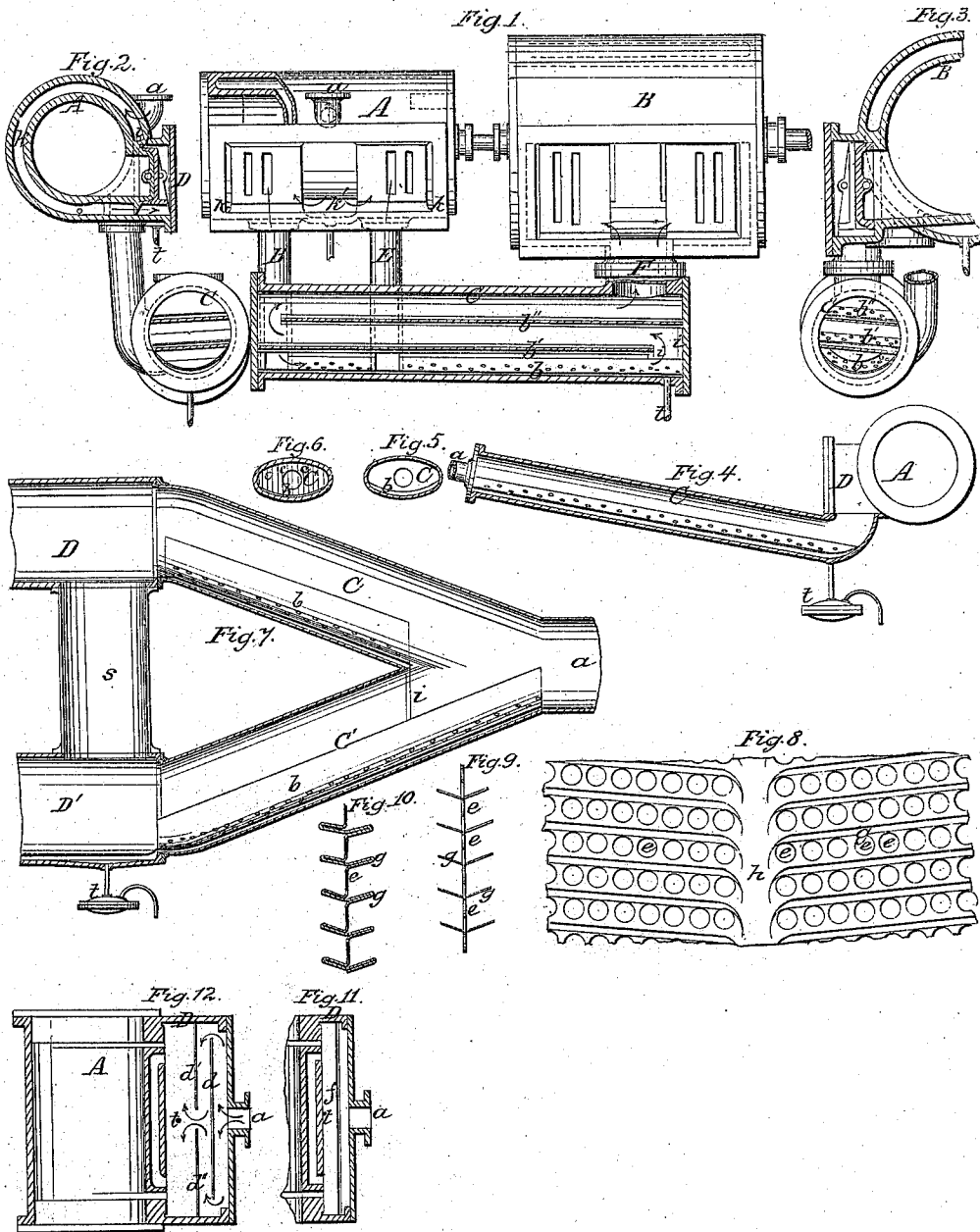


C. E. Emery,

Compound Steam Engine,

N^o 100,512.

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Witnesses

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Letters Patent No. 100,512, dated March 8, 1870; antedated February 18, 1870.

