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

(11) EP 0 927 073 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
12.12.2001 Bulletin 2001/50

(21) Application number: **97940268.2**

(22) Date of filing: **01.09.1997**

(51) Int Cl.[7]: **B01F 3/12**, B01F 5/00, B01F 5/02

(86) International application number:
PCT/HU97/00046

(87) International publication number:
WO 98/08596 (05.03.1998 Gazette 1998/09)

(54) HYDROMECHANICAL MIXING APPARATUS FOR PRODUCING A MIXTURE OF POWDER OR GRANULAR STATE MATERIAL AND LIQUID

HYDROMECHANISCHES MISCHGERÄT ZUR HERSTELLUNG EINER MISCHUNG AUS PULVER ODER MATERIAL IN GRANULATZUSTAND UND FLÜSSIGKEIT

APPAREIL DE MELANGE HYDROMECANIQUE SERVANT A PRODUIRE UN MELANGE DE MATIERE A L'ETAT PULVERULENT OU GRANULAIRE ET DE LIQUIDE

(84) Designated Contracting States:
BE DE ES FI FR GB GR
Designated Extension States:
RO SI

(30) Priority: **30.08.1996 HU 9602379**
01.08.1997 HU 9701343

(43) Date of publication of application:
07.07.1999 Bulletin 1999/27

(73) Proprietor: **Energiagazdálkodási Részvénytársaság**
H-1027 Budapest (HU)

(72) Inventors:
- **SZIVAK, Attila**
  H-1125 Budapest (HU)
- **HANGYAL, János**
  H-2083 Solymár (HU)
- **KISS, József**
  H-1149 Budapest (HU)
- **KOCSIS, Gábor**
  H-1021 Budapest (HU)

(74) Representative: **Vleck, Jan Montagu**
Reddie & Grose,
16 Theobalds Road
London WC1X 8PL (GB)

(56) References cited:
DE-A- 2 602 858
US-A- 2 071 846
US-A- 3 741 533
US-A- 3 891 393
US-A- 4 007 921
US-A- 5 368 385

EP 0 927 073 B1

Description

TECHNICAL FIELD

[0001] The invention relates to a hydromechanical mixing apparatus for producing a mixture of powder or granular state material and fluid.

BACKGROUND ART

[0002] In industry, it is frequently necessary to produce a mixture consisting of powder or granular state material and fluid. The mixing process must ensure hydration on the entire surface of large specific surface grains. In the course of such applications, mixing with a fluid frequently causes the transformation of powder or granular state material, i.e. its chemical and physical characteristics are modified. The extent of mixing and thus that of transformation are determined by the volume of water added and by the technology applied in mixing.

[0003] When applying mixing in such procedures, from the aspects of carrying the mixture through a pipeline, the specific water consumption and the transformation of powder or granular state material, it is frequently advantageous when the powder or granular state material is mixed with a fluid of nearly identical amount as the mass of the material, thereby producing a mixture of high density, 1/2 - 2/1 solid/fluid ratio.

[0004] Such an application is for example the producing of so-called thick slurry consisting of a solid phase combustion residue from a coal or oil fired power station and water at the ratio of 1/2 - 2/1 solid/fluid. When producing thick slurry, making sure that agitation is as intensive as possible is important, because it is desirable that particles of calcium-oxide (CaO) content adhered to the flyash grains, settled in the porous parts of the flyash grains are fully dissolved. Through its so-called puzzolanic activity, the combustion residue of high specific surface would not or only slightly exhibit a cementing characteristic on its own, but in the presence of moisture and at a normal temperature, the materials of silicon or silicon and aluminium content combustion residue enter into a chemical reaction with calcium-hydroxide ($Ca(OH)_2$) resulting from the mixing process and due to this chemical reaction, they are converted to a solid structure material. Intensive mixing ensures a rapid reaction rate. In this way, the thick slurry becomes solid after being delivered along in a pipeline and after being disposed. As a result of appropriate agitation, after solidification, a high volumetric density, high compression strength and low water permeability deposit is created.

[0005] In the case of an appropriately agitated homogeneous thick slurry, undissolved calcium-oxide (CaO) particles, gas or air bubbles do not remain in the mixture and local chemical reactions do not take place. For, they could lead to the creation of cracks, thereby raising the water permeability of deposit, as a result of which detrimental materials could be flushed out of the deposit, and so the deposit could become the source of environment pollution.

