Sept. 29, 1925.

1,555,079

S. W. RUSHMORE

RADIATOR CONDENSER

Filed Nov. 18, 1922

2 Sheets-Sheet 1

Fig. 1.

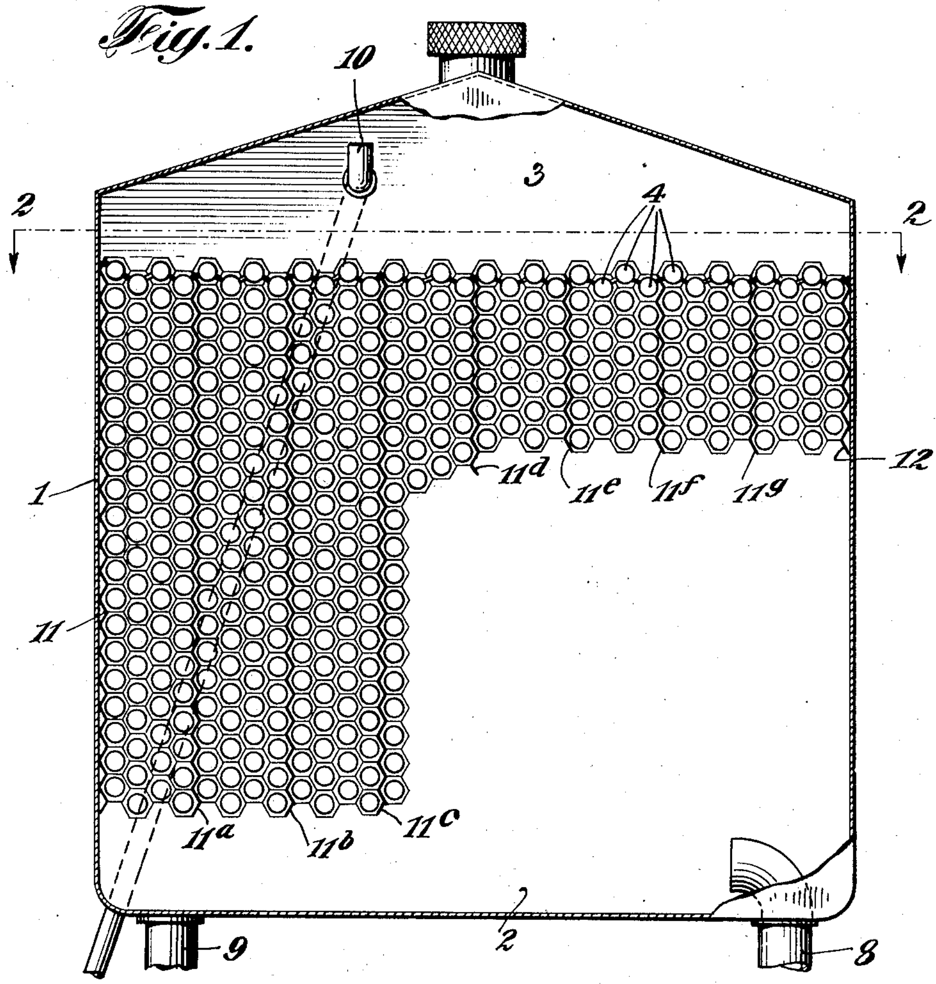
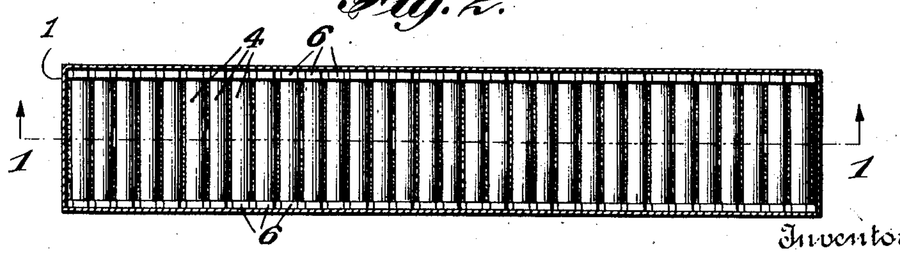


Fig. 2.



