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NOTICE OF ENTITLEMENT

I, BRUCE JAME LAKE, of 5/150 Edmonstone Street, Newmarket, Queensland, 4051, Australia, being the applicant in respect of Application No. 40539/93, state the following:

PART I

1. The person nominated for the grant of the patent is the actual inventor.

PART IV

4. The person nominated for the grant of the patent is the the applicant listed in the declaration under Article 8 of the PCT.

The convention application listed in the declaration made under Article 8 of the PCT was filed in Australia not more than 12 months before the filing of this application.

DATE: 14 December 1994


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BRUCE JAMES LAKE



AU9340539

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DUCT CLEANING DEVICES
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- (56) Prior Art Documents
US 3215560
AU 634304 65933/90 B08B 9/04
AU 603760 58939/90 B08B 9/04
- (57) Claim

1. Cleaning apparatus for removing deposits from enclosures such as vertical ducts, risers, plenums, and the like, said cleaning apparatus comprising:

a hollow body with a bore thereto at which a compressed air line can be attached, in use, to deliver compressed air to the hollow therein; and

a plurality of exit passages for compressed air to flow from the hollow;

said plurality of exit passages are either fixedly arranged in an angularly asymmetric pattern around the hollow body or are able to adopt an angularly asymmetric pattern relative thereto.

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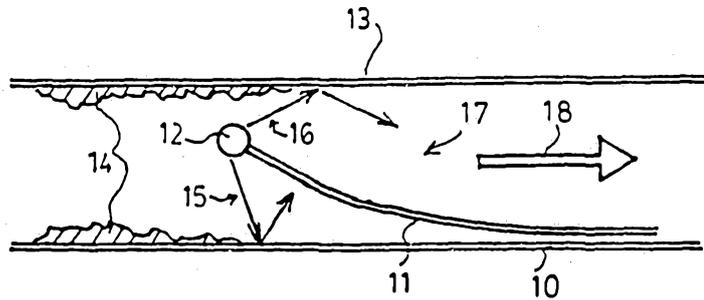


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification 5 : B08B 9/04, 5/02</p>	<p>A1</p>	<p>(11) International Publication Number: WO 93/24246 (43) International Publication Date: 9 December 1993 (09.12.93)</p>
<p>(21) International Application Number: PCT/AU93/00245 (22) International Filing Date: 26 May 1993 (26.05.93) (30) Priority data: PL 2636 26 May 1992 (26.05.92) AU (71)(72) Applicant and Inventor: LAKE, Bruce, James [AU/AU]; 5/150 Edmonstone Street, Newmarket, QLD 4051 (AU). (72) Inventor; and (75) Inventor/Applicant (for US only): McPHAIL, Robert, Valentine [AU/AU]; Cooloolabin Road, Cooloolabin Via Yandina, QLD 4561 (AU). (74) Agent: GRANT ADAMS & COMPANY; Level 9, 144 Edward Street, G.P.O. Box 1413, Brisbane, QLD 4000 (AU).</p>		<p>(81) Designated States: AU, GB, JP, NZ, US. Published With international search report.</p> <p style="text-align: center; font-size: 2em; font-weight: bold;">668564</p>

(54) Title: DUCT CLEANING DEVICES



(57) Abstract

Pneumatic cleaning devices (12, 32, 36) producing plural jets of air do so such as to produce an imbalance of forces on the cleaning device in a transverse plane to their direction of operation. Duct cleaning devices involve a ring of nozzles (34-57) about the axis of the cleaning device (32) with an irregular placement of one or more nozzles to break the general symmetry. Riser cleaning devices (36, 45) involve a plurality of randomly moving tubes (41, 47) whose sum effects a random thrust on the device.

Title: "DUCT CLEANING DEVICES"

FIELD OF THE INVENTION

THIS INVENTION relates to cleaning and, in particular, to cleaning devices whereby ducts, risers, and other like enclosures may be cleared of deposits of dust and other materials and contaminants.

