APPARATUS FOR CARRYING THROUGH CATALYTIC REACTIONS

Filed June 17, 1936 2 Sheets-Sheet 1

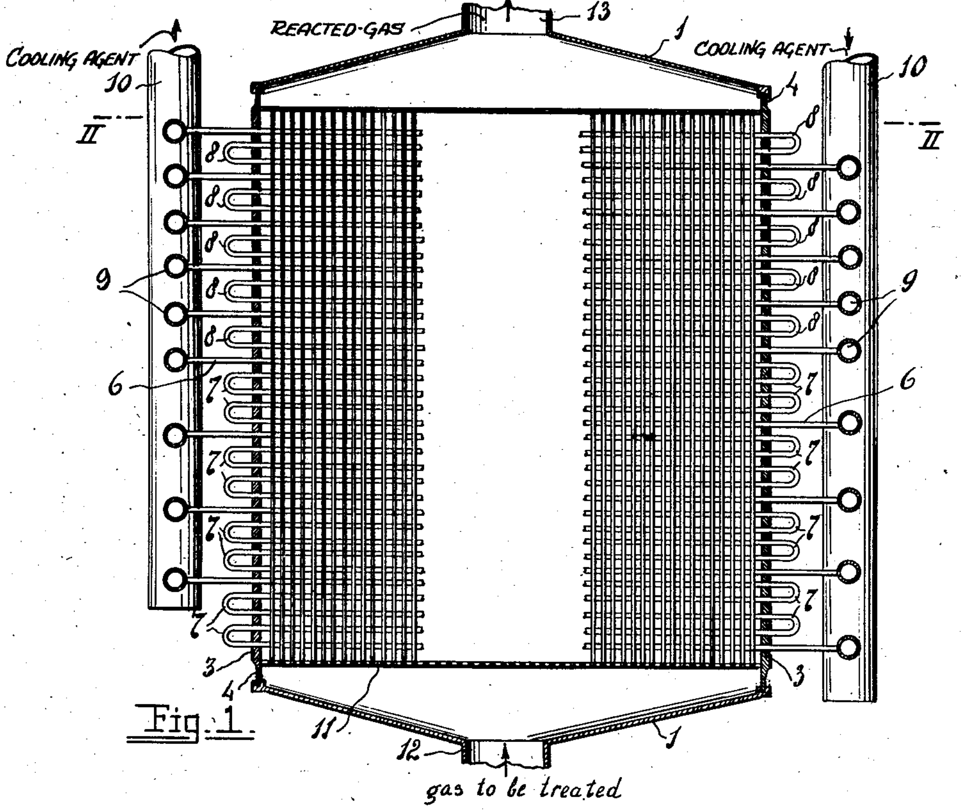


Fig. 1

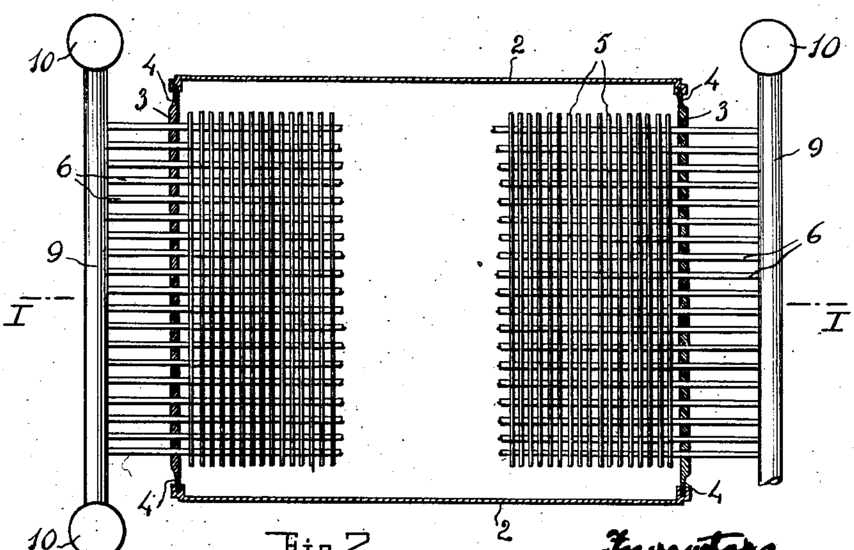


Fig. 2

Inventors
Heinrich Dorndorf,
Max Kolling and Heinrich Traum
by Kuhnhauser, atty.

