

Watson & Smith,
Steam-Boiler Condenser.

N^o 42,720.

Patented May 10, 1864.

A diagram showing a large circle containing several smaller circles, each filled with horizontal lines. The large circle is labeled 'g.2.' at the top left. Inside the large circle, there is a label 'E' in the center. Outside the large circle, there are two labels 'E' on the left and right sides, each with a horizontal line pointing towards the large circle.

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IMPROVEMENT IN SURFACE-CONDENSERS.

Specification forming part of Letters Patent No. 42,720, dated May 10, 1864.

To all whom it may concern:

Be it known that we JOS. JOHN WILLIAM WATSON, of Paris, in the Empire of France, civil engineer, and WILLIAM HENRY SMITH, of Nantes, also in the said empire, merchant, have invented an Improved Description of Surface-Condenser for Steam Engines and other Uses; and I do hereby declare that the following specification, taken in connection with the accompanying drawings, is a full and exact description of the same.

Our invention has for its principal objects, first, the arrangement in a small compass of a much greater extent of cooling-surfaces than can be obtained by the use of pipes of small bore and of such other similar appliances as are at present employed for the surface-condensation of steam and other vapors; second, the arrangement of such surfaces so that they can be more easily cleaned and visited than the surfaces of the condensers on this principle at present in use; third, the suppression of the air-pump to be used in connection with the condenser; fourth, and lastly, the employment of the current of water used for refrigerating the condenser for recording the continuity of the flow of the said water through the refrigerator.

The advantages to be derived from our improvements are founded, mainly, on the following circumstances: Whereas vapors are bad conductors of heat, their condensation is restricted in a great measure to those portions only which are in actual contact with the cooling surfaces, and consequently the amount of condensation is in direct proportion to the extent of such surfaces. To obtain large surfaces, however, by the ordinary means requires a great multiplication of tubes and the occupying of a large space by the apparatus, both of which conditions, apart from the expense, beget many practical inconveniences, much restricting the use of this class of condenser.

In our arrangements, taking into consideration the fact that the areas of circles are as the squares of the diameters, we avail ourselves of the content of the tube as well as of its surface, so that while the total area in contact with the refrigerating-fluid may not be greater or even so great as in a surface-condenser composed of a great multitude of

small tubes, a much larger conducting-surface can be offered to the vapor in fewer tubes of a larger diameter. It follows consequently from this that in any tube or vessel whereof the content is occupied by numerous conducting-surfaces which can be brought in contact with the vapor to be condensed, the work done as a conductor by the external surface, which is bathed by the refrigerating fluid as compared with the work done by the external surface of any similar sized vessel not filled with such conducting-surfaces, will be greatly increased, inasmuch as the outer surface of the former vessel will transmit at any moment all the heat communicated by the vapor to the numerous internal conducting-surfaces, while the outer surface of the latter will yield up solely the heat of that layer of vapor which at that moment finds itself in contact with the inner surface, and which must necessarily be only a very small proportion of the total quantity entering into the vessel. Such being the intention and principle, the means whereby we realize our invention are as follows: We take trunks, tubes, cases, or other vessels, but by preference cylindrical tubes, made of good conducting substances for heat, and of such convenient forms and dimensions as the nature of the application may require, and fill them with an assemblage of divisions of wire-gauze, which may be either in sheets or rolls, so arranged that no vapor or steam entering into the containing vessel can traverse the same without encountering many metallic surfaces; or, in default of using wire-gauze, we obtain an analogous result by employing an assemblage of finely-perforated metal plates, metallic beads or shot, metal filings, chippings, turnings, nails, bundles of wire or metal rods, which, when assembled in the containing vessels, shall afford an infinity of passages and channels for the passage of vapors.

