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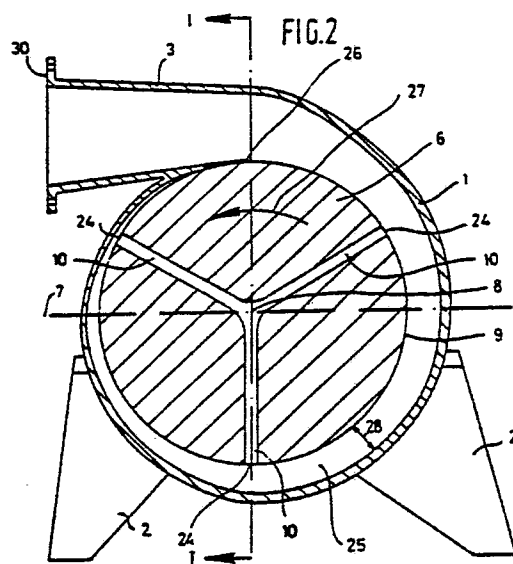
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⑤④ Centrifugal pump for powder and a process and apparatus for the gasification of coal powder.

⑤⑦ Centrifugal pump for introducing powdered solids into a pressurized space (e.g. coal in a pressurized gasifier) comprising a feed inlet (8) and a rotor (6) with passages (10) extending radially outwards from the rotor inlet. The pump also comprises a pump-shell (1) that diverges in the direction of rotation (27) and preferably communicates with a diffuser (3). The shell may consist of two or more identical parts that each surround part of the rotor and the shell may comprise gas inlets. A coal gasification process and -apparatus using the said pump are also described.

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CENTRIFUGAL PUMP FOR POWDER AND A PROCESS AND
APPARATUS FOR THE GASIFICATION OF COAL POWDER

The invention relates to a centrifugal pump for the introduction of powder into a pressurized space, comprising an inlet and a rotor, the inlet leading to the centre of the rotor and the rotor having one or more essentially radial passages normal to the axis of rotation which passages communicate with the inlet and are open at their outward extremity.

Such pumps are known from the U.S. patent specifications Nos. 2,822,097; 3,182,825; 4,049,133 and 4,120,410 and act as ejecting centrifugal pump, i.e. the powder is ejected by the rotor at high velocity into a large vessel, in which vessel the velocity of the particles is reduced to zero. The powder is passed to the centre of the rotor via the inlet and moves in the rotor by the effect of the centrifugal force through the radial passages away from the centre of the rotor in an outward direction and finally leaves these passages through the open extremity with a radial and tangential velocity component.

These pumps are used, for example, to introduce pulverulent solid fuel into a pressurized vessel, such as coal powder which is passed via a vessel to a reactor for the partial combustion of coal which reactor is connected to the vessel. The pressure in the vessel is usually at least 10 atm. and the pump serves to introduce the coal powder which is at atmospheric pressure into the vessel against the pressure difference. Under these conditions the velocity at which the particles leave the rotor is high, in the order of 100 m/sec. in a tangential direction and 10 m/sec. in a radial direction.

The energy invested in this velocity has so far not been put to further use, which is a drawback. Besides, it may under certain conditions be disadvantageous for the powder particles

to be subjected to a rise in temperature by the friction caused by rapid deceleration in the equipment described in the above-mentioned patent specifications.

The present invention envisages the removal of these disadvantages and to this end proposes surrounding the rotor by a casing of which the radial distance to the rotor increases in the direction of rotation to a point at which the casing leads away from the rotor in a tangential direction. The resultant space between the rotor and the casing ensures optimum retention of momentum of the medium ultimately leaving the pump, i.e., the powder particles optimally retain the initial tangential velocity component in the said space and also the gas entrained by the particles optimally assumes this velocity.

In this respect it is essential that starting from the point where the distance between rotor and casing is smallest - seen in the direction of rotation - the space becomes larger as the rotor ejects more powder into the space.

