

April 7, 1931.

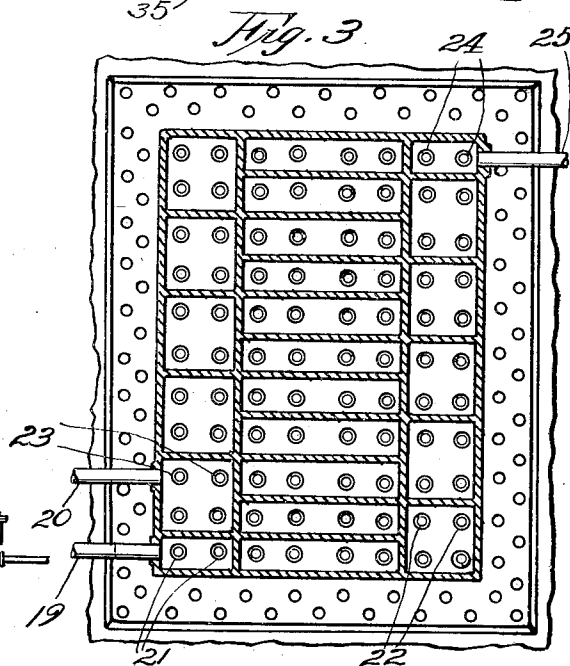
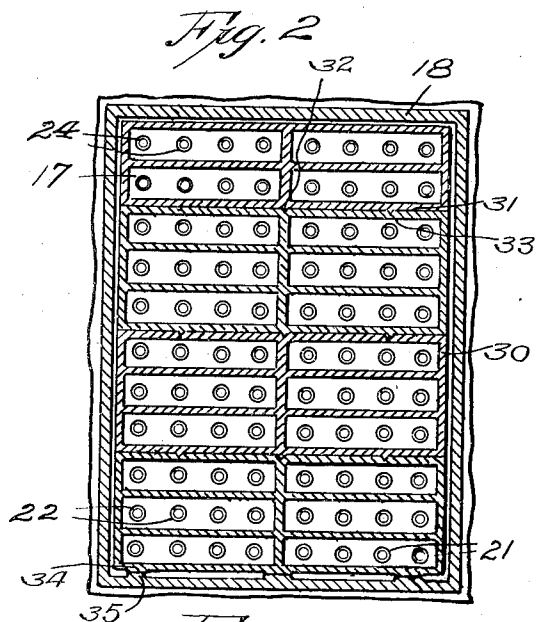
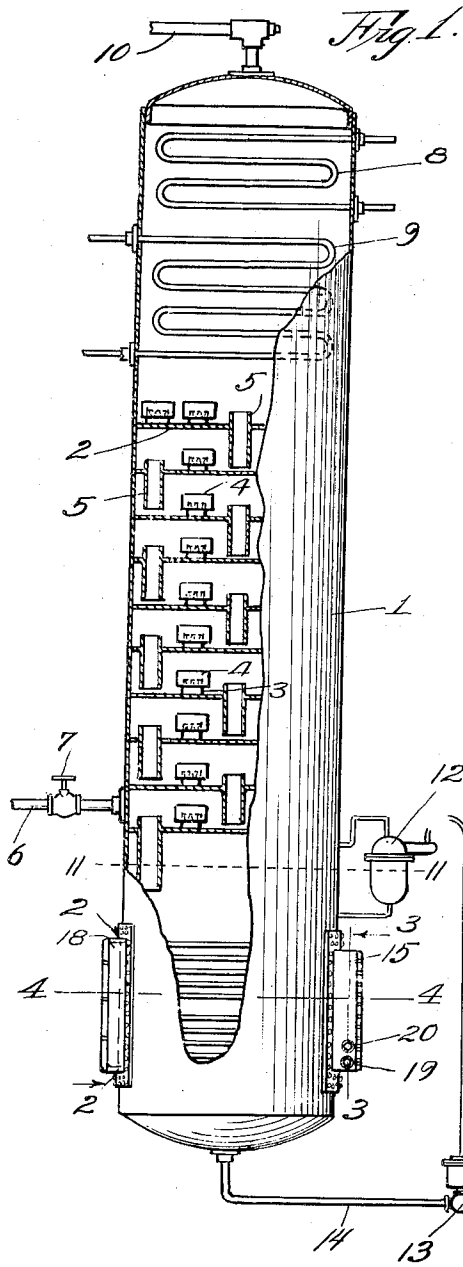
W. M. CROSS

1,799,734

HEAT EXCHANGER

Filed Dec. 17, 1924

2 Sheets-Sheet 1



Witness:

