No. 724,971. PATENTED APR. 7, 1903.

R. D. TOMLINSON.

SURFACE CONDENSER.

APPLICATION FILED AUG. 26, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

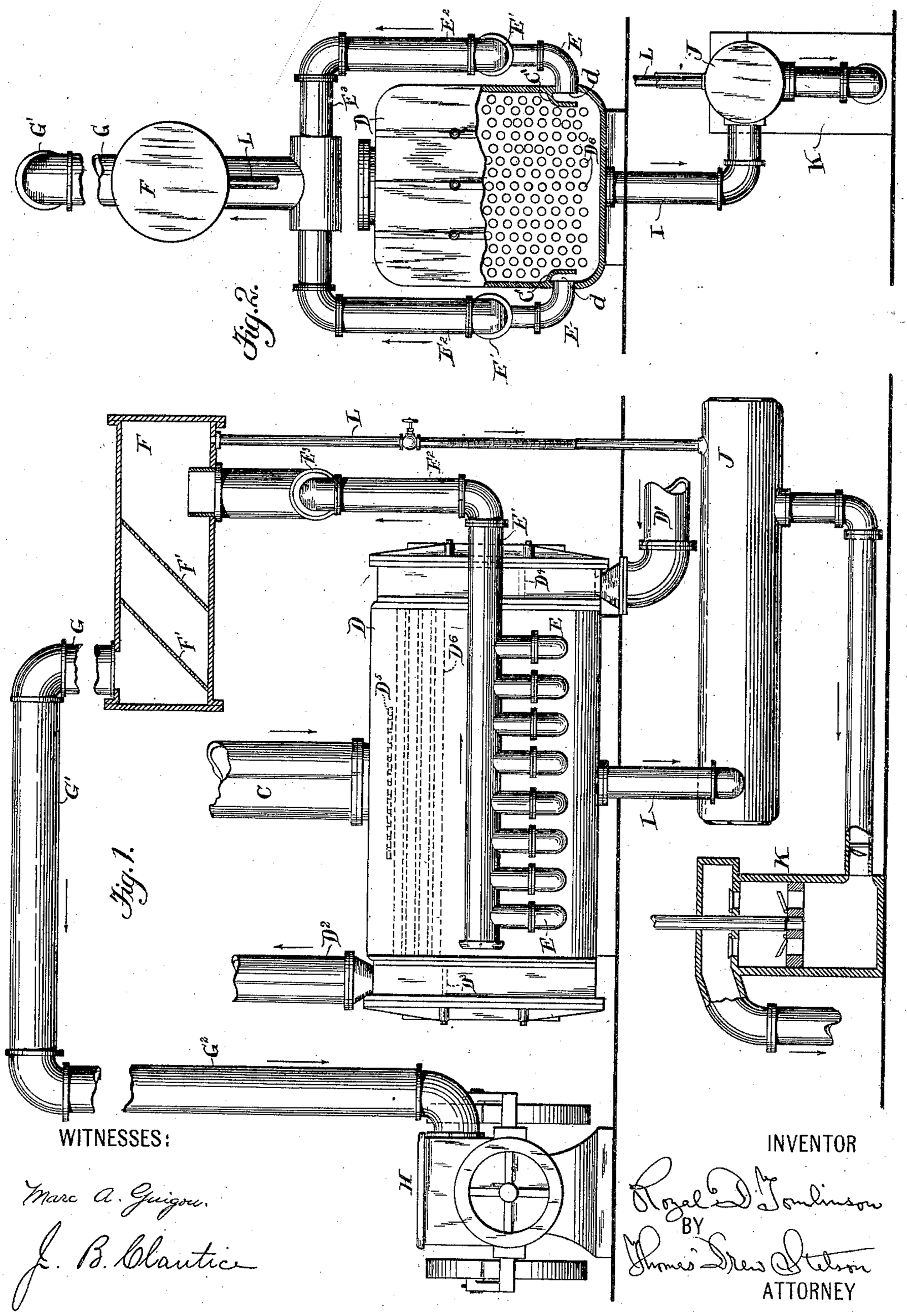

Fig. 1.

Fig. 2.

