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(54) **Procedure for the washing and composition control of abrasive pulps used in the cutting of granite and similar stones and relative apparatus.**

(57) The washing and composition control of an abrasive pulp, used in granite cutting and containing metallic grit with granulometry larger or finer than a predetermined value as well as granite dust, is conducted by means of a separation of said fractions in a tubular water-containing settler. A predetermined volume of pulp is weighed and then discharged into the settler. The collected grit of larger granulometry is weighed tracing back to its concentration in the pulp. The fine metallic grit can in turn be collected and weighed, and thereby recycled or disposed of along with the dust suspension and fine grit. A processor provides for the numerical calculations and control of the processing procedure and of the restoration of fresh metallic grit.

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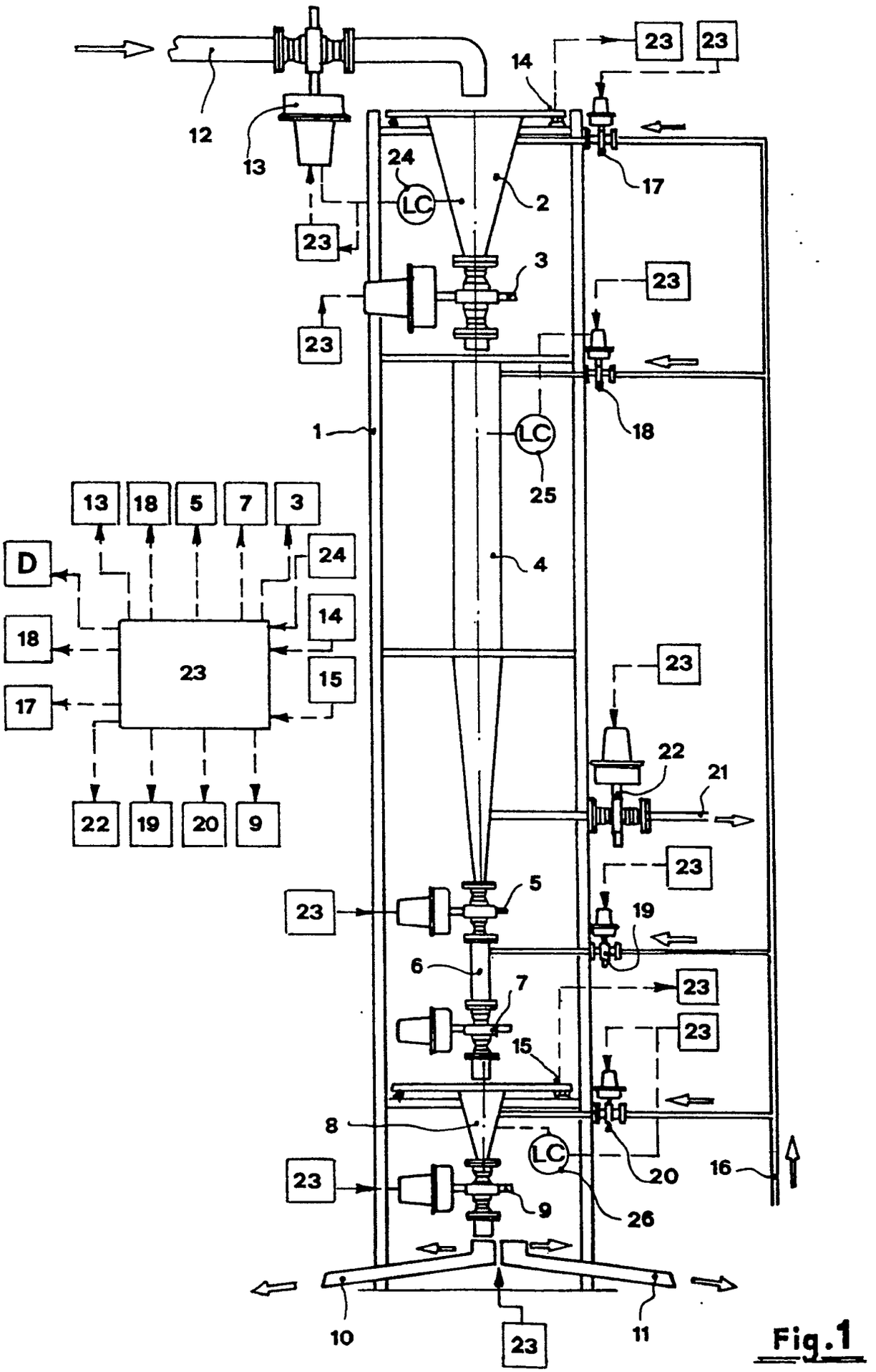
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Fig.1

