

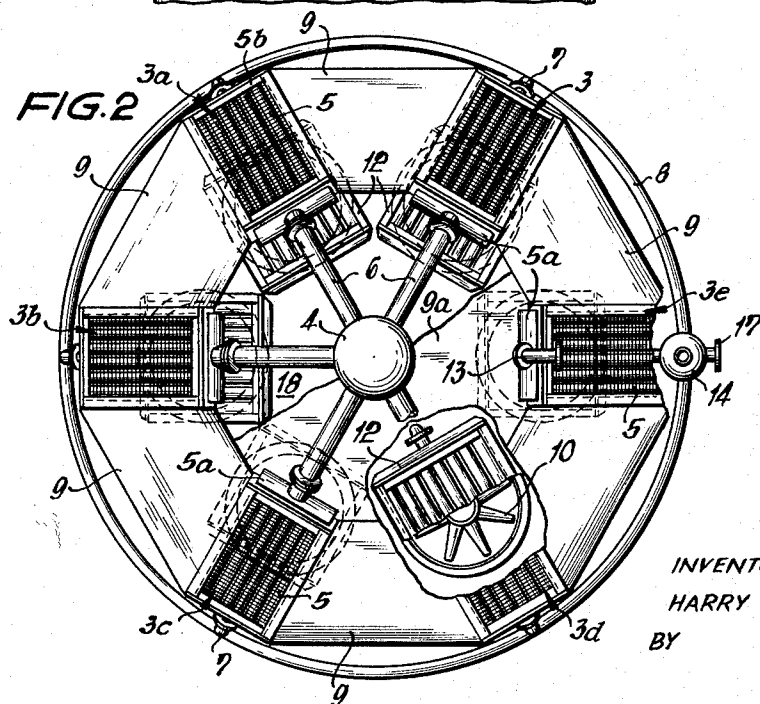
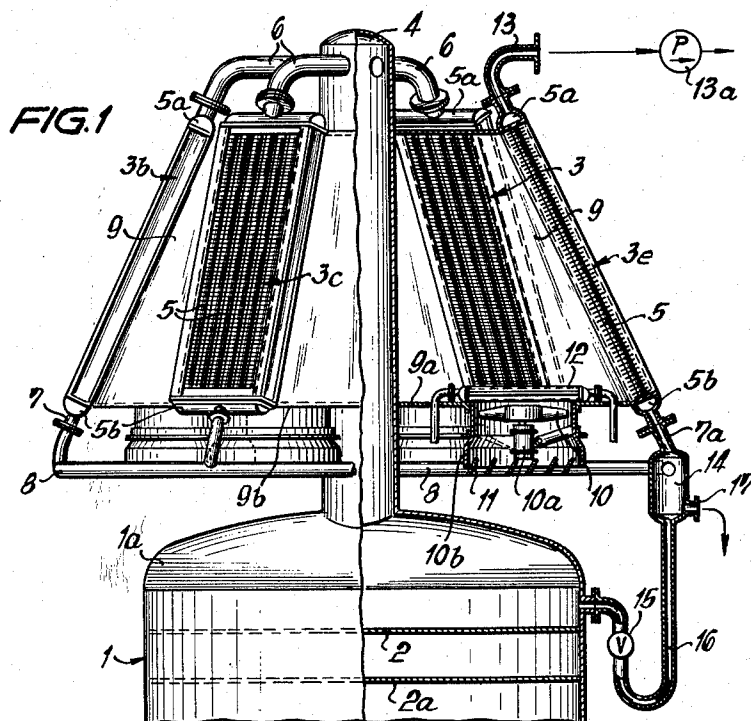
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AIR COOLED CONDENSER FOR DISTILLING APPARATUS

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AIR COOLED CONDENSER FOR DISTILLING APPARATUS

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The present invention relates to distilling apparatus in general, and more particularly to an air-cooled condenser for use in such apparatus. Still more particularly, the invention relates to an air-cooled condenser which is especially suited for use in high-vacuum distillation at comparatively high condensation temperatures, e.g., in distillation and fractionation of organic solvents, alcohol, combination of hydrocarbons, benzol and petroleum.

