Oct. 31, 1967 R. J. STOKER 3,349,841

AIR COOLER FOR SURFACE CONDENSERS

Filed Aug. 4, 1966

3 Sheets-Sheet 1

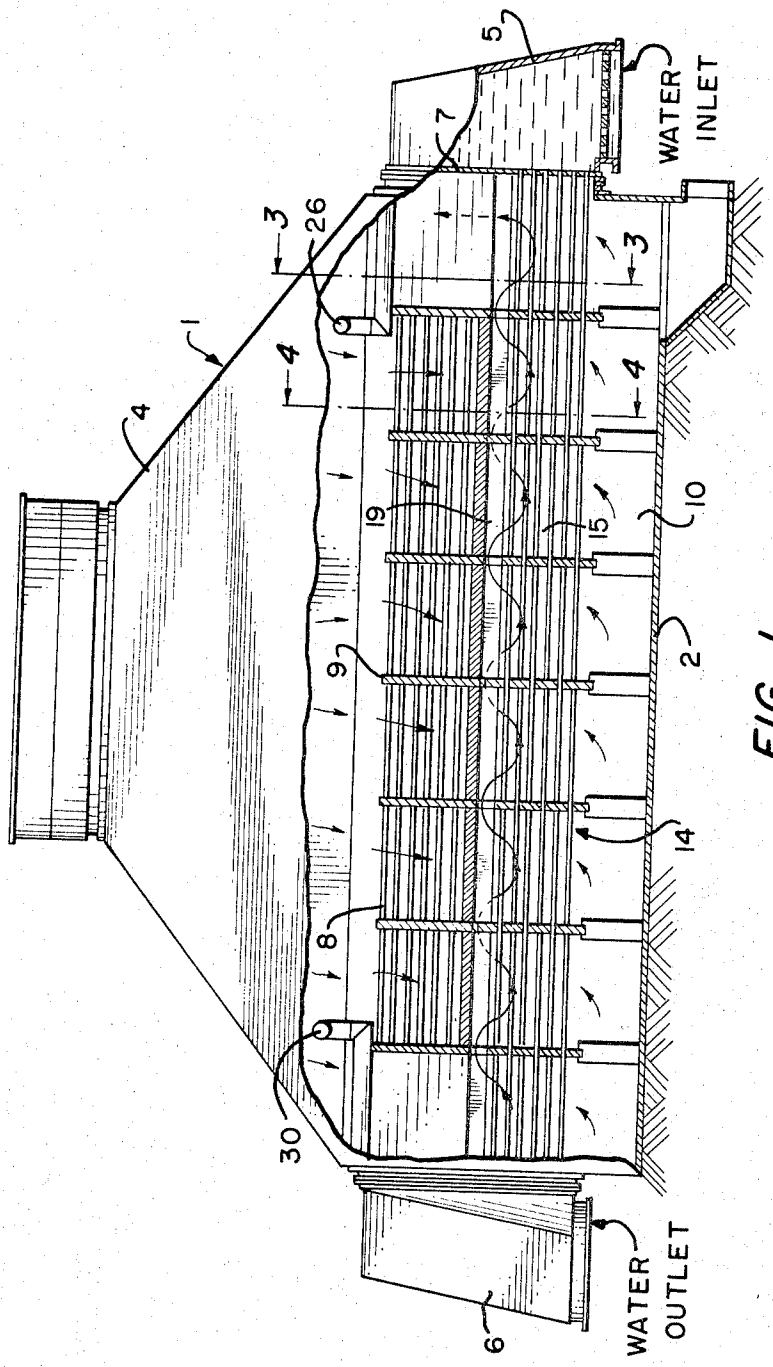


FIG. 1

