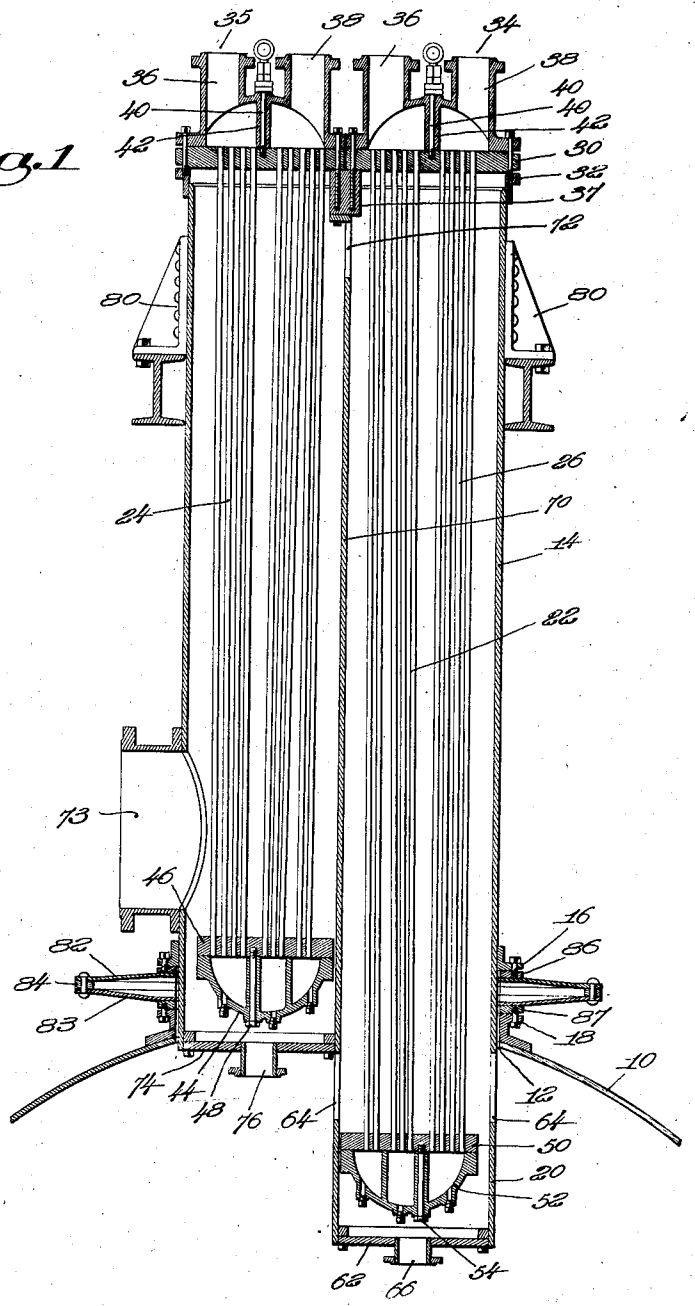
June 11, 1935. C. H. LEACH 2,004,469

HEAT EXCHANGE APPARATUS

Original Filed Nov. 13, 1929 2 Sheets-Sheet 1

Fig. 1



Witness

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Original Filed Nov. 13, 1929 2 Sheets-Sheet 2