In the axial direction both sides of the casing may border the lateral faces of the rotor at which locations some clearance may be left between casing and rotor and/or a seal may be provided between casing and rotor.

If some clearance is left between the casing and the lateral faces of the rotor, gas inlets are preferably present in the casing which issue into the clearance between the casing and the lateral faces of the rotor. This has the advantage that the powder which finds its way into these spaces is blown back into the space of the casing situated radially outside the rotor.

The casing is advantageously provided with one or more gas inlets tangentially issuing into the space around the rotor. The gas which may be injected or drawn in through these gas inlets is then accelerated by the powder particles. It will be evident that providing these gas inlets in the pump will augment the controllability of the powder flow since there will be a

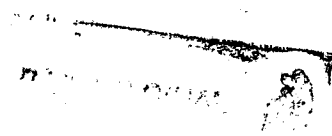
degree of freedom in respect of the quantity of gas supplied and of the initial pressure and velocity of this gas.

Centrifugal pumps of the type according to the invention are very suitable for the supply of pulverulent solid fuel to
5 a reactor for the partial combustion of this powder at elevated pressure, either by having the pump directly connected to a burner debouching into the reactor or by having the pump introduce the powder into a high pressure-operated fluidization vessel from which the fluidized powder is supplied to the burner.
10 Especially in the case of reactors in which two burners are arranged diametrically opposite each other in the wall it is important for both burners to be invariably fed in an identical manner. Particularly in this instance it is most advantageous to provide the pump, if it is directly connected to the burners,
15 with a casing consisting of two identical halves each surrounding half of the rotor and of which casing the radial distance to the rotor increases in an equal manner up to the point where the casing half leads tangentially away from the rotor. Now if each casing half is connected to a burner, there is a high degree of
20 certainty that both burners will be equally loaded.

It will be obvious that the casing may also consist of more than two identical parts.

An advantage of directly connecting the burner(s) to the pump resides in the fact that the velocity of the powder
25 particles is not reduced to zero on their way from the pump to the reactor (as was the case in the above-mentioned state of the art), so that the powder particles need not be accelerated again.

In order to produce an increase in pressure of the gases
30 entrained by the powder, according to the invention, the part or each part of the casing leading tangentially away from the rotor is preferably designed as a diffuser.



As is known the cross-section of a diffuser increases in the direction of flow and the velocity of the gas flowing through the diffuser decreases while the pressure increases.

The space in the pump between casing and rotor may have any
5 suitable cross-section, for example a rectangular or more rounded profile. It will be clear that the part of the casing which leads tangentially away from the rotor will have a cross-sectional shape which will gradually change from that of the said space into a circular shape (if the cross-section of the said space
10 is not also circular). If a diffuser is used, it may provide the gradual change.

The invention also relates to a method for the partial combustion of pulverulent solid fuel at elevated pressure, in which method the powder is passed either directly or via an inter-
15 mediate vessel to the reactor for partial combustion through a centrifugal pump according to the invention.

The exclusive right also pertains to an apparatus for the partial combustion of pulverulent solid fuel at elevated pressure, comprising a reactor into which one or more burners debouch, the burner(s) being connected either directly or via an
20 intermediate vessel to a pump according to the invention.

The invention will now be further elucidated with reference to the attached drawing, to which it is not restricted.

Fig. 1 of the drawing is a schematic representation of an
25 axial cross-section of a centrifugal pump according to the invention;

Fig. 2 of the drawing is a cross-section taken on plane II-II of Fig. 1;

Fig. 3 of the drawing is a schematic representation of a
30 "double-acting" pump according to the invention; and

Fig. 4 of the drawing is a schematic representation of a pump with gas inlets according to the invention.

The centrifugal pump depicted in Figs. 1 and 2 comprises a flat snail-shell shaped casing 1 on a pedestal 2 and provided



with a diffuser-shaped discharge 3, a central inlet 4 and a central bearing housing 5. Within the casing 1 a flat, disc-shaped rotor 6 is present, the rotation shaft 7 of which coincides with the axis of the inlet 4 and with the axis of the bearing housing 5.