APPARATUS FOR CARRYING THROUGH CATALYTIC REACTIONS

Filed June 17, 1936 2 Sheets-Sheet 2

Fig. 4.

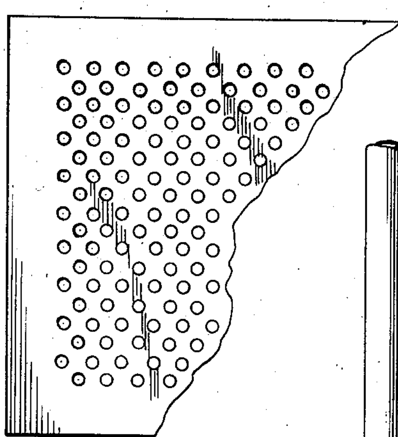
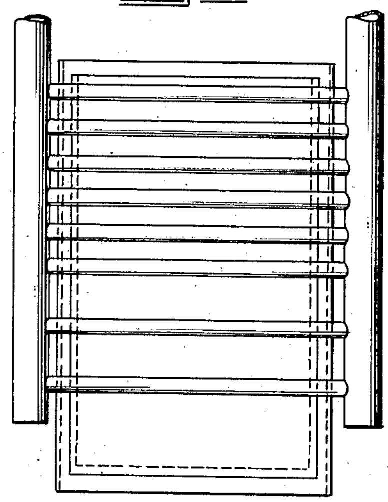


Fig. 3.



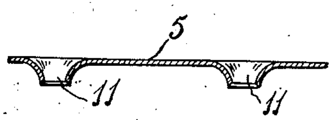


Fig. 6.

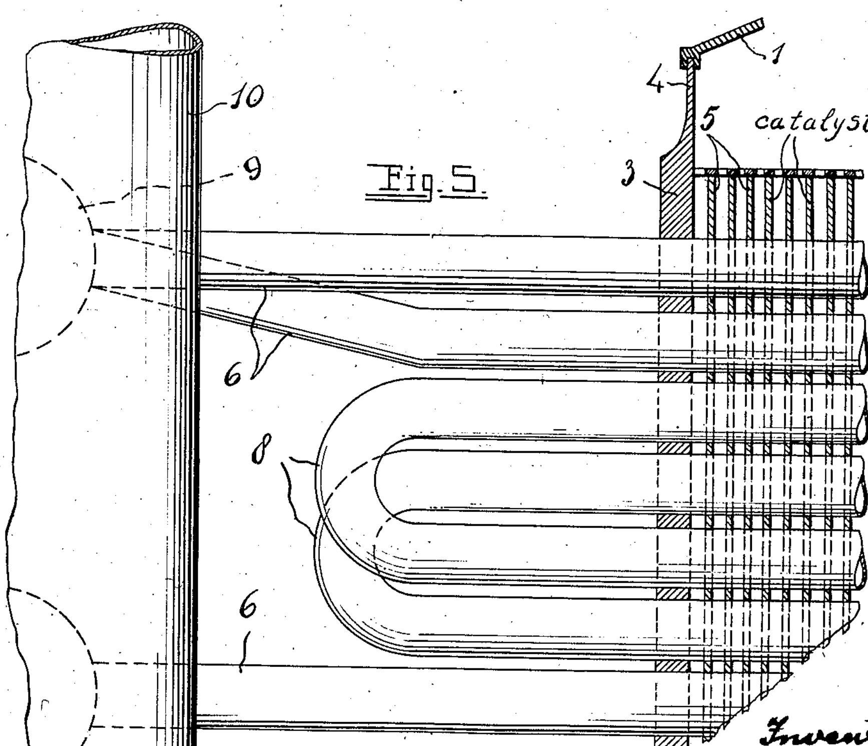


Fig. 5.

Inventors
Heinrich Dorndorf,
Max Kelling & Heinrich Tramm
by Karl Michaelis, Atty.

