an elevated continuation, b'', which serves as a support for an elevated escape-pipe or flue, H.

Between the parts b'' and H there is placed an overbalanced

valve, g', closed in its normal condition, but yielding upward to a puff of steam from the primary condenser A, to let out the air, but immediately closing again, the tendency of which is to keep the chamber B closed against the undue escape of steam, and also to effectually prevent any rush of air into the said chamber B through the escape-pipe H, when a vacuum is produced in the chamber.

Attached to the valve g' is a slender spring coil, g'', which prevents the valve from accidentally remaining open.

I is a pipe, provided with an air-pressure equalizer, J, and communicates, at one end, with any sufficient head of cold water, and at the other end with a jet-spreader, K, that is fixed to discharge in the centre of the primary condenser A when the stop-valve i' is opened, the said valve i' being intended to be opened periodically by a positive motion derived from a cam or eccentric, through an adjustable connecting-rod, operated by the engine in the usual manner.

Branching down from the pipe I is another pipe, L, which, by an upward curve, enters through the under side of divisions b'' of the secondary condenser B, and, turning downward a short distance, ends in a jet-spreader, l'.

This pipe L also has a stop-valve, l'', which may be opened periodically by a positive motion from a cam or eccentric, derived through an adjustable connecting-rod, operated by the engine in the usual manner, or it may be adjusted to keep the jet-spray of l' constantly running, if preferred.

The different parts described being connected together substantially as set forth, and the pipe a' connected to the usual exhaust-chest of the valve or valves of the steam-cylinder of the engine, the moving parts are then to be adjusted to operate as follows, viz.:

Immediately before the crank of the engine reaches its dead-point, the exhaust-valve of the steam-cylinder and the valve C open, and thus allow the first puff of high steam from the steam-cylinder to pass down through the primary condenser A, driving the air and any water of condensation which may be therein before it into the secondary condenser B, when the valve C instantly closes, and the valve i' opens and lets a copious spray of cold water be discharged through the jet-spreader K, which instantly condenses all the steam in the said condenser A, and thus produces, in front of the piston, as perfect a vacuum as can be produced in a condenser. The puff of high steam, which had just previously passed out of the primary condenser A into the secondary condenser B, continues down through the adjusted opening 9, in the partition 8, into contact with the surface of the water in the hot well in the lower part of chamber B, and

thence, partially condensed, up through the opposite opening 9′ in the partition 8 into the division b'', forcing the air therein out through the yielding valve g', which then instantly closes, and the confined steam, being subjected to the spray of cold water from the jet-spreader l', is thereby wholly condensed, thus producing a partial vacuum in the secondary condenser B, the water falling down through the partition 8 into the hot well beneath. Should the vacuum produced in the secondary condenser B cause the water in the hot well to rise, the spring valve 4 in the secondary well F closes, and, consequently, arrests its progress.

The cold-water jet l' in the secondary condenser B is required in marine engines only, for the purpose of saving a sufficient quantity of the water of condensation to keep the boilers supplied; but in land engines the first puff of steam which passes through the primary condenser A, at each exhaust of the cylinders, after passing from the hot well up through the division b'' in a partially-condensed state, forces open the valve g' and escapes, leaving the secondary condenser B with an imperfect vacuum, but, nevertheless, in a condition very favorable to the entrance of the next puff of high steam, together with the water of condensation left in the primary condenser A, in making the preceding vacuum therein.

The described apparatus may have the pipe a' made to communicate either with both or with only one of the exhausts of the steam-cylinder of the engine, as may be deemed necessary or expedient, using either a double or single apparatus, as the adoption of either arrangement may require.

It will be evident, without any further description or explanation, that, as the vacuum required in front of the piston is produced by operating on less than one-half of the exhaust steam liberated just before each stroke of the piston, and the consequent expulsion thereby of the air in the primary condenser, through which the puff passes, a more perfect and rapid condensation of the said steam will be effected, and, consequently, a more perfect vacuum produced in front of the piston, by means of my present invention, than any hitherto produced for the purpose.

It will also be evident that, as my primary is a self-cleaning condenser, or does not require the co-operation of an air-pump, there will be a saving in fuel adequate to the amount heretofore required to operate the air-pump in low-pressure engines having the same-sized steam-cylinder, while the condenser itself is much more simple and less costly in construction.

Claims.

I claim as my invention—

1. The arrangement and combination of a primary condenser

and a secondary condenser with an intervening valve, for the purpose of dividing the exhaust steam preceding each stroke of the piston of a steam-cylinder into two parts, in such a manner as to retain the smaller portion of the high steam of the exhaust within the primary condenser A for condensation, and the consequent production of a more perfect vacuum in front of the piston in the said cylinder, substantially as hereinbefore set forth.

2. In combination with the primary condenser A, the secondary condenser B and the valve C, arranged as described, the employment of a cold-water jet-spreader, l', in the secondary condenser B, the same being arranged to operate therein substantially as and for the purpose hereinbefore set forth.

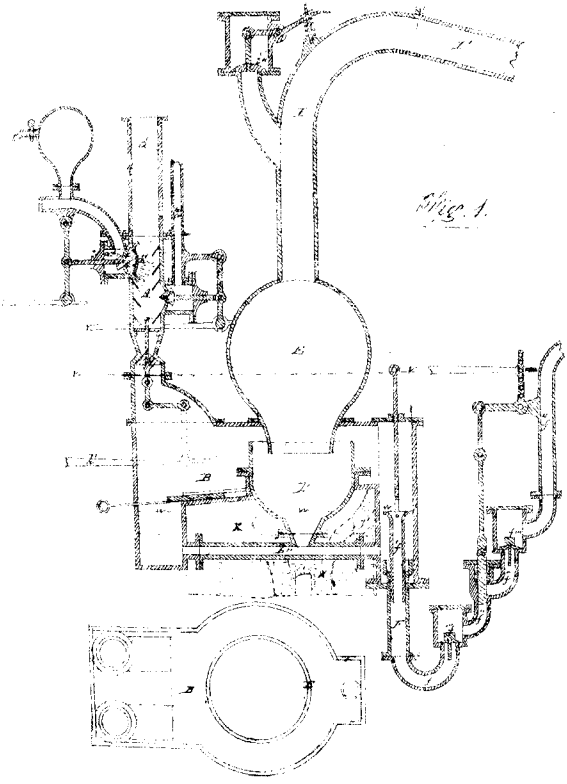
3. In combination with the primary condenser A, the secondary condenser B, and the valve C, arranged as described, the employment of the overbalanced valve g', arranged to operate between the space b'' in the secondary condenser B, and the escape-pipe H, substantially as and for the purpose hereinbefore set forth.

4. The primary condenser, consisting of the chamber A, the cold-water jet-spreader K, and the valve C, operating together as and for the purpose described, in combination with any suitable hot well or receiver of the water of condensation and the steam coming from the said primary condenser, so that the water in said hot well or receiver will be heated for supplying the boilers or steam-generators of a land or fresh-water engine, and the surplus steam allowed to escape.

JOHN HOUPT.

Witnesses:
BENJ. MORISON,
WM. H. MORISON.

John Houpt's improvement in
Condensers for marine Steam Engines



No. 6.

Letters Patent No. 105,457, dated July 19, 1870.

CONDENSER FOR MARINE ENGINES.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Condensers for Marine Engines, of which the following is a specification.

Nature and Objects of the Invention.

My improvements relate to the general construction of a plurality of condensers, as well as to their application to a steam-engine, but more especially to such as are described in my application "allowed" on the 20th day of October, 1869, and those described briefly in the caveats filed by me on the 15th and 22d days of September, 1869, and on the 15th day of January, 1870.

The first part of my invention relates to the construction and combined arrangement of two primary condensers with the respective ends of the steam-cylinder of a marine engine, and with a single secondary condenser, in such a manner that the exhaust steam of the cylinder will be more effectually and easily divided into two portions in passing through the two said condensers, the one portion passing onward toward a tertiary condenser, to be eventually reduced to fresh water for supplying the steam-generators of the said engine, and the other portion being condensed by a jet-spray of cold sea-water, and the saline fluid discharged overboard; the object of this part of my invention being to produce thereby a more perfect vacuum in front of the piston, and also to afford a sufficient supply of fresh water for a marine engine without a special distillatory apparatus for the purpose.

The second part of my invention relates to the construction of the secondary condenser and the pipe leading from it to the tertiary condenser, and to the connection therewith of a force-

pump, in such a manner that, while any required height of water may be maintained in the condenser, and the surplus be discharged overboard, all the vapor discharged into and arising from the water in the said condenser will be conveyed to the tertiary condenser; the object of this part of my invention being to separate more effectually the saline water and the vapor, and rendering the latter available for condensation in the tertiary condenser, for the purpose of affording a supply of fresh water for the steam-generators of the engine.

The third part of my invention relates to the construction of a tertiary condenser, and to its arrangement and combination with the secondary and primary condensers and the respective ends of the steam cylinder, in such a manner that the portion of steam or vapor which passes upward from the secondary condenser will be perfectly and rapidly condensed, and finally discharged by the said tertiary condenser into a reservoir, for the purpose of supplying the steam-generators of the engine with a sufficiency of fresh water.

Description of the Accompanying Drawings.

Figure 1 is a vertical longitudinal section through the middle of one of the primary condensers and the middle of the secondary condenser and their immediate connections, detached from the tertiary condenser.

Figure 2 is a horizontal section of the secondary condenser, below the dotted line V of Fig. 1.

Figure 3 is a vertical section of the tertiary condenser and fresh-water reservoir, detached from the primary and secondary condensers.

General Description.

A is one of the two like primary condensers, communicating by a pipe, *a′*, with its respective end of the steam-cylinders (not shown) of a steam-engine.

B, the secondary condenser.

E, a capacious inverted vapor-receiver, supported upon the condenser B, and opening through the top of the same downward into the mouth of another vapor-receiver, *b′*, within the said condenser B, while its upper end communicates with a capacious steam- or vapor-pipe, I, leading into the drum K of the tertiary condenser or condensing cases C C.

b″ is a horizontal pipe, which forms a communication between the bottom of the condenser B and the bottom of the vessel *b′*, so that any water in the bottoms of B and *b′* will preserve the same level, as indicated by the dotted line W on Fig. 1.

At one end of the bottom of B an opening and pipe, F, are

John Houpt's impt in

Condensers for marine engines.

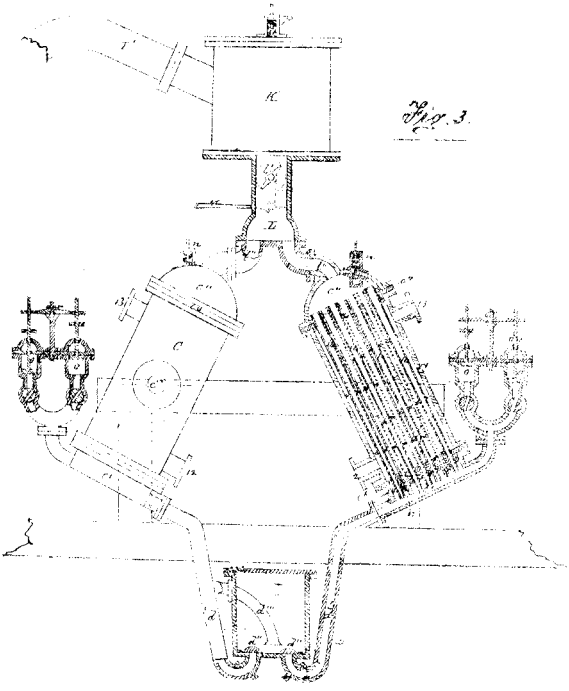


Fig. 3.

provided, for the reception of an adjustable overflow-pipe, f', whereby any required height of the water-surface may be obtained in the condenser B and vessel b'.

The lower end of the pipe F is connected with a series of bent pipes, f'' f''' f'''' f''''', containing suitable valves, and a plunger, G, operated by the power of the engine, so that the surplus or overflow-water of the condenser B will be forced overboard.

Communication between the primary condenser A and the secondary condenser B is closed and opened by means of a valve, H, operated by a rod, h', connected with the engine, substantially as described in my said "allowed" application.

In one side of the primary condenser A there is a recess, covered on the inner side by a perforated plate, a'', and in the middle of the recessed portion there is an opening fitted with a conical plug-valve, a''', in a water-chamber, a^4, which communicates with an elevated fountain-head (not shown), so that, whenever the valve is opened, a jet-spray of cold water will be forced into the condenser A.

At the opposite side of the condenser A, and a little below the jet-spray recess, is a small opening fitted with a conical plug-valve, a^5, covered by a case, which, by means of a pipe, a^6, receives hot air from any suitable air-heating and forcing-chamber, so that, whenever the said valve is opened, a stream of said hot air will be forced into the condenser A.

This valve a^5, and also the valve a''', are operated by the engine substantially in the same manner as the valve H.

Side by side of each other the two primary condensers, of which A is a representation of either, having each an open communication with its respective ends of the steam-cylinder of the engine, and the valves of each of said primary condensers operating alternately as the exhaust steam is received from their respective ends of the said steam-cylinder, and both communicating with one and the same secondary condenser B, as described, the result will be as follows, viz.:

During the entrance of the first puff of steam into either of the primary condensers, the valve H in the bottom of the same being still open, and the valves a^3 and a^5 closed, the said puff of steam and the air in the said primary condenser A will be driven down into the secondary condenser B, and the valve H immediately afterward closed, so that a moiety or portion of the exhaust steam coming from the cylinder will be retained in the condenser A, the valve a^3 now opens and a spray of cold water therefrom condenses the confined steam, and thus produces the vacuum required in front of the advancing piston, and the piston having advanced nearly to the end of its stroke, the valve a^3 closes, and the valve a^5 opens and lets hot air into the condensers A, to overcome the

vacuum, or equalize the pressure in the primary and secondary condensers, and immediately afterward the valve a^5 closes, and the valve H opens, and lets the water in the primary condenser fall by gravitation into the secondary condenser.

The puff of high steam now coming through the open valve H of the other primary condensers, drives the vapor and warm air therein into the secondary condenser B, which vapor and air, together with whatever vapor may arise from the saline water therein, and in the capacious chamber b', will be driven upward into the capacious chamber E, and the said vapor of fresh water then driven upward through the vertical pipe I and the inclined pipe I′ into the drum of the tertiary condenser, the saline water deposited in the secondary condenser B being at the same time kept at any required height or depth therein by the adjustable overflow-pipe f' and the action of the pump-plunger G, operated by the engine so as to discharge overboard, through the pipe f^4, the overflow-water.

The tertiary condenser consists of the drum K and two like cases, C C, of prismatic form, each fitted with a removable sunken bottom, c', and a removable cap, c'', and supported on a substantial frame by means of trunnions c''', in such a manner that, when detached from the outside pipes which connect it with its fellow case and other parts of the engine, it can be tilted to any suitable position required for cleansing or repairs.

The caps c'' c'' are secured upon the upper ends respectively of the cases C C, with a perforated plate, c^4, between, and form chambers which respectively communicate with the drum K above, through a valve-chamber, L, and pipes l'' l'' (see Fig. 3).

The sunken bottoms c' c' are each secured to the respective ends of C C, with two like perforated plates, c^5 c^5, and a correspondingly perforated compressible packing, c^6, between the said cases and bottoms.

Between the cap c'' and the bottom c' of each case C, there are a series of transversely arranged partitions, 11 11 11 11, which extend alternately from opposite sides of the case to the extent of about two-thirds, more or less, of the distance between the said sides.

At a short distance below the lowest of the partitions 11 of each case C there are two flanged openings, 12 12, made for the purpose of the attachment to said case of two pipes (not shown) for the introduction of steady streams of cold sea-water from any sufficiently elevated reservoir, and at the opposite side of the case, near its upper end, there are made two correspondingly flanged openings, 13, to which pipes (not shown) are intended to be attached to carry off the water supplied to the case through the openings 12 12.

