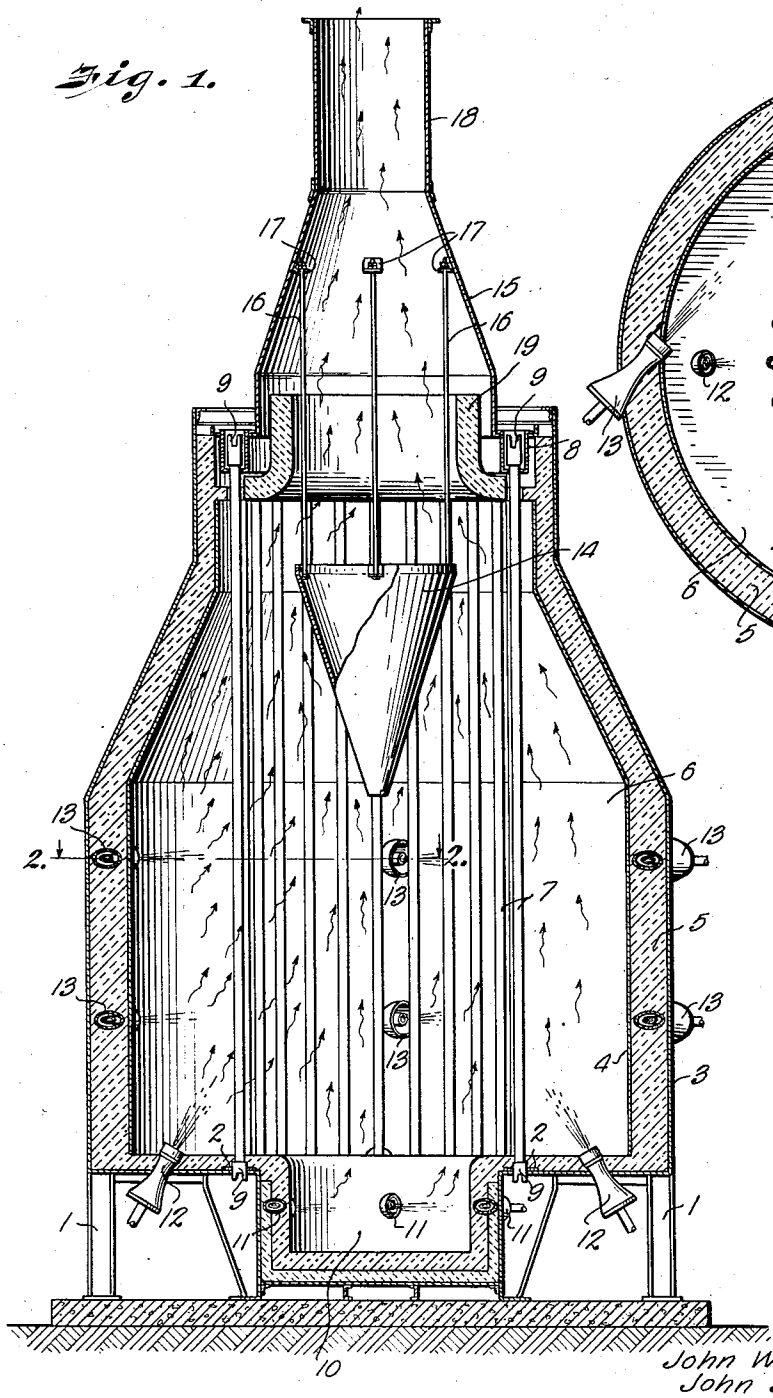
March 17, 1942. J. W. THROCKMORTON ET AL 2,276,528

APPARATUS FOR HEATING FLUIDS

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Fig. 1.



