

No. 846,380.

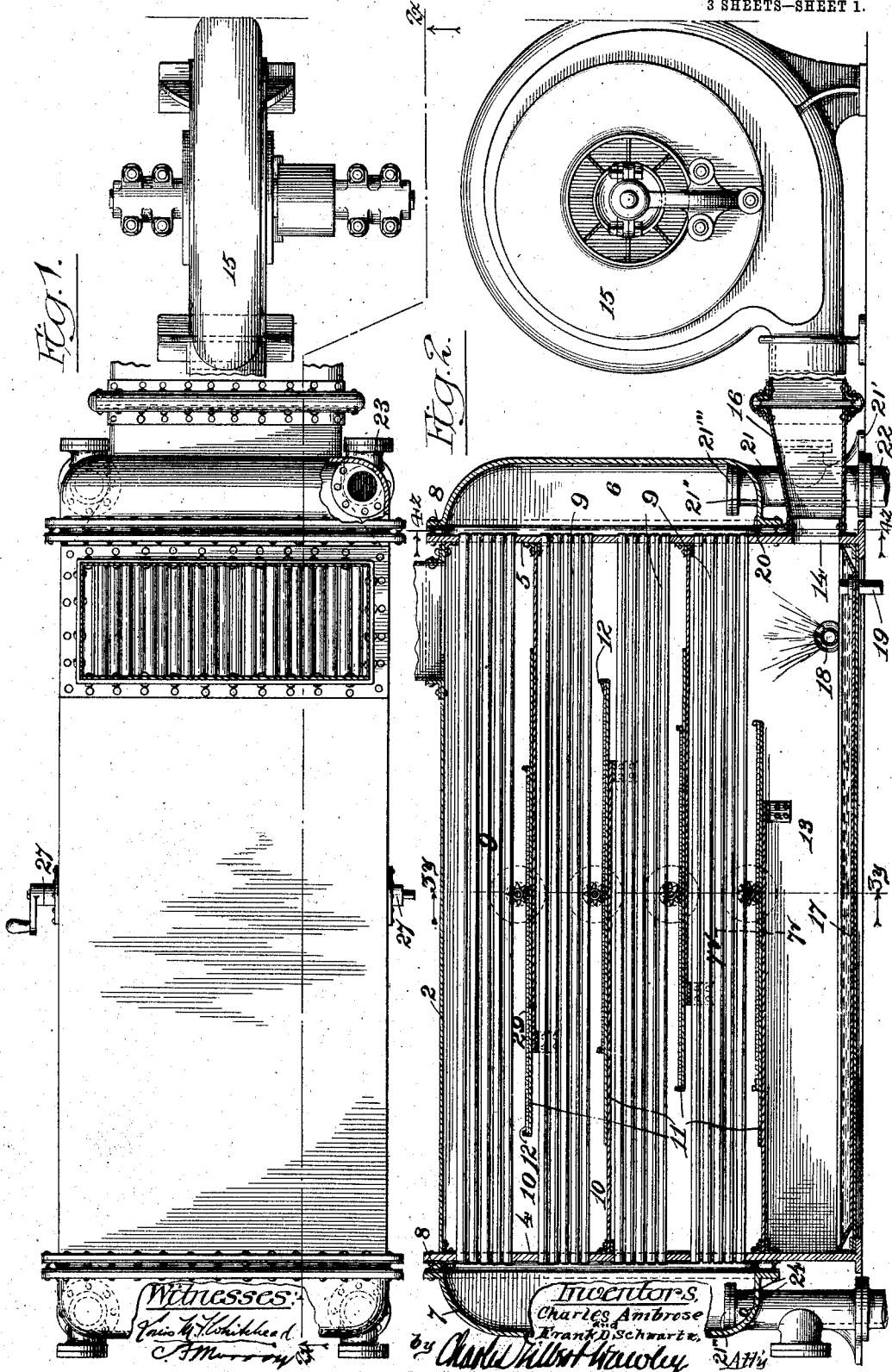
PATENTED MAR. 5, 1907.

C. AMBROSE & F. D. SCHWARTZ.

CONDENSER.

APPLICATION FILED SEPT. 13, 1905.

3 SHEETS—SHEET 1.



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Fig. 3.