The condensation is effected by placing our tubes or vessels when thus filled in contact by their outer surfaces with a refrigerating fluid or liquid, or by allowing the heat imparted to such surfaces to be dissipated by other means. When wire-gauze is employed to obtain the multiplication of surfaces, we cause it to be cut into a number of pieces of the required outline, unless we use it as a roll, choosing such

a fineness as may best conduce to the free passage of the condensed liquid, and at the same time afford the largest number of surfaces in a given space for contact with the vapor. The pieces of gauze are assembled so as to form a series of diaphragms, midribs, or divisions when packed at right angles to the axis of the containing vessel or tube. Sometimes we employ an envelope or cylinder of gauze to contain the said diaphragms, and then insert the whole in the vessels or cylinders forming the condenser, taking care in each case that there is as little solution of continuity as possible between the gauze and the sides of the containing vessel. By this arrangement nothing can be easier than to clean the gauzes should they require it, since it will only be necessary to withdraw the gauze cylinder, and then to separately remove the diaphragms.

We prefer to employ copper as the metal to be used in the construction of the containing vessels as well as to form the conducting-surfaces when they consist of wire gauze, perforated plates, shot, filings, clippings, nails, bundles of wire, rods, &c.; but we use as readily gauze made with brass wire.

When our condenser is used for marine engines, we arrange the required number of copper tubes filed with diaphragms of wire-gauze or other metallic objects, as aforesaid, so that one end of each tube may open into a box or case, which is connected by means of pipes with a reservoir, from which the water is returned back again by means of an ordinary force-pump into the boiler, while the other end communicates with another box, giving entrance by means of pipes to the steam proceeding from the cylinder, of the engine, and which is to be condensed in the tubes. The tubes when connected, as described, are placed within a trunk or cistern, which may be called the "refrigerator," and which communicates by mains of large tubes directly with the outside of the vessel, the openings to the mains being so disposed in the sides of the cistern that when the ship moves either ahead or astern a continuous flow of water shall set through the trunk. The refrigerator is closed at the top with a lid, bolted on, and through which the tubes may be easily visited and cleaned when occasion requires. The mains are capable of being closed by means of sluices or other suitable valves. The position of the condensing-tubes in the trunk or refrigerator may be either vertical, horizontal, or inclined according as it may be found most convenient to arrange the condenser with relation to the other parts of the engine or boiler in the ship.

The condensation of steam effected by the arrangements just described being far more perfect than that which is obtained in ordinary surface-condensers, no air-pump is required, and a simple force-pump for feeding the boiler will be all that is necessary. This pump may be worked either by the engine of

the ship or by means of a donkey-engine, and if the latter be employed the steam to move it may be produced from a small boiler evaporating sea-water, and which steam can afterward be condensed by similar apparatus, the water which is produced being likewise fed to the principal boiler, and thus serves to compensate for the difference always found in practice between the quantity of water evaporated and the quantity of water condensed. By such an arrangement, moreover, the principal boiler may be supplied with distilled water alone and the extra consumption of fuel resulting from the loss of heat occasioned by the extraction of the brine be entirely avoided.

The accompanying drawings represent a form of condenser in which the tubes are disposed vertically, and will serve to illustrate generally the manner of carrying our invention into practice when used in connection with marine engines.

Figure 1 presents a general view of the condenser, arranged within the refrigerator. A A' A'' is the refrigerator, which is connected by the mains B B' B'' with the sides of the ship, and through which the water makes its entrance and escape. These mains are closed by sluices or other suitable valves when it is desired to open the refrigerator. The form of the refrigerator here shown is an oval, the bottom forming an annular rim, which is bolted to the water-case of the condensing-tubes D. The sides are vertical and the top dome-shaped. The top is movable, bolting down to the sides, and is traversed by the steam-pipes, &c., which pass through the stuffing-boxes, and are thus rendered staunch from the escape of any water by their sides. A small standard-pipe, K, fitted with a stop cock, serves to purge the refrigerator of any air that may enter through the mains with the rolling of the ship, and which might lodge in the upper part of the dome.

As mud and slime will collect from the water on the sole of the refrigerator, a pipe, *i*, traverses one of the sides, and then proceeds vertically downward to nearly touch the bottom. The portion of this pipe, which is outside, in like manner bends vertically upward for a height of two feet, or thereabout, a branch pipe taking off from it at about a foot below its termination in this direction. The branch pipe rises some few feet, and then curves over to form a spout, all that is necessary to observe being to take care that no part of the pipe rises to the level of the water outside the ship.

