(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 376 000 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89122322.4**

(22) Date of filing: **04.12.89**

(51) Int. Cl.5: **B01J 8/04, C01C 1/04, C07C 29/15**

(30) Priority: **09.12.88 CH 4551/88**

(43) Date of publication of application: **04.07.90 Bulletin 90/27**

(84) Designated Contracting States: **AT DE ES FR GB GR IT NL**

(71) Applicant: **AMMONIA CASALE S.A.**
Via della Posta 4
CH-6900 Lugano(CH)

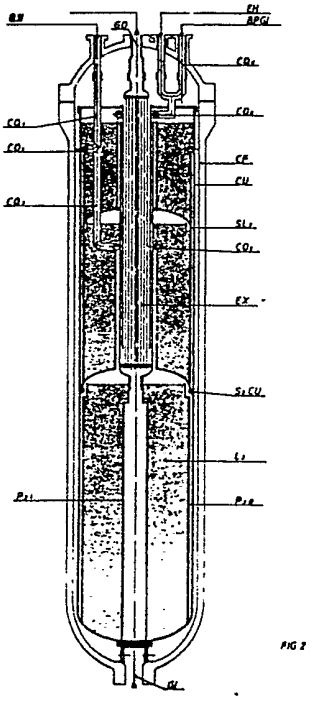
Applicant: **Zardi, Umberto**
Via Lucino 57
CH-6932 Breganzona (Ti)(CH)

(72) Inventor: **Zardi, Umberto**
Via Lucino 57
CH-6932 Breganzona(CH)
Inventor: **Pagani, Giorgio**
Salita dei Frati 13
CH-6900 Lugano(CH)

(74) Representative: **Incollingo, Italo**
AMMONIA CASALE S.A. Via della Posta 4
CH-6900 Lugano(CH)

(54) Reactor for exothermic heterogeneous catalytic synthesis.

(57) A reactor for heterogeneous synthesis is described in which:
- the cartridge-forming shell (CU) is substantially independent of the catalytic baskets (L1, L2, L3);
- at least a first end basket (L1) rests on an intermediate basket (L2) which in turn rests on a packing ring (S2CU) integral with said cartridge shell (CU), the bottom of the two said baskets coupled together being inversely curved with respect to the curve at the bottom of the reactor;
- in said first end bed (L1) a collector (CO1) is placed between the basket's outer wall and the internal face of the cartridge shell;
- in said intermediate bed (L2) a quench collector (CO2) is placed inside the internal cylindrical wall forming the basket; and
- a gas/gas heat exchanger (Ex) is placed in a central position inside the cylindrical wall of at least the catalytic basket closest to the reactor outlet for hot reacted gas.



EP 0 376 000 A1

Reactor for exothermic heterogeneous catalytic synthesis

This invention concerns a reactor for exothermic heterogeneous catalytic synthesis under pressure, and more particularly for the catalytic synthesis of ammonia, methanol, etc., consisting of an outer shell, of an internal cartridge, of several catalytic beds formed by baskets consisting of coaxial cylindrical walls enclosing a granular catalyst, said baskets comprising two baskets at the upper and lower ends and at least an intermediate basket, and of the means to adjust and transfer reaction heat.

Reactors of the above-mentioned type are described in numerous patents by the Applicants. More particularly, in base Patent US No. 4,372,920 the description is given for the first time of a reactor which is today widely known and referred to with the expression "axial-radial"; in US Patent No. 4,405,562 the Applicants have described a particular type of heat exchanger for axial-radial catalytic beds, while the subject of their most recent US Patent No. 4,755,362 consists of a system for reducing energy consumption in classic axial-type reactors by modifying them in situ so as to turn them into axial-radial reactors.

In a recent patent application the Applicants have described a reactor with quenching, with axial-radial gas flow in the catalytic beds where the baskets are independent of the cartridge shell. The preferred configuration of this type of reactor is with three adiabatic beds with two intermediate quenches and with a gas/gas exchanger placed at the bottom, the first two catalytic beds being run through by the gas flowing centrifugally while the gas running through the third bed flows centripetally.

With this preferred embodiment it is possible to dispense with the necessity of providing those flanged connections between the various beds which are indispensable when the baskets are integral with the cartridge shell.

In a further patent application a particular solution is described, in which the bottoms of the baskets are inverted, permitting a better utilization of the available volume, and in which the gas flows outwardly in the first basket and inwardly in the other two. The configuration is with three beds with a quench, an interchanger and possibly a base exchanger.

