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Form 4

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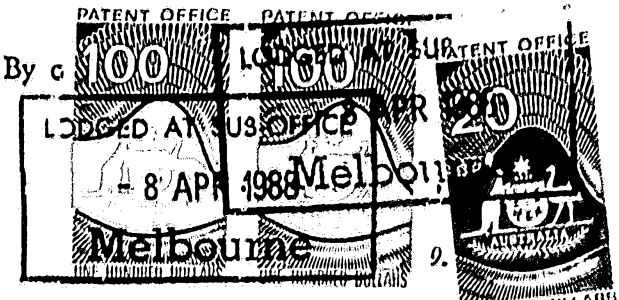

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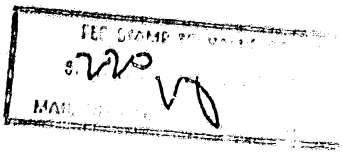

CONVENTION APPLICATION FOR A PATENT

APPLICATION ACCEPTED AND AMENDMENTS
5-4-90

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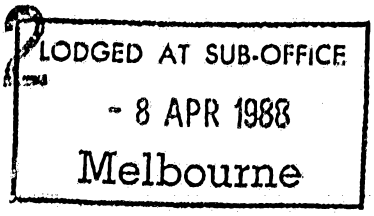

(1) Here insert (in full) Name or Names of Applicant or Applicants, followed by Address (es).

I/We[1] KRUPP POLYSIUS AG

of Graf-Galen-Strasse 17, 4720 Beckum, Federal Republic of Germany

(2) Here insert Title of Invention.

hereby apply for the grant of a Patent for an invention entitled:[2]

METHOD AND APPARATUS FOR CRUSHING BRITTLE MATERIAL FOR GRINDING

(3) Here insert number(s) of basic application(s)

which is described in the accompanying complete specification. This application is a Convention application and is based on the application numbered[3]

P37 12 147.2

(4) Here insert Name of basic Country or Countries, and basic date or dates

for a patent or similar protection made in[4] Federal Republic of Germany on 10th April 1987

~~My~~/Our address for service is Messrs. Edwd. Waters & Sons, Patent Attorneys, 50 Queen Street, Melbourne, Victoria, Australia.

DATED this 7th day of April 1988

(5) Signature (s) of Applicant (s) or Seal of Company and Signatures of its Officers as prescribed by its Articles of Association.

[5] KRUPP POLYSIUS AG

by

Stephen K. Plymin

Registered Patent Attorney

To:

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

(1) Here insert (in full) Name of Company.

In support of the Convention Application made by(1) KRUPP POLYSIUS AG

(hereinafter referred to as the applicant) for a Patent

(2) Here insert title of Invention.

for an invention entitled:(2) METHOD AND APPARATUS FOR CRUSHING BRITTLE MATERIAL FOR GRINDING

(3) Here insert full Name and Address, of Company official authorized to make declaration.

WE ~~xxXXx~~ DIETER HIMMELSKOTTER and HERMANN SCHEICHTHERLE of Graf-Galen-Strasse 17, 4720 Beckum, Federal Republic of Germany

do solemnly and sincerely declare as follows:

1. We are ~~xxxx~~ authorised by the applicant for the patent to make this declaration on its behalf.

(4) Here insert basic Country or Countries followed by date or dates and basic Applicant or Applicants.

2. The basic application as defined by Section 141 of the Act was made in(4) Federal Republic of Germany on the 10th day of April 1987, by KRUPP POLYSIUS AG

~~XXXXXX~~ ~~XXXXXX~~ ~~XXXXXX~~ ~~XXXXXX~~

(5) Here insert (in full) Name and Address of Actual Inventor or Inventors.

3.(5) OSBERT RICHARD KNOBLOCH, Ringstrasse 65, 4840 Rheda-Wiedenbruck, and KARL-HEINZ KUKUCK, Uhrs Knappken 7, 4722 Ennigerloh, Federal Republic of Germany

~~I~~/We are the actual inventors of the invention and the facts upon which the applicant is entitled to make the application are as follow:

The applicant is the assignee of the said actual inventors

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

DECLARED at Beckum Germany

this 22nd day of February 19 88

(6) Signature.