A numerous series of slightly tapering open tubes, 14 14, are secured longitudinally within each case C, by inserting each of said tubes downward through the respectively appropriate perforations in the plate 4, partitions 11 11, and plates c^5 c^6 c^5.

The upper end of each tube is screw-cut around its outer side, and fitted with two nuts, 15 and 16, the lower one serving as a jam-nut or adjustable shoulder, and the other one as a tightener, so that the upper or wider end of the tube 14 can be secured thereby in a water-tight manner, in the said perforated plate c^4.

The perforations in the bottom-plates c^5 c^6 c^5 are made, respectively, to receive the lower part of the tubes in a closely-fitting manner, so that, by means of small screw-bolts 17, the two plates c^5 c^5 can be caused to compress the elastic packing-plate c^6 between them sufficiently to contract the perforations in the packing, or keep it always pressing in water-tight contact around the tubes, and at the same time, so as to allow the lower parts of the said tubes to slide up and down as their lengths may become varied by changes of temperature, without causing any leaking of the water around between them and the packing by such variation.

It will be seen, therefore, that the tubes 14 form a series of open communications between the two chambers formed at the respective ends of each of the prismatic cases C C by their respective caps c'' and bottoms c', and that water flowing under pressure into the said cases through the openings 12, will pass upward from side to side alternately, between the partitions 11 11, and thence out through the openings 13 without entering either the tubes 14, or the chambers c' c''.

The said condensing-cases C C are supported upon their respective trunnions c''', with their upper ends inclined toward each other (see Fig. 3), and are connected with the drum K by means of the chamber L, branch-pipes l'' l'', and the pipes of the respective caps c'' c'', a governor-valve, l', being arranged in the chamber L so as to be periodically opened and closed partially, to equalize the pressure of the puffs of vapor in the cases C C as may be required, by a positive motion derived from the engine through a connecting-rod, M, or its equivalent.

The shallow chambers formed at the lower ends of the cases C C, each communicate through a U-bent pipe, d', with a fresh-water receiver, D, through an intervening valve, d'', opening upward into the said receiver, which latter must be placed at a proper distance below the condenser, to receive and serve as a reservoir for the water of condensation which is to flow down through the tubes 14 of the condensing-cases C C. The fresh water thus supplied to the said reservoir D is intended to be drawn through a bent pipe, d''', to supply the usual steam generators of the engine.

On the upper side of the pipe I there is a safety-valve, i'', opening outward, for the purpose of providing against any excessive pressure of the steam on its passage through pipes I I'.

On the drum K there is a valve, p, opening inward, for the purpose of letting air into the drum to overcome, when necessary, such a vacuum as would cause a return motion in the condensed water of the tertiary when the valve l' is open. On the cap c'' of each of the cases C C of the said tertiary condenser, there is a vacuum-valve, n, opening inward, for the purpose of providing against the possible occurrence of such a vacuum therein as would permit a return of the condensed water in the tubes 14 below, when the valve l' above is closed.

In connection with the sunken bottom c' of each of the cases C C, there are a pair of valves, o o, the one opening outward to allow the air to escape from the lower ends of the tubes 14, and the other opening inward to allow of the entrance of air into c', if at any time necessary.

The valves n, o o, and p, are each made adjustable by a spring and screw-nut, to any degree of pressure that may be required, and are intended to be adjusted so as to act automatically, as the emergencies may require.

The fresh-water reservoir D being entirely below the tertiary condensers K C C, the water from the latter will gravitate into it, and the valves d'' d'' will prevent any possibility of the return of any of said water, should a vacuum occur at any time in the said tertiary condensers.

It will be understood without further description, that, by applying a distinct and independent primary condenser for the reception of the exhaust steam from each end of the steam-cylinder of an engine, so that both will open into one and the same secondary condenser, as described, the water of condensation in the bottom of either of the primary condensers will have time to fall down into the secondary condenser before the first puff of high steam from its end of the steam-cylinder reaches the said primary condenser, and consequently, when the puff of steam arrives, driving out the air in the primary, there will be less likelihood of an excess of steam being produced thereby (before its valve closes), greater than the tertiary condensers might be competent to receive and condense.

It will also be understood that, by increasing the capacity of the secondary condenser, and of the pipe which leads from it to the drum of the tertiary condenser, as shown, the sudden entrance of the puff of high steam and air from the primary condensers, and the expansive effect of the same upon the vapor in the secondary condenser, will be sufficiently provided for to prevent any saline water from entering the tertiary condenser, and at the

same time allow all the fresh-water vapor to be driven onward into the tertiary condenser.

It is intended to apply a small furnace below the bottom of the vessel b' and pipe b'' of the secondary condenser B, as indicated by the dotted line x x, for the purpose of heating the water and generating vapor in the condenser just before starting the engine, and to generate vapor at any time, should there be a deficiency in the regular production to keep up the supply of fresh water for the steam-generators of the engine.

Claims.

I claim as my invention—

1. The combination, with the primary condenser A, of the cold-water spray-valve a''', and the hot-air valve a^5, constructed and arranged to operate substantially as and for the purpose hereinbefore set forth.

2. The combination of two like primary condensers A, with the respective ends of the steam-cylinder of an engine, and with one and the same secondary condenser, B, so as to operate in relation to each other substantially as and for the purpose hereinbefore set forth.

3. The combination, with the secondary condenser B, of the capacious vessel b', the intercommunicating pipe b'', the capacious inverted vessel E and pipes I l', the said parts being constructed and arranged to operate substantially as and for the purpose hereinbefore set forth.

4. The combination, with the secondary condenser B, of the adjustable overflow-pipe f'', and its cylinder F, the plunger G and its cylinder f'', and valves f''' f'''', and the overboard or waste-pipe f^4, the said parts being constructed and arranged to operate substantially as and for the purpose hereinbefore set forth.

5. The tertiary condenser, consisting of the drum K and condensing-cases C C, connected together by the detachable pipes L and l'' l', and arranged and supported upon trunnions c''', substantially as and for the purpose hereinbefore set forth.

6. In combination with the pipe L, the governor-valve l', arranged and operated substantially as and for the purpose hereinbefore set forth.

7. The open tubes 14 14, in the cases C C, in combination with the perforated plate c^4 and screw-nuts 15 and 16, at the upper ends of the said tubes, and the perforated plates c^5, elastic packing-plate c^6, and screw-bolts 17 17, at the lower ends of the said tubes, substantially as and for the purpose hereinbefore set forth.

8. In combination with the respective upper ends or caps c'' c'' of the cases C C, the inlet-valves n n, constructed and operating substantially as and for the purpose hereinbefore set forth.

9. In combination with the respective lower ends or bottoms *c′ c′* of the cases C C, the outlet and the inlet-valves *o o*, constructed and operating substantially as and for the purposes hereinbefore set forth.

10. The combination, with the lower ends of the cases C C, of the detachable fresh-water reservoir D, substantially as and for the purpose hereinbefore set forth.

11. The combination, with the drum K, of the inlet-valve *p*, constructed and operating substantially as and for the purpose hereinbefore set forth.

12. The combination of the drum K with the secondary condenser B, by means of the pipes I′ and I, and the capacious inverted vessel E, arranged in relation to each other substantially as and for the purpose hereinbefore set forth.

JOHN HOUPT.

Witnesses:
BENJ. MORISON,
WM. H. MORISON.

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John Hopfel's impr'd in
Gordon's Permanent Steam Engines

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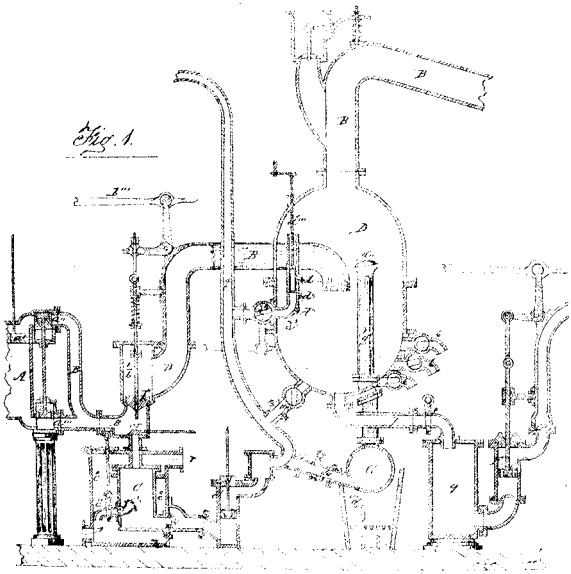
Fig. 1.



Witnesses

Inventor

John Hopfel

No. 7.

Letters Patent No. 109,616, dated November 29, 1870.

IMPROVEMENT IN STEAM-GENERATORS.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain further Improvements in Condensers for Marine Engines, of which the following is a specification.

Nature and Objects of the Invention.

My present improvements relate, generally, to the employment of a plurality of condensers for a single steam-cylinder described in Letters Patent granted to me on the 18th day of May, 1869, but, more especially, to certain improvements in condensers for which Letters Patent, said Patent No. 105,457, dated July 19th, 1870, were granted to me on the 19th day of April, 1870, and to certain further improvements in condensers for marine-engines described in an application filed by me in the United States Patent Office March 24th, 1870.

The first part of my present invention relates to the construction of a comparatively small primary jet-condenser and an air-pump attached, to operate together in combination with a valve, and with a steam passage-way which communicates with both exhausts of the steam-cylinder of an engine and with a tertiary condenser in such a manner as to allow only a small remnant of the exhaust steam coming from the said cylinder to be condensed by a jet-spray of sea-water, in the said primary condenser, to produce the required vacuum before the piston immediately after the first puff or main portion of the said exhaust steam has been discharged through the said valve and passage-way toward the tertiary condenser for the production of fresh water for the steam-generators of the engine; the object of this part of my invention being to provide for the passage of the main portion of the escape steam toward the tertiary condenser, to more effectually prevent

any saline vapor which may arise from the condensing water of the jet-spray in the said primary from reaching the tertiary condenser, and also for the purpose of furnishing the water of condensation, for the steam-generators, of a higher degree of temperature than can be furnished by the ordinary condensers which are intended to produce a vacuum.

The second part of my present invention relates to the construction and arrangement of a secondary chamber or evaporator, in combination with the escape-steam passage-way which leads from the exhausts of the steam-cylinder to the tertiary condenser, and with the hot-water discharge-pipe of the primary condenser; the object of this part of my invention being to produce an additional amount of vapor free from any salines, to compensate for the loss of that portion which is condensed by the saline jet-spray in the primary condenser.

The third part of my invention relates to the combination, with the exhaust-steam passage-way, of a supplementary furnace and boiler or steam-generator in such a manner that aqueous vapor, free from any salines, may be furnished thereby to the said steam passage-way when necessary; the object of this part of my invention being to afford a more simple and inexpensive means of making up for the loss of the fresh-water vapor condensed in the primary condenser.

Description of the Drawing.

Figure 1 is a vertical section representing the steam-cylinder of an engine with its exhausts in communication with the steam passage-way, primary jet-condenser, and the secondary chamber or evaporator, with their respective attachments, arranged substantially in the same vertical plane for the purpose of better illustration.

Figure 2 is a like section of the same parts, modified so as to operate without the secondary chamber or evaporator.

Figure 3 is a side elevation of the tertiary condenser, with its fresh-water reservoir and air-pump attached.

General Description.

A represents the steam-cylinder of a marine-engine, a' its piston, and a'' a''' its exhausts, in communication with the steam passage-way B, the primary jet-condenser C, the secondary chamber or evaporator D, and the head or drum E of the tertiary condenser.

In the passage-way B, near its junction with the two exhausts, a'' a''', of the cylinder A, a valve-chamber, b', is made, in which a spindle-valve, b'', is fitted to be opened upward and closed downward by a positive motion derived through a connecting-rod, b''', from any suitable moving part of the engine, so as to

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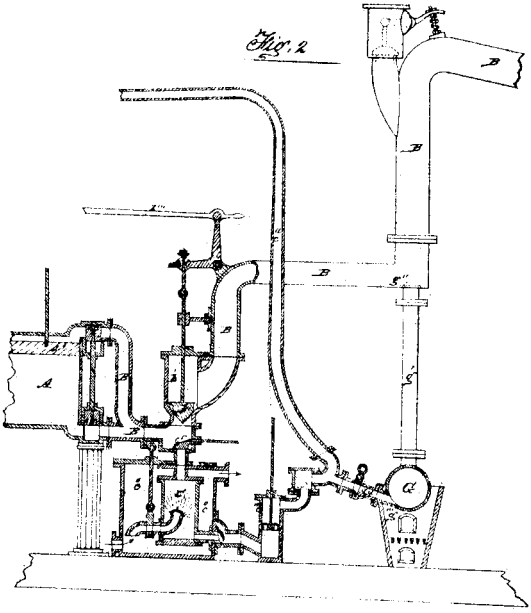
John Houpt's impt in marine steam Engines.

Fig. 2



Witnesses:

Wm Morrison

Wm H. Morrison.

Inventor.

John Houpt

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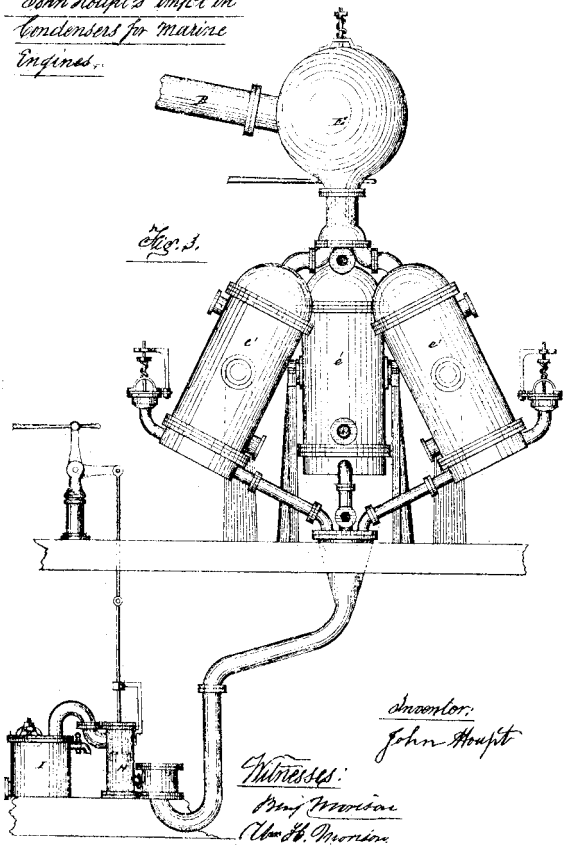
John Houpt's impt in Condensers for Marine Engines.



Inventor:
John Houpt

Witnesses:
Wm J. Morrison
Chas H. Morrison

alternately open and close the passage-way B at a point directly above the primary condenser C.

The primary condenser C is surrounded by a case containing cold sea-water, c^0, and has a jet-spray pipe, c', for the discharge of cold sea-water from the surrounding case into the condenser in a steady spray, regulated by an adjustable stop-cock, c'', and has also communicating with its lower end an air-pump, c''', operated in a positive manner by any suitable moving part of the engine, so as to draw out and force overboard, through a pipe, c^4, the air and the water of condensation deposited in the said condenser.

The upper end of the condenser C communicates with the passage-way B at a point directly below the valve b'', and has at this part a slide-valve c^5, operated in a positive manner by any suitable moving part of the engine in such a manner as to be closed when the valve b'' opens, and open immediately after the said valve b'' closes, and so that when the exhaust-valve of either end of the steam-cylinder A begins to open then the valve b'' opens and lets the first or main portion of the escaping high steam pass upward through the way B toward the head E of the tertiary condenser and then closing, the valve c^5 immediately after opens and lets the remaining small portion of steam pass down into the condenser C (which, being surrounded by cold water c^0 passing through the casing), when it is immediately condensed by the spray c' of cold sea-water, and the required vacuum thus produced before the returning piston, which, having nearly returned, the valve c^5 closes and the air and the warm water of condensation are drawn out of the condenser C and forced overboard through the pipe c^4 by the air-pump c'''.

