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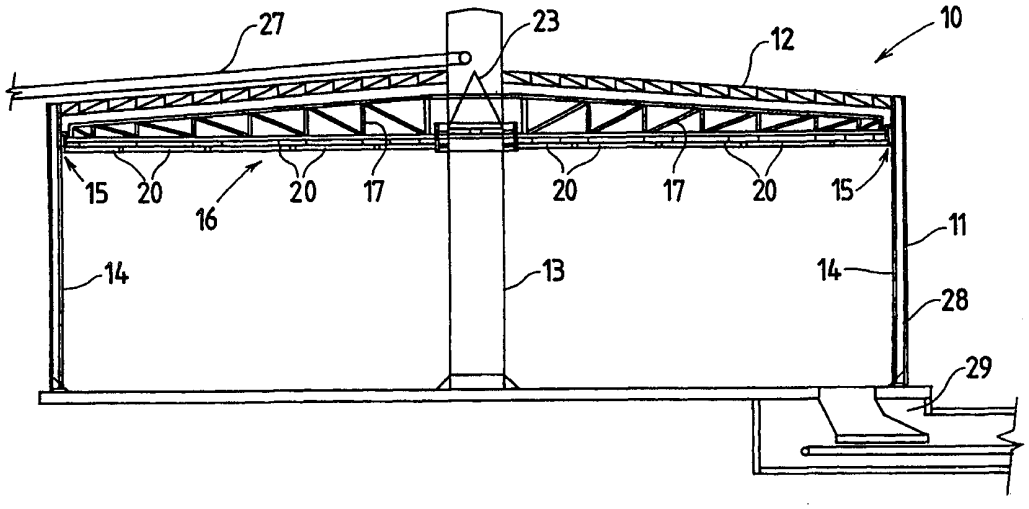
(54) Title: BULK HANDLING APPARATUS



(57) Abstract

This invention provides storage apparatus (10) suitable for storing granular material in a large tank–like storage container (11) into which the material is introduced from an inlet (23) at the top of the container (11) to pile up in normal manner. Height adjustable levelling apparatus in the form of a rotary scraper (16) is supported within the container (11) which engages the uppermost portion of the heaped material and spreads it for levelling the upper surface of material whereby the container may be filled to an upper level surface maximising the useful volume of the container (11). Discharge form a central or peripheral port is likewise maximised by ensuring all material in the container to the discharge level is fed for reclamation.

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BULK HANDLING APPARATUS

TECHNICAL FIELD

This invention relates to bulk handling apparatus and in particular to storage apparatus for storing bulk granular materials.

BACKGROUND ART

Bulk granular materials are typically stored in silos or large sheds. Silos are mostly utilised for storing grain and reclaiming is achieved through a base cone arranged coincident with the repose angle of the grain such that all material will feed gravitationally to a central outlet for discharge from the silo. A disadvantage of this arrangement is that such silos are relatively high and this necessitates additional cost and complexity for equipment to feed grain into the silos.

Mined bulk granular material is often stored in sheds where it may be deposited, for example, by a central conveyor supported in the apex of a conventional portal frame shed. Reclaiming of the product is achieved using front end loaders charging dump hoppers travelling over an outtold conveyor which may be arranged in a tunnel and fed from a central point. Capital cost of such designs are very high and large land areas are required for such storage. Additionally, there is an ongoing reclaiming cost necessitated by the use of supervised machinery to reclaim the material from the shed.

A further disadvantage of these systems is that many bulk solids have properties that will allow the forming of ratholing and make those materials bridge over an out-loading point thereby stopping the exit flow of materials. The problem of bridging and ratholing may become extreme in cases where material has been in static storage for a considerable period of time thereby having allowed gravitational pressures to cause settlement or compaction of what may have been a relatively freeflowing material.

Hydroscopic properties of some materials will allow them to become sticky in storage adding further to the problems of extracting such material from silo type storage.

Mined bulk granular material is also stored as open stockpiles serviced by rail mounted stacker reclaiming machinery. Disadvantages of such systems include the

high cost of stockpiling and management with regard to the environment and high maintenance costs of the necessary equipment for stockpiling and reclaiming.

The present invention aims to alleviate at least one of the above disadvantages and to provide storage apparatus which will be reliable and efficient in use.

DISCLOSURE OF INVENTION

With the foregoing and other objects in view, this invention in one aspect resides broadly in storage apparatus suitable for storing granular material and including:-

a storage container;

a material inlet at the top of the storage container;

a material outlet at the base of the storage container, and

height adjustable levelling apparatus for levelling the upper surface of material contained in the container. Thus the upper surface may be levelled to enable the container to be filled to capacity when filling, and when discharging to level the upper surface to ensure complete discharge of material as the container is emptied from the base.

The levelling apparatus could be any suitable form of conveying apparatus which conveys the material being fed into the container towards the outside of the container when filling and when emptying which conveys the material remaining about the periphery of the container towards the centre for gravitational discharge at the base.

In a preferred embodiment, the levelling apparatus is in the form of a driven rotary scraper rotatable about a vertical axis and having an overall diameter substantially equal to the inside diameter of the container, the scraper having blades thereon engageable with the upper surface of material in the container so as to move the engaged material selectively inwardly or outwardly as required. For this purpose, the blades may be fixed or adjustable and the wheel may be reversible to control the direction of feed of the granular material. Alternatively, the vanes may be reversible or the scraper may include alternate sets which may be lowered for engagement with the granular material.

Preferably the rotary scraper includes an outer ring frame supported on vertically adjustable mountings on or adjacent the container wall. It is also preferred that for best mechanical advantage, the drive apparatus for selectively rotating the wheel are mounted on the vertically adjustable mountings and drive the outer ring frame. The drive motor may drive a pinion engaged with an annular rack on the ring frame. Alternatively, the rotary scraper may be supported from a central column and driven therefrom. However this would impose complexities and high loads due to the need to transmit high operating torque through the column to an inner ring of the rotary scraper.

This invention may also be applied to reclaiming material from an unsupported pile. Thus according to another aspect this invention resides broadly in a method of and apparatus for reclaiming material from a stockpile of granular material including:

providing height adjustable spreading apparatus for spreading material from the upper surface of the stockpile outwardly for passage to the base of the stockpile;

providing reclaiming apparatus at the base of the stockpile, and

operating the spreading apparatus to cause feeding of that material in the stockpile which does not initially flow gravitationally to the reclaiming apparatus toward the base of the remaining stockpile to enable feeding of substantially all the material in the stockpile to the reclaiming apparatus. The stockpile may be supported on a base pad containing the reclaiming apparatus and, if desired, the stockpile may be contained within a peripheral wall.

The reclaiming method and apparatus of this invention may be used to advantage with conventional silos and constitutes a further invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a typical embodiment of the present invention and wherein:-

FIG. 1 is a side view of a storage facility made in accordance with one aspect of this invention and shown partly cut-away;

FIG. 2 is a plan view of one form of a rotary scraper assembly;

FIG. 3 is a part sectional view showing the upper loading details of the container;

FIG. 4 illustrates the peripheral support mechanism for the rotary scraper;

FIG. 5 illustrates an alternate form of peripheral reclaiming apparatus for reclaiming material from the storage container;

FIG. 6 is a cut-away side view of an alternate form of storage facility utilising a central material discharge;

FIG. 7 corresponds to Fig. 6 but illustrates a further discharge arrangement ;

FIG. 8 diagrammatically illustrates one form of friction drive for rotating the rotary scraper;

FIG. 9 diagrammatically illustrates an alternate form of friction drive; and

FIGS 10 and 11 illustrate the rotary scraper support and slide arrangement in plan and side views respectively.