Krupp Polysius AG

(6) [signature] Hermann Scheichtherle (managing director)

To: THE COMMISSIONER OF PATENTS

(12) PATENT ABRIDGMENT (11) Document No. AU-B-14418/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 598122

(54) Title
METHOD AND APPARATUS FOR CRUSHING BRITTLE MATERIAL FOR GRINDING

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(71) Applicant(s)
KRUPP POLYSIUS AG

(72) Inventor(s)
OSBERT RICHARD KNOBLOCH; KARL-HEINZ KUKUCK

(74) Attorney or Agent
WATERMARK MELBOURNE

(56) Prior Art Documents
EP 84383
US 4732334
US 4728044

(57) Claim

1. Method of crushing brittle material for grinding, in which

a) the material for grinding is crushed in a first crushing stage formed by a roller mill (4) using high pressure and in which agglomerates are formed,

b) the product of the first crushing stage is classified on a screen classifier (6) and the oversize fraction is returned to the roller mill (4),

c) and the proportion of the product of the first crushing stage passing through the screen classifier (6) is further crushed in a closed-circuit grinding arrangement (10) which preferably contains a tube mill (11) and a sifter (12),

characterised in that

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d) the material for grinding undergoes treatment for breaking up the agglomerates between the method stages a) and b).

7. Apparatus for crushing brittle material for grinding, containing

a) a roller mill (4) as the first crushing stage, in which the material for grinding is crushed under high pressure and in which agglomerates are formed,

b) a screen classifier (6) for classification of the product of the first crushing stage,

c) a closed-circuit grinding arrangement (10) which preferably contains a tube mill 911) and a sifter (12) for the further crushing of the proportion of the product of the first crushing stage passing through the screen classifier (6),

characterised in that

d) a breaking machine (5) is arranged between the roller mill (4) and the screen classifier (6).

COMMONWEALTH OF AUSTRALIA 598122 Form 10

PATENTS ACT 1952-69

COMPLETE SPECIFICATION

(ORIGINAL)

Class Int. Class

Application Number:
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority :

Related Art :

This document contains the amendments made under Section 49 and is correct for printing.

Name of Applicant : KRUPP POLYSIUS AG

Address of Applicant : Graf-Galen-Strasse 17, 4720 Beckum, Federal Republic of Germany

Actual Inventor: OSBERT RICHARD KNOBLOCH and KARL-HEINZ KUKUCK

Address for Service : EDWD. WATERS & SONS,
50 QUEEN STREET, MELBOURNE, AUSTRALIA, 3000.

Complete Specification for the invention entitled:

METHOD AND APPARATUS FOR CRUSHING BRITTLE MATERIAL FOR GRINDING

The following statement is a full description of this invention, including the best method of performing it known to :- us

Method and apparatus for crushing brittle material for grinding

The invention relates to a crushing method according to the preamble to claim 1 and to apparatus according to the generic concept of claim 7.

A method according to the preamble to claim 1 (or apparatus according to the generic concept of claim 7) is known from Figure 6 of EP-A-84 383. The material crushed in the roller mill is delivered directly to a screen classifier. The oversize fraction is led from the screen classifier to the tube mill (a proportion can also be returned to the roller mill). The proportion of the product passing through the screen classifier passes together with the material discharged from the tube mill to a sifter, and the fines from the sifter form the finished material, whilst the tailings are returned to the tube mill (or a proportion thereof to the roller mill).

A method of this type has certain disadvantages. Practical experiments show that the agglomerates forming the oversize fraction on the screen classifier contain a considerable proportion of fines which is not separated off in the screen classifier in view of the stability of the agglomerates. Therefore the material reaching the tube mill is poorly ~~calibrated~~ sized. Because of the high tailings recycle factor it is necessary for the roller mill to be of large dimensions.

Operational experience with roller mills which have ball mills arranged after them also shows that ball mills react comparatively sensitively to fluctuations in the coarse grain content. This applies equally for ball mills operating by the dry process and by the wet process.

A further disadvantage of this known method is that in view of the size of the agglomerates the oversize fraction precipitated in the screen classifier can only be conveyed to the tube mill pneumatically or hydraulically at very high energy costs. This disadvantage is significant above all when for reasons of plant layout the roller mill and the tube mill have to be arranged distant from one another (for example because in a plant for the manufacture of cement the roller mill has to be arranged in the proximity of the clinker cooler and thus spatially far removed from the closed-circuit grinding plant containing the tube mill or because in a mine the roller mill has to be installed at the working face but the tube mill is located in the dressing plant - equally far away from the roller mill).

The subject of the earlier application DE-A-36 09 229 is a method of crushing brittle material for grinding in which the material for grinding is first of all crushed in a roller mill and then undergoes treatment for breaking up agglomerates, after which the material is sifted and the tailings precipitated during sifting are subjected to further crushing.

