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(54) METHOD FOR SAWING GRANITES

(57) A method for sawing granites and other stones with shot and mud carrying fine and soft materials which separates or not the larger sawing detritus by mechanical means and the smaller detritus or all of it by continually or frequently evacuating a fraction of the carrier mud, this being replaced by adding water, lime and fine and soft materials in adequate proportion and quantity in order to maintain the carrier qualities of the mud and a concentration of stone particles which favours lower consumption of energy, shot, bands and time, without incurring increased costs in purchases, set-up and evacuation of fine and soft materials, which controls the contents of shot in the mud with a transformer whose magnetic flux passes through the circulating mud from the external annular poles and controls the viscosity through the active current of the homogeniser motor.

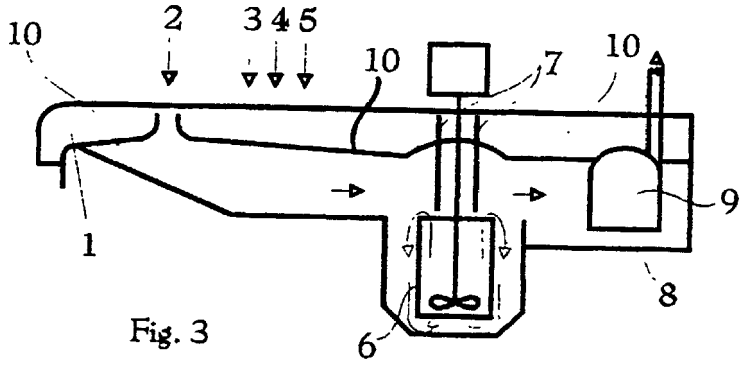

Fig. 3

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Description

TECHNICAL SECTOR

[0001] This method for sawing granite and other hard stones with shot, granulated iron or steel, and mud carrying fine and soft materials fits into the industrial sector producing slabs of 1 cm. or more in thickness and only a few m^2 each, starting from blocks of natural stone as it comes from quarry or squared, generally into several m^3. It can also be used to saw artificial stone. It is applied using conventional machines, with one or more bands, up to 500, which move alternately in pendulum swings of some 50 cm in amplitude and a radius of approximately 135 cm.

STATE OF THE TECHNIQUE

[0002] Hard stones are not currently sawn with multiple diamond discs or diamond edged bands; sawing or cutting with diamonds is still more costly than sawing with steel bands and shot, which means that those who opted for diamond techniques have stopped the equipment they had for this purpose and have installed sawing machines with hard steel and cooling and cleaning mud with steel or white cast iron shot. This method has been used for 60 years, and in an exclusive way when dealing with the production of slabs of 1 to 3 cm. If thicknesses of over 4 cm are produced, then it is preferable to use a diamond disc.

[0003] The cooling and cleaning shot carrier mud used at present contains a volume of (64±3)% of sawing detritus with an average size of 37±7 μm of equivalent diameter, which makes sawing significantly more difficult in terms of cost and time.

[0004] Patent ES 9300185/PCT940009 and earlier ones mention the possibility of sawing with muds that contain low sawing detritus percentages and that owe their carrier power to the presence of fine soft powders, so allowing a reduction in total sawing cost of 1/3 the current one and a triplication in production, but due to the heavy investment needed for their application it has not been possible, for the owner, to apply them or find adequate financing. This new patent intends to solve this problem, with a less perfect method, but one that involves less investment.

[0005] The electromagnetic measurer of shot content in the mud has no precedent. Until 25 years ago determination of the mud shot contents was carried out by hand, and the scheduling of new shot addition and the advance of the sawing machine was by hand also. Since then automatic equipment has come into more general use, which carries out the same tasks of diluting a measured quantity of mud, dragging the light and fine materials and leaving the useful shot with water that is eventually drained and the shot weighed. This operation is done several times per hour and, according to the result, more or less new shot is added automatically.

[0006] In order to determine the viscosity, a commercial viscosimeter is used consisting of a small stirring device with an electric motor whose active intensity gives us an index of viscosity.

EXPLANATION

[0007] The mud leaving the sawing machine is passed through a device of any type that divides the flow in such a way that a small part is separated from the circuit and replaced by an equal amount of water, lime and fine and soft materials plus water to replace the small losses through evaporation, in such a way that the mud returning to the sawing machine always has the same proportions of water, lime, and fine and soft materials per unit, besides the stone particles not separated from the circuit. The shot is recovered from the separated mud by conventional methods, and it is returned to the circuit at the same point as the other new materials, or at another point.