PROCEDURE FOR THE WASHING AND COMPOSITION CONTROL OF ABRASIVE PULPS USED IN THE CUTTING OF GRANITE AND SIMILAR STONES AND RELATIVE APPARATUS

The present invention relates to a process for the washing and composition control of abrasive pulps used in the cutting of granite and similar stones.

The invention also relates to an apparatus for the practical execution of this process.

For the cutting of blocks of granite and similar stones by means of single - or multiple-blade cutting machines, abrasive mixtures of essentially an iron grit base are used which, in the form of a water suspension, are continuously recirculated in the grooves made in the block by the alternative movement of the blades. The abrasive action of these mixtures substained by the movement of the blades progressively cuts the block. The abrasive pulp in circulation becomes progressively enriched with dust from cut material and consumed iron, thus of a granulometry too fine to be effective in the cutting operation. The granulometry of the fresh metallic grit is usually about 1 mm, while the metallic dust of finer granulometry than about 0.3 mm can be considered exhausted.

The problem that is presented in the use of this type of abrasive mixture is on one hand, that of maintaining in the pulp an optimum concentration of metallic grit of granulometry effective in the cutting of the material and on the other hand, that of eliminating the consumed metallic dust and the dusty discard of the material which is cut, maintaining the specific weight of the pulp at a value at which the metallic grit itself always remains in suspension.

Since the consumption of metallic grit also varies with the variation of the type of material which is cut, the quantity of grit to distribute and the concentration of grit in the pulp are currently determined on the basis of experience or empirical data, for which reason the composition of the resulting abrasive pulp may not be optimized with consequent decrease in the cutting yield and increase in consumption.

Currently the washing of the abrasive pulp is accomplished by means of centrifugal cleaners. An alternative process provides for the magnetic separation of the metallic grit and its successive separation into fractions of different granulometry through mechanical filtration. Another process provides for the counter-current washing of the pulp by means of a flow of water under pressure. The principal inconvenience of these and other systems currently in use for the treatment of abrasive pulps, is the low reliability mainly caused by the clogging of the filters, by the variation in the pressure of the washing water, and by the insufficient precision of the centrifugal cleaners with regard to their capacity for washing and separation. From this, a considerable difficulty in the separation of fine grit ($\leqq$ 0.3 mm) from larger grit results. Also with the known systems the quantity of metallic grit to be distributed as a function of the type of granite which is being cut must be predetermined and there is no possibility of evaluating in a sufficiently precise way the quantity of grit to restore as a function of its real consumption.

The object of this invention is to provide a process for the washing and composition control of abrasive pulps used in the cutting of granite and similar stones which prevents the inconveniences related to similar known processes.

A particular object of this invention is to provide a process of the above mentioned type which allows for the measurement of the specific weight of the abrasive pulp, the quantities of metallic grit with granulometry larger or finer than a predetermined value present per litre of pulp, as well as the automatic control of pulp washing operations and restoration of fresh metallic grit for obtaining optimum abrasive mixtures for any type of granite on the basis of real grit consumption rather than assumed values.

The process for the washing and composition control of abrasive pulps according to this invention, is characterized by the fact that first a predetermined volume of said pulp is weighed and then submitted to sedimentation in a liquid phase in order to collect the solid fraction of larger granulometry. Said fraction is then weighed and returned to the collection tank of the pulp in circulation. From the weight and volume data on the pulp and from the weight of said fraction of grit of larger granulometry, the specific weight of the pulp and actual concentration of said grit in the circulated pulp are determined. From comparison to corresponding values of specific weight and to concentrations considered optimum, the quantity of grit to restore and the frequency of washings are established. Preferably, the calculation of the specific weight, the concentration and the quantity to restore are conducted by a computer processor which also controls the correct succession of the various operative phases and the operation of the metering equipment of the metallic grit which is restored from time to time, as well as the frequency of the washings.

