July 14, 1953 A. S. ALLEN 2,645,607

VAPORIZER UNIT AND TRAY

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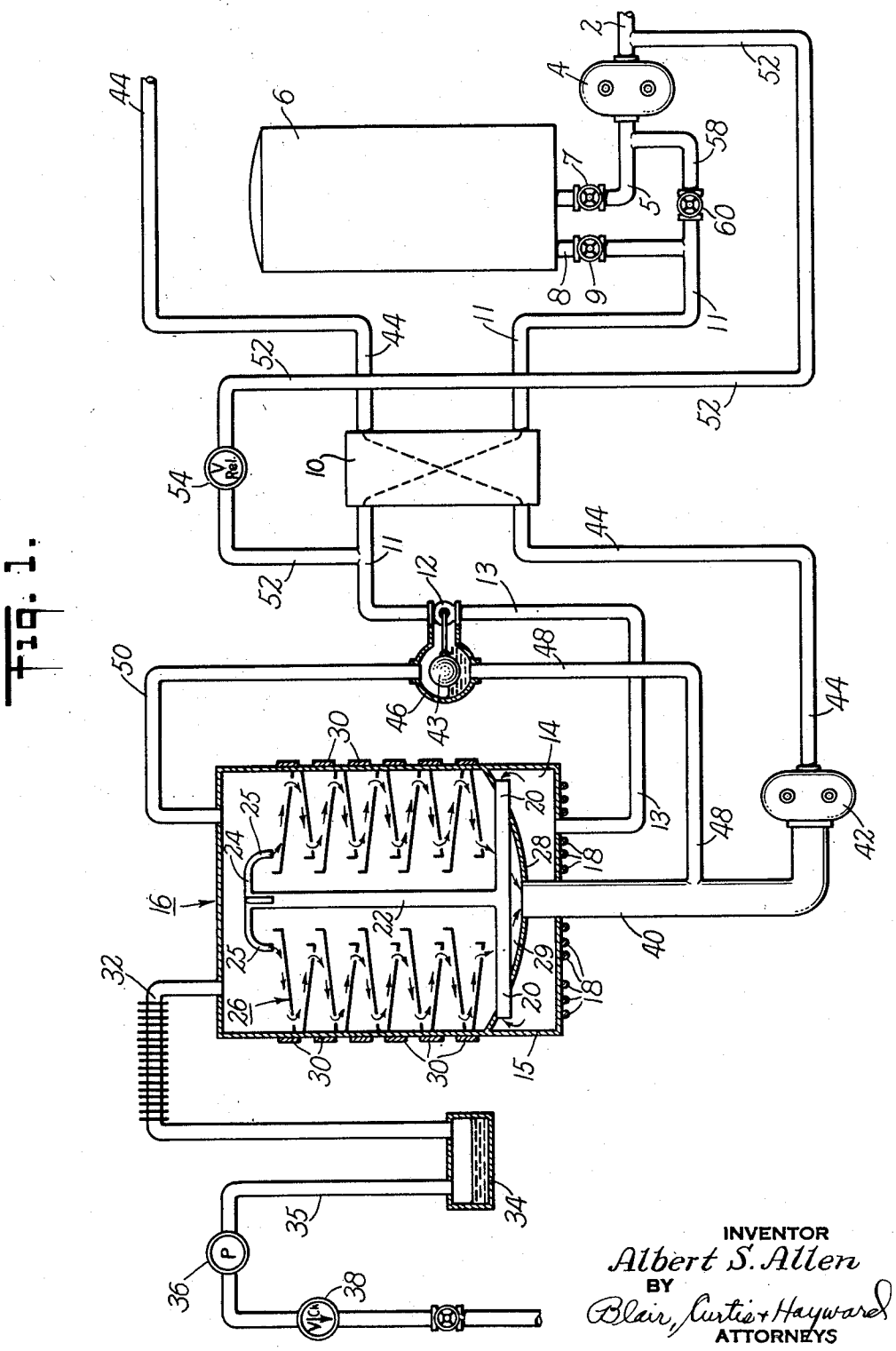

Fig. 1.

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Fig. 2.