Continuing their research, the Applicants have now found that it is possible to transfer the characteristics peculiar to this solution to quench-type reactors (without interchanger) with appreciable advantages both in construction and in operation, thus achieving greater structural simplicity, better operation and smaller costs.

These and other advantages are obtained with a reactor as described in the introduction to the main claim and to the description, which is now characterized by the fact that:

- the cartridge-forming shell is substantially independent of the catalytic baskets;
- at least a first end basket rests on an intermediate basket which in turn rests on a packing ring integral with said cartridge shell, the bottoms of said two coupled basket being inversely curved with respect to the curve at the bottom of the reactor;
- in said first end bed a collector is placed between the basket's external wall and the inside face of the cartridge shell;
- in said intermediate bed a quench collector is placed inside the internal cylindrical wall forming a basket; and
- a gas/gas heat exchanger is placed in a central position inside the cylindrical wall of at least the catalytic basket closest to the reactor outlet for hot reacted gas.

In a first embodiment of the invention, the reactor comprises three beds, the upper bed has the quench collector on its outer periphery with centripetal flow of the quench gas, the intermediate bed resting on the packing ring and acting as support for said first upper basket has the quench collector inside its internal wall with the quench gas flowing centrifugally, the third bed has running through its centre the gas/gas exchanger, the synthesis and quench gas being fed from the top while the reacted gas leaves from the bottom.

In a second embodiment of the invention the upper bed with quench collector on its outer periphery, as well as the intermediate basket with quench collector inside its internal wall, are both run through the centre by a gas/gas exchanger, the synthesis gas being fed from the bottom, the quench gas being fed from the top, and the reacted gas outlet being placed at the top.

The various aspects and advantages of the invention will be better illustrated by the following description of preferred but not limitative embodiment, as shown in the attached drawings which are two schematic and partial views in cross-section.

In Figures 1 and 2, CF indicates the external shell; CU the cartridge; L1, L2, L3 the three catalytic beds, each delimited by substantially perforated external walls P1e, P2e, P3e and internal walls P1i, P2i, P3i; CQ1 and CQ2 the ducts feeding quench gas Q1 and Q2 to collectors CO1 and CO2; EX the gas/gas heat exchanger; Q1l, Q2l and Gl the inlets for quench gas, respectively synthesis gas; CO1 and CO2 the collectors-distributors of quench gas; S12 the support for bed L1 at the top of bed L2 and S2 CU the support for L2 on a ring

of cartridge CU.

In Fig. 1 quench gas Q1 and Q2 enter from the top (inlet Q1I, while Q2I is hidden by Q1I) and through ducts CQ1, CQ2 arrive at collectors CO1 respectively CO2 situated on the outer periphery (corresponding to the top of P1i) of L1, respectively on the inner part (at the top of P2i) of L2. Quench gas Q1, therefore, flows outwardly, while second quench gas Q2 flows inwardly.

The basket of L1 rests on support S12 situated at the top of L2 and is therefore independent of cartridge CU, while said second bed L2 rests on packing ring S2 CU integral with the shell of CU; in this way a seal is easily achieved between the second and third bed. In Fig. 1 the third bed L3 is run through by exchanger EX and the reacted gas leaves from the bottom GO. EH is an electric heater and BPGI is the by-pass for the gas entering the reactor.

In Fig. 2 quench gas Q1 and quench gas Q2 and the supports for the first and second beds are still the same as in Fig. 1, but synthesis gas GI enters from the bottom, the reacted gas GO leaves from the top, a third quench CQo injects cold gas into the annular space above the first catalytic bed L1, and the exchanger EX runs through the two catalytic beds L2 and L1.

Variations and modifications can be made regarding the embodiments illustrated without affecting either the purpose or the spirit of the invention.

Claims

1. Reactor for exothermic heterogeneous catalytic synthesis under pressure, and more particularly for the catalytic synthesis of ammonia, methanol etc., consisting of an outer shell, of an internal cartridge, of several catalytic beds formed by baskets consisting of coaxial cylindrical walls enclosing a granular catalyst, said baskets comprising two baskets at the upper and lower ends and at least one intermediate basket, and of the means to adjust and transfer reaction heat, characterized by the fact that:
- the cartridge-forming shell is substantially independent of the catalytic baskets;
- at least a first end basket rests on an intermediate basket which in turn rests on a packing ring integral with said cartridge shell, the bottoms of said two baskets coupled together being inversely curved with respect to the curve at the bottom of the reactor;
- in said first end bed a collector is placed between the basket's outer wall and the inside face of the cartridge shell;
- in said intermediate bed a quench collector is placed inside the internal cylindrical wall forming the basket; and
- a gas/gas heat exchanger is placed in a central position inside the cylindrical wall of at least the catalytic basket closest to the reactor outlet for hot reacted gas.