Three radial passages 10 connect the centre 8 with the circumference 9 of the rotor, which passages, in the centre 8, communicate with an axial bore 11 which extends from the centre to the left-hand lateral face 12 of the rotor and communicates with the inlet 4 of the casing 1.

At the side of the right-hand lateral face 13 of the rotor there is a central drive shaft 14 which passes through the bearing housing 5 and which is provided with a drive 15. The lateral faces 12 and 13 of the rotor 6 run clear of the inner wall of the casing 1, since both faces are provided at 16 and 17 with a shoulder. At the shoulders 16 and 17 the disc 6 is rotatably mounted on bearings in the casing 1 (in a manner not shown in the drawing) and these bearings are sealed against coal powder. The gaps 18 between the lateral faces 12 and 13 of the rotor and the casing are sealed against the powder to be transported which may find its way into the gaps from the space 3, by gas supplied through the inlet openings 19.

The inlet 4 of the casing is provided with a funnel-shaped connection 20 which may be connected to a bunker with powder by means of a flange 21. In order to ensure uninterrupted supply of powder to the centre 8 of the rotor, a worm screw 22 with drive 23 is arranged in the tubular inlet 4.

The operation of the centrifugal pump depicted in Figs. 1 and 2 is as follows.

The powder is passed through the tube 4 via the funnel 20 by means of the rotating screw 22. Together with the powder an inert gas, such as cold recirculated product gas from the partial combustion of the coal powder, is supplied from the space (not shown) connected to the funnel 20.



The powder and the entrained gas thus find their way into the centre 8 of the rotor 6 via the passage 17. In the rotating rotor the particles and the entrained gas are forced from the centre 8 to the open extremities 24 of the radial passages 10

5 under the influence of the centrifugal force, from which extremities the particles leave the rotor at high velocity. The tangential velocity of the particles upon leaving the rotor is more than 20 m/sec., and is mostly in the order of 100 m/sec.

The space 25 between the rotor 6 and the casing 1 is formed 10 in such a way that, starting from the highest point 26 in the direction of rotation 27, the radial distance 28 between the circumference 9 of the rotor 6 and the inner side of the wall 29 of the casing increases gradually up to the point (in this case the same point 26) at which the space leads tangentially away 15 from the rotor, i.e. the line I-I in Fig. 2 where the diffuser 3 begins.

Each of the passages 10 in the rotor 6 will at any point during the rotation of the rotor eject powder into the space 25 in an essentially tangential direction so that the initial flow 20 of powder which is entrained from point 26 in the direction 27 of the rotor 6 gradually increases in volume. Little velocity is lost by the powder on its way through the space 25.

At the moment when the powder reaches the diffuser 3 it leaves the space 25 and, as appears from the drawing, the cross- 25 section of the diffuser is at that point essentially rectangular (see Fig. 1), whereas at the end of the diffuser (at the level of the flange 30) the cross-section is larger and circular. This transition and the flange 30 serve to connect the pump as apparatus for the supply of powder. In the diffuser the velocity 30 of the particles decreases and the pressure of the gas entrained with the particles increases.

Fig. 3 is a very diagrammatic representation of a cross-section, comparable with Fig. 2, of a double-acting pump according to the invention.

The rotor 31 again comprises a disc which is rotatably mounted on bearings around a shaft in a casing. In addition to walls which run parallel to the disc, the casing comprises two walls 32 and 33 which are complementary and each surround the rotor 31 for 180° . In this way the rotor 31 and the wall 32 enclose a space 34 which diverges in the direction of rotation 35 and which at 36 joints with a diffuser 37 and the rotor 31 and wall 33 enclose a space 38 which diverges in the direction of rotation 35 and which at 39 joints with a diffuser 40.

Seen along the circumference of the rotor, the space 34 begins where the space 38 ends and vice versa.

The rotor 31 has a central powder inlet 41 and two radial passages 42 and 43 which in turn eject powder (and gas) into the space 34 and 38, respectively, during rotation of the rotor.