[0006] To mix a powder or granular state material of 0.001 to 0.1 mm grain size and a fluid, there are so-called hydromechanical mixing procedures and mixing apparatuses. In the mixing space of the hydromechanical mixing apparatus, there are no facilities that would perform the agitation. This mixing procedure is based on the fact that the kinetic energy of a fluid flowing at a determined rate is sufficient by itself to mix the two components, when the bulk powder containing the solid grains must dynamically collide or baffle with the turbulently flowing fluid, having a high kinetic energy. By means of the baffling of flowing material, the powder agglomeration of large specific surface falls apart to form grains, and the total surface of the grains is moisturised, i.e. hydrated. By means of the hydromechanical mixing apparatus, in the case of the materials mentioned above, much better agitation than that in a mechanical mixing apparatus can be accomplished.

[0007] The hydromechanical mixing methods utilise the kinetic energy of flows generated gravitationally and/or by pressure. In the case of gravitational flows, the mixing of fluid and solid phases is carried out in the gravitation space by means of baffle elements installed in a fixed way in the gravitation space, while in the case of applying pressure generated flows, the energy required for agitation is created by the pumping of the fluid.

[0008] In DE-A-26 02 858, a gravitational hydromechanical mixing apparatus is described, known as "hydromix", and used for producing thick slurry. A schematic view of the mixing apparatus is shown in Fig. 1. In a mixing space 1 of the mixing apparatus, the dry bulk flyash flow introduced gravitationally through a hopper 3 in the direction of arrow b collides with the water/slag-slurry flow arriving under pressure from an inlet pipe 10. By baffling with a conic baffle member 8 in the mixing space 1, the mixture is collected in a reservoir 2 in the bottom part of the mixing space 1, by gravitational flow. One part of the mixture is delivered from here by a pump 6 through a pipeline 7 to a disposal place not shown in the figure, and the other part is returned by a circulation pump 4 through a circulation pipeline 5 to the mixing space 1 so that a higher kinetic energy is available for mixing. The air space in the mixing space 1 enables the precipitation of the gas/air bubbles and gases developed during the mixing process, and they escape from the mixing apparatus through a venting pipe 9 during the baffling of the solid and fluid phases.

[0009] In the case of the mixing apparatus described in DE-A-26 02 858, agitation is carried out in a mixing space confined with various baffle elements, by means of the kinetic energy of spinning, turbulent flows from top to bottom developed by the gravitation, where the spinning and turbulent flows only partly fill the volume of the mixing space.

[0010] One disadvantage of this approach is that the

gravitationally poured agglomeration of low volumetric density solid material and fluid does not have sufficient kinetic energy for intensive agitation. The kinetic energy of the mixture gravitationally flowing along the baffling elements of mixing apparatuses having a gravitational mixing space is conventionally increased by the amount of the flowing mixture. Thus, for intensive agitation, high volume mixing spaces are created or the volumetric flow of the circulated mixture is increased, which, however, necessitates costly mixing tanks and fittings.

[0011] A further disadvantage of the approach above is that upon the baffling of solid and fluid materials, some of the powder particles start to float in the mixing space. The collision of floating powder particles with the fluid flow can only be ensured with difficulty, so the floating powder particles escape to the environment through the air space of the mixing apparatus, and so the mixing apparatus becomes a pollution source of the ambient atmosphere.

[0012] In US 3,741,533 another apparatus is disclosed for producing a mixture of dry bulk material and fluid. This known apparatus comprises a special mixing space and recirculating piping and pumping means are provided for recirculating one part of the mixture collected in a slurry reservoir of the apparatus. The apparatus generally has the same disadvantages as discussed above.

[0013] The mixing apparatus disclosed in US 4,007,921 comprises an upper mixing space, a so called dispenser, and a lower mixing space which is a collecting tank with a vent opening on its top. The upper and lower mixing spaces are connected to each other by a conducting pipe having a cross section smaller than that of the upper mixing space. The apparatus further comprises a hopper for introducing the powder or granular state material into the upper mixing space, an inlet pipe for introducing the fluid into the upper mixing space, circulating means for returning at least one part of the mixture into the lover mixing space and a pump for delivering the mixture through an outlet pipeline. Again, the disadvantages of this known apparatus are that the agitation of the dry particles and the fluid is insufficient, and that the floating powder particles can escape to the environment through the vent opening.