BACKGROUND TO THE INVENTION

In air conditioned buildings, for example, conditioned air produced in a plant room is ducted about the building to supply points whereat conditioned air is injected into the rooms of the building. Considerable lengths of ducting are provided with different cross-sections for larger trunk lines down to smaller feeder tubes leading to the supply points. Both inflexible sheet metal constructs and prefabricated flexible tubing is used in establishing the conditioned air network of ducting. In operation of air conditioning systems of this kind, there is a continuous build up of deposits within the ducting. This can comprise dusts, animal matter, building residues, etc. and the buildup provides a breeding ground for bacteria. This buildup establishes a health hazard for building occupants.

Various methods are in use by which a contaminated system might be cleaned. Prior Australian Petty Patent No. 603760 describes a duct cleaning device and reviews some of the less desirable forms of dealing with contamination.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide improved apparatus for use in a pneumatic cleaning process which is suited to cleaning ducts, risers and other like enclosures such as ducts and risers in air conditioning systems.

Other objects and advantages will hereinafter become apparent.

NATURE OF THE INVENTION

The invention achieves its object in provision of cleaning apparatus for removing deposits from enclosures such as ducts, risers, plenums, and the like, 5 said cleaning apparatus comprising:

a hollow body with a bore thereto at which a compressed air line can be attached, in use, to deliver compressed air to the hollow therein; and

a plurality of exit passages for compressed air 10 to flow from the hollow;

said plurality of exit passages are either fixedly arranged in an angularly asymmetric pattern around the hollow body or are able to adopt an angularly asymmetric pattern relative thereto.

15 BRIEF DESCRIPTION OF THE INVENTION

The invention will now be described with reference to various preferred embodiments as shown in the accompanying drawings, in which:-

FIG. 1 is a schematic representation of a work 20 head as it is employed in cleaning ducts;

FIG. 2 illustrates how the cleaning apparatus of the present invention is put to work in cleaning air conditioning ducting;

FIGS. 3 and 4 show a first embodiment of the 25 invention to be used in cleaning ducts;

FIGS. 5 to 7 show another embodiment of the invention which is a riser cleaner which might be used to clean risers associated with air conditioning ducting;

FIG. 8 shows how the riser cleaner of FIGS. 5 to 30 7 might be made to work; and

FIG. 9 shows an alternate riser cleaner.

PREFERRED EMBODIMENTS

One embodiment of the invention consists of a small aluminium device at the end of a hose that is



preferably attached to a diesel compressor. The compressor, typically, is installed in the basement of a multi-storey building with its hose being taken up to the area being worked on via a stairwell, service shaft, etc. An operator on the floor being cleaned introduces the ball and hose into a duct to clean the duct as described below.

The cleaning head has a number of small holes angled rearwardly towards the hose. By choice of the angles, the size and weight of the ball etc., the compressed air forced through the holes enables the head to be self-propelling and to be manoeuvred randomly by the flick of the hose to all sides of the duct. In operation of such a ball, the ball will, as a result of the compressed air flow, move about within the confines of the duct, much as a garden hose flicks about when not held if water pressure is sufficient.

In FIG. 1, the high pressure of each jet of air such as 15 and 16 can be made sufficient, when near the surface 13 of the duct 10, to dislodge all dirt, dust and debris 14 except that which is fused to the surface. Little material may be left on the surface of the duct 10 after the ball has passed by.

Once the cleaning head 12 has been fed down or traversed the section of duct 10 to be cleaned it can be pulled back. The backward facing jets 15 and 16 clean the surfaces as the cleaning head 12 returns down the duct 10 and the direction of the jets 15 and 16 aids in moving the material towards and into the extraction component of the system which generates an air movement 18. Compressed air may be switched on to generate a thrust sufficient to pull the hose down the duct to be cleaned. By tweaking the hose, the cleaning head 12 may be made to flip around inside the duct.