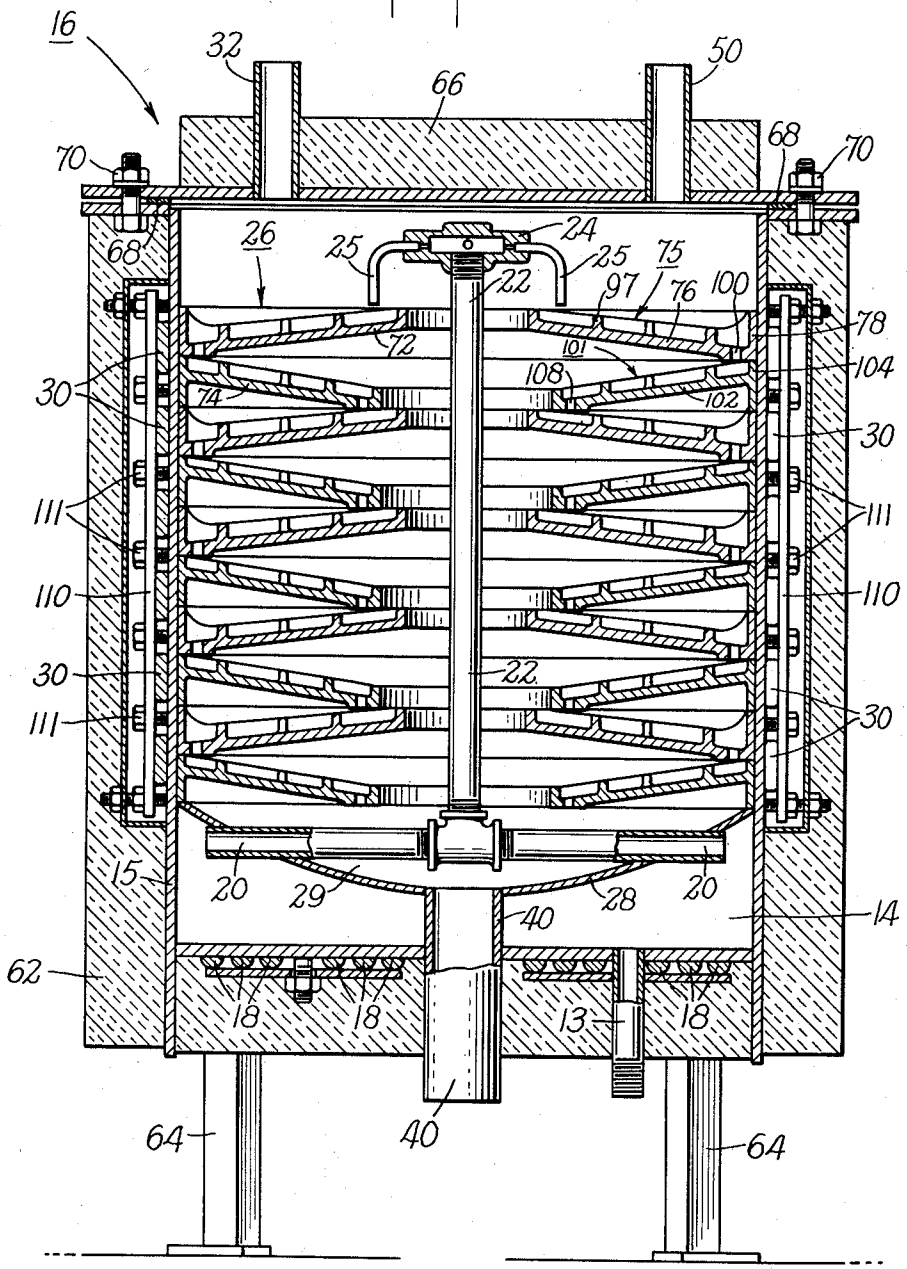

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Fig. 3.