The object of the invention is to develop a method according to the preamble to claim 1 in such a way that the overall size and the necessary drive power of the roller mill are reduced, the operating conditions in the roller mill and in the subsequent further crushing stage are improved and the total energy consumption (including the energy consumption for conveying the material for grinding) is reduced.

This object is achieved according to the invention by the characterising feature of claim 1.

Apparatus according to the invention is the subject matter of claim 7.

Advantageous embodiments of the invention are contained in the subordinate claims.

According to the invention the material for grinding undergoes treatment to break up agglomerates after the first crushing stage but before the screen classification. In this way the fines contained in the agglomerates are released before the subsequent screen classification. Whilst the oversize fraction screened out in the screen classifier is returned to the roller mill, the proportion of the material, which is well ~~calibrated~~ sized (for example 100% under 5 mm), passing through the screen classifier can be conveyed with low energy costs and low wear pneumatically (in the case of dry grinding) or hydraulically (in the case of wet grinding) to the subsequent closed-circuit plant (which preferably contains a

tube mill and a sifter or hydrocyclone). According to the invention the roller mill can be of much smaller dimensions and requires a lower drive power.

It is also advantageous that the product which is well calibrated by the screen classifier (after first being broken up) can be stored in silos without danger of the mixture separating.

By means of the method according to the invention the operating conditions both in the roller mill and in the subsequent tube mill are substantially improved. Thus at least in the case of material for grinding which is difficult to draw in (for example clinker or ore) a marked increase and steadying of the specific throughput of the roller mill can be established. In addition, the operating conditions in the tube mill are significantly steadied by the calibration of the material for grinding achieved by means of the screen classification (after first being broken up).

Because of the possibility of energy-saving and low-wear pneumatic conveying (resulting from the good ~~calibration~~ sizing of the product after crushing and screen classification) the method according to the invention is particularly suitable when the roller mill has to be arranged spatially far away from the tube mill, for example when cement mills (tube mills) which are arranged far away, for example in a separate grinding plant, have to be supplied by a roller mill arranged in the region of the kiln or the cooler.

In a similar manner the method according to the invention permits equally energy-saving and low-wear hydraulic transport in cases in which in a mine the roller mill is set up near the working face, for instance underground, but the tube mills to be supplied are arranged far away above ground in the dressing plant.

The breaking machine arranged according to the invention between the roller mill and the screen classifier can for example be a hammer mill which runs at low speed (preferably 20 to 30 m/s), the material being discharged from the hammer mill either in the air stream or by a grate base.

Another suitable form of breaking machine is an impact mill with fixed impact strips, the material being advantageously discharged through a grate base.

According to a further variant of the invention the breaking machine is formed by a disintegrator with central material delivery and peripheral material discharge.

A further advantageous variant provides as the breaking machine a Simpson mixer which contains a rotary cross assembly equipped with rollers and ploughshares, in which the rollers are kept at an adjustable minimum distance from the base of the mixer so that the product passing through the mixer is only broken up, not ground.

The aforementioned variants of breaking methods or breaking machines relate to the grinding of dry or moist material for grinding.

In the case of wet grinding and/or wet classification the breaking up of the agglomerated material for grinding takes place by the addition of fluid (preferably water) to adjust the fluid content of the slurry necessary for the transport by pumping and/or for the wet classification. In the case of brittle material for grinding the breaking up is achieved merely by adding fluid, i.e. without any further activity; experience shows that the agglomerates of brittle material then break up very easily.

In the case of material for grinding with plastic proportions which resist breaking up, in a further variant mechanical energy is supplied in a mixing vessel in such a way that during a certain period of dwell the agglomerated material for grinding is exposed to more or less sharp fluid jets (preferably water jets) or turbulence which is formed by one or more such fluid jets.

The mesh aperture of the screen classifier can advantageously be chosen with 3 to 8 mm. The screen classifier should thus separate off only the coarse-grained proportion (for example over 5 mm). This leads to a recycle factor (in the circuit formed by the roller mill, the breaking machine and the screen classifier, based on the quantity of material for grinding delivered) of 1.1 to 1.3.

Such a screen classifier is substantially cheaper than a sifter which is supposed to sift out the finished product and consequently cannot be so highly loaded as a screen classifier which merely separates off the coarse-grained proportion.

Some embodiments of the apparatus according to the invention are illustrated in the drawings, in which:

Figure 1 shows a diagram of the whole apparatus,

Figures 2 and 3 show a side view and a plan view of a Simpson mixer,

Figure 4 shows a side view of a hammer mill,

Figures 5 and 6 show schematic representations of further variants.

The apparatus illustrated in Figure 1 contains a rotary kiln 1 with a clinker cooler constructed as a planetary cooler.