Fig. 2

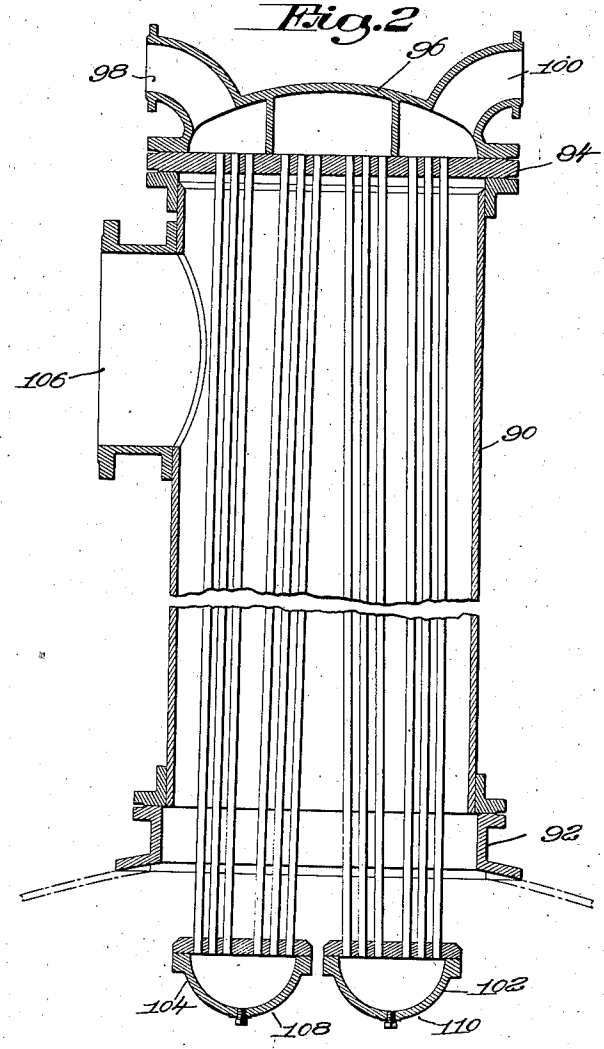


Fig. 3

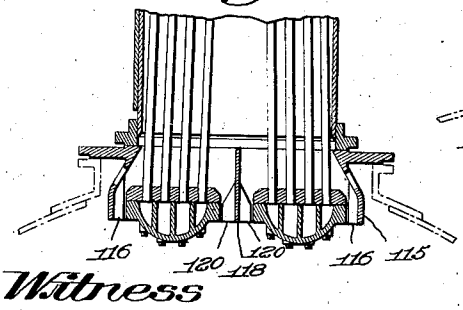
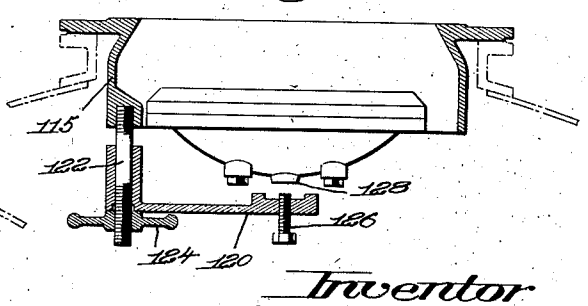


Fig. 4



Witness

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UNITED STATES PATENT OFFICE

2,004,469

HEAT EXCHANGE APPARATUS

Charles H. Leach, Roselle, N. J.

Application November 13, 1929, Serial No. 406,770
Renewed November 12, 1934

8 Claims. (Cl. 257—34)

The present invention relates to heat exchange apparatus, and more particularly to vapor condensers designed for employment in the refining of petroleum oils.

The purpose and object of the present invention are to provide an apparatus particularly adapted for intimate cooperation with distillation towers or bubble towers normally employed for the fractional separation of the components of crude petroleum oil.

With this and other objects in view, the present invention contemplates a tubular condensing apparatus through which is circulated a cooling medium, such as crude oil, with appropriate vapor spaces surrounding the tube assembly and communicating directly with the interior of the distillation tower to cause vapors emerging from the upper portion of the tower to be immediately conducted through the intertubular space, and through contact with the cooled tubes to promote the formation of a condensate of a predetermined character which is returned directly into the upper portion of the tower as liquid. The vapors remaining after partial condensation are conducted outwardly of the condensing apparatus and further condensed and refined in whatever manner may be suitable or desirable. In order to promote sufficient contact between the vapor and the cooling condenser tubes, it may be desirable to provide for more than one vapor pass and to separate the tubes into more than one bundle, permitting the individual tube bundles to independently expand and contract under the influence of temperature changes. By providing a plurality of passes and tube bundles, the desired drop in temperature of the heated vapor during its passage through the condenser may be practically and satisfactorily accomplished.

Essentially the present invention contemplates the provision of one or more tube bundles supported from above the distillation chamber in the bubble tower, and projecting downwardly into the upper portion thereof, the tube bundle or bundles being surrounded by a shell which encloses the vapor space and causes vapors ascending from the bubble tower chamber to pass upwardly about the cooling tubes. In case more than one vapor pass is employed, partition walls may be provided for properly directing the ascending vapor into the first pass, otherwise no partitions are necessary, the tube bundle merely being surrounded by a vapor pass in direct communication with the distillation chamber. The tube bundle is preferably mounted at the upper end in a stationary tube sheet clamped to the shell, the tube bundle being free to expand downwardly through elevations of temperature, and being provided with a floating head at the lower end for sealing the interior of the tubes from the vapor space.

Still further features of the invention consist in certain novel features of construction, combinations and arrangements of parts hereinafter described and claimed, the advantages of which will be obvious to those skilled in the art from the following description.

In the accompanying drawings,

Fig. 1 is a section in elevation of one type of condensing apparatus;

Fig. 2 is a section in elevation of an alternative form of apparatus;

Fig. 3 is a detail illustrating a further modification for guiding the lower ends of the tube banks; and

Fig. 4 is a detail illustrating a method of supporting and removing the floating head cover when desired.

