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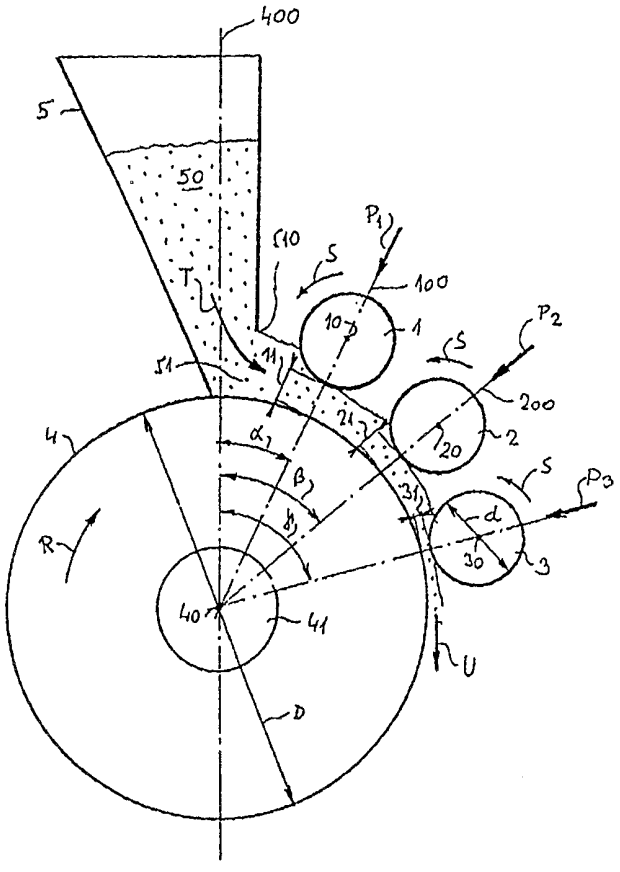
(57) Abstract

The press according to the invention is composed from only one driven roll (4) and at least three not driven milling rolls (1, 2, 3), each one from them is provided with means for their pressing in direction to the axis (40) of driven roll. Their diameters (d) are further according to the invention less or maximally equal to half of diameter (D) of driven roll/4ú and they are located such a way, that between the surface of each from them and between the to them opposite surface of milling roll (4) the idle slots (11, 21, 31) are formed such a way, that each from them is in the direction (R) of rotation of driven roll (4) lesser. The longitudinal axes (10, 20, 30) of milling rolls (1, 2, 3) are laying in the planes (100, 200, 300), which are containing the longitudinal axe (40) of driven roll (4) and they are declined from the vertical plane (400) – which contains also the axis (40) of driven roll (4) – in direction (R) of the rotation of the roll (4). At embodiment with three milling rolls (1, 2, 3) these angles are laying in intervals $\alpha = 0°$ to $15°$, $\beta = 35°$ to $55°$ and $\gamma = 78°$ to $90°$ and their angle position can further individually or in groups adapted.



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MIDDLE PRESSURE MULTI-ROLL PRESS FOR MILLING OF GRANULAR MATERIALS

Technical field of the invention

The invention deals with a middle pressure more roll press for milling of granular materials, especially materials with grindability and different size of grain, where the press is composed from a driven roll and at least two milling rolls, the axes of which are parallel with the axe of driving roll.

The prior art

To fine milling of materials with different hardness and granularity, as are for instance the raw materials for cement production, the cement clinker, lime, limestone, ores and pigments, in these days usually tube - ball mills are usually used or vertical disk refiners, which are combined with the in the same time provided drying of milled raw material.

The disadvantage of ball - tube mills is especially the not symmetrical process of milling, which is caused by undefined contact of the milling filling with the armoring of the grinding mill and with the grist eventually with other bodies, which increase the number of milling contacts. With it the bad energetic effectiveness of the milling is connected.

With use of the recent vertical disk refiners is else possible to increase the milling effectiveness, but for achieving of the desired final parameters the grist has to be supplied under the milling refining discs repeatedly. The corresponding equipment is further of large dimensions, heavy and over saturated with considerable amount of from great part unnecessarily re-circulated material. The duration of the milling is further prolonged by the necessary pneumatic or mechanic

removal of grist, eventually by the combination of both these methods and in the same time the energetic consumption is increased.