An extraction unit may be used for removing

dislodged material. The extraction unit is connected to the end of the duct work that is being cleaned by a hose. The extractor may consist of an adequately powerful electric motor driven blower capable of moving
5 large volumes of air at very high pressure to extract air from the duct being cleaned, and a filtration system is used enabling the collection of the removed material without the possibility of contamination to the interior of the building. The extractor can be effective to
10 create a negative air pressure in the system to obviate losses at registers, etc. The cleaning of the duct work can be done in sections with, typically, 20 to 25 metres of duct work cleaned in one sweep.

FIG. 2 shows the layout of a typical section
15 of duct work with a main trunk 10 and branches such as 21 to 23. The cleaning process can start with the covering of registers such as 24 to 26 attached to the duct work to be cleaned. The extraction tubing 20 can be attached by disconnecting a portion of duct work or,
20 if no alternate method is available, cutting an access hole in the duct. Part of that access includes a small hole for the compressed air hose 11 for the cleaning device 12. The cleaning device 12 is fed into the duct work 10 and is allowed to travel to the end of the duct
25 section being cleaned. The very high air flow from the extraction unit 19 plus the airflow from the cleaning device 12 moves all the dislodged material back down the duct towards the connection for the extraction unit and into the extraction unit.

30 Once the main trunk 10 of the duct work is done then the extraction housing 19 is placed on a branch 28 at the end and the cleaning device 12 is sent down the branch to the main trunk and it is pulled back.

In order to clean the duct, it may be accessed
35 at its end with a purpose built cover plate added over

the end. This cover plate might substitute for an existing access plate or be fitted to an entry hole established in the wall of the ducting at an end or side wall. The cover plate may be provided with a cylindrical connector over which the flexible duct may be sleeved. The flexible duct leads to an extraction unit in which filters of some suitable form may be provided to filter particulate material from the air flow through the duct established by a fan within the extraction unit as described below.

The extraction unit, their fans and the filters are common items and they are supplied to the trade in many different forms as extraction units for a variety of purposes. It is merely a question of selecting a unit with the capacity to deal with the flow volumes the scale of operations determines to be needed. Similarly the compressors coupled to the cleaning head may be any of the compressors of suitable capacity as are currently supplied to various trades.

In a first form of a cleaning device in accordance with the invention, the end of the high pressure line is fitted with a cleaning head, work head or ball 32 shown in FIGS. 3 and 4. The work head 32 may be a generally spherical body machined to fine tolerances in a material, such as a metal like aluminium, with a threaded bore 33 to which the end of a compressed air hose may be coupled. The end of bore 33 is open to an internal volume 30 and by it to side passages such as 34 and 35 which angle back acutely to the axis of bore 33 and the length of hose attached there. The angle might be typically 45° but other angles will be suitable to achieving the desired operation as described herein. A plurality of the passages such as 34 and 35 in FIG. 3 may be provided about the body 32, angularly displaced from one another

and communicated with bore 33 so that pressurised air fed into bore 33 passes to the passages and blasts out of their openings. Thus in FIG. 4, seen looking down along the axis of bore 33, a ring of small passages 50 to 57 exists about the bore 33. These are equal in number in the two hemispheres on either side of the dotted line in FIG. 4. They are equally spaced as shown except the holes that would be at 58 and 59 are omitted or blanked off. The same effect might be produced by varying the inter-nozzle spacing over a more substantial area in a segment of the plane of the nozzles. The object is to produce a thrust off the wall with a small twist when the nozzle has 'stuck' to the wall. The irregularity in pattern is believed to achieve this as otherwise, when the head is rolled over the wall, it presents the same dynamics with respect to the wall if it is symmetrical and looks the same in relation to the wall irrespective of how far it turns. A pattern is sought which breaks the general symmetry at a point or points thereabout. In operation of the work head 32, jets of high pressure air blast outwardly of the work head 32 and backwardly. The outward blast impinges on the walls of the ducting with a force able to move solid deposits. The rearward blast propels material that is dislodged backwardly down the duct being cleaned. The rearward blast creates a forward thrust on the work head capable of pushing it down duct and drawing hose behind it. In practice, the total cross sectional area of the small exit passages is matched to the cross section of the inlet bore and these in turn are matched to the characteristics of the compressor, the pressure and volume of air it can deliver. The inter-relation of these factors determines the thrust which can be generated. For any given compressor and work head mass and dimension, the number and size of holes is readily

