# United States Patent [19]

**Huber**

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[54] **METHOD AND APPARATUS FOR CONDENSING STEAM**


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[21] Appl. No.: **479,722**

[52] **U.S. Cl.** ..... **165/1;** 165/110; 165/122; 165/138; 165/159

[51] **Int. Cl.** ..... **F28b 1/06**

[58] **Field of Search** ..... 165/110, 122, 111, 159, 165/1



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,256,993 | 9/1941 | Van Vleet | 165/159 |
| 3,351,131 | 11/1967 | Berthold | 165/159 |
| 3,424,235 | 1/1969 | Schoonman | 165/110 |
| 3,543,843 | 12/1970 | Gunter | 165/111 |
| 3,731,734 | 5/1973 | Ris et al. | 165/110 X |

FOREIGN PATENTS OR APPLICATIONS

| | | | |
|---|---|---|---|
| 1,057,872 | 2/1967 | United Kingdom | 165/138 |



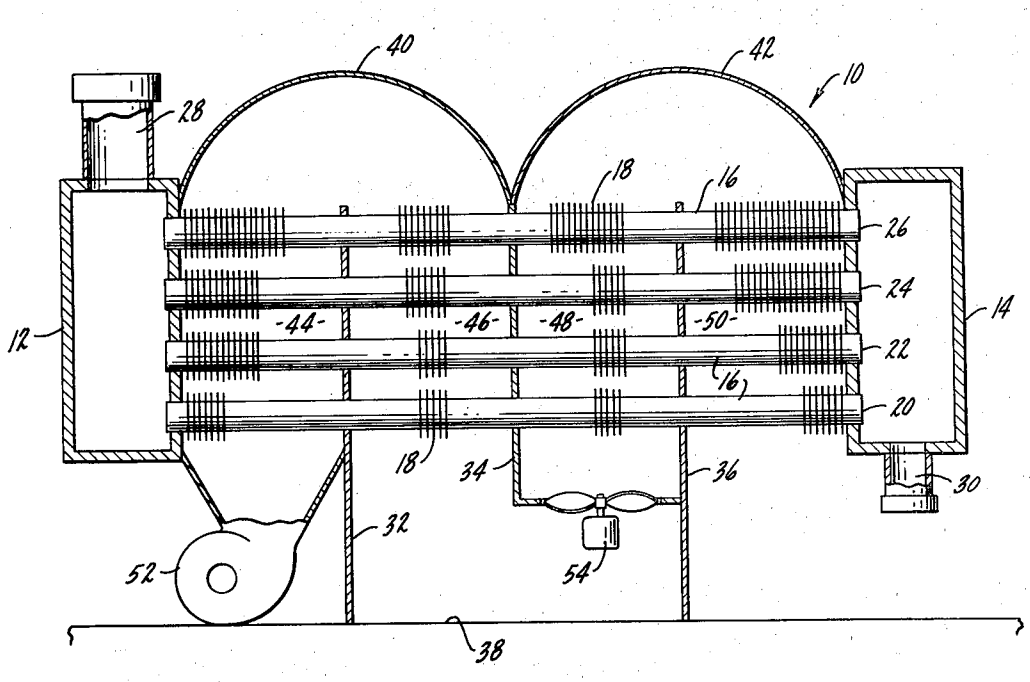
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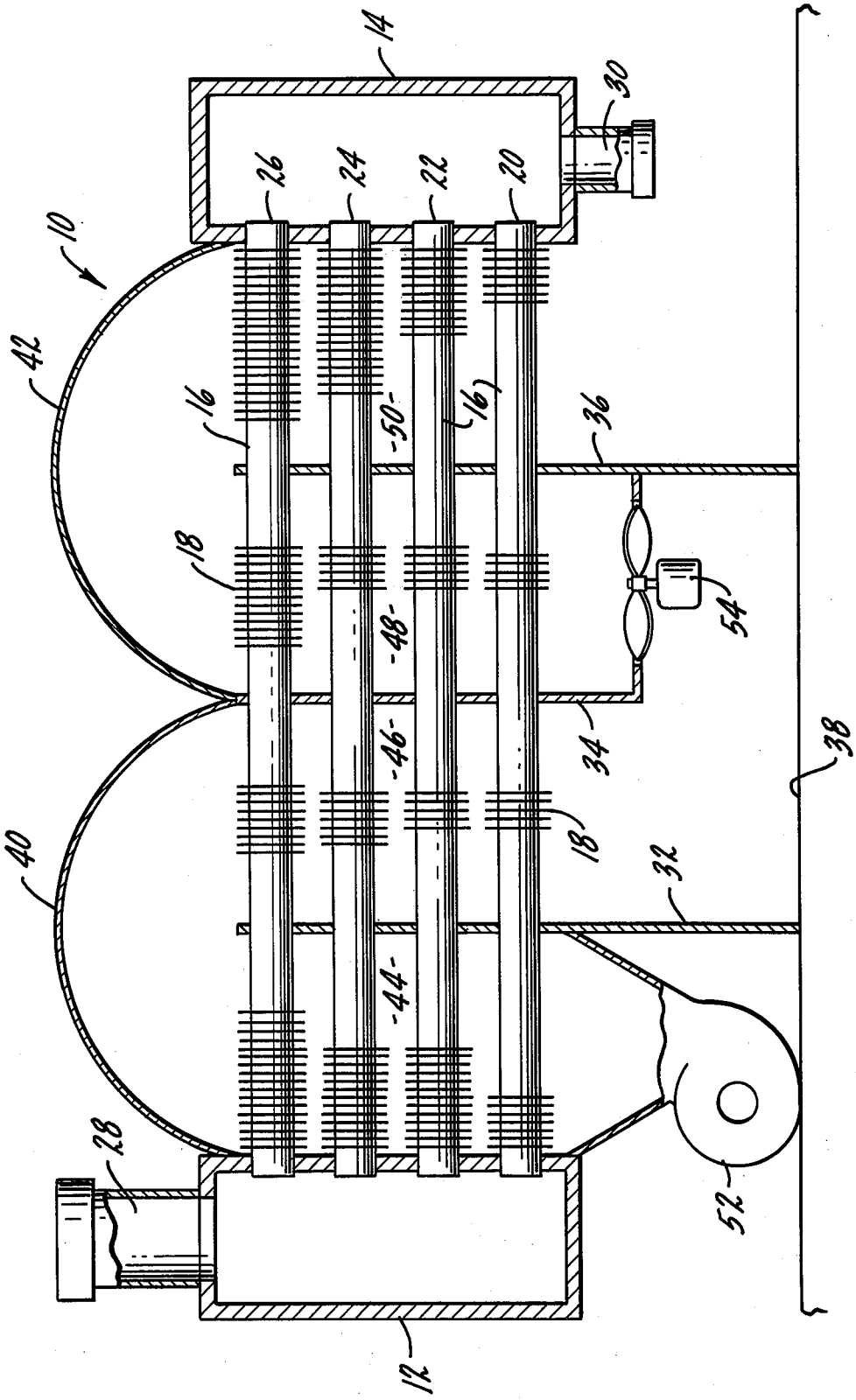