The evaporating or secondary chamber D is a capacious oval-shaped vessel supported in a comparatively elevated position, and into this the steam passage-way B opens (see Fig. 1).

The said chamber D has a bent pipe, d', within it, which is constructed with a series of very minute jet-spray openings d'' d'', controllable by a hand-screw stem, d''', fitted with a stopper at its lower end, so that either one, two, or all of said jet-openings may be stopped or opened at pleasure, and this bent pipe d' communicates with the pipe c^4 and is fitted with a valve, d^4, operated in a positive manner by any suitable moving part of the engine, so as to let warm water pass periodically from the pipe c^4 into the chamber D, the object being to produce an additional supply of fresh-water vapor by the evaporating effect of the high steam from the steam passage-way B upon the saline water from the spray-jets d'' d'', to compensate for the loss occasioned by the condensation of the steam in the primary condenser C.

The lower end of this chamber D is provided with a series of

try-cocks, 6 6 6, by which the height of the water therein may be readily ascertained, and also with an evacuating-pipe, 7, fitted with a stop-cock, 8, and opening into a chamber, 9, which communicates with a force-pump, F, whereby the water in the said chamber D can be drawn out and forced overboard when necessary.

For the purpose of affording a ready means for washing out any saline deposits which may in time accumulate on the bottom of the said evaporating-chamber D, an inlet pipe, 10, fitted with a stop-cock, is fixed to communicate with the said bottom and the warm-water pipe e^4; and for the purpose of affording a ready means of warming up the evaporator D before starting the engine, and also of increasing the quantity of fresh-water vapor, should there not be a sufficiency provided by the action of the steam upon the spray-water in the said evaporating-chamber D, a supplementary evaporator is provided, consisting of a boiler, G, fitted with a steam-pipe, g', which passes vertically up through the bottom of D and opens into the upper end of the same, a gravitating-valve, g'', being applied over the open end of the said pipe.

The said boiler is supported and heated by a small special furnace, g''', and receives its supply of water from the warm-water pipe e^4, through a communicating-pipe, g^4, which is provided with a stop-cock.

As the supplementary boiler G will probably be sufficient to furnish the required amount of fresh-water vapor to compensate in the greater number of marine engines for that lost in the primary condenser, the evaporating chamber D may, in such cases, be dispensed with entirely, and the boiler G relied upon to make up the deficient amount of vapor, by modifying the steam passage-way B and opening the valved end of the pipe g' of the boiler G directly into the said pipe or steam passage-way B, as represented in Fig. 2. This modification has the advantage also of being much less costly in construction.

The tertiary condenser (see Fig. 3) consists of a series of inclined condensing-cases e' e', constructed and operating in connection with a reservoir for the water produced, in the manner described in my application filed in the Patent Office on the 24th day of March, 1870, as before stated; but in my present invention I apply an air-pump, H, so arranged and operated between the condenser and the reservoir I as to produce a sufficient vacuum in the condensers to facilitate the escape steam through the steam passage-way B into the said tertiary condenser without any more expenditure of power in working the said air-pump H than will be sufficient to produce the said partial vacuum, and without straining the sliding joints, as aforesaid.

In the operation of my present invention it will be understood that, as there is but a small remnant of the exhaust steam to be

condensed in the primary condenser C, the temperature therein can be more quickly reduced, and to a lower degree, and therefore a more sudden and better vacuum be produced and maintained in front of the piston than heretofore.

It will also be understood that, as the main portion of the exhaust steam passes into the tertiary condenser, only the small remnant condensed in the primary has to be provided in order to keep up the full supply of fresh water for the steam-generators, and that therefore the mode of producing this deficiency by means of the evaporating-chamber D and the supplementary boiler G, as represented in Fig. 1, or by means of the boiler G alone, as represented in Fig. 2, will be sufficient to produce more vapor than will be required.

Although it is believed that the vapor produced by the action of the high steam upon the very minute spray-jets of the saline water coming from the pipe c^4 will be free from any saline matter, still I prefer the modification shown in Fig. 2, first, because the vapor-generator or boiler G is much more distant, and therefore the vapor will the more certainly be free from any salines by the time it reaches the outlet valve g'' in the top of the pipe g', and second, because it is much less costly of construction.

The partial vacuum produced in the tertiary condenser by means of the air-pump H it will be evident must facilitate the passage of the steam and vapor through the steam passage-way B into the condenser by releasing the latter of a part of the air that may be contained therein.

Claims.

I claim as my invention—

1. The primary condenser C and air-pump c''', in combination with the valve b'' and steam passage-way B, the said parts being constructed and arranged to operate substantially as and for the purposes hereinbefore set forth.

2. The secondary chamber or evaporator D, in combination with the escape-steam passage-way B and the hot-water discharge-pipe c^4, the said parts being constructed and arranged to operate substantially as and for the purpose hereinbefore set forth.

3. The supplementary boiler G, furnace g''', and pipe g', in combination with the escape-steam passage-way B, when arranged substantially as shown in Fig. 2, for the purpose hereinbefore specified.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

NO. 8.

Letters Patent No. 111,937, dated February 21, 1871.

IMPROVEMENT IN STEAM-ENGINES.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Steam-Engines, of which the following is a specification.

Nature and Objects of the Invention.

My invention relates to the combination of a plurality of low-pressure engines with a high-pressure cylinder, having a steam-dividing self-clearing jet-condenser and a superheater between, in such a manner that the portion of steam which passes freely through the dividing condenser will be made sufficient to operate the low-pressure engines; the object of my invention being to economize fuel in the running of steam-engines.

Description of the Accompanying Drawing.

Figure 1 is a vertical central section of a steam-cylinder in communication with a self-clearing jet-condenser, hot well, and superheater.

Figure 2 is substantially a duplicate of Fig. 1.

Figure 3 is also substantially a duplicate of Fig. 1, with the exception of the superheater.

Figure 4 is a modification of Fig. 3, with the addition of an air-pump and superheater.

The superheater of Fig. 1 is intended to be connected with the steam-cylinder of Fig. 2, and the superheater of Fig. 2 is intended to be connected with the steam-cylinder of Fig. 3, the first puff of its exhaust steam either escaping at the waste-pipe, or entering the superheater of Fig. 4, as will be explained.

General Description.

My present invention consists, substantially, in a combination of a series of the steam-cylinders, self-clearing jet-condensers, and su-

2 Sheets
Sheet 1

John Haupt's improved Combination Steam-Engines.

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Fig. 1.

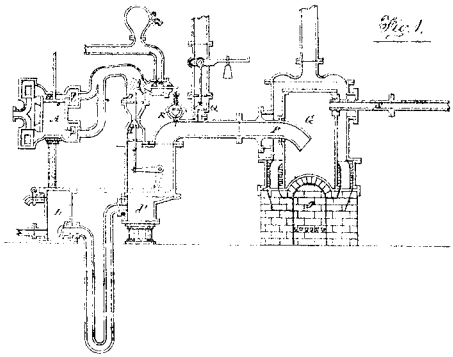
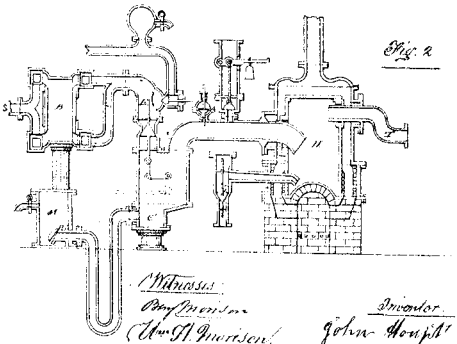


Fig. 2



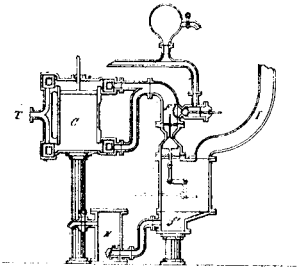
Witnesses:
Oscar Morrison
Chas. H. Morrison

Inventor.
John Haupt

2 Sheets

John Houpt's improved Combination Steam-Engines.

Fig. 3.



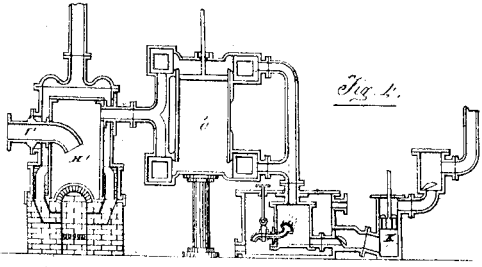


Fig. 4.

Witnesses:
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Wm. H. Morison.

Inventor.
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perheaters of steam, described and set forth in the patents granted to me dated May 18, 1869, April 19, 1870, and reissued May 31, 1870, July 19, 1870, and the application "allowed" July 16, 1870, with such modifications as the said hereinafter described combination rendered necessary and proper.

A B C represent respectively the first, second, and third steam-cylinders;

D E F, their respective self-clearing jet-condensers; and

G H, the respective superheaters of the steam coming from the cylinders A and B.

Although the mode of operation of the several steam-cylinders and self-clearing jet-condensers herein set forth have, substantially, been described in the specifications of my reissued patent dated May 31, and application allowed July 16, 1870, it is considered proper to again explain the operation in the present combination in view of the final result.

The steam is supposed to enter A at, say, fifty pounds' pressure to the square inch above that of the atmosphere; to enter B at, say, fifteen pounds' pressure to the square inch above the atmosphere; and to enter C at, say, five pounds' pressure to the square inch above the atmosphere; and on leaving the condenser F to escape into the external atmosphere through the escape-pipe I, see Fig. 3; or to enter the superheater H′, to supply steam-cylinder C′, at, say, one pound to the square inch either above or below the pressure of the atmosphere. The modification shown in Fig. 4 is, substantially, an ordinary low-pressure engine arrangement, for the purpose of utilizing the exhaust steam, which, at or above the pressure of the atmosphere, would otherwise escape through the waste-pipe I of Fig. 3.

The water of condensation flows into the respective hot wells d' e' and f' of Figs. 1 2 3, and from thence into the respective reservoirs L, M, and N, and from the first-named one, L, the steam-generator may be supplied with a sufficiency of hot water.

The operation of the self-clearing jet-condensers and superheaters, represented in Figs. 1 and 2, will be precisely alike, and, therefore, an explanation of the operation of the one will serve as an explanation of the other.

The operation of the valve d'' divides the exhaust steam coming from the cylinder A into two portions, the first portion passing freely down through the condenser D and thence into the superheater G, from which the next cylinder B will be supplied with steam at a reduced pressure; and the second portion, being arrested and condensed to produce the required vacuum before the piston, is afterwards discharged with the water of condensation down into the hot well d', and from which it flows by gravitation into the reservoir L.

To be more explicit, suppose the piston of cylinder A, moving in its course upward, arrives at *o* near the upper end of the cylinder. Now, the exhaust-valve 1 and the jet-valve *d'''* having just been closed, and the exhaust-valve 2 commencing to open, allow the high-pressure exhaust steam from beneath the piston of the cylinder to escape through the exhaust-valve 2 into the self-clearing jet-condenser D, and immediately on the said jet-condenser becoming sufficiently filled with the exhaust steam to destroy the vacuum existing therein the valve *d''* thereof opens and allows the contained water of condensation to drop down into the hot well d', and by the time the piston of the cylinder A arrives at *o o*, or near to the top of the upward stroke of the piston, the valves 2 and *d''* will be fully opened, and the condenser D will clear itself of all the condensing water and air which may have accumulated therein from the previous condensation, and by the time the crank on the main shaft of the engine (not shown) has passed the dead-centre, and the piston has returned to *o* on its downward stroke, the first puff or main portion of the exhaust steam will have passed out from under the piston and through the open valves 2 and *d''*, in its course through the self-clearing jet-condenser D into the superheater G. The valve *d''* now closes, and the jet-valve *d'''* opens and throws a copious jet-spray of cold water into the condenser D, and thus condenses the remnant or second portion of the exhaust steam, and produces immediately the required vacuum before the piston, and so on.

The superheater G is heated by the small furnace O, by which it is supported and inclosed: and the pipe P, which conducts the steam from the condenser D into the superheater G, has its outlet end curved obliquely downward and laterally, so as to discharge the steam spirally downward into the superheater, and thus favor the required general distribution therein of the steam to be superheated.

The pipe P is also provided with safety-valves Q and R, to prevent the possibility of an explosion or collapse of the superheater.

The superheater G connects, by the pipe S, directly with the supply-valves of the steam-cylinder B, and the superheater H connects, by a pipe, T, directly with the supply-valves of the steam-cylinder C, and the first or main portion of the exhaust steam from the cylinder C escapes into the open air through the waste-pipe I.

A hot-air valve, *h'*, is attached to a pipe, which, at one end, communicates with the interior of the second superheater H, while the other end (not shown) is intended to extend spirally upward through the chimney of the furnace of the superheater G, or any other furnace chimney, whereby it may be kept hot, and to con-

meet with an air-forcing pump, in such a manner that the superheater H may, by the hot air, be kept sufficiently heated without its special furnace, if desired to further economize in fuel.

It is estimated that, if the cylinder A works at fifty pounds' high-pressure, the pressure in B will be about fifteen pounds, the pressure in C five pounds, and the pressure at the waste-pipe I one pound or less.

For the purpose of utilizing this waste of one pound to the square inch in the escape-pipe I, and of affording the advantage of a vacuum, the apparatus shown in Fig. 4 may be attached by its pipe I′ to the waste-pipe I of Fig. 3.

This apparatus (Fig. 4) is a modification of the apparatus shown in Figs. 1 and 2, in so far that an air-pump takes the place of the superheater and produces an exhaust of the air and water in the condenser in the same manner as in the ordinary low-pressure engine, and thus renders available the remnant of steam which otherwise will escape through the waste-pipe I of Fig. 3.

It will be understood, without further description or explanation, that the combination described and set forth will, in view of the amount of work derivable therefrom, greatly economize the fuel required to keep the same in motion.

As a modification of the low-pressure engines, shown in Figs. 2 and 4, the superheaters therein may be dispensed with, for the sake of economy, by enlarging the superheater G of Fig. 1, so as to render it capable of allowing a sufficient expansion of its contained steam to operate, at a pressure of, say, five pounds to the square inch, a series of low-pressure engines, constructed substantially as represented in Fig. 3.

Claim.

I claim as my invention—

The combination of a plurality of low-pressure engines with a primary high-pressure steam-cylinder, A, receiving its steam from any suitable steam-generator, and having a steam-dividing self-clearing jet-condenser, D, and a superheater, G, communicating between it and the several low-pressure engines, and operating together substantially as and for the purpose hereinbefore set forth and described.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

No. 9.

Letters Patent No. 115,208, dated May 23, 1871.

IMPROVEMENT IN STEAM-ENGINES.

THE SCHEDULE REFERRED TO IN THESE LETTERS PATENT AND MAKING PART OF THE SAME.

I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Steam-Engines, of which the following is a specification.

Nature and Object of the Invention.

My improvements relate to the combination of a plurality of low-pressure engines with a primary high-pressure steam-cylinder, having a self-clearing jet-condenser, and a superheater of the exhaust steam communicating between it and the low-pressure engines, for which Letters Patent were allowed to me on the 19th day of October, 1870; and

My present invention consists in the combination of a hot-air supplying apparatus with the superheater of the exhaust steam in such a manner that hot air will be forced into the latter during the operation of the engines; the object of this part of my invention being to aid in increasing the heat and quantity of the steam in the said superheater, and thus economize the fuel of the special furnace beneath the same during the operation of the low-pressure steam-cylinders connected therewith.

Description of the Accompanying Drawing.

Figure 1 is a central section of the high-pressure steam-cylinder and the superheater, in direct communication, drawn in the same vertical plane, together with a central section of the main chimney, and a contained spiral pipe for heating air for the superheater, the said chimney and pipe being shown as in a vertical plane in rear of the first-named vertical plane, the pipes which connect the superheater with the said chimney and the spiral air-heating pipe, respectively, being obliqued backward accordingly.

