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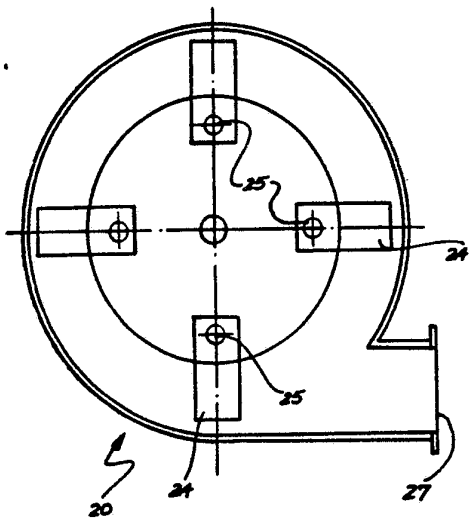
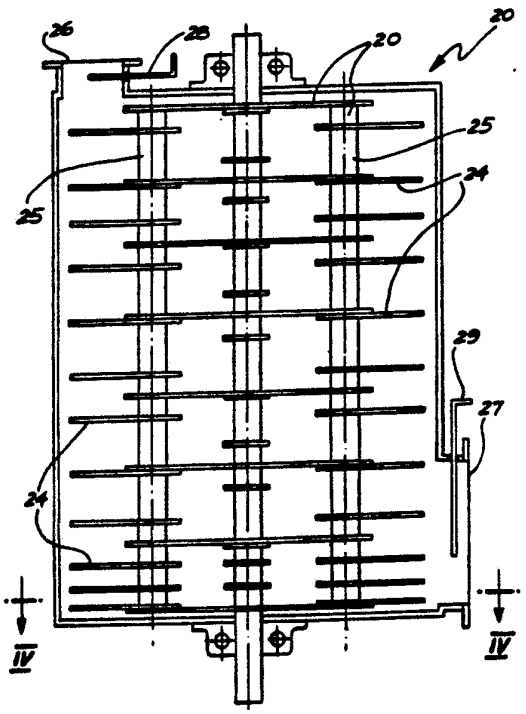
(54) Title: HAMMER MILLS





(57) Abstract

A hammer mill (10, 20) having a rotor or rotors (12, 12a, 22) with hammers (14, 24) includes a particular oriented inlet (15, 26) and outlet (16, 27). The inlet (15, 26) being tangential or axial to the rotor (12, 22) adjacent the inlet and the outlet (16, 27) being tangential to the rotor (12a, 22) adjacent the outlet with the inlet (15, 26) being axially displaced from the outlet (16, 27) with respect to the rotor.

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HAMMER MILLS

The present invention relates to hammer mills and more particularly to a hammer mill able to accommodate grinding of wet and/or oily and/or heat sensitive product without creating blockages.

Existing hammer mills employ a screen member, against which material ground by the hammers is forced, so that once the ground size is small enough it passses through the screen. Such mills suffer significant problems such as high noise output due to the speed of air being forced through the screen during its operation. In order to clear screens and reduce fire risk as well as maintain quality, a conventional hammer mill requires up to one third of its power to generate a sufficient air flow. The noise output of existing screened hammer mills necessitates the wearing of noise reducing ear muffs by operators. Screens also tend to become blocked after some use thereby increasing the heat build up generated by friction in the mill which increases the chance of dust ignition. Frictional heat build up occurs even where there is no screen blockage as particles which are to pass through the screen are invariably slowed by contact with the screen before passing through. Also, as the screen wears in use, the power requirements of the mill are increased in order to maintain a constant sized output.

Material having a significant moisture content, say, in excess of 12 - 14% cannot be easily passed through a screened mill as it tends to plug the screen openings thereby necessitating removal and cleaning of the screen before milling can continue.

Hammer mills without screens are known, as exemplified by French Patent 1,431,158, but they rely on gravitational forces to promote travel of material through the mill. Care must also be exercised in feeding material into such a mill to ensure that it is not forced back out the inlet but is carried into the mill by the hammers.

The present invention proposes a hammer mill which does

not include a screening member at its outlet. The problem then arises as to how to retain the material to be milled within the hammer mill for a sufficeint time for the output particle size to be of a uniform grade and desired size.