DISCLOSURE OF INVENTION

[0014] The object of the invention is to create a hydromechanical mixing apparatus for producing a mixture of powder or granular state material and fluid, in which a relatively small mixing space without costly fittings is available for ensuring the kinetic energy necessary for intensive agitation and in which the mixing of the floating powder particles precipitating in the course of mixing is also ensured.

[0015] Thus, the invention is a hydromechanical mixing apparatus for producing a mixture of powder or granular state material and fluid, the apparatus comprising at least one mixing space, a hopper for introducing the powder or granular state material into the mixing space, an inlet pipe for introducing the fluid into the mixing space, circulating means for returning at least one part of the mixture into the mixing space and a pump for delivering the mixture through an outlet pipeline, wherein said at least one mixing space comprises an upper mixing space and a lower mixing space located one below the other, the upper and lower mixing spaces being connected by a conducting pipe having a cross section smaller than that of the upper mixing space, and wherein said circulating means comprise a first circulating system for delivering one part of the mixture from a bottom part of the lower mixing space into the lower mixing space. According to the invention, said circulating means further comprise a second circulating system for delivering another part of the mixture from the bottom part of the lower mixing space into the upper mixing space.

[0016] By the double circulation according to the invention, the kinetic energy necessary for mixing can be provided without having to use large volume mixing tanks.

[0017] In a preferred embodiment of the invention, the second circulating system comprises a second circulating pipeline having an end protruding into the upper mixing space, said end being divided into jet pipes arranged in a way symmetrical to an axis of the upper mixing space and directing mixture jets into a space confined by the conducting pipe, and the second circulating system comprises a second circulating pump delivering an amount of the mixture so that the mixture jets fill up the total cross section of the conducting pipe. By means of mixture jets filling up the total cross section of the conducting pipe, a suction effect can be accomplished, to make sure that the floating powder particles developed during the mixing process are subject to agitation by drafting in the direction of the conducting pipe.

[0018] In another preferred embodiment, the first circulating system comprises a first circulating pipeline having an end arranged in a way introducing the mixture tangentially at one or more locations into an upper part of the lower mixing space. By means of the tangential introduction, the powder settling on the wall of the lover mixing space can be simply removed, and another baffling type mixing process can be accomplished.

[0019] Preferably, the mixing apparatus further comprises a baffle member located in the lower mixing space below the conducting pipe, said baffle member having a baffle surface with a conic shape or with a shape of increasing steepness towards its tip. Making use of the kinetic energy of the mixture flowing downwards, the baffle member - through the baffling effect - improves the rate of mixing.

[0020] According to other preferred embodiments, the upper mixing space is shaped axially symmetrically in a way narrowing downwards, the inlet pipe is connected tangentially to an upper part of the upper mixing space,

the hopper is connected in the direction of the axis of the upper mixing space to the upper part thereof, the outlet pipeline is connected to the first circulating system, and the lower mixing space is fitted with a venting pipe for exhausting gaseous materials.

BRIEF DESCRIPTION OF DRAWINGS

[0021] The invention will hereinafter be described on the basis of a preferred embodiment depicted by the drawings, where

Fig. 1 is a schematic view of the known mixing apparatus,
Fig. 2 is a schematic view of a preferred embodiment of the inventive mixing apparatus,
Fig. 3 is a cross sectional view of the preferred embodiment in Fig. 2 taken along plane A-A, facing the direction of the arrows, and
Fig. 4 is a cross sectional view of the preferred embodiment shown in Fig. 2 taken along plane B-B, facing the direction of the arrows.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] In the mixing apparatus shown in Fig. 2, the mixing of the powder or granular state material and the fluid takes place in an upper mixing space 11, in a lower mixing space 12 and in a space 13 confined by a conducting pipe 14 connecting the upper and lower mixing spaces 11, 12. In the shown embodiment, mixing spaces 11 and 12 and space 13 are shaped axially symmetrically with a common axis. The powder or granular state material flows through a hopper 15 in the direction of arrow b into the upper mixing space 11. Furthermore, into an upper part of the upper mixing space 11, in a tangential direction, fluid is introduced from a fluid tank 27 by a pump 25, through an inlet pipe 26. Tangential introduction is advantageous because the incoming fluid flushes the powder settling on the inner casing of the upper mixing space 11.

