OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) **Brevet-Patent**

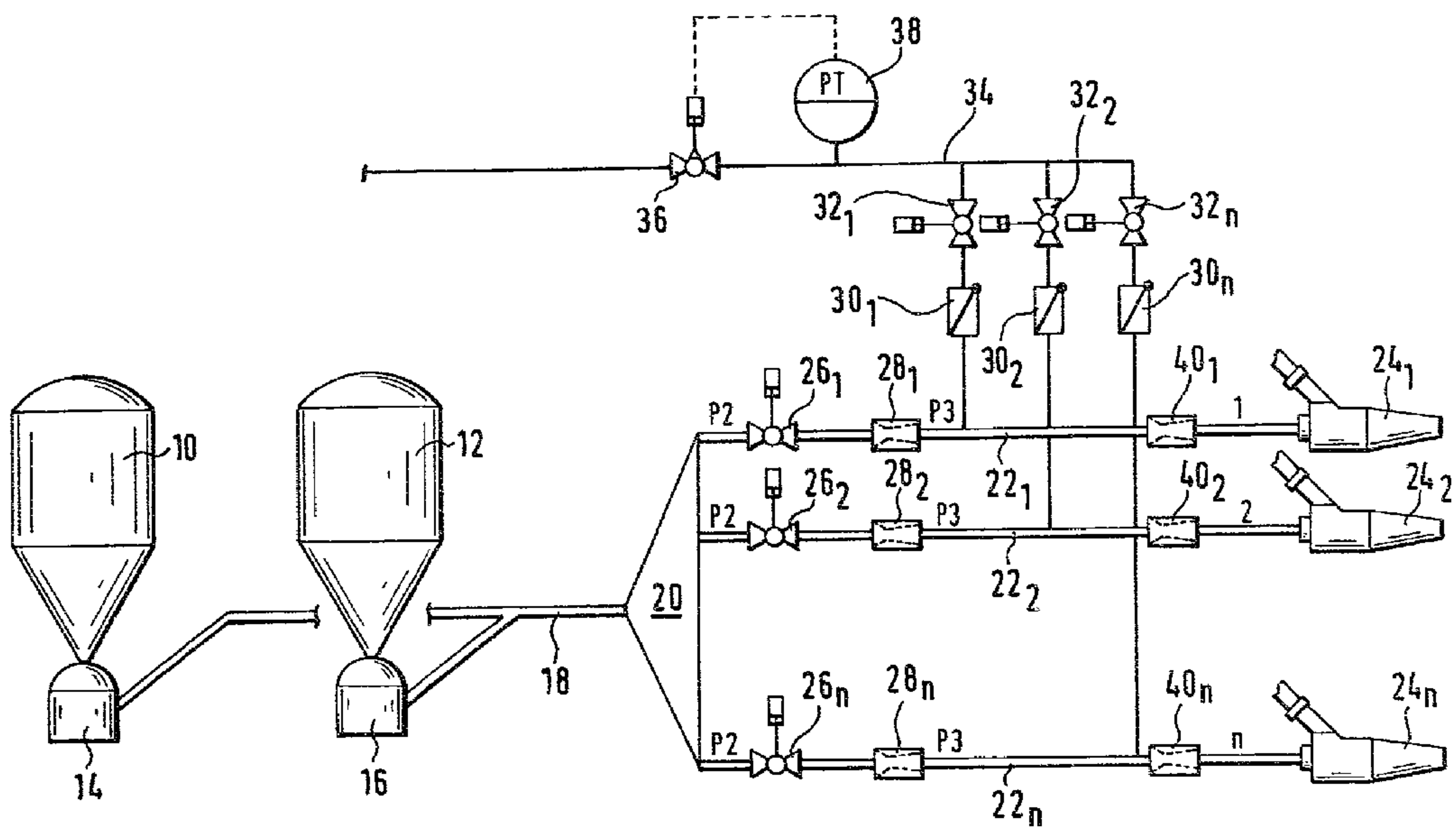
(11) (21) (C) **2,009,766**
(22) 1990/02/09
(43) 1990/08/14
(45) 2000/03/28

(72) Schmit, Louis, LU
(72) Kroemmer, Yvon, LU
(72) Ulveling, Léon, LU
(73) Paul Wurth S.A., LU

