PATENT SPECIFICATION

Application Date: Sept. 15, 1927. No. 24,826/27. **306,054**

Complete Left: June 8, 1928.

Complete Accepted: Feb. 15, 1929.

1138

PROVISIONAL SPECIFICATION.

Apparatus for Carrying Out Exothermic Gas Reactions and Improvements in Regenerating Heat and Cooling the Walls of the said Apparatus.

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:—

In apparatus used for carrying out exothermic gas reactions proceeding at high temperatures, especially reactions under high pressure, such as the synthesis of ammonia from its elements, it is very important to protect the walls of the vessels from the heat disengaged by the reaction.

With this object in view, it has already been proposed to cool the walls of the reaction chamber from the outside by transmitting the heat to the incoming cold gases, and a great variety of proposals have been made for carrying this into effect. Thus, for example, the reaction chamber has been mounted in the interior of a vessel surrounded by an arrangement of tubes which serves for heat exchanging between the gases, and at the same time keeps the walls of the vessel at a low temperature. In other embodiments a cooling system has been employed, consisting of a series of cylindrical pipes placed concentrically one within another, the middle pipe being the reaction chamber, and the gas entering the outer passage and passing from the outside towards the interior through one passage after another in the opposite direction. All these processes, however, are attended with defects and are not always reliable in action.

My foreign correspondents have now found that a particularly effective regeneration of heat and an excellent cooling of the walls of the vessel can be obtained in apparatus for exothermic gas reactions by using a jacketed vessel, for example in the form of two concentrically arranged tubes, the inner space of which is used as a reaction chamber, the outer space between the reaction chamber and the outer shell of the vessel being provided with partitions, so that the incoming cold gas winds about in its passage therethrough. A suitable arrangement for example consists in providing a spiral, preferably of wire or the like, between and in contact with the wall of the reaction chamber and the outer shell of the vessel, thereby compelling the incoming gas to take a sinuous course in traversing the space between the reaction chamber and the jacket shell. Apart from the more uniform cooling of the shell, the heat-extracting effect of the incoming cold gases is multiplied owing to the increased velocity of flow, it being well known that a quick-flowing gas enables a far better exchange of heat to be obtained than with the same volume flowing at a lower rate. A further advantage of the specified construction is the facility with which the regeneration can be regulated by the number of turns of the spiral between the reaction chamber and the outer shell, so that it is easy, by this means, to bring the gases to the required temperature needed for the reaction.

Instead of the aforesaid simple arrangement of spiral, the same object can be obtained with any other form of construction which allows the gas to pass in a sinuous manner between the reaction chamber and the outer shell, for example by the insertion of solid partition walls or the like.

Not only a single contact chamber, however, with a single cooling jacket provided with the said device spirally leading the incoming gases may be employed according to the present invention, but also a plurality of reaction chambers and a plurality of the said cooling jackets alternately arranged one within the other; thus for example, an apparatus for exothermic gas reactions may be constructed by concentrically arranging four or even more tubes one within the other and employing the middle and third free space as reaction chambers and providing the second and fourth interstices with the said spiral guidances for the cooling gases

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Price 4s 6d.

and conducting the incoming gases used for the exothermic reaction or any other cooling gas so that they pass one cooling jacket after the other, thus taking up the heat produced by the reaction of the gases in the reaction chambers. The cooling and reacting gases are preferably conducted on the counter flow principle.

According to the present invention the reaction chamber may thus occupy a comparatively large portion of the vessel, thereby affording a considerable advantage, in respect, for instance, of the limitation of dimensions of a vessel intended for high pressures, in comparison with known embodiments. A further very substantial advantage consists in the ease with which the apparatus can be constructed, as compared with the other processes referred to. The present process may, of course, be also employed in combination with other known systems of heat regeneration. It can be applied, more particularly, in the synthesis of ammonia from its elements; in the production of liquid substances from hydrogen and oxides of carbon and the like; and also in other gas reactions in which hydrocarbons constitute the starting materials or are formed thereby.

Dated this 15th day of September, 1927.

JOHNSONS & WILLCOX,
47, Lincoln's Inn Fields, London W.C. 2,
Agents.

COMPLETE SPECIFICATION.

Apparatus for Carrying Out Exothermic Gas Reactions and Improvements in Regenerating Heat and Cooling the Walls of the said Apparatus.

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:—

In apparatus used for carrying out exothermic gas reactions proceeding at high temperatures, especially reactions under high pressure, such as the synthesis of ammonia from its elements, it is very important to protect the walls of the vessels from the heat disengaged by the reaction.