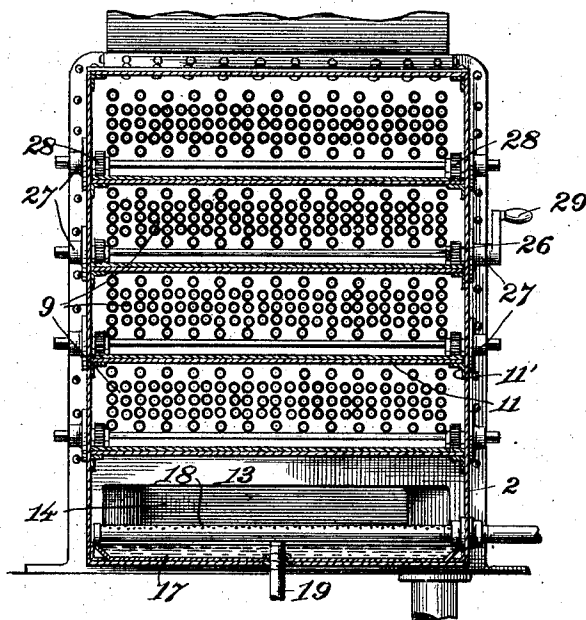
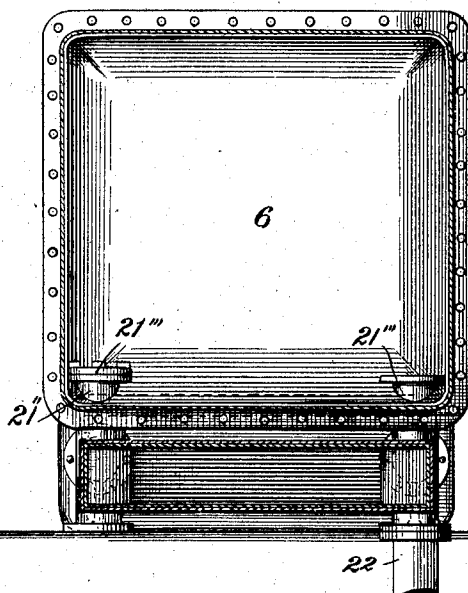


Fig. 4.



Witnesses:

Wm. H. Whitehead
C. A. Murray

Inventors:

Charles Ambrose
and Frank D. Schwartz

by Charles Gilbert Hawley Atty.