The material is delivered from an intermediate bunker 3 serving as a buffer to a roller mill 4 in which the material for grinding is crushed under high pressure and agglomerates are formed.

The product discharged from the roller mill 4 enters a breaking machine 5 which is constructed for example as a Simpson mixer (Figures 2, 3) or a hammer mill (Figure 4).

From the breaking machine 5 the material for grinding passes to a screen classifier 6 from which the oversize fraction is conveyed back to the roller mill 4. The proportion of material crushed in the roller mill 4 and broken up in the breaking machine 5 which passes through the screen classifier 6 is delivered to a silo 8 by a conveying track which operates for example pneumatically.

From here the pre-crushed material passes via a distributor 9 to parallel-connected closed-circuit grinding arrangements 10, 10', 10" which each consist of a tube mill 11 and a sifter 12.

Figures 2 and 3 show a Simpson mixer as one embodiment of the breaking machine 5. In a fixed housing 13 with an outlet chute 13a it contains a rotary cross assembly 15 driven by a shaft 14 and bearing rollers 16 and ploughshares 17. The rollers 16 maintain an adjustable minimum distance from the base of the housing 13 so that the material in the breaking machine 5 is not ground but is merely broken up, i.e. the proportion of fines is released from the agglomerates.

Figure 4 shows the breaking machine 5 in the form of a hammer mill in which the rotor 18 has hammers 19 suspended from it. The material for grinding is introduced through a pipe 20 into the mill housing 21 and discharged pneumatically through a pipe 22. The flow speed of the air delivered via a pipe 23 is adjusted by means of valves 24.

Figure 5 shows a variant of the apparatus diagram shown in Figure 1.

Since the proportion of the product of the first crushing stage passing through the screen classifier 6 (i.e. the material for grinding leaving the cycle formed by the roller mill 4, the breaking machine 5 and the screen classifier 6) already contains a considerable proportion of fines (for example 50% < 90µm) it is sensible to provide a circuit in the finished grinding cycle in which the said material for grinding is delivered first to the sifter 12 together with the material discharged from the tube mill 11. The oversize fraction leaving the sifter 12 is delivered to the tube mill 11. Figure 5 shows this layout of the closed-circuit grinding arrangement 10 which is suitable for many applications.

The sifter 12 can be constructed as a two-stage sifter in which the first stage is set relatively coarse (separation limit for example 300 µm) and the fines are sifted out in a second stage in which the separation limit is for example 12 to 20 µm.

The following example may serve for further explanation of the invention:

A comparison was made between

a) the method according to EP-A-84 383 in which the material crushed in the roller mill is delivered directly to a screen classifier,

b) and the method according to the invention in which a breaking machine for breaking up agglomerates is provided between the roller mill and the screen classifier.

	Variant a	Variant b
Throughput apparatus $\dot{M}$ (t/h)	150	150
Recycle ratio (roller mill)	2.0	1.2
Throughput roller mill $\dot{M}_W$ (t/h)	160	156
Specific throughput $\dot{m}_W$ (ts/hm³)	200	200
Geometric throughput potential μ=D.L.u (m³/s)	1.3	0.78
Necessary dimensions of the roller mill (D x L)	1.4 x 0.66	1.2 x 0.45
Necessary drive power of the roller mill [kW]	600	468

The specific throughput

$$\dot{m}_W = \frac{\dot{M}_W}{D \,.\, L \,.\, u} \quad \left[\frac{t \,.\, s}{h \,.\, m^3}\right]$$

depends upon the grain size distribution of the material delivered to the roller mill. In the case of fresh clinker it is 120 ÷ 150 $\frac{t.s}{h.m^3}$, in the case of a mixture of clinker and returned material it is approximately 200 $\frac{t.s}{h.m^3}$. Because of the higher tailings recycle factor a larger roller mill (with correspondingly higher drive

power) is necessary in variant a than in the variant b according to the invention.

In the above table the following abbreviations are used (which have not already been explained):

roller diameter D (m)
roller gap length L (m)
peripheral speed u (m/s).

In the further embodiment of apparatus according to the invention which is illustrated in Figure 6 the same reference numerals are used for the same components as in Figure 1.

The apparatus contains a gyratory crusher 25 as the primary crusher, from which the pre-crushed material for grinding passes into the intermediate bunker 3 from which it is then delivered to the roller mill 4.

The product discharged from the roller mill 4 passes immediately before the screen classifier 6 to a breaking machine 5' formed by a sprayer through which fluid, preferably water, is delivered to the material for grinding falling onto a curved screen of the screen classifier. The breaking and classification of the material for grinding are aided by the supply of fluid.