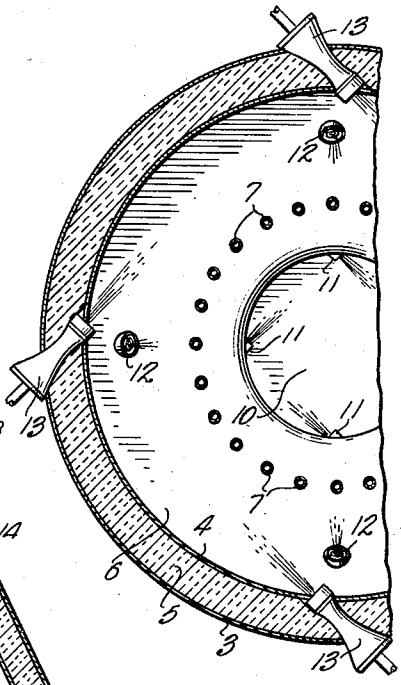


Fig. 2.

INVENTORS.
John W. Throckmorton.
John S. Wallis
BY Thos. E. Scofield
ATTORNEY.

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Fig. 6.

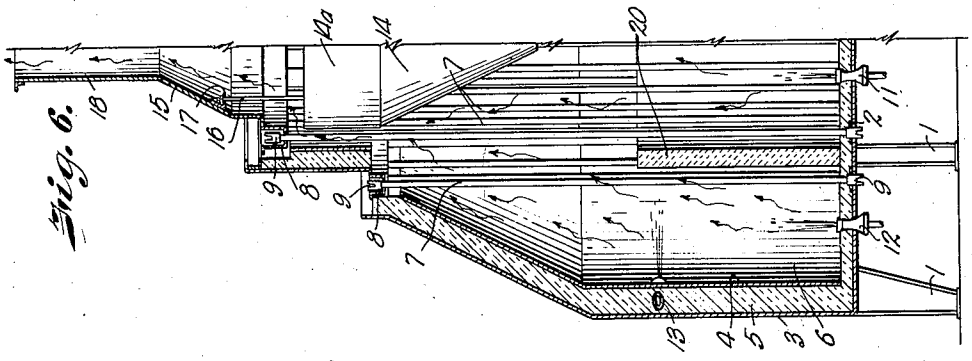


Fig. 5.

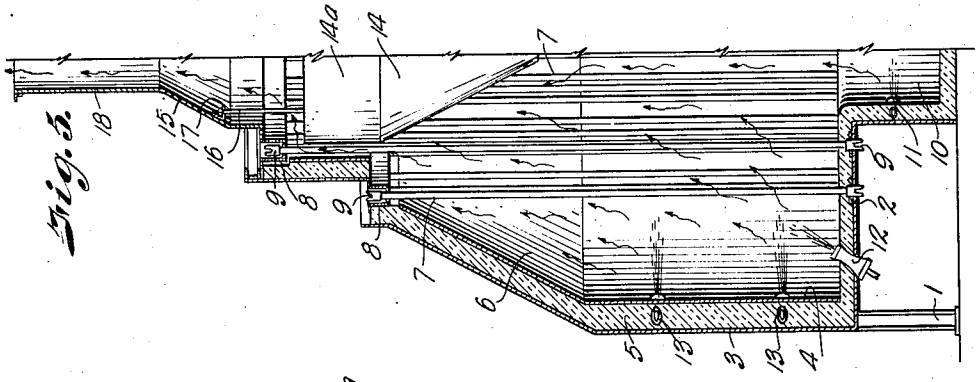


Fig. 4.