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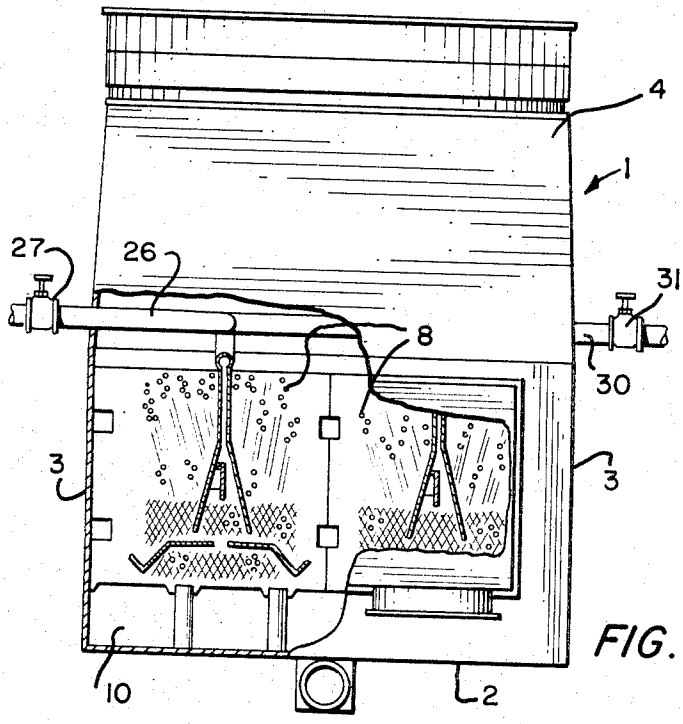


FIG. 2

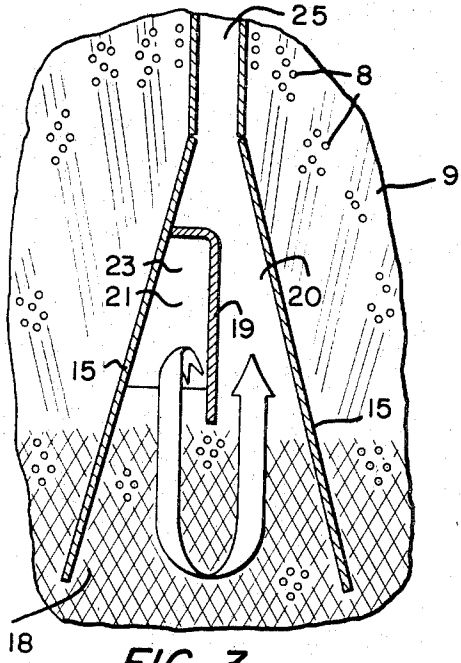
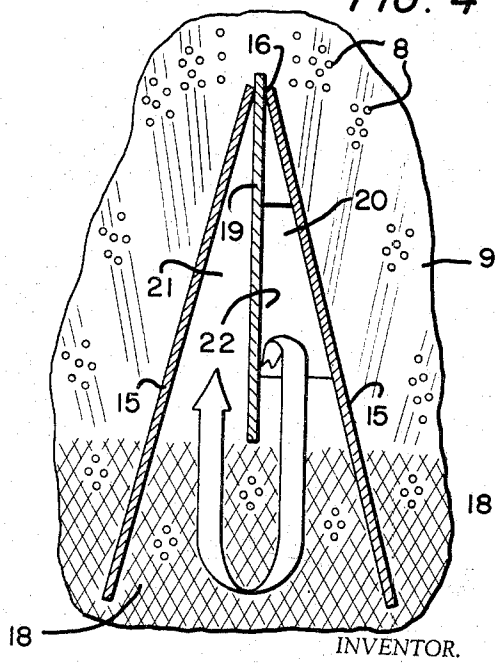