The oversize fraction is conveyed to the roller mill 4, whilst the proportion which passes through the screen classifier passes via a conveying track 7 which operates

for example hydraulically to reach a storage bin 8'. From here the pre-ground and calibrated material is delivered via a distributor to the parallel-connected wet grinding arrangements 10a, 10'a, 10"a, which each consist of a tube mill 11, a conveyor pump 26 and a classifier 12a (preferably a hydrocyclone).

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Method of crushing brittle material for grinding, in which

a) the material for grinding is crushed in a first crushing stage formed by a roller mill (4) using high pressure and in which agglomerates are formed,

b) the product of the first crushing stage is classified on a screen classifier (6) and the oversize fraction is returned to the roller mill (4),

c) and the proportion of the product of the first crushing stage passing through the screen classifier (6) is further crushed in a closed-circuit grinding arrangement (10) which preferably contains a tube mill (11) and a sifter (12),

characterised in that

d) the material for grinding undergoes treatment for breaking up the agglomerates between the method stages a) and b).

2. Method as claimed in claim 1, characterised in that the proportion of the product of the first crushing stage passing through the screen classifier (6) is conveyed pneumatically or hydraulically to the closed-circuit grinding arrangement (10) or to a silo (8) or storage bin

(8') arranged before the closed-circuit grinding arrangement (10).

3. Method as claimed in claim 1, characterised in that the proportion of the product of the first crushing stage passing through the screen classifier (6) is delivered together with the material discharged from the tube mill (11) first of all to the sifter (12) of the closed-circuit grinding arrangement (10), from which the oversize fraction is delivered to the tube mill (11).

4. Method as claimed in claim 1, characterised in that fluid is added to the material for grinding in order to break up agglomerates.

5. Method as claimed in claim 4, particularly for material for grinding with plastic proportions, characterised in that the material for grinding is subjected to mechanical stress simultaneously with the delivery of fluid.

6. Method as claimed in claim 4, characterised in that the addition of the fluid takes place immediately before and/or simultaneously with the classification.

7. Apparatus for crushing brittle material for grinding, containing

a) a roller mill (4) as the first crushing stage, in which the material for grinding is crushed under high pressure and in which agglomerates are formed.

b) a screen classifier (6) for classification of the product of the first crushing stage,

c) a closed-circuit grinding arrangement (10) which preferably contains a tube mill 911) and a sifter (12) for the further crushing of the proportion of the product of the first crushing stage passing through the screen classifier (6),

characterised in that

d) a breaking machine (5) is arranged between the roller mill (4) and the screen classifier (6).

8. Apparatus as claimed in claim 7, characterised in that the roller mill (4), the screen classifier (6) and the breaking machine (5) are arranged spatially distant from the closed-circuit grinding arrangement (10), and in apparatus for the production of cement the roller mill (4), the screen classifier (6) and the breaking machine (5) are preferably arranged between a clinker cooler (2) and a silo (8), whilst the closed-circuit grinding arrangement (10) is arranged after the silo (8).

9. Apparatus as claimed in claim 7, characterised in that the roller mill (4), the screen classifier (6) and the breaking machine (5') are arranged spatially distant from the closed-circuit grinding arrangement (10a), and an apparatus for dressing ore the roller mill (4), the screen classifier (6) and the breaking machine (5') are preferably arranged between a breaker (25) and a storage

bin (8'), whilst the closed-circuit grinding apparatus (10a) is arranged after the storage bin (8').

10. Apparatus as claimed in claim 7, characterised in that the breaking machine (5) is formed by a hammer mill with a low peripheral speed, preferably 20 to 30 m/s, and the material is discharged in the air stream or through a grate base.

11. Apparatus as claimed in claim 7, characterised in that the breaking machine (5) is formed by an impact mill with fixed impact strips, and the material is discharged through a grate base.

12. Apparatus as claimed in claim 7, characterised in that the breaking machine (5) is formed by a disintegrator with central material supply and periphery material discharge.

13. Apparatus as claimed in claim 7, characterised in that the breaking machine (5) is formed by a Simpson mixer which contains a rotary cross assembly (15) equipped with rollers (16) and ploughshares (17), and the rollers (16) maintain an adjustable minimum distance from the base of the mixer housing (13).

14. Apparatus as claimed in claim 7, characterised in that the breaking machine (5') contains an arrangement for delivering fluid to the material for grinding.