determined by drilling side passages until thrust is maximised. In use, the propulsive force on work head 32 is utilised to feed the work head 32 and hose down a duct to be cleaned, to pass the work head to the end
5 when the hose is drawn slowly backward to utilise the air blast both as a means of dislodging material and as a means of sweeping it. Given suitable air pressure it is possible to sweep large objects such as dead rats and solid garbage left behind by people working on the
10 ducting. The above described system is an effective means of sweeping out concertina style flexible ducting. The air blast forces dust out of the ribs of the material in a manner not duplicated by brooms or brushes.

15 In operation of this work head a good result depends on its random side to side movements. In operation of these devices they will 'stick' to a duct wall. A twist on the hose will see them flick away to resume motion across the duct in a randomly oriented
20 movement. In order to have this achieved as sensitively as possible, it has been found that heads with carefully machined hollow centres, and precise side bores to form nozzles, work best when an equal number of exit bores or nozzles is provided in opposite hemispheres, the nozzles
25 are equally angularly spaced except that two nozzles are missing, one from each hemisphere, and from any positions except diametrically opposed positions and preferably generally substantially in opposite quarters to create an asymmetric character to the thrust of the
30 cleaning head. By this means, only a slight twitch on the hose will free a 'stuck' cleaning head.

In manufacturing this first embodiment, the hollow body may be produced by moulding. However, in practice, the body is preferably cut in half, machined
35 to precision, its bores formed and all edges tidied with

a similar level of precision before fitting the halves together again.

The work head 32 might be provided with a sensing device such as a television camera whereby the success of a cleaning operation can be continually monitored. A miniature camera might be mounted looking forwardly of the work head 32. The work head might be fitted with brushes for some applications. The system might be put into practice with a range of self-propelled work heads each tailored for specific ducts and cleaning tasks. In each case, in accordance with the invention, the nozzles are arranged so as to produce an asymmetric thrust.

FIGS. 5 to 7 show a device for cleaning air conditioning risers. It is designed to work with and complement the cleaning system described hereinabove.

The aluminium sphere 36, approximately 75 mm dia., is drilled and tapped to receive a compressed air line fitting at 37. Radially, and preferably in at least two rows, are a series of drillings, one row on the centre line and square to the sphere's axis and the other slightly above and preferably at about 30° to the axis. The drawing shows 16 holes but this number is not fixed as either more or less are required according to the volume and pressure of the air supply. Nothing is gained and much is lost if the total area of "exhaust" holes exceed the supply. These holes are countersunk at the sphere surface to allow the "feelers" to be described below to bend under impact without being cut by the edges of the bores in the sphere.

The "feelers" or lengths of tube such as 40 may be about 8 mm dia. and of a certain length and flexibility each of which influences the other and they may have at their outer end a restriction of hard

plastic or metal tube 42 which is, with the air stream, a part of the whole which effects the cleaning. The object of the lengths of tube is to snake about randomly as compressed air flows therethrough and out the end in the form of a jet. In this, longer lengths of more rigid tube will be required to produce movement than will be required if more flexible tube is used. The end piece 42 provides a means by which the tube end can be reduced in cross section to establish a desired jet strength.

The "feelers" or lengths of tube 40 are secured in the sphere 36 by adhesive or any other suitable means and in the event of damage they can be replaced by hand reaming the residue and replacing as required. The end piece 42 might be made with wear in mind. The effect of the flicking end impacting on a wall is to assist the air jet in dislodging deposits. The end pieces might be adapted by surface structures that assist this chipping effect as by addition of abrasive coatings, etc.