Referring particularly to the illustrated embodiment of the invention, the upper portion or crown of a bubble tower is indicated at 10, with an opening 12 formed therein for the reception of the lower end of the condenser. The condensing apparatus comprises generally a tubular shell 14 provided with a connecting flange 16 adjacent the lower portion, which is mounted upon an annular ring 18, in turn mounted upon the cover portion 10 of the tower and forming a marginal rim for the opening 12. The shell 14 is provided with a downwardly extended portion 20, which may be either integral therewith or formed as a separate portion to partially enclose and guide a tube bundle indicated generally at 22. The remainder of the shell, partially surrounding a second tube bundle 24, projects just below the top of the bubble tower, as indicated in the drawings. Both of the tube bundles, each comprising a multiplicity of cooling tubes 26, are supported from a divided upper tube sheet 30, the two parts of which are mounted on a ring 32 connected to the upper portion of the shell 14. Supported above the tube sheet 30 and connected thereto are cooling fluid heads 34 and 35 having inlet and outlet connections 36 and 38, respectively. These cooling fluid heads are conveniently connected to the tube sheet by through bolts 40, passing through integral portions 42 of the head and serving to stiffen and strengthen the two parts of the head. The two portions of the stationary head 30 or upper tube sheet are supported at their inner edges by a forged section 37 rigidly

connected to the shell at opposite ends. By providing separate and independent tube assemblies, the erection and assembly of the unit is facilitated owing to the fact that the shell assembly and each of the tube assemblies may be mounted independently. Furthermore, separate parts of the tube sheet may be removed for inspection of the tubes when desired without dismantling the complementary part. The provision of the rigidly mounted forged section supporting the parts of the tube sheet along the inner edges affords less opportunity for buckling of the tube sheet and provides for rigidity of the entire construction.

The lower end of the tube bundle **24** is provided with a floating tube sheet **46**, cooperating with a head **44** rigidly connected thereto by through-bolts **48**. The lower end of the tube bundle **22** in a like manner is provided with a floating tube sheet **50**, cooperating with a head **52** secured to the tube sheet by through-bolts **54**. The passage of cooling fluid through the tube bundles may be controlled in any desired fashion by properly dividing the stationary and floating heads to control and direct the cooling fluid flow in the manner best adapted to secure the desired reduction in temperature of the vapor during its traverse through the intertubular space.

As will be evident, the tube bundle **22** is substantially longer than the tube bundle **24**, and due to this increased length projects downwardly into the upper portion of the bubble tower for a sufficient distance to permit free ascent of the vapors about the lower portion of the tube bundle **22**. As will be evident, the lower portion of the tube bundle is surrounded by a shell portion **20**, having a lower cover member **62** to form a basin for the reception of the condensate, the shell above the floating head **50** being provided with vapor openings **64** of ample capacity to permit the ascending vapors to move freely in an upward direction lengthwise of the tube bundle **22**. The condensate from this ascending vapor column moves downwardly along the tube surfaces and through the intertubular space by gravity, is collected in the basin formed above the cover **62**, and is thence discharged directly back into the upper portion of the tower through the opening **66**.

The ascending vapor is confined to the space surrounding the first tube bundle by a partition member **70**, extending from top to bottom of the condensing apparatus and having one or more openings **72** in the upper portion for conducting the vapor at the top of the first pass into the space surrounding the second tube bundle **24**. The vapor thereafter descends lengthwise of the second tube bundle, and is thereafter discharged through the vapor outlet nozzle **73**, the condensate formed in this second pass discharging downwardly into the basin formed by the cover plate **74**, and thence being returned to the upper portion of the bubble tower through the outlet **76**.

It will be evident that with this construction the heated vapors are taken directly from the upper portion of the bubble tower and partially condensed by contact with the tubular surfaces in such a manner as not to interfere with the return of condensate to the bubble tower, and without losing any of the available heat of the vapor due to the conduction of the vapor, as is normally the case from the bubble tower to the condensing apparatus separated therefrom. By providing two bundles of dissimilar length and mounting these bundles directly over the bubble tower space, I am enabled to conduct vapor to the intertubular space above the condensate discharge, and in such a manner as not to interfere with the return of the condensate to the distilling space.

I am enabled to provide a mounting for the condenser unit independently of the bubble tower as through brackets **80**. This is accomplished through the provision of an expansion member consisting of complementary diaphragms **82** and **83** connected at their outer peripheries through a ring **84**, and at their inner peripheries to opposed bolting flanges **16** and **18** through mounting rings **86** and **87**. With this construction the upper bolting flange **16** is connected directly to the exterior of the shell which slides freely within the mounting rings **86** and **87** and the lower bolting flange **18**, permitting relative movements of the bubble tower structure with respect to the condenser shell, due to the relative expansion and contraction of the two members. Inasmuch as the bubble tower unit approximates fifty feet in height, it is evident that without some such provision it would otherwise be necessary to support the condenser unit directly upon the upper portion of the bubble tower, causing the latter to rise and fall with movements of the bubble tower.