15. Apparatus as claimed in claim 14, characterised in that the breaking machine is formed by a mixing vessel in which the material for grinding is subjected to mechanical stress simultaneously with the delivery of the fluid.

16. Apparatus as claimed in claim 14, characterised in that the arrangement for delivering fluid is formed by a sprayer arranged above the screen classifier (6) which is provided with a curved screen (6a).

DATED this 7th day of April 1988.

KRUPP POLYSIUS AG

EDWD. WATERS & SONS
PATENT ATTORNEYS
50 QUEEN STREET
MELBOURNE. VIC. 3000.

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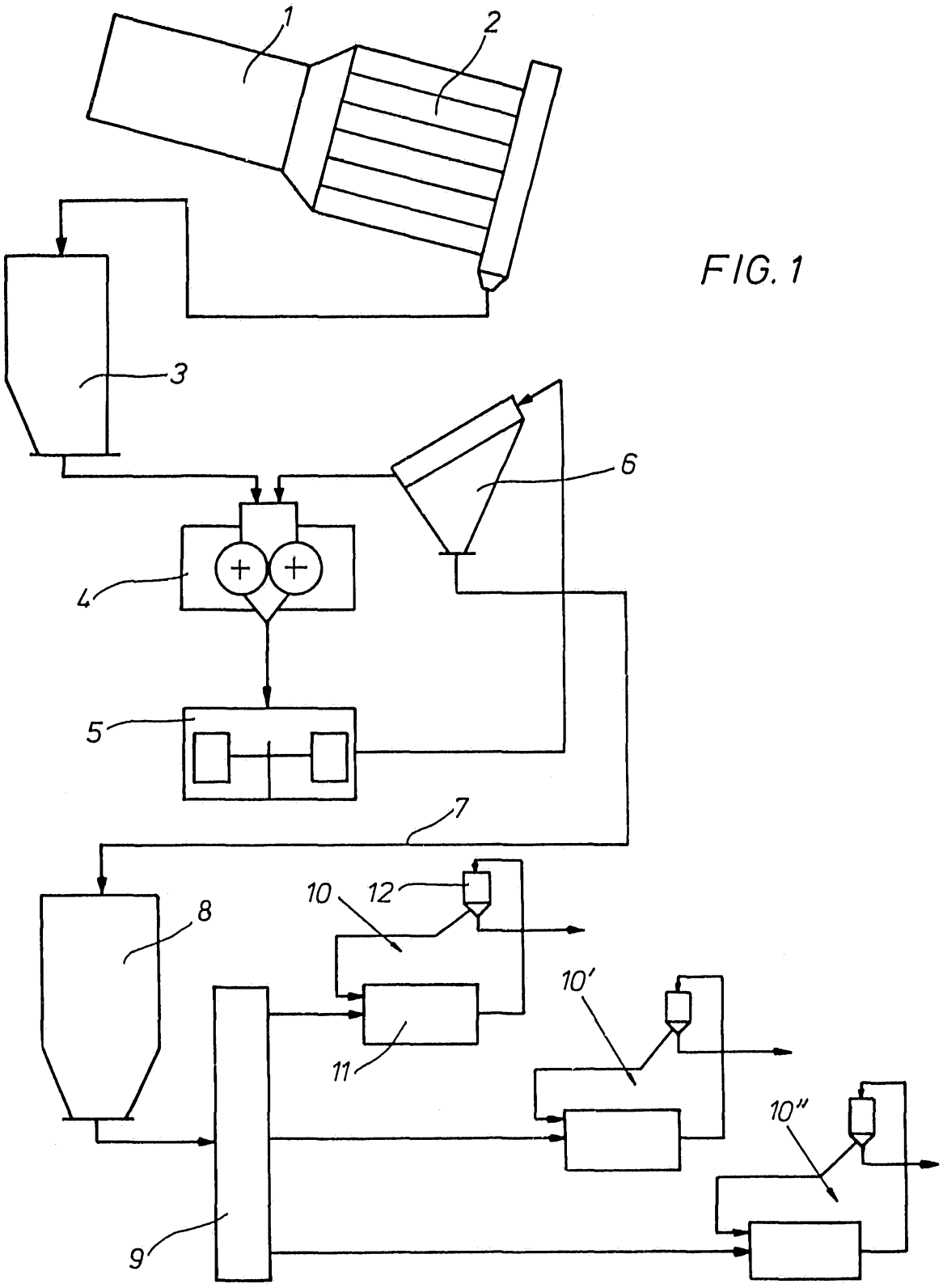