It will be clear that, provided the two halves of the casing are identical in design, fluctuations in the flow of powder or, for example, deliberate variations in the speed of the rotor will be noticeable in a perfectly identical manner at the outlets of the diffusers 37 and 40.

Finally, Fig. 4 depicts a single-acting pump of which the rotor 44 has four radial passages 45 and of which the casing 46 is provided with a number of gas-supply nozzles 48 which tangentially issue into the space 47 between casing and rotor.

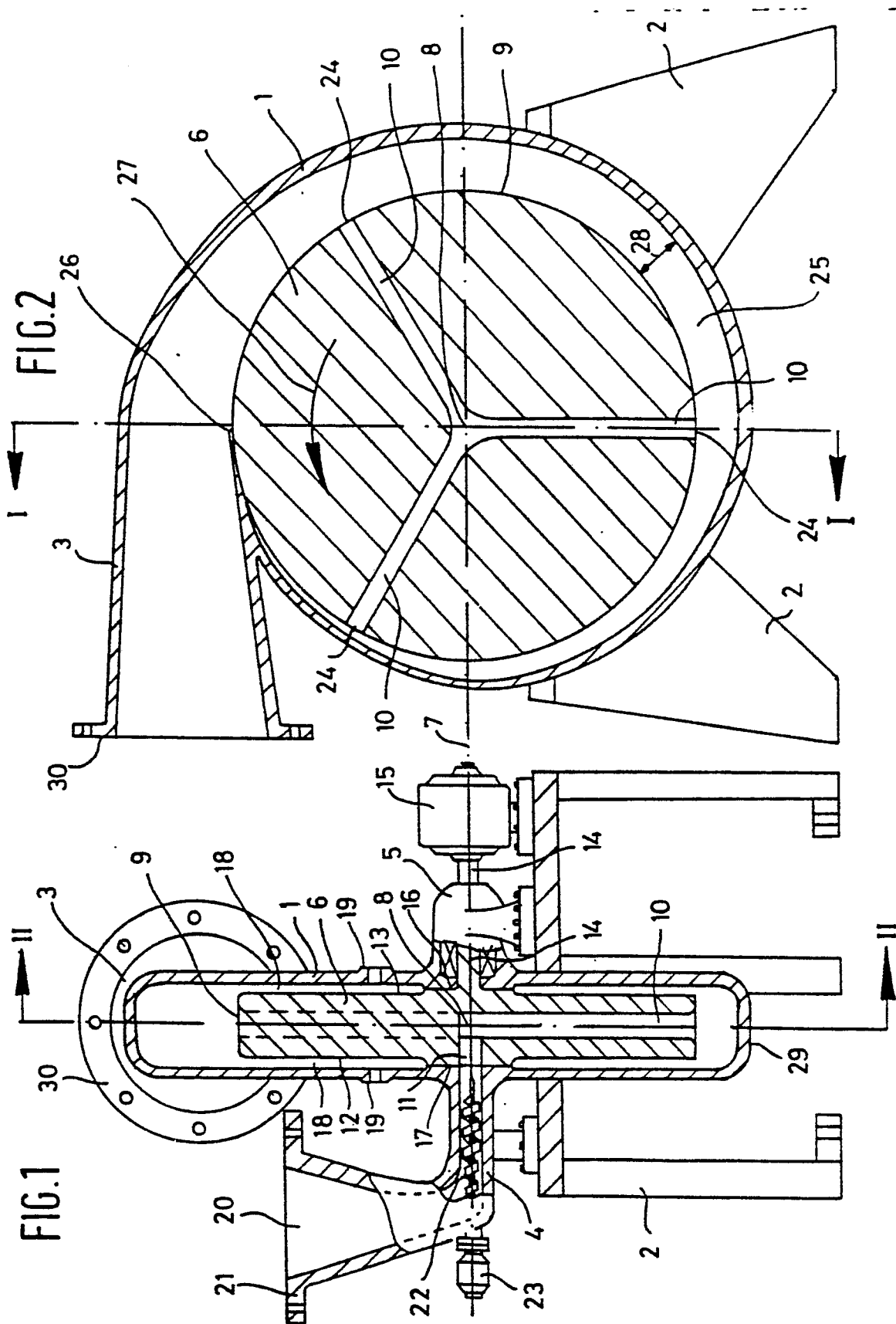
The gas introduced into the space 47 through these nozzles 48 is accelerated in said space under the influence of the powder which is ejected into the space 47 by the rotor 44. The gas may be drawn in by the space 47 or be injected into it at the required initial velocity. By controlling the quantity of gas and/or the velocity of the gas, influence may be exerted on the pressure and/or the velocity of the gas/powder mixture leaving the diffuser 49. Alternatively, the quantity of gas and/or the velocity of the gas may be adapted to the rotational velocity of the rotor 44.