At use of roll presses, in which usually forces from 20.000 kN up to 25.000 kN act to the milled material at one pass between the rolls, grits in form of compressed pieces are produced. For creation of grist of final requested properties, that means especially fine grist with mutually segregated grains, it is necessary the formed compressed pieces to de-agglomerate, to sort and eventually to after mill, for instance in ball mills. The system of described equipment is once more demanding for energy consumption. Beside this the roll presses could be applied for hard, brittle material and with low moisture content only.

There is known a milling method for materials with large range of grindability and with different granularity, which is realized in more consecutive steps, and this in system of more middle pressure presses. At realization of this method the milled material is stepwise formed in one step, in the following step is pre milled and calibrated in height and in the third step is after milled. The pressures of milling rolls are stepwise increased in the individual steps and the idle slot sizes are conversely decreased.

The disadvantage at realization of this method of system of known simple eventually double roll presses is namely the necessity of use of additional mechanism for material transfer between the individual grinding steps, what in considerable range disturb the milling process continuity.

The aim of the invention

The disadvantages of the letter mentioned milling method are in considerable extent removed by the object of this invention, which is a middle pressure more roll press for milling, grinding of grainy materials, especially materials with different grindability and different grain size, where the press is composed from a driving roll and at least two milling rolls, the axes of which are parallel to the driven roll axe.

The essence of the invention is that the milling rolls are not provided with own drive, and their diameter is less or equal up to the half of driven roll diameter and they are set mechanically such a way, that between the surface of each of them and the to them opposite milling roll surface idle slots are formed such a way, that each idle slot is in direction of the rotation movement of the driven roll less as to it precedent idle slot and that each from the milling rolls is provided with means for their pressing in direction to the longitudinal axe of driving roll.

An other essence of the invention is that the longitudinal axes are embedded in planes, which are containing the longitudinal axe of driven roll and which are declined from the vertical plane containing the driven roll axe in direction of driven roll axe rotation speed up to stepwise increasing angle α, β, γ, whereas the sizes of angles α, β, γ, which include the individual axes containing the longitudinal axe of according milling roll and the longitudinal driven roll axe to the vertical plane are in the ranges $\alpha = 0^\circ$ to 15°, $\beta = 35^\circ$ to 55°, $\gamma = 75^\circ$ to 90°.

In an advantageous construction version according to invention is the system of at least two milling rolls set on a common body, which is accommodated for angle slight turning around the driven roll longitudinal axe.

The essence of the invention is also that the pressure force of milling roll, which is consecutive in of driven roll rotation speed direction, is greater as the pressure force of previous milling roll. In a favorable version the pressure forces are chosen so, that the pressure force of first milling roll is 15% to 25% and the pressure force of second roll is 250 to 50% of the total of pressure forces, acting to all milling forces. Additionally at least one pressure force can be periodically changeable.

Finally the essence of invention is, that at least one from the milling rolls is set in regard to the driven roll with aid of a self-locking hydraulic circuit.

The use of a middle pressure more roll press according to the invention enables as to its compactness in regard to the up to now known construction versions a systematic milling of material and at the same time increases the energetic effectiveness of the milling process, and this namely such a way that the grist is formed before the transfer in three consecutive continuous steps, that means without transferring between the individual steps, the height of milled layer is systematically decreased and the

influence of milling forces are more times repeated. With stepwise increasing of loading forces with the following releasing is additionally increased the number of active contacts between the grains of milled material, what have a positive result in the process of partial cutting, whereas the not desired compressed pieces - which should be at recent constructions disconnected - are not created.

Summary of Figs on the drawings

Possible variants of constructions of middle pressure more roll press according to the invention are schematically illustrated on enclosed drawings, where on the Fig. 1 the vertical cross section of middle pressure more roll press with three independent milling rolls is demonstrated, on the Fig. 2 the vertical cross section of an other construction version of middle pressure more roll press from the Fig. 1 is demonstrated, and on the Fig. 3 a construction version of middle pressure more roll press according to the Fig. 1 with three connected milling rolls is demonstrated and on the Fig. 4 a vertical cross section of middle pressure more roll press according to the invention and with milling roll connected with an independent self-locking hydraulic circuit is demonstrated.