In operation, the riser cleaner of FIGS. 5 to 7 is lowered by the air hose 43 as in FIG. 8 and a support cable into the riser 44 through some appropriate opening and compressed air is then switched on to activate the riser cleaner. Each of the feelers then moves rapidly in random pattern flicking and darting and imparting to the sphere 36 a random path such that it pumps vigorously from all sides of a riser 44 of any cross sectional shape or area. The riser cleaner swings randomly around the volume of the riser on the end of its hose being randomly thrust at any time in a direction determined by the sum of the random thrusts of the flexible outlets. In FIG. 8, side passages to distribute air, leading to riser 44, are blocked off at 61. An extraction unit 62 may be placed at the bottom

of the riser.

As each feeler 40 flicks the wall of the riser 44 it aids cleaning as it dislodges matter both by the mechanical action of striking and the discharging air blast.

The riser cleaner is lowered as far as required or as far as the air delivery hose and lifting means (winch) 63 will allow. Unlimited length does not alter in any appreciable way the action of the device.

A fan, filter, suction, unit is positioned at the lowest practical point and withdraws the contaminated air through filters where the contaminants are trapped for later safe disposal. As before, this extraction unit 62 is designed to preferably create a negative air pressure in the riser so that all released dust, etc., flows to the extraction unit's filters.

FIG. 9 shows an alternate form of riser cleaner which might be used in square risers. In this device a square shaped tubular ring 45 is suspended at 46 and compressed air is injected into the tube. The periphery of the tubular ring 45 is provided with a plurality of feelers or lengths of tube 47, each having a free end 48 able to flick about randomly as described above in respect of the device of FIGS. 5 to 7.

The invention has been described above with reference to preferred embodiments. Clearly the principles at work in the devices according to the invention can be realised in a variety of ways. With regard to the duct cleaning device, geometries other than spherical could be used and other patterns of nozzles other than the single ring of nozzles, a double ring, for example, could be used. With regard to the riser cleaning device, this too might be varied with other body shapes, patterns for mounting flexible tubes thereto, and different tube end pieces such as inserts

which provide a plurality of jets, for example, instead of the single jet per tube as above. This latter variation is readily put into practice by an insert whose central bore from the flexible tube opens in a ring of small nozzles in the side walls of the insert.

The claims defining the invention are as follows:

1. Cleaning apparatus for removing deposits from enclosures such as vertical ducts, risers, plenums, and the like, said cleaning apparatus comprising:

a hollow body with a bore thereto at which a compressed air line can be attached, in use, to deliver compressed air to the hollow therein; and

a plurality of exit passages for compressed air to flow from the hollow;

said plurality of exit passages are either fixedly arranged in an angularly asymmetric pattern around the hollow body or are able to adopt an angularly asymmetric pattern relative thereto.

2. Cleaning apparatus as claimed in Claim 1 wherein:

the hollow body is generally spherical with a concentric spherical hollow thereto and the plurality of exit passages are equally angularly spaced about the bore on a circle in a plane orthogonal to the bore except that two exit passages at angularly spaced positions which are not diametrically opposite are omitted.

3. Cleaning apparatus as claimed in Claim 2 wherein:

the two omitted passages are in substantially opposite quarters.

4. Cleaning apparatus as claimed in Claim 2 wherein:

the hollow body is moulded aluminium, it is cut in half, machined and bored to precision and then rejoined to form the cleaning apparatus.

5. Cleaning apparatus as claimed in Claim 1 wherein:

the plurality of passages lead each to a length of open ended flexible tube.



6. Cleaning apparatus as claimed in Claim 5 wherein:

the diameter of the tube is reduced by a tubular insert at its end.

5 7. Cleaning apparatus as claimed in Claim 5 wherein:

the open ends have a multiple nozzle insert therein to each generate a plurality of jets of air.

8. A method cleaning risers using cleaning apparatus as claimed in any one of Claims 5 to 7 wherein:

10 the cleaning apparatus is lowered into a riser on a winch whereby to move it vertically along the riser and the cleaning apparatus is supplied with compressed air to power the cleaning apparatus within the riser.