The present invention consists in a hammer mill having an inlet adjacent one axial end of and tangential or axial to a rotor fitted with a plurality of circumferentially spaced apart hammers and an outlet disposed at a location adjacent the other axial end of and tangential to said rotor whereby the material to be milled migrates along said rotor from the inlet to the outlet.

In one form the tangential inlet and outlet each extend half the axial extent of the rotor but from opposite ends of the rotor. A preferred form of mill comprises a slide gate at the inlet and/or outlet to vary the respective openings so that, at a given rotor speed and hammer configuration, the grist of the milled product can be varied.

Hammer mills in accordance with the present invention have been found to function well irrespective of the orientation of the mill.

By means of this invention a significant increase in impacts on a sample of material to be milled is ensured as such material must migrate from the inlet along the rotor before it can be expelled at the outlet. Conventional hammer mills most often have full rotor width radial inlets and full rotor width radial outlets in order to provide a maximum throughput for an installation which requires a substantial airflow to transport milled material and maintain open screen holes (in the case of a screened mill).

In a preferred form where a finer grind is required a hammer mill in accordance with the invention comprises a pair of adjacent rotors of the same axial extent which are both rotated in the same direction so as to produce opposing actions at the tangential point of exchange. In this embodiment the impacts applied to the material are greatly

increased and in particular the impacts applied to the material at a location between the two rotors are at double the tip speed of a single rotor running at the same r.p.m. and with the same diameter. Therefore, the speed of rotation of the twin rotors may be reduced, resulting in energy savings, while the size of the output particles from the mill equate with the product of a single rotor mill operating at a higher rotational speed.

A preferred embodiment of a hammer mill in accordance with the present invention will now be described by way of example with reference to the accompanying drawings, in which:-

Fig. 1 is a sectional view of twin rotor hammer mill in accordance with the invention;

Fig. 2 is the sectional view II-II of the hammer mill of Fig. 1;

Fig. 3 is a sectional view of a single rotor hammer mill in accordance with the present invention; and

Fig. 4 is the sectional view IV-IV of the hammer mill of Fig. 3.

Referring to Figs. 1 and 2 of the drawings which show a hammer mill 10 having an outer casing or housing 11 and containing a pair of rotors 12, 12a rotatable by shafts 13, 13a. Each rotor 12, 12a is fitted with a plurality of pivotally mounted hammers 14 at four circumferentially spaced apart locations (see Fig. 2). A tangential inlet is located at one axial extremity of rotor 12 and a tangential outlet 16 is located at the opposite axial extremity of rotor 12a.

In order to improve the migration of material being milled from the inlet 15 to outlet 16 the hammers may be shaped in a manner to assist such movement by thrusting particles in appropriate directions when impacted by hammers 14.

The hammer mill 10 is fitted with slide gates 17, 18 at inlet 15 and outlet 16, respectively. By adjusting the

degree of opening of the inlet 15 and/or outlet 16 with these slide gates it is possible to increase or decrease the dwell time of the material to be hammered within the mill 10 and thereby vary the particle size of the milled end product. Even though the drawings depict the mill with inlet 15 uppermost it has been found to operate most satisfactorily in other orientations, as the direction of rotation of rotor 12 is such as to draw the material to be milled toward rotor 12a instead of tending to drive that material back out through the inlet, which would occur if the direction of rotation of rotor 12 is reversed.

The hammer mill 20 of Figs. 3 and 4 comprises an open form rotor 22 fitted within housing 21 on shaft 23. The rotor 22 carries pivotally mounted hammers 24 and four rods 25 evenly circumferentially displaced around the rotor. The inlet 26 in this embodiment is oriented axially of rotor 22 and outlet 27 is tangential to the rotor at its opposite end. Each of inlet 26 and outlet 27 is fitted with a slide gate 28, 29 respectively and those slide gates operate in similar fashion to the corresponding gates 17, 18 in the embodiment of Figs. 1 and 2.

Typical rotor speeds for screened hammer mills are of a magnitude such that the tip speed of the hammers is of the order of 18,000 ft./min. but can be as high as 28,000 ft./min. By using a single rotor hammer mill in accordance with this invention I have been able to achieve an equally fine grind at a tip speed of 10,000 ft./min. with reduction in the amount of dust and noise produced.

