(No Model.) 2 Sheets—Sheet 1.

C. A. DIXON.

SURFACE CONDENSER.

No. 351,583. Patented Oct. 26, 1886.

Fig. 1.

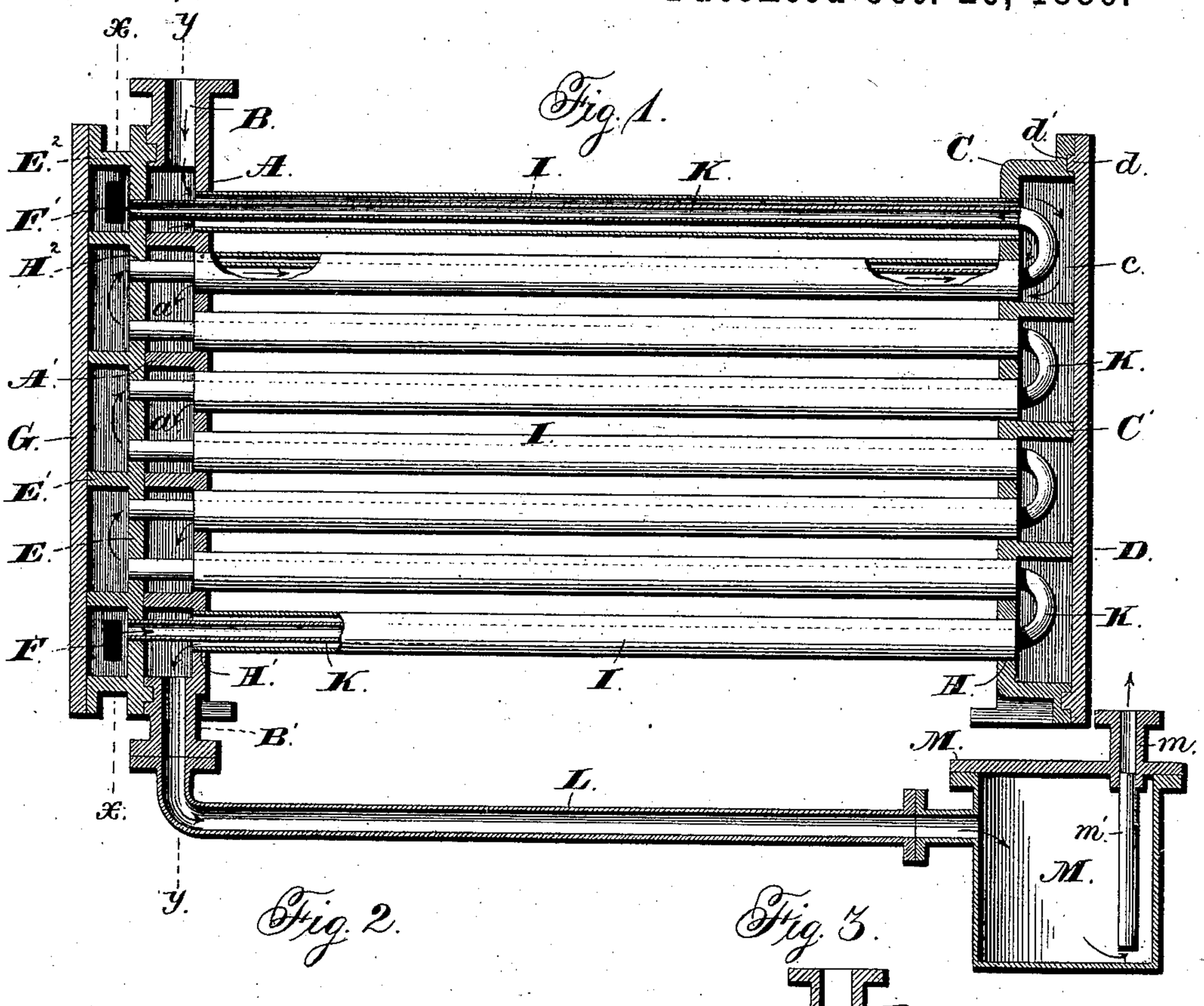


Fig. 2.

