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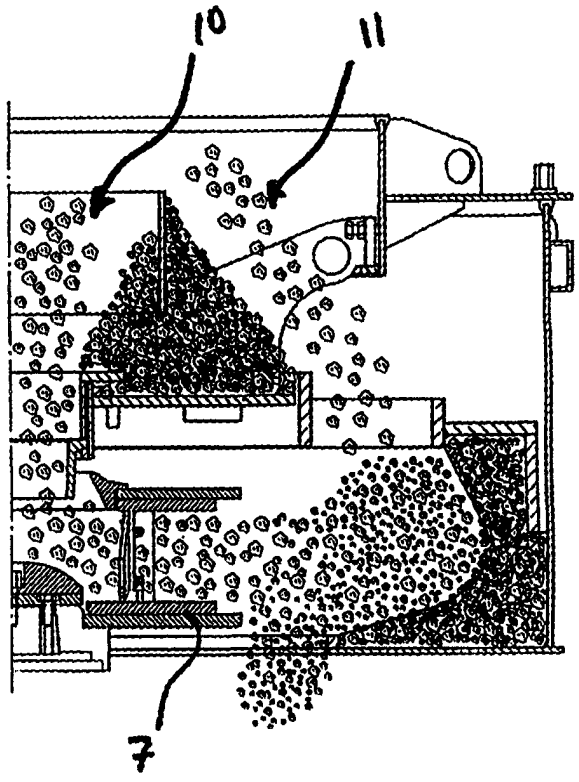
(54) Title: ROTOR FLOW MATCHING TO MINERAL BREAKING CHAMBER

(57) Abstract

In a rotary mineral crusher a method of either localising the wear on a weir tip (1) in the crusher and/or focusing the output of the rotor (7) into its interaction chamber and/or reducing mineral erosion of the exterior of the rotor (7) by mineral piece particles energised by the output from the rotor (7). The rotary mineral crusher is of a kind having a rotor (7) into which the mineral pieces to be reduced in size, that is crushed, are fed from above and at least substantially axially over the axis of rotation of the rotor (7) to thereafter migrate on an acceleration locus or loci of migration there retained bed or retained beds of mineral pieces from the rotor (7) substantially radially of the rotor (7) into the surrounding interaction chamber capable of retaining the lining of the mineral material. The method comprises or includes retaining the, or each, rotor (7) retained bed of mineral pieces with weir-like means defining a sacrificial edge or weir tip (1) over at least substantially the transverse extend of a migration locus at each edge. The sacrificial edge is of the form which allows an enhanced flow of mineral pieces over a preferred region of the sacrificial edge without reliance for such enhanced outflow (2), on a symmetric "V" or "U" or scallop. The means to retain the lining of mineral pieces of the surrounding interaction chamber is also configured so as to provide a preference for interaction of mineral pieces in a zone of the surrounding chamber adequately lined with such mineral pieces. Optionally, there is also provided shielding means (5, 6) to at least substantially confine the mineral pieces of the interaction zone from the rotor (7), save over the enhanced outflow (2) focus, and thereof at least towards the retained lining of the mineral pieces of the interaction chamber.



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ROTOR FLOW MATCHING TO MINERAL BREAKING CHAMBER

TECHNICAL FIELD

The present invention relates to improvements in and/or relating to mineral breakers.

BACKGROUND OF THE INVENTION

Our mineral breaker was first disclosed in Australian Patent Specification No. 463819. Such a mineral breaker was revolutionary at the time since it embodied a system whereby a plurality of the mineral beds are defined within a rotating element (rotor) thus ensuring the majority of the wear (save for a hardened wear tip) is of mineral against mineral.

Enhancements of the original machine are disclosed in our New Zealand Patent Specification No. 198307 (AU 557168), 201190 (EPO 101277 and AU 562251), 201418, 213510, 217752, 217753, 222648 and 250027 (WO 95/11086).

Our New Zealand Patent Specification 201190 discloses an improvement whereby, as an enhancement, a hardened wear tip blade is mounted within a recess at the edge of a carrier which is to be positioned at a position where, in the manner of a weir, the smaller pieces of mineral overflow to exit the device.

US Patent 2992783 (Wirth et al) also show a mineral breaker of a kind having a substantially vertical axis feed into a rotor.

US Patent Specification 4940188 of J Rodriguez and D Rodriguez discloses yet a further refinement of the system. This US Patent discloses the use of a weir member which acts substantially as a straight edged wear tip but which better manages the weir erosion.

New Zealand Patent Specification 248953 (WO 95/10358) Tidco International Limited discloses yet a further refinement of the weir tip aspects.

In our WO 95/11086 there is disclosed and claimed a variety of tip defining assemblies for inclusion in a rotor of such a mineral breaker, the weir-like edge being configured, assembled or otherwise arranged to provide a region of flow enhancement such that a greater depth of mineral pieces passes over that edge region favoured to be eroded and to retain a bed of material having a transverse surface conforming to the weir-like

edge. Symmetric contours for such a weir-like edge are defined with the preferred forms being to a V, U or other scalloped configuration.

Attention is also drawn to our as yet unpublished New Zealand Patent Specification Nos. 229518 and 299299 and to our unpublished patent specification being filed simultaneously herewith.