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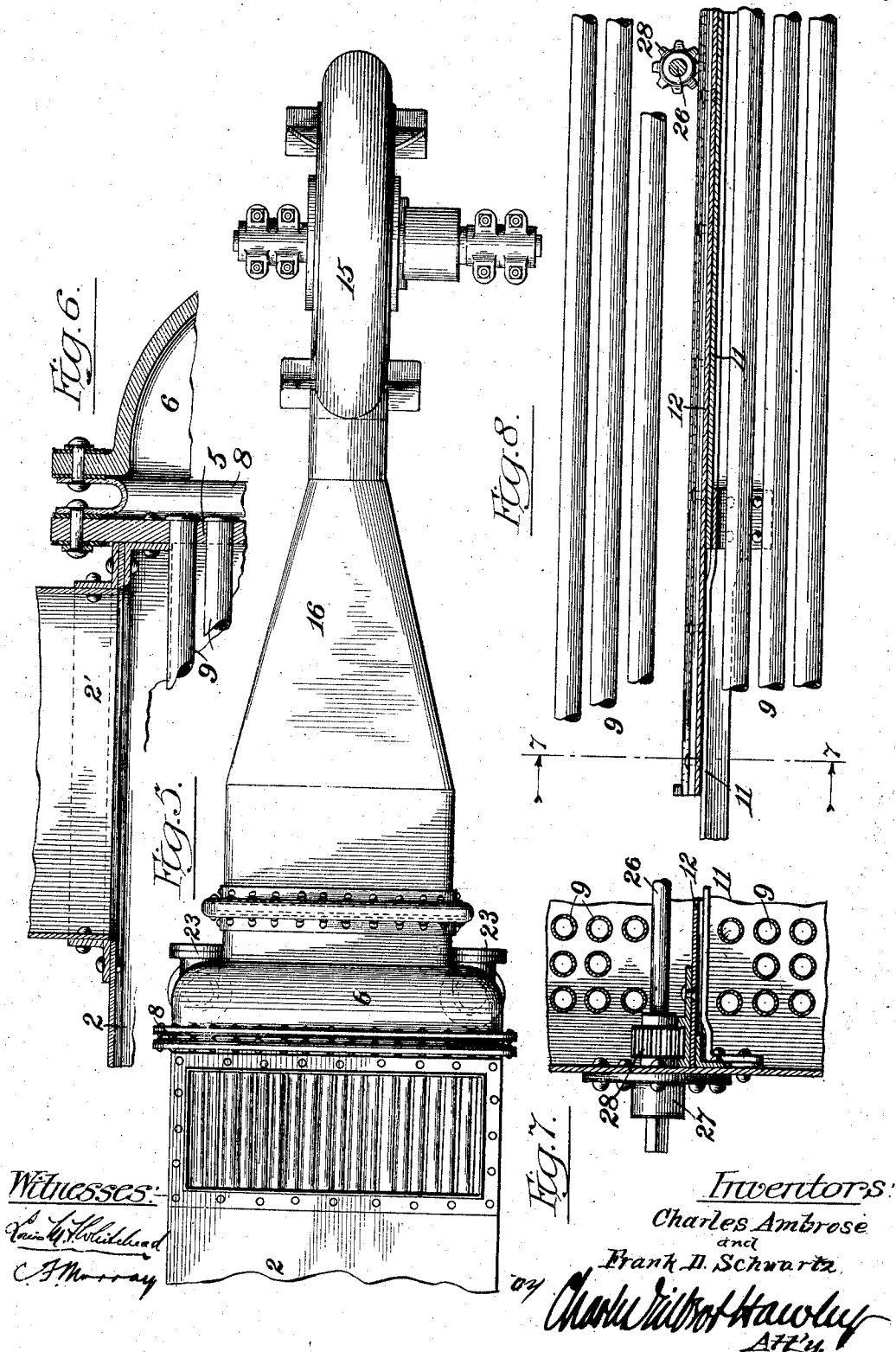
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3 SHEETS—SHEET 3.



UNITED STATES PATENT OFFICE.

CHARLES AMBROSE AND FRANK D. SCHWARTZ, OF CHICAGO, ILLINOIS.

CONDENSER.

No. 846,380.

Specification of Letters Patent.

Patented March 5, 1907.

Application filed September 13, 1905. Serial No. 278,211.

To all whom it may concern:

Be it known that we, CHARLES AMBROSE and FRANK D. SCHWARTZ, citizens of the United States, and residing at Chicago, Cook county, Illinois, have invented a certain new, useful, and Improved Condenser for Steam, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to improvements in steam-condensers, and has special reference to improvements in condensers of that class properly described as "air-cooled" condensers, wherein air is used as the cooling medium.

The object of our invention is to provide apparatus that shall be adapted to and shall enable the substitution of air for water in the condensation of steam in power plants.

There are in this country many arid and semi-arid regions in which the scarcity of water compels the use of simple direct-exhaust engines, because of the excessive cost of the water required for the operation of water-cooled condensers in connection with compound and turbine engines. This fact, coupled with the smaller cost of moving an adequate volume of air, has lead us to provide apparatus wherein confined bodies of steam may be condensed by exposure to rapidly-moving currents of air. We are aware that others have undertaken the solution of the same problem, but within our information and knowledge the results secured have not been wholly satisfactory as to the vacuum maintained, and in every case the apparatus has been objectionable because of its great size in proportion to water-cooled condensers of the same capacity.

The special objects of our invention are to provide an air-cooled steam-condenser that shall be as or more efficient than water-cooled condensers of the same approximate size and capacity, that shall be little, if any, larger than a water-cooled condenser of equal capacity, that shall use the supplied air in the most effective and economical manner possible, that shall be of less cost than water-cooled condensers of the same capacity, that may be operated with less attendant expense than such water-cooled condensers, that shall enable the maintenance of a high vacuum, and which shall be of such construction and

arrangement of parts that its operation may be nicely and accurately regulated and controlled in response to atmospheric changes and variations in the load or work to be performed.