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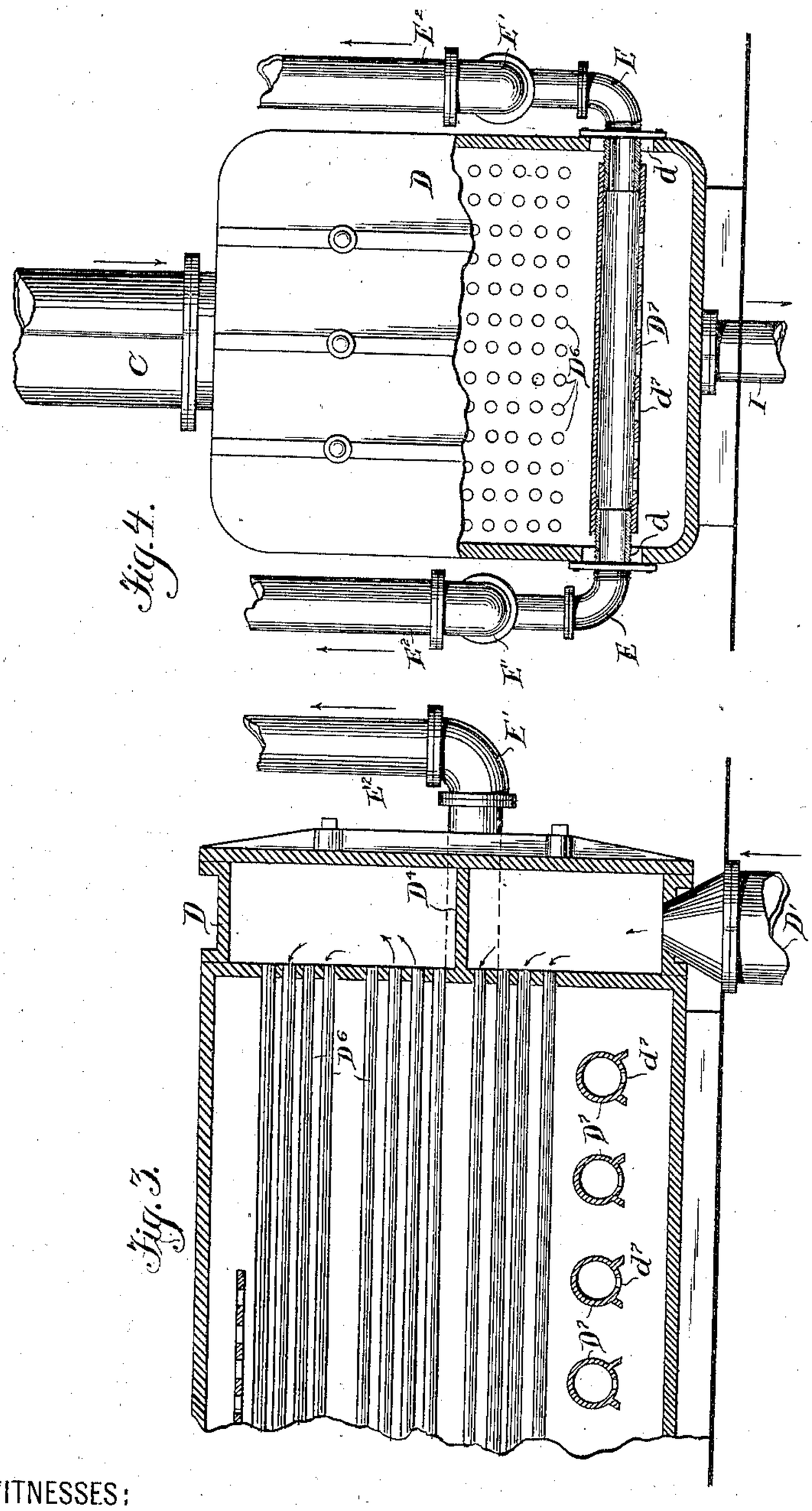

Fig. 4.

Fig. 3.