Inventor

Samuel W. Rushmore

By George C. Heau

his Attorney

Sept. 29, 1925.

1,555,079

S. W. RUSHMORE

RADIATOR CONDENSER

Filed Nov. 18, 1922

2 Sheets-Sheet 2

Fig. 3.

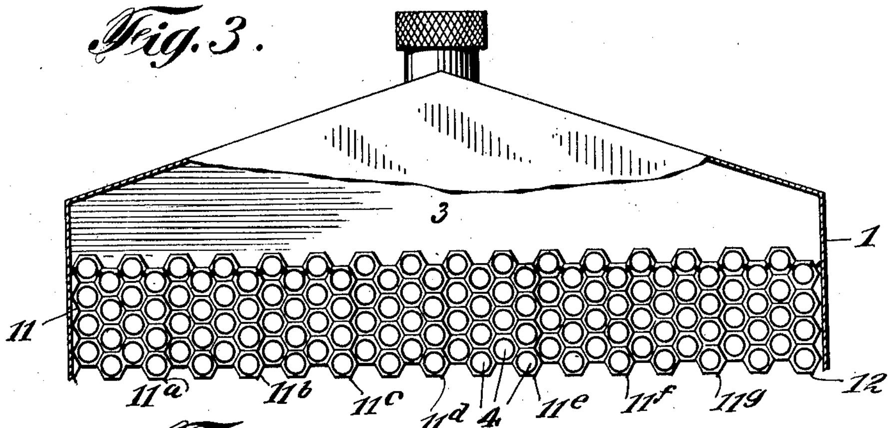


Fig. 4.

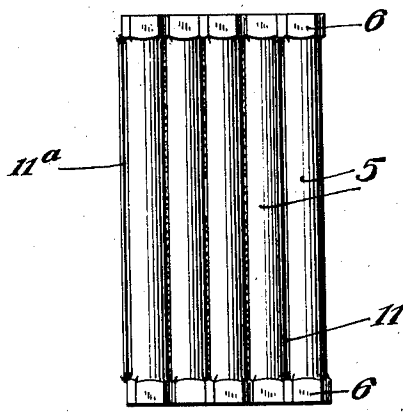
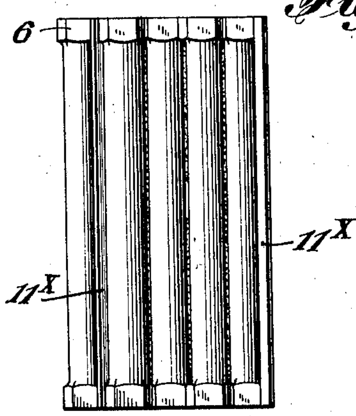


Fig. 5.



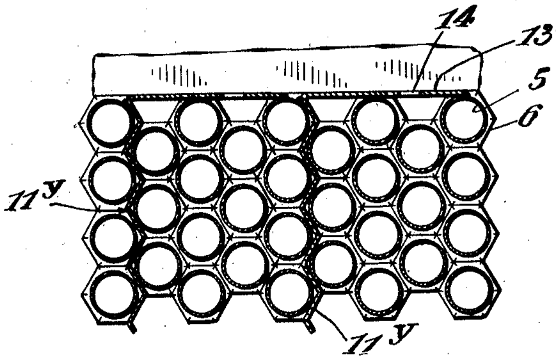


Fig. 6.

Inventor
Samuel W. Rushmore

By George C. Heinicke [signature]
his Attorney

Patented Sept. 29, 1925. **1,555,079**

UNITED STATES PATENT OFFICE.

SAMUEL W. RUSHMORE, OF PLAINFIELD, NEW JERSEY.

RADIATOR CONDENSER.

Application filed November 18, 1922. Serial No. 601,681.

To all whom it may concern:

Be it known that I, SAMUEL W. RUSHMORE, a citizen of the United States, and resident of Plainfield, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Radiator Condensers, of which the following is a specification.