The present invention has been found to be effective with both wet and dry milled material as the limitations produced by passing milled material through a screen are eliminated. It has also been found that hammer mills in accordance with the present invention are suitable for milling products and at the same time adding liquids to produce a homogeneously mixed product without adversely

affecting mill performance. In addition significant energy savings can be achieved by use of the present screenless hammer mill.

To increase the efficiency of the mill the internal surfaces of the housing adjacent the rotor or rotors could be fitted with breaker bars in the form of, say, wear resistant segments of square, round or triangular section which have the effect of deflecting the material impacted by the hammers back into the path of the hammers.

It will be appreciated that the foregoing description with particular reference to embodiment is not limiting upon the broadest aspects of the invention as understood from this disclosure.

The claims defining the invention are as follows:-

1. A hammer mill having an inlet adjacent one axial end of and tangential or axial to a rotor fitted with a plurality of circumferentially spaced apart hammers and an outlet disposed at a location adjacent the other axial end of and tangential to said rotor whereby the material to be milled migrates along said rotor from the inlet to the outlet.

2. A hammer mill as claimed in claim 1 wherein the tangential inlet opening extends from one end of the rotor up to half the axial extent of the rotor and the outlet opening extends from the other end of the rotor up to half the axial extent of the rotor.

3. A hammer mill as claimed in claim 1 or 2 comprising means for varying the extent of the opening of the inlet and/or outlet.

4. A hammer mill as claimed in claim 3 wherein the means for varying comprises an adjustable slide gate movable across each of the inlet and/or outlet openings.

5. A hammer mill as claimed in any one of the preceding claims wherein the hammers are shaped to impart a motion to the material being milled from the inlet toward the outlet.

6. A hammer mill as claimed in any one of the preceding claims comprising two parallel rotors fitted with hammers.

7. A hammer mill as claimed in claim 6 wherein the hammers of the two rotors are spaced apart so as not to intermesh during rotation of the rotors.