IMPROVED STEAM AND WATER-SEPARATOR FOR STEAM-ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

Be it known that I, CHARLES E. EMERY, of Brooklyn, Kings county, New York, have invented a new and useful Separator for Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings making part of this specification.

The object of this invention is to separate from the steam before it enters the cylinder the water arising from condensation and primage, thereby saving the heat required to evaporate this water in the cylinder, and producing economy of fuel. This is accomplished by an addition to the steam-chest, or in the arrangement of partitions and passages in the main or an auxiliary steam-chest, in combination with means for withdrawing any water that may be collected.

When the invention is applied to a double-cylinder engine, it consists in means whereby the steam, after doing its work in one engine, is freed from the resulting water of condensation before it enters the cylinder of the next.

In the drawings—

Figure 1 represents a double-cylinder engine and separator, and

Figures 2 and 3, vertical transverse sections of the same.

Figure 4 is a vertical longitudinal section, and

Figure 5, a vertical transverse section of a separator of elliptical section attached to a steam-chest.

Figure 6 is an additional vertical transverse section, to show a different interior arrangement.

Figure 7 represents a vertical section of a separator applied to a steam-chest containing puppet-valves.

Figure 8 is a side view, and

Figures 9 and 10, vertical cross-sections of a method of making a perforated plate or partition.

Figure 11 is a horizontal section of a steam-chest, showing position and arrangement of a perforated plate, and

Figure 12 is a similar view of a method of arranging vertical partitions in a steam-chest.

A is the steam-cylinder;

B, the larger steam-cylinder of a double-cylinder engine;

C, the separator;

D, the steam-chest; and

a, the steam-pipe.

The same letters in all the figures refer to corresponding parts.

The separator depends for its action upon two principles—first, that of gravity, and, second, that of capillary or surface attraction. When steam, mixed with water, is passing through a pipe, the water, by its superior gravity, falls to the bottom, providing sufficient time be given; and, if the current be sufficiently slow, the water may be effectually separated.

Ordinarily, the velocity of the passing current carries the water along with the steam, and prevents separation. I obviate this by enlarging the steam-pipe or chest, so that the steam flows to the cylinder-port with a low velocity, and the water has an opportunity to fall to the bottom, out of the current. In addition to this, in many instances, I cause the steam to pass along metal surfaces, to which the water adheres, and forms drops, which unite and flow to the bottom of the chest.

A very efficient form of the separator is shown in figs. 4, 5, and 6. To the steam-chest D, at or near its bottom, is attached a large inclined pipe, C, preferably of the oblong section shown. The steam-pipe a is attached to that end of C which is farthest from the steam-chest. The capacity of C is made as great as is convenient, but the operation is satisfactory when C and D together are large enough to supply the steam required for one revolution of the engine. The steam entering at a is reduced in velocity as it moves through C, so that before it enters the cylinder the water has had time to reach the bottom. The distance through which the water has to fall may be reduced by making the pipe C narrow in a vertical direction, as shown, but this particular shape is not essential. In some instances, I place slightly above the bottom of C, a perforated plate, b. The water runs through the perforations, and is thus kept out of the passing current of steam. The separated water flows to the lowest point, and is drawn off by a cock or trap, t.

I prefer that the water be drawn off continuously, as thereby there is no possibility of any great amount going through the engine. I also find that in this way the water carries off in solution much of the air which vitiates the vacuum of a condensing-engine. Instead of this, however, a reservoir may be connected to C, which can be emptied occasionally; or the bottom of the vessel C may be allowed to fill up to a certain height, and the water be drawn off at regular intervals.

The object of connecting the separator C to the bottom of the steam-chest D is to enable me to withdraw the water from the two at the same point; but other evident arrangements of the connections may be employed, which, in some instances, will require that the water be withdrawn at more than one place.

In the separator, as shown in figs. 4 and 5, the greater density of the water is almost entirely depended upon to separate it from the steam. Fig. 6 represents a section of a similar tube, in which surface attraction is brought into play. To accomplish this, a number of plates, c c, is so inserted in the tube that the steam passes between them on its way to the cylinder.