2. Reactor according to claim 1, characterized by the fact that said reactor comprises three beds, the upper bed has the quench collector on its outer periphery with centripetal flow of the quench gas, the intermediate bed resting on the packing ring and acting as support for said first upper basket has the quench collector inside its internal wall with centrifugal flow of the quench gas, the third bed has running through its centre the gas/gas exchanger, the synthesis gas and the quench gas being fed from the top while the reacted gas leaves from the bottom.

3. Reactor according to claim 1, characterized by the fact that the upper bed with quench collector on its outer periphery, as well as the intermediate basket with quench collector inside its internal wall are both run through the centre by a gas/gas exchanger, the synthesis gas being fed from the bottom, the quench gas being fed from the top, and with the reacted gas outlet placed at the top.

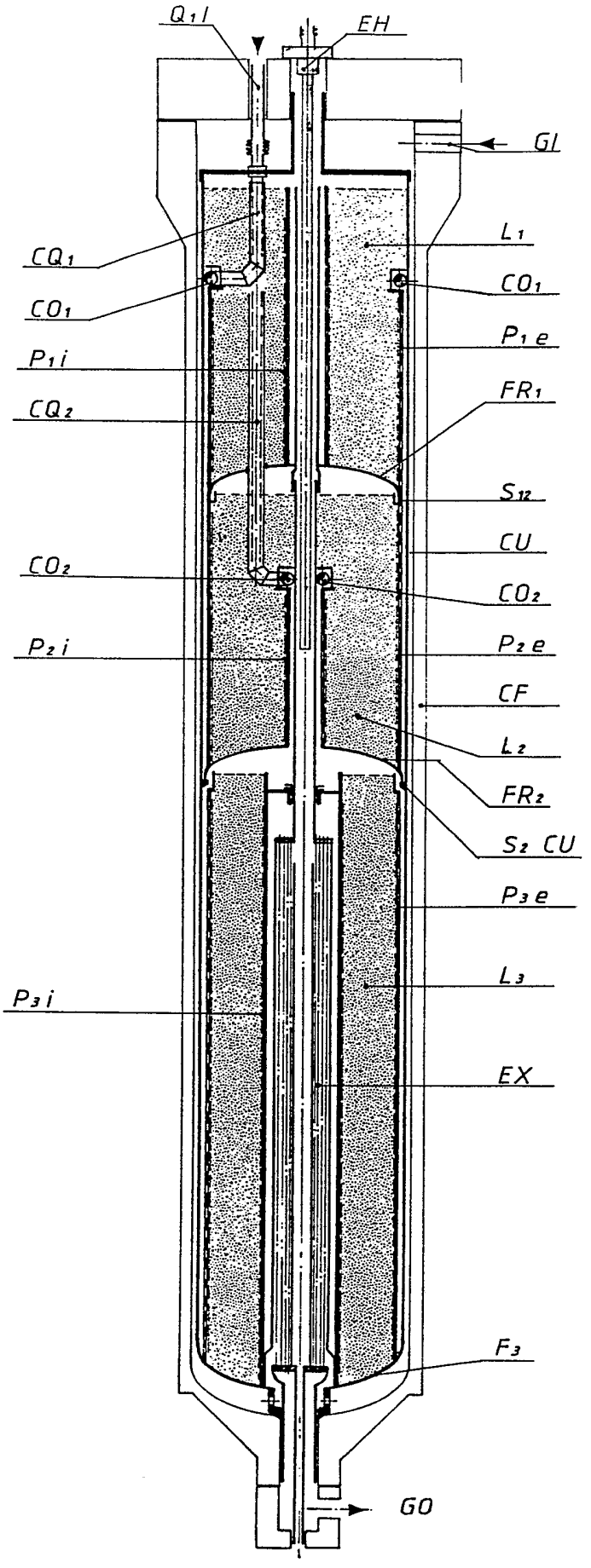

Q1 I
EH
GI
L1
CQ1
CO1
CO1
P1 e
P1 i
FR1
CQ2
S12
CU
CO2
CO2
P2 e
P2 i
CF
L2
FR2
S2 CU
P3 e
L3
P3 i
EX
F3
GO

Fig. 1

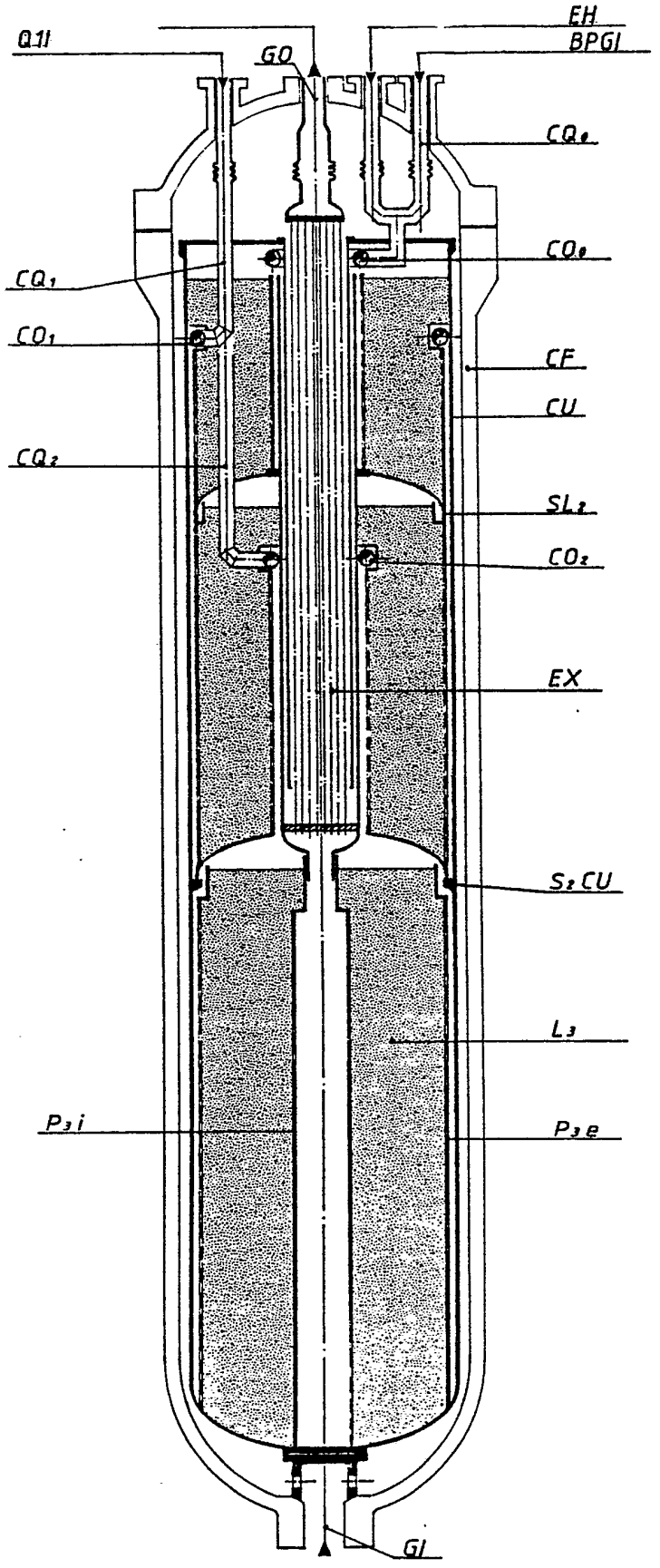

EH
BPGI
Q11
GO
CQe
CQe
CQ1
CO1
CF
CU
CQ2
SL2
CO2
EX
S2CU
L3
P3i
P3e
GI

FIG.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 12 2322

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,P	EP-A-0 297 474 (AMMONIA CASALE) * Claims 1-6; figures 1-3 *	1-3	B 01 J 8/04 C 07 C 1/04 C 07 C 29/15
A,P	EP-A-0 332 757 (AMMONIA CASALE) * Claims 1-8; figure 4 *	1-3	
A,D	US-A-4 755 362 (ZARDI) * Column 6, line 49 - column 7, line 14; figure 3B *	1-3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 01 J
C 01 C
C 07 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02-04-1990	MEERTENS J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)