8. A hammer mill as claimed in claim 6 or 7 wherein the rotors are rotated in the same direction.

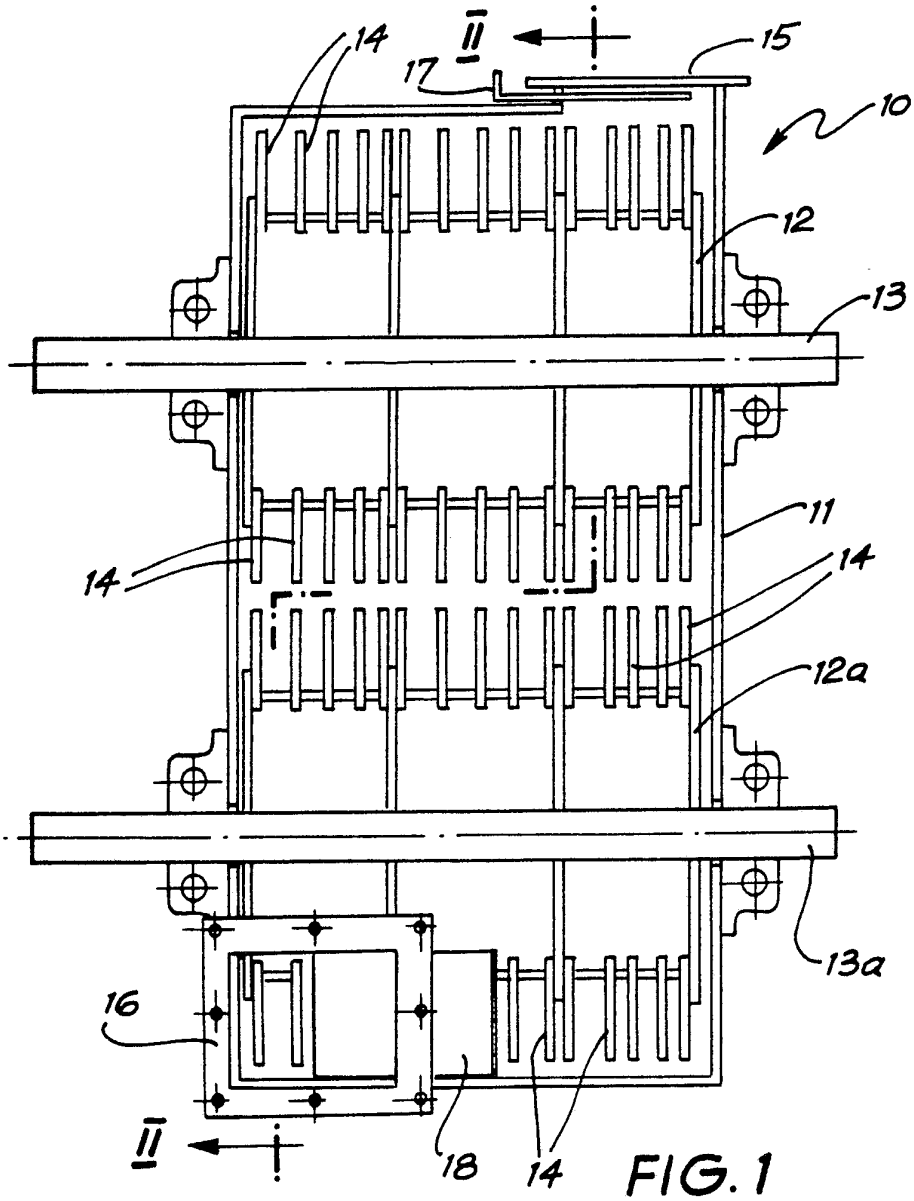

FIG. 1

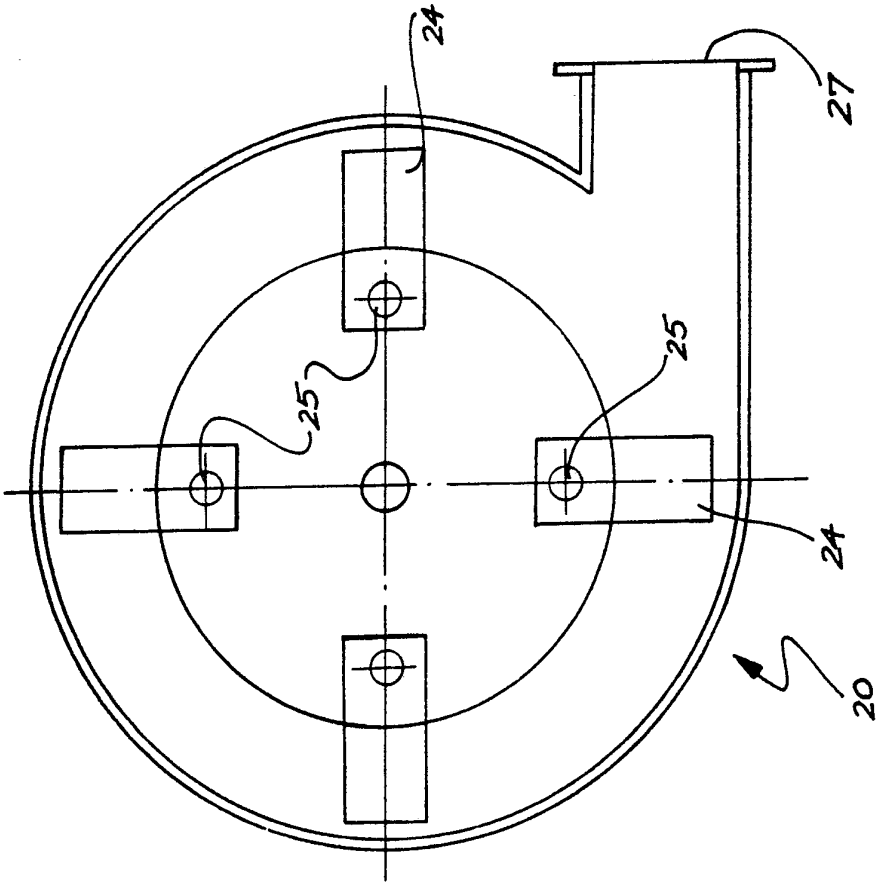

FIG. 4

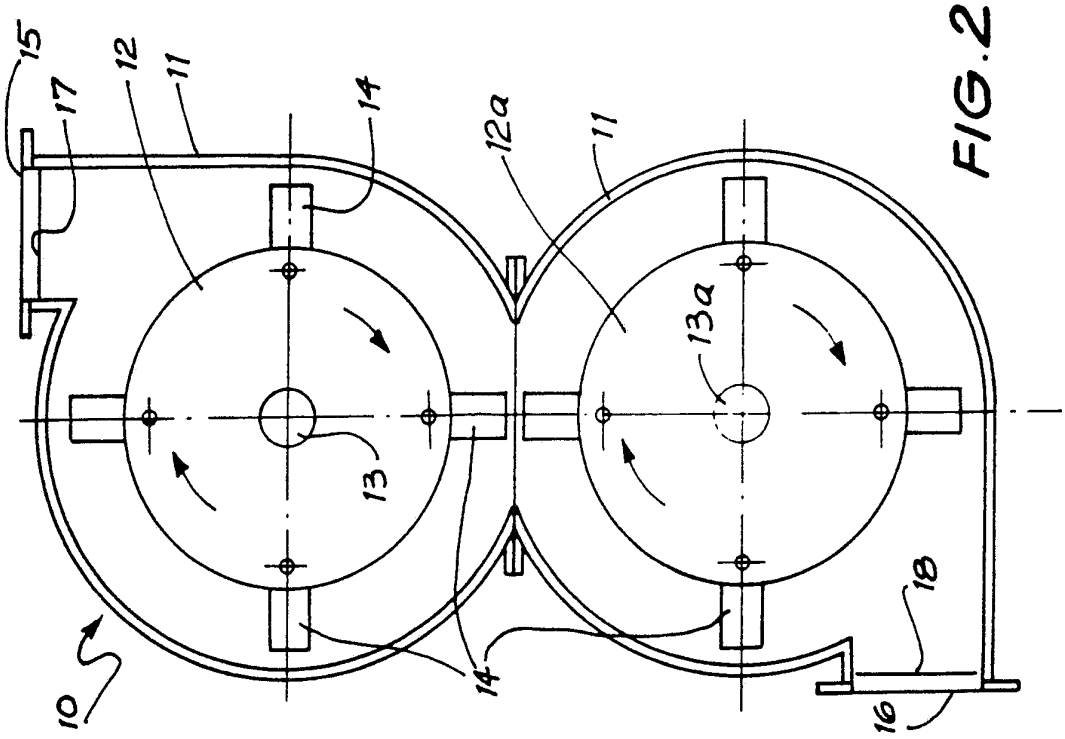

FIG. 2

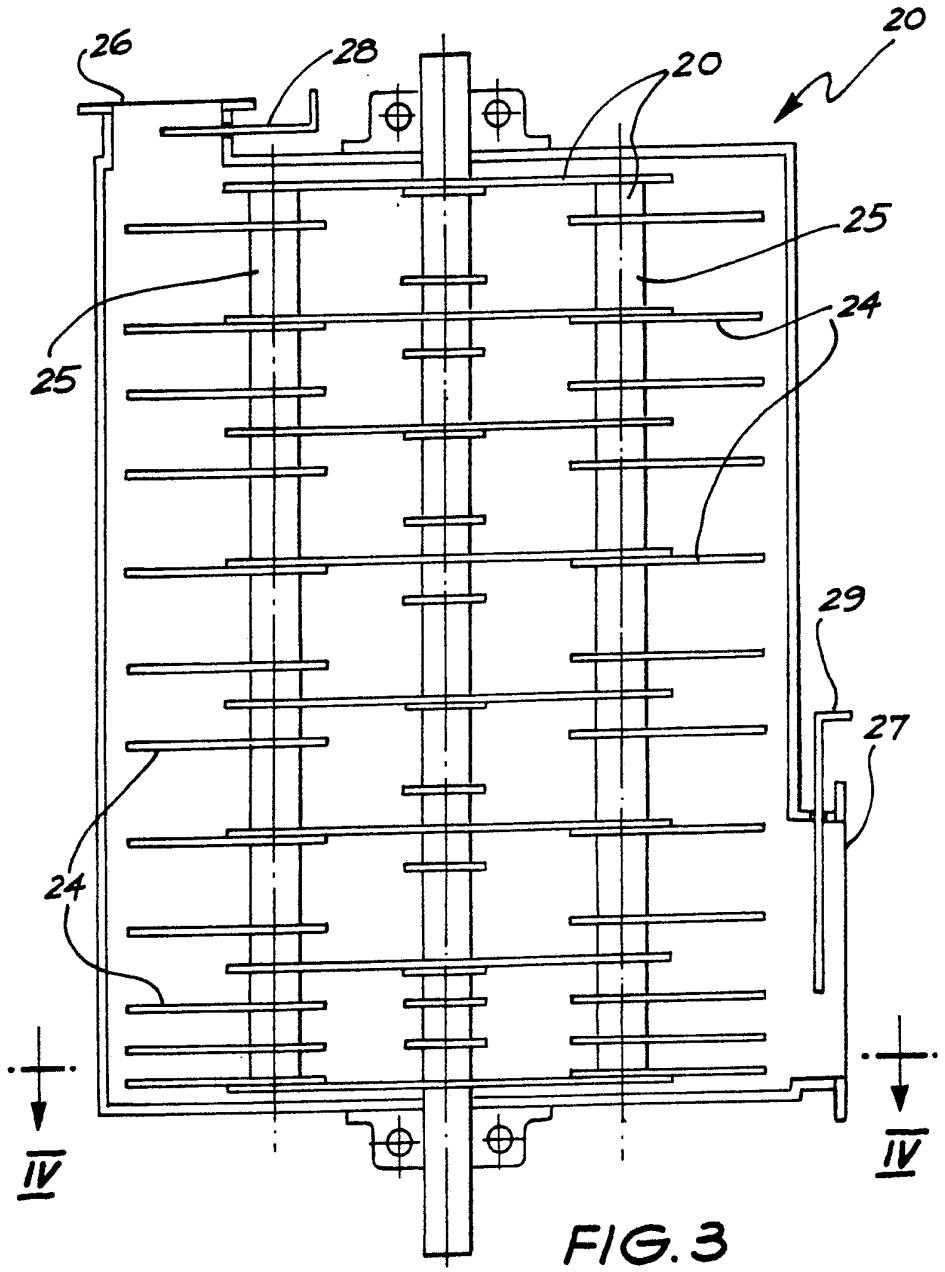

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 83/00125

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] B02C 13/10, 13/286

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B02C 13/10, 13/286
US Cl.	241-186R, 241-188R