The full content of all of the aforementioned specifications is hereby here included by way of reference.

The present invention is therefore directed to providing at least one of a number of possible advantages through localising or focusing the radial high energy streams from the rotor in a rotary mineral crusher where such output high energy materials are to impact mineral pieces within a surrounding crushing chamber. Preferably such a chamber is lined with a lining or bed of mineral pieces (irrespective of whether or not there is a secondary or by-pass flow of other pieces into such a chamber that by-passes the rotor) and from which chamber there is an exit for at least one stream of material of reduced average particle size to that of the original infeed material into the rotor and/or by-passing the rotor into the crushing chamber.

BRIEF SUMMARY OF THE INVENTION

Accordingly in a first aspect the invention consists, **in a rotary mineral crusher, a method** of any one or more of

(i) localising wear on a wear tip in the crusher,

(ii) focusing the output of the rotor into its interaction chamber, and

(iii) reducing mineral erosion of the exterior of the rotor by mineral particles energised by the output from the rotor,

said rotary mineral crusher being of a kind having a rotor into which mineral pieces to be reduced in size (ie: "crushed") is fed from above and at least substantially axially of the axis of rotation of the rotor to thence migrate on an acceleration locus or loci of migration via a retained bed or retained beds of mineral pieces from the rotor substantially radially of the rotor into a surrounding interaction chamber capable of retaining a lining of the mineral material,

said method comprising or including

retaining the or each rotor retained bed of mineral pieces with weir-like means

defining a sacrificial edge (the "wear tip") over at least substantially the transversal extent of the migration locus at each such edge, said sacrificial edge being of a form which allows an enhanced outflow of mineral pieces over a preferred region of the sacrificial edge without reliance for such enhanced outflow on a symmetric "V", "U", or scallop form, and

configuring the means to retain the lining of mineral pieces of the surrounding interaction chamber so as to provide a preference for interactions of mineral pieces in a zone of the surrounding chamber adequately lined with such mineral pieces, and

optionally, providing shielding means to at least substantially confine the mineral pieces of the interaction zone from the rotor save over the enhanced outflow focused band(s) thereof at least towards the retained lining of mineral pieces of said surrounding interaction chamber;

Preferably there is the additional step of providing interaction zone confinement means (eg: shielding means) to reduce the opening available for the outflow stream of mineral pieces to enter into the surrounding interaction chamber with its retained mineral piece lining.

Preferably said interaction zone confinement means are stationary.

Preferably said interaction zone confinement means is or are in addition to said shielding means.

Preferably said shielding means is or are stationary.

In a further aspect the present invention consists in **a rotary mineral crusher** modified so as to perform inevitably a method as previously set forth.

In still a further aspect the present invention consists in, **in a rotary mineral crusher**,

the provision of

a rotor in to which mineral to be crushed is fed at least substantially axially of the substantially horizontally rotating rotor to thence migrate on an acceleration locus (or loci) of migration via a weir-like member/assembly retained bed of mineral pieces (or a plurality thereof) to flow from the rotor substantially radially of the rotor, and

a surrounding interaction zone defined by static means capable of retaining a lining of mineral pieces,

the construction and arrangement being such that each said weir-like

member/assembly provides other than with a simple vertical sacrificial (preferably hardened edge) over the full transverse extent of said migration locus at such edge means (not a symmetric "v", "u" or scallop form but can be a straight edge that is not vertical or parallel to the rotor axis) which enhances the outflow of mineral pieces over one specific region of such edge or several specific regions of the edge.

Preferably said lining of mineral pieces are confined by means, top and/or bottom, to reduce the opening to the lining for the outflow stream of mineral pieces.

Preferably there is shielding means between said rotor and the lining to at least reduce contact of the rotor by mineral pieces once they have entered the interaction zone.

Preferably the arrangement is as depicted in any one of the following drawings.

Preferably said weir-like member/assemblies are in any of the form insofar as type, material, or mounting is concerned as defined in any one of the earlier mentioned patent specifications but which asymmetric in the form of the edge when viewed as it will be positioned into the locus of migration eg; half a v, half a u or some other scallop form (eg; a step form).

Some asymmetric forms may even be some of those non symmetric forms included in Figure 13 of our NZ Patent Application filed simultaneously herewith.

As used herein throughout the terms "crushing", "mineral", are to be construed broadly. "Mineral" includes within its scope any material capable upon mutual collision with like materials of disintegrating into smaller pieces. "Crushing" clearly embodies other than crushing under sheer weight. "Crushing" is used to describe size reduction as a result of single or multiple interactions between different pieces of the material.

In a further aspect the present invention consists in **a method** as previously defined comprising the additional step of providing means to reduce the opening available for the outflow stream of mineral pieces to enter, (e.g. preferably one or two lips) into the crushing chamber with its retained mineral piece lining.

In addition preferably there is the step (by providing a shroud or shield that remains during use in fixed relationship with the means that retains the lining) of minimising the effect of rebounding mineral pieces or deflected mineral pieces on the exterior of the rotor at least on those surfaces thereof above and below any at least one circumferential or peripheral port defined adjacent or in part by said weir-like member(s)/assembly(s).

In still a further aspect the present invention consists in **apparatus and/or method(s)** substantially as herein described with reference to any one or more of the accompanying drawings.