MODES FOR CARRYING OUT THE INVENTION

The storage apparatus 10 is in the form of a low profile container 11 having a low pitched roof 12 supported by a the container wall 23 and centrally by a large diameter central column 13. A series of guide post assemblies 14 are arranged vertically about the inside periphery of the container 11 and rotary support apparatus 15 are engaged with the post assemblies 14 for vertical movement along the posts and support of the peripheral edge of the rotary scraper 16. The material is introduced over a spreading cone 23 from a feed conveyor 27 and discharged from a peripheral reclaiming chamber 29 adjacent the side wall 28.

In the illustrated embodiment, the container is an eighty metre diameter container with a wall height of about twenty metres and is adapted to contain about 80,000 tons of mined or manufactured granular material, such as bauxite or map dap fertiliser.

The rotary scraper 16 illustrated in Fig. 2 has a series of radial arms 17 which extend from an inner annular hub 18 to an outer annular rim 19 which support scraper blades 20 in a suitable arrangement thereon. The blades 20 extend downwardly from the underside of the arms 17 so as to engage the top surface of material contained in the container 11.

As illustrated in Fig. 4, the outer rim 19 includes an angle section member 21 having a vertical web which provides radial location against the centring rollers 24 supported by the rotary support apparatus 15 and a horizontal web 25 providing vertical support on the horizontal centring rollers 26. Both the rollers 24 and 26 are

arranged for free rotation about their respective axes and are supported on each support apparatus 15.

The inner face of the vertical web 22 is also formed as an annular gear which meshes with a driven gear 30 mounted directly on the output shaft of a motor/gearbox assembly 31 mounted on the rotary support apparatus 15. In order to resist the torque applied to the support apparatus 15 by the drive motor 31, each guide post assembly 14 includes spaced apart posts between which the support apparatus 15 engages. Each support apparatus 15 is suspended from the upper edge of the container by a remotely operated hoist, all of which are operated simultaneously so that the rotary scraper 16 can be raised and lowered to a selected position.

The inner hub 18 rotates freely about the central column 13 which extends upwardly to provide an equipment deck 35 adjacent the roof and upwardly therebeyond to support the roof and to support the discharge chute and upper end of the loading conveyor 37. If desired, a transfer conveyor 38 may also be supported to take the product to an adjacent storage facility once the container is full. A flap valve 40 is provided for directing the flow either to the transfer conveyor 38 or the discharge chute 36 for discharge upon a cone shaped spreader cap 41 from which the granular material flows into the container.

As shown in Fig. 5, discharge from the base of the container 11 is achieved through a reclaiming chamber 42 adjacent the sidewall 43 of the container 11. A first belt-type 45 conveyer transfers material falling through the inlet 44 to an outloading conveyor 46 which elevates the material to a desired delivery station.

The storage apparatus 60 illustrated in Fig 6 utilises a centrally arranged auger 61 disposed within the central column structure 62 about which material to be stored is introduced via a distribution cone 63 adjacent the column structure 62. The auger 61 has a center shaft 65 supported by bearings 66 at its ends, and where so dictated by engineering design at suitable intermediate positions along its center shaft 65. The bearings 66 allow the auger to rotate about its axis. The auger 61 is belt or chain driven by an electric motor 67 which is positioned adjacent the lower bearing 66 for suitable maintenace or service access away from the discharge port 68 at the base of the auger 61.

The apparatus 70 illustrated in Fig. 7 is a variation on the aparatus 10 of Fig. 1. In this form a reclaim tunnel 71 extends across the base of the container 72 so as to be fed gravationally from opposed peripheral reclaim chambers 73. As in the earlier embodinemts feed is introduced axially from an inload conveyor 75 which dumps onto the apex 76 of the distribution cone 77 for even distribution thereabout. A conveyor 78 is supported in the tunnel 71 for transferring material fed through the chambers for discharde as required.

In use, in each of the above storage apparatus the feed distributed about the distribution cone will tend to pile up around the central column. However rotation of the rotary scraper in one direction will engage the scraper blades with the sloped face of the piled material and feed it outwards until the sloped face is levelled. The rotary scraper is then raised to feed any further matrial supplied about the column toward walls of the container until te container is filled to the uppermost level of the rotary scraper.

When discharging material, gravity feed will initiall feed material to the central reclaiming station or the peripheral reclaiming station or stations. The material which remains, either against the walls in the case of a central discharge, or about the column in the case of peripheral discharge can then be fed toward the respective reclaiming station by lowering the rotary scraper to engage the top of the remaining material and rotating it in the reverse direction to feed material inward to the column for discharge, or in the same direction for feeding material to peripheral discharge stations. The rotary scraper may be lower to a position adjacent the floor so that practically all material is discharged.

Figs. 8 and 9 show alternate friction drives for peripherally driving the rotary scraper 100. In Fig 8, the top annular chord 80 of the rotary scraper 10 is provided with a drive flange 81 extending thereabout. A reversible friction drive wheel 82 is engaged with the flange 81 for rotating the rotary craper 100.

The wheel 82 is driven from a motor 83 carried by a pivot bracket 84 mounted on a slide plate 85 moveable along one of the peripheral guide post assemblies. The slide plate 85 also carries a lower reaction wheel 89 on a further pivot bracket 86 which may be pivoted upwards by a selectively operable ram 87 and linkage 88 to clamp the flange 81 between the friction wheel 82 and the reaction wheel 89 so as to regulate the driving force transferred to the rotary scraper. Thus the rotary scraper

may stall if undue loads are applied thereto such as by forcing the scraper too deeply into a pile of material to be levelled, without damaging the motor or drive.

In the arrangement illustrated in Fig. 9, each radial truss 90 from which the scraper blades are suspended carries a round-section ring 91, 92 at the end of its upper and lower chords 93, 94. A friction driving wheel 95 engages a flange mounted on the top ring 91 and a reaction wheel 96 supports the lower ring 92. The raction wheel is supported directly on the slide 97 while the drive wheel 95 extends from a motor/gearbox assembly supported pivotally from the slide 97 and adjustably by the selectively operable ram 98 which is used to regulate the drivng force applied to the rotary scraper as described above.

The slide 97 as illustrated in Fig. 10 has opposed vertically extending angle rails 103 which engage captively through slide blocks 101 about the diagonally arranged square-section rails 102 which form the vertical chords of a composite post assembly 105. Opposed pulley wheels 106 supported at the top of the slide 97 enable the slides to be raised and lowered by hoist cables, not shown, which extend between the wheels 106 on the slide 97 and the wheels 110 supported at the top of the post 105 and driven by an electric winching arrangement 111 for raising and lowering the slide. The vertical rails 102 are connected to the sidewall,shown dotted at 112, through stand-off mounting brackets 113.