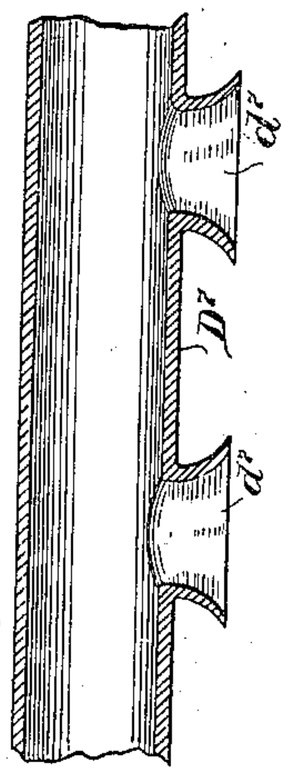

Fig. 6.

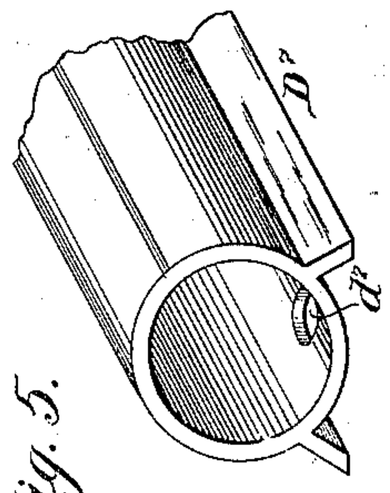

Fig. 5.

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SURFACE CONDENSER.

SPECIFICATION forming part of Letters Patent No. 724,971, dated April 7, 1903.

Application filed August 26, 1902. Serial No. 121,089. (No model.)

To all whom it may concern:

Be it known that I, ROYAL D. TOMLINSON, a citizen of the United States, residing in the borough of Manhattan, in the city and State of New York, have invented a certain new and useful Improvement in Surface Condensers for Steam-Engines, of which the following is a specification.

I have devised means for successfully applying to a surface condenser two air-pumps—one to pump the air and the other to pump the water. Such have been before used with jet condensers; but no means have been before available for realizing their advantages with surface condensers.

The feed-water when pumped into the boiler contains a certain quantity of air, which is liberated and accompanies the steam through the engine. In my apparatus the condensation of the steam is gradual, commencing among the warm tubes near the top and becoming more complete at the several levels below. The thin fluid matter remaining uncondensed changes its condition greatly, first having only the ordinary very small proportion of air; but after the steam has been mainly condensed the thin gaseous matter remaining and continuing to move downward in the same manner as the steam will be almost entirely air. My apparatus is adapted to utilize this change of the character of the uncondensed fluid in connection with a surface condenser and by pumping out but a small volume to attain a better vacuum than usual with no increased expenditure of power.

I bring the exhaust-steam from the engine through a large pipe offering practically no resistance, introducing it into the surface condenser at the top, and remove the water and air from the bottom. I take the air, with a very small admixture of uncondensed steam, from a series of equal apertures equally spaced near the bottom, and thus remove it uniformly from all points in the base of the condenser, taking it away by an ordinary quick-acting dry-air pump. I combine with this a reservoir at a lower level to receive the water, obviously much less than with a jet condenser. In this reservoir the water-surface may rise and sink as the water is received and removed. This allows the use of a slow wet-air pump.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is a side elevation, and Fig. 2 is an end elevation, certain portions being in vertical section. Fig. 3 is a longitudinal section through a portion, showing a modification. Fig. 4 is a corresponding end view, partly in cross-section. Fig. 5 is a perspective view of a portion thus modified. It is on a larger scale. Fig. 6 is a vertical section through the same portion of one of the transverse perforated tubes, modified by omitting the longitudinal ribs and substituting trumpet-shaped lips surrounding each of the large orifices.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

D is the condenser; D′, a pipe which brings the condensing water from any convenient source, as a circulating-pump, (not shown,) and D^2 is the delivery-nozzle, through which such water is discharged.

There are in the condenser D two horizontal partitions D^3 and D^4 about equally spaced. The circulating water, entering cold through the pipe D′, traverses the length of the condenser three times, being received at the bottom at the right hand in Fig. 1 and moving along the bottom to the left, where it rises and moves at the mid-height to the right, where again it rises and moves through the upper portion of the condenser to the left, and where, having absorbed the heat of the steam, it is delivered to flow idly away.