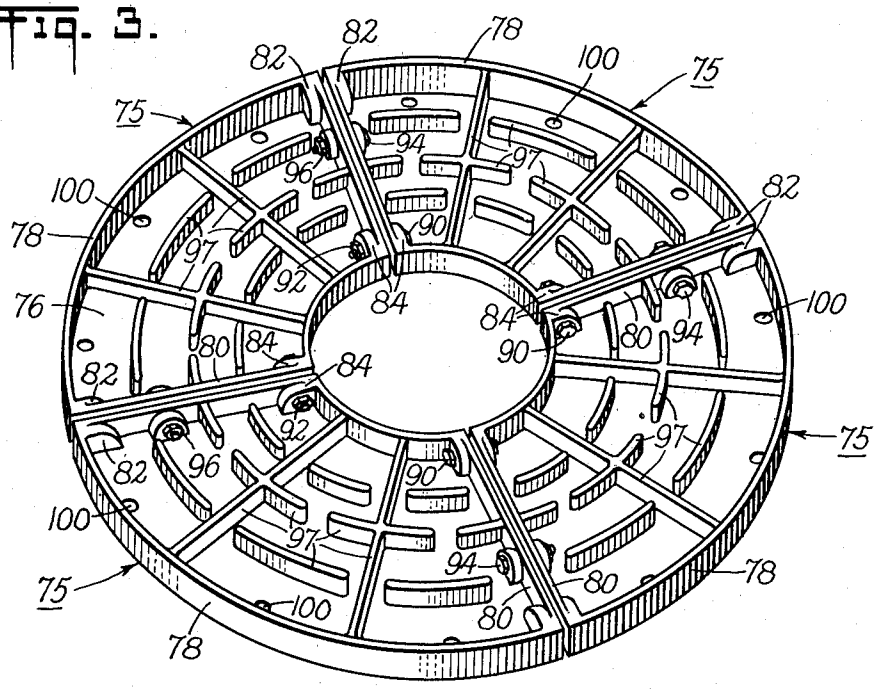
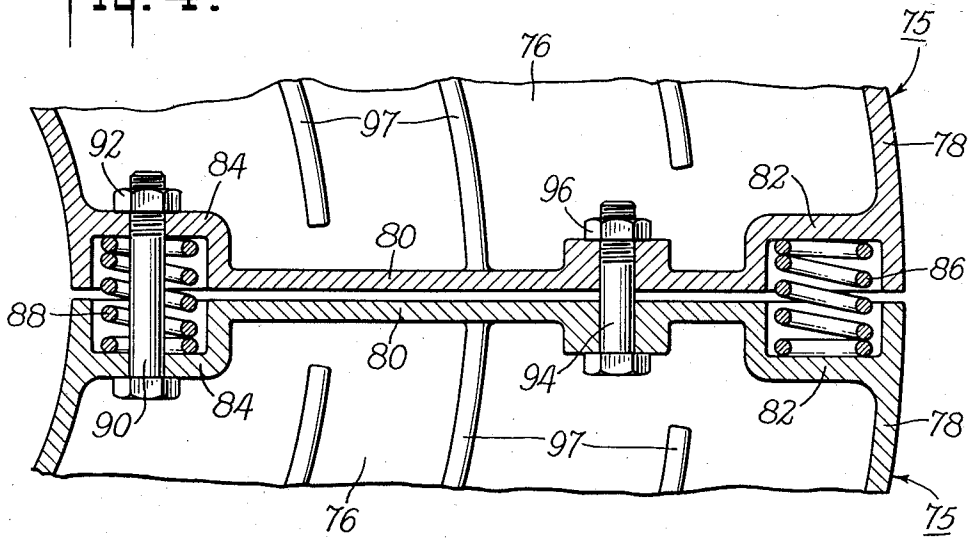


Fig. 4.



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Patented July 14, 1953 2,645,607

UNITED STATES PATENT OFFICE

2,645,607

VAPORIZER UNIT AND TRAY

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Application October 30, 1948, Serial No. 57,465

12 Claims. (Cl. 196—111)

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This invention relates to the conditioning of oil and the like, and more in particular to a system for removing foreign materials from oil such, for example as oils which are used in transformers, refrigerators, turbines, and engines. This invention also relates particularly to a vaporizer for removing volatile substances from oil or the like.

An object of this invention is to provide an improved system for reconditioning oil wherein the disadvantages of the prior art systems are avoided, and wherein extremely efficient operation is obtained. A further object is to provide an efficient and dependable arrangement for removing volatile substances from a liquid such as oil. A further object is to provide for the efficient heating of a liquid such as oil as it passes in a thin stream through the heating zone. A further object is to carry out the above with absolute safety and yet with assurance that thorough treatment is obtained. A further object is to provide apparatus for carrying out the above which is light in weight, sturdy and compact in construction, efficient and dependable in operation, and inexpensive to manufacture, operate and maintain. These and other objects will be in part obvious and in part pointed out below.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a schematic view showing an oil conditioning system incorporating the present invention;

Figure 2 is a side elevation with parts in section of a vaporizer unit which is part of the system of Figure 1;

Figure 3 is a perspective view of one of the trays of the unit of Figure 2; and,

Figure 4 is a vertical section showing certain of the structure of the tray of Figure 3.