It will be evident that many variations are possible in the shape of the rotor, the shape and number of the radial passages therein (the rotor may, for example, consist of two discs between which the radial passage comprises a single slot) as well as in
5 the shape and cross-section of the space between the rotor and the casing. The feed and drive of the pump shown may, of course, also be effected in a different manner.

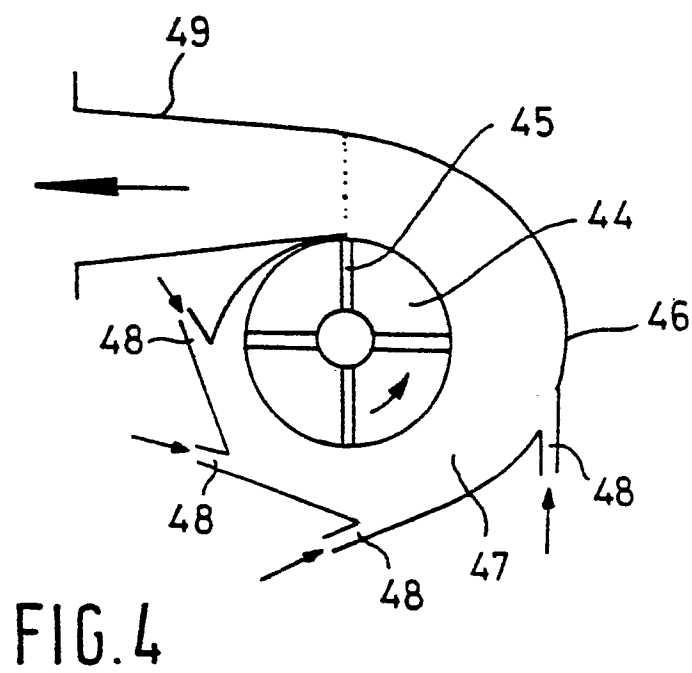
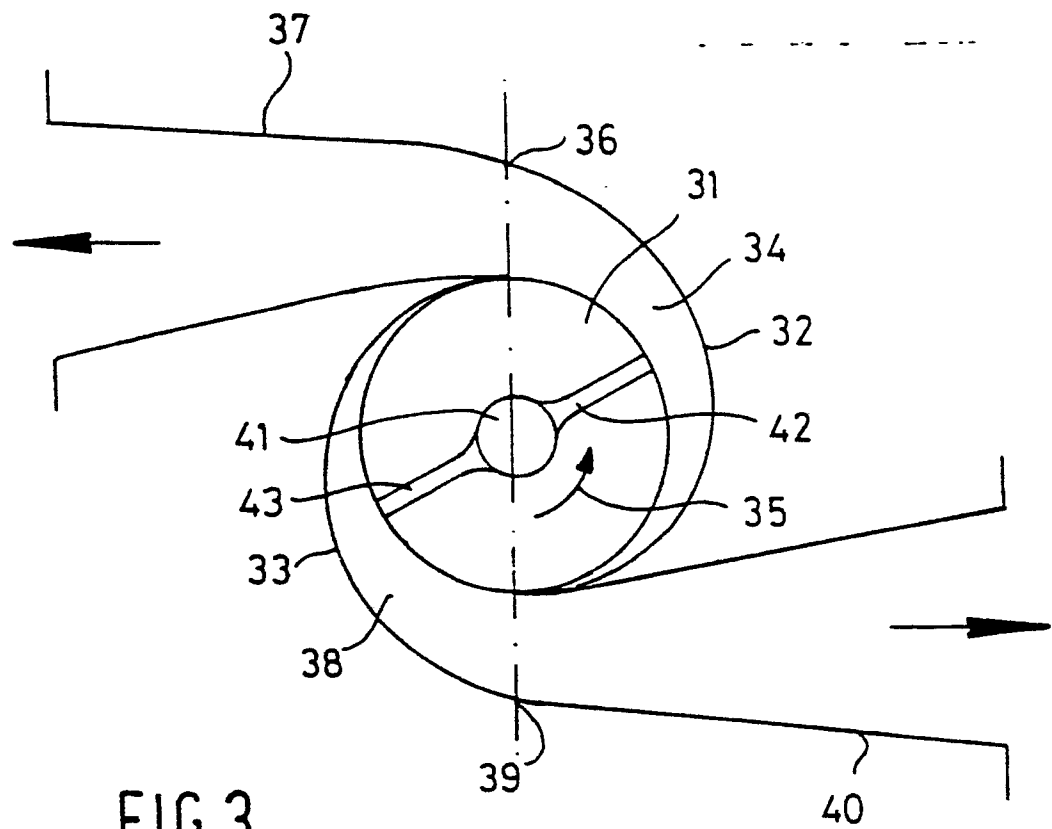
C L A I M S