In a particularly preferred embodiment of the process according to this invention, the fraction of finer granulometry is also collected, and weighed in order to calculate the concentration of the circulating pulp thus providing for the disposal of the entire volume collected or of a portion of it while recirculating the remaining portion.

In particular, the fractionated sedimentation of the volume of pulp derived from the pulp circulation system can be accomplished in a vertical tubular water-containing container.

Advantageously, for the determination of the

weight of the fraction of larger granulometry and, if provided for, that of finer granulometry, a predetermined volume containing either one or the other said fractions is weighed.

The reliability of the process is guaranteed by the fact that, in order to separate the different components of the mixture (in particular large grit from fine grit), recourse is made only to the force of gravity and to the different resistances to motion in a fluid opposed by particles of different granulometry. For this reason, at first approximation, with regard to the metallic grit, the speed of sedimentation is proportional to the diameter of the particles, while with regard to the granite dusts, having a specific weight 3.54 times lower than that of iron, they behave, with respect to sedimentation, approximately like iron particles of a diameter as many times smaller. This guarantees that even the granite dust of larger granulometry (for example 1 mm in diameter) can be effectively separated from the metallic grit.

Another object of this invention is to provide an apparatus for the washing and composition control of abrasive pulps used in cutting granite and similar stones functioning according to the process referred to above.

Such apparatus comprises a tubular settler for the separation of the fraction of metallic grit with a granulometry larger than a predetermined value from that of finer granulometry than said value and from granite dusts, fit to be filled with washing liquid and having inlet and discharge sections communicating interceptably respectively with a first container for the collection of a predetermined volume of abrasive circulating pulp and a second container for the collection of the sediment deposited on the bottom of said settler. The invention also provides for weighing means associated with the first and second containers for weighing respectively the volume of pulp removed and the sediment collected, and computer processor means for providing the specific weight of the pulp and the concentration of the fraction of larger granulometry in said pulp providing from weight data and for the control of the operative sequence, the control of restoration of fresh metallic grit and the frequency of the washings.

Other characteristics and advantages of the process and apparatus for the washing and composition control of abrasive pulps used in the cutting of granite and similar stones according to this invention will become clear in the following description of one of its possible embodiments given as an example but not limitative with reference to the attached drawings in which:

- figure 1 is an elevational side view of the apparatus according to this invention;
- figure 2 is a view of a simplified possible variation of the apparatus according to this invention.

With reference to figure 1, it has been indicated at 1 a vertically positioned frame on which are mounted, from high to low: a first container 2, of the hopper type, the bottom of which communicates through a motorized valve 3 with the inlet section of a vertical axis tubular settler 4, the discharge section of which, intercepted by a motorized valve 5, communicates with an intermediate tank 6. Intermediate tank 6 communicates by way of a motorized interception valve 7, with a second collection container 8 of the hopper type, the bottom of which, intercepted by a motorized valve 9, can be alternatively put in communication with a duct 10 confluent in the collection well of the abrasive pulp of the circulation circuit, or with a duct 11 connected to disposal facilities or mud treatment plant. First container 2, second container 8 and intermediate tank 6 are aligned along the vertical axis of tubular settler 4.

First collection container 2 is supplied by a collector 12 intercepted by a motorized valve 13, derived from the abrasive pulp circulation circuit. Also, first container 2 as well as second container 8, are mounted on respective loading cells 14 and 15 for the weighing of a predetermined volume of abrasive pulp collected in container 2 and of sediment collected in container 8.

The apparatus is connected to a line 16 for the supply of washing liquid, in particular water, and connections to first container 2, settler 4, intermediate tank 6 and second container 8 intercepted respectively by motorized valves 17, 18, 19 and 20 are provided for. At a certain level above the bottom of the settler 4 a duct 21 is provided on which a motorized valve 22 is mounted to make the liquid containing the finer particles flow to disposal facilities or to the mud treatment plant.