My present invention relates to radiators, particularly radiators for use with cooling systems of the type which operate by the boiling and condensing cycle for the cooling of automotive engines, on the principle described in my Patent No. 1,378,724, granted May 17, 1921. In such system the water and steam from the engine jacket is discharged into a separating chamber in the bottom of the radiator, the water being returned to the engine jacket and the steam rising into the air-cooled passages of the radiator, so that the radiator operates as an up-flow condenser, the condensate returning by gravity against the upward flow of steam.

In said patent this method is referred to as applicable to radiators of the types which are now employed as standard equipment on automobiles, trucks, etc., but such radiators are primarily designed for cooling of water instead of steam, by down-flow instead of up-flow, and I have discovered that in the practical operation of such radiators by the "steam cooling" system, the potential cooling capacity is not properly utilized.

The primary difficulty is that the fan which draws the cooling air through the radiator, induces a much heavier blast in the central portions of the condensing area than at the sides. Consequently the central portions are capable of radiating much more heat and condensing much more steam per unit of cooling surface, than are the sides. But the side passages which are least cool are designed to have the same, or less, flow resistance than the central portions, with the result that where the relatively frictionless, massless steam is substituted for water, the balance between the several up and down passages, as regards flow capacity and condensation capacity, is completely upset.

Careful experiment shows that long before the total volume of steam to be condensed becomes great enough to tax the cooling capacity of the radiator as a whole, the inferior cooling capacity at the sides will be over-taxed. The heat therefore creeps higher up, heating the side portions; the air becomes lighter so that the hot air and steam rise into the empty space at the top of the radiator displacing the colder air downward (because the colder air is heavier and because air, even at 212° F., is about 60% heavier than steam); but the same or even greater volume of steam flowing directly up into the better-cooled central portions is condensed long before it reaches the top, the passages and air above it being kept cold by the fan. The upflowing steam can push the air upward only the limited height to which such steam rises before being condensed.

As a result there remains in the central portion of the radiator a body of air which is supported from below by up-flowing steam and sealed in above by steam rising from the sides. Reverse curl or eddying of such steam from the sides may serve to scavenge out more or less of the air in the relatively open space above the honeycomb, but has practically no effect on the air trapped and kept cold in the narrow central passages of the radiator. Hence the air thus trapped, stays trapped, practically excluding the steam which might otherwise flow in from top, sides and bottom.

While this objectionable action may be more readily analyzed and understood in connection with radiators of the type in which the steam passages are parallel vertical conduits having no cross flow connections except at top and bottom, nevertheless, the same action is found to occur to an undesirable extent in radiators of the type in which the honeycomb is built up from a multiplicity of short horizontal tubes forming an interconnected net-work of passages.

In my prior application, Serial No. 520,209, filed December 6, 1921, I have disclosed how this difficulty may be obviated by increasing the flow resistance at the sides of the radiator by making the air tubes of larger size. By this expedient the radiating area at the sides is also increased as compared with the radiating area at the center.

My present application discloses another and simpler method of obviating the same difficulties. The present method involves using cross tubes for the air which are all of the same size and therefore of the same radiating area. I render the flow resistances at the sides independent of the flow resistances at the center by interposing a series of vertical partitions and closing in the flow path exits between tubes of the top row, except for individual vents controlling escape of steam and air from the net-work of flow paths between adjacent partitions.

Two general methods are shown. The simplest is to simply run solder in the narrow spaces between the top sets of tubes, preserving only one or more vents for each partitioned section. This may be easily accomplished in practice by simply inserting a wedge or spacer between two of the top tubes of each section before running in the solder. Another way is to provide the partition strips with horizontal sections closing in the tops of each group of tubes, each top closure being provided with a vent of the desired flow capacity.

In either case, the partition strips may be the same as the strips now used to close in the tubes at the sides of the radiator. In practice the core of the radiator may be built up from one side to the other by assembling in hexagonal relation a number of rows of tubes necessary to constitute one of the side sections, then inserting a partition strip, then assembling an additional number of tubes necessary to constitute the second section, and so on up until the entire width of the radiator has been built up. Either before or after the core has been soldered into the radiator casing which affords the usual lower and upper cavities, the interspaces between tubes of what is to be the upper row, may be closed in either by soldering between the adjacent tubes or by bending across the soldering the horizontal extensions of the vertical partition strips.