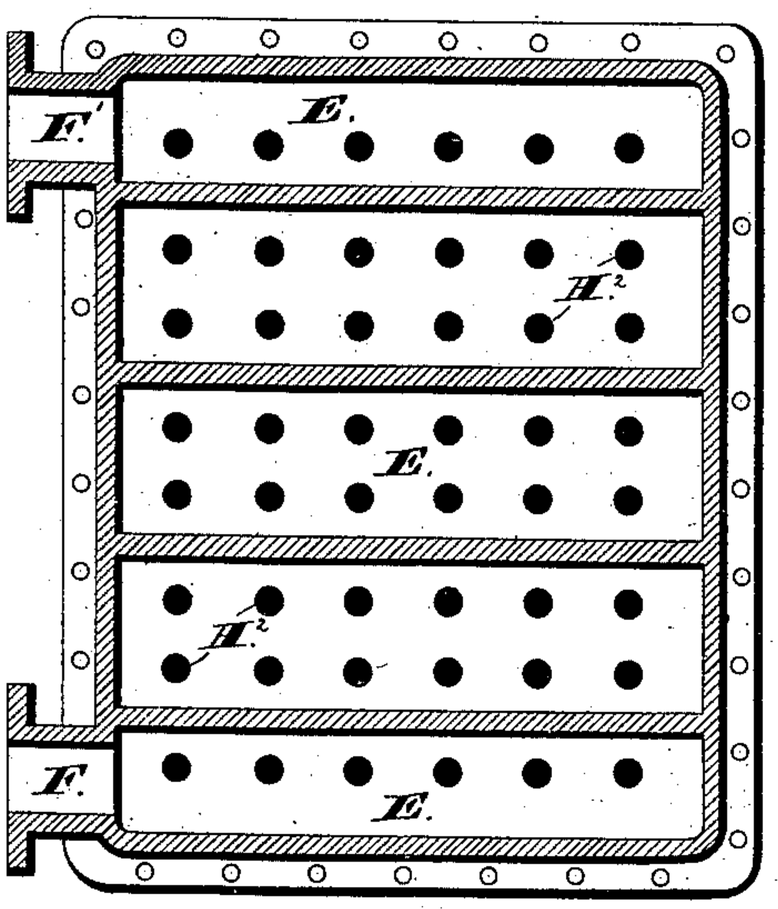
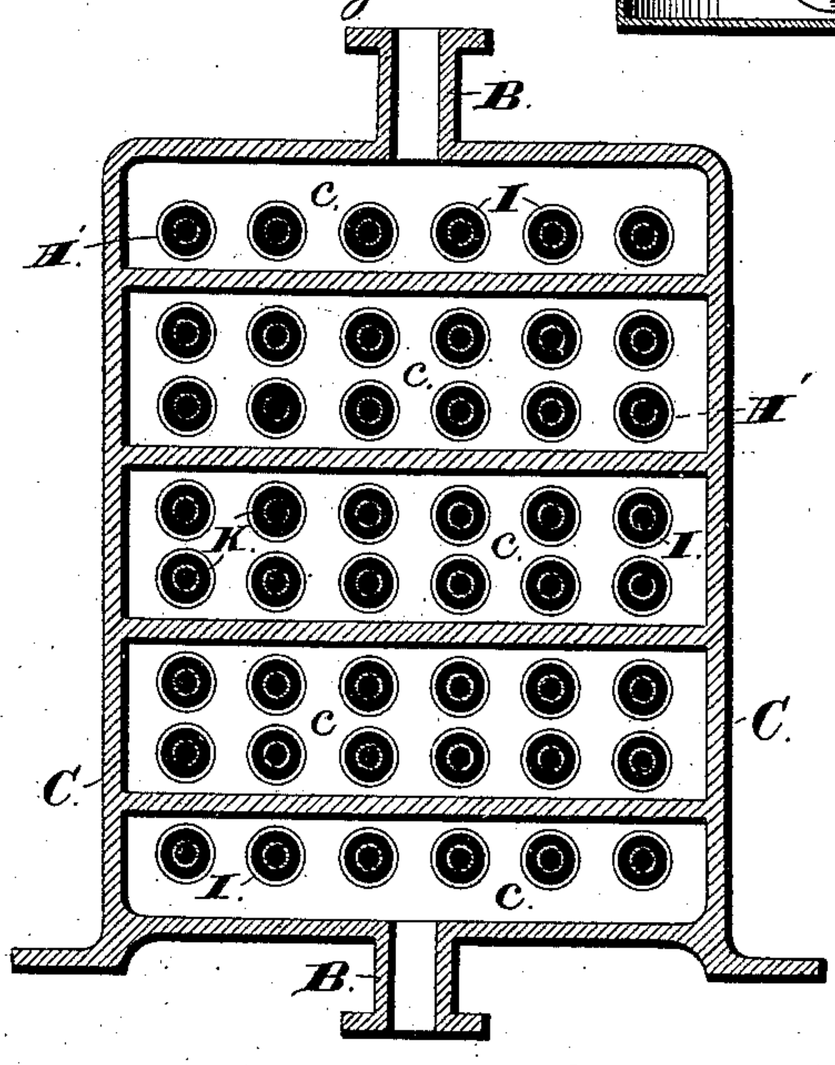