Each plate may be extended through the whole length of the separator, and also into the steam-chest,

if desired; or short plates may be arranged in succession throughout the length of the separator or steam-chest. Evidently, also, the plates may be so shortened and multiplied in number as to be simply rows of wires extending through the separator and chest.

The plates *c c* may be set as closely as possible, to avoid actual contact with each other, so long as the aggregate space between them is sufficient to pass the steam at a velocity no greater than in an ordinary steam-pipe, though I prefer that the total area of the spaces should be two to three times that of the steam-pipe.

As the steam passes between the plates *c c*, the particles of water adhere to the metal, and, forming drops, run to the bottom, and may pass through a perforated plate, *b*, and be withdrawn, as before.

Fig. 12 shows a separating arrangement, placed within an enlarged steam-chest of a slide-valve engine.

d d' are vertical longitudinal plates, extending from the top to the bottom of the steam-chest, and so arranged that steam entering at *a* passes in either direction about the ends of *d*, and between the ends of *d'*, as shown by the arrows, and thus reaches the cylinder-ports.

The method of arranging these plates may be greatly varied, the object being to cause the steam to travel some considerable distance before entering the cylinder, and thus, by gravity and the surface attraction, be separated from the water, which falls to the bottom, and is withdrawn, as before described.

In fig. 11 is shown a perforated plate applied to an ordinary steam-chest. A similar arrangement may be made in a separating-chamber or auxiliary steam-chest.

The steam enters at *a*, and is divided up into minute streamlets, and passes through the plate *f*, the water adhering to the metal surfaces.

Common wire-gauze may be used for a perforated plate, but it is liable to the objection that, when the amount of water is considerable, the drops obstruct the openings, and are carried through, instead of running down the vertical wires to the bottom of the chest. To remedy this, the number of screens may be multiplied, so that each will separate a smaller quantity.

When the room is limited, I construct the plate in the manner shown in figs. 8 and 9. The perforations *e e* are arranged in rows, as shown, and on either side, underneath each row, are arranged troughs *g g*, inclined toward a whole portion of the plate at *h*, and then turned down, as shown, to form a passage toward the bottom.

The steam, in passing through the plate, leaves the water on the edges of the holes, from which it flows into the troughs *g g*, and through them to the spaces like *h*, which conduct it out of the current of steam to the bottom of the chest.

Fig. 7 represents a separator applied to the steam-chest of a vertical engine with puppet-valves.

The steam-pipe *a* branches into two parts *C* and *C'*, one entering the upper chest, the other the lower one, the area of each being made as great as practicable.

If the side pipe *s* be omitted, the steam for one end of the cylinder is parting with its water in *C*, while the dry steam in the other pipe is being pushed into the cylinder. With the side pipe *s* in use the action is substantially the same, with an opportunity for steam to pass two ways into each chest. The action of this separator is the same as that shown in figs. 4 and 5.

The perforated plate *b* keeps the separated water out of the current, and it is conducted to the lowest point and withdrawn through *t*.

A small pipe, *i*, takes the water collected by the upper plate *b''* and carries it underneath the lower one.

In *C* and *C'* may be inserted vertical plates *c c c*,

as in fig. 6, and single large pipe may be employed, as in fig. 4.

In figs. 1 and 2, cylinder *A* is supplied with a combined steam-jacket and separator, and the two cylinders are connected by still another form of separator, *C*.

Cylinder *A* is surrounded by a steam-jacket, *k*, which opens into the bottom of the steam-chest at *k'*, but is closed off from the same at the top by a partition, *j*. Steam enters at *a*, just above the partition *j*, and circulates at a slow velocity around the cylinder and parts with its water, which runs to the bottom of the steam-chest and is withdrawn.

It will be observed that the bottom of the steam-chest is considerably below the bottom of the cylinder-ports, also, that the pipe *t* is attached to the lowest part of the chest, so that the water flows directly to the point from which it is withdrawn.