Computer processor 23 controls the operating cycle of the apparatus according to this invention sending command signals to the various motorized valves and receiving weight data from loading cells 14 and 15. The opening of valve 13 commands the influx of the abrasive pulp from collector 12 into first collection tank 2, the level of which is controlled by controller 24. When a predetermined level is reached in container 2, the value of which is read and sent to processor 23, valve 13 is closed and, through loading cell 14, the weight of the content of container 2 is taken and sent to processor 23 for the calculation of the specific weight of the abrasive pulp collected. Water is then allowed to flow into settler 4 by opening valve 18 to a level predetermined and checked by level controller 25 while valves 5 and 7 are respectively open and closed. The opening of valve 3 is then commanded which causes the pulp contained in container 2 to precipitate in the water contained in settler 4, where the large metallic grit separates rapidly from the finer particles collecting in intermediate tank 6. A predetermined time after the opening of valve 3, valve 5 is closed in order to prevent the finer and lighter parti-

cles from ending up in intermediate tank 6.

The opening of valve 7 then makes the grit fall from tank 6 to second collection container 8 where water is also sent by opening of valve 20 until a predetermined volume is reached, under the level control of controller 26. This volume is weighed by loading cell 15 and the datum is sent to processor 23 for calculation of the concentration (g/l) of the large size grit in the abrasive pulp. When the weighing is completed, the opening of valve 9 is operated to return the weighed grit to the circulating pulp collection basin through duct 10.

While the washing of intermediate tank 6 and second container 8 is carried out by means of timed opening of valves 19 and 20, valve 22 is also opened to make the water suspension present in settler 4 flow through duct 21, while the fine metallic grit is collected on the bottom of settler 4. Newly opening valve 5, the fine size grit is transferred to intermediate tank 6 and from here, opening valve 7, in second container 8, which is submitted to weighing in the same way used for large size grit, by loading cell 15, and the measured weight is sent to to processor 23 for calculation of the concentration in the pulp.

At the end of the cycle, the timed opening of valves 17, 18, 19 and 20, provides for the quick washing of the containers and the ducts. The washing water is sent to the disposal facilities through duct 11.

The actual concentration values of large size grit and fine size grit thus measured are compared with respective,previously memorized values considered optimum and, as a function of the results of that comparison carried out by computer processor 23, said processor controls the fresh metallic grit metering equipment D (not shown) for the restoration to the circulating pulp, while, as for the fine grit, it controls its return to the circulating pulp collection basin by way of duct 10 or rather its removal from the cycle by way of duct 11.

In figure 2 a simplified possible variation of the apparatus according to this invention in which neither the possibility of measuring directly the concentration of the fine metallic grit, nor its possible recirculation is provided for. In this case the large metallic grit which collects on the bottom of settler 4 is discharged directly into second container 8 by opening valve 5 and is weighed according to the already defined modalities, after having emptied from settler 4 through drainage duct 21 the suspension containing fine grit and granite dusts. The desirable separation of the large grit is obtained by regulating the time between the inlet of the mixture into settler 4 and the opening of valve 22.

A practical example of the execution of the process according to this invention provided for the use of a tubular settler of a diameter 0,3 m and height 2,5 m. From the circuit of the abrasive pulp a fraction of 40 l. was drawn the specific weight of which, following weighing in the first container 2 with loading cell 14, resulted 1.650 g/l. Following weighing in second container 8, the presence of 2.400 g of large metallic grit, of nominal granulometry larger than 0,3 mm, and 4.000 g of fine metallic grit, that is of nominal granulometry of less than 0,3 mm, were revealed in the pulp fraction. The concentration of large size grit therefore resulted 60 g/l in the circulating pulp, a value considered acceptable for the cutting of granite, while that of fine grit resulted 100 g/l. From the analysis of the two granulometric fractions a loss of about 10% of large grit in the fine grit and about an equal presence of fine grit in the large grit were revealed. Considering that the washing of the granite dusts, from the large metallic grit is complete, a yield of 90% separation is considered good, a yield which can further be improved optimizing the operative parameters of the process.