Fig. 3.



Witnesses:
Jas. E. Hutchinson.
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Inventor.
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by Brindle & Russell.
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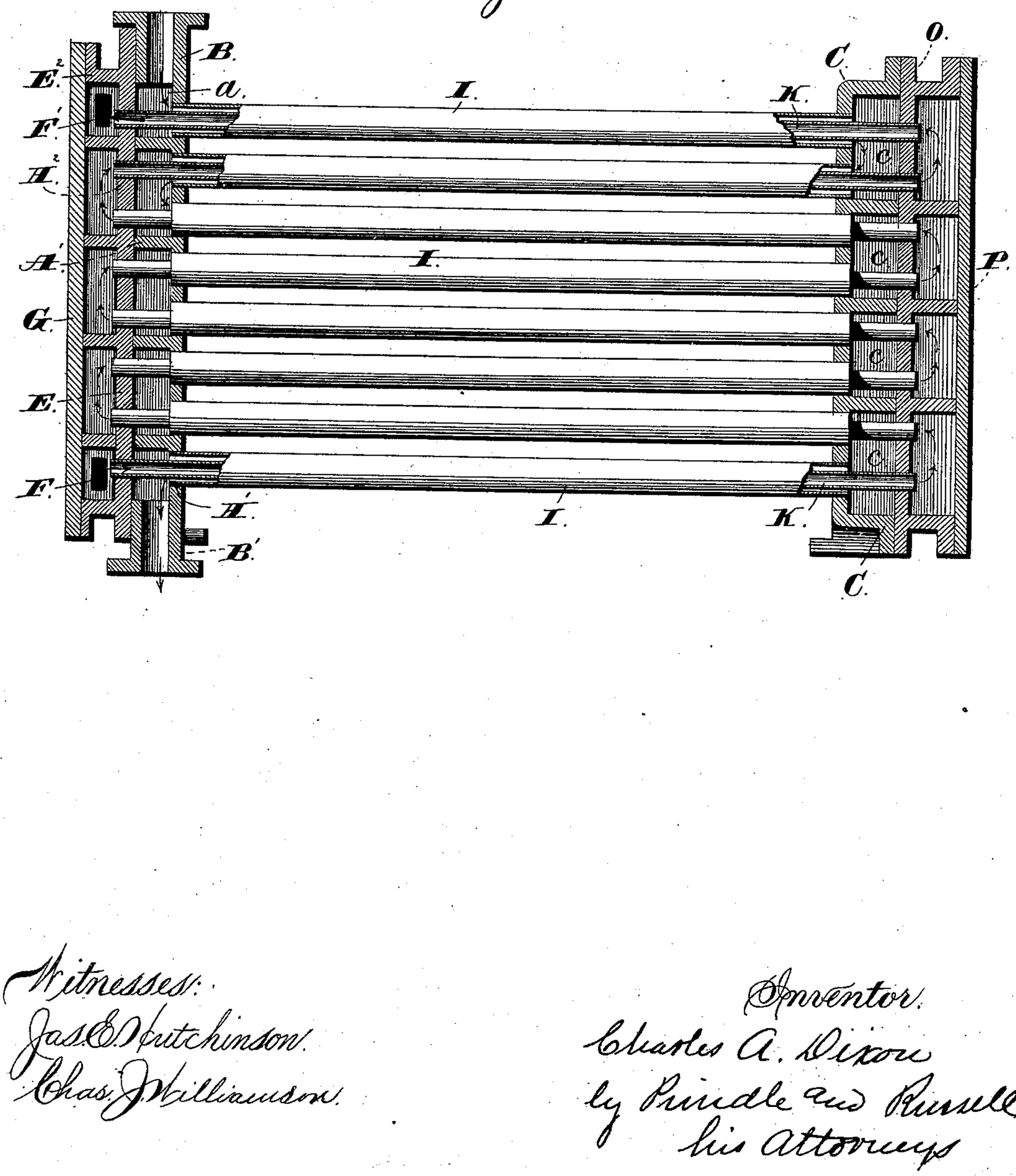
Fig. 4.