In the present case I have shown the invention as applied to a cross tube radiator designed and proportioned somewhat as in the Rolls-Royce car. In radiators of this type, the core is rectangular so that the flow paths at the sides of the radiator are of the same height as the flow paths at the center. In these radiators the flow paths are such that in practice about seven partitions dividing the radiator into eight vertically segregated sections will be found desirable. All of the sections may be obstructed and vented at the top in either of the ways described, but in practice the cooling capacity at the center of the radiator is usually so great that it will be sufficient to close off and vent three sections on each side, leaving the two center sections substantially unobstructed.

The above and other features of my invention will be evident from the description in connection with the accompanying drawings, in which—

Fig. 1 is a vertical section of a cross tube radiator on the line 1—1, Fig. 2, showing my invention applied thereto.

Fig. 2 is a section looking down on the line 2—2, Fig. 1.

Fig. 3 is a vertical section like Fig. 1 but showing a modification.

Fig. 4 is a detailed view showing the partition plates as extending only to the hexagonal heads of the cross tubes.

Fig. 5 is a similar view showing the partition strips extending through from front to rear face of the radiator.

Fig. 6 is a detailed vertical section showing the vertical partition strips as having integral horizontal extensions closing in the top of sections between each adjacent pair of partitions.

In these drawings, the cross tubes are shown in detail and approximately full size only in Figs. 4, 5, and 6. It will be understood that in Figs. 1, 2, and 3 the tubes are shown proportionally larger in size and fewer in number than in actual practice, the actual radiator core comprising many more tubes than shown in these figures. Moreover the minimum interspaces between adjacent tubes are less than indicated, usually about $\frac{1}{32}$ inch.

In Fig. 1 the radiator is shown as comprising a casing 1 having the usual lower space or chamber 2 and upper space or chamber 3 and the intermediate "core" or "honeycomb" comprising a multiplicity of front-to-rear tubes 4, the interiors of which afford parallel paths for through-flow of cooling air from front to rear. Usually the tubes have cylindrical body portions 5 and hexagonal ends 6, the hexagonal ends being all the same size for convenience of assembly and soldering, while the cylindrical portions are preferably of slightly less diameter than the minimum diameter of the hexagon so as to afford a net-work of interspaces 7 for up-flow of steam which is to be condensed. The bottom space 2 is provided with an inlet 8 and an outlet 9, through which the circulation from the water jacket is short-circuited, the space 2 serving as a separating chamber for the steam.

The top of the radiator may be provided with a filler cap, and, if desired, with an overflow pipe 10. Any other desired forms of vent, including pressure vent valves, such as shown in my said patent, may be employed if desired.

As is usual in radiators of this type there are zig-zag sheet metal strips 11, 12, secured to the sides 1 and closing in the outside hexagonal faces of the tubes 4. Similar strips, as 11^a, 11^b, 11^c, 11^d, 11^e, 11^f, and 11^g, are arranged parallel with 11 and 12 at intervals across the honeycomb dividing the same into vertically extending sections. In each of these sections, there is cross communication between the vertical flow paths, but the partition strips prevent cross communication between the flow paths of the different sections.

The sections are closed in at the top by running in solder as indicated in Figs. 1 and 2, the solder being omitted, however, at one point between two of the tubes at the top of each section to afford a common vent for all of the vertical flow paths included in said section. In actual practice the tubes have only about $\frac{1}{32}$ inch clearance, so that, if the surfaces are properly fluxed, the hot solder easily fills and seals the interspaces. In fact, I have discovered that in practice a skilled operator can "run" the solder between the tubes with surprising speed, only a few minutes being required for a large radiator. A thin flat wooden wedge is stuffed in the place where the vent is to be and is withdrawn after the soldering has been completed, no special care being required.

