[Second Edition.]

PATENT SPECIFICATION

Application Date: April 15, 1929. No. 11,608/29. **327,025**

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Complete Accepted: March 27, 1930.

PROVISIONAL SPECIFICATION.

Improvements in and Apparatus for Carrying Out Endothermic Catalytic Reactions.

I, JAMES YATE JOHNSON, a British Subject, of 47, Lincoln's Inn Fields, in the County of London, Gentleman, do hereby declare the nature of this invention (which has been communicated to me from abroad by I. G. Farbenindustrie Aktiengesellschaft, of Frankfort-on-Main, Germany, a Joint Stock Company, organized under the Laws of Germany), to be as follows:—

Generally speaking endothermic reactions have hitherto been carried out in a periodic manner with the employment of heat accumulators. In many cases however a continuous manner of working is preferable, for example by heating the reaction chamber externally. This manner of working is employed especially for gas reactions for which heat-conducting catalysts are used; in this case the transference of heat from the walls of the reaction chamber to the gas to be converted is better than in cases in which the chambers are not filled with catalysts of this nature. The heating of the reaction chamber may be advantageously effected by means of firing gases. Since however it is difficult to heat a large chamber externally so that a sufficiently rapid replacement of the heat used up in the interior takes place, the chamber is subdivided into a number of tubes or chambers or the like. Even in this case however the amount of heat transferred from the heating gases to the walls of the reaction chamber and to the interior thereof is generally speaking still too small, since the transference of heat takes place mainly by convection.

My foreign correspondents have now found that the transference of heat when carrying out endothermic catalytic reactions takes place very satisfactorily when care is taken that the heating of the reaction chamber is effected exclusively or mainly by heat radiation. This may be advantageously attained by carrying out the heating of the reaction vessel by means of heat radiating surfaces; these may be arranged on one or more sides outside the reaction vessel, if necessary so that the chamber containing the catalyst is completely surrounded. In this manner a radiation of heat from the surfaces, which are heated by means of heating gases or in some other manner for example by an electric current, to the walls of the reaction chamber takes place. As heat radiating surfaces of this kind may be mentioned for example the walls or crowns of the furnaces used for burning the heating gases, which are constructed of fireproof material, and care is taken by appropriate leading of the heating gases and arrangement of the reaction vessel with respect to the walls of the furnace that the amount of heat radiated to the walls of the reaction chamber from the walls of the furnace is greater than the amount of heat transferred by the direct contact of the heating gases with the same. The walls of the furnaces may be constructed as lattices in order to increase the heat radiating surface area. The efficiency of these surfaces may be still further increased when materials are employed for their manufacture which have a high heat absorptive or heat emissive power, preferably those which in this respect approximate as closely as possible to an absolutely black body and which at the same time are stable to heat, for example metals or metal oxides, in particular those of the iron group. The surfaces may be prepared entirely or only partly of the said materials for example they may be provided with a coating of these materials.

The nature of the invention will be further described with reference to the accompanying drawing which shews in longitudinal section in Figure 1 and in cross-section in Figure 2 an arrangement of apparatus according to this invention, but the invention is not restricted to this arrangement.

A furnace for heating 10 contact tubes R consists of three chambers K_1, K_2, and K_3 about 0.5 metre in width, 2.5 metres in length and 3 metres in height. The central chamber K_2 serves as the combustion chamber for the heating gases which enter through an opening A. The upper part of the walls between the three chambers consists of lattice-like brickwork. The heating gases pass upwards through the central chamber K_2, heat the

[*Price* 1/-]

walls between the chambers and pass through the brickwork lattice into the chambers K_1 and K_3 in each of which contact tubes R are arranged in alignment. The heating gases flow downwards in the chambers K_1 and K_3 past the said contact tubes R and flow out below through passages B. The heat necessary for heating the contact tubes is partly transferred by the gases flowing past them, but to the greater part is supplied by heat radiation from the hot walls between the three chambers. In consequence of the fact that the contact tubes are arranged in alignment, all the tubes are very uniformly heated.

This arrangement of apparatus may be advantageously employed for example for the catalytic conversion of methane and steam into carbon monoxide and hydrogen or for thermal decompositions of organic compounds, for example methane, which proceed endothermically.