As much as the possible embodiment just described of the invention provides for the weighing of a predetermined volume containing large grit discharged from the settler 4, it is evident that the weighing of said grit can be carried out directly after having mechanically percolated the water which accompanies it. It is also clear that the control of the level in containers 2 and 8 can be achieved instead of with weight control instrumentations, by an overflow of the added water contemporaneously keeping under control the weight of the containers themselves. When the weight no longer increases it means that the water has begun to overflow and the delivery can therefore be interrupted noting at the same time the final weight. The weight of both fine and large size grit fractions may also be obtained, instead of by loading cells, in an indirect way by reading the level of the grit in the container 8 or by measuring the variation of the intensity of a magnetic field that is proportional to the mass of the metallic grit.

Variations and/or modifications can be brought to the process and apparatus for the washing and composition control of abrasive pulps used in cutting granite and similar stones according to this invention, without departing from the scope of the invention itself.

Claims

1. A process for the washing and composition control of abrasive pulps used in cutting granite and similar stones, said pulps comprising metallic grit with a granulometry larger and finer than a predetermined value as well as granite dusts, characterized by the fact of being comprised of the following phases:
   - weigh a predetermined volume of said pulps;
   - submit to sedimentation in a liquid phase

said volume of pulp in such a way as to collect the fraction of said grit of granulometry larger than said value;
– obtain the weight of said fraction thus collected;
– calculate from the weight and volume data of said pulp and from the weight of said fraction of grit of larger granulometry the concentration of the latter in said circulating pulp and the specific weight of said pulp;
– recycle said fraction of grit of larger granulometry;
– control, on the basis of the data on the concentration of the grit of larger granulometry and on the specific weight of the pulp, the restoration of the grit and the washings of the abrasive grit present in the pulp.

2. A process according to claim 1, wherein said fraction of metallic grit with granulometry finer than said value is also collected, said fraction being then weighed so as to trace back the concentration of said grit in said circulating pulp, the quantity of said metallic grit with finer granulometry that is recycled being comprised between 0 and 100%.

3. A process according to previous claims, in which said volume of abrasive pulp is fed to a tubular water containing container.

4. A process according to previous claims, in which said fraction of larger granulometry and, when collection is provided for, said fraction of finer granulometry have water added to them up to a predetermined volume and said volume is weighed.

5. A process according to claims 1, 2 and 3, in which said fraction of larger granulometry and, when its collection is provided for, said fraction of finer granulometry, are weighed after the suspension water has been percolated.

6. An apparatus for the washing and composition control of abrasive pulps used in the cutting of granite and similar stones, said pulps comprising metallic grit with a granulometry larger or finer than a predetermined value as well as granite dusts, characterized by the fact that it comprises a tubular settler (4) for the separation of the fraction of metallic grit of larger granulometry from that of finer granulometry and from granite dusts, fit to be filled with washing liquid and having an inlet section and a discharge section communicating in an interceptable way respectively with a first collection container (2) of a predetermined volume of the circulating abrasive pulp and with a second container (8) for the collection of sediment deposited at the bottom of said settler, weighing means (14,15) being provided, associated with said first and second containers, for providing the weight respectively of said volume of pulp drawn and of the volume of sediment collected, and data processing means (23) for calculating the specific weight of the pulp and the concentration of the fraction of metallic grit of larger granulometry in said pulp from the weight data, as well as for the control of the operative sequence, of the restoration of fresh metallic grit and of the frequency of the washings.

7. Apparatus according to claim 6, in which said settler is provided with an interceptable bottom section (6).

8. Apparatus according to claims 6 and 7, in which said second collection container (8) comprises two different selectable discharge ducts (10,11) communicating with an abrasive pulp collection basin and respectively with disposal facilities or a mud treatment plant.

9. Apparatus according to claims 6 to 8, in which at a certain level above the bottom of said settler an interceptable drainage duct (21) is provided for.

10. Apparatus according to claims 6 to 9, in which said first and second collection containers (2,8), said settler (4) and said bottom section (6) of the settler are connected in an interceptable way to a washing liquid distribution network (16).