15 9. A method of cleaning risers as in Claim 6 wherein:

an extraction unit is coupled to the riser at the bottom thereof to exhaust air therefrom and maintain a negative air balance in the riser.

20 10. A method of cleaning risers as claimed in Claim 7 wherein:

the side distribution ducts leading from the riser are blocked off prior to cleaning the riser.

25 11. Cleaning apparatus for removing deposits from enclosures such as ducts, risers, plenums and the like substantially as hereinbefore described with reference to FIGS. 3 to 9.

30 12. A method of cleaning risers substantially as hereinbefore described with reference to FIG. 8.

DATED 29 February 1996

BRUCE JAMES LAKE

By his Patent Attorneys

GRANT ADAMS & COMPANY



FIG 3

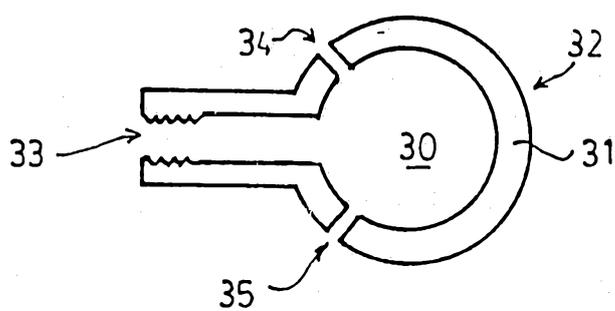
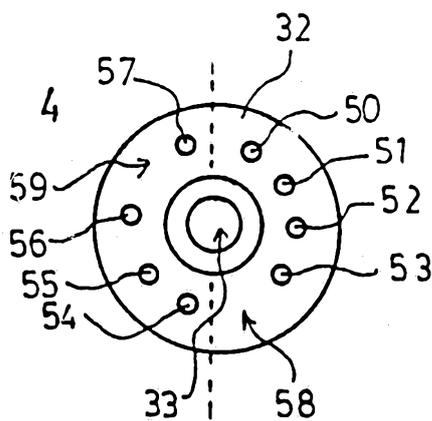