[57] **ABSTRACT**

A method and apparatus for attaining an even distribution of steam following through the heat exchange tubes of an air cooled steam condenser. The method resides in the return of the cooling air, which has passed across initial lengths of the heat exchange tubes, back across the tubes to give an opposite temperature differential in the succeeding tube lengths so as to mollify the temperature effects which cause a maldistribution of the steam in the condenser. A preferred embodiment is disclosed which includes partitions and return hoods separating the heat exchange tubes along their lengths into air flow directing passages. The cooling air is directed sequentially through these passages, changing flow direction as it passes from one passage to the next.


**7 Claims, 1 Drawing Figure**




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# METHOD AND APPARATUS FOR CONDENSING STEAM

## BACKGROUND OF THE INVENTION

This invention relates to heat exchangers and in particular to air cooled steam condensers. More particularly, the invention relates to a unique method and apparatus for accomplishing an even steam distribution by controlling the air passing across the stream condenser.

Air cooled steam condensers usually include a plurality of condenser tubes arranged in rows, one behind the other in the direction of air flow of the cooling air. Steam enters the condenser inlet header which communicates with the inlet ends of the tubes and then flows through the tubes wherein it is condensed. Fans blow cooling air across the tubes in an air flow direction generally perpendicular to rows of tubes. The steam is condensed by the cooling air to form condenssate as it travels through the tubes, and the condensate is collected at the outlet ends of the tubes in a suitable outlet header.