C is a large nozzle through which the exhaust is received from one or more steam-engines. (Not represented.) The steam, with its ordinary small proportion of air, entering through the pipe and nozzle C is spread by a perforated plate D^5 and moves down through the spaces between the water-tubes D^6, imparting its heat to the cooler surfaces of such tubes and becoming condensed. On approaching the bottom of the condenser after having traveled through the joggled spaces between the pipes from the top downward and being fur-

ther condensed at every step the thin gaseous matter remaining is composed largely of air. I take this to the dry-air pump from each side of the condenser near the bottom. (See Figs. 1 and 2.)

It is important that the steam be circulated as uniformly as practicable through the whole interior of the condenser. The spreader-plate D^5 contributes to this end; but there may remain considerable pockets in which the steam does not circulate actively and which, becoming filled with the air which remains after the condensation of the steam, defeats the efficiency of such portions of the condenser. I insure uniformity of the delivery from all parts of each side along the bottom and also promote the even distribution of the steam during the whole of its descent by arranging equally-sized and equally-spaced apertures *d* in a continuous row, one at each side near the bottom, with provisions for drawing the gaseous matter, mainly air, out uniformly through all these apertures.

It is not possible by the spreader-plate D^5 to introduce the steam into the spaces between the mass of pipes D^6 so as to exactly conform to the resistances encountered at different points. The greatest liability to such pockets is at the ends; but if the spreader throws the steam greatly toward the ends the mid-length is liable to "pocket," which term I use to mean becoming filled with air, which is stationary, or nearly so, and greatly reduces the efficiency of the apparatus.

The effect of my arrangement is to induce a uniform descent of the steam through the spaces between the condenser-tubes D^6 at each end and through all the intermediate portions of the condenser.

It will be understood that the condensing water flows through the lowermost tubes D^6 in its coldest condition, through the tubes at the mid-height in a medium condition of warmth, and in passing through the highest tubes it is raised very nearly to the temperature of the incoming steam; but these successive increases in the warmth of the water at each level and the more minute increase at the several successive stages in each tube being colder at the end where it enters and warmer at the end where it leaves does not defeat the advantage due to the uniformity of the distribution of the steam attained by my invention.

The thin gaseous matter, mainly atmospheric air, with a varying but always small proportion of uncondensed vapor drawn out uniformly through the passages *d*, is led upward through curved pipes E, secured to each, into connecting-pipes E′, of which one extends longitudinally on each side of the condenser, as clearly shown in Fig. 2. After extending beyond one end of the condenser these pipes E′ connect by elbows with upright pipes E^2, and these are joined by another elbow and extension E^3 and led into a large T, which connects with the bottom of a vessel F and extends a little upward into the interior thereof. This vessel is provided with inclined perforated partitions or screens F′ and serves as a separator to arrest and lead downward any remaining water or oil in the steam. Such liquid is led down by a pipe L into the condense-water receiver J and is taken away by the wet-air pump K. The "air," as I will now term it, thus rid of the last remaining condense liquid, is carried upward about thirty-three feet through a pipe G, a part of which is broken out to reduce the size of the drawing, thence led horizontally through a pipe G′, and finally downward through a pipe G^2 into the induction-port of a quick-working pump H, reciprocated by steam or other suitable power, (not shown,) and which serves as the dry-air pump to force out all the thin air thus received into the atmosphere.

It is important to avoid ever carrying dense liquid into the dry-air pump H, even when through any derangement, as a fracture of a tube D^6, a large quantity of such shall be momentarily drawn out through the pipe E.

The water of condensation, sometimes known as "condense-water," together with the water which may have leaked through any small defect in the joint and any oil which may be present, is carried through a different course. It gathers in the bottom of the condenser D and descends through a pipe I into an intermediate chamber or reservoir J. This should be of sufficient capacity to allow the fluctuations in quantity due to the intermittent working of a slow air-pump K, driven by a steam-engine or other suitable power, which performs the usual functions of an air-pump, drawing out the requisite quantity of water to maintain uniform conditions in the apparatus.