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2 Sheets-Sheet 2

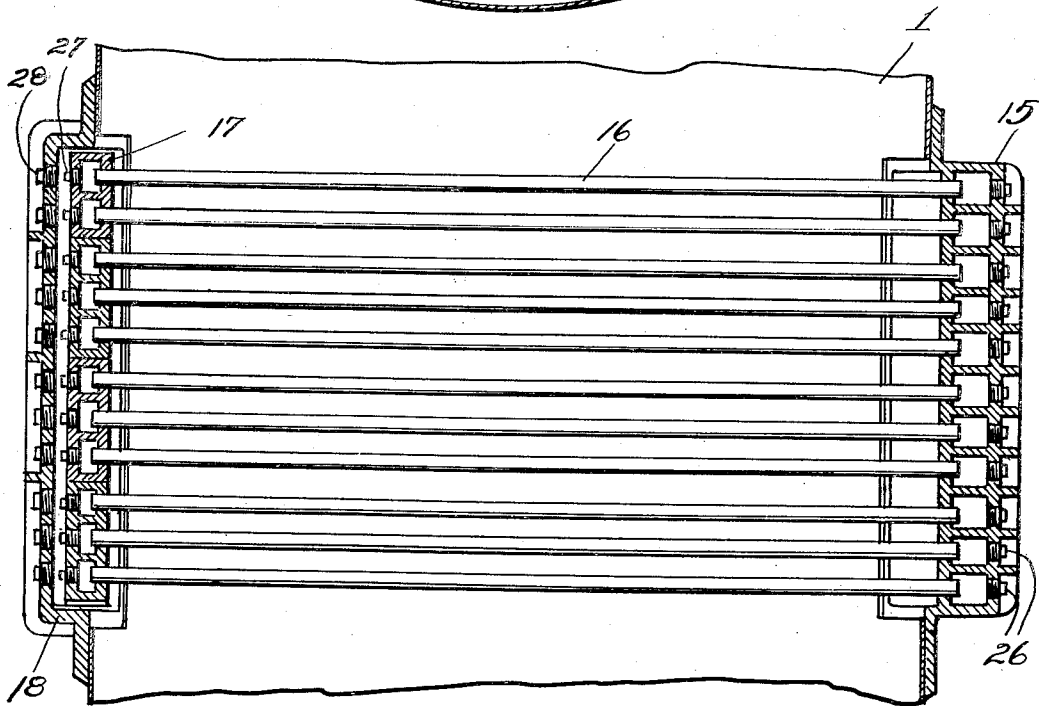
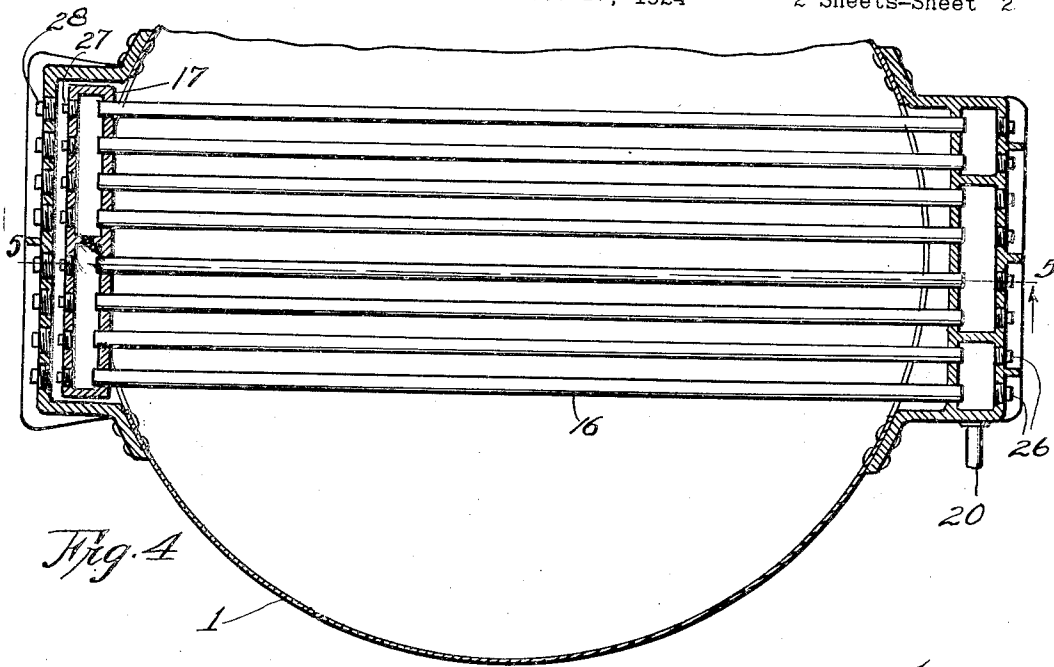


Fig. 5

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UNITED STATES PATENT OFFICE

WALTER M. CROSS, OF KANSAS CITY, MISSOURI, ASSIGNOR, BY MESNE ASSIGNMENTS,
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HEAT EXCHANGER

Application filed December 17, 1924. Serial No. 756,474.