Other objects of our invention will appear hereinafter.

Having in view these general and special objects, our invention consists, broadly, in an air-cooled steam-condenser having as its principal members a large drum or casing, means for driving large volumes of air there-through, suitable flue-sheets at the ends of said drum, a large number of steam-tubes extending through the drum and having their ends held in said flue-sheets, partial partitions arranged in said drums and providing therein a plurality of longitudinally-extending communicating air-ducts, whereby the air admitted to the drum is caused to move longitudinally upon and about said steam tubes or flues to effectively cool the same, and steam-admission and exhaust heads connected with said flue-sheets and in communication through said tubes or flues, whereby steam admitted to said tubes is quickly deprived of its heat and the temperature of the water of condensation is lowered to such point as to insure the maintenance of a high vacuum.

Further and specifically, our invention consists in an air-cooled steam condenser comprising an air-drum, in combination with flue-sheets closing the ends of said drum, a plurality of groups of steam-tubes arranged one above the other in said drum and held in said flue-sheets, said drum being provided with an air-trunk beneath the lowermost group of tubes, adjustable members arranged within said drum between the groups of tubes and providing a tortuous air-passage within the drum, suitable steam admission and exhaust heads communicating with said tubes, and a blast-fan connected with the air-trunk in the lower part of said drum to drive large volumes of air therethrough; and, further, our invention consists in an air-cooled steam-condenser, characterized as above, which is so constructed that the steam-tubes in different parts of the condenser may be subjected to different treatments for the purpose of equalizing the work performed in the different tubes and also the temperature of said tubes, it being desirable

that the tube temperature, and hence the expansion and contraction of the tubes, shall be uniform throughout; and, further, our invention consists in various details of construction and in combinations of parts, all as hereinafter described, and particularly pointed out in the claims.

The invention will be more readily understood by reference to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a plan view of a steam-condenser embodying our invention. Fig. 2 is a vertical longitudinal section of the condenser on the line 2^x 2^x of Fig. 1. Fig. 3 is a vertical transverse section on the line 3^y 3^y of Fig. 2. Fig. 4 is a front end elevation of the machine on the line 4^z 4^z of Fig. 2. Fig. 5 is a plan view of the front end of the condenser and the blast-fan. Fig. 6 is an enlarged sectional detail on the line 6^u 6^u of Fig. 5. Fig. 7 is an enlarged sectional detail substantially on the line 7^v 7^v of Fig. 2, showing the means employed for adjusting the longitudinal partitions within the air-drum. Fig. 8 is a longitudinal sectional detail on the line 8^w 8^w of Fig. 7.

The principle of our invention and the essential structural features of the apparatus are such that they admit of embodiment in apparatus or machines of different forms, and it is not our intention to confine our invention to the specific structures herein shown and described. By way of example, it may be here stated that our invention may be carried out with either a suction or a blast fan as a means for moving air through the condenser, yet the structures in the two cases are quite different.

We have chosen to present in this application the broad aspects of our invention in connection with a specific structure that includes a blast-fan, having already presented in another application, entitled "Steam-condenser," filed August 28, 1905, Serial No. 276,118, a somewhat-different structure, specially adapted to and including a suction or exhaust fan.

As shown in the drawings, 2 represents the air-drum which constitutes the body of our machine. This air-drum extends to the floor 3, being closed at the top, bottom, and sides. Its ends are closed by flue-sheets 4 and 5, which, preferably, also extend to the floor. Attached to the outer sides of the flue-sheets are the steam admission and exhaust heads 6 and 7.

8 are expansion-joints, which permit movement of the flue-sheets, such movement being occasioned by the expansion and contraction of the steam-tubes 9. These tubes 9 are arranged in groups. (See Figs. 2 and 3.) The tubes extend longitudinally in the drum, and their ends are secured in the flue-sheets 4 and 5. It will be noted that spaces