Figure 2 is a detached central vertical section of a pair of connected low-pressure steam-cylinders with their respective jet-condensers and hot wells, and a hot-water reservoir, with an escape-pipe for the waste steam, in common.

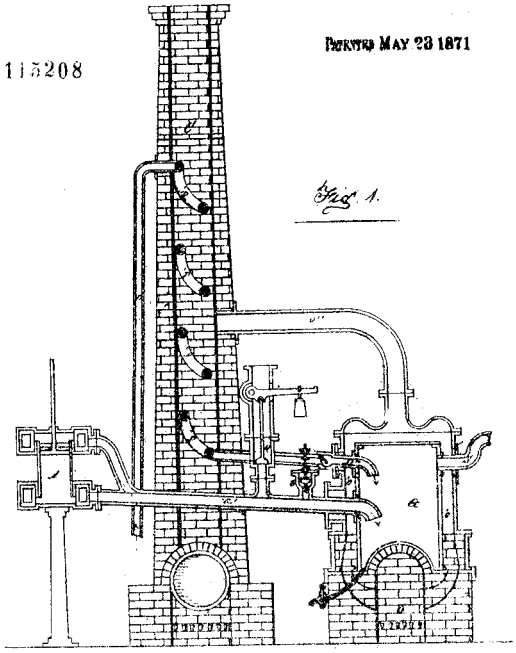
Sheet 1

John Houpt's impt in Steam Engines.

115208

PATENTED MAY 23 1871

Fig. 1.



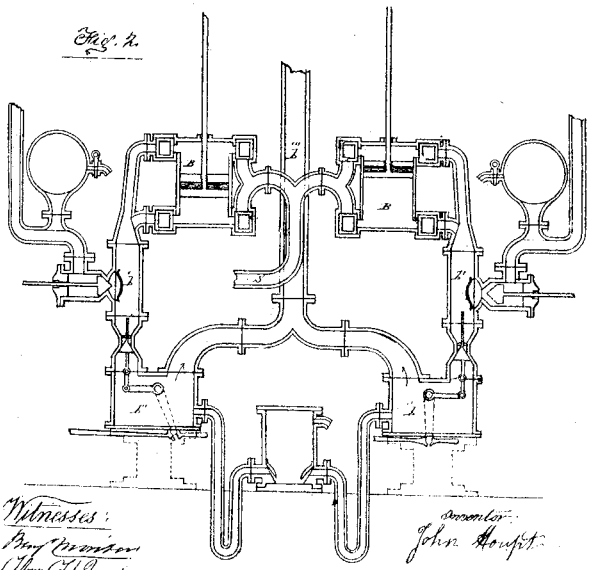
Witnesses:
Geo. Snowden
Chas. H. Morrison

Inventor — John Houpt

Sheet. 2.

John Houpt's impvt in Steam Engines.

Fig. 2.



Witnesses:
Ben Thomson
Wm. H. Morison

Inventor:
John Houpt

General Description.

The high-pressure steam-cylinder A communicates, by its exhaust-pipe a', directly with the steam-chamber of the superheater G, and this steam-chamber communicates, through the branched pipe S, with the pair of low-pressure steam-cylinders B B.

The small furnace-flue a'' of the superheater G opens into the main or boiler-furnace chimney C, and the pipe D for supplying hot air to the said superheater extends upward from any suitable air-forcer or blower, not shown, outside of the chimney, and, entering the latter at a sufficient height, descends in large spiral coils down through the flue of the chimney C to a point at a short distance above the furnace, where it passes out through the side of the chimney, and at D'' enters and opens downward into the steam-chamber of the superheater G.

The exhaust-pipe a' is provided with an inward-opening valve, 3, to provide against the possibility of a collapse of the steam-chamber of the superheater G on stopping off the heat for some length of time, and also with an outward-opening valve, 4, to limit the degree of pressure in the said steam-chamber.

The general construction and arrangement of the steam-cylinder A and superheater G are the same as are shown in Fig. 1 and described in the specification of my said allowed application of the 19th of October, 1870, with the important exception that the self-clearing jet-condenser and its necessary adjuncts, between the said steam-cylinder of high pressure and the superheater therein shown, are, in the present application, entirely dispensed with, the exhaust steam of the cylinder A passing directly into the superheater G, as herein shown in Fig. 1.

The superheater G, as herein shown in Fig. 1, I have made of the most simple construction; but for a practically-working engine I would prefer something of the tubular form, as being more effective for the purpose.

The low-pressure cylinders B B are in communication with the same steam-supplying pipe S, and are intended to operate together to give steady rotary motion to the same main shaft of an engine, by means of cranks arranged at a right angle to each other, not shown, and thus, of course, render a ponderous fly-wheel unnecessary.

Each one of the pair of low-pressure cylinders B B is provided with its respective self-clearing jet-condenser b', and the necessary hot wells b'' b'', and escape-pipe b''' for the waste steam, substantially as represented in Fig. 2, and as described and set forth in my said allowed application; and therefore any further description in relation to the low-pressure cylinders herein set forth need not here be given, except to state that it is my inten-

tion to attach to the one superheater G as many of such pairs of low-pressure cylinders as the power or capacity of the said superheater G may be competent to operate.

Operation.

Suppose the high-pressure steam-cylinder A to be working at a pressure of fifty pounds of steam to the square inch, the exhaust entering the superheater G will expand in proportion to the capacity of the latter, producing, say, a pressure therein of five pounds to the square inch, the outlet-valve 4 being weighted to open after that degree of pressure is obtained. The low-pressure cylinders B B can then be operated by a pressure of five pounds to the square inch of their respective pistons, a vacuum in their respective condensers b' b' being produced, as described in my said allowed application, provided the pressure of the steam in the said superheater G be kept up to five pounds to the square inch.

This working power in the superheater G will be kept up by means of the small special furnace o beneath the same, in connection with the surrounding flue-space o', which opens into the main chimney C through the flue-pipe o'', aided, if desirable, by means of the air-heating pipe D, the coils of which, being kept heated by the hot draught of the main chimney C, heat the air which is to be driven through them by means of any suitable blower attached to the air-receiving end of the said pipe D, and the consumption of fuel in the special furnace o is thus greatly diminished.

It will be understood that the working steam-pressure in the cylinder A and in the superheater G may be increased proportionately to, say, one hundred pounds or more in A, and ten pounds or more in G; and that for producing such a high pressure in A a small superheater, of sufficient strength, heated by a special furnace, may be attached between the usual steam-generator and the cylinder A in the usual well-known manner, so that the steam from the generator may be sufficiently superheated for the purpose, and thus the extra cost of a sufficiently-strong steam-generator or boiler for the purpose avoided.

Claim.

I claim as my invention—

In combination with the superheater G, the air-heating and supplying-pipe D, operating to aid in increasing the heat and quantity of the steam in the superheater G, substantially as and for the purpose hereinbefore set forth.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

Impt in Steam Engines:
John Houpt.

PATENTED JUN 27 1871

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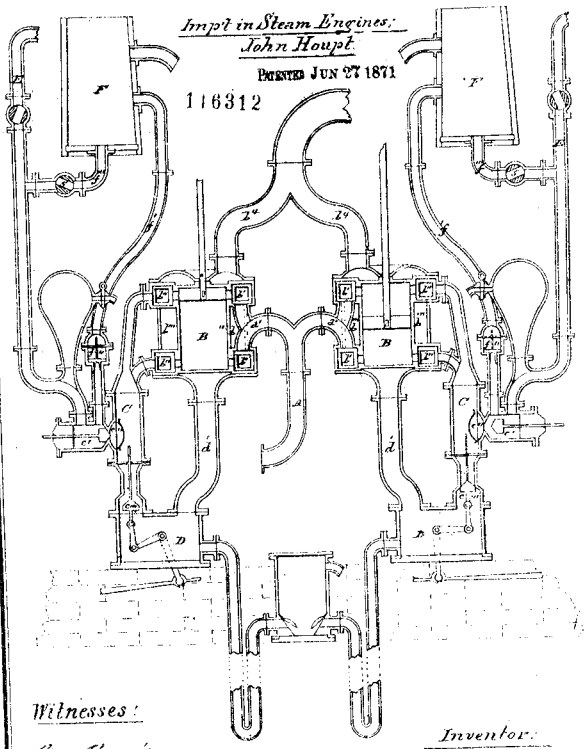


Witnesses:

Wm Thornton

Wm H. Morson

Inventor:

John Houpt

No. 10.

Specification forming part of Letters Patent No. 116,312, dated June 27, 1871.

IMPROVEMENT IN STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Steam-Engines, of which the following is a specification:

My improvements relate to a mode of maintaining a cool condition of the water required for the jet-condenser of a steam-engine located where water is scarce or dear; and also to the utilization of the exhaust steam, which has hitherto been generally allowed to escape directly from the steam-cylinder (or from the self-clearing jet-condenser, patented to me April 19, 1870, and reissued May 31, 1870) to the furnace-chimney or to the open air, by causing the said exhaust steam to serve as a preserver of the heat of the said cylinder sufficiently to prevent any condensation of the steam therein while the engine is in operation.

The first part of my invention consists in the arrangement of an elevated water-vessel in combination with the main water-supply pipe and the jet-valve chamber, in such a manner that, as the jet-valve closes, the momentum of the moving supply-water will cause the water in the valve-chamber to ascend upward toward the elevated vessel, from whence it may again enter the main supply-pipe by gravitation; the object of this part of my invention being to keep the water in the jet-valve chamber constantly changing, and thus to prevent its becoming warmed by the heat of the said condenser. The second part of my invention consists in the arrangement of a steam-jacket chamber around the steam-cylinder of an engine, in combination with a pipe communicating with the exhaust-steam pipe of the cylinder, or of the hot well of a condenser, and with a pipe leading either into the chimney of the furnace or into the open air; the object of this part of my invention being to preserve the heat of the cylinder by means of the usual waste steam.

The drawing represents two distinct steam-cylinders operated by steam from the same steam-pipe. The said steam-pipe A is intended to be extended into communication with the usual steam-boiler or generator, or into communication with a superheater, and is branched at a' a', so as to communicate with the respective parts b' b' of the two distinct steam-cylinders B B, the exhausts b'' b'' of which latter communicate with respective jet-condensers c c, each of which operate by dividing the exhaust steam into two portions, condensing one portion to produce the vacuum before the piston, and discharging the other portion into the hot well D below, as described in the specification of the said Letters Patent hereinbefore referred to.

In my present invention, an open steam-pipe, d', leads upward from each of the hot wells D D into a space, b''', formed by a steam-jacket which incloses the steam-cylinder, and from this space an escape-pipe, b^4, conveys the steam to the usual chimney of the furnace or to the open air. The valve-chambers c' c' of the jet-sprays c'' c'' are each supplied with cold water through a pipe, E, from an elevated reservoir, not shown, and communicating with the said valve-chamber and with a water-vessel, F, above it, is a pipe, f'', which is fitted with a drop-valve, f''', that opens upward, while another pipe, f'''', fitted with an adjustable valve, 5, forms a communication between the water-vessel F and the pipe E.

The pistons of the two cylinders B B are intended to move, in part, alternately in the same directions, and immediately after the first puff of the exhaust steam has passed through and thus cleared the condenser C of any air and water therein the valve c''' closes, and immediately afterward the spray of cold water enters and condenses the imprisoned portion of the steam and produces the vacuum required, as described in the Letters Patent hereinbefore referred to. The valve of the spray-pipe, closing suddenly, causes the water in the valve-chamber c' to rise, from its momentum, upward through the valve f''' in the pipe f'', toward the vessel F, and thus prevents it from becoming warmed by contact with the condenser C, and consequently can be repeatedly used by flowing into the valve-chamber c' through the pipe E. The first portion of the steam which is projected into the hot well D at every stroke of the piston passes upward into the space b''' which incloses the steam-cylinder, imparts heat to the latter, and eventually escapes into the usual furnace-chimney or into the open air.

I claim as my invention—

1. The elevated vessel F and pipe f'', in combination with the valve-chamber c' and reservoir-pipe E, the said parts being con-

structed and arranged to operate substantially as and for the purpose hereinbefore set forth.

2. In combination with the steam-heating chamber *b'''* around the steam-cylinder B of an engine, a pipe, *d'*, which forms a communication between the said chamber and the exhaust-steam pipe of either a steam-cylinder, a superheater, or the hot well of a condenser, substantially as described, for the purpose of keeping up the heat of said steam-cylinder by the waste steam of the engine, as described.

JOHN HOUPT.

Witnesses:
BENJ. MORISON,
WM. H. MORISON.

No. 11.

Specification forming part of Letters Patent No. 124,359, dated March 5, 1872.

IMPROVEMENT IN EXHAUST STEAM-ENGINES AND FORCE-PUMPS.

Specification describing a certain Improved Exhaust Steam-Engine and Force-Pump, invented by JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania.

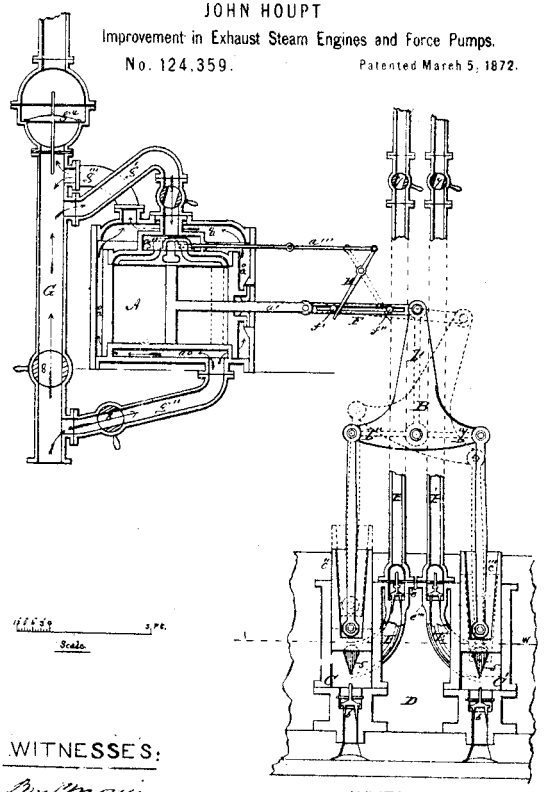
My invention relates to the utilization of the exhaust or waste steam of any high-pressure steam-cylinder; of any low-pressure steam-cylinder having my exhaust-steam dividing and self-clearing jet-condenser (patent reissued May 31, 1870) attached; or from any other convenient source of waste steam that may be at hand, by causing the said steam to operate a comparatively large cylinder of a low-pressure steam-engine (either with or without a crank and fly-wheel attached), by the condensation alone of said steam in the said low-pressure cylinder, at a pressure generally not much greater than the pressure of the atmosphere, and sometimes even a little below the pressure of the atmosphere, to drive a double-acting force-pump, constructed and arranged substantially as hereinafter described and set forth, for the purpose of supplying water to the steam-boiler or generator, and for other purposes.

Referring to the accompanying drawing, A is the low-pressure steam-cylinder, to be operated by condensation alone (condenser not shown); G, the steam-pipe to supply the said low-pressure steam-cylinder A with the exhaust or waste steam, as aforesaid. The said pipe G communicates with the low-pressure cylinder A by means of a branch-pipe, g', and also with a steam-jacket space, a^{0}, around the said cylinder A, by means of an inlet branch-pipe, g'', and an outlet branch-pipe, g''', the said exhaust-pipe G being provided with a pressure-regulating valve, g^{4}, located above the said branch-pipes g' g'' g'''. B is an inverted T-lever supported upon its fulcrum, with its upright or longer arm b' articulated to the piston-rod a' of the cylinder A by an intervening bar, F, and its two shorter arms, b'' b''', articulated, respectively, to the two plunger-rods of the plungers c'' c''' of the two like upright cylinders C C′ of the double-acting force-pump, which is firmly secured and supported in a well or water-tank, D. The

JOHN HOUPT

Improvement in Exhaust Steam Engines and Force Pumps.

No. 124,359. Patented March 5, 1872.



Scale.

WITNESSES:

Ben Morrison

Wm. H. Morrison.