(51) Int.Cl.^{5} F23K 3/00
(30) 1989/02/14 (87 453) LU

(54) **METHODE D'INJECTION PNEUMATIQUE DE DOSES DE SUBSTANCES POUDREUSES, DANS UNE CHAMBRE DE MELANGE, A PRESSION VARIABLE**

(54) **METHOD FOR THE PNEUMATIC INJECTION OF METERED QUANTITIES OF POWDERED SUBSTANCES INTO A CHAMBER AT A VARIABLE PRESSURE**



(57) The method consists in forming in a single metering device a pneumatic mixture comprising the powdered substances and the propellent gas, in propelling this mixture through a common main (18) into a distributor (20) in which the mixture is split into secondary currents which are sent to each of the injection points respectively through secondary pipes (22 1, 22_2, ... 22_n), in determining the flow rate in each of the secondary pipes (22_1, 22_2, ... 22_n) by the tuyere (28_1, 28_2, ... 28_n) flow cross-sections and in influencing the transport conditions in each secondary pipe (22_1, 22_2, ... 22_n) by acting on the pressure P3 downstream from each tuyere (28_1, 28_2, ... 28_n) in order to maintain this pressure at a determined value. The method is aimed more particularly at the injection of powdered coal into a blast furnace.

ABSTRACT

METHOD FOR THE PNEUMATIC INJECTION OF METERED QUANTITIES OF POWDERED SUBSTANCES INTO A CHAMBER AT A VARIABLE PRESSURE

The method consists in forming in a single metering device a pneumatic mixture comprising the powdered substances and the propellent gas, in propelling this mixture through a common main (18) into a distributor (20) in which the mixture is split into secondary currents which are sent to each of the injection points respectively through secondary pipes (22_1, 22_2,... 22_n), in determining the flow rate in each of the secondary pipes (22_1, 22_2,... 22_n) by the tuyere (28_1, 28_2,... 28_n) flow cross-sections and in influencing the transport conditions in each secondary pipe (22_1, 22_2,... 22_n) by acting on the pressure P3 downstream from each tuyere (28_1, 28_2,... 28_n) in order to maintain this pressure at a determined value.

The method is aimed more particularly at the injection of powdered coal into a blast furnace.

Figure 1.

2009766

METHOD FOR THE PNEUMATIC INJECTION OF METERED QUANTITIES OF POWDERED SUBSTANCES INTO A CHAMBER AT A VARIABLE PRESSURE

The present invention relates to a method for injecting, by a pneumatic method, metered quantities of powdered substances, at different points, into a chamber which is at a variable pressure, according to which a pneumatic mixture consisting of the powdered substances and the propellent gas is formed in a single metering device, this mixture is propelled through a common main into a distributor in which the mixture is split into secondary currents which are sent to each of the injection points respectively through secondary pipes.

With no limitation being implied, the invention will be described more particularly with reference to its preferred application, in other words the injection of solid fuels, in particular powdered coal, into an industrial furnace, such as a blast furnace.

Among the known methods and plants for injecting solid fuels into a tank furnace, two different types can essentially be distinguished. In the plants of the first type, the powdered coal is released under pressure from a distributing hopper into a series of metering apparatuses in which the mixture of powdered coal and propellent gas is formed and from which the mixture thus formed is conveyed towards the points for injection into the tank furnace. In these plants, one metering apparatus is generally employed for each tuyere stock or for each pair of tuyere stocks, with the result that the quantities injected through the tuyere stocks may be metered individually. These plants have the advantage of enabling a high degree of accuracy of the individual flow rates. On the other hand, they have the disadvantage that they require many relatively long pipes between the distribution hopper and the tank furnace. Furthermore, metering may be made difficult by the various variable parameters, in particular fluctuations in pressure inside the furnace, which have repercussions on the cost of the plant, because of the need for numerous measurements and

A

regulation loops.

In the second type of plant, only one metering device is employed at or downstream from the distribution hopper. In this metering apparatus, the overall flow rate of the powdered coal is regulated so as to inject a predetermined quantity of powdered coal per unit time. These plants use the method described in the introduction, in other words the metered current containing the required quantity of coal is divided in a distributor into identical secondary currents. These plants have the advantage that the distributor is arranged in immediate proximity to the furnace so as to reduce the length of the secondary pipes and, consequently, the space requirement around the furnace.