11. Apparatus according to claims 6 to 10, in which said tubular settler is arranged along a vertical axis and said first and second collection containers are aligned along said axis.

12. Apparatus according to claims 6 to 11, in which said first and second collection containers are under level control (24, 26).

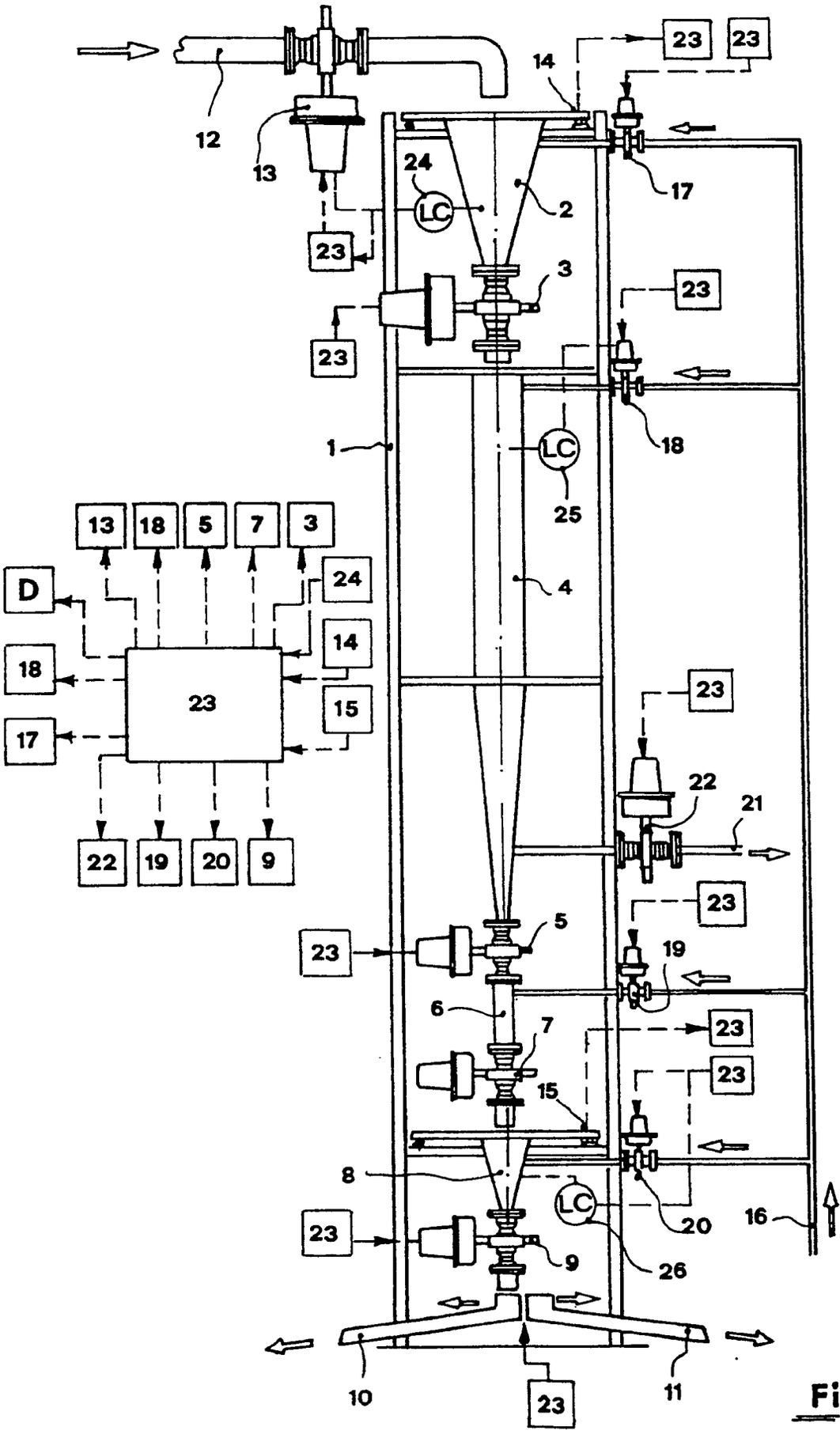
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Fig.1