In a further aspect the present invention consists in **a tip defining component or assembly** for inclusion in a rotor of a mineral breaker, said tip being engageable directly to or via a holder to the rotor to define a weir-like edge that extends substantially transversely of the direction from which mineral pieces in use are to overflow from a retained bed thereof, said edge being **characterised in that** it is configured, assembled or otherwise arranged to provide a region of flow enhancement such that a concentrated stream of mineral pieces passes preferentially over that part of the edge region, said weir-like edge not being symmetric in that transverse view.

Preferably the top defining component or assembly is of any of the kinds generally as described in any one of the aforementioned patent specifications but which includes therein a change configuration to at least the primary wear tip thereof so as to provide by its asymmetry the desired concentration or focusing of the stream.

The present invention also consists in the use of apparatus of the present invention.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred forms of the present invention will now be described with reference to the accompanying drawings in which;

Figure 1 is a perspective view of apparatus typical of that marketed by this company as a rotary mineral crusher under the BARMAC™ trade mark,

Figure 2 is an elevational cross-section of part of the assembly as shown in Figure 1 showing how the extremity of the rotor and its outlet port for material accelerated into an outward radial flow (from its original gravity assisted axial feed into the rotor) is flung into a reaction chamber or zone (the crushing chamber) which is to define a stationary bed for containing the mineral piece interactions as well as for providing a surface for

impacting prior to cascading of broken pieces downwardly from the chamber,

Figure 3 shows the normal mode of operation by reference to the stationary bed of the reaction chamber and the material outflow when the apparatus typified by that of Figure 1 is being operated with a single feed, i.e. the axial feed down into the rotor,

Figure 4 is a similar view to that of Figure 3 but showing the greater number of interactions that occurs when some of the in feed of mineral pieces is diverted to bypass the rotor and enters directly into the reaction or interaction chamber, the downward outlet from the interaction chamber being shown by reference to the downwardly moving broken down pieces,

Figure 5 is a similar view to that of Figure 2 but showing a flow path for rotor flung mineral pieces into the interaction zone where the wear-like edge is vertical, i.e. the mineral that flung outwardly from each outlet port of the rotor over the full depth of the rotor,

Figure 5A shows the straight edge preferably a sacrificial hardened edge, e.g. with carbide of the wear-tip assembly, typically used in such apparatus,

Figure 6 is a similar view to that of Figure 5 but showing the more focused and narrow in extend outflow of mineral pieces from the rotor where a "V" tip of a kind as disclosed in (by way of example our PCT/NZ94/00111 (WO95/11086) patent specification),

Figure 6A shows the preferred "V" configuration of such a wear-tip,

Figure 7 is a similar view to that of Figure 6 but shown how such a focused flow path from the rotor allows rotor shields to extend both downwardly and upwardly to prevent mineral pieces in the interaction zone from easily impacting back against erodible metal regions of the high speed rotor, such shields preferably being stationary,

Figure 8 shows a retained bed of preferred form of rotor tuned in accordance with the technology being disclosed in the patent application being filed simultaneously herewith, the geometries at the weir-like edge and the trailing geometry being such as to tune the retained bed(s) of the rotor to encourage a sweeping downward curving flow over the retained bed so as to exit at a "focused" region that has been focused between a bottom plate (which itself may be optionally protected) or which may be protected by some measure of enhanced bed retention at lower edges by using an asymmetric "V" wear-tip

(all as disclosed in the patent specification being filed simultaneously therewith by us) and which can if desired include a step down plate or other rotor element or elements so as facilitate a greater sweep without too much rotor depth,

Figure 9 is a similar view to that of Figure 7 but showing how the tuned bed and asymmetric wear-tip of Figure 8 modifies the focus of the flow but still enables the use of a downwardly extending stationary shroud or shield for the rotor,

Figure 9A shows in a manner similar to that of Figures 5A and 6A the preferred asymmetric edge of the wear-tip.

DETAILED DESCRIPTION

The description of the present invention will be described by way of example only in respect of a BARMAC™ machine of a kind as depicted in Figure 1. Any of the prior art or other forms of such rotary mineral crusher lend themselves to the incorporation of the apparatus, methods and procedures of the present invention.

The present invention recognises that by appropriate use of a focusing wear-tip 1 (see Figure 6, 6A and Figure 7) - preferably a substantially symmetric "V"- a focused outflow 2 occurs as opposed to the non-focused outflow 3 (see Figure 5) which occurs when a straight vertical edge 4 for a wear-tip is utilised. This therefore allows the utilisation of stationary upwardly extending shields 5 and downwardly extending shields 6 to protect the rotor 7.

In alternative forms such as those disclosed by reference to Figure 8 (and incorporated in our patent specification filed simultaneously herewith, the full content of which is thereby here included by way of reference) asymmetric wear-tip forms such as shown in Figures 9 and 9A lend themselves to a differently focused outflow path 9.

The rotor 7 outwardly flings material pieces as shown in Figures 3 and 4 which are the primary axial feed mineral pieces. When the apparatus is being operated in the by-pass dual flow mode (as shown in Figure 2) an outward by-pass flow of, for example, 10% of the overall mineral piece flow enhances interactions, this by-pass flow 11 (as depicted in Figure 4) greatly increasing the number of pieces in the interaction zone or crushing chamber.