On the other hand, these plants have the disadvantage that the variable parameters, in particular fluctuations in the pressure in the furnace, must be controlled, as well as the influence of the features of the various pipes, in order to obtain a uniform or determined distribution of the overall flow rate metered to the various tuyere stocks, as these parameters all influence the pressure gradient in the secondary pipes and, consequently, the flow rate of the powdered coal in these pipes. Various strategies have already been provided for this purpose. It has, for example, already been proposed to deliberately lengthen some pipes, or to provide them with calibrated flow orifices in order to compensate for the influences of the differences in the features of the pipes which are, for example, varying lengths, their cross-section of flow resulting from manufacturing tolerances or from wear and the influence of their layout (horizontal, vertical or oblique). However, both these differences and the measurements necessary to compensate for their influences are very difficult to detect and to determine. Furthermore, these compensatory or corrective measures do not enable the influence of the variations in pressure in the furnace to be eliminated.

Another solution, (see EP-A1-0,211,295) consists

A

in providing a tuyere or a narrowed cross-section, either in the secondary pipes or in the distributor, where a pressure head is created necessary for acceleration of the pneumatic current up to the speed of sound. Acceleration of the pneumatic current up to the speed of sound has the advantage that the flow conditions upstream from the point where the supercritical speed is produced are no longer influenced by the flow conditions downstream from this point. This has, of course, the great advantage that it is no longer necessary to take into account the fluctuations in pressure and other variable parameters existing in the secondary pipes or in the chamber into which the powdered substances are injected. However, the tuyeres necessary for the acceleration up to the speed of sound require a high pressure head and a relatively small flow cross-section, which gives rise to a high pressure at the inlet and a high consumption of propellent gas and requires preliminary screening of the powdered coal in order to remove the coarse particles and to prevent risks of obstructing the tuyeres.

Document JP-A-5855507 discloses a control method for the pneumatic injection of powdered coal into n tuyeres of a shaft furnace. The powdered coal is directed in the form of a pneumatic flow to a distributor, in which it is distributed between n secondary ducts (Ai) connected to the n tuyeres of the shaft furnace. The n secondary ducts (Ai) are designed so as to exhibit the same pressure drop for the same flow rate. Each of these secondary ducts (Ai) is connected to a source of compensating gas via an individual control valve (Fi). The control valve (Fi) of each secondary duct (Ai) is associated with an independent control circuit comprising a differential pressure sensor (Di) which measures, upstream of the injection point (Ci) of the compensating gas, the pressure drop between an upstream measuring point and a measuring point downstream of this secondary duct (Ai). These n control circuits are designed so that they individually control the n flow rates of compensating gas in such a way as to keep the n pressure drops measured by the n differential pressure sensors constant. It is obvious that the implementation of this control method necessitates considerable control means.

The object of the present invention is to provide a

A

novel method which enables a uniform or determined distribution of the powdered substances in the secondary pipes and the influence of the variable parameters on this distribution to be eliminated.

In order to achieve this object, the method proposed by the present invention is essentially characterized in that the flow rate is determined in each of the secondary pipes by the tuyere flow cross-sections and that the transport conditions in each secondary pipe are influenced by acting on the pressure downstream from each tuyere in order to maintain this pressure at a determined value.

The method proposed is based on the recognition that all the variable parameters downstream from the tuyere affect the flow rate of the powdered coal through these tuyeres by modifying the pressure immediately downstream from the tuyere, in other words by varying the pressure head or head loss in this tuyere. In other words, by providing means to compensate the effects of the variable parameters on the pressure downstream from the tuyeres, so as to maintain the pressure at a determined value, the flow rate through these tuyeres, which is determined by their flow cross-section, is no longer affected by unwanted variations in pressure head as these variations are determined in all the tuyeres, given that the downstream pressure is maintained at a determined value and that the upstream pressure is determined as desired.

Although these tuyeres give rise to an acceleration of the pneumatic current, this acceleration remains far below the speed of sound, with the result that the pressure upstream from the tuyeres may be maintained at a lower level and that the flow cross-sections of the tuyeres may be wider than those employed in the methods operating at the speed of sound.

The pressure is acted upon by injecting a compensating gas at a determined pressure downstream from each tuyere. The gas is injected at the same pressure in all the secondary pipes.

In order to reduce the consumption of compensating gas, compensating tuyeres may advantageously be provided in each of the secondary pipes downstream from the tuyeres, in order to compensate the differences in the features between the various secondary pipes.