In Fig. 3, I have shown how the partition sheets 11^a, etc., may be of a width merely equal to the distance between hexagonal heads of the tubes, the edges being interiorly sealed by the solder, as indicated. If desired, the partitions may be extended through from front to rear, as indicated at 11^x, Fig. 5.

Fig. 6 shows how the tops of the sections may be closed in by having the sheet metal cap elements 13 each provided with a vent 14. In the form shown the closure 13 is a folded over end or extension, integral with sheet metal partition strip 11^y. The free ends of these strips may be soldered to each other or both soldered to one of the transverse tubes as indicated in said Fig. 6.

It is obvious that the number of partitions and the vertical sections segregated thereby may be considerably greater or less than the number shown in the drawings. It is not always necessary to close in and vent all of the sections. For instance, as in Fig. 3, the two center sections may be left entirely open at the top; or, as in Fig. 1, they may be all closed in and vented.

By having all the sections closed in and vented, the liability of cross flow of steam in the upper tank and down-flow thereof trapping air in the central tubes is greatly reduced. As explained elsewhere, the vents, while of sufficient capacity to permit in and out breathing of air during the normal slow variations of height of steam in the radiator, are yet small enough to throttle and greatly retard any outrush of steam. When the central sections are closed and vented as in Fig. 1, there is the additional advantage that if the operator should remove the filler cap immediately after stopping the engine when working at full load, there would not be any possibility of a copious discharge of steam and boiling water. In such case the discharge out of the filler opening could be only the combined discharge from the six smaller vents of the side sections, plus the two larger vents of the center sections. The areas of the latter are preferably made substantially larger than the breather vents of the side sections, being designed for properly throttled relief for excess water and steam, under such conditions; so that the combined discharge will be too small to produce an outrush such as would cause injury to the inquisitive operator. In either Fig. 1 or Fig. 2, the discharge vents may be directed away from the filler opening or deflecting plates may be interposed above the open tops of the central sections.

Broad claims covering my present invention will be found in my prior application, Serial No. 520,210, filed December 6, 1921, as also further details as to means for and advantages of restricting flow of steam at the sides and less well-cooled sections of the radiator. The claims hereof are limited to features not specifically claimed in said prior application.

I claim:

1. A variable-duty, air-cooled radiator including a lower chamber with means for discharging boiling liquid or steam into said lower chamber and for withdrawing therefrom the separated liquid and condensate; and, above said chamber, a radiating core or honeycomb comprising a multiplicity of transverse tubes for through-flow of cooling air, arranged so that their interspaces form an interconnecting net-work of paths for upward flow of steam from said lower chamber, in combination with a desired number of upwardly extending partitions dividing the net-work into a plurality of separate sections, said interspaces being of restricted flow section so as to afford substantial flow resistance thereby tending to equalize the upflow into the several sections.

2. A variable-duty, air-cooled radiator including a lower chamber with means for discharging boiling liquid or steam into said lower chamber and for withdrawing therefrom the separated liquid and condensate; and, above said chamber, a radiating core or honeycomb comprising a multiplicity of transverse tubes for through-flow of cooling air, arranged so that their interspaces form an interconnecting net-work of paths for upward flow of steam from said lower cham-

ber in combination with a desired number of upwardly extending partitions dividing the net-work into a plurality of separate sections, and flow-limiting means for certain of said sections.

3. A variable-duty, air-cooled radiator including a lower chamber with means for discharging boiling liquid or steam into said lower chamber and for withdrawing therefrom the separated liquid and condensate; and, above said chamber, a radiating core or honeycomb comprising a multiplicity of transverse tubes for through-flow of cooling air, arranged so that their interspaces form an interconnecting net-work of paths for upward flow of steam from said lower chamber in combination with a desired number of upwardly extending partitions dividing the net-work into a plurality of separate sections, and vented flow-limiting means for the upper ends of the side sections.

4. A variable-duty, air-cooled radiator including a core or honeycomb comprising a multiplicity of transverse tubes for through flow of cooling air, arranged so that narrow interspaces between adjacent tubes form an interior net-work of cross-communicating paths for flow of the medium to be cooled, certain sections of said net-work which have different cooling capacities being divided from one another to prevent cross flow of steam between them, in combination with means for up-flow supply of steam or vapor into the lower portions of the several sections of the net-work, and for removing the down-flowing condensate; selected sections which have less condensing capacity being arranged to have greater flow resistance.