In many different types of apparatus, oil is used under circumstances wherein purity is important, but where the oil is subjected to contamination by liquids, gases or solid particles. For example, oil is used as an electric insulator in transformers, circuit breakers, and cables, and it is quite important that the moisture content be kept at an extremely low value so that the desirable dielectric properties of the oil are maintained; and this oil may become contaminated with dirt, or where electric sparks occur the oil may partially burn to form carbon particles and this may interfere with the dielectric properties of the oil and with ability of the oil to circulate. Similarly, in refrigeration systems it is important that the oil be kept free of water vapor and other contamination such as dirt particles. The lubricating oil in internal combustion engines is apt to become diluted with the fuel and it may become contaminated with dirt and carbon particles. The removal of contamination so as to insure the desired purity of these oils is referred to as "reconditioning" of oil; and it is an object of the present invention to provide an improved system for reconditioning these and similar oils or like liquids.

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In accordance with the present invention a unitary system is provided which includes a filter unit for first removing the solid particles from the oil and a vaporizer unit within which the oil is heated so as to drive off vapors and gases. The oil is pumped through the filter unit and it then flows in a controlled manner into the vaporizer unit where it flows in thin streams or layers down a plurality of serially related trays, and the trays are heated so that the temperature of the oil is gradually raised. The oil passes from the vaporizing unit in heat-exchange relationship with the oil passing to the vaporizer unit so that a relatively low temperature supply of pure oil is provided.

Referring particularly to Figure 1 of the drawings wherein one embodiment of the invention is shown schematically, the oil to be conditioned is drawn in (see the lower right-hand portion of figure) through a pipe 2 by a rotary pump 4. Pump 4 delivers the oil through a pipe 5 having normally open valve 7 therein to a filter unit 6 of a known type. Within the filter unit the oil is subjected to a thorough filtering action so as to remove all insoluble materials and particles and the oil then passes from the filter unit through a pipe 8. Pipe 8 has a normally opened valve 9 therein and the oil flows from pipe 8 through a pipe 11, a heat exchanger 10, a float-controlled valve 12 and a pipe 13 to the preheater section 14 of a vaporizer 16. Vaporizer 16 has a tank 15 at the bottom of which the preheater section is formed by a dished or downwardly concave wall 28. While within the preheater section the oil is preheated by an electric heater unit 18 and it then passes through a pair of aligned pipes 20 to a vertical pipe 22 and thence upwardly to a header 24.

The preheated oil passes from a header 24

through twelve distribution pipes 25 (only three of which appear in the schematic showing of Figure 1) into the uppermost of a set of vaporizing trays 26 which are represented schematically and which will be described in detail below. The oil flows in a thin layer or sheet form from one tray to the next beneath it, and at the bottom of the lowest tray it falls onto a sump 29 formed by the dished wall 28 which separates the preheater section 14 from the main portion of the vaporizer tank 15. While flowing down the trays the oil is heated by the heat from a set of strip heaters 30 fixed to the outer wall of the vaporizer tank. Thus, the filtered oil is subjected to a gradual heating while flowing in a thin sheet form so as to drive off all volatile liquids such as hydrocarbons and water as well as gases such as air which are contained in the oil, and pure oil collects in sump 29.

At the top of the vaporizer tank there is a finned pipe 32 through which the gases and vapors pass and are cooled and they then pass downwardly to a tank 34; and, during this passage the vapors are recondensed as liquids which collect in this tank. The uncondensed vapors and gases are pumped from the top of tank 34 through a pipe 35 by a vacuum pump 36 and are discharged through a check valve 38. The pure oil is withdrawn from sump 29 in the bottom of the vaporizer tank through a discharge pipe 40 connected to the center of wall 28 by a pump 42. The oil then passes through heat exchanger 10 in heat-exchange relationship with the oil passing to the vaporizer, thus, to heat the incoming oil and to cool the conditioned oil; and pure oil passes from the heat exchanger through a pipe 44.

It is desirable to maintain a pool of oil in sump 29 so that oil can be removed as desired by operating the positive discharge pump 42; and, therefore valve 12 is so controlled that oil is delivered to the vaporizer unit at only the rate necessary to maintain the desired level of oil in the sump. Accordingly, valve 12 has its float 43 positioned in a tank 46 which is connected at its bottom to oil sump 29 through pipes 48 and 40, and at its top through a pipe 50 to the top of the vaporizer tank. Therefore, the oil level in tank 46 is the same as that in sump 29, and when the oil level in the sump falls, float 43 is lowered so that valve 12 is moved toward its fully opened position, and when the oil level in the sump and the float rise and valve 12 is moved toward its fully closed position.