Examples of embodiment of the invention

An example basic embodiment of the construction of middle pressure more roll press according to the invention is schematically demonstrated on the Fig. 1. The press is composed from a driven roll **4** of diameter **Δ** with a longitudinal axe **40** , which is laying in the vertical plane **400** . The driven roll **4** is set on the co-axial spindle **41** and by mean of this it is coupled with the non demonstrated mechanism for its forced drive for rotation in the direction of the arrow **R** .

As it is further demonstrated on the Fig. 1, three non driven rolls are set in the right upper quadrant in co-axial location with the driven roll **4** , where these rolls are free rotating and serving for milling and have in principle the same diameter **d** , e.g. the

first milling roll 1 with longitudinal axe 10 , the second milling roll 2 with longitudinal axe 20 and the third milling roll 3 with longitudinal axe 30 . The longitudinal axes 10 , 20 , 30 of milling rolls 1 , 2 , 3 are defining together with the longitudinal axe 400 of driven roll 4 the three planes 100 , 200 , 300, which are declined from the vertical plane 400 in direction R of rotation of driven roll 4 with the angles α, β and γ. Each from the milling roll rolls 1 , 2 , 3 are set and turning and together with this setting they are connected with the non demonstrated mechanism, which provides the necessary milling pressure P_1 , P_2 and P_3 . Such mechanism could be for instance a pressing hydraulic mechanism of usual design. The setting of milling rolls is further made such a way, that at their side location in direction of pressures P_1 , P_2 and P_3 , that means in location nearest to the driving roll 4 there are between its surface and between the surface of corresponding milling roll 1 , 2 , 3 a constant idle slots 11 , 21 , 31 formed, and this such a way, that their size is decreasing stepwise in direction R of the driven roll rotation.

The diameter d of milling rolls 1 , 2 , 3 is always less as the diameter D of driven roll 4 , in an advantageous embodiment it is in the range of relation D:d = 2 to 4.

An other part of middle pressure more roll press according to the invention is the storage 5 with the grist 50 and with the output slot 51 , provided with the output edge 510 . The storage 5 is at the described example embodiment set over the driven roll 4 , namely in the area of vertical plane 400 .

The construction according an other example embodiment of middle pressure more roll press according to the invention is schematically demonstrated on the Fig. 2. As it is evident, this in the principal design parameters equal with the construction according to the Fig. 1. It differs from it with it, that the plane 100 , in which the longitudinal axe 10 of first non driven milling roll 1 is laying, in this case is laying in the vertical plane 400 , so the angle $\alpha = 0^\circ$ and the corresponding planes 200 , 300 of second milling roll 2 and of the third milling roll 3 are declined from the vertical plane 400 with the angel $\beta = 45^\circ$ and $\gamma = 90^\circ$. An other construction element is, that the grist storage 5 is declined against the driven roll 4 rotation direction R . The principle of

stepwise decreasing of idle slots 11 , 21 , 31 , described at the first example embodiment remains at this embodiment preserved.

As it is demonstrated on the Fig. 2 with dashed lines, this example embodiment can be completed with a sorting system 7 with sorter 70 , for instance with air sorter and a returning transport element 700 which is ended in the storage 5.

The example embodiment according to the Fig. 3 differs from the previous ones principally in it, that the three milling rolls 1 , 2 and 3 - which are mutually turned in relation to the vertical plane 400 with angles α, β and γ -are set together with aid of the body 6, which is set swinging in relation to the longitudinal axe 40 of driven axe 4. The body 6 does not hang together with the essence of the invention and it is provided from one hand with not demonstrated means for setting of milling rolls 1, 2, 3 , and from other hand with means for setting of angle position of the assembly in the angle + - δ in comparison to the vertical plane 400. The function of here also not driven milling rolls, their pressure forces P_1 , P_2 and P_3 , realized with known, for instance hydraulic means, and also the setting of their - on the Fig. 3 not demonstrated - idle slots remains the same.