With this object in view, it has already been proposed to cool the walls of the reaction chamber from the outside by transmitting the heat to the incoming cold gases, and a great variety of proposals have been made for carrying this into effect. Thus, for example, the reaction chamber has been mounted in the interior of a vessel surrounded by an arrangement of tubes which serves for heat exchanging between the gases, and at the same time keeps the walls of the vessel at a low temperature. In other embodiments a cooling system has been employed, consisting of a series of cylindrical pipes placed concentrically one within another, the middle pipe being the reaction chamber and the gas entering the outer passage and passing from the outside towards the interior, through one passage after another in the opposite direction. All these processes, however, are attended with defects and are not always reliable in action.

My foreign correspondents have now found that a particularly effective regeneration of heat and an excellent cooling of the walls of the vessel can be obtained in apparatus for exothermic gas reactions by using a jacketed vessel, for example in the form of two concentrically arranged tubes, the inner of which is used as a reaction chamber, the outer space between the tubes being provided with partitions, so that the incoming cold gas which acts as a cooling agent winds about in its passage therethrough while in direct contact with the hot wall of the reaction chamber. A suitable arrangement for example consists in providing a spiral, preferably of wire or the like, between and in contact with the wall of the reaction chamber and the outer shell of the vessel, thereby compelling the incoming gas to take a sinuous course when in contact with the hot walls of the reaction chamber in traversing the space between the reaction chamber and the jacket shell. Apart from the more uniform cooling of the shell, the heat-extracting effect of the incoming cold gases is multiplied owing to the increased velocity of flow, it being well known that a quick-flowing gas enables a far better exchange of heat to be obtained than with the same volume

flowing at a lower rate. A further advantage of the specified construction is the facility with which the regeneration can be regulated by the number of turns of the spiral between the reaction chamber and the outer shell, so that it is easy, by this means, to bring the gases to the required temperature needed for the reaction.

Instead of the aforesaid simple arrangement of spiral, the same object can be obtained with any other form of construction which allows the gas to pass in a sinuous manner when in contact with the hot walls of the reaction chamber between the reaction chamber and the outer shell, for example by the insertion of solid partition walls or the like.

Not only a single contact chamber, however, with a single cooling jacket provided with the said device spirally leading the incoming gases may be employed according to the present invention, but also a plurality of reaction chambers and a plurality of the said cooling jackets alternately arranged one within the other; thus for example an apparatus for exothermic gas reactions may be constructed by concentrically arranging four or even more tubes one within the other and employing the middle and third free space as reaction chambers and providing the second and fourth interstices with the said spiral guidances for the cooling gases and conducting the incoming gases used for the exothermic reaction or any other cooling gas so that they pass one cooling jacket after the other, thus taking up the heat produced by the reaction of the gases in the reaction chambers. The cooling and reacting gases are preferably conducted on the counter flow principle.

According to the present invention the reaction chamber may thus occupy a comparatively large portion of the vessel, thereby affording a considerable advantage, in respect, for instance, of the limitation of dimensions of a vessel intended for high pressures, in comparison with known embodiments. A further very substantial advantage consists in the ease with which the apparatus can be constructed, as compared with the other processes referred to. The present process may, of course, be also employed in combination with other known systems of heat regeneration. It can be applied, more particularly, in the synthesis of ammonia from its elements; in the production of liquid substances from hydrogen and oxides of carbon and the like; and also in other gas reactions in which hydrocarbons constitute the starting materials or are formed thereby.

I will further describe the invention by way of example with reference to the accompanying drawings, in which Figure 1 illustrates apparatus suitable, for example, for the synthesis of ammonia from its elements, while Figures 2 and 3 shew a modified form of apparatus.

Figure 1 is a vertical section of the apparatus, in which a mixture of nitrogen and hydrogen is introduced at E and passes upwards through the intermediate space between the catalyst chamber K and outer shell M in a spiral path, which is effected by an arrangement of a wire spiral or spirals D. The gas then passes from above downwardly into the catalyst chamber K leaving the apparatus at A. A heat insulating material J is arranged as a lining between the said catalyst chamber K and the outer shell M.

In the modification shewn in vertical section in Figure 2 and in plan in Figure 3 a mixture of nitrogen and hydrogen is introduced at E and passes upwards in a sinuous course around the reaction tubes. The said sinuous course is effected by disposing baffles S^1 in the space S of the apparatus which baffles are so arranged that they overlap alternately from the right and from the left, within the apparatus. The gas mixture enters the catalyst tubes K from above and passes downwards therein and leaves the apparatus at the effluent A. A heat insulating material J is arranged between the catalyst tubes K and the outer shell M.