A solid plunger, similar to the plunger of a force-pump, rises and falls by the action of a screw within that part of the pipe *i* which continues on above the branch, and by sliding in front of the orifice of the branch pipe serves as a valve for affording or for interrupting communication between the pipe *i* and the branch pipe. When this valve is raised, the difference of the level of the water outside the vessel and within the refrigerator causes a pressure which forces the "sludge" which

may have collected at the bottom to rush up the pipe *i* and to be delivered through the branch pipe into any vessel, such as a bucket, placed to receive it. The dirt, therefore, which forms a constant source of annoyance by incrusting the tubes in ordinary surface-condensers, and thereby greatly diminishing the action, may by this method be frequently removed, and the thorough efficiency of the external surfaces of the tubes at all times maintained.

Fig. 3 shows one-half of the refrigerator in plan on the line *e*. The condensing-tubes *EE E*, Figs. 1, 2, and 3, are of copper and filled with brass wire-gauze, having about two thousand five hundred interstitial spaces between the wires within the area of one inch square.

The disks of gauze are arranged as shown in Fig. 4, where *y* represents a ring of brass wire and *x* the gauze, which is lapped over the ring at its edges. By this mode of assembling them the gauzes are held at a certain distance from each other and kept perfectly horizontal in the tube. One end of each tube is fixed into a circular tube-plate, which may be of copper or iron, and which forms the bottom of a shallow chamber, *c*, serving to receive the steam from the engine by means of the steam-pipes *F' F'*. The tubes carry a collar brazed onto them at about three inches from the end, the said three inches of tube passing freely through the hole in the tube-plate. This collar, which is of gun-metal or brass, is screwed down to the tube-plate in the ordinary manner, but its outer rim is surrounded by a ring of zinc, which is then lightly soldered both to it as well as to the plate, and which serves to protect the plate from being eaten away (if of iron) by the galvanic action due to the contact of two metals of different degrees of oxidizability. A similar mode of protection is used in all parts of the apparatus where iron and copper may occur in conjunction in the presence either of steam or water. The other end of each tube is connected in a similar manner with a tube-plate forming the upper side of a receptacle, *D*, made for receiving the water dropping from the tubes, and which thence runs away by the pipes *G' G'*, Figs. 1 and 6, to the pump-reservoir *L' L'*, Fig. 6. Three of the tubes are connected together, Fig. 3, at their lower ends by means of a triangular-shaped box, *m*, closed on all sides except at its angles, where it opens into the tubes. A pipe communicates, however, with the top and leads to the ordinary vacuum-gage. This arrangement permits of the perfectness or otherwise of the vacuum in the tubes themselves being ascertained; but perhaps a better plan is to introduce the vacuum-tube into the receptacle *D* just below the ends of the tubes, as a more general indication of the state of the vacuum in the whole condenser is thereby afforded.

F' F' are the steam-pipes, of which *F'* communicates with the superior port and *F'* with the inferior port of the engine cylinder. Both

pipes, however, communicate, as shown, Fig. 1, before entering the steam-receptacle *C*.

Inasmuch as before introducing steam into the condenser the latter will contain air which would interfere with the action of the surfaces by preventing the steam from coming into contact with them, we have availed ourselves in the following manner of the action of the steam-jet to rid ourselves of its presence. Fig. 5 shows in section through the axis a vertical hollow inverted cone made of thin sheet-copper, closed in at the base but open at the top. A pipe, *a*, communicates with the steam receptacle of the condenser *C*, and enters the cone at its side, being then bent upward to near the mouth of the cone, where it terminates. This pipe, which is of very small bore is furnished with a stop-cock, by which the communication with the steam-chest of the boiler can be opened or closed at pleasure. When the pipe *c* is open, a rush of steam escapes from it through the mouth of the cone, the orifice of which is regulated so that the cone of issuing steam shall exactly fill the opening, and draws out with it by means of the pipe *a* all the air contained in the condensing-tubes, steam-pipes, engine-cylinders, water-receptacles, pump-reservoir, &c., and thus the engine is set to work with much greater immediate efficiency than when the air has to be gradually displaced from the cylinders and condenser by the air-pump after the engine has been set in motion, as in ordinary cases.