[0023] In the lower mixing space 12, below the conducting pipe 14, a baffle member 16 is located. In the depicted embodiment the baffle member 16 is of a conic shape, but it can also be formed with a baffle surface of increasing steepness towards its tip. Furthermore, the mixing space 12 includes a venting pipe 17 for exhausting gaseous materials.

[0024] One part of the mixture collected in the bottom part of the lower mixing space 12 is delivered by a first circulating system comprising a first circulating pipeline 22 and a first circulating pump 19 to an upper part of the lower mixing space 12, and an other part of the mixture by a second circulating system comprising a second circulating pipeline 21 and a second circulating pump 18 into the upper mixing space 11. One part of the circulated mixture is delivered by a pump 20 through an outlet pipeline 23 connected to the first circulating system after the first circulating pump 19. In a preferred embodiment, the second circulating system delivers approx. five times the volume delivered by the pump 20, and the first circulating system delivers two or three times as much.

[0025] An end of the second circulating pipeline 21 protruding into the upper mixing space 11 is divided into four jet pipes 24 for ejecting the mixture as shown in Fig. 3, said jet pipes 24 being located symmetrically to the axis of the upper mixing space 11 in a way that they direct their mixture jets to the space 13 confined by the conducting pipe 14. This jet pipe arrangement surrounds the powder or granular state material flowing in through the hopper 15. Thus in the upper mixing space 11, a high intensity agitation of mixture jets coming in with a high kinetic energy through the jet pipes 24, the fluid of an amount accurately determined for mixing and coming in through the inlet pipe 26 and the gravitationally entering solid phase is achieved. In a preferred embodiment of the invention, the diameter of jet pipes 24 is 30 to 50 mm.

[0026] The amount of the mixture delivered by the second circulating pump 18 in the second circulating system is preferably selected in a way that the mixture jets fill up the total cross section of the conducting pipe 14. In this way, a suction effect is imposed by the mixture jets in the upper mixing space 11, to make sure that floating powder particles precipitating from the powder or granular state material are moved in the direction of the mixture jets and so they are mixed with the mixture flow.

[0027] In the upper mixing space 11 a suction of such an extent must be generated that the powder particles remaining floating after the baffling of bulk powder or granular state material and the circulated mixture jets are directed to the mixture jets by the suction. An appropriate suction effect is accomplished in the preferred embodiment depicted if in the space 13 the flow rate of the mixture is between 6 and 8 m/s. Without the suction effect, the floating powder particles not mixing with the mixture jets cling to the inner surface of the mixing apparatus, thereby gradually blocking the air space and the hopper 15 leading to the mixing space 11. In the preferred embodiment depicted, the suction effect is also facilitated by the mixing space 11 having a funnel shape narrowing downwards. The suction effect so generated keeps under suction the air space of the funnel-shaped mixing space 11, the hopper 15 ending in the air space and the inlet pipe 26.

[0028] In the lower part of the mixing space 11 a very good mixing can be achieved as a result of the baffling and the suction. However, the baffled mixture flowing through the conducting pipe 14 still has a significant amount of kinetic energy, which could be utilised in order to ensure a better mixing and for removing the gas and air from the mixture. This kinetic energy is utilised in the lower mixing space 12 having a gravitational air space below the conducting pipe 14, in a way that the mixture flowing downwards through the conducting pipe 14 collides with the surface of the baffle member 16, so that it

loses its kinetic energy in the course of intensive mixing, being splashed apart in the upper part of the mixing space 12, and reaching the lower mixing space 12 by gravitational flow.

[0029] The first circulating pipeline 22 is introduced in a tangential direction into the upper part of the lower mixing space 12, as shown in Fig. 4. The mixture flow introduced in a tangential direction facilitates the comminution of larger grains, and as a result of centrifugal force it generates, the gas and air bubbles escape from the mixture. To this end, of course it is necessary to provide a gravitational field and the removal of escaping gases and/or air from the mixing space.

[0030] In the mixing apparatus according to the depicted preferred embodiment of the invention, in the upper part of the lower mixing space 12, again an intensive mixing process is accomplished as one part of the mixture splashed apart by the baffle member 16 collides with the mixture flow moving around on the inner casing of the mixing space 12.