FIG. 1

FIG. 2

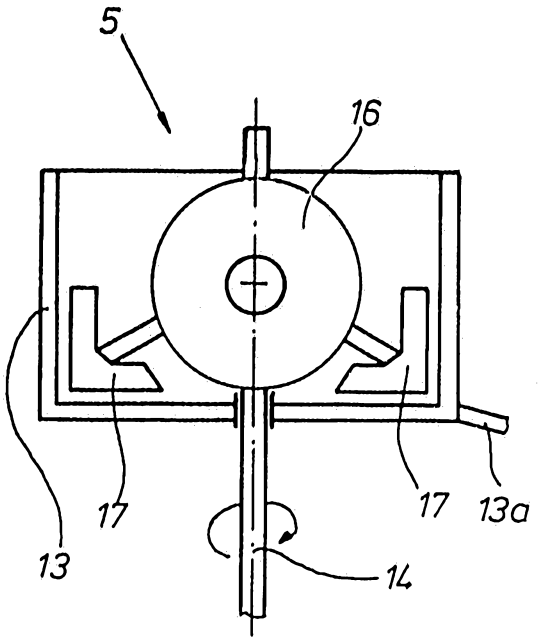
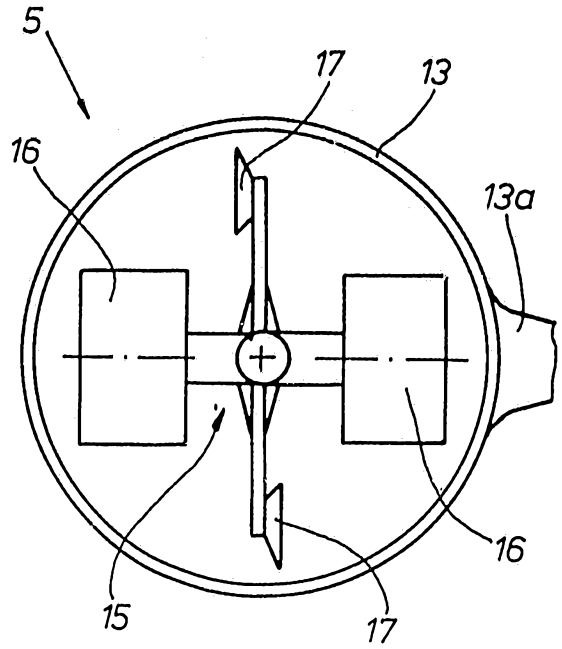


FIG. 3



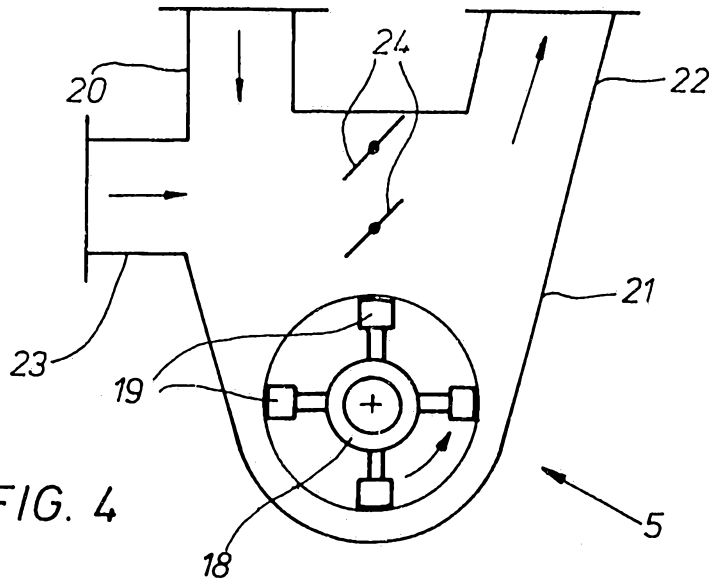
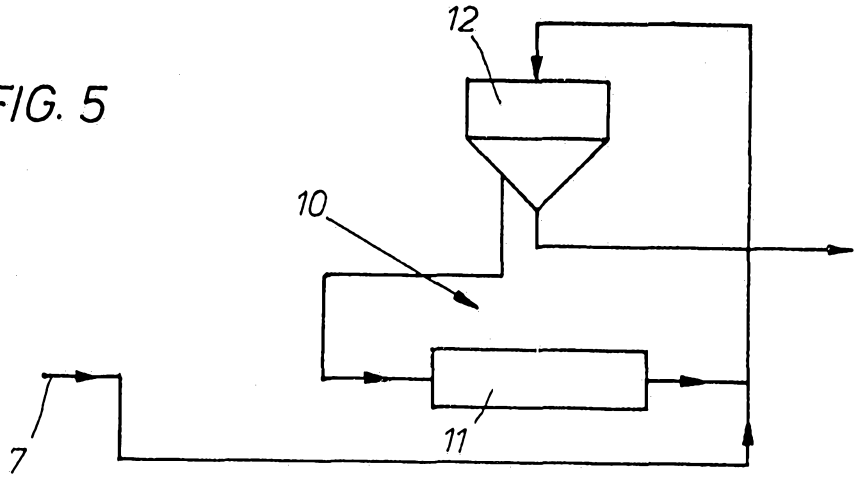