One serious problem which is encountered in condensers of this type results from the fact that the temperature of the air increases as it flows past the successive rows of tubes. Thus, there is also a drop in the temperature differential between the air and the fluid within the tubes of successive rows of tubes. Consequently, greater amounts of steam will condense in the tubes of the rows nearest the air flow than in the tubes of successive rows. As a result, the condensable steam in the tubes of the rows nearest the air flow may be fully condensed a considerable distance from the outlet header. This not only represents poor utilization of the tube surfaces, but also creates a very hazardous situation in environments in which the ambient temperature is considerably below the freezing point of the condensate. That is, the condensate may freeze up and thereby choke the tubes in the first row, which causes the air flow to successive rows to be at a lower temperature so that the tubes of successive rows may also become frozen up.

The solution to this problem has been the subject of much recent research and development. It has been proposed to either vary the distribution of steam to the tubes or the rows of tubes or vary the heat exchanging capacities of the tubes of different rows. For example, in accordance with one proposal, the tubes of successive rows are provided with successively smaller openings therethrough, either by way of different sizes of tubes or different sizes or orifices in the tubes. In accordance with another proposal, the heat exchanging capacities of the tubes of successive rows are adjusted by various means, such as fins of different spacing, fins of different sizes, etc., along the lengths of the tubes.

All of the heretofore proposed solution to the above stated problem have either controlled the distribution of condensable steam which enters the respective rows of tubes or controlled the heat exchanging capacities of the respective rows of tubes. In contrast, the present invention provides a unique solution to the problem by controlling the circulation of the cooling air which travels past the respective rows of tubes.



## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a unique method for attaining even steam distribution through an air cooled steam condenser.

Another object is to provide an air cooled steam condenser having plurality of rows of substantially identical heat exchange tubes which condense substantially the same quantity of steam through each tube.

With these and other objects in view, the invention resides in the return of the cooling air, which has passed across initial lengths of the heat exchange tubes, back across the tubes to give an opposite temperature differential in the succeeding tube lengths so as to mollify the temperature effects which cause the maldistribution of the steam in the condenser. A preferred embodiment of the present invention includes partitions and return hoods separating the heat exchange tubes along their length into air flow directing passages. The cooling air passes sequentially through these passages, changing flow direction as it passes from one passage to the next. An additional booster fan or blower is provided to attain additional air movement capacity through the passages.

## BRIEF DESCRIPTION OF THE DRAWING

Other objects and many of the attendant advantages of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing in which the FIGURE is an elevational view, partially in section and partially in schematic, showing a preferred embodiment of the present invention.

## DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the FIGURE, an air cooled steam condenser, constructed in accordance with the present invention, is indicated generally at **10.** Condenser **10** includes an inlet header **12** at one end, an outlet header **14** at the other end, and heat exchanger tubes **16** extending therebetween and thus connected in parallel to one another. Helical fins **18** are preferably provided around tubes **16** to increase heat transfer. Tubes **16** are mounted parallel to each other in plurality of rows **20,** 22, 24, and **26** spaced one above the other. Tubes **16** are mounted to have a slight incline from inlet header **12** to outlet header **14** so that condensate flows or drains into header **14.** A steam inlet pipe **28** directs steam, such as the exhaust from a steam turbine, to be condensed into header **12.** A condensate outlet pipe **30** directs condensate from header **14** to service. The hereinabove structure is typical to most heretofore known steam condensers and the specific construction details are well known to those skilled in the art.

In accordance with the present invention, a plurality of transverse partition walls **32, 34,** and **36** intersect the tubes **16** and divide same into four substantially equal lengths. The upper edges of partition walls **32, 34,** and **36** extend a short distance above the tubes **16** in row **26.** The lower edges of partition walls **32** and **36** extend downward and contact the floor **38.** The lower edge of partition wall **34** extends downward a short distance below the tubes **16** in row **20** and is spaced from the floor **38.** A pair of curved return hoods **40** and **42** respectively span the distance between the upper edge of partition wall **34** and the inlet header **12** and the outlet

header 14. The upper edges of partition walls 32 and 36 are respectively spaced from the return hoods 40 and 42. Side panels (not shown) extend from the floor 38 to a point at or above the return hoods 40 and 42 so as to define four closed cooling air flow passages 44, 46, 48, and 50 in series with one another.

A blower or fan assembly 52, of conventional construction, is provided immediately below and in closing relationship to flow passage 44. Blower assembly 52 draws ambient cooling air and directs it up through passage 44 and then serially through passages 46, 48, and 50 in cooling relationship to the heat exchange tubes 16. A booster blower or fan assembly 54 may be provided to increase the cooling air flow rate leaving passage 46 and entering passage 48.