INVENTOR:

John Houpt

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lower ends or base of the pump-cylinders C C′ are respectively provided with inlet-valves 6 6, and at a short distance above their bases the cylinders have respective branch conduits, E E′, provided with outlet-valves e'' e'''. Each of the conduit-pipes E E′ communicates with its respective cylinder C or C′ through a triangular or wedge-shaped opening, 5, which has its base upward, so that, as either of the respective plungers c'' or c''', which has a range limited to the length of the opening, passes downward over the same, the area of the said opening will be diminished gradually until closed, and, consequently, there cannot occur any jar or shock from the plunger in reaching its lowest limit in forcing the water upward through the conduit-pipe. Each of the pipes E E′ has an adjustable valve or cock, 7, whereby the passage of the water through the pipe can be regulated in quantity, so as to control the speed of the piston of the steam-cylinder A. The supply-steam may be simultaneously conveyed through the pipes G g' g'' into both the steam-chest a'' of the cylinder A and the steam-jacket space a^0, which surrounds the said cylinder A, an outlet pipe, g''', allowing the steam inclosed by the jacket to communicate freely with the steam in the upper part of the main supply-pipe G, the object of the said steam-jacket and the branch-pipes g'' and g''' being to keep up the temperature of the cylinder A by the passage of exhaust steam through the space a^0, substantially in the manner described in the patent granted to me dated the 27th day of June, 1871. At a short distance above the branch-pipe g''' the main pipe G is provided with an upwardly-opening valve, g^4, which is intended to be adjusted to open from any slight pressure (above that of the atmosphere) of the steam in the said pipe G, because the piston of the low-pressure cylinder A is not intended to be moved by any pressure of said steam above that of the atmosphere (because it would, to the same degree, lessen the effective power of the high-pressure engine), but simply by a vacuum produced from the condensation of the steam in the cylinder A, before the piston. The exhaust steam in the pipe G enters the cylinder and follows the piston as it moves in the vacuum on its opposite side, and thus giving the required reciprocating motion to the same, to operate the plungers c'' c''' of the force-pump, the branch-pipe g' conducting steam into the valve-chest a'', from which it is alternately admitted into both ends of the cylinder A. The main pipe G and its branch g' are each provided with a stop-cock or cut-off valve, 8, whereby either the whole or a portion of the supply-steam may be caused or permitted to pass through the steam-jacket space a^0 before it enters the steam-chest a'', as may be found desirable, at any time during the operation of the engine. The valve-rod a''' of the cylinder A is articulated to one end of a lever, H (of the first order), and the other end of

said lever is operated by two adjustable pins or stops, f' f''', in the bar F, which alternately come in contact with the end of the lever H as the piston-rod a' moves outward and inward, and thus vibrate the lever H on its fulcrum and operate the steam-chest valve of the cylinder A. The surface of the water in the tank D is to be kept up to the dotted line V W, for the purpose of insuring a full supply beneath the plungers. Now, if the cylinder A is operating with a good vacuum and with a full stroke, the plungers of the force-pump will alternately descend to the lowest point of their respective wedge-shaped openings 5 5, and no further, and, consequently, stop the passage of any of the water from beneath the plungers, but in such a gradual manner that there will not be any objectional hammering or jar produced; but, as it is not absolutely required that this exhaust steam-engine should work at a full stroke of the piston, the adjustable stops f' f'' in the bar F must be so adjusted as to move the lever H, and consequently the slide valve in the steam-chest a'', within such limits as may be found desirable to prevent any excessive strain upon the pump.

I claim as my invention—

1. The combination of the low-pressure cylinder A and its surrounding steam-jacket space a^0 with the steam-conducting pipes G g' g'' g''' and their respective valves g^4 8 8, in communication with the exhaust steam of any steam-engine, the said mechanical devices being constructed and arranged to operate the low-pressure cylinder A by the pressure of the atmosphere upon one side of its piston, forcing the latter into the vacuum produced by the condensation of the steam at its opposite side within the cylinder, substantially in the manner hereinbefore set forth.

2. The bar F, which is articulated to the piston-rod a' of the low-pressure cylinder A and to the upright arm b' of the pump-lever B, as set forth, in combination with the adjustable stops f' f''' and with the lever H, which is articulated to the valve-rod a''' of said cylinder, as set forth, the said mechanical devices being arranged to operate the valve of the said steam-cylinder A, and also to operate the lever B of the pump, substantially as and for the purposes described.

3. In combination with the pump-lever B, actuated by the low-pressure steam-cylinder A, as described, the plungers c'' c''' in the respective cylinders C C′, the respective wedge-shaped openings 5 5 in said cylinders, and the respective adjustable gauge-cocks 7 7 in the exit-pipes e'' e''', arranged to operate together upon the water of the tank D, substantially as and for the purpose hereinbefore set forth.

JOHN HOUPT.

Witnesses:

SAMUEL MANN,
MADISON SHAFFER.

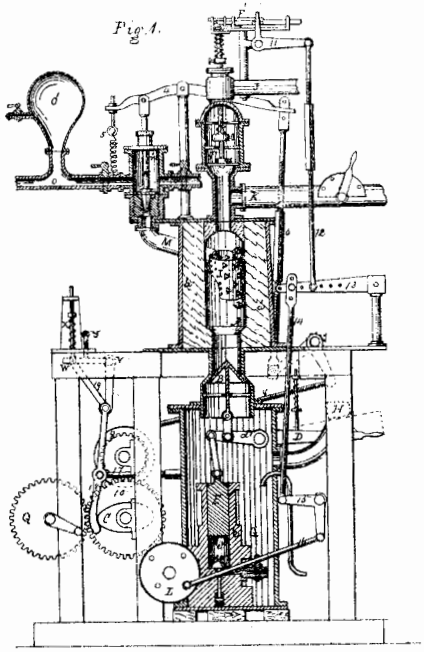
2 Sheets--Sheet 1.

J. HOUPT.

Improvement in Jet-Condensers for Steam-Engines.

No. 131,351. Patented Sep. 17, 1872.

Fig. 1.



WITNESSES.

Benj Morison.

Wm H Morison.

INVENTOR.

John Houpt.

No. 12.

Specification forming part of Letters Patent No. 131,351, dated September 17, 1872.

IMPROVEMENT IN JET-CONDENSERS FOR STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Jet-Condensers for Steam-Engines, of which the following is a specification:

My said improvements relate to the self-clearing jet-condenser, for which Letters Patent, dated April 19, 1870, were granted to me, and reissued May 31, and numbered 3999. The first part of my invention relates to the operation of the bottom valve of the condenser whereby it closes by a positive motion to allow the vacuum to be produced, and opens freely on the entrance of the next puff of steam from the cylinder; the object of this part of my invention being to cause the double functions of the said condenser—*i.e.*, its clearing condensing functions—to be effected more perfectly. Another part of my invention relates to a spring-valve in a case communicating with the upper end of the condenser, in combination with a sliding stop, in such a manner that the said valve will be held firmly closed while the first puff of steam from the cylinder of the engine passes through the condenser, and will then be left free to open from any excess of pressure of the remaining exhaust steam in the condenser above that of the atmosphere; the object of this part of my invention being to retain no more steam for condensation in the condenser than will prevent the entrance of atmospheric air. Another part of my invention relates to a water-tank and plunger in communication with each other through suitable openings, and a lever and an elastic stop, in combination with the bottom valve of the condenser, in such a manner that the cam causes the lever to close the bottom valve of the condenser by a positive motion, and thus leaves it to be afterward freely opened by the first puff of exhaust steam; the

object of this part of my invention being to produce the requisite movements of the said valve in a smooth and steady manner, or without any jarring or irregularity. Another part of my invention relates to a perforated curved plate of sheet metal, secured by one of its vertical edges to the inner side of the condenser, in such a manner as to cause a tangential entrance of the jet of cold water to be turned or deflected in a circular direction around in the condenser, and also at the same time to permit portions of the water to spurt through the perforations in the plate; the object of this part of my invention being to facilitate the condensation of the steam confined within the said condenser, by a more perfect or thorough distribution of the cold water. Another part of my invention relates to the mode of preventing the water in the jet-conducting pipe from becoming warmed before it enters the condenser.

Figure 1 is a vertical section of my improved condenser and its adjunctive devices for operating the same, embodying my invention. Fig. 2 is an elevation, showing the rear side of the parts shown in Fig. 1.

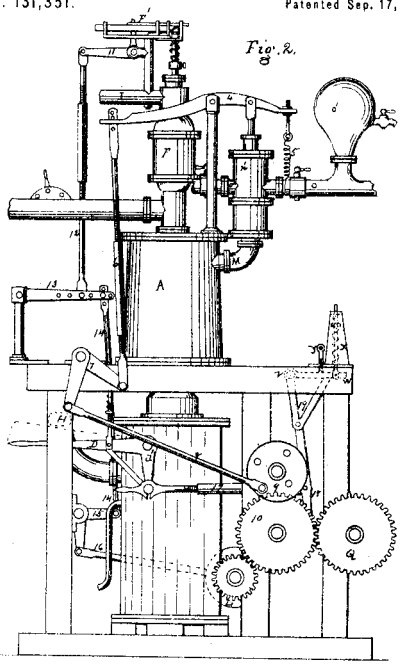
A is the condenser; B, the bottom valve of the condenser; C, a cam which gives motion to the lever D and plunger E, whereby the movements of the valve B are regulated; F is the spring-valve and case whereby the pressure of the steam in the condenser is controlled, and the entrance of atmospheric air prevented; F′, the sliding bolt for holding the valve F firmly down while the first puff of steam is passing through the condenser; G is the water-tank in which the plunger E operates; H, the elastic stop (see dotted lines), whereby a rebound is given to the rising arm of the lever D in starting the upward movement of the valve B; and I, the curved perforated deflecting plate in the condenser A. The outer sides or walls of the condenser A are made of iron, and the inner side thereof lined with a thick layer of wood, a', or its equivalent poor conductor of heat or cold. The bottom valve B is conical and opens outward and downward; it is articulated to lever D, the fulcrum of which latter is at d'. The shorter end of lever D is articulated to the plunger E, which latter is adapted to slide up and down within a case, e', which has V-openings e'', which communicate with the water-tank G; and has also a bottom valve, e''', which permits the water to enter from the tank G when the plunger E is being started upward, and the V-openings allowing the water to pass out as the plunger sinks downward, until the said V-openings are gradually closed. When the valve B is blown open by the first puff of the exhaust steam the plunger E descends in the case e' until the V-openings are closed, thus checking it gradually, and at the same time the long arm of lever D strikes against the elastic bearing H, and, rebounding

2 Sheets--Sheet 2.

J. HOUPT.

Improvement in Jet-Condensers for Steam-Engines.

No. 131,351. Patented Sep. 17, 1872.



WITNESSES.

Benj. Morison.
Wm. H. Morison.

INVENTOR.

John Houpt.

gives the upward start to the plunger, and the further depression of the said arm of the lever D and the consequent elevation of the shorter arm, by the positive action of the cam C upon the lever, closes the valve B. (See Fig. 1.) The spring-valve F and its case are secured so as to communicate with the upper end of the condenser A, at a short distance above the opening of the exhaust steam-pipe K. The said valve is kept closed by a spring pressure which is but little in excess of that of the atmosphere, and consequently will open and allow steam to pass out of the condenser A into and through the exit-pipe J, when the pressure of the steam in the condenser A is but a little greater than the pressure of the atmosphere; and, therefore, during the entrance of the first puff of exhaust steam to clear the condenser of air and water through the bottom valve, the spring-valve F would open and prevent the required downward passage of said first puff, if the said spring-valve was not permanently held down in the meantime. To effect this the sliding bolt F′ is provided and operated by a crank, L, and articulating connecting-rods, so that before the first puff of steam enters the condenser A the sliding bolt F is pushed over the upper end of the spindle or stem of the valve F′, and thus holds the valve permanently down upon the condenser A and prevents the escape of any steam through it until the bottom valve B is closed, when instantly the bolt F′ is withdrawn, and so much of the second portion of the steam retained in the condenser by the said valve F as may be found sufficient to preclude the air and produce the vacuum required. The pipe J is intended to enter the furnace-chimney and have a few spiral turns therein to prevent the entrance of cold air into the pipe, and thus prevent any condensation of the steam therein. The plunger E slides freely up and down in a case, e', which is fixed in a vertical position on the bottom of the water-tank G. A communication between the tank and the case e' is afforded by V-shaped openings e'' (two of which only are shown), and also through a valve, e''', in the bottom of the case e', so that, as the plunger moves downward in the cylinder e', it forces the water out through the openings e''; which latter becoming gradually smaller, the plunger consequently descends more and more slowly until it is stopped by closing the said openings; and at the same instant the longer arm of the lever D, to which the plunger E is articulated, strikes against the under side of the elastic stop H, and, rebounding, starts the plunger E and consequently the valve B upward; and the valve B then closing by a positive motion derived from the cam C, the water entering through the gauge-cock and the valve e''' and following the rising plunger, prevents the occurrence of any vacuum beneath the plunger until the latter uncovers the V-openings and allows the water to enter through them

also. The jet-water deflecting-plate I is punched with numerous triangular holes, made by cutting through two sides and bending the thus divided metal in an inward direction, so as to afford stops whereby the impinging water will be deflected outward through the said curved plate, and then the said plate secured permanently by one of its edges to the inner side of the condenser A, and finally curved in an involute form, leaving an increasing space between for the jet-water to pass freely through the numerous perforations as it is driven by the force of the jet (which enters through the condenser tangentially) over the inner side of the said deflector, and thus distributed in the most favorable manner for causing a sudden condensation of the steam and the production of the vacuum required. The injecting-pipe M and its valve N communicate with the valve-chamber n' and the water-supplying pipe O, which latter is intended to communicate with any sufficiently-elevated reservoir to force the water in a rapidly-moving jet into the condenser at the moment when the said valve N is raised for the purpose, an air-chamber, O′, being in communication with the pipe O at a short distance in advance of the valve N, which serves as a cushion to receive the reacting force of the current consequent upon the sudden closing of the conical valve N, and also by reaction to give increased force to the current produced by the next opening of the said valve. For the purpose of preventing the valve-chamber n' and that part of the pipe M which is in immediate communication therewith from becoming warmed by the steam as it passes into the condenser A, a small pipe, O″, fitted with a suitable regulating-cock, is to be adjusted to allow a small portion of the water in the said pipe M and valve-chamber n' to flow steadily out, and thus provide for a constant accession of the cold water to the pipe M and valve-chamber n'. The valve N is operated immediately and alternately by the lever 4 and spring 5, which are connected to the main driving-wheel Q by the intervening adjustable rod 6, lever 7, rod 8, crank-wheel 9, and gear-wheel 10. The sliding bolt F′ is operated immediately by the lever 11, which is connected to the said main driving-wheel Q by the intervening adjustable rod 12, lever 13, rod 14, lever 15, rod 16, crank-wheel L, and gear-wheel 10. The valve B of the condenser A is operated mainly by the lever D, in connection with the plunger E in the water-tank G and the elastic bearing H′, the said lever D being put in periodical motion through the arm d', rod 17, swing-bar 18, and cam C on the shaft of the gear-wheel 10. The swing-bar 18 is articulated to the lower corner of a triangular piece, 19, the corner V of which is pivoted to a stationary part of the frame of the machine, while the corner W is suspended from a spring, X, the tension of which latter is adjusted by means of a screw-

stem, Y, which bears upon the upper edge of the piece 19 at any point near the said spring X. The object of this device is to allow the upper end of the swing-bar 18 to give or move inward toward the cam side, when the machine is driven with unusual rapidity for the purpose of relieving the bar 18 of the rigidity which the impact of the cam O would otherwise encounter under an unusual speed.

I claim as my invention—

1. The devices consisting of the lever D, plunger E, water-tank G, and elastic bearing H, or their equivalents, in combination with the valve B, the said devices being arranged to operate together, substantially as hereinbefore described, for the purpose of periodically closing the said valve B by a positive motion, and also allowing it to be periodically opened by the first puff of the exhaust steam entering the condenser, substantially as hereinbefore set forth.