C′ represents shields cast on the inner faces of the condenser, one on each side, covering the junctions of each row of the orifices *d*, which communicate with the pipes E. These shields have the effect to insure that any water trickling down the inner faces of the interior shall be deflected and caused to fall to the bottom of the condenser under all circumstances. If there is not other room for these rows of shields, I omit such number of tubes as shall be required to allow sufficient space.

I attach importance to the fact that the shielded apertures *d*, through which the air is taken out to be led up to the dry-air pump, are arranged at low points in the condenser, because the gaseous matter is more largely air in the lower portions than in the higher portions of the condenser. The gaseous matter in the pipe C is mainly steam when it is received and distributed by the plate D^5 in all portions of the top; but the steam becomes condensed in descending between the cold tubes D^6, while the originally small proportion of air therein remains unchanged in quantity, and it becomes a larger and larger proportion as the gaseous matter moves downward. By locating the apertures *d* low and

shielding them so that they do not receive the descending drops of water these apertures *d* and the connected pipes E, &c., take out, mainly, air.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. There may be great changes in the proportions of the parts. The tubes may be larger or smaller than shown. I propose usually to employ small and thin tubes supported at two points intermediate. The condensing water may make a greater number of returns. I esteem it important to the most complete working that it returns one or more times and that the coldest tubes—those which allow the first travel of the water across the space between the tube-sheets—be at the bottom and the warmest be at the top or near the surface, whichever it be, where the steam is received, so that the incoming steam will be carried well in among the closely-packed and warm tubes, so that it will continue to be moved toward the colder delivery at the bottom before the condensation has proceeded so far as to liberate much air. I want all the air shall be dragged along and practically all the steam shall be condensed before the mixture reaches the level of the apertures *d*.

Fig. 3 shows a modification which in theory gives a still more even draft from all parts of the base of the condenser. In this form a few more of the condenser-tubes are omitted, taking care, if necessary, to add a little to the breadth or depth of the condenser to accommodate a sufficient number, and large tubes D^7, each liberally perforated along the bottom, are extended across the interior of the condenser from the apertures *d* on one side to the corresponding apertures on the other side. They tend to guard against the possible forming of any pocket at any intermediate points between the two sides of the condenser. In the high vacuum which my invention aids to maintain the air and steam or the air alone, whichever it may be, possesses so little force that its flow from the central part to the sides to give the uniform descent at all points which is desired may be materially promoted by providing the straight smooth ways afforded by these cross-tubes. The apertures d^7 in the bottoms of these should all be large; but I prefer that those near the mid-length be larger or nearer together, or both, than near each end. The material of these open-bottom cross-pipes may be thin, as there is very little strain on them. Their whole duty is to shed off the denser liquid and afford the thin gaseous matter so free a flow from all parts of the bottom that the descent in the irregular spaces between the condenser-tubes shall be uniform throughout the whole condenser.

I have shown ribs extending along on each side of the row of bottom apertures in Figs. 3, 4, and 5.

The modification shown in Fig. 6 shows pendent lips instead. Various other forms may be used. The object is to be certain to shed off the water descending from above and allow only air to enter and be conducted laterally.

I claim as my invention—

1. The combination of a dry-air pump and a wet-air pump with a surface condenser having shielded apertures *d* at low points in the condenser and provisions for taking out the air therefrom independently of the water, arranged to serve substantially as herein specified.

2. The combination of a dry-air pump and a wet-air pump with a surface condenser provided with apertures *d* distributed in lines along the delivery portion and with pipes E leading from such apertures to the dry-air pump adapted to equalize the movement of the mixture of steam and air through the several spaces, all substantially as herein specified.

3. The combination of a dry-air pump and a wet-air pump with a surface condenser provided with apertures *d* distributed in the delivery portion and with pipes E leading from such apertures to the dry-air pump adapted to equalize the movement of the steam and air through the several spaces, and with a capacious receiver in a connection from the bottom to the wet-air pump, all arranged to serve substantially as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

R. D. TOMLINSON.

Witnesses:
J. B. CLAUTICE,
M. F. BOYLE.