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

AU: IPC B02C 13/10, 13/286, 13/288, 13/282

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	AU, B, 13403/33 (MASON) 20 September 1934 (20.09.34)	(1, 3)
X	AU, B, 64207/60 (237966) (NATURIZER CO.) 5 April 1962 (05.04.62)	(1, 5)
X	GB, A, 780661 (SERGEANT) 7 August 1957 (07.08.57)	(1, 3)
X	SU, A, 412935 (ROZHKOVSKII ET AL) 31 May 1974 (31.05.74) (Derwent English Language Abstract X, p.14, week V45)	(1)
X	US, A, 1573040 (CRITES) 16 February 1926 (16.02.26)	(1, 3, 4)
X	US, A, 1603520 (CRITES ET AL) 19 October 1926 (19.10.26)	(1, 3, 4)
X	US, A, 1647555 (WELLS) 1 November 1927 (01.11.27)	(1)
X	US, A, 1758010 (PETTINOS) 13 May 1930 (13.05.30)	(1, 3, 4)
X	US, A, 1765309 (O'NEILL) 17 June 1930 (17.06.30)	(1, 3)
X	US, A, 3226045 (SHELTON Jr. ET AL) 28 December 1965 (28.12.65)	(1, 3)

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
15 November 1983 (15.11.83)	21 November 1983 (21-11-83)
International Searching Authority [1]	**Signature of Authorized Officer** [20]
Australian Patent Office	A.S. Moore

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