[0008] The mud leaving the sawing machine can also be sent to a closed area free from CO_2 where it is passed through a jig to separate out the larger stone particles and the useful shot. The larger stone particles are separated from the useful shot in a cyclone or by any other conventional method, sending them out or to a conventional cleaning machine for use in other processes; while the shot is reincorporated into the mud returning to the sawing machine before passing through a shot contents homogeniser.

[0009] The mud containing smaller-sized stone particles that has passed through the jig, is sent to an inflow channel to the homogeniser, provided with an overflow in such a way that mud containing stone particles that does not have access to the homogeniser goes through the overflow and is taken out before the mix with new mud and shot. For this to happen, the entrance channel, the homogeniser and the pump well form a slurry containing group with walls that are high enough all round except for the overflow, in such a way that if the level rises, more mud goes out through the overflow, and if it drops, less goes out. The pump regulates the flow sent to the machine and the established program regulates the renewal or new mud flow, and because of the relative situation only loaded mud is evacuated. In the homogeniser there are one or two screens that impede the passage of mud over it without being homogenised by recirculation or agitation.

[0010] Also arriving at the homogeniser, besides the shot and the unpoured mud, is a convenient amount of new

mud made up of water saturated with lime properly mixed with an adequate proportion of fine and soft materials. Thus, by regulating the supply of new mud, it is possible to evacuate the correct amount of overflow mud containing particles and to keep the stone particle content in the mud at a more convenient percentage for each stone being sawn, without any need for a regulator.

[0011] The aim of the screening jig is to remove from the circuit the larger particles that are susceptible to this type of economic procedure so as to keep the content of detritus in the mud below the maximum level without the need to evacuate so much loaded mud with a greater loss of fine and soft materials. The screening also avoids the entry of mud with larger particles into the machine, which would cause greater use of energy, shot, bands and sawing time. The absence of CO_2 in the screening area is necessary so that CO_3Ca does not form and obstruct the screen meshes when reacting with the lime dissolved in the water, vital so as not to stain the stones with iron oxides that are produced by the shot and bands oxidising.

[0012] In the method with no screening, approximately 1 litre/second x band of mud can be made to flow through the sawing machine, as is done at present without fine and soft materials, and 1 ± 0.6 cm^3/second x band can be separated, although such a high recirculation index is unnecessary, $1000cm^3/1cm^3 = 1000$. In the method with screening, in order to avoid a large amount of screening, the most convenient recirculation index would be between 6 and 40.

[0013] According to experiments carried out, there should be a volumetric ratio between the lime water and the fine and soft materials of approximately 78 to 22 so as to fulfil the proper conditions for fluidity and power as a carrier and in dragging the shot and the stone particles. Therefore, if we take as a maximum 72% of stone particles we will have as a minimum 22% of water and 6 % of fine and soft materials, approximately, as the possible field of operation for this method.

[0014] The savings obtained by this method in consumption of shot, bands, energy and sawing time will be lesser than those from the method consisting of keeping the stone particle contents as low as possible, from 5 to 10%, as was previously considered as economically optimal in experiments carried for earlier patents, but, because of the lower investment for this method, it is more easily applicable.

[0015] In both cases, the fine and soft materials can be put into the circuit as powder, adding in turn the necessary water, lime and shot, or as a mud prepared with the adequate viscosity to support the shot and flow well in the slots.

[0016] The presence in the equipment of an electric motor that works the homogeniser whose power depends on the viscosity of the mud makes it unnecessary to install a viscosimeter. For greater sensitivity a condenser is attached to the motor that provides all the reactive current it demands when empty and the current demanded from the mains will be proportional to the power, and reliable maximum and minimum limits can be established between which the current corresponds to the maximum and minimum values for viscosity the mud must have and acting on a robot which regulates and gives alarms when regulation is impossible.

[0017] The shot contents regulator is made up of two electrical circuits, a primary one and a secondary one, and a magnetic circuit, partly of magnetic plate, which closes through the mud, whose permeability depends upon the concentration of shot in the mud which can vary between 5% and 8% in volume, although it is currently (5±1)%. The transformer or autotransformer thus constituted has a current in the secondary which varies almost proportionally with the volumetric contents of shot whose magnetic permeability is greater than that of the mud, if its primary is energised with a constant current.