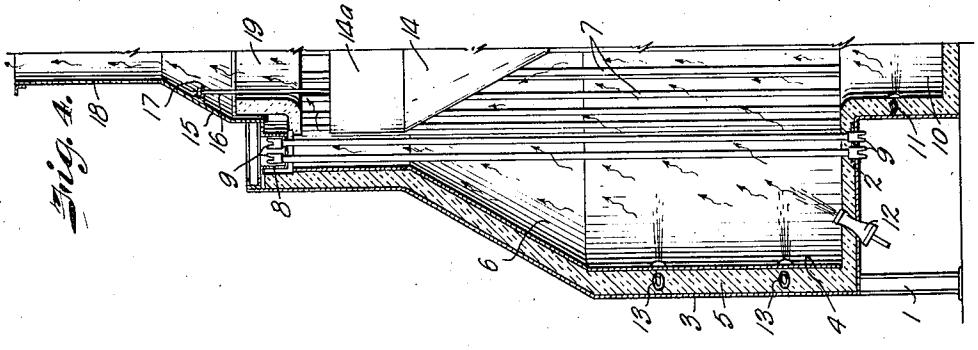
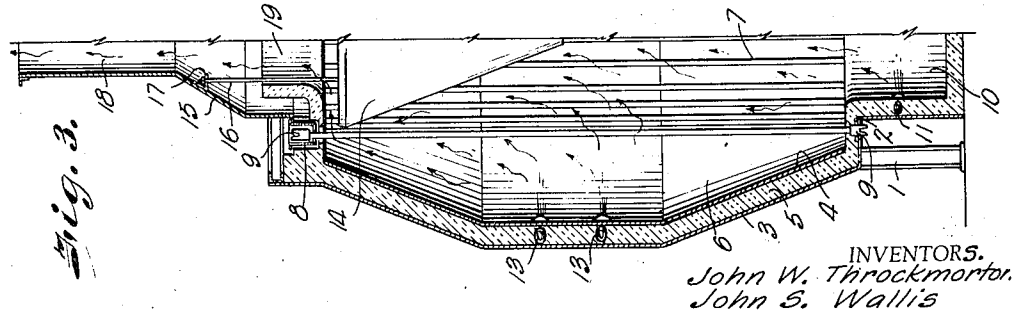


Fig. 3.



INVENTORS.
John W. Throckmorton.
John S. Wallis
BY Thos. E. Scofield.
ATTORNEY.

Patented Mar. 17, 1942

2,276,528

UNITED STATES PATENT OFFICE

2,276,528

APPARATUS FOR HEATING FLUIDS

John W. Throckmorton, Wilton, and John S. Wallis, Darien, Conn., assignors to Petro-Chem Development Company, New York, N. Y., a corporation of Delaware

Application May 2, 1941, Serial No. 391,522

2 Claims. (Cl. 122—356)

Our invention relates to a furnace construction for heating fluids and more particularly to a tubular furnace in which the heat exchange elements or tubes are vertically positioned in a combustion chamber around the perimeter of a circle and the combustion gases circulated over the tubes and through the combustion chamber to transfer relatively uniform radiant and convection heat to the tubes throughout their lengths.

The furnace is adaptable for use in any connection where fluids are to be heated, as for instance in the chemical industry for processing and distillation, and in the oil industry for distillation, cracking and for other types of thermal processing as well as boilers and steam generation.

This invention is an improvement over the furnace shown in our copending applications, Serial No. 343,272, filed June 29, 1940, and Serial No. 384,892, filed March 24, 1941.

One object of our invention is to provide a furnace in which uniform heat intensity is distributed throughout the full length of all of the heat exchange elements or tubes.

Another object is to provide a furnace of high efficiency in which radiant heat is uniformly supplied to the lower portions of the tubes and convection heat to the upper portions of the tubes.

A further object of the invention is to provide a furnace setting in which a plurality of heating elements such as tubes are arranged in the setting and fired in such a manner that uniform heat distribution is obtained circumferentially and longitudinally of the tubes.

Another object of our invention is to provide radiant reflecting surfaces and sources of combustion gases outside of the heat exchange elements which will supplement the radiant heat furnished from the combustion gases inside of the heat exchange elements to distribute radiant heat more uniformly over the entire heat transfer surfaces of the tubes or heat exchange elements.

Other and further objects of our invention will appear from the following description.

In the accompanying drawings which form part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views;

Fig. 1 is a sectional view of a furnace showing one embodiment of our invention.

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

Figs. 3, 4, 5, and 6 are half sections showing modifications of the construction shown in Fig. 1.