[0031] The mixing apparatus according to the invention has been described for mixing powder or granular state material and fluid. The mixing apparatus can be used advantageously for producing thick slurry, when in a relatively small mixing space, the intensive mixing of slag and/or flyash, and water or thin slag slurry is performed without contaminating the environment.

[0032] It will be evident to those skilled in the art that the above disclosure is exemplary only and that various other alternatives, adaptations and modifications may be made within the scope of the present invention as defined by the following claims.

Claims

1. Hydromechanical mixing apparatus for producing a mixture of powder or granular state material and fluid, the apparatus comprising at least one mixing space, a hopper for introducing the powder or granular state material into the mixing space, an inlet pipe for introducing the fluid into the mixing space, circulating means for returning at least one part of the mixture into the mixing space and a pump for delivering the mixture through an outlet pipeline, wherein said at least one mixing space comprises an upper mixing space and a lower mixing space located one below the other, the upper and lower mixing spaces being connected by a conducting pipe having a cross section smaller than that of the upper mixing space, and wherein said circulating means comprise a first circulating system for delivering one part of the mixture from a bottom part of the lower mixing space into the lower mixing space, **characterised in that** said circulating means further comprise a second circulating system (18, 21) for delivering another part of the mixture from the bottom part of the lower mixing space (12) into the upper mixing space (11).

2. The apparatus according to claim 1, **characterised in that** the second circulating system (18, 21) comprises a second circulating pipeline (21) having an end protruding into the upper mixing space (11), said end being divided into jet pipes (24) arranged in a way symmetrical to an axis of the upper mixing space (11) and directing mixture jets into a space (13) confined by the conducting pipe (14).

3. The apparatus according to claim 2, **characterised in that** the second circulating system (18, 21) comprises a second circulating pump (18) delivering an amount of the mixture so that the mixture jets fill up the total cross section of the conducting pipe (14).

4. The apparatus according to any of claims 1 to 3, **characterised in that** the first circulating system (19, 22) comprises a first circulating pipeline (22) having an end arranged in a way introducing the mixture tangentially at one or more locations into an upper part of the lower mixing space (12).

5. The apparatus according to any of claims 1 to 3, **characterised by** further comprising a baffle member (16) located in the lower mixing space (12) below the conducting pipe (14), said baffle member (16) having a baffle surface with a conic shape or with a shape of increasing steepness towards its tip.

6. The apparatus according to claim 1, **characterised in that** the upper mixing space (11) is shaped axially symmetrically in a way narrowing downwards, the inlet pipe (26) is connected tangentially to an upper part of the upper mixing space (11), and the hopper (15) is connected in the direction of the axis of the upper mixing space (11) to the upper part thereof.

7. The apparatus according to claim 1, **characterised in that** the outlet pipeline (23) is connected to the first circulating system (19, 22).

8. The apparatus according to claim 1, **characterised in that** the lower mixing space (12) is fitted with a venting pipe (17) for exhausting gaseous materials.

Patentansprüche

1. Hydromechanische Mischvorrichtung zur Herstellung eines Gemischs aus pulver- oder granulatförmigem Material und Fluid, wobei die Vorrichtung folgendes umfasst: wenigstens einen Mischraum, einen Trichter zum Einleiten des pulver- oder granulatförmigen Materials in den Mischraum, ein Einlassrohr zum Einleiten des Fluids in den Mischraum, ein Zirkulationsmittel zum Zurückführen we-