The focused stream and matching tighter crushing chamber made possible is to make greater usage of the kinetic energy of the outwardly accelerated pieces from the rotor

7.

In Figures 1 and 2 stationary members 12 hold a stationary receptor bed of mineral pieces accessible by the energised mineral pieces only via the annular outlet 13 into the interaction chamber 14. These members 12 define a retained bed as shown as 15 in Figure 3 and in Figure 9.

As depicted (eg; see Figure 5) the exiting material is much narrower and more dense in its energised outflow. This enables the use of a tighter crushing chamber for more efficient crushing.

The narrower exit path also lends itself to the use of the rotor shields (such as 5 and 6) depicted.

The preferred embodiment shown enables

(i) a reduction in input energy to achieve the same number of mineral breaking interactions,

(ii) a reduction in wear from decelerated or rebounding mineral pieces or chips on the rotor, and

(iii) more localised wear only on sacrificial (yet hardened) regions of the wear tops which preferably are easily changeable.

WHAT WE CLAIM IS:

1. In a rotary mineral crusher, **a method** of any one or more of

(i) localising wear on a wear tip in the crusher,

(ii) focusing the output of the rotor into its interaction chamber, and

(iii) reducing mineral erosion of the exterior of the rotor by mineral particles energised by the output from the rotor,

said rotary mineral crusher being of a kind having a rotor into which mineral pieces to be reduced in size (ie: "crushed") is fed from above and at least substantially axially of the axis of rotation of the rotor to thence migrate on an acceleration locus or loci of migration via a retained bed or retained beds of mineral pieces from the rotor substantially radially of the rotor into a surrounding interaction chamber capable of retaining a lining of the mineral material,

said method comprising or including

retaining the or each rotor retained bed of mineral pieces with weir-like means defining a sacrificial edge (the "wear tip") over at least substantially the transversal extent of the migration locus at each such edge, said sacrificial edge being of a form which allows an enhanced outflow of mineral pieces over a preferred region of the sacrificial edge without reliance for such enhanced outflow on a symmetric "V", "U", or scallop form, and

configuring the means to retain the lining of mineral pieces of the surrounding interaction chamber so as to provide a preference for interactions of mineral pieces in a zone of the surrounding chamber adequately lined with such mineral pieces, and

optionally, providing shielding means to at least substantially confine the mineral pieces of the interaction zone from the rotor save over the enhanced outflow focused band(s) thereof at least towards the retained lining of mineral pieces of said surrounding interaction chamber.

2. A method of Claim 1 wherein there is the additional step of providing interaction zone confinement means to reduce the opening available for the outflow stream of mineral pieces to the retained mineral piece lining of the surrounding interaction chamber.

3. A method of claim 2 wherein said interaction zone confinement means are stationary.

4. A method of claim 2 or 3 wherein said interaction zone confinement means is or are in addition to said shielding means.

5. A method of claim 4 wherein said shielding means is or are stationary.

6. A rotary mineral crusher having a rotor in to which mineral to be crushed is fed at least substantially axially of the substantially horizontally rotating rotor to thence migrate on an acceleration locus (or loci) of migration via a weir-like member/assembly retained bed of mineral pieces (or a plurality thereof) to flow from the rotor substantially radially of the rotor, and

a surrounding mineral piece interaction zone defined by static means capable of retaining a lining of mineral pieces,

the construction and arrangement being such that each said weir-like member/assembly provides other than with a simple vertical sacrificial edge at least substantially over the full transverse extent of said migration locus at such edge means (not a symmetric "V", "U" or scallop form but can be a straight edge that is not vertical or parallel to the rotor axis) which enhances the outflow of mineral pieces over one specific region of such edge or several specific regions of the edge.

7. A crusher of claim 6 wherein the arrangement is as depicted in any one of the following drawings.

8. A crusher of claim 6 wherein said lining of mineral pieces are confined by means, top and/or bottom, to reduce the opening to the lining for the outflow stream of mineral pieces.

9. A crusher of claim 6 or 8 wherein there is shielding means between said rotor and the lining to at least reduce contact of the rotor by mineral pieces once they have entered the interaction zone.

10. Apparatus substantially as herein described with reference to any one or more of the accompanying drawings.

11. A tip defining component or assembly for inclusion in a rotor of a mineral breaker, said tip being engageable directly to or via a holder to the rotor to define a weir-like edge that extends substantially transversely of the direction from which mineral pieces in use are to overflow from a retained bed thereof, said edge being characterised in that it is configured, assembled or otherwise arranged to provide a region of flow enhancement such

that a concentrated stream of mineral pieces passes preferentially over that part of the edge region, said weir-like edge not being symmetric in that transverse view.