An important object of the invention is to provide an air-cooled outdoor condenser for distilling apparatus whose cooling action is affected only little or remains unaffected by fluctuations in the temperature or by movements of atmospheric air, and whose cooling action may be controlled with utmost accuracy in all types of climate and all year around.

Another object of the invention is to provide a condenser of the just outlined characteristics which is especially suited for condensing head products having a high point of solidification.

A further object of the invention is to provide a condenser of the above described type in which the coolant cannot react or mix with the head product.

An additional object of the invention is to provide a condenser of the above outlined characteristics which is constructed, assembled and mounted in such a way that the vaporized head product covers very short distances on its way to the condenser so that the drop in pressure of the head product is reduced to a minimum.

A concomitant object of the present invention is to provide an air-cooled condenser for the head product of a distilling or rectifying column which is of extremely compact and space-saving design, which is capable of removing all or nearly all traces of head product from the gaseous carrier, and which may be used as a lightweight substitute for air- or water-cooled condensers of presently known design.

An additional object of the instant invention is to provide a condenser of the above outlined characteristics whose coolant-circulating system is constructed in such a way that the prime mover or movers for the coolant-circulating devices are automatically cooled when the condenser is in actual use.

Still another object of the invention is to provide an air-cooled condenser for distilling apparatus in which the quantity and the temperature of coolant may be regulated in a very simple and efficient manner.

With the above objects in view, the invention resides in the provision of an air-cooled condenser which is mounted on the riser tube extending upwardly from the head of a distilling or rectifying column. The condenser comprises a plurality of condenser means each of which includes an upper chamber, a lower chamber, and a plurality of preferably parallel and ribbed condenser tubes or condenser elements which extend between and communicate with the chambers. The upper chambers of at least some condenser means are connected to the riser tube so that the vaporized head product and the inert gases or drawn-in air may pass downwardly through the condenser pipes in which the product is condensed and flows into the lower chambers which latter are connected with a collecting means having connections with the column and

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outlet means through which the distillate may be withdrawn from the apparatus. The condenser means form a polygonal structure about the riser pipe and the upper chambers are closer to the riser pipe than the lower chambers. The condenser further comprises means for circulating air between the pipes of its condenser elements.

Certain other features of the invention reside in the provision of wall means forming with the condenser elements an enclosed space about the riser tube, in the provision of specially constructed and mounted air circulating means which include means for regulating the admission of air to the space about the riser tube, in the provision of means for preheating the air before the air reaches the condenser pipes, and in the provision of means for separating the head product from the gaseous carrier after the major part of the head product is condensed in the condenser pipes of the elements connected to the riser tube.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of a specific embodiment with reference to the accompanying drawing, in which:

FIG. 1 is a fragmentary partly elevational and partly vertical sectional view of a distilling apparatus comprising an air-cooled condenser which embodies my invention; and

FIG. 2 is a top plan view of the structure shown in FIG. 1, with certain component parts broken away.

Referring now to greater detail to the illustrated embodiment, there is shown a distilling apparatus which comprises a distilling or rectifying column 1 having a head 1a and a vapor outlet or riser tube 4 which communicates with and extends upwardly from the head 1a. The two uppermost horizontal plates 2, 2a are indicated somewhat schematically in the interior of the column 1. The air-cooled condenser of my invention comprises a plurality of condenser means 3, 3a, 3b, 3c, 3d, 3e disposed about the tube 4 and forming a polygonal structure in which each of the condenser means constitutes a portion of a facet or side of a truncated hexagonal pyramid. Each condenser means comprises a number of parallel, upwardly and inwardly inclined, preferably identically configured ribbed condenser pipes 5 or tubular condenser elements whose upper ends are connected to and communicate with the interior of an upper distributor chamber 5a and whose lower ends are connected to and communicate with a lower distributor chamber 5b. The upper chambers 5a of the condenser means 3-3e are closer to the tube 4 than the lower chambers 5b, and the chambers 5a of the condenser means 3-3d are communicatively connected with the upper end portion of the riser tube 4 by short radially extending connecting pipes 6. The lower chambers 5b of the condenser means 3-3d are communicatively connected with a large diameter annular collecting conduit 8 by means of short connecting pipes 7.