In Fig. 6 the arrangement of the force-pump is shown partly by a vertical section, partly in elevation, and represents the disposition which would be adopted for the condensers and where one would be on one side and one on the other side of the ship, with the pump between them. The condensers are elevated above the pumps, so that the top of the pump barrel may be under the bottom of the water-receptacle of the condenser. *L' L'* is a cast-iron box, divided by a partition, *L*, so as to form two separate reservoirs communicating with the condenser by means of the pipes *G' G'*, and with the pump-chamber *M* by means of the ball-and-socket valve *O*. *P' P'* are the solid plungers of the pumps. *N' N'* are the feed-pipes, communicating with the boiler, the entrance to which out of the pump-chamber is also closed by a ball-and-socket valve, *O'*. *O'* is a small dome-topped cylinder intended to contain air, which is compressed by the influx of water during the descent of the plunger, and reacts to force the water onto the boiler while the plunger ascends. This air also acts as a spring, relieving the blow on the water and regulating its motion to a gradual flow instead of a sudden movement. Being only bolted on, the cylinder on being removed gives access to the valve *O'* should it become deranged.

We do not confine ourselves to the exact form of the condenser illustrated in our drawings and described hereinbefore in connection

with marine engines, but modify the same according to the requirements of the engine or ship to be fitted.

When our condenser is applied to stationary engines, it is also obvious that other means than those described must be resorted to in order to renew the water in the refrigerator, and the choice of them must necessarily be left to the position and circumstances under which the engine is erected.

When the condenser is used in connection with marine engines, and the water is introduced into the refrigerator in the manner described, it is desirable that the engineer should be able to ascertain the rate of flow of the water through the refrigerator. We provide for this by the following arrangement: A small wheel turning freely upon an axis supported horizontally within the refrigerator and in a line with the inflowing current of water carries several flat vanes, which, however, are inclined at such an angle to the plane of the wheel as to cause the latter to turn when the moving particles of water communicate their impulse to the vanes, and which movement is either fast or slow, according as the current varies with the speed of the ship.

To render the rotation of the wheel measurable, the axis is provided with an endless screw cut upon it, and which works into a toothed wheel placed below it and turning on an axle carried by a forked lever, by means of which it can be raised into contact with the screw or separated from it, at option. This same axle forms a pinion working into another wheel, also carried by the fork of the before-mentioned lever, but which turns much more slowly than the first wheel. The second wheel is provided with a bevel-pinion gearing into a horizontal bevel-wheel, which is centered on a vertical shaft passing through a disk which is collared into the cover of the refrigerator, and which is made sufficiently large that when it is detached the whole apparatus may be bodily removed from the refrigerator. The upper end of the vertical shaft carries a bevel-pinion gearing with a vertical bevel-wheel, which is fastened to a disk turning with it and having its periphery divided into regular intervals.

Before this rotating disk another fixed disk is placed, hiding the former except at one point, where a slit enables the divisions to be seen as they successively present themselves when the disk turns. To use this instrument the lever is raised by means of a rod passing through the cover of the refrigerator and the wheels brought into gear with the endless screw cut on the shaft, to which are attached the vanes. The number of rotations then given to the disk in a given interval of time indicates the velocity of the current passing through the refrigerator.

Our condensers are equally applicable for use in distilleries, where they will replace the worms at present employed, also for chemical works, where they may be substituted for the present arrangements for heating by steam, for taking the place of steam-pipes for warming houses, drying, &c.; in fact, they may be generally applied to all processes and purposes where heating by steam is admissible, or where it is intended to collect liquids from the condensation of vapors.

Having now described the nature of our said invention, together with the best methods with which we are at present acquainted for carrying the same into practical effect, as well as indicated the applications for which in our present experience we think it to be best fitted, we would remark that we do not confine ourselves to the precise details hereinbefore given, but wish it to be understood that we claim as our invention and desire to secure by Letters Patent—

The use in steam-condensers of tubes or other vessels filled with wire-gauze or its equivalent, substantially in the manner and for the purpose specified.

In testimony that the foregoing is a correct description of our said invention we have hereunto subscribed our names in the presence of two witnesses.

JOSEPH JOHN WILLIAM WATSON.
WILLIAM HENRY SMITH.

Witnesses:

PETER BARROW,
HENRY SUTTON.