FIG 4



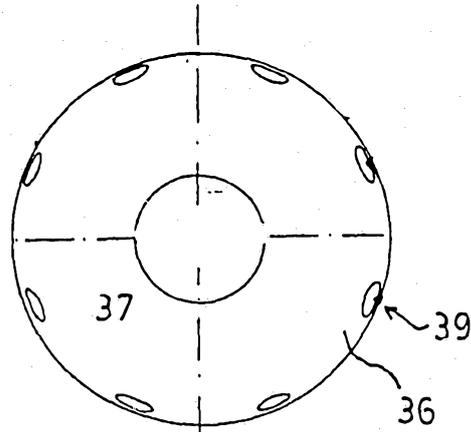


FIG 5

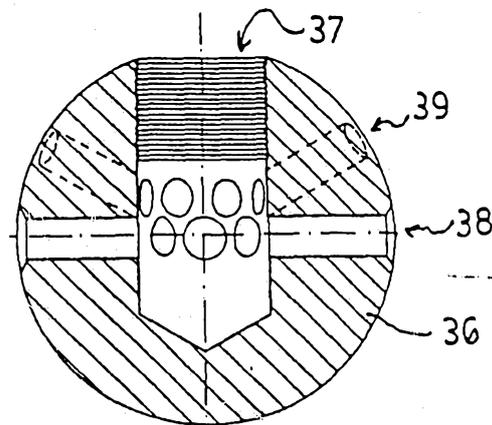


FIG 6

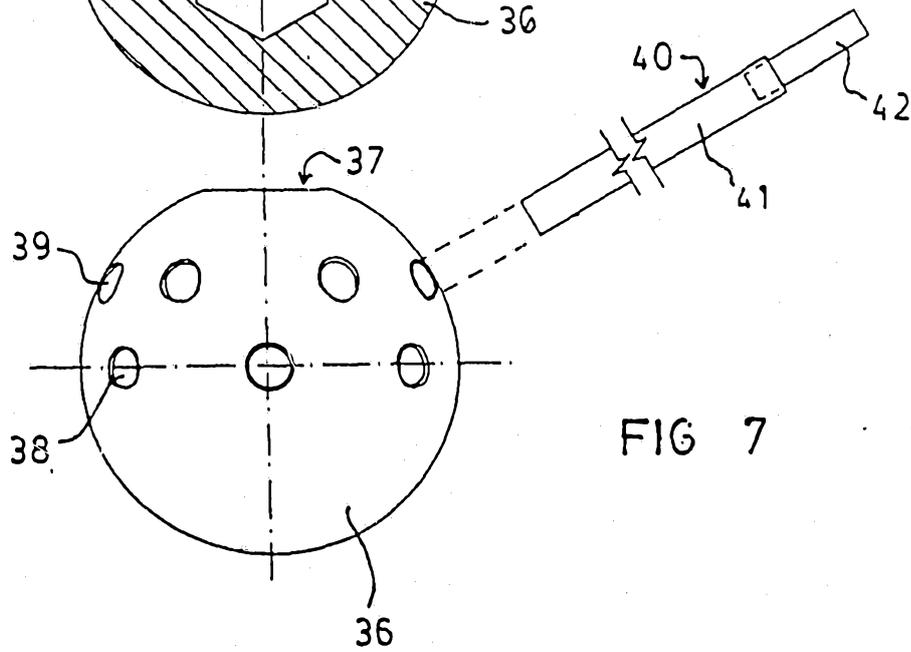
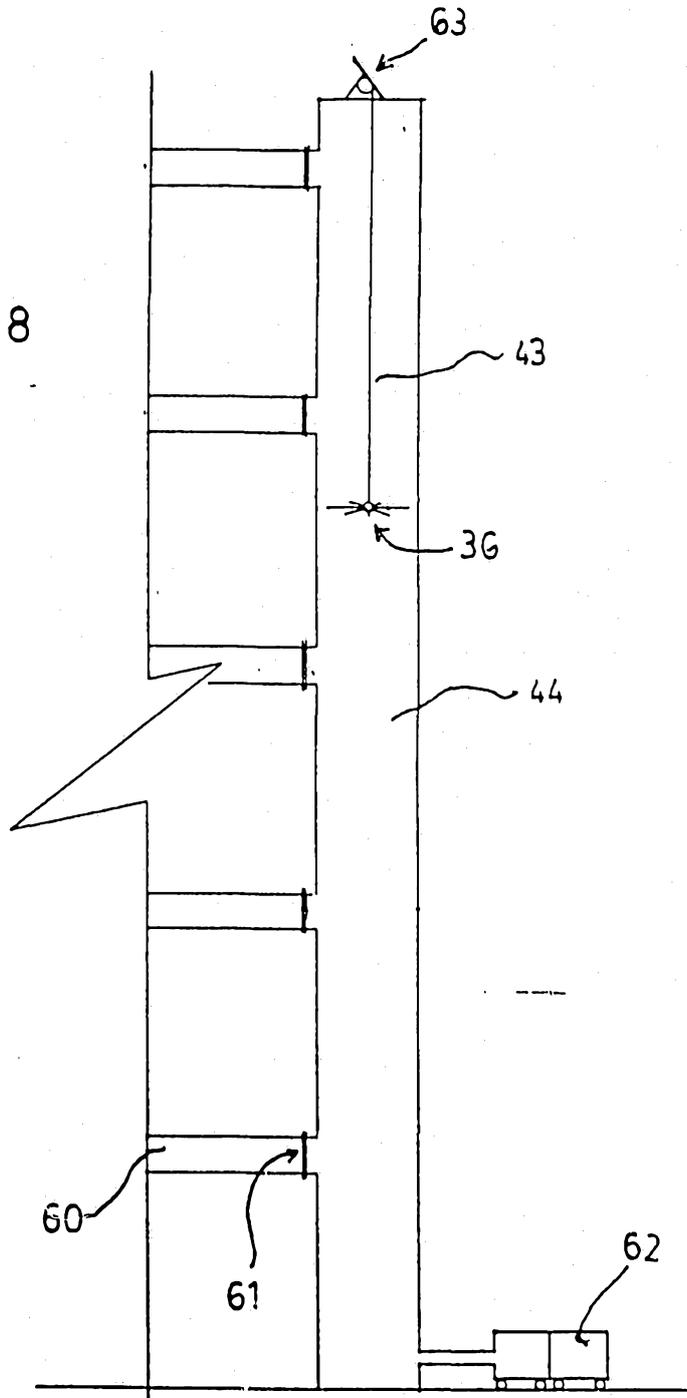