Pump 4 is of the positive displacement type so that oil is pumped through the filter unit at a constant rate, and when valve 12 restricts the flow the pressure tends to build up in pipe 11. However, pipe 11 is connected to pipe 2 through a pipe 52 having a pressure relief valve 54 therein, and when the pressure in pipe 11 reaches a predetermined value valve 54 opens and oil flows through pipe 52 to pipe 2; in this way the oil in excess of that which passes through valve 12 returns to pipe 2 and is recirculated through the filter unit. This arrangement not only gives accurate control upon the supply of oil to the vaporizer unit, but it also has the advantage that the recirculation of oil through the filter unit raises still higher the standard of purity of the oil. Under some circumstances it is desirable to operate the system without the filter unit, and therefore, the discharge pipe 5 from pump 4 is connected to pipe 11 through a pipe 58 having a normally closed valve 60 therein; and the filter unit is by-passed by closing valves 7 and 9, and by opening valve 60 so that the oil from pump 4 passes directly to pipe 11.

The details of construction of the vaporizer unit are shown in Figures 2, 3 and 4 where the parts are numbered to correspond with Figure 1. Tank 15 is covered by heat insulation 62 and the unit is mounted on three legs 64. The top of tank 15 is closed by a removable cover 66 which has a gasket 68 around its periphery and is clamped in place by a plurality of bolts 70. There are five pairs of the trays with each pair being formed by a somewhat frusto-conical tray 72 which slants downwardly and radially outwardly, and a somewhat similar tray 74 which slants downwardly and radially inwardly. Referring particularly to Figure 3 each tray 72 is formed by four segmental tray units or sections 75, each of which is formed by a sloping bottom wall 76 which slopes away from the center axis, an arcuate side wall 78, and two radial side walls 80 (see also Figure 4). Each wall 80 has two spring pockets 82 and 84 positioned respectively adjacent the inner and outer peripheries of the tray, and each of these pockets receives the end of a spacer spring. Thus, the two adjacent mating pockets 82 receive the two ends of a spacer spring 86, and the two adjacent mating pockets 84 receive the opposite ends of a spacer spring 88. Concentric with pockets 82 are holes through which extends a bolt 90 having a nut 92 thereon, and the central portion of each side wall 80 has a similar hole therein which receives a bolt 94 having a nut 96. Thus, as shown in Figure 4 springs 86 and 88 urge the tray segments or sections apart, but bolts 90 and 94 limit this movement. Wall 76 has on its upper surface a web structure 97 which tends to spread the oil as the oil flows along the bottom wall of the tray. Adjacent the center and ends of walls 78 there are oil outlet or drain openings 100 in the bottom wall through which the oil flows to the tray 74 beneath it. As indicated above in connection with the discussion of Figure 1, oil is supplied to the vaporizer unit at the center of the top tray 72 through twelve distribution pipes 25. Referring now to Figure 3 wherein the twelve tray sections are shown, each of the twelve distribution pipes delivers oil to a tray section and the oil in each section flows outwardly and downwardly to its drain opening 100.

Each of trays 74 (Figure 2) is similar in construction to trays 72 except that the trays 74 slope toward the center axis; thus, each tray 74 is formed by four sections 101 and has a sloping bottom wall 102, an arcuate side wall 104, and two radial walls. Adjacent the inner periphery of each tray are oil outlet or drain openings 108 through which oil flows from the tray.

The arcuate walls of the tray sections are of the contour of the inner surface of tank 15, and the lower-most tray rests at its outer periphery upon wall 28 and the other trays are stacked one upon another with their arcuate walls contacting each other. In assembly, nuts 92 and 96 are tightened sufficiently to reduce the overall effective diameter of each of the trays to something less than the inner diameter of tank 15. This compresses springs 86 and 88, and the construction is such that the trays are then relatively rigid and they may be lowered without difficulty into tank 15. After each tray is properly positioned, its nuts 92 and 96 are loosened so that its springs 86 and 88 are no longer restrained and they urge the tray sections apart. This in-

creases the overall effective diameter of the tray so that the arcuate wall of each tray section is urged tightly against the adjacent portion of the inner surface of tank 15. Thus, after assembly the trays are easily put into place and then are held in fixed relationship within the tank. As indicated above, the contour of the arcuate walls of the tray sections is the same as that of the inner surface of tank 15, and this insures that a good heat-exchange relationship is established between the tank wall and each of the tray sections. Heaters 30 are held by clamp bars 110 and bolts 111 tightly against the outer surface of tank 15, and therefore, the heat from the heaters passes readily to the trays. The trays are of cast aluminum and the heat distributes itself throughout the entire bottom surface of each tray section. Thus, the oil flowing down the trays in thin streams is subjected to an even heating effect so that vapors and gases are driven from it.

