Sept. 7, 1926. 1,599,228

H. D. GIBBS

PROCESS AND APPARATUS FOR EXOTHERMIC CATALYTIC REACTIONS

Filed July 27, 1920

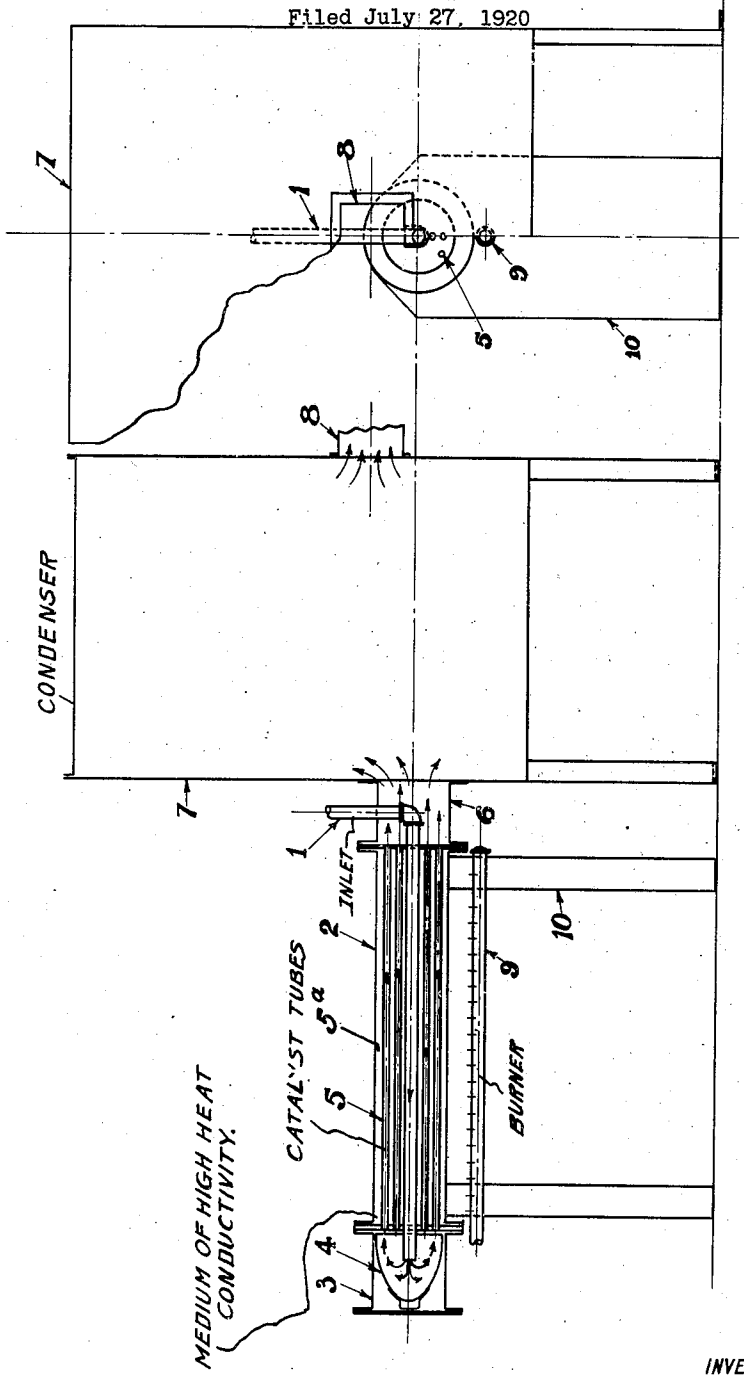


Fig. 2

Fig. 1

INVENTOR

H. D. Gibbs,

BY J. R. Squair,

ATTORNEY

Patented Sept. 7, 1926. 1,599,228

UNITED STATES PATENT OFFICE.

HARRY D. GIBBS, OF PENNS GROVE, NEW JERSEY, ASSIGNOR TO E. I. DU PONT DE NEMOURS & COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

PROCESS AND APPARATUS FOR EXOTHERMIC CATALYTIC REACTIONS.

Application filed July 27, 1920. Serial No. 399,354.

This invention relates to catalytic oxidation apparatus and process, and comprises an apparatus which, although of relatively large capacity, is so constructed as to be operable under precisely controlled conditions.

It is well-known that many oxidation reactions are exothermic, and it is very difficult to carry on these reactions on a large scale practicable for commercial operations, and remove the large amount of heat generated in the process of the reaction. It is also well-known that many of these reactions will proceed in very satisfactory manner on a smaller scale, but on a large scale, the concentration of the large amount of heat in the apparatus results in the destruction of the apparatus or the rapid combustion of the desired products of the reaction, resulting in unsatisfactory yields.