Patented Feb. 28, 1939

2,148,545

UNITED STATES PATENT OFFICE

2,148,545

APPARATUS FOR CARRYING THROUGH CATALYTIC REACTIONS

Heinrich Dorndorf, Witten-Ruhr, Max Kelting, Mulheim-Ruhr, and Heinrich Tramm, Oberhausen-Holten, Germany

Application June 17, 1936, Serial No. 85,790
In Germany June 26, 1935

2 Claims. (Cl. 23—288)

Our invention relates to means for carrying through catalytic reactions, accompanied by a rise in temperature, between gases and more especially the synthetical production of benzine hydrocarbons by the interaction of oxygen compounds of carbon with hydrogen gas in the presence of solid catalysts or contact masses, as disclosed for instance in the specification of German Patent 484,337.

It is an object of our invention to provide apparatus for use in the carrying through of such reactions, wherein the heat developed in the reaction is abducted and the catalyst cooled according to the requirements of highest yield.

In order that such cooling means be suitable for use in processes of this character, they must possess a high specific thermal efficiency, being formed with large heat abducting (cooling) surfaces, and means must further be provided for uniformly maintaining predetermined temperatures at all points of the apparatus. Furthermore the several parts of the apparatus must be firmly secured in their relative positions during operation.

In order to comply with these various requirements, we provide, in an apparatus according to the present invention, a great number of cooling tubes, at least five rows of such tubes, each comprising at least five cylindrical tubes, being arranged in superposition, and cooling ribs, formed of metal sheets or plates, being provided, each of which is traversed by all the tubes and extends substantially at right angles to them. We arrange these sheets in closely spaced relation and preferably at a distance not exceeding for instance 7 mms. from each other.

We prefer to arrange at least twice the number of tubes in superposition than in juxtaposition and we prefer arranging the tubes of one row of tubes in staggered relation to the tubes of an adjoining row in order to minimize the spacing between these tubes.

We take care to connect the sheet metal ribs with the tubes in the manner best suited for a faultless transmission of heat from one to the other and to this end we force the sheets onto the tubes or, preferably, the walls of the tubes against the perforations of the sheets by expanding the tubes or by other suitable means.

In order to uniformly space the rib plates, we may form them with suitable projections or we may arrange between the sheets, during the construction of the apparatus, spacers which may be subsequently removed after the tubes have been fixed in the perforations of the sheets by expansion or otherwise.

The cooling liquid may be supplied to and withdrawn from all the tubes by connecting the ends of the tubes with common collector mains or chambers. We prefer combining a plurality of tubes by means of bends into coils, the ends of which are then connected with the collector mains. In one and the same cooling apparatus coils of equal or of different length may be arranged and we are thus enabled to create zones of different thermic capacity within one and the same cooling apparatus or to adapt the thermic capacity to the thermic requirements of each individual zone.

As is well known to those skilled in the art, cooling apparatus are subject, during operation, to variations of length and width in consequence of expansion or contraction. These variations render it extremely difficult to enclose the system of cooling tubes in a gas-tight casing or to maintain the gas-tight enclosure of the tubes during operation. In the majority of cases leaks will occur at the ends of the apparatus, i. e., in the end walls of the casing, which are traversed by the tubes.

In order to overcome these difficulties, we form the rigid end walls or alternatively all the walls of the casing enclosing the system of tubes with marginal portions of reduced thickness, thereby enabling these walls to yield, like diaphragms, to the pressure or pull exerted upon them by the expanding or contracting tubes. Owing to the capacity of the casing walls, obtained by this arrangement, of yielding elastically, the points, where the tubes are fitted in the walls, if desired by welding, as well as the joints of the casing, are considerably relieved from injurious tension.

In the drawings affixed to this specification and forming part thereof, an apparatus embodying our invention is illustrated diagrammatically by way of example.

In the drawings,

Fig. 1 is an elevation, partly in vertical section on the line I—I in Fig. 1, and

Fig. 2 is a plan view, partly in horizontal section on the line II—II in Fig. 1, of such an apparatus, the middle part of which is broken away.

Fig. 3 is an end view, drawn to a smaller scale.