nigstens eines Teils des Gemisches in den Mischraum und eine Pumpe zum Fördern des Gemisches durch eine Auslasspipeline, wobei der genannte wenigstens eine Mischraum einen oberen Mischraum und einen unteren Mischraum umfasst, die untereinander angeordnet sind, wobei der obere und der untere Mischraum durch ein Leitungsrohr mit einem Querschnitt miteinander verbunden sind, der kleiner ist als der des oberen Mischraums, und wobei das genannte Zirkulationsmittel ein erstes Zirkulationssystem zum Fördern eines Teils des Gemisches von einem unteren Teil des unteren Mischraums in den unteren Mischraum umfasst, **dadurch gekennzeichnet, dass** das genannte Zirkulationsmittel ferner ein zweites Zirkulationssystem (18, 21) zum Fördern eines anderen Teils des Gemisches vom unteren Teil des unteren Mischraums (12) in den oberen Mischraum (11) umfasst.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** das zweite Zirkulationssystem (18, 21) eine zweite Zirkulationspipeline (21) umfasst, von der ein Ende in den oberen Mischraum (11) vorsteht, wobei das genannte Ende in Strahlrohre (24) unterteilt ist, die so angeordnet sind, dass sie symmetrisch zu einer Achse des oberen Mischraums (11) sind und Gemischstrahlen in einen Raum (13) leiten, der von dem Leitrohr (14) begrenzt wird.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** das zweite Zirkulationssystem (18, 21) eine zweite Zirkulationspumpe (18) umfasst, die eine Menge des Gemisches fördert, so dass die Gemischstrahlen den gesamten Querschnitt des genannten Leitrohres (14) ausfüllen.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** das erste Zirkulationssystem (19, 22) eine erste Zirkulationspipeline (22) umfasst, von der ein Ende so angeordnet ist, dass es das Gemisch tangential an einem oder an mehreren Orten in einen oberen Teil des unteren Mischraums (12) einleitet.

5. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** sie ferner ein Ablenkelement (16) umfasst, das sich im unteren Mischraum (12) unterhalb des Leitrohres (14) befindet, wobei das genannte Ablenkelement (16) eine Ablenkfläche mit einer konischen Form oder mit einer Form aufweist, deren Steilheit in Richtung auf ihre Spitze zunimmt.

6. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der obere Mischraum (11) axial symmetrisch so geformt ist, dass er sich nach unten verengt, das Einlassrohr (26) tangential mit einem oberen Teil des oberen Mischraums (11) und der Trichter (15) in der Richtung der Achse des oberen Mischraums (11) mit seinem oberen Teil verbunden ist.

7. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Auslass-Pipeline (23) mit dem ersten Zirkulationssystem (19, 22) verbunden ist.

8. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der untere Mischraum (12) mit einem Lüftungsrohr (17) zum Ablassen von gasförmigen Stoffen ausgestattet ist.

Revendications

1. Appareil de mélange hydromécanique pour produire un mélange de poudre ou de matière à l'état granulaire et un fluide, l'appareil comprenant au moins un espace de mélange, une trémie pour introduire la poudre ou la matière à l'état granulaire dans l'espace de mélange, un tuyau d'admission pour introduire le fluide dans l'espace de mélange, des moyens de circulation pour renvoyer au moins une partie du mélange dans l'espace de mélange et une pompe pour refouler le mélange à travers une canalisation de sortie, dans lequel ledit au moins un espace de mélange comprend un espace de mélange supérieur et un espace de mélange inférieur situé l'un en dessous de l'autre, les espaces de mélange supérieur et inférieur étant connectés par un tuyau conducteur ayant une section transversale plus petite que celle de l'espace de mélange supérieur, et dans lequel des moyens de circulation comprennent un premier système de circulation pour refouler une partie du mélange d'une partie inférieure de l'espace de mélange inférieur dans l'espace de mélange inférieur, **caractérisé en ce que** lesdits moyens de circulation comprennent en outre un deuxième système de circulation (18, 21) pour refouler une autre partie du mélange de la partie inférieure de l'espace de mélange inférieur (12) dans l'espace de mélange supérieur (11).

2. Appareil selon la revendication 1, **caractérisé en ce que** le deuxième système de circulation (18, 21) comprend une deuxième canalisation de circulation (21) ayant une extrémité avançant dans l'espace de mélange supérieur (11), ladite extrémité étant divisée en des tuyaux de décharge (24) arrangés d'une manière symétrique à un axe de l'espace de mélange supérieur (11) et dirigeant les jets de mélange dans un espace (13) restreint par le tuyau conducteur (14).

3. Appareil selon la revendication 2, **caractérisé en ce que** le deuxième système de circulation (18, 21) comprend une deuxième pompe de circulation (18)

refoulant une quantité du mélange de sorte que les jets de mélange remplissent la section transversale totale du tuyau conducteur (14).

4. Appareil selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le premier système de circulation (19, 22) comprend une première canalisation de circulation (22) ayant une extrémité arrangée d'une manière à introduire le mélange tangentiellement à un ou plusieurs emplacements dans une partie supérieure de l'espace de mélange inférieur (12).