[0018] The advantages of this method lie in its small application investment. With no screening jig, and feeding the mud circuit manually with fine and soft materials, the investment is zero. Minimum cost is achieved by automating it. With a screening jig, which is useful when there is quartz in the stone, better costs are achieved than without one because the quartz in the sawing breaks into curled shell shapes of 0.5 to 15 μm thick and with diameters from 50 to 300 μm, which means that a large part can be separated through screening.

EXPLANATION OF THE FIGURES

[0019]

Fig. 1 - Scheme of the method with no screening.

Fig. 2 - Scheme of the method with screening.

In both schemes the numbers represent:

0.- Sawing machine

1.- Pump which collects the slurry leaving the sawing machine and, when necessary, the new shot.

2.- Screen

3.- Mud overflow evacuation channel which goes to a shot separator (5) in the method with no screening.

4.- Homogeniser for the contents of shot and fine and soft materials. Unnecessary when there is a large mud flow.

5.- Shot recoverer. In the process with no screening this can poured into the pump well (1). In the process with screening it is poured into the channel (3).
6.- Mill feeding pump.
7.- Residue tanks.
8.- Fine and soft materials silo.
9.- Pump and water tank for shot separation.
10.- New shot feeder tank.

Fig. 3. - Lengthways cross-section of a mixing-homogenising and pumping channel.

1.- Overflow.
2.- Input of loaded mud.
3, 4 and 5.- Input of new mud and shot or fine and soft materials in powder, lime, water and shot.
6.- Homogeniser.
7.- Screens.
8.- Pump well.
9.- Pump.
10.- Possible surface free of circulating mud.

Fig. 4 and 5 - Cross-section and plan view of the measurer for volume percentage of shot in mud.

1.- Tube through which the mud circulates.
2.- Shot in suspension of 0.1 to 0.5 ∅
3.- Support reel for the magnetic coils and rings.
4.- Primary and secondary coils. May be just one as in autotransformers.
5.- Magnetic plate in rings and columns. There may be 2, 4 or any other amount.
6.- Electrical connection terminals.
7.- Unit closing screws.
8.- Lids, removable, to ease magnetic plate fitting.

BEST APPLICATION METHOD

[0020] With a large flow of mud, the mixing channel for fine and soft materials is placed higher than the sawing machine feed, the homogeniser is not needed and the mud falls directly onto the sawing machine. The recovered and new shot can be poured into the pump well 1, fig. 1.

[0021] With a small flow, with or without screening, the homogeniser is needed and the schemes in figs. 1 and 2 should be kept to. Replacement of fine and soft materials can be done in all cases in powder or prepared mud.

[0022] Feeding of fine and soft materials into the circuit or a pre-mixer can be done from a hopper or from $1m^3$ sacks with axle-free spiral steel screw tube, worked by a variable speed or two-speed motor or with several feeders, controlled by robot in the same way as water addition and machine advance. In the hopper or sack there will be a 50 Hz vibrator in order to avoid bridge formation.

[0023] The 1^{st} installation can be made provisionally for personal control, but it will be automated straight away.

HOW TO EXPLOIT THE METHOD

[0024] An attempt is to be made to establish contracts with current stone saw operators to participate in the savings that will be produced by applying the method, with or without screening on machines that are working without fine or soft materials, without demanding an advance from the stone saw operators. The work and installation will be done by the patent holder, at a charge, adapting to the characteristics of each plant.

Claims

1. Method for sawing granites and other stones, with shot and mud carrying fine and soft materials characterised by the contents of stone particles being kept high, to the percentage level most convenient in order to allow the lowest sawing cost, pouring off a part of the mud which contains as many stone particles as have been produced by sawing, continuously or frequently, and likewise characterised because the amounts of water, lime, and fine and soft materials that have been poured out of the mud circuit are also replaced continuously or frequently. Also characterised because the composition of the input mud to the machine, excluding shot, can vary between the following lim-

its: stone particles less than 66%; lime water more than 28%; and fine and soft materials more than 6%, all in volume, according the characteristics of the stone and the characteristics and prices of the fine and soft materials.

2. Method for sawing granite and other stones with shot and mud containing fine and soft materials as described in claim 1, characterised because at the sawing machine outlet all the mud is made to pass through a screen with a mesh small enough to be compatible with the lowest sawing cost, which separates the particles of stone not passing the mesh from the mud, from among which the useful shot is recovered and is returned to the mud which has passed through the mesh, characterised also by the screen mesh being in an area free of CO_2.