The substantially triangular areas between the adjacent condenser means 3-3e are closed by upwardly and inwardly inclined plate-like wall members 9, and another substantially horizontal plate-like wall member 9a closes the upper end of the space 18 formed between the condenser means by extending between the upper chambers 5a in surrounding relationship about the upper portion of the tube 4 beneath the connecting pipes 6. A further horizontal wall member 9b extends between the lower chambers 5b to close the lower end of the space 18.

Beneath the condenser means, i.e. slightly inwardly of the lower chambers 5b, there are provided air circulating

means in the form of bladed or vaned blowers or fans 10 which draw atmospheric air upwardly into the space 18 defined by the condenser elements 3-3e and the wall member 9-9b. These blowers are provided with separate motors 10a which are disposed at the suction sides thereof and each of which is preferably provided with individual adjusting means (not shown) so that the blowers may be operated selectively or together, depending on the momentary temperature of the atmospheric air, on the temperature of the head product which passes from the tube 4 through the pipes 6 and upper chambers 5a downwardly through the condenser pipes 5 and through the chambers 5b into the lower pipes 7 to be collected in the annular conduit 8. The motors 10a are automatically cooled by the air streaming upwardly to the respective blowers. The blowers 10 are rotatable about vertical axes and are mounted in substantially vertically extending tubular casings 10b which may be secured to the wall member 9b. The air-discharging upper ends of the casings 10b are open so that they may communicate with the space 18, and the air-admitting lower or suction end of each of these casings receives an adjustable control means in the form of louvers 11 which are used for regulating the admission of air to the respective blowers. The louvers 11 may be adjusted manually or by remote control. Adjacent to the open upper ends of the casings 10b, there are provided heating elements 12 which consist of smooth or ribbed tubing adapted to receive a heating medium, such as vapors or steam, in order to preheat the air sucked by the respective blowers 10. Such preheating of air is of importance if the distilling apparatus is operating in freezing weather or when the nature of the head product is such that the condensation in ribbed condenser pipes 5 takes place at a comparatively high temperature. The air blown into the space 18 about the tube 4 is compelled to escape through the interstices between the adjacent condenser pipes 5 of the condenser elements 3-3e and thereby brings about condensation of the distillation product as the latter passes downwardly from the chambers 5a toward the chambers 5b.

The purpose and the mounting of the condenser means 3e differ from the purpose and mounting of the condenser means 3-3d. This condenser means 3e constitutes a secondary cooling means and also serves as a means for partially condensing the inert gases or drawn-in air which still contains a certain percentage of the distillation product. The upper chamber 5a of the means 3e is communicatively connected with a conduit 13 which leads to a schematically indicated source of vacuum 13a. This source of vacuum may assume the form of a pump, an ejector or the like. The lower chamber 5b of the means 3e is communicatively connected with a connecting pipe 7a which leads to the upper portion of a collecting or separating tank 14 mounted in the collecting conduit 8. The lower portion of the tank 14 is connected with the column 1 by a return conduit 16 which contains a flow regulating valve 15 and whose discharge end communicates with the column above the uppermost horizontal plate 2. The lower portion of the tank 14 is provided with an outlet 17 through which the condensate may be withdrawn from the distilling apparatus.

The distilling apparatus embodying my improved air-cooled condenser operates as follows:

When the column 1 is in actual use, a mixture of inert carrier gases, of vaporized head product, of undesirable inert gas or gases, and of drawn-in air is formed in the head 1a above the uppermost plate 2 and advances upwardly through the tube 4 and through the pipes 6 into the upper chambers 5a of the condenser means 3-3d. From the chambers 5a of these means, the mixture passes through the respective ribbed condenser pipes 5 where it is subjected to the cooling action of air drawn by the blower or blowers 10 so that the head product is con-

densed and descends into the lower chambers 5b and through the connecting pipes 7 into the collecting conduit 8. The condensate flows through the conduit 8 and into the tank or receptacle 14 and, depending on the position of the regulating valve 15, returns through the conduit 16 as a reflux into the upper portion of the column 1 above the uppermost plate 2 or is withdrawn through the outlet 17 as the ultimate distillation product.