The amount of heat which can be transferred by heat radiation according to the present invention is in many cases a multiple of the quantity of heat which can be transferred mainly by convection even with the most satisfactory leading of the heating gases. The advantageous consequence of this is that in many cases considerably greater throughputs can be obtained through the reaction chamber than by the employment of the kinds of heating hitherto used; in many cases the industrial conduction of strongly endothermic reactions, in particular gas reactions, is for the first time rendered remunerative by the process in accordance with the present invention.

Dated this 15th day of April, 1929.
J. Y. & G. W. JOHNSON,
47, Lincoln's Inn Fields, London,
W.C. 2,
Agents.

COMPLETE SPECIFICATION.

Improvements in and Apparatus for Carrying Out Endothermic Catalytic Reactions.

I, JAMES YATE JOHNSON, a British Subject, of 47, Lincoln's Inn Fields, in the County of London, Gentleman, do hereby declare the nature of this invention (which has been communicated to me from abroad by I. G. Farbenindustrie Aktiengesellschaft, of Frankfort-on-Main, Germany, a Joint Stock Company, organized under the Laws of Germany), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Generally speaking endothermic reactions have hitherto been carried out in a periodic manner with the employment of heat accumulators. In many cases however a continuous manner of working is preferable, for example by heating the reaction chamber externally. This manner of working is employed especially for gas reactions for which heat-conducting catalysts are used; in this case the transference of heat from the walls of the reaction chamber to the gas to be converted is better than in cases in which the chambers are not filled with catalysts of this nature. The heating of the reaction chamber may be advantageously effected by means of firing gases. Since however it is difficult to heat a large chamber externally so that a sufficiently rapid replacement of the heat used up in the interior takes place, the chambers is subdivided into a number of tubes or chambers or the like. Even in this case however the amount of heat transferred from the heating gases to the walls of the reaction chamber and to the interior thereof is generally speaking still too small, since the transference of heat takes place mainly by convection.

My foreign correspondents have now found that the transference of heat when carrying out endothermic catalytic reactions takes place very satisfactorily when care is taken that the heating of the reaction chamber which is separated from the heating space is effected exclusively or mainly by heat radiation. This may be advantageously attained by carying out the heating of the reaction vessel by means of heat radiating surfaces; these may be arranged on one or more sides outside the reaction vessel, if necessary so that the chamber containing the catalyst is completely surrounded. In this manner a radiation of heat from the surfaces, which are heated by means of heating gases or in some other manner for example by an electric current, to the walls of the reaction chamber takes place. As heat radiating surfaces of this kind may be mentioned for example the walls or crowns of the furnaces used for burning the heating gases, which are constructed of fireproof material, and care is taken by appropriate leading of the heating

gases and arrangement of the reaction chamber with respect to the walls of the furnace that the amount of heat radiated to the walls of the reaction chamber from the walls of the furnace is greater than the amount of heat transferred by the direct contact of the heating gases with the same. The walls of the furnace may be constructed as lattices in order to increase the heat radiating surface area. The efficiency of these surfaces may be still further increased when materials are employed for their manufacture which have a high heat absorptive or heat emissive power, preferably those which in this respect approximate as closely as possible to an absolutely black body and which at the same time are stable to heat, for example metals or metal oxides, in particular those of the iron group. The surfaces may be prepared entirely or only partly of the said materials for example they may be provided with a coating of these materials.

The invention will be further described with reference to the drawing accompanying the Provisional specification which shews in longitudinal section in Figure 1 and in cross-section in Figure 2 an arrangement of apparatus according to this invention, but the invention is not restricted to this arrangement.

A furnace for heating say 10 catalyst tubes R consists of three chambers K_1, K_2 and K_3 about 0.5 metre in width, 2.5 metres in length and 3 metres in height. The central chamber K_2 serves as the combustion chamber for the heating gases which enter through an opening A. The upper part of the walls between the three chambers consists of lattice-like brickwork. The heating gases pass upwards through the central chamber K_2 heat the walls between the chambers and pass through the lattice brickwork into the chambers K_1 and K_3 in each of which the catalyst tubes R are arranged in alignment. The heating gases flow downwards in the chambers K_1 and K_3 past the said catalyst tubes R and flow out below through passages B. The heat necessary for heating the catalyst tubes is partly transferred by the gases flowing past them, but to the greater part is supplied by heat radiation from the hot walls between the three chambers. In consequence of the fact that the catalyst tubes are arranged in alignment, all the tubes are very uniformly heated.

This arrangement of apparatus may be advantageously employed for example for the catalytic conversion of methane for steam into carbon monoxide and hydrogen or for thermal decompositions of organic compounds, for example methane, which proceed endothermically.