FIG. 3

FIG. 4



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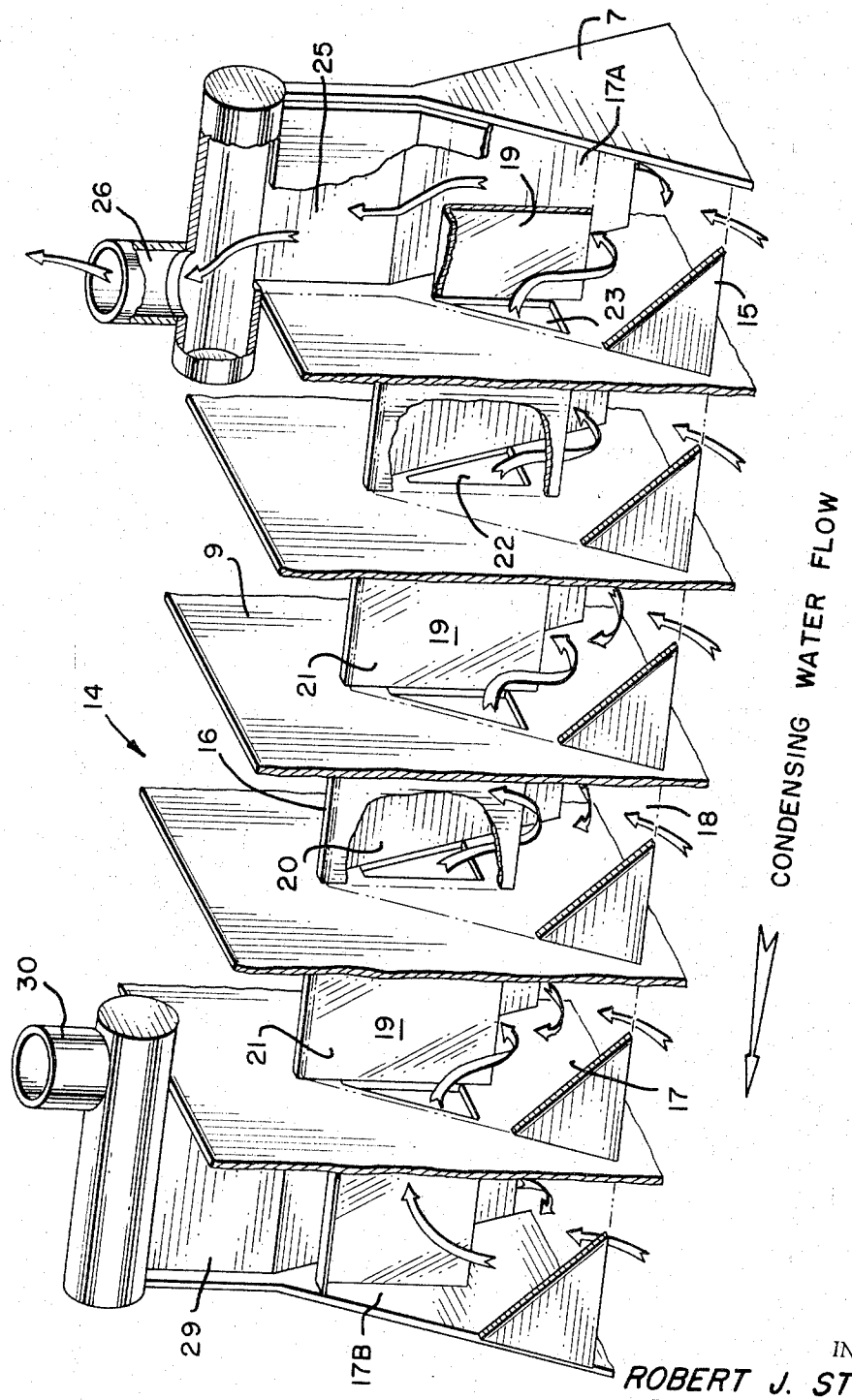


FIG. 5

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AIR COOLER FOR SURFACE CONDENSERS

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ABSTRACT OF THE DISCLOSURE

A surface condenser including an air cooler having an elongate body extending parallel to the condenser tubes and surrounding a plurality of air cooler tubes. The elongate body is divided into a plurality of longitudinal spaced sections by transverse partitions. Each section is divided into a pair of compartments by a longitudinal wall and each partition includes a portion for connecting compartments on the opposite sides of the partition with the ports in adjacent partitions being connected to different compartments so that fluid flowing longitudinally will be forced to follow a torturous path before reaching the end of the air cooler where it is exhausted. The air cooler is arranged to exhaust from either end alternately to cooperate with alternate directions of flow of cooling liquid through the air cooler tubes.