The inert gases and drawn-in atmospheric air follow the route of the condensate from the condenser pipes 5 of the condenser means 3-3d all the way to the tank 14, and thereupon ascend through the lower chamber 5b and upwardly through the condenser pipes 5 of the means 3e. In the pipes 5 of the means 3e the ascending inert gases and air are cooled substantially to the atmospheric temperature and are sucked through the conduit 13 by the vacuum generating means 13a. Any condensate separated in the means 3e from the ascending gases flows into the lower chamber 5b of this means and through the conduit 7a to the tank 14. When the condensation temperature of the head product is rather high, the gases ascending into the condenser means 3e carry substantial quantities of vaporized head product so that there is substantial flow of condensate from the means 3e through the conduit 7a and to the tank 14. If the operator desires to withdraw the condensate from the distilling apparatus, he closes the valve 15 and opens the non-illustrated valve in the outlet 17.

When the distilling apparatus is operated in cold weather, e.g. during the winter, it is advisable to start the operation at a fraction of the maximum output. In such instances, hot fluid (e.g. steam) is introduced into the pipes or coils of the heaters 12 so that air sucked by the blowers 10 is preheated by heat exchange with the pipes of the heater 12 before it reaches the condenser pipes 5 of the condenser means 3-3e. In addition, one or more blowers 10 may be turned off so that the circulation of air occurs at less than maximum rate and the cooling action of air passing between the condenser pipes 5 is reduced accordingly. Additional control of the rate of air flow into the space 18 about the tube 4 may be achieved by adjusting the position of the louvers 11.

By preventing excessive cooling of the condenser means 3-3e, the operator or operators may prevent eventual freezing or coagulation of the condensate in the pipes 5 and/or chambers 5b, for example, if the coagulation or solidification temperature is in the range of 20-30° C. and if the distilling apparatus is operated in subzero weather, e.g. at -20° C. Of course, when a blower 10 is turned off, the operator moves the respective louvers to closing position so as to prevent the escape of air from the space 18 through the casing 10b of the idle blower, i.e. to prevent that air drawn by the revolving blower or blowers would escape through one or more casings 10b rather than through the interstices between the condenser pipes 5. The dimensions of the heaters 12 are selected in such a way that they may heat the air advancing upwardly through the casings 10b to a temperature higher than the solidification temperature of the condensate.

The air-cooled condenser of my invention is particularly suited for use in extreme high-vacuum distillation which is carried out in apparatus comprising columns in the height range of between 30-50 meters. As shown in FIG. 1, the diameter of the condenser may exceed only slightly the diameter of the column and the height of the condenser may approximate the diameter of the column. The diameter of the column may be in the range of 3-5 meters.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are

intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is:

1. In a distilling apparatus of the type wherein the vaporized head product ascends through a riser tube which extends upwardly from the head of the distilling column, an air-cooled condenser for the head product comprising a plurality of spaced condenser means each including an upper chamber, a lower chamber, and a plurality of tubular condenser elements extending between and communicating with said chambers, said upper chambers being arranged closer to said riser tube than said lower chambers; wall means disposed between, above and below said condenser means so as to form with the elements thereof an enclosed space about the riser tube tapering toward the top of the latter; means for connecting the upper chambers of at least some of said elements with the riser tube so that the head product may pass through said condenser elements toward the respective lower chambers, whereby the condensate will flow downwardly in said condenser elements at portions thereof facing said riser tube; means for circulating air between the condenser elements of said condenser means so as to condense the head product passing therethrough, said air circulating means comprising a substantially annular casing for each of said condenser means said casings disposed beneath the respective condenser means and received in said wall means, each of said casings having an air-admitting lower end and an air-discharging upper end communicating with said space, a blower received in each of said casings and rotatable about a substantially vertical axis so as to draw air upwardly and into said space so that the air will brush first against said inwardly facing portions of said condenser elements along which the condensate flows before passing out of said space between said condenser elements, and means disposed at the lower ends of said casings for regulating the admission of air to the respective blowers; and means connected with the lower chambers of said condenser means for collecting the condensate.