This invention relates to improvements in heat exchangers, and refers more particularly to a tower construction adaptable for use in treating vapors, particularly hydrocarbon vapors in their travel from a distillation source to a stage of condensation.

Among the objects of the invention are, to provide a tower construction in which the vapors are introduced into the bottom and are caused to rise through a series of pools of liquid, which pools are successively cooler in temperature from the bottom to the top of the tower; to provide a construction whereby the liquid is coursed in an opposed direction to the vapors, separating out from the vapors in the separate pools a condensate which overflows to the pools below and is collected in the bottom of the tower; to provide a construction in which a relatively hot medium is introduced to the bottom of the tower in order to reboil the collected condensate or cooling liquid in order to drive off the lighter fractions or relatively low boiling point vapors for retreatment in the tower; to provide a mechanical construction devised to withstand the relatively wide range of temperatures to which it is subjected and one in which expansion and contraction is compensated for particularly in the lower reboiling portion, and a construction in which an efficient heat exchange is effected to reboil the liquid by passing the hot medium in a continuous passage through a plurality of relatively small coils and during the travel of the hot medium to provide an immense radiating surface and a more complete heat exchange.

In order to prevent the obstructing of the inlet to the reboiling element through deposition and accumulation of deleterious matter from the medium, a plurality of inlets are provided in order that an alternate inlet may be used should one become obstructed.

Fig. 1 is an elevational view of the tower with portion of the shell broken away.

Fig. 2 is a view taken along the line 2—2 in Fig. 1.

Fig. 3 is a view taken along the line 3—3 in Fig. 1.

Fig. 4 is a sectional plan taken along the line 4—4 in Fig. 1.

Fig. 5 is a view taken along the line 5—5 in Fig. 4.

Referring to the drawings, the tower is preferably constructed in the form of a cylindrical shell such as that shown at 1, although a square, rectangular tower may as well be used. Centrally in the tower are constructed a plurality of pans or separating partitions 2, through which extend risers 3 surmounted by caps 4. Liquid collects in pools upon the partition 2 and overflow or downcomer pipes 5 maintain the level of the liquid on the separate pools and permit the liquid to overflow to the pool below. Vapors are introduced to the tower through vapor line 6, controlled by a valve 7, and pass upwardly through the risers to the adjacent pool above, being caused to percolate or bubble through the liquid in the successive pools by the caps which surmount the risers and reverse the flow of the vapors.

In the upper portion of the tower are positioned further cooling means in the form of coils 8 and 9. Through these coils are circulated cooling mediums which further serve to separate out the higher boiling point fractions from the vapors. The uncondensed vapors pass off through the line 10 to further treating stages not shown. In each of the separate pools there is separated from the vapors liquid condensate which accumulates and is maintained at a level by the overflow of stand pipes 5. The excess liquid passes in a reverse direction to the vapors, gravitating downwardly through the system to the bottom of the tower where it is collected and maintained at a level—shown by the dotted line 11—by an automatic liquid level regulating device 12. This device controls the valve 13 in the drawoff line 14. The function of this particular device forms no part of the invention, and for that reason is only diagrammatically shown.

In the bottom of the tower is a reboiling unit which consists of a fixed header 15, tubes 16, a floating header 17 and a housing 18 in which the floating header is positioned. The function of this reboiler is to reheat and

reboil the condensate collected in the bottom of the tower in order to drive off all but the relatively higher boiling point fractions, producing a more uniform reflux condensate withdrawn through the line 14 and eliminating the lighter fractions from this oil body which materially increases the yield of distillate which passes over through the top of the tower in the form of vapors.

As mentioned, this tower is particularly adapted for use in an oil treating system such as an atmospheric distillation process or a cracking process in which pressure is used. A heating medium such as the liquid residual material withdrawn from the stage of conversion in a cracking system, may be circulated through the reboiling unit in order to give up its heat to the reflux condensate in order to drive off the lighter fractions therefrom. This hot liquid is introduced to the reboiling unit by means of either inlet pipes 19 or 20. A double inlet is provided in order that the operation of the apparatus need not be suspended should the lower inlet line 19 become obstructed with accumulated material such as carbonaceous material suspended in the form of free carbon in the residual liquid.

The passage of this heating liquid through the reboiler, is shown best in Fig. 3. Being introduced through the inlet line 19, it is coursed through the lower layer of tubes in the form of a double stream designated as 21, rising at the right end through the square header to the two tubes in the layer above, shown a 22, and passing thence in the pairs of tubes up and back and at the same time horizontally in a reverse direction to the layer below, working back to the left side where it rises again to the next layer 23. Thus, the oil is coursed successively through the separate layers of tubes to the top layer 24 and is discharged through the outlet pipe 25. It will be noted that the alternate inlet pipe 20 supplies the oil to the layer of tubes 23, the third layer above the bottom row of tubes, and may be used as the inlet for the heating medium should the lower tubes become obstructed or clogged.