5. A variable-duty, air-cooled radiator including a core or honeycomb comprising a multiplicity of transverse tubes for through flow of cooling air, arranged so that narrow interspaces between adjacent tubes form an interior net-work of cross-communicating paths for flow of the medium to be cooled, certain sections of said net-work which have different cooling capacities being divided from one another to prevent cross flow of steam between them, in combination with means for up-flow supply of steam or vapor into the lower portions of the several sections of the net-work, and for removing the down-flowing condensate; and means for closing in and venting the flow path exits at the upper ends of the sections which have less condensing capacity.

6. A variable-duty, air-cooled radiator including a core or honeycomb comprising a multiplicity of transverse tubes having cylindrical body portions and interfitting hexagonal ends for through flow of cooling air, arranged so that narrow interspaces between adjacent tubes form an interior net-work of cross-communicating paths for flow of the medium to be cooled, in combination with means for up-flow supply of steam or vapor into the lower portions of the several sections of the net-work, and for removing the down-flowing condensate; the flow path exits between certain tubes of the upper rows being sealed and vented to afford the desired degree or restriction.

7. A variable-duty, air-cooled radiator including a core or honeycomb comprising a multiplicity of transverse tubes having cylindrical body portions and interfitting hexagonal ends for through flow of cooling air, arranged so that narrow interspaces between adjacent tubes form an interior network of cross-communicating paths for flow of the medium to be cooled, certain of the flow paths between certain tubes being closed by solder to modify the flow capacities in desired regions.

8. A variable-duty, air-cooled radiator including a core or honewcomb comprising a multiplicity of transverse tubes for through flow of cooling air, arranged so that narrow interspaces between adjacent tubes form an interior net-work of cross-communicating paths for flow of the medium to be cooled, certain of the flow paths between certain tubes being closed by solder to modify the flow capacities in desired regions.

9. A condenser in which the cooling element comprises a multiplicity of transverse tubes arranged so that narrow interspaces between adjacent tubes form an interior network of cross-communicating paths for flow of medium to be cooled, in combination with a plurality of vertically arranged partition strips dividing the net-work into a plurality of vertically extending sections and means for closing in and venting the tops of the side sections.

10. A condenser in which the cooling element comprises a multiplicity of similar transverse tubes each having slightly enlarged hexagonal end portions laterally fitting hexagonal end portions of adjacent tubes, arranged so that narrow interspaces between the body portions of adjacent tubes form an interior net-work of cross communicating paths for flow of medium to be cooled, in combination with a plurality of vertically arranged partitions dividing the net-work into a plurality of vertically extending sections, each partition being a reversely bent strip of sheet metal, the edges of which extend between, conform to and fit the hexagonal sides of the ends of the tubes which it separates; and means for closing in and venting the tops of the side sections.

11. An air-cooled condensing apparatus including a multiplicity of transverse tubes for through flow of cooling air and affording interior, laterally distributed, parallel paths for flow of fluid to be cooled, some of

which parallel paths have less cooling capacity than others; and means for supplying said fluid to the parallel paths from a common source; certain of the parallel flow paths of less cooling capacity being arranged to have substantially greater total flow resistance than those having greater cooling capacity; for the purpose and with the result that the fluid automatically flows in greater quantity to the flow paths having greater cooling capacity.

12. A cross tube radiator core for use as an upflow steam condenser comprising plurality of connected sections, each section including similar tubes with cylindrical bodies and hexagonal ends, the ends being laterally interfitted to form rows, zig-zag strips of sheet metal interposed between the edges of adjacent sections and solder closing the interspaces between the tubes at the upper ends of the sections.

13. A radiator as specified in claim 12 and wherein vent holes are provided in the solder.

Signed at New York, in the county of New York and State of New York, this 16th day of November, A. D. 1922.

SAMUEL W. RUSHMORE.