2. A condenser as set forth in claim 1, further comprising heating means disposed at the upper ends of said casings for preheating the air admitted to said space.

3. A condenser as set forth in claim 1, wherein said collecting means comprises an annular conduit disposed beneath and communicating with said lower chambers, and a collecting tank in said collecting conduit, said condenser further comprising return conduit means connecting said tank with the column, valve means in said return conduit means for regulating the reflux of condensate to the column, and outlet means for discharging condensate from said tank.

4. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between said groups of condenser elements and defining with the latter a space around said riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that the vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; and blower means for blowing air upwardly into

said space so that the air will contact first said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly to pass then between said tubular condenser elements out of said space.

5. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between, above, and below said groups of condenser elements and defining with the latter a substantially closed space around the riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that the vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; and blower means for blowing air upwardly into said substantially closed space so that the air will contact first said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly to pass then between said tubular condenser elements out of said space.

6. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between, above, and below said groups of condenser elements and defining with the latter a substantially closed space around the riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; blower means for blowing air upwardly into said substantially closed space so that the air will contact first said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly to pass then between said tubular condenser elements out of said space; and heater means cooperating with said blower means for heating the air, when desired, before it is blown against said portions of said tubular condenser elements along which the condensate flows downwardly to prevent solidification of the condensate during operation of the distilling arrangement in cold weather.

7. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of

groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between, above, and below said groups of condenser elements and defining with the latter a substantially closed space around the riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that the vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; and a plurality of air blowers, one for each group of condenser elements, and each arranged in an opening formed in said wall means below said groups of condenser elements and respectively arranged directly below the respective group of condenser elements for blowing air upwardly into said space against said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly so that the air will first contact said inwardly facing portions of said tubular condenser element before it flows between said tubular condenser elements out of said space.

8. A distilling arrangement as defined in claim 7 and including regulating means for regulating the amount of air blown into said space by each of said air blowers.

9. A distilling arrangement as defined in claim 8 in which said regulating means comprise adjustable louvre means arranged beneath each air blower.

10. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between said groups of condenser elements and defining with the latter a space around said riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that the vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; blower means for blowing air upwardly into

said space so that the air will contact first said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly to pass then between said tubular condenser elements out of said space; and means connected to the upper ends of the remaining groups of condenser elements for withdrawing gases therefrom.

11. A distilling arrangement comprising, in combination, an elongated distilling column having a head at the upper end and a riser tube having a diameter which is only a fraction of that of said column and projecting coaxial with the latter from the upper end thereof so that the vaporized head product will rise in said riser tube; air-cooled condenser means including a plurality of groups of tubular condenser elements arranged spaced from each other around said riser tube and having each one end located at a higher elevation and closer to the axis of said riser tube than the other end thereof; wall means between said groups of condenser elements and defining with the latter a space around said riser tube tapering toward the upper end of the latter; means connecting the upper ends of at least a preponderant number of said groups of tubular condenser elements with the upper end of said riser tube so that the vaporized head product may pass through said tubular condenser elements to condense therein, whereby the condensate will flow downwardly in said tubular elements at portions thereof facing inwardly toward said riser tube; means for connecting the lower ends of said groups of tubular condenser elements in parallel; blower means for blowing air upwardly into said space so that the air will contact first said inwardly facing portions of said tubular condenser elements along which the condensate flows downwardly to pass then between said tubular condenser elements out of said space; and vacuum generating means connected to the upper ends of the remaining groups of condenser elements for withdrawing gases therefrom.

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