From the illustrated embodiment of the invention, it will be evident that movements of the floating heads, due to expansion and contraction of the respective tube bundles, are guided and controlled by the surrounding portions of the shell and partition. The provision of some means for guiding the floating heads and preventing injurious contact between the tubes themselves and the surrounding shell is desirable not only during the operation of the apparatus but during assembly and removal of the tube bundles. It will be evident, however, that in so far as the guiding function is concerned, a skeleton type of guide would be adequate for maintaining the proper relationship between the floating heads and the surrounding shell, and at the same time permitting free communication between the first vapor pass and the interior of the bubble tower.

In Fig. 2 I have illustrated a somewhat modified form of construction in which an enclosing shell **90** is mounted directly upon a supporting ring or flange **92** connected to the upper portion of the bubble tower. The tube bundles are supported from a single stationary head **94** surmounted by a cover member **96** having cooling fluid connections **98** and **100**. The lower ends of the tube bundles are provided with floating heads **102** and **104** which are located within the upper portion of the bubble tower chamber, the tube ends projecting downwardly therein. The vapor rising from the interior of the bubble tower passes upwardly above the tube bundles, and is directed out through a vapor nozzle **106**. The interior of the tubes is cooled by a fluid in the usual manner passing in partial counter-current flow, and guided by passages formed in the interior of the cover member **96**, and the cover members **108** and **110** connected to the floating heads. In Fig. 3 I have shown a method of guiding and maintaining the floating heads, which comprises a downwardly extending and outwardly flared annular flange **115** having interior guides **116** for engagement with the floating heads, and also provided with an intermediate web **118** having similar guides **120** for engaging the floating heads. With this construction the floating heads are maintained in proper relationship, and the discharge of condensate thereabouts and therebetween is ensured. In Fig. 4 I have illustrated mechanism for facilitating the removal of either floating head which comprises a supporting

arm or jack 120 pivotally supported on a shaft 122 threaded in the flange 115 and capable of rotation beneath the head by elevation of the arm to be adjusted by a hand wheel 124 to bring the arm into supporting position beneath the cover. Thereafter, by unbolting and disconnecting the cover from the head, it may be swung into inoperative position on the arm, and access to the interior of the tubes made possible. If so desired, the arm may be connected with the cover by a threaded member 126 which engages with a threaded opening 128 formed concentrically of the cover, as indicated.

What is claimed is:

1. The combination with a distillation tower of a tubular condenser having a plurality of tube bundles, one of the bundles projecting downwardly into the upper portion of the tower and having provision for free communication between the tower and the intertubular space surrounding the bundle.

2. Apparatus of the character described comprising a distillation tower, a shell mounted upon the upper portion of the tower, a plurality of condenser tubes supported within the shell, certain of the tubes being longer than others and projecting downwardly within the tower, means for affording free communication between the upper portion of the tower and the intertubular space, and means for discharging the condensate directly from the intertubular space into the tower.

3. Apparatus of the character described comprising a distillation tower, a shell mounted on the tower, a stationary tube plate supported on the outer end of the shell, a plurality of condenser tubes depending from the plate, floating heads connected to the lower ends of the tubes at different heights, and means located between the floating heads for affording communication between the tower and the intertubular space.

4. A condenser adapted to be mounted in operative relationship to distillation apparatus comprising tube bundles of dissimilar length capable of independent contraction and expansion, and means for admitting vapor about the lower end of the long tube bundle.

5. A condenser adapted to be mounted in operative relationship to distillation apparatus comprising tube bundles of dissimilar length capable of independent contraction and expansion, means for admitting vapor about the lower end of the long tube bundle, and means for discharging condensate from the space beneath the lowest portion of the tube bundles.

6. A condenser adapted to be mounted in operative relationship to distillation apparatus comprising tube bundles of dissimilar length capable of independent contraction and expansion, means for admitting vapor about the lower end of the long tube bundle, and means for independently collecting and discharging condensates from the space beneath each of the tube bundles.

7. The combination, with a distillation tower, of a tubular shell above the tower, a series of cooling tubes within the shell, means for mounting the shell independently of the tower, and expansible and contractible connections between the shell and tower to permit relative movements of the two under the influence of varying temperatures.

8. Heat exchange apparatus comprising a shell, a stationary tube support at the upper portion of the shell, a series of tubes depending from the support, a floating head connected to the lower end of the tubes and having a detachable cover portion, and a supporting arm movable into and out of operative position beneath the cover to detachably support and permit removal of the cover from the floating head.

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