Nov. 24, 1931. C. L. SMITH ET AL 1,833,340

ORIFICE PLUG

Filed Jan. 14, 1929

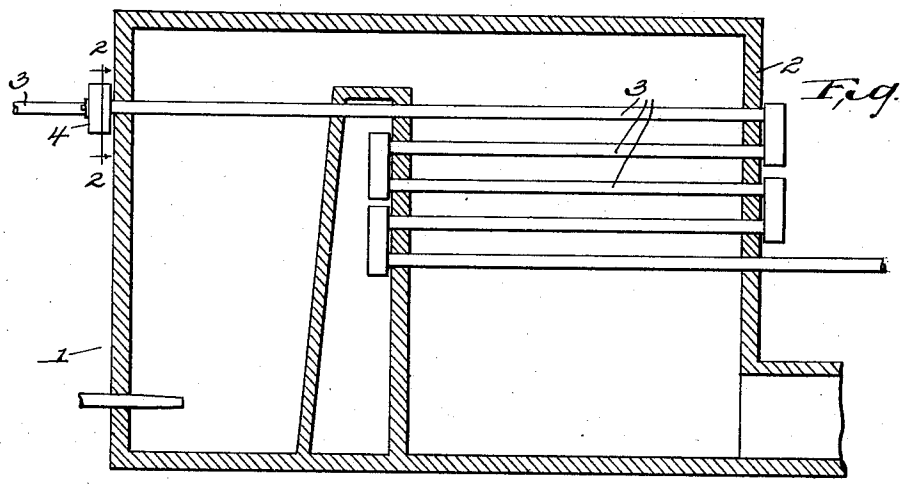


Fig. 1

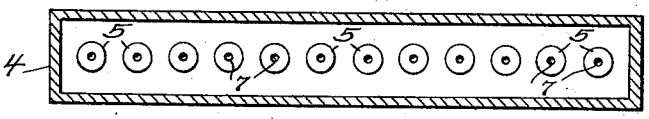


Fig. 2

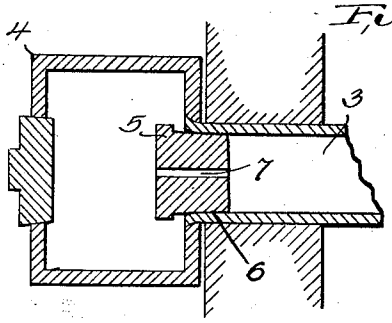


Fig. 3

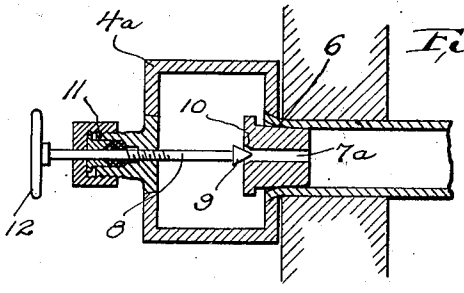


Fig 5

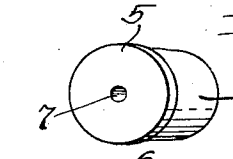


Fig. 4

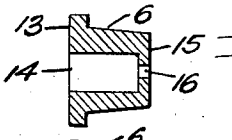


Fig. 6

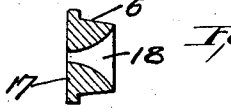


Fig. 7

Inventor

Clyde L. Smith

Audley E. Harnsberger

By W. S. McDowell

Attorney

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UNITED STATES PATENT OFFICE

CLYDE L. SMITH AND AUDLEY E. HARNSBERGER, OF CHICAGO, ILLINOIS, ASSIGNORS TO THE PURE OIL COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF OHIO

ORIFICE PLUG

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This invention relates to improvements in liquid heating apparatus, and has particular reference to heaters of the type embodying a plurality of tubes through which the fluid, either in liquid, vaporous or gaseous state, to be heated is passed and brought into contact with the heated walls of said tubes for heat transfer purposes. These tubular heaters or pipe stills are used by petroleum oil refiners for heat treating oil for the purpose of vaporizing and/or cracking oils in accordance with various refining processes. In certain of these systems oil vapor is brought into a manifold or header with which communicates a plurality of parallel or multiple tubes. It has been found that unless these tubes are uniform in internal diameter and subjected to the same conditions of temperature the oil vapor instead of passing in uniformly proportionate quantities through each of the tubes, possesses a tendency to flow to a greater extent than normal through one or more of said tubes and to a lesser extent through the other tubes. This gives rise to undesirable conditions particularly in the matter of heat treating the oil uniformly to a desired temperature and in the maintaining of oil at such temperatures for a desired period of time.