1. A centrifugal pump for the introduction of powder into a pressurized space, comprising an inlet and a rotor, the inlet leading to the centre of the rotor and the rotor having one or more essentially radial passages normal to the axis of rotation
5 which passages communicate with the said inlet and are open at their outward extremity, characterized in that the rotor is surrounded by a casing of which the radial distance to the rotor increases in the direction of rotation to a point at which the casing leads away from the rotor in a tangential
10 direction.
2. A pump as claimed in claim 1, characterized in that the casing is provided with one or more gas inlets tangentially issuing into the space around the rotor.
3. A pump as claimed in claim 1 or 2, characterized in that
15 some clearance is left between the casing and the lateral faces of the rotor, into which clearance gas inlets issue.
4. A pump as claimed in claim 1, 2 or 3, characterized in that the said casing consists of two identical halves each surrounding half of the rotor and of which casing half the radial distance
20 to the rotor increases in equal manner up to the point where the casing half leads tangentially away from the rotor.
5. A pump as claimed in claim 1, 2, 3 or 4, characterized in that the part or each part of the casing leading tangentially away from the rotor is designed as a diffuser.
- 25 6. A method for the partial combustion of pulverulent solid fuel at elevated pressure, characterized in that the powder is passed to the reactor for partial combustion either directly or via an intermediate vessel through a centrifugal pump as claimed in any one of the preceding claims.

7. An apparatus for the partial combustion of pulverulent solid fuel at elevated pressure, comprising a reactor into which one or more burners debouch, characterized in that the burner(s) is (are) connected, either directly or via an intermediate vessel, to a pump as claimed in any one of claims 1-5.
8. An apparatus as claimed in claim 7, in which two burners are arranged diametrically opposite each other, characterized in that the burners are connected to a pump as claimed in claim 4.



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EUROPEAN SEARCH REPORT

0015037
Application number
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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ...)
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			TECHNICAL FIELDS SEARCHED (Int. Cl. ...)
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			& member of the same patent family. corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	12-05-1980	DE SCHEPPER	



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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
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	<u>FR - A - 1 402 582</u> (EDWARDS) * Whole document * --	1	
	<u>US - A - 3 746 465</u> (VANDOORN) * Whole document * --	1	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
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