It is evident, that the design can be, without influence to the essence of the invention, modified for mutual connection of less number of milling rolls 1 , 2 and 3.

The milling rolls 1 , 2 and 3 are generally free turning, in an alternative version, which is not demonstrated on the Figs, at least one from them can be braked, and this mechanically or hydraulically, electrically, etc.

On the Fig. 4 is schematically demonstrated the example embodiment version for regulation of the pressure force of milling roll by mean of a self-locking hydraulic circuit 8 , which is generally created according to an older patent AO 244 268. For increasing of the clarity is this modification demonstrated and described in connection to the first milling roll 1 and to it acting pressure force P_1 only.

To the driven roll 4 with longitudinal axe 40 and spindle 41 the first milling roll 1 with longitudinal axe 10 , which is revolving on the hinge 12 , is turned. The pressure force P_1 , acts similarly as at previous example embodiments in the plane 100 , which is defined by the longitudinal axe 10 of first milling roll 1 and longitudinal axe 40 of driven roll 4 . On the opposite side of driven roll 4 there is co-axially with the first

hydraulic cylinder 13 the additional hydraulic 81 located, with piston 810 and with piston rod 811 , which is leant to the suspension 80 , which is connected with the non demonstrated press body according to the invention , for instance with aid of the spindle 41 of driven roll such a way, as it is demonstrated on the Fig. 4. The areas above both pistons, e.g. above piston 130 of first hydraulic cylinder 13 and above piston 810 of additional hydraulic cylinder 81 are mutually interconnected with interconnecting tube 82 , to which the switching element 820 is inserted, where this element does not hang together with the object of invention and therefor it is demonstrated on the Fig. 4 schematically only.

The middle pressure more roll press according to the invention will work according to the Fig. 1 as follows. The grist of middle grindability, composed for instance from material of same kind, as cement clinker with middle value of 80 Hg (Hardgrove) and with grains with size range from 0.1 mm to 45 mm, acquired as output raw material from the not demonstrated rotary kiln, is stored in the storage 5 . From it is supplied through natural way in direction of arrow T and through the output slot 51 to the surface of driven roll 4 , and this in a layer, the thickness of which is determined by the properties of grist and also by co-influence of the driven roll 4 rotation speed and the width of output slot 51 with the output edge 510 .

Under the influence of the driven roll 4 rotation in the direction of arrow R and of the following contact with the first milling roll 1 , which starts at contact with grist 50 to revolving in direction of the arrow S , the input layer of grist 50 is pulled in the first idle slot 11 , where the first milling phase - the forming - is realized by the mutual influence of both rolls and the pressure force P_1 . Namely here is realized the destruction of greater grains of grist 50 , which is then coming out from the area of first milling roll 1 in a layer with lesser grain size differences of milled material and the thickness of which corresponds at least to the size of first idle slot 11 . After passing the first milling roll 1 the pressure to the formed grist 50 will be released and the layer is taken away with the corresponding part of driven roll 4 surface and is transported to the second milling roll 2 , the idle slot of which is lesser as at the previous one - the first milling roll 1 , and so it is lesser as the thickness of layer from the previous milling stage.

The second milling roll 2 , which is turning once more in the direction of arrow S , is acting to the formed grist 50 by mutual influence of the surfaces of driven roll 4 and the second milling roll 2 , the lesser idle slot 21 and the greater pressure force P_2 such a way, that it will be pre milled and it will be better calibrated in height. The output layer of grist 50 with a lesser thickness passes after repeated releasing from the pressure force P_2 to the third milling roll 3 , where then under influence of the pressure force P_3 , which once more greater as in the previous stage, and under influence of once more lesser idle slot 31 , the final after milling of grist 50 , will be realized, and then it will without restraint fall out in direction of the arrow U to further technological processing.

By setting of mutual angle locations of individual milling rolls 1 , 2 , 3 and by changing of their pressure forces P_1 , P_2 , P_3 it is possible to arrange the equipment working conditions for to work in optimal way considering the processed grist and to its eventual character changes, especially to change of granularity range. The arrangement of working conditions can be made also continuously according to actual situation and this using usual regulation elements and circuits.