FIG 7

4 / 5

FIG 8



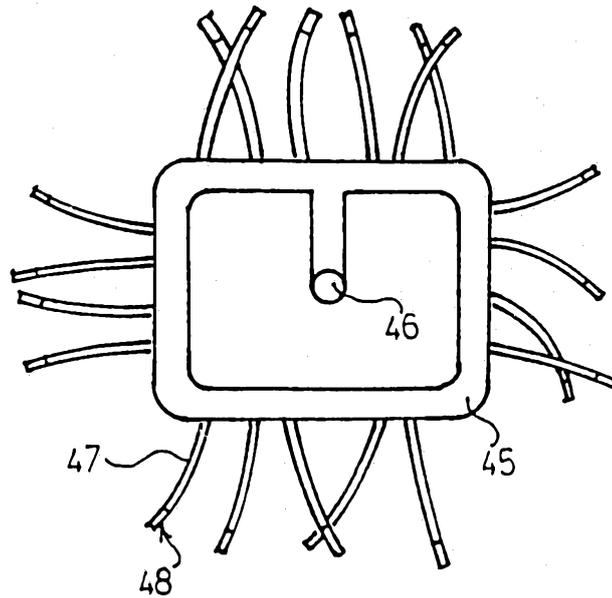


FIG 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 93/00245

A. CLASSIFICATION OF SUBJECT MATTER
 Int. Cl.⁵ B08B 9/04, 5/02

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 5; B08B 9/04, 5/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 AU: IPC as above

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A, 3215560 (KREDIT et al) 2 November 1965 (02.11.65) See Whole Document	1
X	AU,B, 58939/90 (603760) (LAKE) 22 November 1990 (22.11.90) See Whole Document	1
X	AU,A, 65933/90 (LAKE) 21 February 1991 (21.02.91). See whole document.	1
P,X	AU,A, 29824/92 (LAKE) 25 February 1993 (25.02.93) See whole document.	1

Further documents are listed in the continuation of Box C.

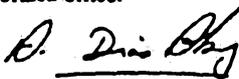
See patent family annex.

<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search
 31 August 1993 (31.08.93)

Date of mailing of the international search report
 7 SEP 1993 (7.09.93)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 93/00245

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	WO,A, 91/13699 (SIGERSET) 19 September 1991 (19.09.91). See whole document	1
X	WO,A, 92/05888 (FAXON) 16 April 1992 (16.04.92). See whole document	1
A	WO,A, 90/12662 (COLLETT) 1 November 1990 (01.11.90) See Whole Document.	1
A	WO,A, 91/02602 (CLEAN MILJO MALMO AKTIEBOLAG) 7 March 1991 (07.03.91)	

INTERNATIONAL SEARCH REPORT
Information on patent family membe.

International application No.
PCT/AU 93/00245

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	65933/90	NZ	235973				
WO	9113699	AU	73456/91	CA	2076383	EP	551262
		FI	923999	NO	923494	SE	9100486
WO	9205888	AU	86407/91	CA	2092552	EP	550598
		FI	931514	NO	931183	SE	9003183
WO	9012662	AU	55534/90	EP	469058	US	5003998
WO	9102602	AU	62769/90	SE	9103829		
END OF ANNEX							