Referring to the drawings, supported on a concrete base is a pedestal 1 which carries tube supports 2 and a prefabricated metal sheathing 3. An internal alloy sheathing 4 is spaced from the sheathing 3 and between the outer casing 3 and inner reflecting surface 4 is insulation 5. While an internal alloy sheathing 4 is shown as in our previous copending applications, when utilizing the double firing both inside and outside of the tube circle the alloy sheathing may be dispensed with and the conventional type of refractory setting used. This insulating material is preferably mono-block, high temperature, or may be arranged in layers with rock wool blanket or the like. Vertically positioned within the combustion chamber 6 are a plurality of vertical heat exchange elements or tubes 7 arranged around the perimeter of a circle within the combustion chamber and held in place at their upper extremities by a U-shaped channel 8 which renders accessible the removable return bend connections shown at 9. Similar return bend connections are available through the tube supports 2 at the lower ends of the tubes. At the bottom and positioned centrally of the combustion chamber is a combustion pot 10 in which are located burners 11. These burners are preferably arranged tangentially of the combustion pot and may be of the directional type so that the combustion heating gases produced from the burning of liquid or gaseous fuel can be directed into the combustion chamber according to the direction in which the burners are arranged. These burners 11 furnish the heating gases to the combustion space inside of the circle of tubular heating elements. Outside of the heating elements and within the space 6 are burners 12 extending through the bottom of the furnace and burners 13 entering the furnace through the side walls. The flow of combustion gases is generally shown by the directional arrows within the combustion chamber. The heating gases from the burners inside of the circle of vertical tubes swirl upwardly in a spiral path until they reach the conical deflector 14. The combustion gases from the burners 12 and 13 outside of the circle of tubes rise and join the combustion gases from burners 11 in a constricted passageway between the cone 14 and the upper truncated cone section of the combustion chamber adjacent the conical reflecting baffle. The cone 14 is of alloy metal or other reflective material including refractories and is supported from the inverted funnel-shaped

flue 15 by rods 16, fastened to the base of the cone and to supports 17 arranged around the inside of the flue. The inverted funnel-shaped flue 15 has, mounted at its top, a chimney or stack 18. The lower base of the flue 15 is supported upon the channel 8 through which the ends of the heating tubes extend. Into the base of the flue 15 rises a cylindrical throat of insulating material 19, which has a widened base to collect the combustion gases passing around the base of the reflecting cone 14 and direct them into the flue 15 and to stack 18.

In the modification shown in Fig. 3, combustion gases are generated within the combustion pot 10 by burners 11 in a similar manner to that shown in Fig. 1. The combustion chamber, however, is somewhat differently shaped, being tapered both at the top and bottom and fired outside of the tube near a central position at burners 13. The remainder of the construction is substantially identical to that explained in connection with Fig. 1 with the exception that the reflecting cone 14 is somewhat larger in order to supply a larger reflecting surface.

The modification shown in Fig. 4, in so far as the combustion chamber is concerned, is similar to that shown in Fig. 1, the space 6 outside of the tubes being fired by burners 12 and 13, and the combustion space within the tubes fired by burners 11 within the combustion pot 10. In this modification, however, the conical baffle or reflecting cone 14 has a cylindrical portion 14a at its base which produces a considerably longer restricted passage between the cylindrical portion of the cone and the upper cylindrical portion of the combustion chamber. In this modification also there are two rows or banks of tubes 7 in place of the single row shown in Figs. 1 and 3.

The modification shown in Fig. 5 is similar to that shown in Fig. 4, except that the inner bank of tubes adjacent the reflecting cone 14 are somewhat longer than the outer bank of tubes. This outer bank of tubes receives radiant heat from the combustion gases emitted from burners 12 and 13 and the reflecting wall of the combustion chamber. The long tubes which constitute the inner bank receive radiant heat from combustion taking place in combustion pot 10 from gases produced by fuel consumed in burners 11. In Fig. 1 and in the modifications shown in Figs. 3, 4, and 5, the burners 11 and 13 are tangentially arranged, while burners 12 are of the directional type, discharging the gases at an angle toward the outer surface of the heat exchange elements.

In Fig. 6, the combustion chamber, tube banks and reflecting cone are similar to the construction shown in Fig. 5. Burners 13 are arranged tangentially of the combustion chamber and centrally thereof, while the burners through the bottom of the chamber, 11 and 12, are arranged to supply heat inside and outside of the combustion chamber similarly to the previous figures except that burners 11 are raised to the floor of the chamber as the combustion pot 10 has been eliminated. The design eliminating the ignition or combustion pot 10 may be applied as well to the proceeding modifications, if desired.