This invention relates to surface condensers and in particular to the air cooler in a surface condenser.

In general, an air cooler is installed in a surface condenser among a bank of tubes at a location where it can collect air and other non-condensibles mixed with vapor. After entering the air cooler, a pressure differential causes the non-condensibles to flow toward the cooler end of the air cooler where they are usually exhausted from the condenser by means of a vacuum source such as an ejector. In flowing through the air cooler, it is desirable that the non-condensibles be cooled as much as practical, to reduce the amount of intermixed vapor, before being exhausted from the air cooler by the vacuum source.

The principal object of this invention is to provide an air cooler which forces the non-condensibles in the air cooler to follow a tortuous or winding path in flowing toward the colder end of the air cooler to obtain the maximum cooling effect on the non-condensibles prior to being exhausted from the air cooler.

Other important objects are: to provide an air cooler which is relatively simple in construction and economical in cost; to provide an air cooler in which non-condensibles can flow in alternate directions along the length of the air cooler; to provide an air cooler in which non-condensibles can be drawn from either end; and to provide a condenser evacuation system for use in single pass condensers in which the cooling water flow can be reversed.

In general, the foregoing objects of the invention are attained in an air cooler structure including an elongate body enclosing an elongate passage and being divided lengthwise into a plurality of sections by plural transverse partitions. Each section is divided into compartments by a longitudinal wall. Each partition includes a port for interconnecting compartments on the opposite sides of the partition and with the ports located in adjacent partitions being connected to different compartments in the section between the adjacent partitions. As a result of this structure, fluid flowing from one section into a second section is forced to flow around the wall in the second section before exiting from that second section, thus following a tortuous path causing increased surface

contact of the fluid with the cooling pipes in the air cooler.

The invention is described in connection with the accompanying drawings wherein:

FIG. 1 is a longitudinal elevation of a surface condenser containing the air cooler of this invention and having portions broken away to show the interior of the condenser;

FIG. 2 is an end elevation of the condenser of FIG. 1 with portions broken away;

FIG. 3 is a section taken on line 3—3 in FIG. 1;

FIG. 4 is a section taken on line 4—4 in FIG. 1; and

FIG. 5 is a perspective view of the air cooler of FIG. 1 with the tubes in the air cooler being omitted to show the details of the air cooler and with the air cooler being shortened in length.

The surface condenser shown in FIGS. 1 and 2 includes a bottom **2**, a pair of opposite sides **3**, and a top or steam dome **4** adapted to be connected to the exhaust conduit of a turbine (not shown). Looking at FIG. 1, the condenser **1** further includes a right end water box **5** and a left end water box **6**. Either one of the water boxes **5** and **6** may serve as a water inlet header, depending on the direction of water flow through the condenser. Each of the water boxes **5** and **6** are open to tube sheets **7** located at opposite ends of the condenser **1** and interconnected by bundles of horizontally extending water tubes **8**. The tubes **8** are supported intermediate the tube sheets **7** by a plurality of horizontally spaced vertical partitions **9**. Water condensing on the tubes **8** flows or drips into a hot well **10** located on the bottom of the condenser below the tube bundles. The particular condenser illustrated in FIG. 1 is known as a single-pass surface condenser, due to the fact that the water in the tubes **8** is limited to a single pass through the condenser **1**. All of the foregoing structure is conventional in the surface condenser art.