10 are left between the several groups of tubes, and in these spaces we arrange the longitudinal partitions 11, the same being parallel with the tubes. Each partition (see Figs. 2 and 3) extends from side to side of the drum or casing 2, and the partitions are alternated or staggered, as shown, to form a tortuous longitudinal air-passage within said drum. It will be noted that each division of the longitudinal passage contains a group of tubes 9. The partitions 11 are of less length than the drum, a space or opening being left between the inner end of each partition and the adjacent flue-sheets. This space is preferably larger in the case of the lower partition 11 and becomes smaller toward the top of the drum, the opening in the upper partition being smallest. As a means to vary the sizes of the communication-openings between the passages we provide each partition 11 with a movable sheet or extension 12, arranged to slide on the partition 11 and overhanging the inner end thereof. The particular means employed for moving the extensions or regulators 12 will be more fully described hereinafter. The top of the drum 2 is provided with an air-outlet opening 2'. The lower part of the air-drum contains an air-trunk 13 beneath the lowest partition 11. This air-trunk has an air-entrance opening 14 at its end adjacent to the opening in the lowest partition 11. 15 represents an air-blast fan, and 16 a blast-trunk, which is connected to the air-trunk 13 at the opening 14. When the fan 15 is in motion, a strong blast of air is delivered to the air-trunk 13, and escaping from the trunk the air flows rapidly upward through the many divisions of the longitudinal air-passage, making its escape finally at the exit 2' at the top of the air-drum. That portion of the air-trunk 13 opposite the entrance of the blast serves as a compression-chamber and tends to steady the current of air flowing through the drum. In the lower part of the air-trunk we provide a water-pan 17, which is kept full of water, and the air which enters from the blast-fan flows over the extensive water-surface, and is thereby effectually moistened. 18 represents a water-feed pipe, and 19 the overflow-pipe belonging to the pan or basin 17.

The construction of the steam-heads is peculiar. They are identical, and the description of one will serve for both. The head proper is little more than a cap, open at its inner side and substantially coextensive with the flue-sheets containing the steam-tubes. The bottom 20 of the head 6 is substantially on a level with the lowermost row of steam-tubes in order that it may deliver all water of condensation into said tubes. The head 6 is supported by two legs 21, one at each side, provided with broad flanges or feet 21'. The latter are firmly bolted to the floor or foundation, making the steam-head a

rigid structure. The legs 21 are integral with the head-casting, and their upper ends 21'' are extended through and into the head, rising to a point considerably above the lowermost steam-tubes 9. In this manner we form a water-trap in the bottom of the steam-head to prevent the backflow of water into the steam-supply pipe. The said legs 21 are hollow, and either one thereof may be connected with the steam-supply pipe 22. The upper end of the other hollow leg is preferably closed by a cap-plate 21''' within the head. The steam-supply pipe 22 generally rises through the floor; but as it is in some cases above the floor we cast one or more T's 23 upon each leg 21, these being closed when not used as pipe connections. This particular form or construction of the steam-admission head is specially advantageous, inasmuch as an opening is left beneath the head, through which opening the air-trunk 16 may pass, as shown. In the exhaust-head we avoid the trap feature above described by boring one or more holes 24 in the top of the hollow leg 21, which is connected with the vacuum-pipe 25.

We come now to the description of the adjustable partitions or partial floors within the air-drum. As the drum is filled with air under pressure, the making of openings therein must be avoided. We therefore employ a number of rotary shafts 26 for operating the several movable partitions. These shafts enter the drum through bearings or boxes on the sides of the drum, and, as best shown in Figs. 2, 3, 7, and 8, each shaft is provided with two small pinions 28, same being fixed to the shaft. The movable part 12 of the partition is provided with two gear-racks 29, wherewith the pinions engage. The ends 26' of the shaft are square, and by applying the key-crank 29 to either of said ends the shaft may be rotated. Obviously such rotation of the shaft will move the extension or part 12 toward or from the adjacent flue-sheet, according to the direction in which the shaft 26 is turned. The shafts 26 and their pinions serve another purpose—viz., that of holding the movable parts 12 upon the stationary partition parts 11 and the angle-bar extensions 11' thereof. We prefer to provide but one key 29 with each machine, for an obvious reason.