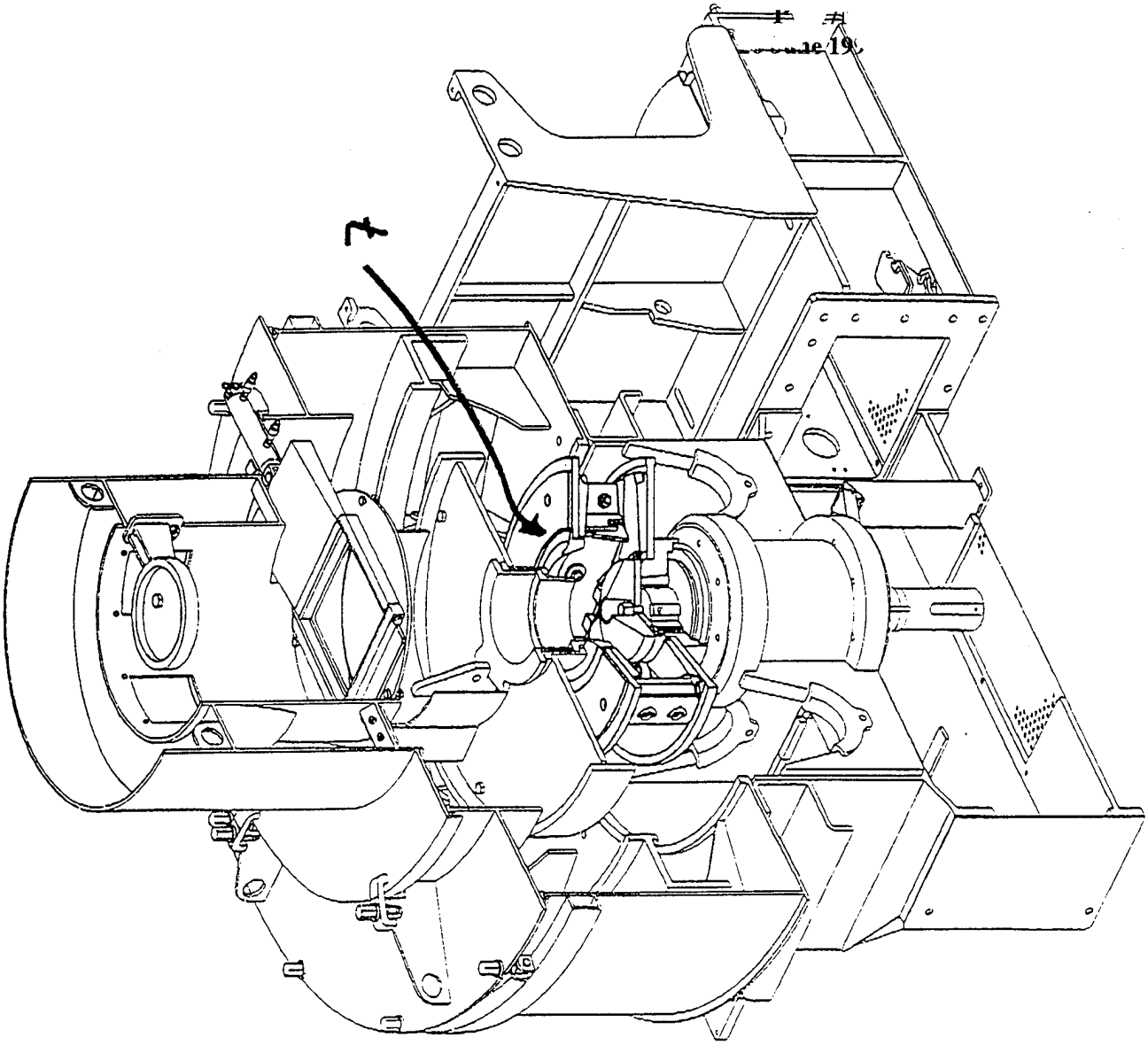

FIG 1

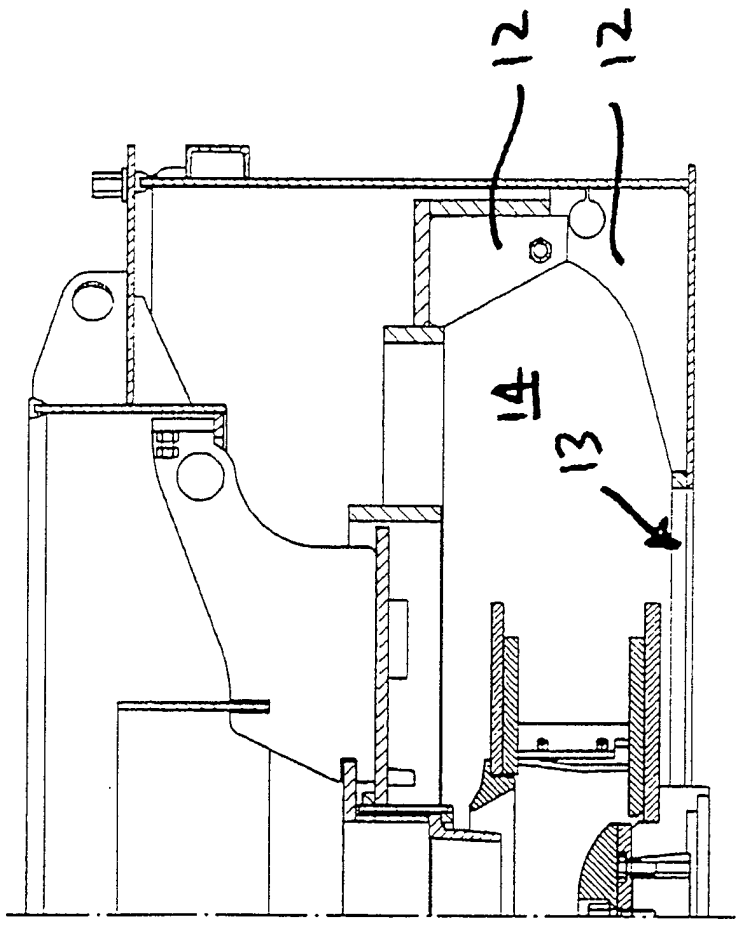

FIG 2

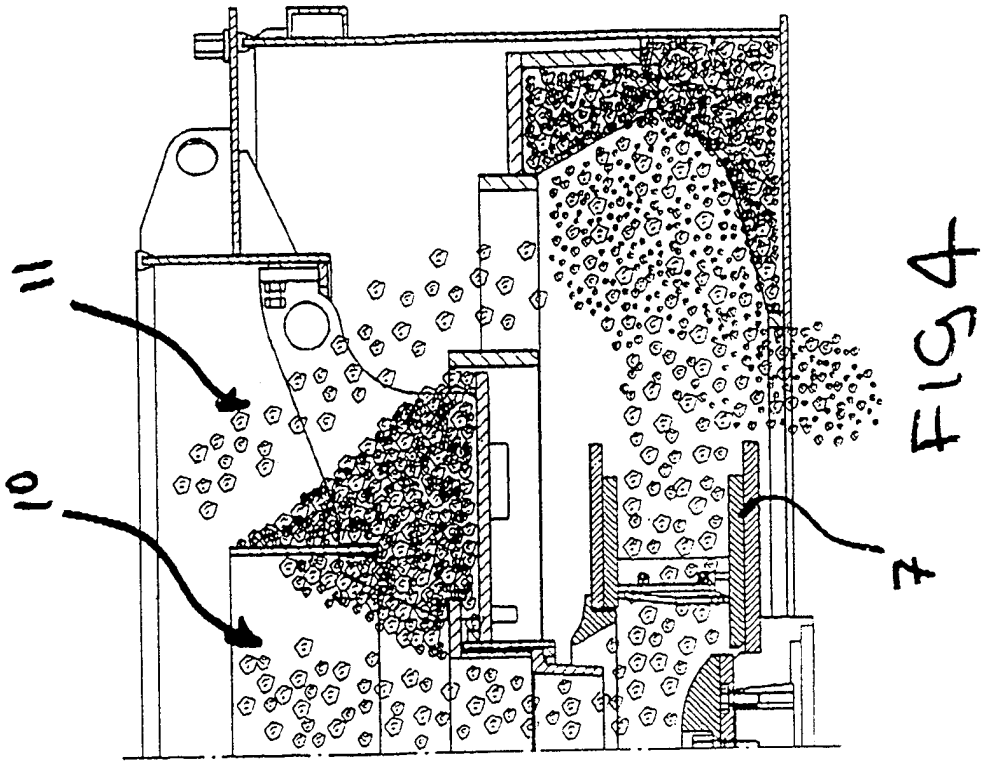

FIG 4

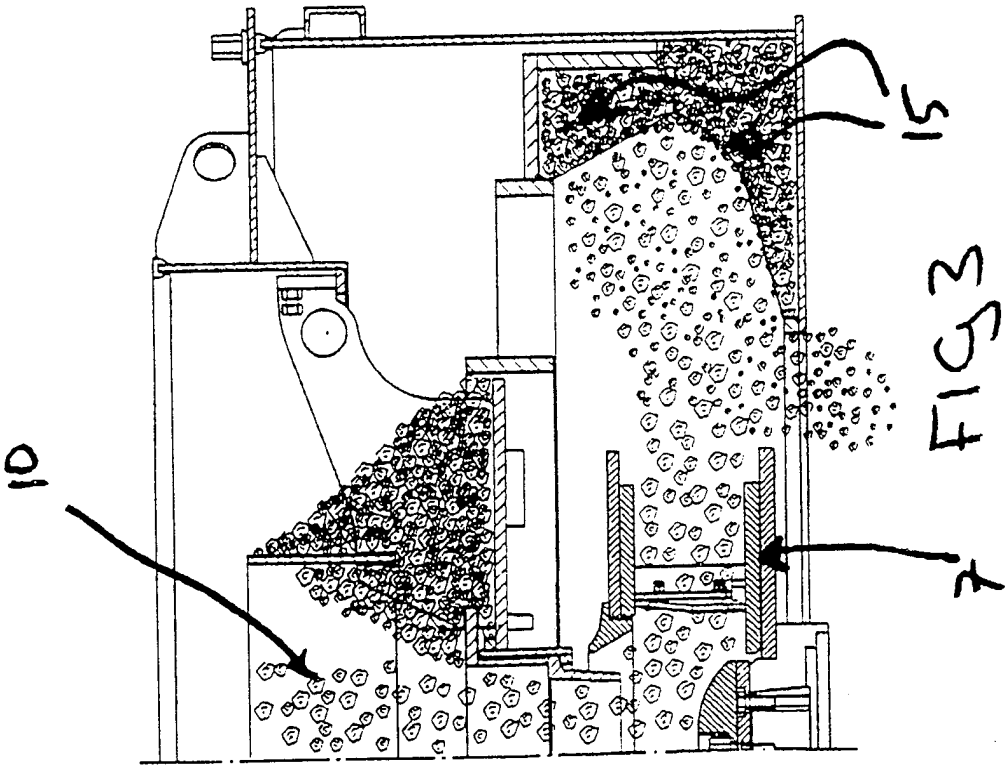

FIG 3

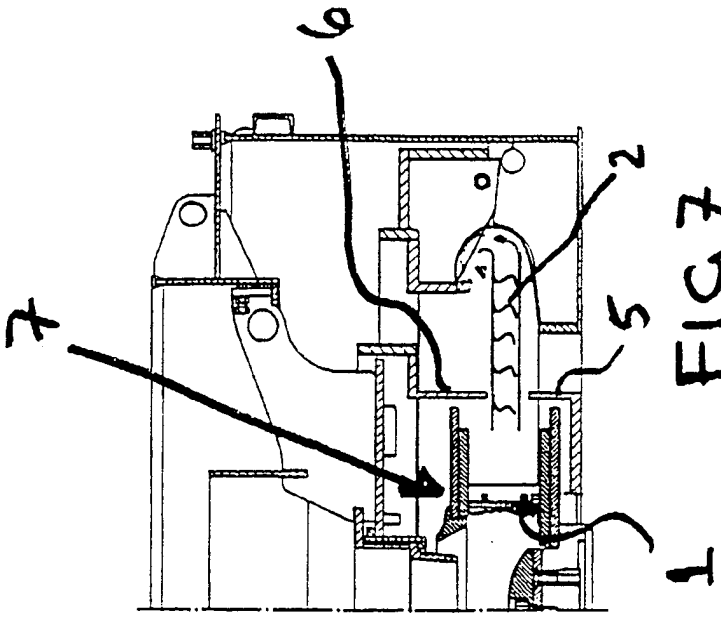

FIG 7

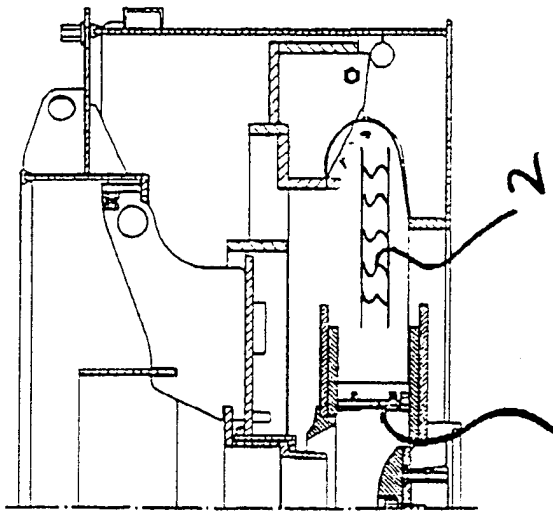

FIG 6

FIG 6A

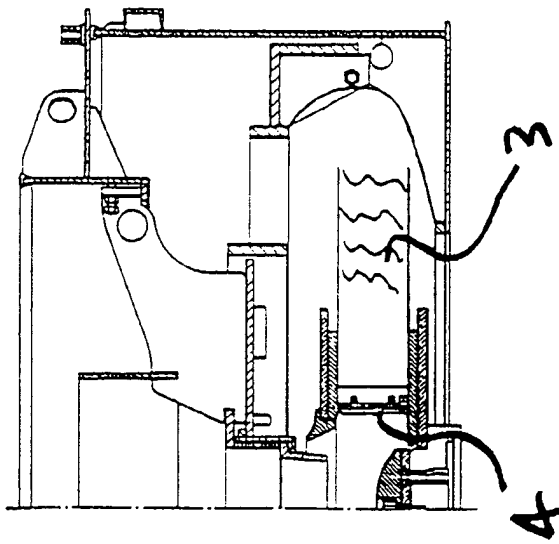

FIG 5

FIG 5A

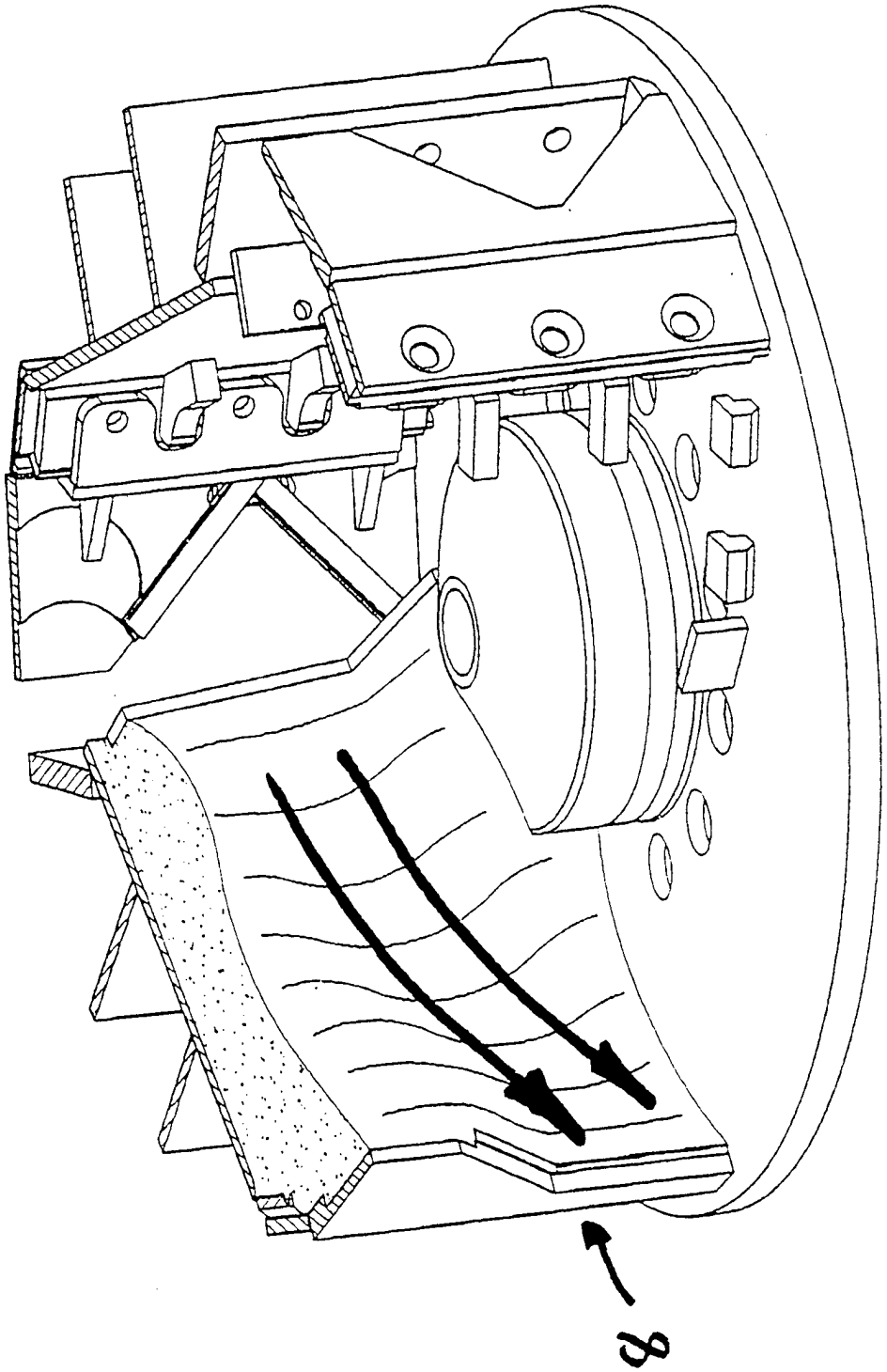

FIG 8

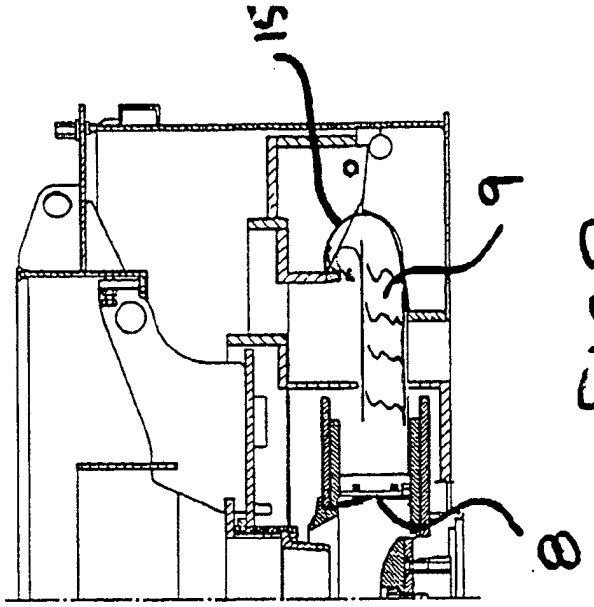

FIG 9

FIG 9A

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 98/00075

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B02C 007/11, 007/08, 013/282

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): B02C 007/11, 007/08, 007/00, 013/282

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)
WPAT: IPC(6) AS ABOVE
JAPIO: IPC (6) AS ABOVE + weir + focus

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AU 36804/97 A (Svedala Barmac) 12 March 1998 Whole document	
A	WO 95/11086 A (Barmac Associates) 18 October 1994 Whole document	
A	US 4940188 A (Rodriguez et al) 10 July 1990 Whole document	

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

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Date of the actual completion of the international search	Date of mailing of the international search report
28 August 1998	-4 SEP 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929	Authorized officer DAVID K. BELL Telephone No.: (02) 6283 2309

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 98/00075

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95/10358 A1 (Tidco International) 20 April 1995 Whole document	
A	WO 98/10359 A1 (Tidco International) 20 April 1995 Whole document	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/NZ 98/00075

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	36804/97	AU	40368/97	WO	9809729		
WO	9511086	AU	80061/94	BR	9407849	CA	2174644
		CZ	9601150	EP	724484	NZ	250027
WO	9510358	AU	78247/94	EP	722365	NZ	274265
		ZA	9408035				
WO	9510359	AU	78248/94	NZ	274266	ZA	9408032

END OF ANNEX