3. Method for sawing granite and other stones with shot and mud carrying fine and soft materials as described in claims 1 and 2, characterised by the mud circuit being equipped with a channel with high sides and one high end, the other end having an adjustable-height overflow through which excess mud loaded with particles leaves the circuit, characterised by there being, beyond the overflow, in the channel, the arrival inlet for mud loaded with particles coming from the sawing machine, which can be higher, lower or beside, and characterised because, between the inlet of the loaded muds and the other end of the channel, which delivers the muds to a homogeniser and pump well or an outlet to the sawing machine, the new mud or its separated constituents and the shot, recuperated and new, are introduced into the channel.

4. Method for sawing granites and other stones with shot and mud carrying fine and soft materials as described in claims 1 or 2, characterised because the measuring of the shot contents of the mud is done electromagnetically with a transformer whose magnetic circuit is closed through the shot circulating with the mud through a non-magnetisable tube, whose variations in proportion vary the current in the secondary.

5. Method for sawing granites and other stones with mud carrying fine and soft materials as described in claims 1 or 2, characterised by the viscosities of the new mud and all the mud being controlled by the active currents of the motors in the new mud mixer and in the homogeniser or a in a mud pump.

Amended claims under Art. 19.1 PCT

1. Method for sawing granites and other stones, with shot and mud carrying fine and soft materials characterised by the contents of stone particles being kept high, to the percentage level most convenient in order to allow the lowest sawing cost, pouring off a part of the mud which contains as many stone particles as have been produced by sawing, continuously or frequently, and likewise characterised because the amounts of water, lime, and fine and soft materials that have been poured out of the mud circuit are also replaced continuously or frequently. Also characterised because the composition of the input mud to the machine, excluding shot, can vary between the following limits: stone particles less than 66%; lime water more than 28%; and fine and soft materials more than 6%, all in volume, according the characteristics of the stone and the characteristics and prices of the fine and soft materials, and likewise characterised because at the outlet or the slots or the sawing block, the stone particle contents plus shot is equal or greater than 40% in volume.

2. Method for sawing granite and other stones with shot and mud containing fine and soft materials as described in claim 1, characterised because at the sawing machine outlet all the mud is made to pass through a screen with a mesh small enough to be compatible with the lowest sawing cost, in all cases greater than 55 μm, which separates the particles of stone not passing the mesh from the mud, from among which the useful shot is recovered and is returned to the mud which has passed through the mesh, characterised also by the screen mesh being in an area free of CO_2.

Statement under Art. 19.1 PCT

In patent WO9417969A a method is claimed for sawing with muds which contain a low content of sawing detritus - stone particles - in such a way that stone particles plus shot is lower than 40% in volume of the mud, at the outlet of the sawing slots, by which in PCT/ES99/00102 an additional characterisation is introduced in claim 1 in order to point out that contents of stone particles plus shot of 40% in volume at the outlet of the slots is claimed.

In patents ES8702220A and WO9417969A the contents of sawing detritus in the mud is the lowest possible, from 0 to approximately 35% assuming 5% of shot, all in volume, and fine and soft materials are recovered, whereas in PCT/ES99/00102 the opposite is practised. They are three different patents.

In patent EP767035A reference is made to a filter which cuts between 5 and 30 μm, whereas PCT/ES99/00102 refers to a screen with an aperture greater than 55 μm according to the modification introduced here. But furthermore

there are the following differences:

EP767035A	PCT/ES99/00102
cutting with continuous wire	sawing with bands
continual movement	alternating movement
abrasive of 5 to 30 μm	shot of more than 55 μm, up to 1000
suspension in water or oil	suspension in mud of fine and soft material

In the other patents cited in the search no other relationships are observed.