2. The spring-valve F, in combination with the upper end of the condenser A, substantially as and for the purpose hereinbefore set forth.

3. The perforated curved deflecting plate I within the condenser A, in combination with the tangential jet-opening therein, the said parts being constructed and arranged to operate together substantially as and for the purpose hereinbefore set forth.

JOHN HOUPT.

Witnesses:
BENJ. MORISON,
WM. H. MORISON.

No. 13.

Specification forming part of Letters Patent No. 136,917, dated March 18, 1873.

IMPROVEMENT IN CONDENSING APPARATUS FOR STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented a certain Compound Condensing Apparatus for Marine Steam-Engines, of which the following is a specification:

My invention relates to marine steam-engines generally, and especially to the marine steam-engine described in the Letters Patent No. 109,616, granted to me for "improvement in steam-generators," dated November 29, 1870. The first part of my invention consists in the peculiar construction and arrangement of a comparatively large surface-cooler, in combination with the exhaust-pipe of the steam-cylinder (or with the primary jet-condenser of the same) and the secondary surface-condenser of a marine steam-engine, as hereinafter set forth; the object of this part of my invention being to enable me to greatly reduce the size or capacity, and consequently the cost of construction, of the secondary and tertiary condensers when the latter are used in connection with said marine engines. Another part of my invention consists in the peculiar construction and arrangement of a tertiary condenser, as hereinafter set forth, in combination with the secondary surface-condenser of a marine steam-engine; the object of this part of my invention being the production of a perfect condensation of all the steam or vapor that may pass as such from the secondary condenser with which the said tertiary condenser communicates, and thus economize the fresh water required for keeping up the supply for the steam generators or boilers of the engine.

Figure 1 is a vertical section of the condensing portion of a marine steam-engine embodying my invention. Fig. 2 represents that portion of a marine steam-engine having the "conjoined steam-cylinder and primary condenser" patented to me

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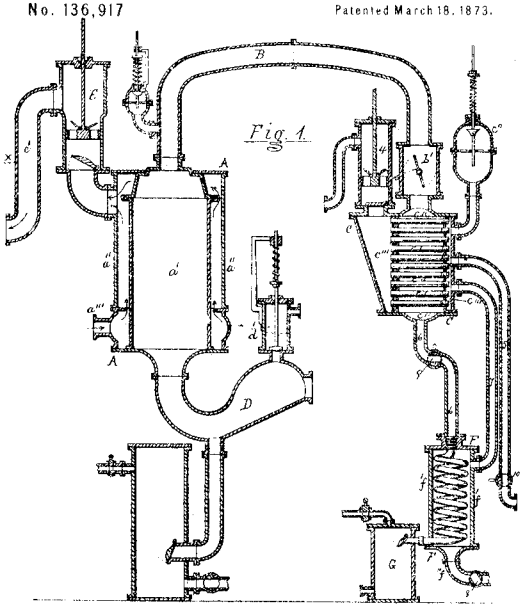
2 Sheets--Sheet 1.

J. HOUPT.

Condensing Apparatus for Steam-Engines.

No. 136,917 Patented March 18, 1873.



WITNESSES:

Benj. Newton

Wm. H. Morrison

INVENTOR:

John Houpt

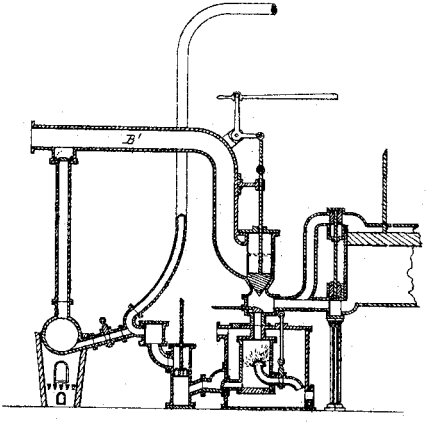
2 Sheets--Sheet 2.

J. HOUPT.

Condensing Apparatus for Steam-Engines.

No. 136,917. Patented March 18, 1873.

Fig. 2.



WITNESSES

Benj Manson.
Ulr H. Morrison

INVENTOR.

John Houpt

November 29, 1870, before named herein. The object of presenting this figure is to show the point of connection between my present invention and the conjoined steam-cylinder and primary condenser of a marine steam-engine.

The surface-cooler is a large steam-chamber, A A, the upper end of which communicates, through a long and capacious pipe, B, with the upper end of the secondary surface-condenser C C, while the lower end of said cooler communicates through a pipe, D, with the conjoined primary condenser and exhaust-pipe, or either of them, of a marine steam-engine. The said cooler A A consists of a steam-chamber proper, a', surrounded by a cold-water case, a'', through which, by the action of a circulating-pump, E, cold sea-water is drawn into the lower part of the said case a'' (by means of a pipe, a''', which is intended to be fixed water-tight through the side of the ship), and forced out (as it is drawn from the upper part of the said cooler) through a pipe, e', leading from the pump E through the side of the ship, so as to discharge the water at a point below the surface of the sea, the dotted line x indicating the surface-line of the sea. By thus discharging the current of cooling-water below the surface of the sea the power required to lift the water and keep up a constant flow upward through the cooler A is but trifling. Attached to the pipe D there is a safety-valve, d', adapted to open from any extraordinary pressure of the exhaust steam entering the pipe D. At the end of the pipe B, near its point of connection with the secondary or surface condenser C C, there is a valve, b', connected by its crank-shaft to any suitable moving part of the engine, so that it will be nearly closed during the first part of each puff of the exhaust steam entering the cooler A, and gradually opened immediately afterward. The object of this valve b' and of the large extent and capacity of the pipe B is, first, to prevent the steam from being driven, by the force of said puffs, down through the secondary condenser C C, or further, and thus prevent its condensation; and, second, to allow the exhaust steam ample room to expand, and cause a steady and nearly uniform flow of steam from the cooler into the condenser C C. The secondary condenser C C is of the ordinary construction, excepting that it is smaller, and has, comparatively, a much less number of the cooling-pipes, set further apart from each other—an advantage derived from the presence of the surface-cooler A A—whereby the exhaust steam passing through the latter is reduced in temperature and pressure before it enters the condenser. The water- or cooling-pipes c' c', open at both ends, project through a steam-chamber, c'', so as to communicate freely with the whole interior of an inclosing water chamber or case, c''', which is kept fully supplied with cold sea-water by means of a circulating-pump, F,

which draws the said cold water (through a pipe, 5, which communicates with the sea through the side of the ship) into the condenser and forces it overboard. A valve-chamber, c^6, provided with a spring-valve, communicates with the upper part of the interior of the water-case c''', and serves as an air-chamber and relief-valve in preventing any improper strain upon the joints of the said condenser by the action of the circulating-pump 4. The steam-conducting pipe B communicates with the interior of the steam-chamber c'' through the upper end of the latter, and the lower end of said steam-chamber c'' opens into a pipe, 6, which enters a cold-water case, f' f', of a tertiary condenser, F F, and coils spirally around in the latter like the worm of a still, and opens on the outer side of the lower end of said water-case into the hot well G, from which the boilers of the engine are to be supplied while the latter is in operation. The bottom end of the condenser F communicates with a pipe, f'', which extends through the side of the ship (not shown) into the sea, from whence the required cold water is drawn by the action of the circulating-pump 4, upward through the pipe 7, which forms the communication between the two cold-water cases f' and c''' of the respective condensers C and F. The pipe F'' has an adjustable cock, 8, whereby the current of water passing upward through the case f' is controlled or regulated as to quantity at the pleasure of the engineer. The pipe 6 has an adjustable cock, 9, whereby the engineer can, at pleasure, prevent an excess of steam from getting down into the tertiary condenser F and "blowing out," instead of being condensed therein as required. There is also an adjustable cock, 10, in the water-pipe 5, which mainly supplies the condenser C C, so that the current of water passing through the said pipe can be regulated as to quantity at the pleasure of the engineer, and the cold water for either or both condensers C and F be acquired through either or both said pipes 5 and f'', as the requirements of both or either may render proper.

It will be evident that the cooler A A will greatly reduce the temperature of the exhaust steam entering it, and that in connection with the long capacious pipe B the said steam will be allowed to expand, and by the action of the valve b' be prevented from entering the secondary condenser in puffs, and acting together that the cooled and expanded steam will enter the said condenser in a steady or uniform and continuous manner. Another advantage derived, which is of importance in marine steamers especially, is that the extended pipe B permits the condensers to be located at any distant point in the ship from the steam-cylinder. It will also be evident that, during the operation of a marine steam-engine having the tertiary condenser F arranged and attached as described in relation to the secondary or surface con-

denser C C, any steam which may as such pass down through the pipe 6 will be most certainly condensed in the spiral coils within the cold-water case f', and pass out as fresh water into the hot well G, from which the boilers of the engine are to be supplied during the operation of the latter; and that the great reduction in the size and in the number of the pipes of the secondary condenser (permitted by the intervention of cooler and expander A A between the said condenser and the steam-cylinder of the engine) will proportionately reduce the cost of the original construction of the surface-condensers for marine steam-engines; and also that the reduced size and more simple construction of the tertiary condenser F F will render it less costly and more durable than the tertiary condenser described in my said Letters Patent, and shown by Fig. 3 of the drawing therein.

I claim as my invention—

1. The surface-cooler A A, with its circulating-pump E, safety-valve d', and pipe B, the said parts being constructed, arranged, and combined to operate substantially as and for the purpose hereinbefore set forth and described.

2. The tertiary condenser F F, with the pipes 6, 7, and f'', in combination with the secondary surface-condenser C C, or its equivalent surface-condenser, the said condensers being constructed and arranged to operate together substantially as and for the purpose hereinbefore described and set forth.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

No. 14.

Specification forming part of Letters Patent No. 136,918, dated March 18, 1873.

IMPROVEMENT IN JET-CONDENSERS FOR STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain further Improvements in the Self-Clearing Jet-Condenser for Steam-Engines, of which the following is a specification:

My invention especially relates to the construction and arrangement of certain improved devices, hereinafter described and set forth, for operating the valves of the self-clearing jet-condenser for which Letters Patent No. 131,354 were granted to me, dated September 17, 1872, the object of my present invention being the production and application of more simple, inexpensive, effective, and accurately-working devices for operating the valves of said condenser.

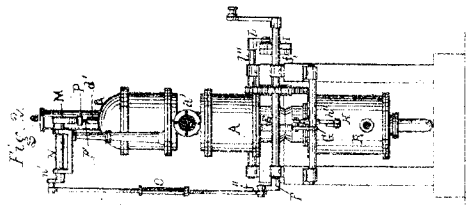
Figure 1 is a vertical sectional side view of the self-clearing jet-condenser embodying my present invention. Fig. 2 is an end elevation of the same, presenting in front the main driving-shaft of the condenser-valves.

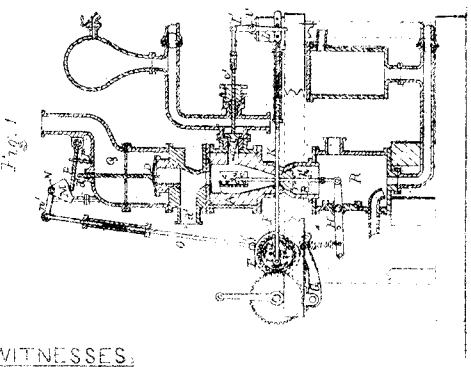
The bottom valve B, water-jet valve C, and top valve D are constructed and arranged to be operated periodically in relation to the condensing-chamber A, substantially as described in my said patent No. 131,354; but the devices for giving the required motions to said valves are quite different in construction, arrangement, and application from those set forth and described in said patent. The closing of valve B is effected by means of a cam, E, which is adjustably secured on a horizontally-arranged shaft, F, so that the full or convex edge of said cam will, during the rotary motion of the shaft, periodically depress the swinging end of a horizontally-arranged arm, G, which is adjustably connected to the vertical stem of said valve B, and to arm G by means of a horizontally-arranged lever, H, and connecting rods and links *h′ h″*, thus closing said valve by a positive motion. The opening

J. HOUPT.

Jet Condensers for Steam-Engines.

No 136 918. Patented March 18, 1873.





WITNESSES:

Jno. C. Morison

Wm. H. Morison.

INVENTOR:

John Houpt

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of said valve B is produced by its gravitation in connection with that of the water of condensation in the condensing-chamber A and the pressure or impetus of the first portion of the puff of steam entering the chamber, when, by the continual rotary motion of the shaft F, the straight or recessed edge of the cam E has passed over the depressed end of the arm G, and thus permits the latter to rise, and consequently allow the valve B to open downward, and let the water and air contained in the condensing-chamber A pass out with the first portion of the puff of steam entering the said chamber. The water-jet valve C is operated by means of a wrist-pin fixed in the adjustable disk-plate I (which is secured to a face-plate, f'') by means of slots and set-screws i' i' i', which face-plate is permanently fixed on the front end of shaft F in the usual well-known manner. An adjustable horizontally-arranged rod, K, and two vertically-arranged arms, L L′, fixed in opposite directions (one upward and the other downward) on the respective ends of a rock-shaft, l'', connect the said wrist-pin of the plate I with the said valve C by a joint, c', and thus together alternately open and close the said water-jet valve by positive motions during the rotary motion of the shaft F. The top valve D is periodically held down in its closed position upon the condensing-chamber A by means of a cam, M, which is fixed upon one end of a rock-shaft, N, the crank n' of which is operated by a crank, f''', on the shaft F, through an adjustable connecting-rod, O, the said cam M being in contact with the upper side of a lever, P, which is kept in contact with the said cam M by means of a small spiral spring, p', pressing continually upward against said lever P. As the cam is vibrated it periodically presses the lever P downward upon the stem d' of the valve D, and thus holds the valve firmly closed upon the condensing-chamber A when the latter requires to be closed, and afterward rising allows the said valve to be opened by any excess of pressure of steam above that of the atmosphere, which may be in the condensing-chamber A, the said escaping steam passing to the furnace-chimney (not shown) through the escape-chamber and pipe Q.

Explaining the operation of my invention, I will suppose the piston of a vertical steam-cylinder to be near the top of the cylinder, and that the high-pressure exhaust steam has been discharged from beneath the piston through the outlet-valves B and D of the condensing-chamber A, together with the water of condensation and accumulated air therein, as will hereinafter be explained. The cold-water jet-valve C has just been opened, as represented in Fig. 1, and throws a copious jet of cold water into the condensing-chamber A, and thus produces the desired vacuum beneath the piston of the steam-cylinder (not shown)—which communicates with the condensing-chamber A through the pipe

a′—while the said piston is traveling on its way downward; but before the piston reaches the bottom of the cylinder the cold-water jet-valve C is closed, and the top valve D is held down firmly by the pressure of the cam M on the lever P; and the bottom valve B, being now relieved from the pressure of the cam E, is free to drop open as soon as the vacuum is destroyed in the condensing-chamber A by the first part of the next puff of the exhaust steam rushing from the upper end of the cylinder through the said pipe *a′* into the condensing-chamber A, and driving the water of condensation and accumulated air down through the valve B into the hot well R below, and, immediately after the water and air have thus been discharged from the condensing-chamber A, the said valve B is again closed, as before, and the top valve D, being immediately relieved from the pressure of the cam M, is free to be raised by any excess of its pressure above that of the atmosphere, and thus allow the said steam to escape into the chamber and pipe Q, and thence into the furnace-chimney, which latter prevents any cold air from striking back into the chamber or pipe Q.

It will be seen that the devices hereinbefore described and shown in the drawing for operating the several valves B C D are much more simple and inexpensive of construction and application than the respective devices for the same purposes set forth in my said Letters Patent No. 131,351, and that they will be more effective and accurate for accomplishing their respective purposes, and less liable to derangement in use.

I claim as my invention—

1. The cam E, swinging arm G, and lever H, in combination with the valve B, the said parts being constructed and arranged to operate together substantially as and for the purpose hereinbefore set forth and described.