It is therefore an outstanding object of the present invention to provide each of said tubes at the ends thereof where they enter or communicate with the header or manifold, with removable orifice plugs. These plugs close or obstruct the open ends of the tubes and are provided with accurately drilled axial passages of uniform diameter so disposed that an even flow of the oil vapor from the header or manifold into each of such tubes will be secured, the said plugs serving to meter the flow of the oil vapor to insure the requisite distribution of said vapor into each of said tubes.

It is a further object of the invention to form said orifice plugs so that they can be conveniently supplied to or removed from the ends of the tubes or pipes into which they are fitted or inserted in order that the tubes may be conveniently cleaned or repaired from time to time or to permit of changes being made in the plugs for the purpose of repairing the diameter of the inlet passages provided in said plugs leading from the header or manifold into the tubes.

With these and other objects in view which will appear as the description proceeds, the invention consists in the novel features of construction, combinations of elements and rangements of parts hereinafter to be fully described and pointed out in the appended claims.

In the accompanying drawings:

Figure 1 is a vertical transverse sectional view taken through a pipe still provided with the orifice plugs forming the present invention,

Figure 2 is a vertical sectional view taken on the plane indicated by the line 2—2 of Figure 1,

Figure 3 is a detail longitudinal sectional view taken through a header and communicating pipe and showing the position of the orifice plug in the inlet end of said pipe,

Figure 4 is a detail perspective view of the plug,

Figure 5 is a detail sectional view of a modification, and

Figures 6 and 7 are detail sectional views of modified types of plugs.

Referring more particularly to the drawings, the numeral 1 designates a pipe still used, for example, in the heating of oil vapors for the purpose of cracking the same. The pipe still comprises a setting 2 which is formed to include a plurality of longitudinally extending tubes or pipes 3. These tubes or pipes are arranged in parallel rows or passes and are supported in connection with the setting 2 in any desired manner. Oil or oil vapor is admitted into the inlet row of said tubes and flows serially, or otherwise, as desired, through the said rows of tubes in order that the fluid may be subjected to the internal temperatures of the still for a sufficient period of time to secure or attain a requisite degree of temperature necessary to effect certain operations.

The inlet end of the still is provided with longitudinally extending header or manifold 4, into which oil vapor is lead, for example,

from any suitable source and under any desired pressure. The inlet row 3 of tubes enters the header or manifold 4 in order that the oil vapor introduced into said header may be distributed for uniform flow through each of said tubes or pipes. It has been found in practice that due to variations in diameter of the tubes or pipes, owing often to manufacturing methods, there is a variation in the quantity of vapors flowing through the same row of tubes, that is, certain of said tubes permit of the passage of a greater quantity of vapor than other tubes in the same row or pass and this results in undesirable conditions due to the lack of uniformity in the heat treatment of the oil vapors.

Therefore, we have found that by placing orifice plugs, indicated at 5, in the ends of the tubes 3, where the latter communicate with the header or manifold, this condition can be greatly alleviated and uniformity in flow secured. In a preferred form of the invention each of the plugs consists of a metallic body having a tapering outer wall indicated at 6. These plugs may be driven into the ends of the pipes 3 and will frictionally maintain their positions, as shown in Figure 1, therein. Axially each plug is provided with a longitudinally extending carefully drilled bore 7 which conforms to the diameter of the bores or passages provided in the remaining plugs. This construction permits each tube or pipe to possess an entrance opening of the same effective diameter. Each tube, therefore, presents the same conditions of oil flow and the passage of vapor from the header or manifold 4 into said tubes. The header is of open construction so that the vapor pressures therein will be uniform throughout all parts thereof. The plugs, therefore, serve to meter the flow of oil vapor into the tubes so that each tube handles the same quantity of oil vapor. The construction thus provides for better regulation in the matter of insuring equalized heat treatment to all proportions of a body of oil vapor, or other fluid, passing through the still. By separably forming the plugs in relation to the tubes or pipes, convenience is to be had in cleaning the tubes or pipes of carbon or other deposit since the plugs may be readily removed to permit of the entrance of cleaning or scraping tools. Again, by the provision of separable plugs changes may be made from time to time in the diameter of the bores or passages formed axially in said plugs. For example, in handling certain fluids a bore of greater diameter is necessary or desired than in the handling of other fluids.