Other characteristics and features of the invention will emerge from the detailed description of some embodiments given hereinbelow by way of illustration, with reference to the attached drawings in which:

Figure 1 diagrammatically illustrates a first embodiment of the method proposed by the present invention.

Figure 1 shows two silos 10, 12 in which the powdered coal is stored which is intended to be sent into a blast furnace in order to maintain the combustion process. The total flow rate of the powder to be injected into the furnace is regulated in two metering apparatuses 14, 16 which are alternately connected by a main 18 to a distributor 20 which may be of the type described in the document EP-A1-0,211,295. In this distributor, the primary pneumatic current is split into secondary currents which are forwarded through secondary pipes 22_1, 22_2,...22_n to the tuyere stocks 24_1, 24_2,... 24_n of a blast furnace. Each pipe 22_1, 22_2,...22_n has a closing valve 26_1, 26_2,...26_n for cutting, as desired, one or more tuyere stocks 24_1, 24_2,...24_n from the distribution circuit.

The flow rate in each secondary pipe 22_1, 22_2,... 22_n is determined by the flow cross-section of a tuyere 28_1, 28_2... 28_n provided in each of the secondary pipes downstream from the valves 26_1, 26_2,... 26_n. This flow cross-section is larger than that of the so-called critical-speed tuyeres with the result that risks of obstructions are virtually eliminated and that the system operates with a pressure P_2 which is considerably smaller upstream from the tuyeres.

Although the flow rate of the powdered coal through the tuyeres 28_1, 28_2... 28_n is determined by the flow cross-sections of the latter, this flow rate is nevertheless dependent on the pressure head through these tuyeres, in other words on the ratio P2/P3. Now, if P2 remains constant, P3 is subjected to the influence of the

A

fluctuations in pressure in the furnace and is dependent on the physical parameters of the secondary pipes, as explained hereinabove.

In order to overcome this, the invention proposes artificially maintaining a given pressure P3 downstream from each of the tuyeres 28_1, 28_2,... 28_n. This is achieved according to the embodiment in Figure 1 by connecting each of the secondary pipes 22_1, 22_2,... 22_n downstream from the tuyeres 28_1, 28_2,... 28_n through a non-return flap 30_1, 30_2,... 30_n and a closing valve 32_1, 32_2,... 32_n to a pipe 34 for a compensating gas. The pressure of the gas in the pipe is set at a value PT by a regulating valve 36 controlled by a manometer 38 with the result that the pressure P3 downstream from all the tuyeres is established and maintained at the same value PT. The value of PT may be determined empirically when a plant is installed by measuring P3 in each of the secondary pipes 22_1, 22_2,... 22_n for varying flow rates of coal and by selecting for a given flow rate a value PT which is equal to at least the strongest of the n pressures measured in the n secondary pipes 22_1, 22_2,... 22_n.

During operation of the system, the influence of the parameters or fluctuations which tends to modify one or more pressures P3 downstream from the tuyeres is automatically compensated by a more or less strong induction of compensating gas at the pressure PT, which means that all the pressures P3 are maintained permanently at the value PT, independently of the downstream parameters or fluctuations.

It is possible to reduce the consumption of compensating gas by providing in each of the secondary pipes 22_1, 22_2,...22_n compensating tuyeres 40_1, 40_2,... 40_n which are given dimensions so as to compensate the differences between the features of the secondary pipes 22_1, 22_2,... 22_n such as differences in length, cross-sections, layouts etc..., and which normally have repercussions on the value of P3.

A

CLAIMS

1. A method for the pneumatic injection of metered quantities of powdered substances at different injection points into a chamber under a variable pressure, said method comprising the following steps:

   forming a pneumatic mixture consisting of the powdered substances and a propellant gas in a metering device,

   feeding said pneumatic mixture through a common main into a distributor,

   splitting said pneumatic mixture into several secondary pneumatic currents in said distributor,

   feeding each of said secondary pneumatic currents through a separate secondary pipe to one of said injection points in said chamber,

   connecting each of said secondary pipes to a source of compensating gas, thus defining a compensating gas injection point for each secondary pipe;

   creating a pressure drop by means of a tuyere in each secondary pipe between the distributor and the compensating gas injection point, said pressure drop being chosen so as to determine, for an identical pressure PT at all the compensating gas injection points, a desired flow rate of the powdered substances through each of said secondary pipes, and

   adjusting the pressure of the source of gas so as to set a pressure at all the compensating gas injection points that is substantially equal to the said pressure PT.