2. The adjustable wrist-pin disk-plate I and face-plate *f′* on the shaft F, the adjustable connecting-rod K, and the rock-shaft *l″* and arms L and *l′*, in combination with the water-jet valve C, the said parts being constructed and arranged to operate together substantially as and for the purpose hereinbefore set forth and described.

3. The crank *f″* on the shaft F, the adjustable connecting-rod O and rock-shaft N, cam M, lever P, and spring *p′*, in combination with the valve D, the said parts being constructed and arranged to operate together substantially as and for the purpose hereinbefore set forth and described.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

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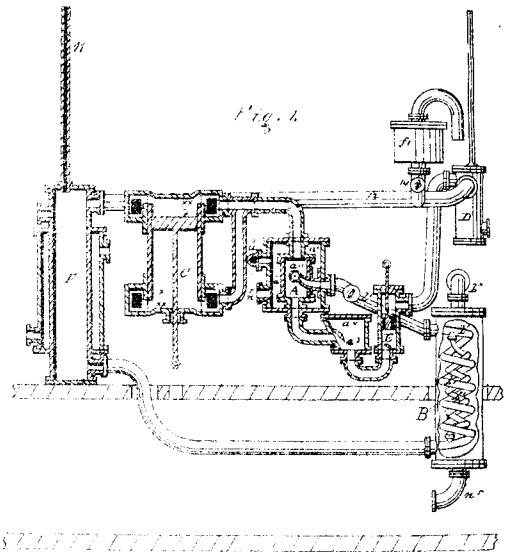
4 Sheets--Sheet 1.

J. HOUPT

Condensing Apparatus for Marine Steam-Engines.

No. 144,203 Patented Nov. 4, 1873.



Witnesses:

Geo. Mendon

Wm. H. Monroe

Inventor:

John Houpt

No. 15.

Specification forming part of Letters Patent No. 144,203, dated November 4, 1873: application filed August 2, 1873.

IMPROVEMENT IN CONDENSING-APPARATUS FOR MARINE STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented certain Improvements in Condensing-Apparatus for Marine Steam-Engines, of which the following is a specification:

The first part of my invention relates to the combination of a refrigerator with an ordinary jet-condenser in such a manner that while cold sea-water is used in condensing the exhaust steam of the engine the said sea-water is prevented from mingling therewith, and all the water within the condenser is discharged therefrom, entirely fresh or free from any saline matter, for using over and over again in the steam-generator, and in the jet-sprinkler of the said condenser.

Another part of my invention relates to the combination, with the said combined jet-condenser and refrigerator, of a dividing-valve chamber, and a plurality of surface condensers having self-closing check-valves, and being connected with an air-pump in such a manner that, as soon as the puff of high-pressure exhaust steam has passed through the dividing-chamber toward the surface condensers, by raising the self-closing valve in said chamber an inlet-valve, between the chamber and condenser, operated by the engine, suddenly opens to the remnant of steam, which, expanding, enters the vacuum produced and supported by the constantly-running jet-spray in the condenser, and thus the required vacuum before the piston of the steam-cylinder is produced. The larger portion of the puff of exhaust high steam having previously passed through the now closed check-valve into the surface condensers is ultimately condensed therein by cold sea-water, without mingling therewith, and the succeeding puffs of high steam, aided by the exhausting action of an air-pump, drive

any contained steam and air forward through suitable check-valves, which immediately afterward close and prevent any return of the steam or air, while the water of condensation, free from any saline matter, passes into the hot well and reservoir for subsequent use, over and over again, in the jet-condenser and steam-generator in the same manner; the said surface condensers are, therefore, partially self-clearing in their operation.

Figure 1 is a vertical section of the jet-condenser and refrigerator in connection with the steam-cylinder, pump, hot well, and reservoir, with short portions of the entrance and exit-pipes for cold sea-water of refrigerator. Fig. 2 is a vertical section of the same parts that are shown in Fig. 1, and of the dividing-valve chamber communicating with the jet-condenser and the pipe leading to the surface condensers, and showing, also, the air-pump connected to the reservoir for hot water. Fig. 3 is a vertical section of the several surface condensers and a steam expander and cooler, connected together by pipes for supplying cold sea-water for condensing the steam, and pipes for conveying the fresh water of condensation to the reservoir, and showing also the pipe and valves of a circulating-pump, which is not shown. Fig. 4 is a plan view, showing the relative arrangement of the several parts shown in Figs. 1, 2, and 3. Fig. 5 is an enlarged central section of one of the cold-water condensing-tubes, and sections of the tube-plates, and fastening of the same in the surface condenser, which is provided with straight tubes. Fig. 6 is a plan view of the steadying-rings of the tube-plates of the surface condenser, which has the plurality of spirally-coiled steam-tubes therein. Fig. 7 is a vertical section of Fig. 6 and the tube-fastenings.

Referring to Fig. 1, A is the jet-condenser; B, the refrigerator; C, the steam-cylinder of the engine; D, the hot well for supplying the steam-generator (not shown); E, the air-pump for elevating the water discharged from the jet-condenser A to the hot well D; F, the hot-water reservoir; and f', a "primer," to fill up the reservoir should there be a deficiency of fresh water therein for starting the engine, the said primer to be supplied with fresh water by the condensation of steam generated by a supplementary steam-generator and furnace (not shown).

Referring to Fig. 2, the same parts referred to above will be seen, with the addition of the dividing-valve chamber G and its valves in communication with the jet-condenser A and steam-cylinder C, and with the addition also of the air-pump H.

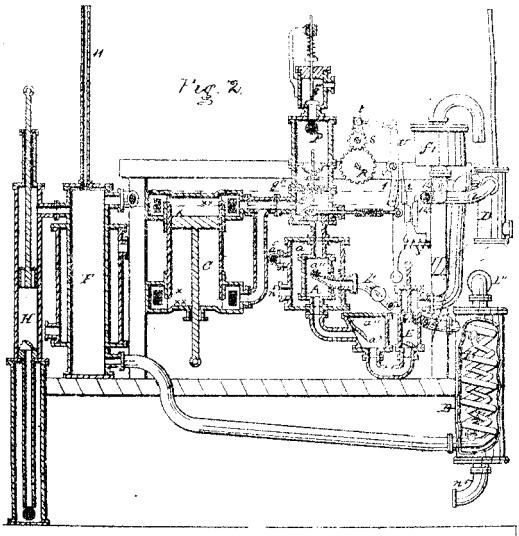
Referring to Fig. 3, I is a capacious surface condenser, containing numerous straight condensing-water tubes 4 4, passing through an inclosing steam-space within the said condenser I, which communicates, through a pipe, P, with the dividing-valve

4 Sheets--Sheet 2.

J. HOUPT.

Condensing Apparatus for Marine Steam-Engines.

No. 144,203. Patented Nov. 4, 1873.



Witnesses

Benj Monroe

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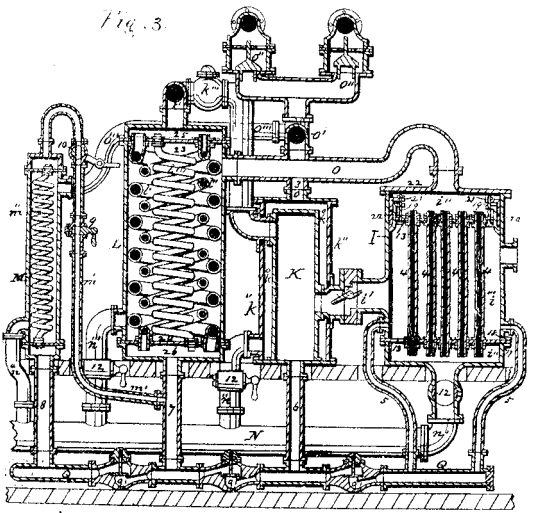
4 Sheets- Sheet 3

J. HOUPT

Condensing Apparatus for Marine Steam-Engines.

No. 144,203 Patented Nov. 4, 1873.

Fig. 3.



Witnesses.

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4 Sheets--Sheet 4

J. HOUPT.

Condensing Apparatus for Marine Steam-Engines.

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Fig. 4.

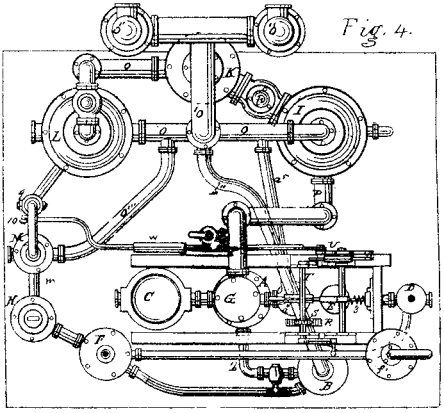


Fig. 5.

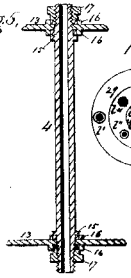


Fig. 6.

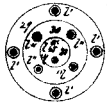
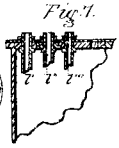


Fig. 7.



Witnesses:

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chamber G (see Fig. 4), and, through a check-valve, i', with the steam-space in the steam expander and cooler K, which, through pipe k', communicates with the upper and lower steam-spaces in the ends, respectively, of the surface condenser L, through a plurality of spirally-coiled steam-pipes, l', l'', and l''', which communicate with another surface condenser, M, which, being the final condenser, I name "save-all." It contains a spirally-coiled steam-tube, l, between two end spaces which communicate with pump H through pipe m. (See Fig. 4.) N is a cold-water supply-pipe, which is intended to communicate, through one side of the ship, with the sea, and through branch-pipes n' n'' n''' n^4, with the condensing-water tubes and spaces, respectively, of the surface condensers I K L M, and circulation of said cold sea-water upward through the said condensers, and finally overboard—produced by means of any suitable double-acting circulating-pump (not shown), connecting with the valve-chambers o'' o''', and with the condensing-water spaces of the surface condensers. Q is a horizontally-arranged conduit-pipe, which, by means of branches 5 5 6 7 8, receives the fresh water of condensation from the surface condensers, and conveys it to the air-pump H, whereby it, with whatever air it contains, is lifted up into the reservoir F, from which the air escapes through pipe 11.

Referring to Fig. 4, the letters thereon indicate the same parts referred to by like letters in the figures just described. The condenser A (see Fig. 1) is an ordinary jet-condenser, surrounded by a cold-water case, a', through which cold sea-water is intended to pass upward continually. The refrigerator B is a case containing a plurality of spirally-coiled tubes, b' b', for supplying cold fresh water to the jet-sprinkler a''. The cold sea-water is intended to be drawn from the sea by means of any suitable circulating-pump (not shown) attached to the refrigerator and to the cold-water space around the condenser by means of suitable conduits b'' n^5, so that the said cold sea-water will be constantly flowing upward through the said refrigerator-case, and through the space a' of the condenser, to the circulating-pump, and thence overboard, thus cooling down the hot fresh water coming from the reservoir F, and serving also the two-fold purpose of supplying cold sea-water to cool the jet-sprinkler a'' and the space a' of the condenser. The water of condensation, together with the condensing water in the condenser A, passes, by gravitation, down through a check-valve, a^3, into a receiver, a^4, from whence it is forced upward, by the air-pump E, into the hot well D, from which latter the steam-generator (not shown) is supplied with fresh water. Any deficiency of the supply of fresh water in the reservoir F, at the starting of the engine, is intended to be

supplied from the primer f'', the said primer to be kept supplied by means of a small supplementary furnace and boiler (not shown) capable of generating enough steam to be condensed for the purpose of making up any deficiency of fresh water which may escape from leaking or otherwise, the condensation being effected by discharging the steam from said supplementary boiler directly into the condensing-apparatus, and from thence by suitable connecting-pipes and stop-cocks, into the primer f'' by means of the air-pump E. The said supplementary boiler may also afford steam enough to work a donkey-engine, and the exhaust steam thereof condensed to supply fresh water for the steam-generator of the main engine when the latter is not at work or stopped for repairs.

The parts constituting the apparatus shown in Fig. 1, and just fully described, are sufficient for steamers of the smaller class, but for steamers of the larger class, which afford ample room or space for the addition of a plurality of large surface condensers, I construct and apply the latter, substantially as shown in Figs. 2, 3, and 4.

The upper end of the jet-condenser A is provided with a communicating-chamber, G, and valves g' and g'', whereby the exhaust high steam from the steam-cylinder C is divided or separated into two parts, the larger portion of the puff of steam passing up through the self-closing check-valve g'', and onward, through a pipe, P, toward the surface condensers I K L M, and immediately afterward the valve g' is suddenly opened to the vacuum maintained in the jet-condenser by the constant discharge of cold fresh water from the jet-sprinkler, as before stated, and thus the vacuum before the piston is produced, as required, by the expansion and condensation of the smaller portion or remnant of the puff of steam; and immediately before the next puff of exhaust high steam is discharged from the cylinder the valve g' closes, the water of condensation, together with the condensing water, passing ultimately to the hot well D or reservoir F, as before described. The pipe for conducting fresh water to the primer f'' is intended to communicate with the pipe 12, which connects the reservoir F to the hot well D, each being also provided with a stop-cock, 14, to control the direction of the said water forced upward by the air-pump E.

The valves g' and g'' are respectively constructed, arranged, and operated as follows, viz.: The check-valve g'' is self-closing, and has a short up-and-down motion, the first being produced by the puff of steam from the cylinder C entering the chamber G, and the second or downward motion by its gravitation toward the condenser A the instant that the valve g' opens to the vacuum in the said condenser. The valve g' is caused to open and close

communication between the chamber G and the condenser A by sliding motions produced by means of a rotating cog-wheel, R, in gear with a pinion, S, which latter has exactly half the number of teeth or cogs contained in the wheel R, and is fixed on a crank-shaft, T, the arm l' of which oscillates a cross-arm, U, on the end of a rock-shaft, V. The lower end of the arm U is connected by an adjustable rod, W (see Fig. 4), to a governor-valve, 10, in the steam-tube m', Fig. 3, which enters the "save-all" condenser M, and is operated, as will be hereinafter explained, to prevent the impulse of the puff of steam from passing into the said save-all M or blowing through the same, so as to drive out any steam that may have reached the latter and remained uncondensed therein. The upper end of the said cross-arm U, Fig. 4, is connected to the arm l' of the crank-shaft T: and rock-shaft V, which has the arm U, has another arm, 1, which is slightly curved, and during one direction of the rocking motion of the shaft V suddenly and rapidly presses backward a lever, 2, which is of the second order, and connected by an adjustable rod to the sliding valve g', and thus suddenly closes the said valve, and, receding, the lever 2 as suddenly opens the valve, the lever being caused to follow closely the arm 1 by the force of a spring, 3.

The operation of the parts just described in connection with the chamber G, condenser A, and steam-cylinder C, will be understood by the following explanation: Suppose the piston of the steam-cylinder C to be moving in its upward course, and has arrived near x in the upper end of the cylinder. The cut-off slide-valve g' has now just commenced closing the communication between the said steam-cylinder and the small jet-condenser A, and by the time the said piston reaches x the communication will be entirely cut off; and by the time the said piston reaches x x the main portion of the puff of the exhaust high steam coming from the cylinder C has raised the check-valve g'' on its way through the chamber G toward the surface condensers communicating therewith: and by the time the piston on its returning course has reached x the valve g' suddenly opens and allows the small remnant of steam to expand, in consequence of the vacuum maintained in the condenser A by the constant action of the jet-sprinkler a' therein, and the consequent closing down of the check-valve g'', thus producing the required vacuum before the piston as it is about to return to the opposite end of the cylinder, when the same conditions are produced in like manner and effect: and in both cases the water of condensation and the condensing water in the condenser A pass down into the receiver a^1, from whence it is elevated by the action of the air-pump E into the hot well D, as before stated.

On the top of the chamber G there is a safety-valve, g''',

which can be readily adjusted to any predetermined pressure of steam in the chamber G, if desirable.