One of the objects of my invention is to provide a large scale apparatus wherein the ease of controlling the reaction which is characteristic of small scale operations may be retained.

Other objects of the invention will become apparent from the following description.

One embodiment of my invention is shown in the accompanying drawings in which Fig. 1 is a diagrammatic view of a horizontal section through the apparatus, and Fig. 2 shows a rear elevation with part of the condenser broken away.

The apparatus comprises a casing 2 having in the front end a header or manifold 3 provided with the curved surface 4, and at the other end a conduit 6 leading into a condenser 7. Extending lengthwise through said casing, and equally spaced apart, are tubes 5 adapted to be partly filled with catalytic material. Surrounding the pipes 5 and filling the interior of the casing 2 is a medium 5^a of high heat conductivity. The condenser 7 is provided with an outlet 8 leading to any suitable recovery apparatus. A burner 9 is disposed beneath the casing 2, both the burner and the casing being supported by brick-work or other suitable frame-work 10. An inlet pipe 1 for introducing a fluid into the apparatus extends into the conduit 6 and through the center of the casing 2.

The operation may be described with reference to the catalytic oxidation of naphthalene to phthalic anhydride. The interior of the casing 2 having been filled with a material of high heat conductivity, such as a mixture of sodium and potassium nitrates, and the tubes 5 being partly filled with an oxidation catalyst such as vanadium oxide, the casing 2 and its contents are heated by the burner 9 until the temperature reaches about 500° C. A mixture of air and naphthalene vapors is then conducted by the pipe 1 through the casing 2, where it becomes preheated, and into the manifold 3 and then through the catalytic tubes 5, where the naphthalene is oxidized to phthalic anhydride. The mixture of nitrogen, unused oxygen and phthalic anhydride vapor passes into the condenser 7 where the phthalic anhydride condenses and is separated from the permanent gases, the latter escaping through the flue 8.

As soon as the oxidation is well started the burner 9 can be shut off, the heat of the reaction being more than sufficient to maintain the temperature at 500° C. Instead of a mixture of sodium and potassium nitrates as the heat conducting medium in the casing 2, there may be used various other heat conducting materials, either solid or liquid, for example, other fused salts, materials of high boiling points, such as molten metals, etc.

The curved surface 4 of the manifold 3 should be such as to distribute the gases uniformly to the several catalytic tubes 5; the best distribution of gases is obtained when this surface is a parabola of revolution.

With the apparatus above described the catalytic oxidation of a large amount of a hydrocarbon vapor such as naphthalene vapor can be effected in a short time, ordinarily at temperatures above 200° C. without losses due to local overheating of the catalytic material with corresponding decomposition of the substances to be oxidized. This desirable result is due to the fact that the medium 5^a, of high heat conductivity, permits of a rapid and uniform conduction throughout the apparatus of the heat generated in the several catalytic tubes, the excess heat being radiated or dissipated about as fast as it is generated. The cata-

lytic material is in this way maintained at a uniform temperature throughout the casing 2.

Although I have described and shown in detail one specific embodiment of my invention, it will be understood that the apparatus may be changed in various respects without departing from my invention. Thus, the condenser 7 may be shaped in various ways, depending largely upon the material produced as a result of the catalytic oxidation. Although the pre-heating of the vapors by passing them through the casing 2 is desirable, it is not an essential feature of my invention.

I claim:—

1. The process of producing phthalic anhydride by the catalytic oxidation of naphthalene which comprises passing a mixture of naphthalene vapor and an oxygen-containing gas through a plurality of relatively small, catalytic reaction zones containing an oxidation catalyst at a temperature of from about 400 to 600° C., and causing rapid dissipation of heat in excess of that required to continue the reaction by maintaining said zones in contact with a medium of high heat conductivity.

2. The process of producing phthalic anhydride by the catalytic oxidation of naphthalene which comprises passing a mixture of naphthalene vapor and an oxygen-containing gas through a plurality of small, hot, catalytic reaction zones disposed in a medium of high heat-conductivity.

3. The process of producing phthalic anhydride by the catalytic oxidation of naphthalene which comprises passing a mixture of naphthalene vapor and an oxygen-containing gas through a plurality of small, hot, catalytic reaction zones evenly disposed in a medium of such high heat conductivity as to dissipate excess heat and to maintain said zones at a uniform reacting temperature.

4. The process of producing phthalic anhydride by the catalytic oxidation of naphthalene which comprises passing a mixture of naphthalene vapor and air through a plurality of relatively small, catalytic reaction zones at a temperature between about 400 and 600° C., and causing rapid dissipation of heat in excess of that required to continue the reaction by maintaining said zones in contact with a medium which is a liquid at said temperature and which has a high heat-conductivity.

In testimony whereof I affix my signature.

HARRY D. GIBBS.