In practice, it is better to remove the water continuously by means of a trap or cock, but the lower part of the chest may be used as a reservoir, to be emptied at intervals, care being taken not to raise the water level sufficiently to interfere with the free passage of steam through *k*.

To prevent water from lodging in the side of the jacket underneath the steam-pipe *a*, a hole, *l*, makes a connection with a pipe running to the bottom of the steam-chest or with the jacket in the cylinder-head, and the latter is kept free from water by another opening into the bottom of the jacket. The steam-jacket *k* may be arranged as a separator in two other ways.

First, the partition *j* may be at the bottom of the cylinder, and the steam-pipe *a* may enter near it, in which case the opening *k'* would be at the top. The steam, in such case, would circulate up and over the cylinder, and the water would collect in both jacket and chest, and could be withdrawn by two openings; or small holes, connecting the jacket and chest, could be made at the bottom to pass the water from one to the other and to a single outlet. Such an arrangement, without the water-outlet, is accurately represented by fig. 2, inverted, though in practice, the cylinder-ports should be at the bottom of the cylinder. Again, the steam-jacket may open at both its extremities into the chest *D*, and the steam-pipe enter the jacket opposite the chest.

Either of these arrangements accomplishes the object of my invention, when combined with means for collecting the water, and a pipe, *t*, or equivalent, for withdrawing the same before it enters the cylinder-ports. In Watt's early engine, and in ordinary practice, all the water which collects in a combined jacket and chest passes into the cylinder and produces a loss, which my arrangement avoids.

E E are the exhaust-pipes of cylinder *A*, and lead the exhaust steam from *A* into the separating-chamber *C*.

In this particular construction the exhaust steam enters the bottom of *C*, passes upward and over one end of a horizontal partition, *b'*, and over the other end of a similar partition, *b''*, and enters the second steam-cylinder *B* to perform more work.

The steam, in passing along this circuitous route, is separated from the water, which drops upon the perforated plates. The partitions *b' b''* are inclined laterally and the chamber longitudinally, so that the water flows to one end and is withdrawn at *t*, that on *b' b''* passing to the bottom through pipes *i i*. In many instances the pressure in *C* will be less than that of the atmosphere, in which case the water may be removed by a connection with the condenser or air-pump, or a special pump may be arranged to remove it.

Any other form of separator may be used to connect the cylinders, that shown in figs. 4 and 6 for in-

stance, and in an engine in which the steam is used in more than two cylinders a separator may be interposed between each pair.

It is not necessary that the double cylinders should be placed in the same line and have a common piston-rod. Each cylinder may have its own connection directly to the shaft, and by making the chamber C of large capacity, to equalize the pressure, the engines may be attached to cranks set at different angles.

I am aware that many steam-chests and steam-cylinders are provided with valves or their equivalents, whereby water that may collect therein can be withdrawn, but my invention is distinctive, from the fact that it consists of special separating arrangements, forming part of or combined with the steam-chest, and with a receptacle for the water, and means for withdrawing the same.

I am further aware that perforated plates and screen have been used to free steam from water in steam-drums of boilers, and therefore do not claim them, except in the combination herein described.

I do not claim interposing the chamber C, fig. 1, between the cylinders of a double-cylinder engine independent of the mode of constructing and operating such chamber, as a similar vessel has been used before to equalize the pressure and permit of the superheating of the steam.

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

1. The steam-chest D, arranged as a separator and combined with steam-pipe *a*, substantially as herein specified.
2. The separating-chamber C, combined with steam-pipe *a*, steam-chest D, and pipe, *t* all constructed and arranged substantially as described.
3. The partitions *c c*, combined and arranged substantially as described.
4. The perforated plate *f*, combined and arranged substantially as described.
5. The arrangement of the perforated plates *b b* in the vessels or pipes C, substantially in the manner specified.
6. The pipe *t*, combined with a steam-chest and jacket, substantially as described.
7. The partition *j*, combined and arranged substantially as described.
8. The combination, with a double-cylinder engine, of a separating-chamber C, constructed, arranged, and operating substantially as described.

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Witnesses:

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