The winches used to raise and lower the rotary scraper are preferably positioned atop the guide posts and spaced evenly about the periphery of the container. Additional winches may be provided intermediate the guide posts if desired and such as may be required for very large diameter containers where there may be a significant span between adjacent posts. Alternatively multi-stage pneumatic rams or the like may be used as the means to raise and lower the rotary scraper.

From the above it will be seen that the overall height of the container is relatively low and this facilitates filling of the container. Furthermore the use of a spreader enables the container to be filled to capacity and completely emptied, thus effectively using the space for storage. In addition all processing is achieved without the need for supervised machinery such as front end loaders.

FIG. 12 is a sectional view of a conventional silo 110 which utilises he central feed auger 111 of this invention for discharging the contents therefrom. In this embodiment the auger 111 extends the full depth of stored product.

FIG. 13 illustrates the central feed auger utilised only in the bottom or conical section 18 of a conventional silo 115 as this may be all that is required to provide assistance for the material to exit the silo.

It will of course be realised that the above has been given only by way of illustrative example of the invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is defined in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. Storage apparatus suitable for storing granular material and including:-
a storage container;
a material inlet at the top of the storage container;
a material outlet at the base of the storage container, and
height adjustable levelling apparatus for levelling the upper surface of material contained in the container.

2. Storage apparatus as claimed in claim 1, wherein the storage container provides an
upright substantially cylindrical storage zone and the levelling apparatus is a driven rotary scraper rotatable about the axis of the cylinder and having an overall diameter substantially equal to diameter of the cylinder.

3. Storage apparatus as claimed in claim 2, wherein the rotary scraper is selectively
operable to spread material either toward the outside of the container or toward the centre of the container.

4. Storage apparatus as claimed in claim 2 or claim 3, wherein the rotary scraper has
non-radially oriented blades thereon which engage the upper surface of stored material.

5. Storage apparatus as claimed in claim 4, wherein the container is filled by introducing material thereto at a location adjacent either the axis of the container or the periphery of the container and to discharge material at the other of either the axial or peripheral location and wherein the rotary scraper is selectively rotatable in either a clockwise or anti-clockwise direction so as to selectively spread material toward the outside of the container or toward the axis of the container.

6. Storage apparatus as claimed in claim 3 or claim 4, wherein the rotary scraper has
blades which are reversible for controlling the direction of spreading the granular material.

7. Storage apparatus as claimed in any one of the preceding claims, wherein the rotary scraper includes a blade support frame supported on vertically adjustable mountings.

8. Storage apparatus as claimed in claim 7, wherein the support frame is an outer ring frame supported on vertically adjustable mountings on or adjacent the periphery of the container.

9. Storage apparatus as claimed in claim 8 and wherein the drive apparatus for selectively rotating the scraper is mounted on the vertically adjustable mountings and drives the outer ring frame.

10. Storage apparatus as claimed in claim 9, wherein the drive apparatus is a friction drive.

11. Storage apparatus as claimed in claim 10, wherein the friction drive includes a driving wheel and an opposing reaction wheel supporting the ring frame against non-driving loads imposed by the friction drive wheel.

12. Storage apparatus as claimed in any one of the preceding claims and including a central column structure about which material to be stored is introduced and through which material is discharged from the container.

13. Storage apparatus as claimed in claim 12, wherein the central column strructure storage houses an auger for assisting flow from the container

14. A method of reclaiming material from a stockpile of granular material including:-

providing height adjustable spreading apparatus for spreading material from the upper surface of the stockpile outwardly for passage to the base of the stockpile;

providing reclaiming apparatus at the base of the stockpile, and

operating the spreading apparatus to cause feeding of that material in the stockpile which does not initially flow gravitationally to the reclaiming apparatus toward the base of the remaining stockpile to enable feeding of substantially all the material in the stockpile to the reclaiming apparatus.