FIG. 1 further shows an air cooler **14** located among the bundles of tubes **8** at a location where it can collect air and other non-condensible fluids for eventual exhaust from the condenser. The air cooler **14** extends longitudinally parallel to the tubes **8** between the opposite ends of the condenser **1**. In general, the air cooler **14** is located among the tubes **8** at a point where most of the steam entering the condenser will have been condensed before reaching the air cooler. In the remainder of this description, the non-condensible fluid will be referred to as air, which is the case in most steam condensers. However, it could be some other gas.

In an optimum design, the only fluid entering the air cooler **14** should be non-condensible fluid, such as air intermixed with whatever water vapor it may be carrying. As is well known, air entering the water cooler is saturated; hence the amount of water vapor intermixed or carried by the air is determined by the temperature and pressure of the air. In addition to collecting the air in the condenser, the air cooler **14** is designed to cool the air to as low a temperature as practical before exhausting it from the condenser so as to reduce the amount of water vapor lost with the air and to increase the efficiency of the condenser.

The air cooler **14** is shown in perspective in FIG. 5. In general, it has an inverted V-shaped cross section formed by a pair of downwardly diverging sides **15** extending horizontally along the length of the condenser **1**. The end walls of the air cooler **14** are formed by the tube sheets **7** located at the opposite ends of the condenser. Alternately, the end walls could be formed by separate plates. In general, the downwardly diverging sides **15** are joined at their top edges to form an apex **16**, as shown in FIG. 4. The sides **15** of the air cooler

enclose a longitudinal passage or space for receiving fluid from the condenser interior. This space is divided into sections 17 by the plurality of partitions 9 which extend transversely through the air cooler. Each of the sections 17 is open at its bottom to form an inlet 18 for receiving air from the condenser 1. It will be understood that a plurality of the water tubes 8 extend through the air cooler 14.

Each of the sections 17 includes a longitudinal center wall 19 extending downwardly from the apex 16 of the sides 15 over a major portion of the depth of the air cooler 14. The wall 19 divides each section 17 into a pair of compartments 20 and 21 located on opposites sides of the wall 19. Fluid flowing from either one of the compartments 20 and 21 is forced to flow around the bottom edge of the wall 19 before entering the other compartment, as indicated by the arrows in FIGS. 3 to 5. Looking at FIG. 4, the right hand compartment has the reference number 20 and the left hand compartment is 21.

Each of the partitions 9 includes either a right hand port 22 or a left hand port 23 for interconnecting compartments located on the opposite sides of the partition 9. The location of the ports will alternate between adjacent partitions so that, looking at FIG. 5, one partition will have a right hand port 22 for interconnecting the right hand compartments 20 located on the opposite sides of that partition while the next adjacent partition will have a left hand port 23 for interconnecting the left hand compartments 21 located on the opposite sides of that partition.

As a result of this arrangement, air flowing into a left hand compartment 21 will be forced to flow around the lower edge of the center wall 19 before entering the right hand compartment 20 and flowing through the right hand port 22. This path of fluid flow is indicated in FIG. 5 by the various arrows. As a result of causing the air to flow along a tortuous path, the air will be forced to flow over a larger surface area of the water tubes in the cooler than would be the case if the air were allowed to flow directly from one section 17 to another section 17 of the air cooler 14.

Since the water entering the condenser tubes 8 is colder than that exiting from the condenser, the water inlet end of the air cooler 14 will operate at a lower temperature and pressure than the water outlet end of the air cooler. This pressure differential causes the air to flow toward the colder end of the air cooler. In FIG. 5 the colder end is indicated as being the right hand end 17A. Air entering any part of the air cooler 14 flows lengthwise in the air cooler until eventually entering the right hand end section 17A. Air in the right hand end section 17A is drawn upwardly through an outlet port 25 and through a suction line 26 which is connected to a vacuum source (not shown) such as an ejector. The suction line 26 includes a valve 27 for selectively sealing off the suction line 26 from the vacuum source.