The modification shown in Fig. 6, in which a baffle wall 20 is used, offers a design in which two separate heating circuits are mounted in the same furnace setting and have controlled heat supply to each circuit. Such conditions arise in the cracking of petroleum where the heating and soaking circuits require variable heat loads; also in two stage distillation, different amounts of heat are required for the separate stages. By varying the firing of burners 12 and 13 outside the baffle wall 20 with respect to the firing of burners 11 inside the baffle wall, the above desired variance of heat load and controlled conditions of heat supplied to each circuit is obtained.

The tapering of the top of the combustion chamber in the form of a truncated cone and the inverted baffle cone offer reflecting surfaces for radiant heat generated in the spaces inside and outside of the tubes and direct this radiant heat more uniformly upon the upper portion of the tubes. The shape of the combustion chamber and the baffle cone also serve to constrict the passageway through which the combustion gases flow from inside and outside of the tubes to the flue, increasing the velocity of the gases as their temperature decreases, thus obtaining a better heat exchange upon the upper portions of the tubes. The burners 11 and 13 are arranged tangentially as shown in Figs. 1 to 5 inclusive, to give the gases a whirling motion, both inside and outside of the tube banks. The reflected or radiant heat from both the cone and the cylindrical and conical surfaces of the combustion chamber, as well as from both sides of the cylindrical wall 20 in Fig. 6, distributes evenly over the lower portions of the heating elements radiant heat generated inside and outside of the tube banks. The convection heat supplied principally to the upper portions of the tubes is concentrated and the velocity of the gases increased by restricting the passageway through which the gases must pass from the combustion chamber to the flue.

In the modifications shown in Figs. 4, 5, and 6, where a short convection zone exists between the combustion chamber and flue, it is contemplated that extended surfaces such as fins may be used on the tubes to distribute more uniformly the convection heat of the combustion gases.

By the use of such a convection zone in the upper part of the combustion or heating chamber, it may be unnecessary to use brickwork in the top of the furnace, because the flue gas is sufficiently low in temperature to be introduced directly into the stack. By the construction shown in Fig. 1, and the subsequent modifications, there is provided a furnace of high efficiency wherein the heat of the combustion gases is distributed as radiant and convection heat throughout the full length of the tubes, all of the tube surfaces operating at the maximum possible heat transfer rate. The interior of the tubes is rendered accessible for cleaning by suitable cleanout connections at the top and bottom, and the construction is such that it lends itself easily to replacement or repairs of either the tubes or combustion chamber.

Observation ports may be placed at convenient locations in order that the operators can at all times determine conditions within the furnace.

It will be undersood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is, therefore, to be understood that our invention is

not to be limited to the specific details shown and described.

Having thus described our invention, we claim:

1. A furnace including in combination a combustion chamber of circular cross section, the upper portion simulating a truncated cone, a plurality of vertically disposed heat exchange elements positioned in said combustion chamber and substantially around the perimeter of a circle, means positioned within said combustion chamber within said space surrounded by said heat exchange elements and located in that portion of the combustion chamber simulating a truncated cone having the form of a cone with its apex depending, said cone and truncated portion of the combustion chamber adapted to progressively decrease the cross sectional area of the upper part of said combustion chamber, and separate sources of combustion heating gases positioned inside and outside of the circle of heat exchange elements.

2. A furnace including in combination a combustion chamber of circular cross section, the upper portion simulating a truncated cone, a plurality of substantially vertical heat exchange elements positioned in said combustion chamber and substantially around the perimeter of a circle, means positioned within said combustion chamber within said space surrounded by said heat exchange elements and located in that portion of the combustion chamber simulating a truncated cone having the form of a cone with its apex depending, said cone and truncated portion of the combustion chamber adapted to progressively decrease the cross sectional area of the upper part of said combustion chamber, and separate sources of combustion heating gases positioned inside and outside of the circle of heat exchange elements and tangentially in the combustion chamber wall adjacent its mid-section.

JOHN W. THROCKMORTON.
JOHN S. WALLIS.