The fixed header 15, shown in section in Fig. 3, is fixedly mounted upon the side of the tower either by bolts, rivets or otherwise secured. Opposite the end of each of the tubes is a removable cleaning plug such as shown at 26 in order that the tubes may be cleaned should it become necessary. The opposite ends of the tubes terminate in a floating header 17 equipped with cleaning plugs 27 and movably positioned at the end closure 18 which has cleaning plugs 28 opposite the plugs 27 in order that the tubes may be cleaned from both the fixed end 15 and from moveable end 17. The purpose of the moveable header is to permit expansion and contraction of the tubes and metal parts due to

the high temperature at which the medium is circulated through the reboiler. The compound floating header 17 of the reboiler is preferably made up of individual sections 30, shown best in Fig. 2, in order that it may be more easily assembled and repaired. These sections contact with each other at the faces 31 and are provided with V-shaped members 32 fitting into suitable channels 33 in the adjacent sections in order to restrict lateral movement over each other while permitting unrestricted longitudinal movement. The bottom section is provided with a plurality of feet 34 which abut corresponding members 35 of closure 18. Tube supports may be positioned near the ends of the tubes to prevent sagging.

It is recognized that heretofore it has been common practice to pass a heating medium through liquid oil in a tower or introduce live steam for the purpose of driving off the lighter fractions. It is submitted, however, that there has not heretofore been a satisfactory apparatus for introducing a hot medium, such as the residual material produced in a cracking unit, and circulating it in the manner shown, providing for an efficient and effective heat exchange and preventing the clogging due to accumulated material and at the same time providing an apparatus which will satisfactorily prevent leaks due to excessive stress and strain caused by the uneven expansion and contraction of the metals, resulting from uneven and wide temperature range to which the metal is subjected.

While this apparatus has been particularly described with reference to its adaptation to the treatment of hydrocarbon vapors, it is appreciated that it may, as well, be used in the treatment of other vaporous material, water or other mediums being used in place of the oil in the reboiling element.

I claim as my invention:

1. A reboiling element for fractionating towers, comprising a unitary partitioned header, a compound partitioned header, a plurality of sets of tubes arranged in series and connected into the partitioned headers to permit a continuous flow of the medium passing through the element, and inlet and outlet ports in one of the headers, the unitary header fixedly mounted in the tower, the compound header so mounted as to permit only longitudinal movement of its components.

2. A reboiling element for fractionating towers, comprising a partitioned fixed header and a compound header, a plurality of sets of tubes arranged in series and connected into the headers to permit a continuous flow of the medium passing through the element, inlet and outlet ports for the fixed header, the several members of the compound header being mounted in the tower so as to permit only horizontal movement thereof.

3. A reboiling element for fractionating

towers, comprising an integral partitioned header, a compound partitioned header, a housing for the compound header, a plurality of sets of tubes arranged in series and connected into the partitioned headers to permit a continuous flow of the medium passing through the element, inlet and outlet ports in one header, one header fixedly mounted in the tower, the other movable therein to permit expansion and contraction of the metal, cleaning plugs opposite the ends of the tubes in both the fixed and movable headers, and separate plugs in the housing in aligned relation with the tubes.

4. A reboiling element for fractionating towers, comprising an integral partitioned header, a compound partitioned header, a plurality of sets of tubes arranged in series and connected into the partitioned headers to permit a continuous flow of the medium passing through the element, and inlet and outlet ports in one of the headers, one header fixedly mounted in the tower, the other movable therein to permit expansion and contraction of the metal, and an auxiliary inlet port for eliminating the necessity of discontinuing the flow of liquid through the reboiling element should one inlet port become clogged.

5. In a reboiling element for fractionating towers, a compound floating header comprising a plurality of independent, superimposed, movable header elements, and partitions within each element.

6. A compound floating header comprising a plurality of independent, superimposed, movable header elements, each separate element being provided with a plurality of tired, horizontal partitions and a vertical partition defining separate chambers in said elements.

7. In a header construction of the character described, in combination, a plurality of separate partitioned header elements independently movable, oppositely positioned sets of apertures in the header elements, sets of tubes connected into one set of apertures and individual closure plugs for the apertures of the oppositely positioned set.

8. A compound floating header comprising a stack of superimposed independently moveable header elements, and means to confine the movement of the elements to a single plane.

9. In a reboiling element for fractionating towers, a compound floating header comprising a plurality of independent, superimposed, moveable header elements having V-shaped members adapted to fit in corresponding channels in adjacent members.

WALTER M. CROSS.