Witnesses:
Jas. E. Hutchinson.
Chas. J. Williamson.

Inventor.
Charles A. Dixon
by Pindle and Russell
his Attorneys

UNITED STATES PATENT OFFICE.

CHARLES A. DIXON, OF NEWBURG, NEW YORK, ASSIGNOR TO ROBERT WHITEHILL, OF SAME PLACE.

SURFACE-CONDENSER.

SPECIFICATION forming part of Letters Patent No. 351,583, dated October 26, 1886.

Application filed April 29, 1886. Serial No. 200,603. (No model.)

To all whom it may concern:

Be it known that I, CHARLES A. DIXON, of Newburg, in the county of Orange, and in the State of New York, have invented certain new and useful Improvements in Surface-Condensers; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figure 1 shows a longitudinal section of my condenser; Fig. 2, a transverse sectional view of the same on line *x x* of Fig. 1; Fig. 3, a similar view of the same on line *y y* of Fig. 2, and Fig. 4 a longitudinal sectional view of a modified form of my condenser.

Letters of like name and kind refer to like parts in each of the figures.

The object of my invention is to provide an improved surface-condenser for condensing steam or compressed gases in machines for liquefying gases; and to this end my invention consists in the condenser, and the construction, arrangement, and combination of the parts thereof, as hereinafter specified.

In the drawings, A designates a head, preferably rectangular in shape, open toward the outer side. Such head is divided into a series of chambers, *a a*, by the parallel partitions or flanges A′ A′, whose outer faces are flush with the sides of the header, so that if a plate should be put over the open side of the head a series of separate closed chambers would be formed. Into the upper one of these chambers enters the inlet passage or pipe B, for admitting the steam or gas to be condensed, and from the lower chamber extends the outlet passage or pipe B′, for the exit of the condensed steam or gas.

Opposite head A, and parallel therewith, is the correspondingly-formed head C, divided up into separate chambers *c c* by the parallel partitions or flanges C′ C′, such chambers being, however, one less in number than the chambers in head A. Such flanges C′ C′ are arranged alternately with reference to those on head A—that is, each partition C′ is opposite the middle of the space between two of the partitions A′ A′ on head A.

The outer side of head C is closed by a plate, D, fitting closely down upon the sides of the head and the partitions, so as to form a series of parallel closed chambers, as shown best in Fig. 1. Such end plate is preferably provided with a rib, *d*, fitting into a groove, *d′*, all around the head, so as to make a tight joint and secure the end plate most firmly in place. Bolts, rivets, or other fastening means, as desired, can be used to secure the plate in place on the head. Over the outer open side of the head A is similarly placed and secured a plate, E, which, like plate D, closes the head and forms, with the partitions on the head, a series of closed chambers. Such plate E, however, instead of being plane on its outer side, is provided with partitions E′ E′, extending across its outer face, corresponding in position with those on head A, and with a partition, E², extending around its edge of the same height as partitions E′ E′, so that a series of transverse chambers are formed to correspond in position with those on head A. Into the lower one of these chambers enters the inlet port or passage F for the condensing water or liquid, and from the upper one opens the outlet port or passage F′ for such water or liquid. Fitting over the outer face of the chambered plate E is the end plate, G, fastened or secured in any desired way, preferably to an outwardly-extending rib on partition E².