The air cooler 14 is designed for use in a condenser wherein the direction of water flow through the tubes 8 may be reversed. When the direction of water flow is reversed from that shown in FIG. 5, the left hand end section 17B becomes the colder end of the air cooler 14. The left hand end section 17B is constructed similar to the right hand end section 17A in that it has an outlet port 29 connected to a suction line 30 which is also connected to a vacuum source (not shown) and includes a valve 31 for selectively closing the suction line 30.

In the normal operation of the condenser, one of the valves 27 or 31 will be closed while the other will be open, the open valve being connected to the colder end of the air cooler as determined by the direction of water flow through the condenser tubes 8. It will be recognized that regardless of the direction of air flow in the air cooler 14, this air flow will be forced to follow a tortuous path as it flows along the length of the air cooler 14 from section to section 17 of the air cooler 14.

While a single embodiment of the invention is illustrated and described, it should be understood that this invention is not limited merely to the particular structure described in the specification and shown in the drawings but may include other embodiments and modifications utilizing the concepts and teachings of the invention.

Having described my invention, I claim:

1. A housing for air cooling tubes of a surface condenser comprising:
- an elongate hollow body partially enclosing an elongate passage and adapted to be mounted in a condenser to extend parallel with and house a plurality of the air cooling tubes of the condenser;
- a plurality of spaced partitions extending transversely across said passage to divide said passage into sections;
- said body including an inlet for each of said sections for receiving fluid from said condenser;
- each of said sections including a wall extending longitudinally between adjacent partitions and dividing said section into a pair of compartments; means providing an opening in said wall intercommunicating said pair of compartments; and
- each of said partitions including a port for interconnecting compartments on the opposite sides of said partition and with the ports in adjacent partitions being connected to different compartments in the section between the adjacent partitions whereby fluid flowing from one section into an adjacent section is forced to flow around said wall in said adjacent section before exiting from said adjacent section.

2. The housing of claim 1, the combination comprising:
- a vacuum source connected by a first line to one of the end sections of said housing for withdrawing fluid therefrom.

3. The housing of claim 2, the combination comprising:
- a valve in said first line for shutting off said vacuum source from said one end section;
- a vacuum source connected to the opposite end section of said housing by a second line; and
- a valve in said second line for shutting off said last named vacuum source from said opposite end section of said housing whereby fluid can be alternately withdrawn from opposite end sections of said housing.

4. In a surface condenser having a series of parallel tubes, an air cooler mounted among said tubes and extending generally parallel to said tubes, said air cooler comprising:
- an elongate body enclosing an elongate passage extending generally parallel to said tubes;
- a plurality of spaced partitions extending transversely across said passage at an angle to said tubes and dividing said passage into a plurality of sections;
- said body including an inlet for each of said sections for admitting fluid into said sections from said condenser;
- each of said sections having a wall extending longitudinally between adjacent partitions and dividing said section into a pair of compartments; means providing an opening in said wall intercommunicating said pair of compartments; and
- each of said partitions containing a port for interconnecting compartments on the opposite sides of said partition and with the ports of adjacent partitions being connected to different compartments in the section between the adjacent partitions whereby fluid flowing from one section into an adjacent section is forced to flow around said wall in said adjacent section before exiting from said adjacent section.

5. In the condenser of claim 4, the combination comprising:

a vacuum source connected by a first line to one of the end sections of said air cooler for withdrawing fluid therefrom.

6. In the condenser of claim 5, the combination comprising:

a valve in said first line for shutting off said vacuum source from said one end section;

a vacuum source connected to the opposite end section of said air cooler by a second line; and

a valve in said second line for shutting off said last named vacuum source from said opposite end section of said air cooler whereby fluid can be alternately withdrawn from opposite end sections of said air cooler.

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