In Figure 5 a construction is set forth for varying the effective size of the orifices by outside regulation. This is attained by means of a valve-like construction consisting of a threaded stem 8 which terminates in a tapered extension 9 movable toward and away from a seat 10 provided in connection with the orifice passage 7*a*. The stem passes through a packing gland 11 formed in connection with a header 4*a*, and the exterior of the stem is equipped with a hand-wheel 12 by which the stem may be manually rotated to move the conical head 9 toward and away from the seat 10. This construction makes each orifice act somewhat like a valve, and by means of which the vapor flow through the individual tubes can be regulated. The construction permits of the use of a thermocouple or other temperature indicating means in the vapor outlet of each converter tube in order to regulate the temperature of the outlet individually by manipulation of the apparatus shown.

In the form of the invention disclosed in Figure 6 the orifice plug 13 is provided with an enlarged axially disposed chamber 14 which terminates rearwardly in a thin wall 15 in which is formed the regulating orifice 16. The plug 13 is formed to fit in the inlet end of the pipe 3 in precisely the same manner as the plug 5. In Figure 7 a further modification is set forth wherein the plug 17 is formed with a bell-shaped orifice 18 having the inlet portion thereof arranged toward the header and the enlarged portion thereof disposed within the co-operating tube. By this construction better contact of the oil vapor with the heated walls of the tube is obtained in areas closely adjacent to the orifice than in that type of orifice having a uniform diameter throughout its length.

It is well known that the capacity of orifices of the thin plate and diverging types have a constant discharge capacity when the downstream pressure is .57 or less of the absolute upstream pressure. In other words, if the pressure drop across an orifice is sufficiently high, there could be a variable downstream pressure at the tube inlet and still force the same quantity of vapor through each of the parallel tubes. A concrete illustration of this is as follows: If 30 pounds gauge or 44.7 pounds absolute pressure is maintained on the inlet header, which would be the pressure on the upstream side of the orifices, said orifices would be then designed of such diameter that the downstream pressure would not be greater than .57 times the absolute upstream, which would be 25.48 pounds absolute, or 10.78 pounds gauge. Up to this pressure of 10.78 pounds there could be other pressures on the downstream side of the orifices and still have a constant throughout through each of the many tubes in parallel. For instance, one tube may show only five pounds pressure on the downstream side of the orifice, and another on account of slight accumulation of coke may show seven pounds, and a third due to more coke may show 10.78 pounds, but each tube would be passing the same amount of vapor because the

flow of the vapor is determined by the orifice itself and not by the condition of the tube on the downstream side of the orifice. It will be understood that the co-efficient .57 for critical pressure may not be entirely accurate for a mixture of oil vapor and steam. However, it can be used as an approximate value explaining the principles of the invention.

What is claimed is:

1. In a vapor phase hydrocarbon oil converter, a plurality of tubes, a vapor manifold communicating in common with the entrance ends of said tubes, and a plurality of removable plug members frictionally fitted into the entrance ends of said tubes, said plug members being each formed to include an axially disposed orifice of materially less diameter than the inside diameter of said tubes, whereby oil vapors passing through said manifold will be distributed uniformly in quantity to each of the tubes communicating with the manifold.

2. An orifice plug for tubular vapor phase hydrocarbon oil converters comprising a metallic body having a tapered outer wall whereby the body may be frictionally inserted into the open end of a converter tube, and said body being further formed with a longitudinally and axially disposed passage, said passage possessing a diameter materially less than that of the inside diameter of the tube in which the plug member is positioned.

3. An orifice plug for metering hydrocarbon oil vapor flow at converting temperatures through parallel tubes having a common source of vapor supply, said plug comprising a substantially cylindrical body arranged to be frictionally received within the open end of a tube, and said body being further formed with a longitudinally and axially disposed orifice which possesses a materially less diameter than the inner diameter of the tube in which the plug is positioned.

4. In a vapor phase hydrocarbon oil converter, a furnace having mounted therein a plurality of parallel tubes, an oil vapor manifold communicating in common with the vapor entrance ends of said tubes, a plurality of removable plug members fitted into the vapor entrance ends of said tubes, said plug members being formed to include an axially disposed orifice of materially less diameter than the inside diameter of the tubes in which the plug members are positioned, and means in said furnace for heating the oil vapors passing through said tubes to converting temperatures.

In testimony whereof we affix our signatures.

CLYDE L. SMITH.
AUDLEY E. HARNSBERGER.