15. A method as claimed in claim 14, wherein the stockpile is supported in a container.

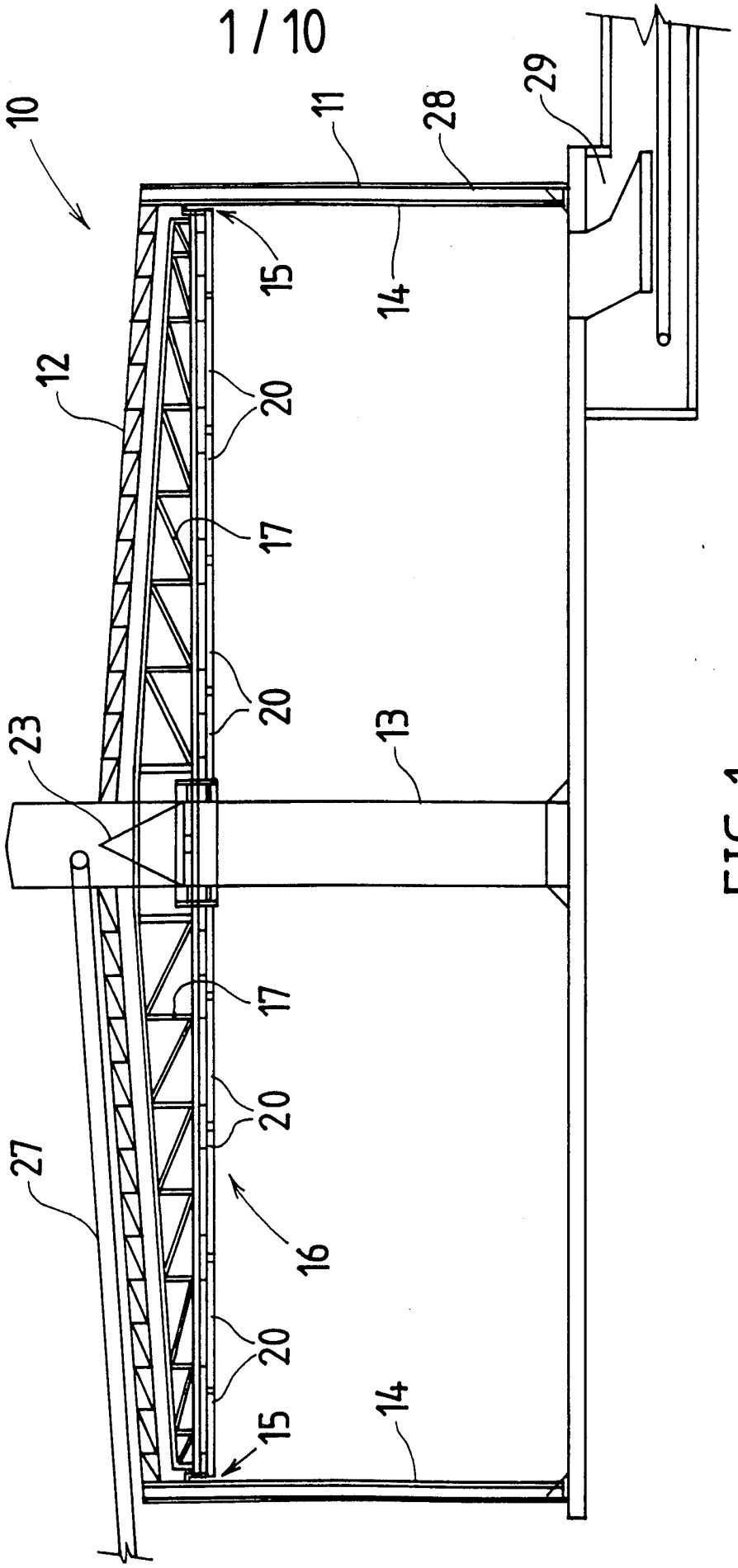
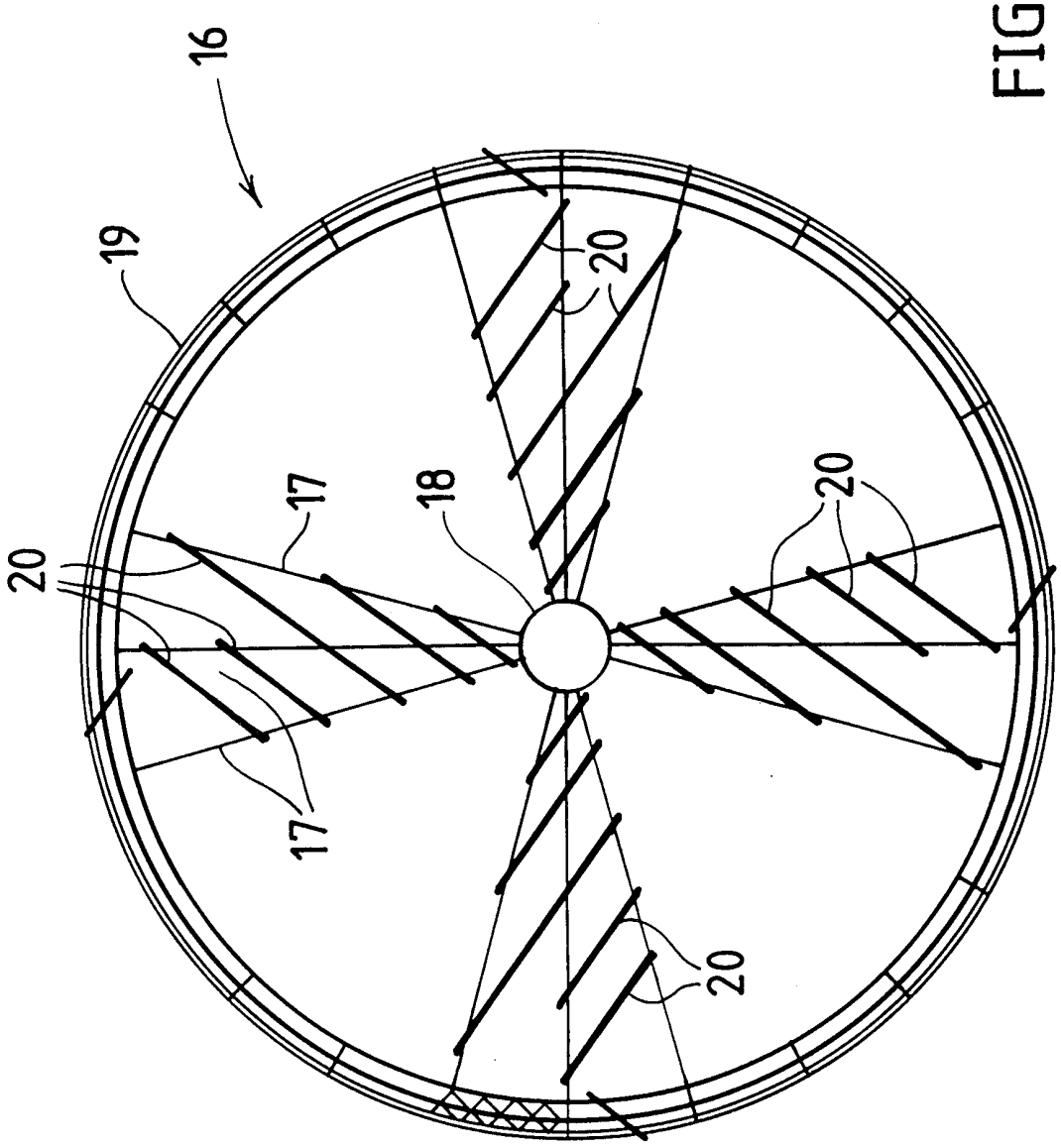