5. Appareil selon l'une quelconque des revendications 1 à 3, **caractérisé** en comprenant en outre un membre de chicane (16) situé dans l'espace de mélange inférieur (12) en dessous du tuyau conducteur (14), ledit membre de chicane (16) ayant une surface de chicane d'une forme conique ou d'une forme à pente de raideur croissante vers sa pointe.

6. Appareil selon la revendication 1, **caractérisé en ce que** l'espace de mélange supérieur (11) est formé symétriquement de manière axiale d'une façon rétrécissante vers le bas, le tuyau d'admission (26) est connecté tangentiellement à une partie supérieure de l'espace de mélange supérieur (11), et la trémie (15) est connecté dans le sens de l'axe de l'espace de mélange supérieur (11) à la partie supérieure de celui-ci.

7. Appareil selon la revendication 1, **caractérisé en ce que** la canalisation de sortie (23) est connectée au premier système de circulation (19, 22).

8. Appareil selon la revendication 1, **caractérisé en ce que** l'espace de mélange inférieur (12) est pourvu d'un tuyau de ventilation (17) pour évacuer des substances gazeuses.

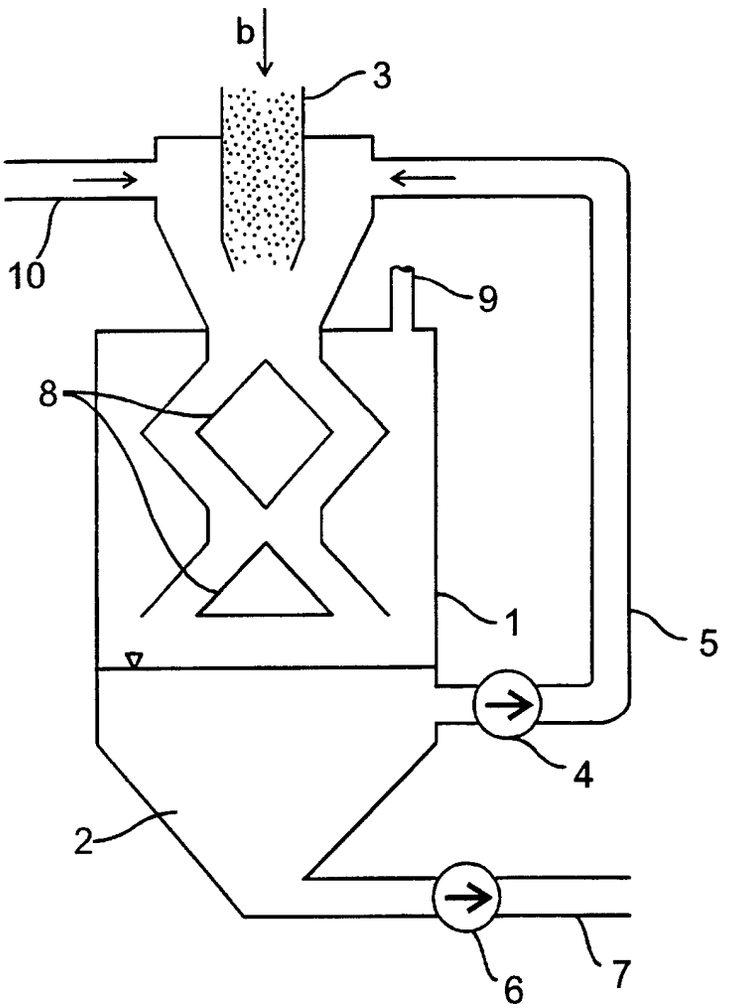

Fig. 1

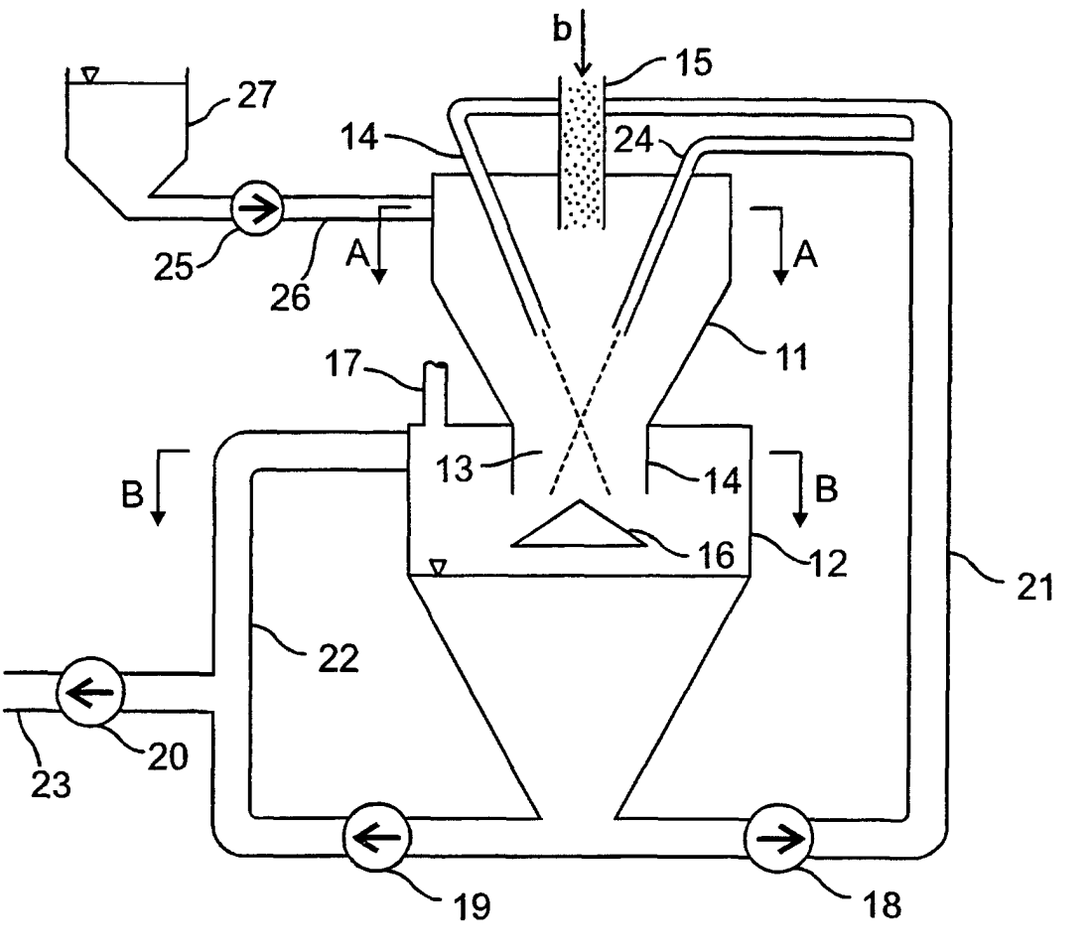

Fig. 2

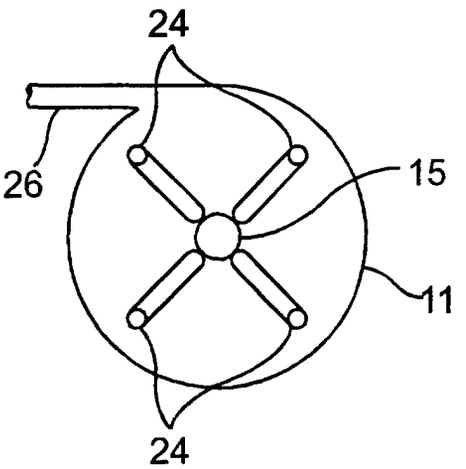

Fig 3.

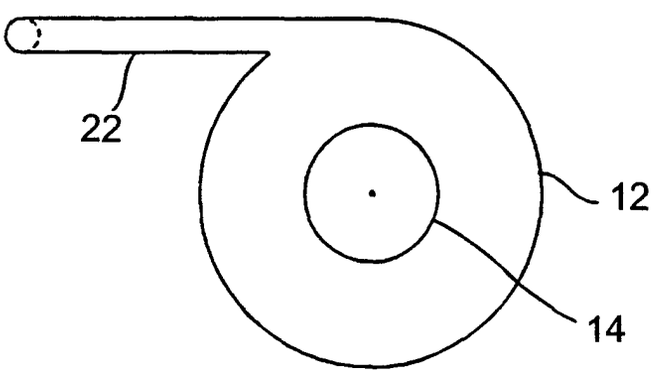

Fig 4.