With the construction as described so far we have a series of closed and separate chambers in head A, a series of correspondingly-arranged closed and separate chambers outside of head A, and in head C another series of closed separate transverse chambers, having with reference to those in head A an alternate arrangement. None of these separate chambers are connected directly; but they only communicate through tubes and passages, as will hereinafter be set forth.

In the inner side or plate of head C are the parallel series of openings H H, there being two of these series opening into each of the chambers in the head. In the inner side or plate of head A are a series of openings, H′ H′, corresponding with and opposite those in head C. Of these openings H′ H′ only one series open into each of the upper and lower transverse chambers in head A. Into each of the other chambers in this head two of the series

open, the upper one of the series, on account of the relative positions of the chambers in the two heads A and C, being opposite the lower one of the pairs of series in a chamber in head C. Into such opposite openings in the two heads are fastened, by expanding or otherwise, the opposite ends of tubes I I. With the construction described such tubes will then put the upper chamber in head A into communication with the upper chamber in head C, and the latter chamber into communication with the second chamber in head A, and so on. Steam or gas flowing in through port F will then flow from the upper chamber in head A to the corresponding chamber in head C, then back into the second chamber in head A, then across to the second chamber in head C, and so on, back and forth from head to head, and, finally, out at port or passage F'. In the plate E, opposite the openings H' H', are the smaller openings H^2 H^2, opening into the chambers on such plate or head. In these openings are fastened, by expanding or otherwise, the open ends of the smaller tubes, K K, extending through tubes I I, so as to leave annular spaces within the latter tubes around tubes K K. The tubes K K, passing through the upper series of tubes, I I, are at their outer ends in the chambers in head C to be connected directly with the tubes K K of the series next below. This I prefer to do by extending each tube K, from the point where it is fixed in plate or head A, through a tube, I, then bending it downward and backward, and extending it back through the next lower tube I to the plate or head again. With this construction water admitted to the lowest chamber on plate or head A, through the port F, will flow through tubes K K, within tubes I I, to the opposite ends of the latter tubes, and then back into the next higher chamber in head or plate E. This flow of water through tubes K K continues back and forth throughout the extent of tubes I I until the uppermost chamber in head or plate E is reached, from which it can flow out through port or passage F'. It will be noticed that the flow of water through its tubes takes place in a direction opposite to that of the flow of steam or gas to be condensed through the steam or gas tubes. From the gas or steam outlet passage or port B' a suitable conducting-pipe, L, extends to the collecting-chamber M, into which the condensed steam or gas flows. Such chamber is provided with a cover or cap, M', provided with a tubular connection or nozzle for the outlet of liquids from the chamber. Within the chamber M is the pipe *m'*, having its lower end near the bottom of such chamber and its upper end connected with the tubular connection or outlet-nozzle *m*. With this arrangement only the liquid will be drawn off from the chamber through the pipe *m'* and nozzle, as such pipe takes only from near the chamber-bottom.

In Fig. 4 I show a modified form of my apparatus, in which, instead of using a series of U-shaped tubes, K K, for conducting the condensing water or liquid through one series of steam or gas pipes and back again, I use a series of simple straight tubes. Instead of having the head C and its chambers closed by a simple end plate, as in the other form of apparatus described, I use a second head, O, whose inner side or plate fits close against head C and closes its transverse chambers. Such head O has a series of chambers formed, by transverse partitions, just like those in head C and corresponding in position with them, and is closed by the end plate, P. The open ends of tubes K K are extended through the chambers in head C, and are fastened, by expanding or otherwise, in openings in head O, with their bores communicating with the chambers in such head. With this construction the condensing water or liquid flows through the lower series of tubes K K into the lower chamber in head O, from there back through the next series of tubes into the second chamber in head E, and so on. The flow of water through the tubes K K takes place just as and in the same direction as in the other form of apparatus. The chambers in head O simply serve to connect the ends of the tubes K K and direct the water through them, as indicated by arrows in Fig. 4. With regard to the opposite ends of the series of tubes K K, the chambers in heads E and O are for precisely the same purpose, and act in the same way.