FIG. 1

FIG. 2



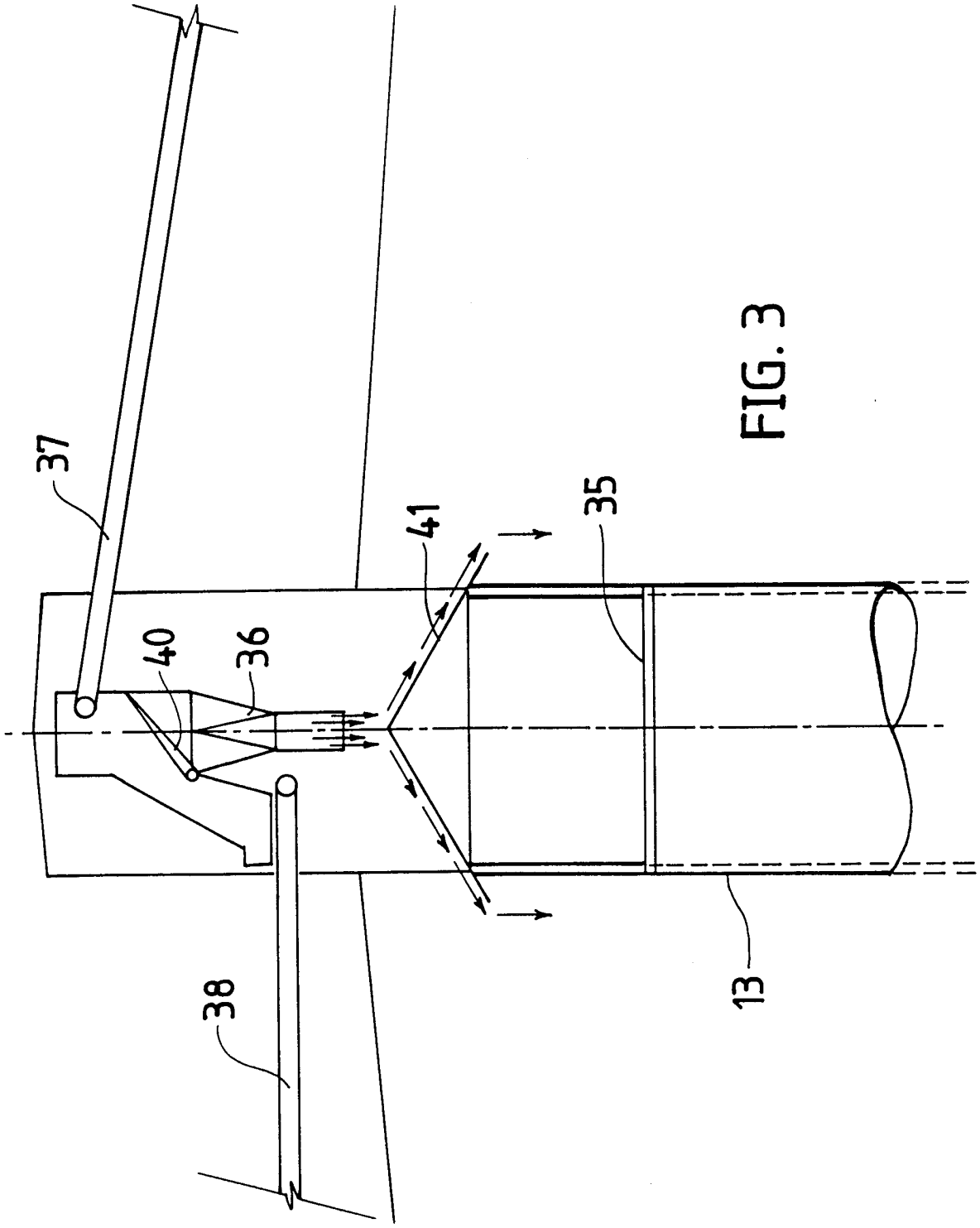


FIG. 3

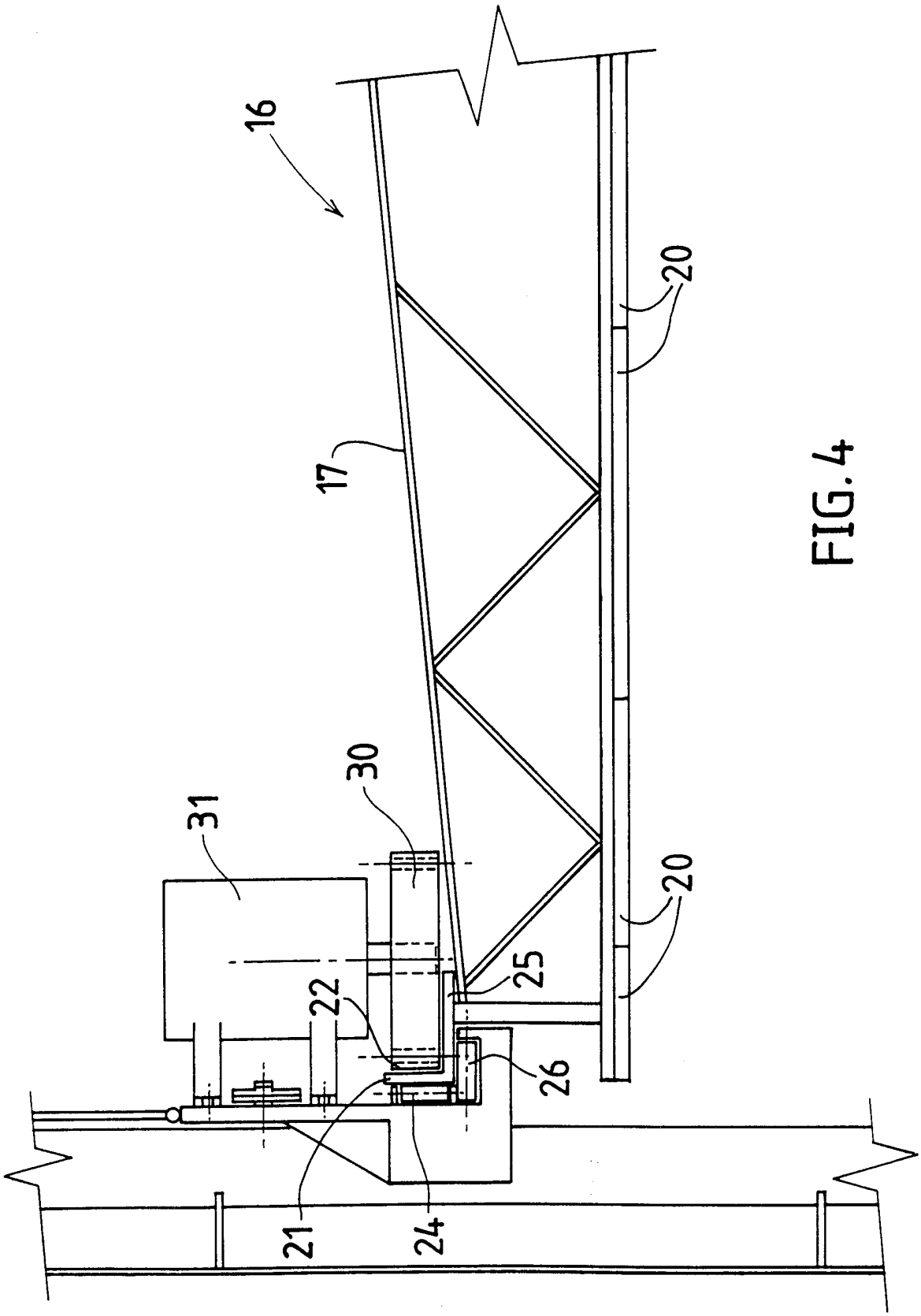


FIG. 4

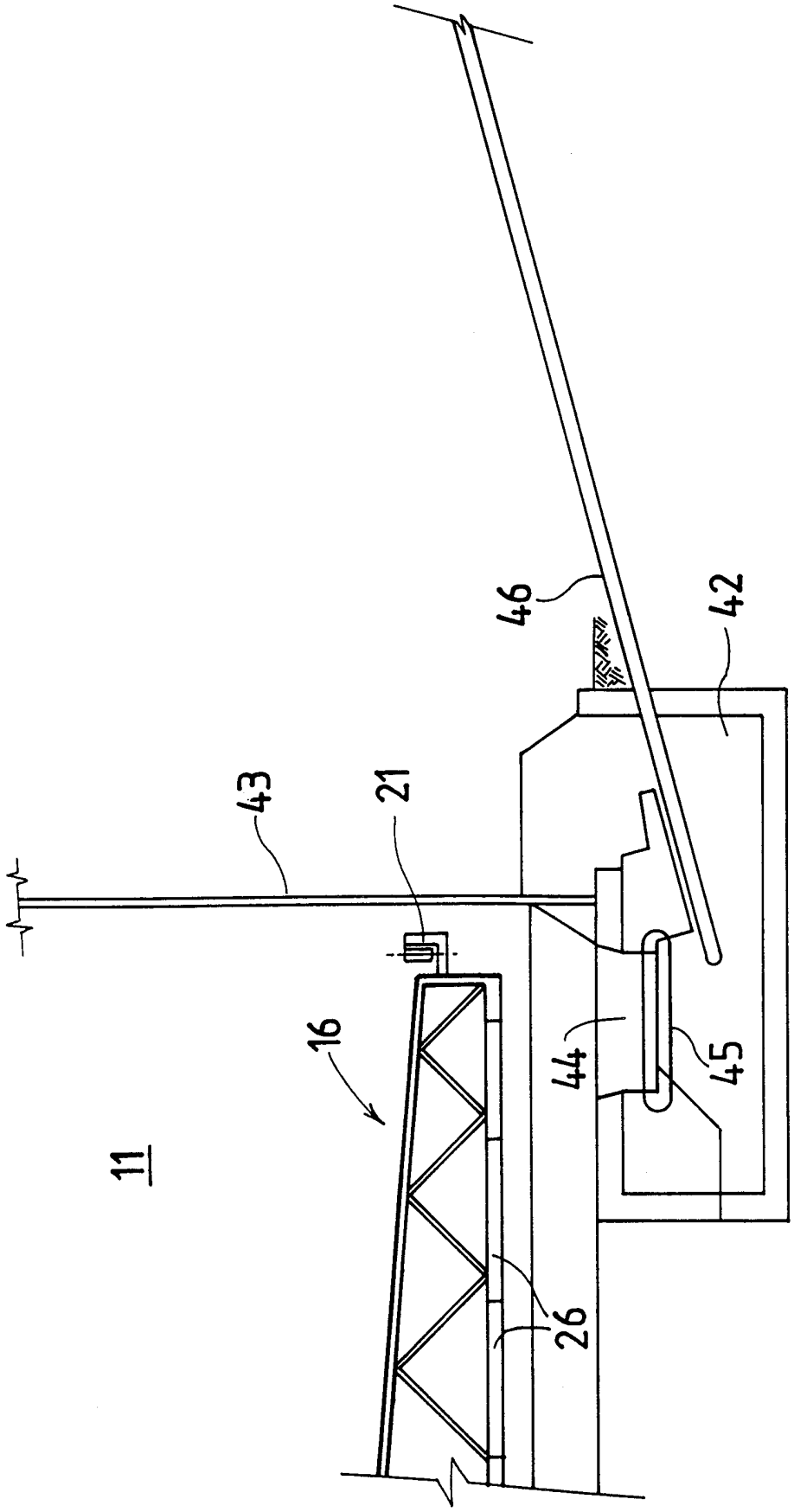


FIG. 5

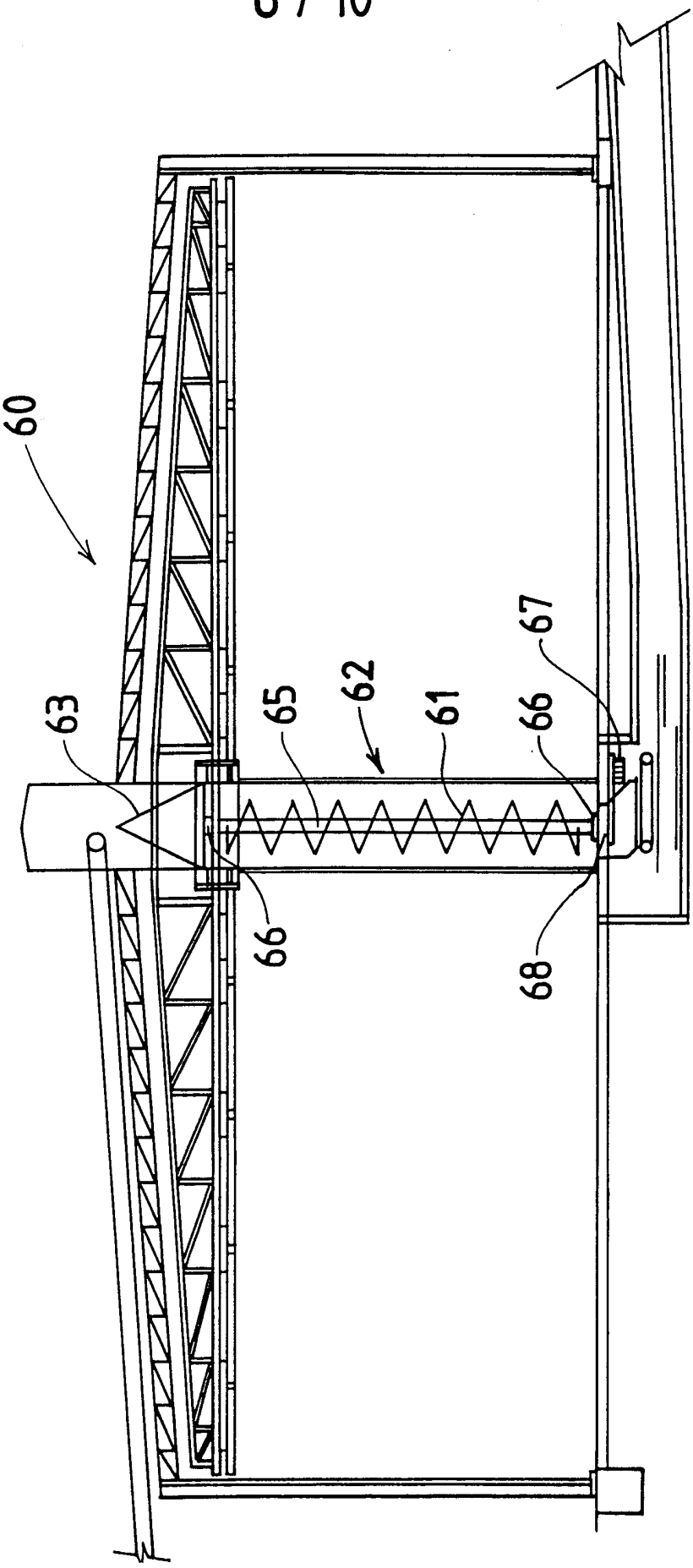


FIG. 6

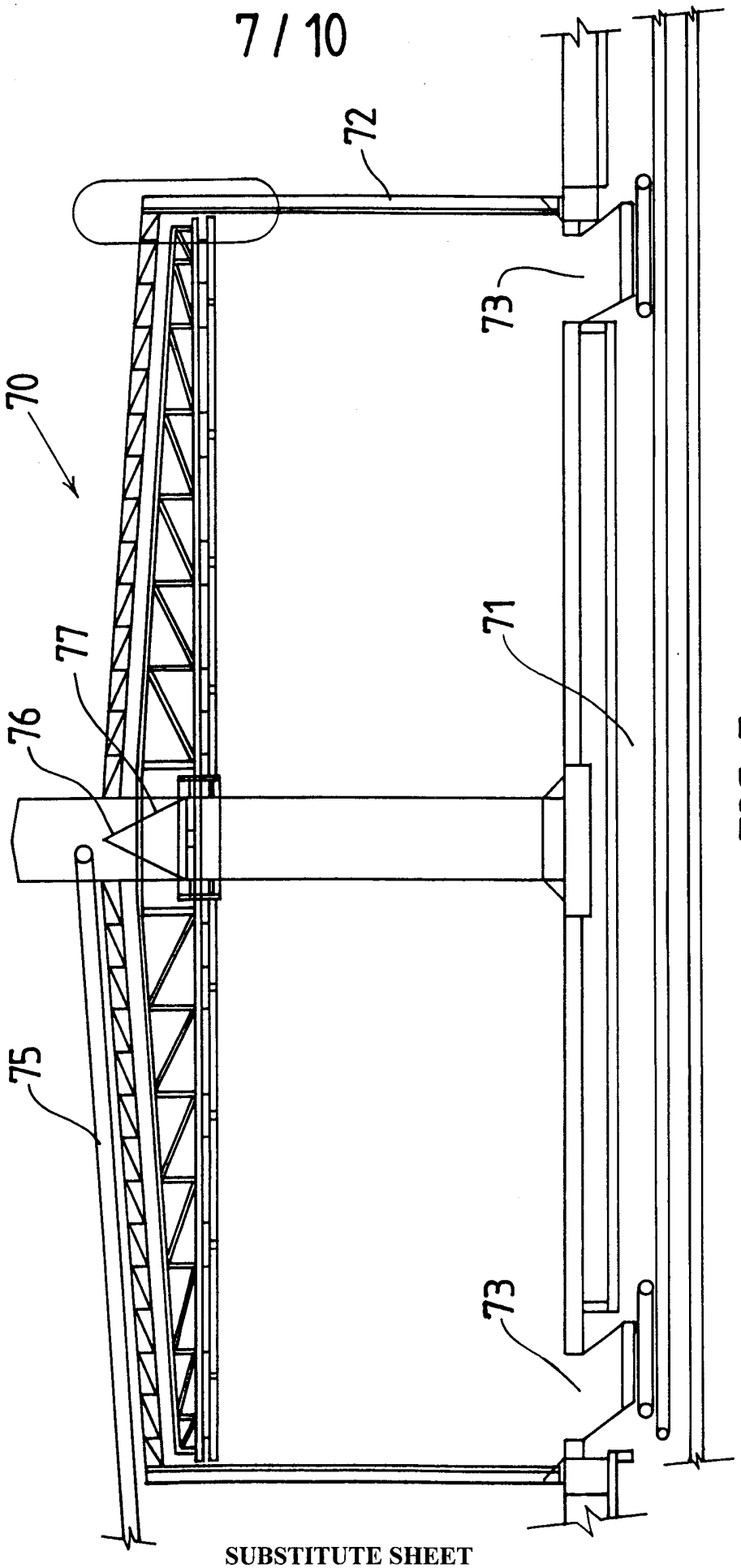


FIG. 7

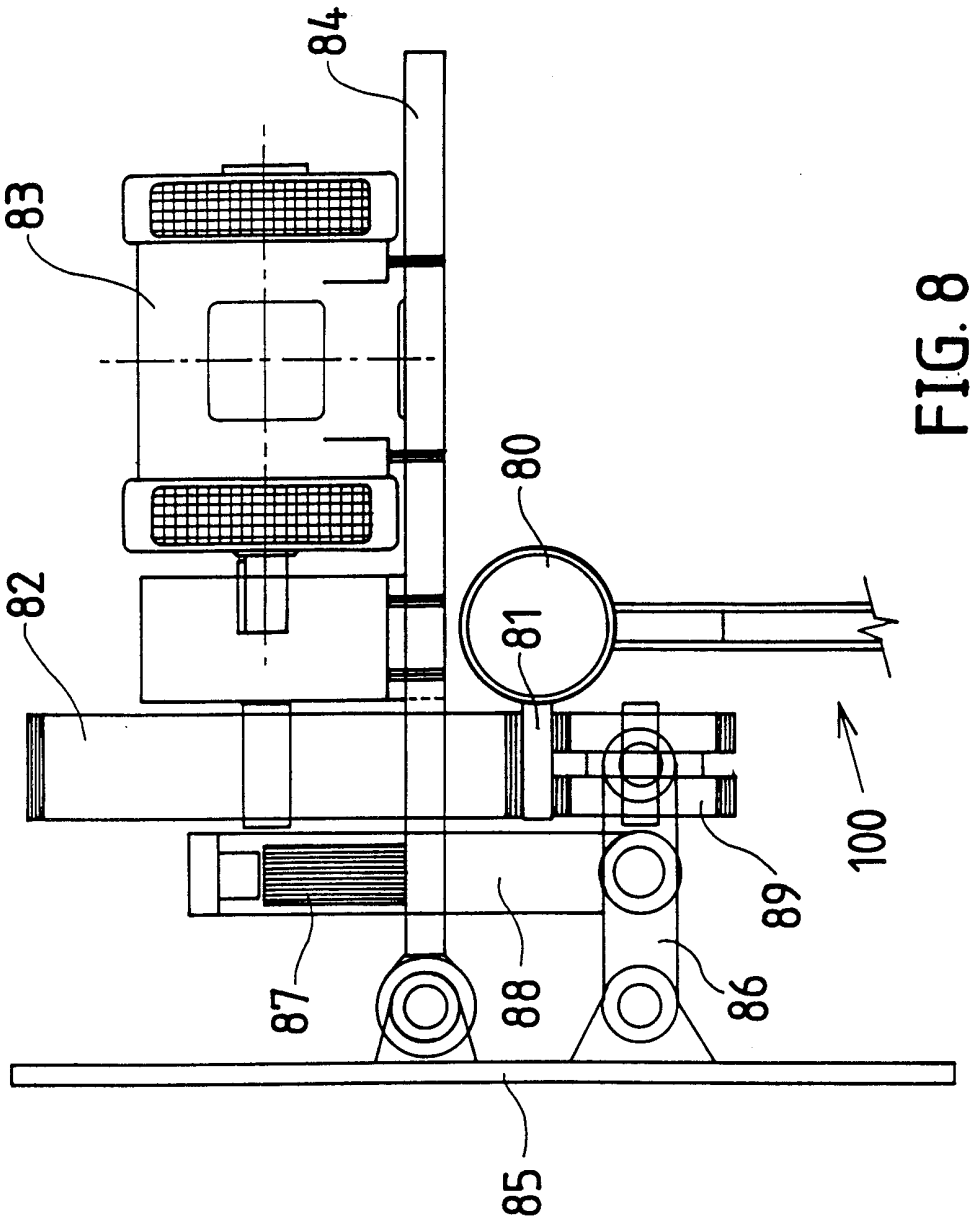


FIG. 8

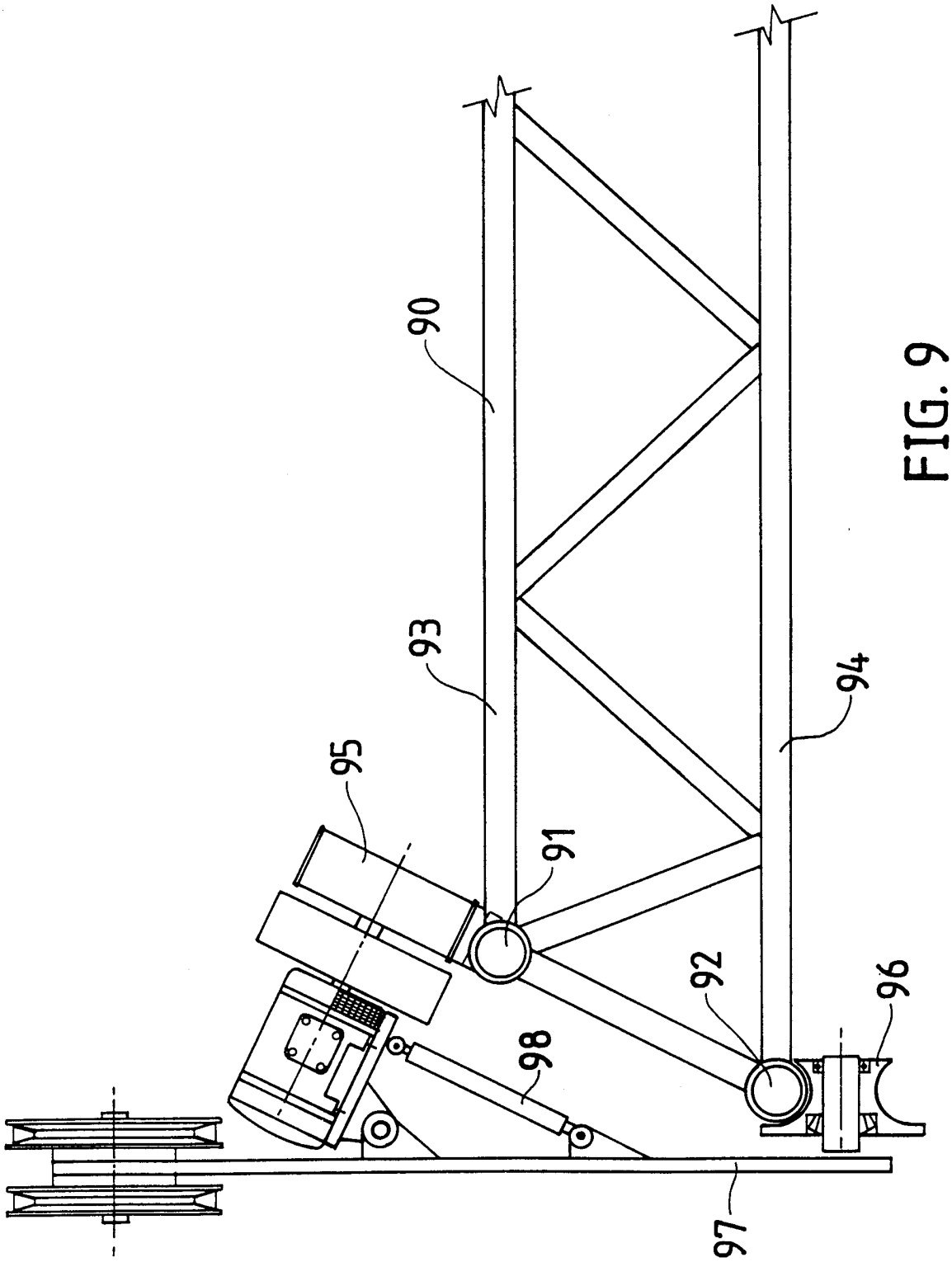


FIG. 9

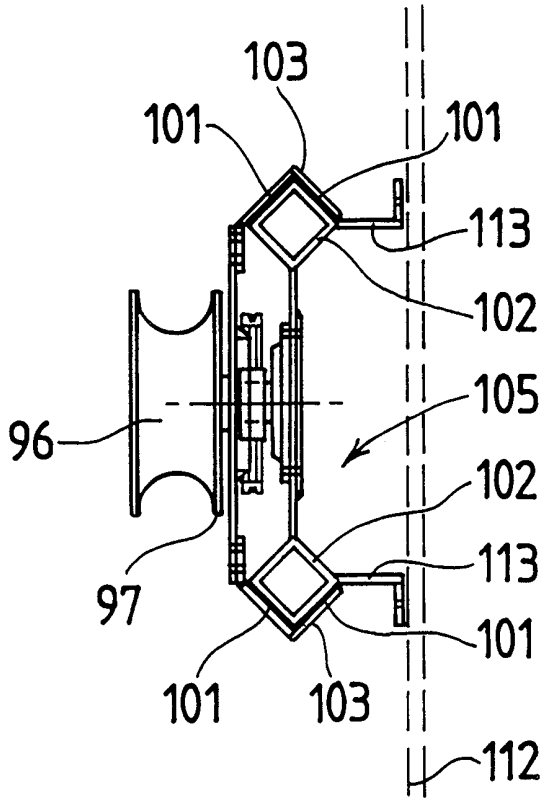

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FIG. 10