The middle pressure more roll press according to Fig. 2 is working generally similarly to the previous example embodiment. In this example embodiment the grist is for instance cinder with a middle grindability of 35 Hg and with grain size from 0.1 mm to 5 mm. As to the greater mutual angle distances of milling rolls 1 , 2, 3 , where at this version their generally limit angle location are used, the grist 50 after passing between the individual milling phases is transported in direction R of the rotation of driven roll 4 for a longer period of time and for this reason it is released from the previous pressure phase longer as it had been at previous example. This fact contributes to a more favorable realization of next milling step, and this especially in cases, when a mixture of materials of different hardness and different granularity of individual components is entering into the milling process, for instance when the grist is a mixture of blast furnace cinder, of cement clinker and gypsum at preparation of blast furnace cinder cement.

The processed grist is coming out generally by free fall in direction of arrow U and it is once more transported to further technologic step. In case of existence of a

fraction with greater granularity the coming out grist is transported to a sorting system 7 , where its sorter 70 separates the desired fine fraction, where this is the led once more in direction of arrow U . The undesirable rough fraction is then transported outside the sorting system 7 and with the returning transport mean 700 returned to the storage 5 , as it is on the Fig. 2 demonstrated with dashed line. The greater angle distance of milling rolls 1 , 2 , 3 also enables to enter the finer fraction, separated in the sorting system 7 to an other as first milling step. It enables also to transport it to such step an independent component of the mixed grist 50 .

The function of middle pressure more roll press according to Fig. 3 is generally the same as at design according to Fig. 1. With the possibility of adjustment of angle location of all three milling rolls 1 , 2 , 3 in whole with a slight turning of the body 6 with an angle + γ it is but possible to adjust namely the input conditions to he system of milling rolls 1 , 2 , 3 to lesser continuous character changes of grist 50 .

At realization of requested constant pressure force, for instance of pressure force P_1 through self-locking hydraulic circuit according to Fig. 4, is the influence of here demonstrated circuit according to invention AO 244 268 the following. At open regulation member 820 the areas of first hydraulic cylinder 13 over the piston 130 and the area of additional hydraulic cylinder 81 over its piston 810 are mutually interconnected. The circuit is with here not demonstrated means set under pressure such a way, that the piston 130 is acting to the first milling roll 1 with a pressure force P_1 of requested size. That means also, that in the whole hydraulic system there is a constant pressure. At input of a thicker grist layer under the first milling roll 1 the piston 130 is shifted against the acting pressure force P_1 . Its value would undesirably changed this way at use of usual hydraulic pressing system. But it is not the situation at system according to the Fig.4, as the relatively great movement of piston 130 of first hydraulic cylinder 13 is compensated by the system of additional hydraulic cylinder 81 .

It is evident, that the solution of construction of middle pressure more roll press according to the invention is not limited to the here described example embodiments. So it is possible without change of the essence of invention to build a construction with greater number of milling rolls, eventually to accommodate the construction for independent setting of angle location of individual milling rolls 1 , 2 , 3 . It is possible

also, especially at convenient input conditions of the grist **50** given under the milling rolls **1** , **2** , **3** , for instance when the diameter **d** of one from them is relatively to the diameter **D** of driven roll great and when additionally the maximal grain size of grist **50** is not great, to adapt the setting of at least one milling roll, for instance the second milling roll **2** such a way, that it will be braked. In such case also shearing tension is arising in the milling area, where such shearing tension contributes to the desirable disconnection of grist **50** grains. Also the diameters **d** of milling rolls **1** , **2** , **3** have not to be the same and they can be adapted to the working conditions in the individual milling steps.

As last but not least, also the equipment for creation of desirable pressure forces P_1 , P_2 , P_3 can be adapted, or at least one from them such a way, that its value will be periodically changing.

The industrial applicability

The middle pressure more roll presses according to the invention can be used as integral part of technological equipment at mass production of powdered materials, especially at milling of materials with different granularity and great range of grindability, for instance as a part of cement production, at production of cement clinker with cinder addition etc.