The vaporizer may be used without the filter unit when it is unnecessary to remove solid particles. For example, the vaporizer may be used to treat either sour or sweet crude oil for removing such constituents as hydrogen sulphide, butane, propane and water, and it may also be used for removing sulphur. Tests have indicated that the sulphur content may be reduced from five percent to as low as 1.25 percent. For certain processes a filter unit is connected to pipe 44 so that the oil or the like is subjected to a filtering action after passing through the evaporator.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A vaporizer unit comprising a substantially cylindrical tank having a vertical axis and a heat conducting side wall, a plurality of trays within said tank positioned one above the other and having peripheral surfaces which conform to and tightly engage the inner surface of said side wall, each of said trays comprising a plurality of tray sections divided from each other along radial planes, and pockets adjacent the ends of the dividing walls of said section, a plurality of spacer springs in said pockets to urge said sections away from each other transversely of said planes, a plurality of bolts to hold said sections together, a pre-heater section in the bottom of said tank formed by a concave wall positioned directly beneath the lowest tray and spaced upwardly from the bottom wall of the tank, a pipe assembly extending from said pre-heater section to the top of said tank, and having oil discharge means directing oil into the uppermost of said trays, and heater means on the outer surface of said side wall to heat the trays.

2. In a vaporizer unit the combination with tank means having a heat-conducting side wall of a plurality of trays within said tank positioned one above the other, each of said trays comprising a plurality of tray sections divided from each other along radial planes, and spring means urging said sections away from each other transversely of said planes, and heater means on the outer surface of said wall to heat the trays.

3. A vaporizer unit comprising a substantially cylindrical tank having a heat conducting side wall, a plurality of trays positioned one above the other in said tank having peripheral surfaces which conform to and tightly engage the inner surface of said side wall, each of said trays comprising a plurality of tray sections separated along radial planes and provided with a plurality of circumferential baffles and radial dividers, a pair of well portions along each edge of said tray sections, coil springs mounted therein to urge the tray sections away from each other.

4. In a vaporizer the combination of a substantially cylindrical tank, a plurality of trays positioned one above the other within said tank, each of said trays being formed by four substantially identical tray sections held together by a plurality of bolts and urged toward a spaced relationship by a plurality of springs acting in cooperation with said bolts.

5. A vaporizer unit comprising a substantially cylindrical tank having a vertical axis and a heat-conducting side wall, a plurality of trays within said tank positioned one above the other and having peripheral surfaces which conform to and tightly engage the inner surface of said side wall, each of said trays comprising a plurality of tray sections divided from each other along radial planes and spring means to urge said sections away from each other transversely of said planes, and heater means on the outer surface of said side wall to heat the trays.

6. A vaporizer unit as described in claim 5 wherein at each of said radial planes there are two wall portions of the adjacent tray sections each of which has a spring pocket therein, and wherein a coil spring is positioned with its two ends positioned respectively within said pockets thereby to provide the spring means urging the tray sections away from each other.

7. A vaporizer unit as described in claim 5 which includes, a preheater section in the bottom of said tank formed by a concave wall positioned directly beneath the lowest tray and spaced upwardly from the bottom wall of the tank, and a pipe assembly extending from said preheater section to the top of said tank, and having oil discharge means directing oil into the uppermost of said trays.

8. A vaporizer unit as described in claim 5 wherein said trays are of two types alternately positioned with one type having a downwardly and radially outwardly slanting bottom wall and the other type having a downwardly and radially inwardly slanting bottom wall, each of said trays having an arcuate peripheral wall which is a segment of a cylinder.

9. A vaporizer unit as described in claim 8 wherein each of said trays is formed by four substantially identical tray sections held together by a plurality of bolts and urged toward a spaced relationship by a plurality of springs.

10. A vaporizer tray having a substantially circular periphery and formed by more than two substantially identical tray sections each of which has two radial side walls with each wall having adjacent its ends pockets which receive the ends of spacer springs, and means holding said tray sections together.

11. A vaporizer tray having an arcuate peripheral wall which is substantially a segment of a cylinder, formed by a plurality of substantially identical tray sections each of which has two radial side walls with each wall having adjacent its ends pockets which receive springs which urge

said sections toward a spaced relationship and means holding said tray sections together.

12. A vaporizer tray as described in claim 11 wherein said tray sections number four and have peripheral walls adapted to conform to and tightly engage the side walls of a vaporizer tank.

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