In operation, steam to be condensed enters inlet header 12 through inlet pipe 28 and then passes through the heat exchange tubes 16 at substantially equal flow rates. The steam condenses as it passes through the tubes 16 and enters outlet header 14 as condensate for discharge through outlet pipe 30. The cooling air is initially drawn vertically upward into passage 44 by blower assembly 52 and successively passes around the lengths of tubes 16 within passage 44 in rows 20, 22, 24, and 26. As the cooling air passes around each successive row of tubes 16, the temperature of the cooling air drops, and consequently the heat transfer drops, resulting in a reduced amount of steam being condensed in each successive row of tubes 16. The cooling air leaving passage 44 ccontacts hood 40 and is directed in reverse flow down through passage 46 successively around the lengths of tubes within passage 46 in rows 26, 24, 22, and 20. This reverse flow of the cooling air through passage 46 results in an increase in the amount of steam condensed in the tube lengths within passage 46 in the rows which had reduced condensation in the initial passage of the cooling air through passage 44. The cooling air is then directed upward through passage 48 and back down passage 50 in a similar manner and causes a similar result to the lengths of tubes 16 within these passages as that caused by the passage of the cooling air respectively through passages 44 and 46.

Changing the direction of the cooling air flow passing across the succeeding lengths of the tubes 16 effectively mollifies the temperature differential effects which tend to cause maldistribution of the steam in the condenser. The number of cooling air passes may be varied as needed to alleviate the distribution problem. Under most conditions, two passes, as provided by the present invention, should suffice. One or more booster fans 54 may be provided at intermediate points in the system to attain additional cooling air flow rate capacity.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed:

1. A method for condensing steam in an air cooled steam condenser having a plurality of substantially identical heat exchange tubes arranged in a plurality of generally parallel rows, comprising the steps of: passing steam through each of said tubes at substantially the same flow rate; and passing cooling air across the initial lengths of the heat exchange tubes in one direction and then back across succeeding lengths of the heat exchange tubes in an opposite direction so as to mollify the effects of temperature differential of the cooling air as it passes from one row of tubes to the next.

2. The method as defined in claim 1 wherein the cooling air makes at least two passes in each direction across succeeding lengths of the heat exchange tubes.

3. The method as defined in claim 2 including the step of boosting the cooling air flow across the heat exchange tubes after it has passed across at least the initial lengths of the tubes.

4. In a steam condenser of a type in which a plurality of substantially identical heat exchange tubes are arranged in a plurality of generally parallel rows, extending between and communicating with a steam inlet header and a condensate outlet header; and in which the rows of tubes extend transversely of and at spaced intervals perpendicular to the direction of air flow of cooling air that passes over and around the rows of the tubes to condense steam flowing through the tubes from the inlet header; the improvement including partition means arranged across said rows of heat exchange tubes for directing the passage of cooling air across the initial lengths of said tubes in one direction and then back across succeeding lengths of said tubes in an opposite direction so as to mollify the effects of temperature differential of the cooling air as it passes from one row of said tubes to the next.

5. The invention as defined in claim 4 wherein said partition means directs the cooling air at least twice in each direction across succeeding lengths of said tubes.

6. The invention as defined in claim 5 including booster means for increasing the cooling air flow across said tubes after it has passed across at least the initial lengths of said tubes.

7. The invention as defined in claim 5 wherein said partition means includes a plurality of spaced partition sections extending perpendicular to said tubes and dividing same into substantially equal lengths, alternate partition sections extending downward to contact a floor section of said condenser and the other partition sections being spaced from said floor section, and return hood sections connecting the upper edges of said other partition sections and spaced above said alternate partition sections so as to cause the flow of cooling air to pass over and then under adjacent partition sections.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

PATENT NO. : 3,882,925
DATED : May 13, 1975
INVENTOR(S) : Ferdinand V. Huber

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 1, line 60 the word "solution" should be --solutions--.

In column 2, line 45 after "in" insert --a--.

In column 3, line 7 after "blower" delete --or--.

In column 3, line 30 the word "ccontacts" should be --contacts--.

In column 4, line 31 after the word "inlet" insert the phrase --to the outlet--.

Signed and Sealed this
sixth Day of January 1976

[SEAL]

*Attest:*

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*Attesting Officer*

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*Commissioner of Patents and Trademarks*