I am aware that in Specification No. 289,759 a process has been proposed for carrying out exothermic catalytic gas reactions of the kind in which the gases which are to react, are heated prior to reaction by circulating them in indirect contact with the catalyzing material, which process consists in circulating the said gases, immediately before they are brought into contact with the catalyzing material, simultaneously over two or more distinct surfaces or groups of surfaces enclosing the space occupied by the catalyzing material and through which the heat exchange takes place, the transmission of heat through the said surfaces being regulated during the operation of the process by regulating the quantities of gases which respectively circulate before or while they react, over the different surfaces or groups of surfaces, and I do not claim any regulation of the quantities of the incoming or issuing gases.

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:—

flowing at a lower rate. A further advantage of the specified construction is the facility with which the regeneration can be regulated by the number of turns of the spiral between the reaction chamber and the outer shell, so that it is easy, by this means, to bring the gases to the required temperature needed for the reaction.

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Fig. 1.

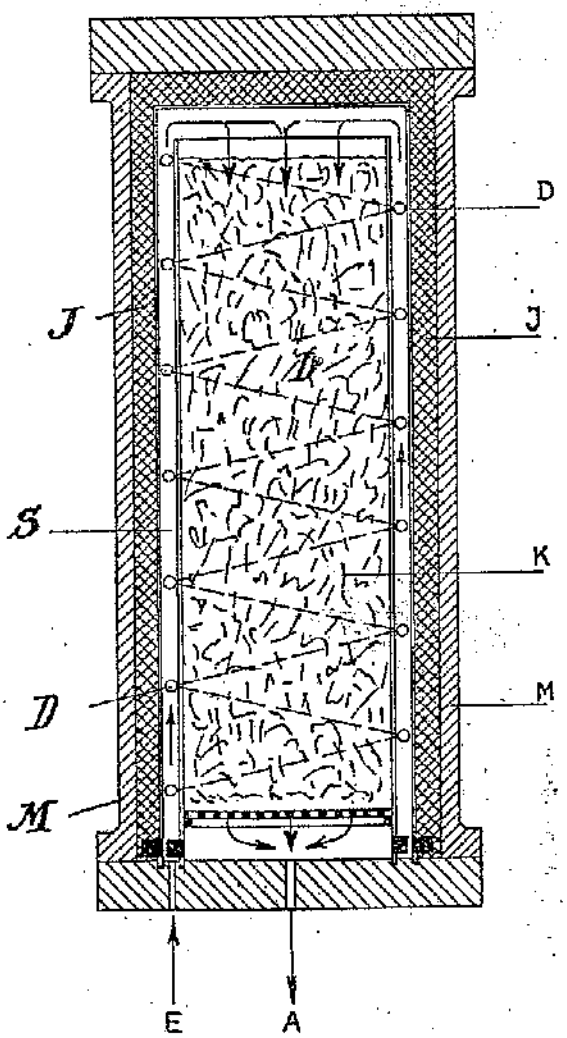

Fig. 2.