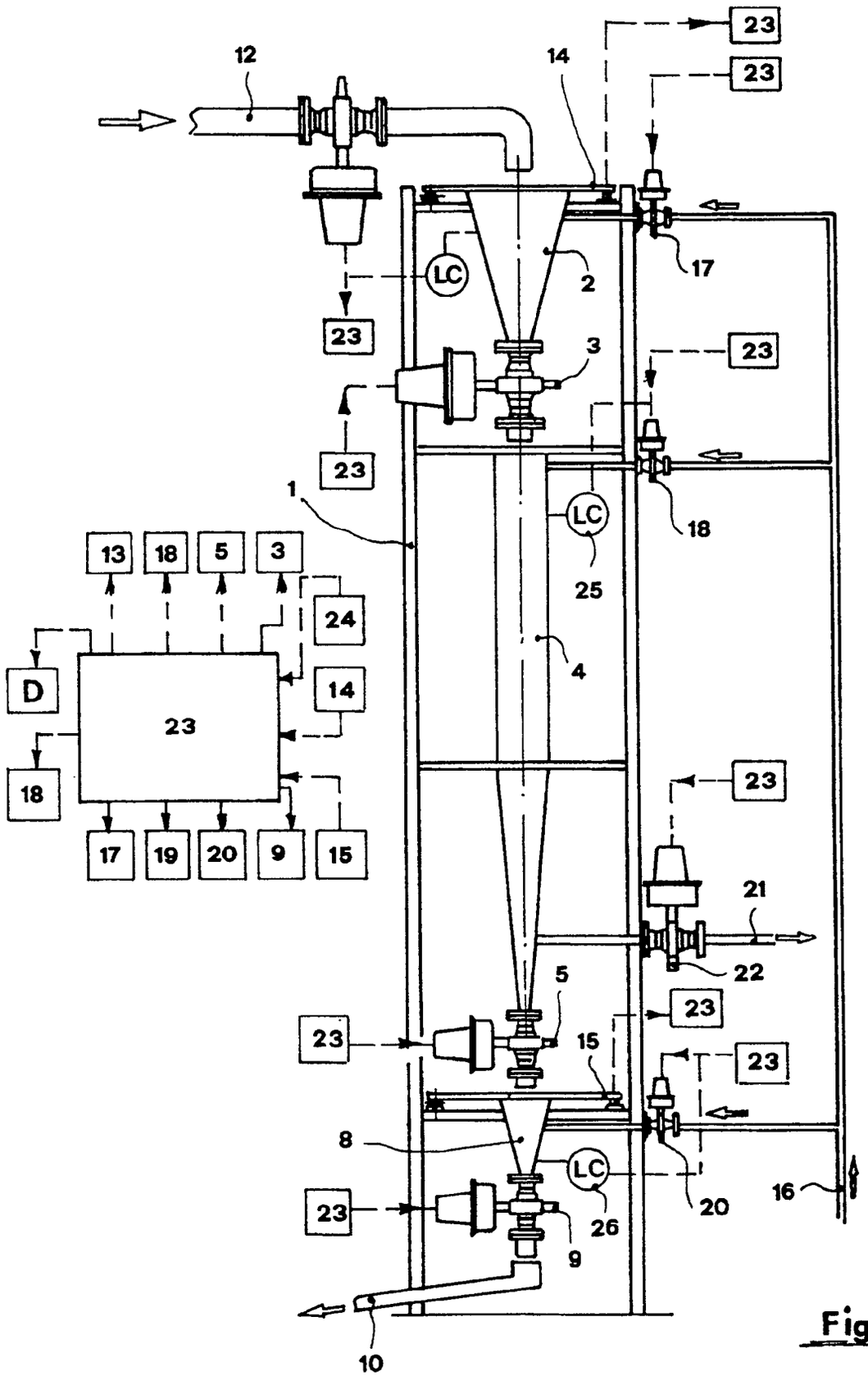
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Fig. 2