The operation of our invention is as follows: Steam is supplied to the admission-head 6 and flows therefrom through the tubes 9 toward the exhaust-head 7. The usual vacuum-pump (not shown) is connected with said head 7. The movable partitions 12 are so adjusted that the communication-openings between the air-trunk and the several divisions of the tortuous air-passage diminish in size toward the top of the drum. The effect of this arrangement is to shorten the linear movement or travel of the air in the

lower air-passages and relatively increase the travel in the upper air-passages. In other words, the rising temperature of the air as it progresses from the bottom to the top of the condenser is compensated by increasing the exposure of the steam-tubes to said air. Obviously changes of atmospheric temperature and changes in the quantity of steam supplied to the condenser may be readily met by simply adjusting the longitudinal partitions to increase or decrease the linear travel of the air in the tortuous passage as required. The blast of cold air which is supplied to the condenser takes on the necessary moisture while traversing the air-trunk 13 and flowing along the tubes in the drum effectively deprives the confined steam of its heat. Our condenser is of great capacity, and its dimensions are little, if any, greater than those of a water-cooled condenser of equal capacity.

It is obvious that numerous modifications of our invention will readily suggest themselves to one skilled in the art, and therefore we do not confine the invention to the specific constructions herein shown and described.

Having thus described our invention, we claim as new and desire to secure by Letters Patent—

1. In a steam-condenser an air-drum, in combination with flue-sheets, at the ends of said drum, a plurality of groups of steam-tubes, arranged in said flue-sheets, a plurality of longitudinal partitions arranged between the groups of tubes and providing a tortuous longitudinal air-passage within said drum, an air-trunk at the bottom of the drum parallel with said air-passage, a blast-fan connected with said air-trunk and suitable steam admission and exhaust heads communicating with said steam-tubes, substantially as described.

2. In a steam-condenser, an air-drum, containing a plurality of longitudinal partitions, dividing the same into an air-blast-steadying trunk open at one end only and a tortuous longitudinal air-passage, in combination with groups of tubes arranged in the divisions of said passage, steam admission and exhaust heads communicating with said tubes, air-moistening means provided in said air-trunk and a blast-fan, for delivering air to said trunk, substantially as described.

3. In a steam-condenser, a closed air-drum, containing a steadying-trunk and a tortuous air-passage and having air entrance and exit openings at the ends of said passage, in combination with means for increasing and decreasing the length of said passage, a fan connected with said drum, steam-tubes arranged longitudinally in the air-passages of said drum and steam admission and exhaust heads, communicating with said tubes, substantially as described.

4. In a steam-condenser, a closed air-drum,

having air entrance and exit openings and containing a tortuous longitudinal air-passage, in combination with means for moving air through said passage, steam-tubes, arranged longitudinally in the several divisions of said air-passage, steam admission and exhaust heads communicating with said steam-tubes and a water-trap provided in said steam-admission head, substantially as described.

5. In a steam-condenser, an air-drum, provided with air entrance and exit openings and having an air-trunk and a water-pan or drum in its bottom, in combination with horizontal, staggered partitions in said drum, horizontal, longitudinal steam-tubes extending through the ends of said drum, steam admission and exhaust heads communicating with said tubes, and means for causing large volumes of air to flow over said pan and upward through said drum, substantially as described.

6. In a steam-condenser, an air-drum, provided with air entrance and exit openings and containing a plurality of steam-tubes, in combination with steam admission and exhaust heads closing the ends of said drum, a plurality of longitudinally-adjustable partitions in said drum, rotary shafts extending across said partitions, shaft-bearings in the

sides of the drum, and means for rotating said shafts to adjust said partitions, substantially as described.

7. In an air-cooled steam-condenser, an air-drum containing steam-tubes, in combination with a plurality of longitudinal partitions therein, movable partition parts, racks at the sides of each said part respective rotary shafts borne in the walls of said drum and gears on said shafts, meshing with said racks for adjusting said parts, substantially as and for the purpose specified.

8. In a steam-condenser, an air-drum having flue-sheets closing its ends, in combination with a plurality of tubes held in said sheets, longitudinal partitions within said drum, steam admission and exhaust heads, an air-trunk or pressure-steadying chamber in the bottom of said drum, and a blast-fan adapted to discharge air into said air-trunk, substantially as described.

In testimony whereof we have hereunto set our hands, this 9th day of September, 1905, in the presence of two subscribing witnesses.

CHAS. AMBROSE.

FRANK D. SCHWARTZ.

Witnesses:

CHAS. MURRAY,

H. S. AUSTIN.