I do not limit myself to any particular way or means of fastening the tube-ends in the heads. They can be expanded into reamed holes or openings, and soldered or fixed in any desired way so as to be tight.

In my condenser, arranged and operating as described, with the cooling and condensing liquid flowing inside of the thin annular sheet or stream of fluid to be condensed, obviously the cold of such liquid will be most advantageously applied—that is, so as to abstract the greatest amount of heat from the fluid to be condensed. As the cooling or condensing liquid enters at the point where the fluid to be condensed flows out from the apparatus, and flows, as described, in a direction constantly opposite to the direction of the flow of such fluid, it follows that the greatest degree of cold is applied to the fluid just where it is needed—that is, where such fluid has become most cooled.

If the condensing liquid should enter at the same point as and flow along through the apparatus in the same direction with the fluid to be condensed, the liquid, absorbing heat from the fluid as it flows along, would be raised in temperature more and more as it approached the discharged end of the apparatus, and consequently could not lower the temperature of the fluid to any great extent. With such a construction and operation of the apparatus it would be necessary to have several separate condensers and pass the fluid to be condensed through them successively.

With my apparatus, with the cooling liquid flowing in a direction opposite to that of the

flow of the fluid to be condensed, such fluid, as it passes through the apparatus, is continually meeting or being brought under the influence of colder and colder condensing liquid, and being continually reduced in temperature until at the end of its passage it is subjected to the greatest degree of cold obtainable in such liquid, and flows out with a temperature as low as that to which the cooling and condensing liquid can be reduced.

The opposite heads A and C need not, of course, be parallel to each other, as shown, or in any particular relative positions.

Having thus described my invention, what I claim is—

1. In a condenser, in combination with a series of horizontal tubes arranged one under the other, said tubes being connected alternately with the opposite ends of the succeeding lower tubes, an inlet for the cooling medium connected with the lower end of the series of tubes, the series of outer tubes surrounding such other tubes and correspondingly connected, and the inlet for the fluid to be cooled connected with the series of outer tubes at its upper end, substantially as and for the purpose described.

2. In a condenser, in combination with the two heads A and C, provided with transverse chambers, the tubes connecting such chambers, so that fluid flowing into the tubes at one end of the series will be caused to circulate throughout the whole series, and a series of tubes within such tubes, arranged so as to conduct a cooling medium throughout the extent of the outer tubes, substantially as and for the purpose specified.

3. In combination with the heads A and C, provided with the transverse chambers, the series of tubes connecting the upper chambers in the heads, the series of tubes connecting the lower chambers in the heads, the series of tubes connecting each of the other chambers in head A with the chamber preceding it in the series of chambers in head C, the series of tubes connecting the corresponding chambers in the series in both heads, the head E having chambers corresponding with those on head A, the tubes extending from these chambers through the lower tubes opening into the corresponding chambers in head A, and around back through the tubes opening into the next lower chamber in head A, inlet and outlet ports communicating with the upper and lower chambers in head A, and inlet and outlet ports or passages into and from the lower and upper chambers, respectively, in head E, substantially as and for the purpose set forth.

4. In combination with the condenser and means for conducting away the fluid condensed thereby, the reservoir and means for drawing off the contents thereof from near its bottom, substantially as and for the purpose described.

5. In combination with the reservoir for receiving the condensed fluid or liquid from the condenser, the discharge connection or nozzle and the pipe communicating therewith, extending down within the reservoir to a point near its bottom, substantially as and for the purpose specified.

6. In combination with the circulating-tubes of the condenser, the heads provided with partitions to form chambers and closing-plates for the heads, substantially as and for the purpose shown.

In testimony that I claim the foregoing I have hereunto set my hand this 16th day of March, 1886.

CHAS. A. DIXON.

Witnesses:

ROBERT WHITEHILL,

LEWIS M. SMITH, Jr.