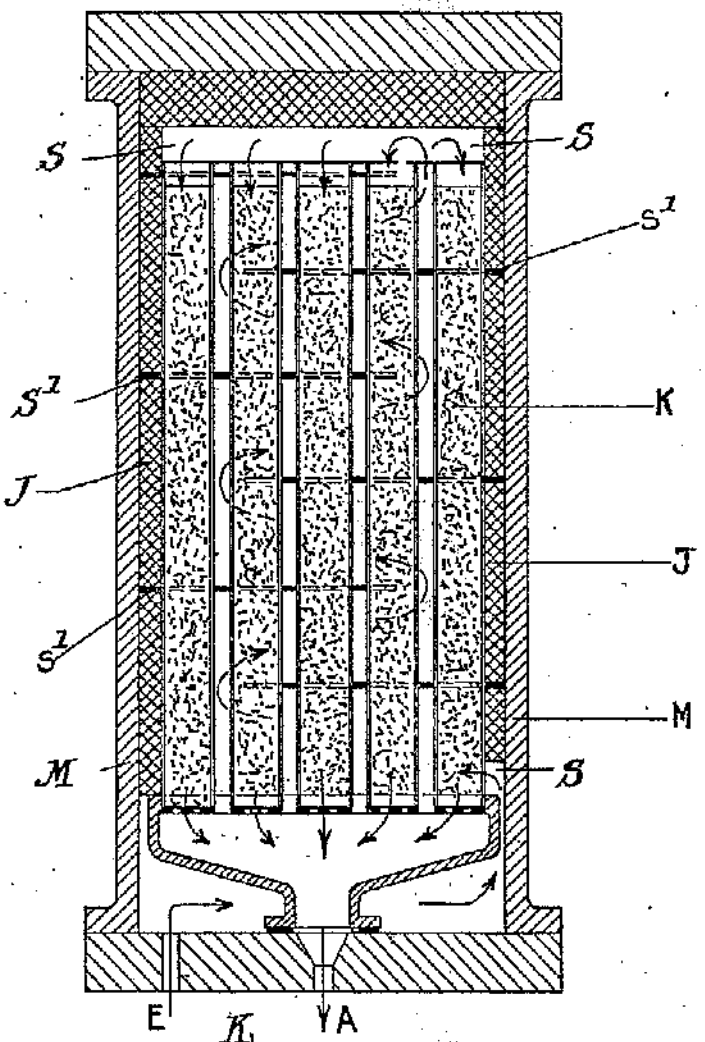

Fig. 3.

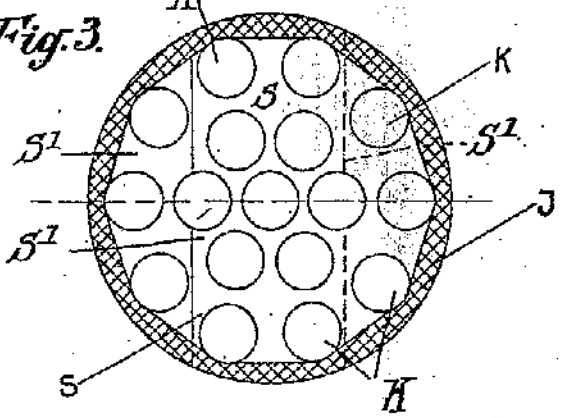

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Fig. 1.

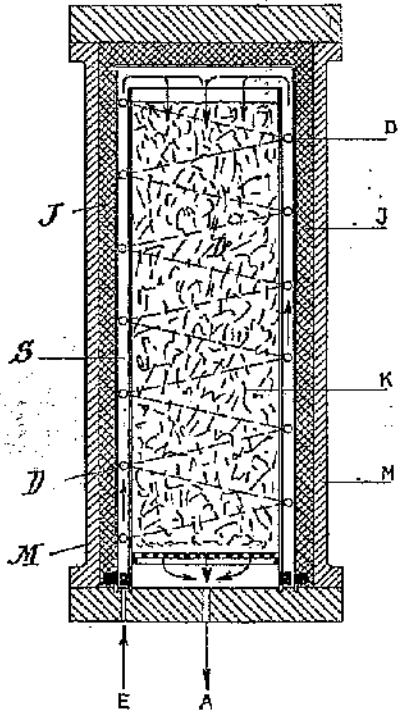


Fig. 2.

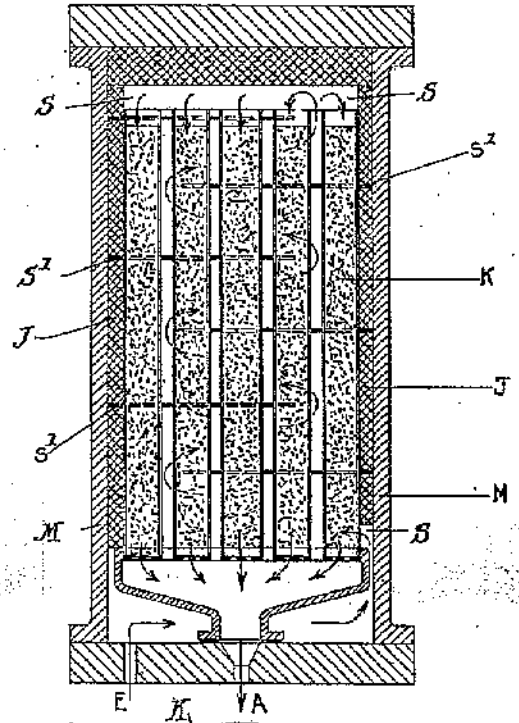
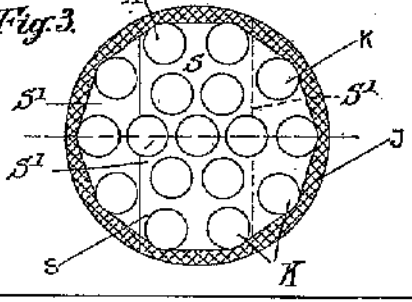


Fig. 3.



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