(Patent claims)

Claims

1. A middle pressure more roll press for milling of granular materials, especially with different range of grindability and different grain size, composed from a driven roll and at least two milling rolls, the axes of which are parallel with the driven roll axis, ***characterized in that*** the milling rolls (1,2,3) are not equipped with own drive, their diameter (d) is less or maximally equal to one half of the diameter (D) of driven roll (4) and that they are mechanically distributed such a way that between the surface of each from them and between the to them opposite surface of milling roll (4) the idle slots (11, 21, 31) are formed such a way, that each idle slot (21, 31) is in the direction (R) of rotation of driven roll (4) lesser as to it precedent idle slot (11, 12), and that each from the milling rolls (1,2 ,3) is provided with means for creation of pressure force in direction to the longitudinal axe (40) of driven roll (4).

2. A middle pressure more roll press according to the claim 1, ***characterized in that*** the longitudinal axes (10, 20, 30) of milling rolls (1, 2, 3) are laying in planes (100, 200, 300), which include the longitudinal axe (40) of driven roll (4) and that they are declined in direction (R) of the rotation of driven roll (4) with a stepwise increasing angle (α, β, γ) from the vertical plane (400), which includes the axis (40) of driven roll (4),

3. A middle pressure more roll press according to the claim 1 or to claim 2, ***characterized in that*** the values of angles (α, β, γ), which are between the individual planes (100, 200, 300) and the vertical plane (400) are in the range $\alpha = 0^\circ$ to 15°, $\beta = 35^\circ$ to 55°, $\gamma = 78^\circ$ to 90° and where the planes (100, 200, 300) include the longitudinal axe (10, 20, 30) of corresponding milling roll (1, 2, 3) and the longitudinal axe (40) of driven roll (4).

4. A middle pressure more roll press according to one from the claims from 1 to 3, ***characterized in that*** the system of at least two milling rolls (1, 2, 3) is set on

common body (6), which is accommodated for slight angle turning around the longitudinal axe (40) of driven roll (4).

5. A middle pressure more roll press according to one from the claims from 1 to 4, ***characterized in that*** the pressure force (P_2, P_3) of milling roll (2, 3), following in direction (R) of the rotation of driven roll (4) is greater as the pressure force (P_1, P_2) of previous milling roll (1, 2).

6. A middle pressure more roll press according to claim 5, ***characterized in that*** the pressure force (P_1) of first milling roll (1) is 15% to 25% and the pressure force (P_2) of second milling roll (2) is 25% to 50% from the total of pressure forces (P_1, P_2, P_3), which are acting to all milling rolls (1, 2, 3).

7. A middle pressure more roll press according to one from claims 1 to 6, ***characterized in that*** at least pressure force (P_1) is periodically changing.

8. A middle pressure more roll press according to one from claims 1 to 7, ***characterized in that*** at least one from milling rolls (1, 2, 3) is set in regard to the driven roll (4) with aid of a self-locking hydraulic circuit (8).

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/CZ 00/00015

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B02C4/02

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 7 B02C

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 practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 025 623 A (F.J. STRAUB) 24 December 1935 (1935-12-24) page 2, left-hand column, line 54 -right-hand column, line 32	1,2
Y		5
A		3,4,6-8

Y	DE 38 23 929 A (SMIDTH & CO AS F L) 23 February 1989 (1989-02-23) column 5, line 61 -column 6, line 38; examples 2-4	1,2,5
A		7,8

Y	DE 17 96 963 U (ESCH-WERKE KG.) 1 October 1959 (1959-10-01) the whole document	1,2,5

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 31 805 C (CH. MOREL) 10 June 1885 (1885-06-10) the whole document	1,2,5
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 270 (C-1063), 26 May 1993 (1993-05-26) & JP 05 007784 A (SUMITOMO JIYUUKIKAI CHIYUUTAN KK), 19 January 1993 (1993-01-19) abstract	4
A	US 3 372 878 A (VERDIER ANDRE LOUIS) 12 March 1968 (1968-03-12) column 5, line 15 -column 6, line 9; figures 3,4	1,8

1

INTERNATIONAL SEARCH REPORT

.nformation on patent family members

Inter ›nal Application No
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