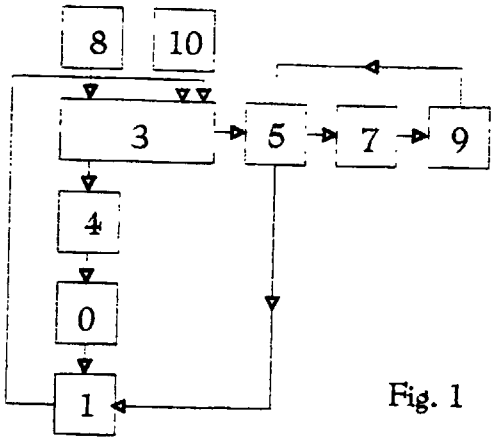

Fig. 1

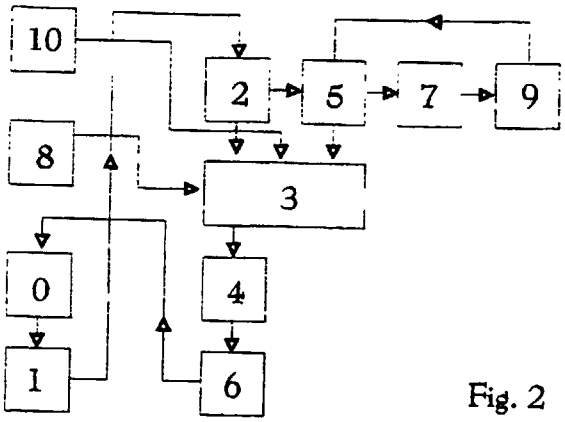

Fig. 2

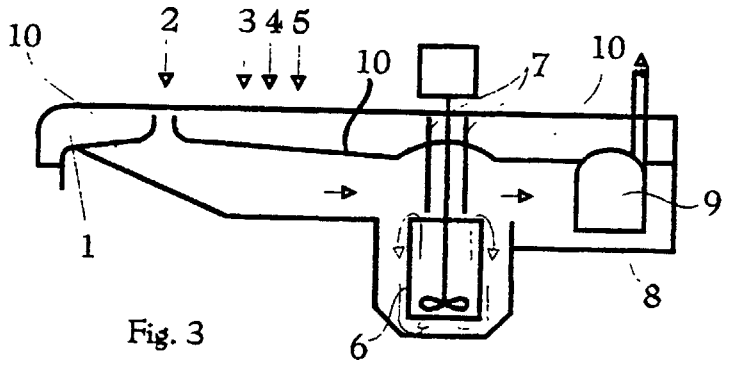

Fig. 3

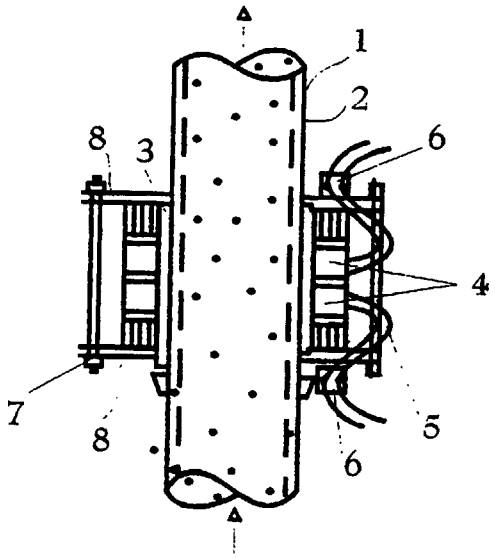

Fig. 4

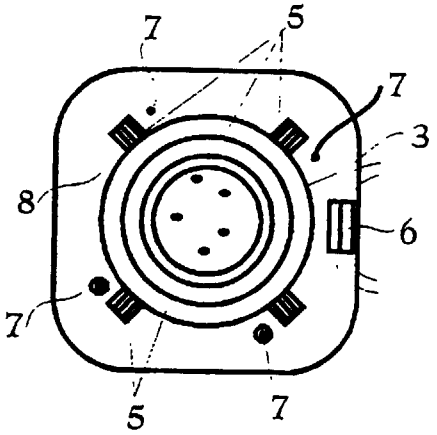

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES 99/00102

A. CLASSIFICATION OF SUBJECT MATTER

IPC^6: B28D 1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^6: B28D, B24B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, PAJ, CIBEPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ES 8702220 A (CASTRO), 16 October 1986 (16.10.86), the whole document	1,4-5
Y	EP 767035 A (TOYAMA), 09 April 1997 (09.04.97), column 1-3, 25-26; figure 1	1,4-5
Y	FR 2578470 A (S.A.R.L.), 12 September 1986 (12.09.86), the whole document	1,4-5
Y	US 4059929 A (BISHOP), 29 November 1977 (29.11.77), columns 1-6	1,4-5
A	EP 445085 A (MAGGI), 04 September 1991 (04.09.91), columns 6-8	1,4
A	US 4762422 A (TONCELLI), 09 August 1988 (09.08.88), the whole document	5
A	WO 9417969 A (CASTRO), 18 August 1994 (18.08.94), pages 9-11; claims 8; figures 17-19	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 1999 (30.06.99)	13 July 1999 (13.07.99)
Name and mailing address of the ISA/ S.P.T.O. Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/ES 99/00102

Patent document cited in search report	Publication date	Patent familiy member(s)	Publication date
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Form PCT/ISA/210 (patent family annex) (July 1992)