FIG. 4

FIG. 5



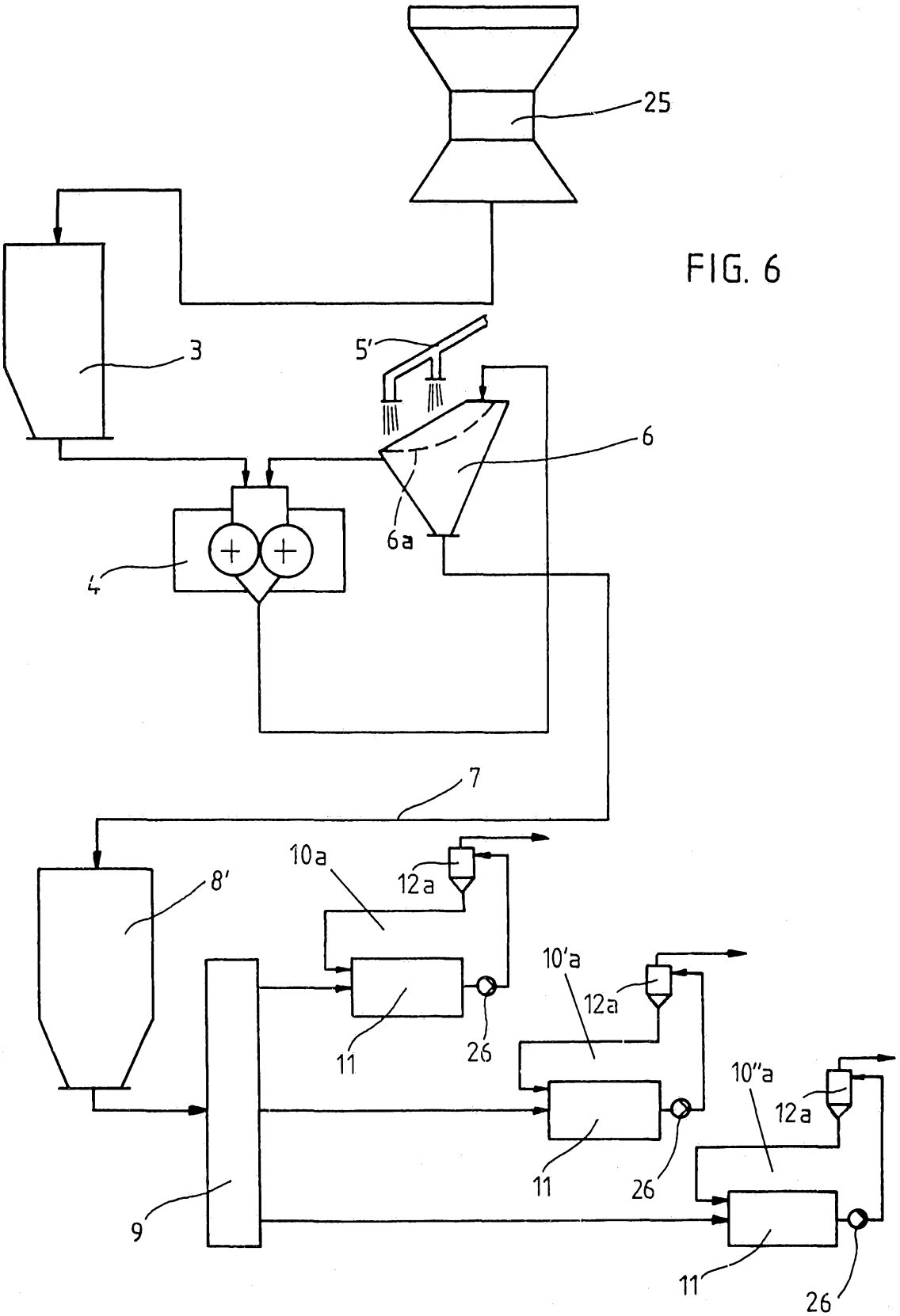


FIG. 6