Fig. 4 illustrates part of one of the metal sheets forming cooling ribs and

Fig. 5 is a side elevation, partly in vertical section, drawn to a larger scale, of an end wall of the casing with systems of tubes and a collector main.

Fig. 6 illustrates a detail.

Referring to the drawings, 1, 1 are the funnel-shaped top and bottom walls, 2, 2 are the side walls and 3, 3 are the end walls of the casing. The walls 1 and 2 may be uniform in thickness throughout. The end walls 3 are formed with marginal portions 4 reduced in thickness to the extent of being able to yield to pressure exerted upon the end walls 3 by the expanding or contracting tubes. Between the end walls and in parallel to them extend vertically through the apparatus a great number of sheet metal plates 5 in closely spaced relation, being preferably spaced for instance not more than 7 mms. These plates, which form the heat abducting or cooling ribs, and the end walls 3 are traversed by the system of cooling tubes 6. In the apparatus shown in the drawings thirty-five rows of cooling tubes are shown in superposition and each of these rows comprises nineteen juxtaposed tubes. Four groups of superposed tube systems, each comprising five tubes connected by bends 7, are arranged in the bottom part of the apparatus, while groups of three superposed tubes connected by bends 8 are arranged in the top part of the apparatus. The ends of the coils of five and three tubes thus formed are fixed to the distributing tubes 9 at either end of the apparatus which extend between and communicate with the collector mains 10.

Fig. 5 shows the staggered arrangement of the tubes or coils of tubes.

The spaces enclosed between adjoining plates 5 and between these plates and the end walls 3 are filled with the catalyst resting on a perforated bottom through which ascends the gas mixture to be reacted, entering at 12 and escaping at 13. It is obvious that the comparatively thin vertical layers of catalyst are cooled very effectively by the cooling medium, which enters through the collector main 10 at the right hand end of the apparatus, as indicated by the arrow, and passes through the distributing tubes 9 and the coils of cooling tubes 6 into the tubes 9 and collector mains 10 at the left-hand end, to escape in the direction indicated by the arrow.

Obviously the thermic conditions in each section of the apparatus can be predetermined and controlled by suitably choosing the number of tubes combined into a coil.

Owing to the elasticity of the marginal portions 4 of the end walls the tubes 6 are free to expand and contract without creating the danger of their seats in the end walls leaking.

As shown in Fig. 6, projections 11 may be formed in the cooling ribs or sheets 5, for instance by stamping, to form spaces controlling the correct spacing of adjoining sheets.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

We claim:

1. Gas reaction apparatus, particularly adapted for precise temperature control as required for the synthetical production of benzine hydrocarbons from hydrogen and a carbon oxide, comprising in combination, a gas-tight casing having opposed end walls defining a catalytic chamber, a plurality of superposed rows of cooling tubes extending substantially horizontally through said casing and through the end walls thereof, thin heat conductive plates extending in closely spaced juxtaposition through the whole length of said catalytic chamber in the direction of flow of the reaction gas and substantially throughout the entire width of said chamber substantially at right angles to and traversed by said cooling tubes, said plates forming heat abducting elements and defining narrow shafts, thin layers of a catalyst arranged within said shafts intermediate said plates, and means for passing the gas to be reacted through said apparatus in the direction of said plates.

2. Gas reaction apparatus, particularly adapted for precise temperature control as required for the synthetical production of benzine hydrocarbons from hydrogen and a carbon oxide, comprising in combination, a gas-tight casing having opposed end walls defining a catalytic chamber, a plurality of superposed rows of cooling tubes extending substantially horizontally through said casing and through the end walls thereof, the outer ends of several pluralities of adjoining tubes being connected to form several coils, thin heat conductive plates extending in closely spaced juxtaposition through the whole length of said catalytic chamber in the direction of flow of the reaction gas and substantially throughout the entire width of said chamber substantially at right angles to and traversed by said cooling tubes, said plates forming heat abducting elements and defining narrow shafts, thin layers of a catalyst arranged within said shafts intermediate said plates, and means for passing the gas to be reacted through said apparatus in the direction of said plates.

HEINRICH DORNDORF.
MAX KELTING.
HEINRICH TRAMM.