2. The method according to claim 1, wherein local pressure drops are created downstream of said compensating gas injection points by means of compensating tuyeres.

A

2009766

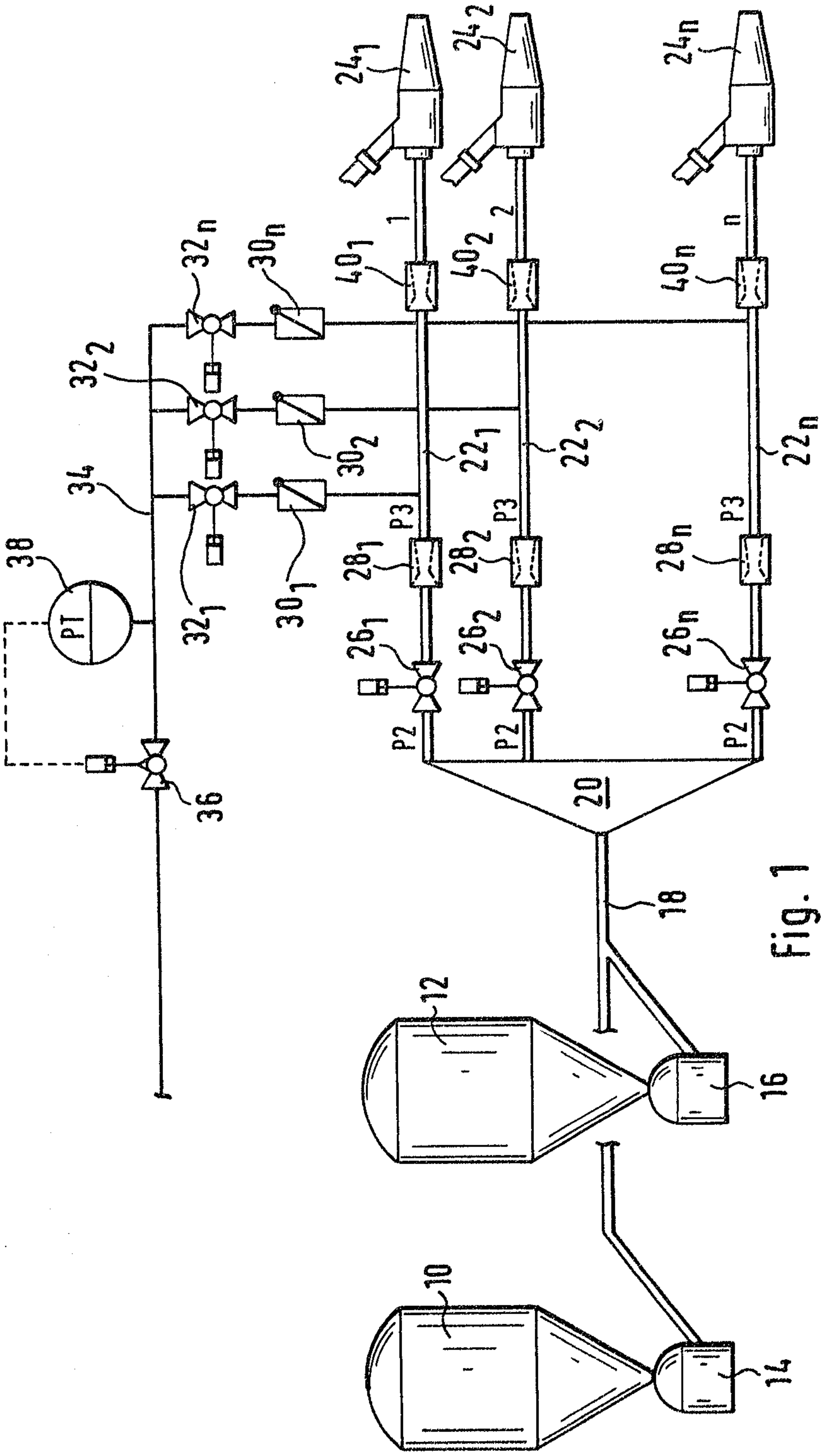


Fig. 1

Agents for the Applicant/s