The amount of heat which can be transferred by heat radiation according to the present invention is in many cases a multiple of the quantity of heat which can be transferred mainly by convection even with the most satisfactory leading of the heating gases. The advantageous consequence of this is that in many cases considerably greater throughputs can be obtained through the reaction chamber than by the employment of the kinds of heating hitherto used; in many cases the industrial conduction of strongly endothermic reactions, in particular gas reactions, is for the first time rendered remunerative by the process in accordance with the present invention.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. The improvement in carrying out endothermic catalytic reactions which consists in heating the reaction chamber or chambers containing the catalyst which is or are separated from the heating space, mainly or exclusively by heat radiation.

2. The improvement in carrying out endothermic catalytic reactions as claimed in claim 1 which consists in effecting the heating of the reaction chamber or chambers by means of heat radiating surfaces.

3. Apparatus for carrying out endothermic catalytic reactions substantially as described and shewn in the drawing accompanying the provisional specification.

4. Apparatus as claimed in the preceding claiming clause in which the walls of the reaction chambers and/or the heat radiating surfaces consist completely or partly of material of high heat emission power.

Dated this 15th day of January, 1930.

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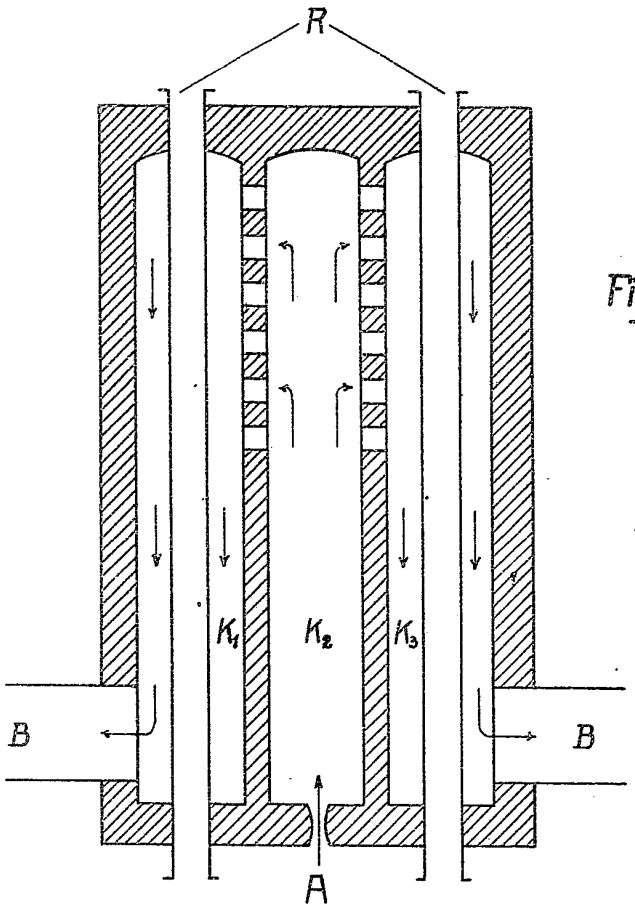

Fig.1

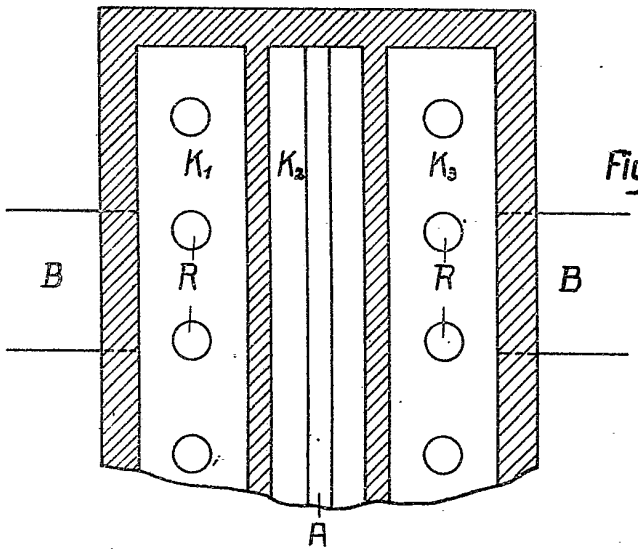

Fig.2

Charles & Read Ltd, Photo Litho.