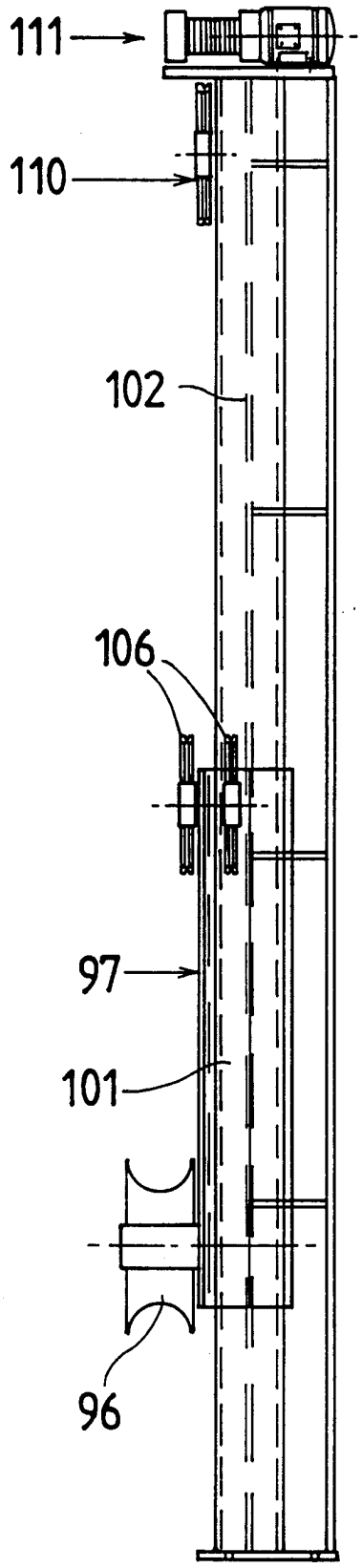
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FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00747

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B65G 65/38, B65D 88/54, E04H 7/22

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)
B65G 65/3:, 65/4:, 33/14, 69/02, 3/04, 3/00, B65D 88/08, 88/54, A01F 25/14, 25/16, 25/18, 25/20, E04H 7/2:7/3:, F23K 3/-

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)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2535374 A (DUBROEUCQ N) 4 May 1984 whole document	1-15
X	US 3908840 A (LAMBERT JR.) 30 September 1975 whole document	1-15
X	FR 2294944 A (COIGNET S.A.) 16 July 1976 whole document	1-15

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

[X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00747

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 86/01185 A (AJOSTAHLBAU GMBH & CO. KG) 27 February 1986 whole document	1-15
X	DE 4141824 A (NEUERO FARMUND & FOERDERTECHNIK GMBH) 1 July 1993 whole document	1-15
X	DL 114243 A (STREDISKO PRO VYNAL) 20 July 1975 abstract	1-15
X	Derwent Abstract Accession No. 84-170097/27, class p12, SU 1050604 A (FOMIN L U) 30 October 1983 abstract	1-15

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 99/00747

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					
US	3908840	CA	1011677				
WO	8601185	AU	45469/85	DE	3429023	DK	1434/86
		EP	190177	NO	861314		

END OF ANNEX