I will now proceed to describe the surface-condensing apparatus, invented for the purpose of saving as much as possible of the fresh water of condensation of the steam, for supplying the steam-generators of the largest class of marine steamers with the same.

The surface condenser I is a capacious chamber containing numerous straight cold-water tubes, 4 4, secured steam-tight in tube-plates, which divide the chamber into two water-spaces, i'' i'', and a steam-space, i''', between the water-spaces. Steam which has puffed through the check-valve g'' passes through the pipe P into the steam-space i''' in I, where it is partly condensed by the cold-water tubes 4 4, and the water of condensation conveyed down through the tubes 5 5 into a horizontal conduit-pipe, Q, which leads to the air-pump H, while the uncondensed steam and air, under the impulse of the puff, pass onward through the self-closing check-valve i' into the expander and cooler K, the said check-valve i' closing, and thus preventing any return of the passed steam or air. The condensing water is drawn, by the exhaustive action of a circulating-pump (not shown), from the sea, through a large pipe, N, which is intended to enter the sea through a suitable part of the side of the ship, and open into the water-space i'' of the condenser I, the said sea-water then passing upward through the tubes 4 4 into the space i'' thereat, and onward through pipes o and o', and overboard through the circulating-pump before referred to.

The manner of securing the tubes 4 4 in the tube-plates of condenser I is more clearly shown in Fig. 5; and, therefore, referring to said figure, 15 15 are flanges around near the screw-cut ends of each tube 4, and 16 16 16 16 are flanges around the tube-holes in the two respective tube-plates, which leave flat surfaces between the flanges and hole for the bearings of respective packing-rings, which are compressed steam-tight by the flanges 15 15 of the said tube on one side of the plate, and by flanged screw-nuts 17 screwed firmly against the packing, and thus not only producing steam-tight joints between the ends of the tubes and the end plates 13 13, but providing, by means of the elastic packing-rings, for the usual expansion and contraction of the tubes from changes in their temperature. The lower tube-plate is secured steam-tight, in the usual manner, between the flanges 17 and 18 of the lower portion of the condenser I (see Fig. 3); and the upper plate 13 is secured, movably, steam-tight by means of draw-bolts 19 19, whereby the flange of a packing jam-ring, 21, is drawn down upon a packing, 20, which is applied around between the flanged rim of the said tube-plate and the inner side

of the wall of the condenser, so as to cause the said packing to be pressed steam-tight against the latter. The cap 22 of the condenser I is bolted down water-tight upon the flanged upper edge of the wall of the condenser, in the usual manner. The expander and cooler K is a capacious surface condenser, consisting of an inner chamber, without any tubes within it, inclosed by another chamber, k'', which leaves a cold sea-water space, k^5, around and above the said inner chamber, through which space the cold water passes upward from supply-pipe N through pipe n'', and thence outward through pipes o^3 and o' to the circulating-pump before named. The puff of exhaust high steam, passing through valve i', enters, and, expanding in the inner chamber of K, becomes rapidly cooled in consequence, and the water of condensation passes down through pipe C into pipe Q, and thence to the air-pump H, while the steam and air remaining, as such, are driven, by the impulse of the puff through k' and a check-valve at k''', into the upper end of condenser L. The condenser L is a capacious chamber, in which a plurality of spirally-coiled steam-tubes, l' l'' l''', are secured, in a steam-tight manner, in two tube-plates, 23 24, which are secured steam-tight between the flanged edges of the ends of the body and the closing cap and bottom, respectively of the condenser, and thus divide the whole interior of the condenser into two shallow end spaces, 25 26, and a large middle space, 27. (See Fig. 3.) There are three series of concentrically-arranged spiral coils, l' l'' l''', in the middle space 27, the open screw-cut ends of which project through the said tube-plates respectively, and are secured in the lower plate 24 by means of flanges around on the tubes, and screw-nuts on the projecting ends, with elastic-packing washers between them; and in the upper plate 23 substantially in the same manner, excepting that, in order to facilitate the application or withdrawal of either of the concentric series of tubes, and especially to hold them in proper relation to the holes in the upper tube-plate, when the same is not in place, I apply three concentric interlapping plates, 29 30 31 (see Figs. 6 and 7), directly over or upon the flanges around the upper ends of the tubes l' l'' l''', the holes in said interlapping plates corresponding with the holes in the tube-plate 23, the lower elastic washer being placed between the concentric interlapping plates and the end plate 23, so that, when the screw-nuts are tightened, the tubes l' l'' l''' will be secured steam-tight in their respective plates 23 24. There are four of the tubes l' in the outer series, four, l'', in the next series, and two, l''', in the central series, as represented in Fig. 6, and the coils of the outer series are pitched to run the water of condensation down in the same direction, either to the right or left, as that in which the central series runs it, while the series between

the outer and the central series are pitched to run it in an opposite direction; the object being to prevent any circular continuous motion in the cooling water through which the several series of the tubes pass. The water of condensation in the spiral tubes runs down into space 26, thence through tube 7 into pipe Q, and onward to the air-pump H, while the remaining steam and air, as such, in the said spiral tubes, pass upward through the branch-pipe m' and its regulating cock 9, and the governor-valve 10 therein, into the upper end of the spirally-coiled steam-tube m'' in the save-all condenser M; the cold condensing water passing from the supply-pipe N up through M, and thence through pipe o''' and onward to the circulating-pump; while water of condensation—if any steam or aqueous vapor shall have reached the said save-all condenser M—passes down through pipe 8 into conduit Q, and thence to the air-pump H.

The check-valves q' q' q', in the pipe Q, operate synchronously with the check-valves of the respective surface condensers, by yielding to the force of the puff of exhaust high steam, and immediately afterward closing, and thus preventing any return of either air, steam, vapor, or water of condensation which may have passed through the same; and the closing of the governor-valve 10 (by means of the devices which connect it with the movements of the sliding valve g' in the chamber G, as before described) on the crossing of the slide-valve in the chamber G, prevents the force of the puff of exhaust high steam from driving the steam or vapor, as such, through the save-all condenser M, and then, immediately afterward, opening gradually, the steam or vapor passes into the condenser M and is condensed to water. Thus the surface condensers I K L M, with their respective valves, operate together to effect the same result; *i. e.*, the preservation of all the fresh water of condensation that may be obtainable from the exhaust high steam of a marine engine.

In regard to the refrigerator B, whereby the warm fresh water of condensation coming from the hot well or reservoir is refrigerated or cooled down for the jet-sprinkler a'' in A, it is intended that the said refrigerator be constructed of any size, form, and number of tubes therein, that may be required to produce the refrigerating effect upon the warm fresh water passing through it, in steamers of the largest class, which require that a proportionately larger amount of cold fresh water be used in the jet-condenser to produce the vacuum required before the piston of the engine.

In the medium class of marine steamers the surface condenser L may be detached, and the save-all condenser M attached directly to the condenser K, in applying the apparatus to a marine steamer.

I claim as my invention—

1. The combination, with a jet-condenser, A, of the refrigerator B, the reservoirs F and f', the hot well D, and the pump E, the said parts being constructed and arranged together substantially as and for the purpose hereinbefore set forth and described.

2. The dividing-valve chamber G, with its dividing-valves g' and g'', in combination with the jet-condenser A, refrigerator B, hot well D, surface condenser I, expander and cooler K, surface condenser L, save-all condenser M, air-pump H, the governor-valve 10, the self-closing valve i', and the check-valves q' q' in the pipe Q, the said parts being arranged to operate together substantially as set forth, for the purpose of saving all the fresh water of condensation, for using over and over again in the jet-condenser A and the steam-generator of a marine-engine, as described.

JOHN HOUPT.

Witnesses:

BENJ. MORISON,

WM. H. MORISON.

No. 16.

Specification forming part of Letters Patent No. 150,952, dated May 19, 1874.

IMPROVEMENT IN SURFACE-CONDENSERS OR REFRIGERATORS FOR MARINE STEAM-ENGINES.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the County of Bucks and State of Pennsylvania, have invented an Improved Surface-Condenser or Refrigerator for Marine Steam-Engines, of which the following is a specification:

The object of my invention is to produce a more rapid and effective cooling-down of the fresh water from the hot well, at any point of its passage from said well to the jet-condenser of the engine, in order that the said fresh water may be used over and over again for condensing the exhaust steam as it reaches the said condenser: and my invention consists in the peculiar construction of the surface-condensers or refrigerators, as will be fully described with reference to the accompanying drawings: in which

Figure 1 is a vertical central section of the surface-condenser or refrigerator, arranged between the hot well and the jet-condenser, and in communication with both, and also in connection with the circulating-pump, whereby cold sea-water is drawn out of the said refrigerator and discharged overboard.

Figure 2 is a horizontal section of the surface-condenser or refrigerator shown in Fig. 1.

Figure 3 is an enlarged sectional representation of the mode of fastening the ends of the spiral tubes in the end plates of the surface-condenser or refrigerator shown in Fig. 1.

In Fig. 1 the hot well B is represented as being connected with the air-pump C (through an intermediate reservoir, or hot well, B′) at some distance from the refrigerator A, for the purpose of showing it more distinctly: but it is intended that the said pump C, and the hot well B, shall be close to the reservoir B′, or that the hot well be made large enough to serve as both reservoir and hot well. D is the jet-condenser, E the circulating pump, and F the steam-cylinder of the engine.

The surface-condenser or refrigerator A consists of a large cylindrical case, containing numerous spiral tubes, *a′ a′*, secured therein in a water-tight manner, as will be immediately described

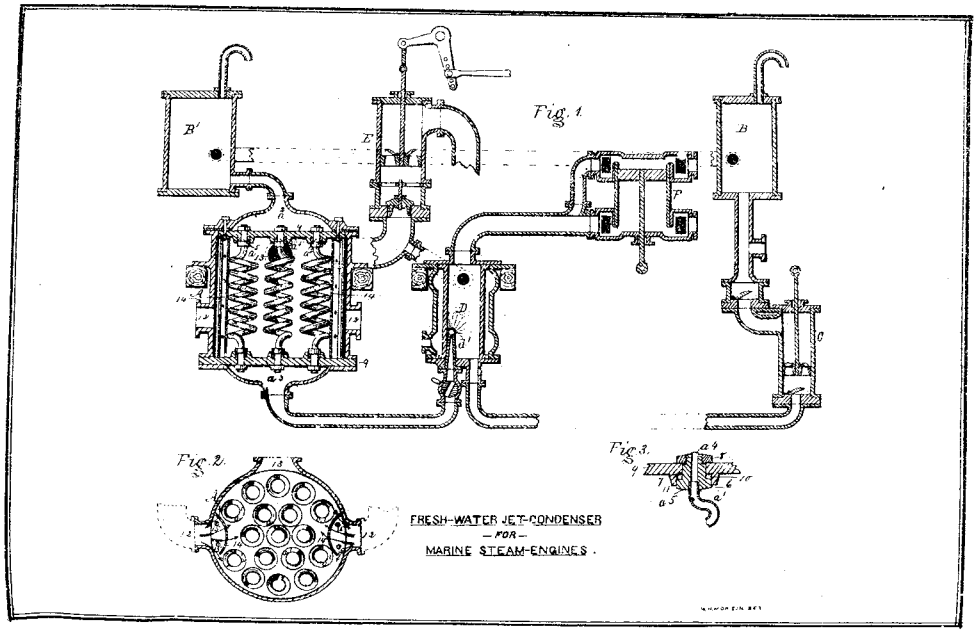
Fig. 1.
Fig. 2.
Fig. 3.
FRESH-WATER JET-CONDENSER
— FOR —
MARINE STEAM-ENGINES.

herein, and communicating at their upper ends with a single pipe, a'', which enters the reservoir B′, and at their lower ends with a single pipe, a^3, which enters as a jet-sprinkler, d', into the jet-condenser D.

The spiral tubes a' are each made of very thin sheet-copper, or other suitable sheet metal, and their upper and lower ends, respectively, left straight, and then inserted and soldered fast and water-tight, in juxtaposition with a corresponding longitudinal hole, a^4, in a casting, a^5, of brass, or other suitable metal. (See Fig. 3.) This casting (a^5) has a cylindrical flange, 6, around the end which receives the spiral tube a^4, and a square or hexagonal stem 7, the outer end of which is made cylindrical and screw-cut to fit a screw-nut, 8, whereby the said casting a^5 can be drawn so as to bring its flange to bear tightly against an elastic packing between it and the thick brass-end plate 9, which forms its respective end of the surface-condenser case: thus making a water-tight joint thereat. The said plate 9 is cast with numerous square or hexagonal holes corresponding with the diameters of the castings a^5, respectively, and also, with surrounding flanges 11, on the inner sides of the plates 9 9, corresponding in diameters with the flanges 6, for the purpose of preventing the elastic packings 10 from being expanded in their respective diameters.

By this simple mode of fastening the ends of the spiral tubes a' to the upper and to the lower plates 9 of the surface-condenser or refrigerator A, a perfectly tight and secure joint will be produced with facility thereat, and the tubes a' being of very thin sheet metal, and of spiral form, there will be no liability to crack or split in tightening up the drawing screw-nuts, nor from changes in the temperature by contact with the hot and cold water.

Cold water from the sea is introduced into the case of the surface-condenser or refrigerator A, through the side of the ship—as indicated by the dotted lines of Fig. 2—the said sea-water entering A at 12 12, from the supply-pipes, which are intended to be in a horizontal plane, below the surface of the sea, at about the depth of the said condenser or refrigerator, or so that the upper end of A will be nearly in the same horizontal plane as the surface of the sea: and consequently the circulating-pump E will not require the power for working it to be much above or greater than will be required to overcome friction, and lift the water drawn thereby from the said condenser or refrigerator, from a greater depth than the outlet opening 13, near the top of the latter, and to discharge the said water overboard.

Opposite to each of the inlet openings 12 12, for the entrance of the cold sea-water into A, there is fixed a curved deflector, 14, which is perforated, and secured in place by means of two posts, 15 15; the said deflectors being arranged, respectively, so as to

leave an open space between one side-edge of the same and the side of the case, so that the entering sea-water may be mainly directed *away from* the outlet opening 13, and also generally diffused, at the same time, among the tubes a' a', for the purpose of more equally and effectually cooling them.

The hot fresh water passes from the reservoir B′ by gravitating down through all the spiral tubes a' a', and thence through a^3 into the jet-spreader d', from which it issues in a copious jet-spray of cold fresh water, into the surrounded chamber of the said jet-condenser D. The hot water of condensation, together with the condensing spray-water, then pass to the air-pump C, which again discharges the same into the hot well B which communicates directly with the reservoir B′; and thus the same fresh water is used over and over again in the condenser D, without mingling with any saline water whatever.

It will be understood, without any further description, that, as the surface-condenser or refrigerator A is arranged between or in immediate connection with the hot fresh-water reservoir B′ and the jet-condenser D, and also in near communication with the sea, through the circulating-pump E, a comparatively much smaller space will be required in the ship for locating and securing the same; that much less expense will be incurred in connecting the said surface-condenser or refrigerator A to the hot water reservoir B′ and to the jet-condenser D, because of the lesser length of the communicating pipes for the purposes; and that the powerful refrigerating character of A will render it fully adequate to the purpose intended, especially in view of the fact that the spiral tubes a' a' are to be made of very thin sheet metal, and therefore best suited for the rapid transmission of the cooling effect of the cold sea-water to the fresh water passing through the said tubes a' a'.

It will also be seen that the construction of the surface-condenser or refrigerator A, especially in regard to the mode of securing the said spiral tubes a' to the end or top and bottom plates 9 9 of the same, will more effectually prevent leaking and cracking open of the tubes in tightening up the screw-nuts, or in changes from temperature, than any other mode heretofore used.

I claim as my invention—

The surface-condenser or refrigerator A, constructed of a plurality of spiral tubes a', open at both ends, and arranged and secured in the end or top and bottom plates of the containing case by means of the castings a^2 and screw-nuts 8, as set forth and described, for the purpose specified.

JOHN HOUPT.

Witnesses:

BENJ. MORISON.

WM. H. MORISON.