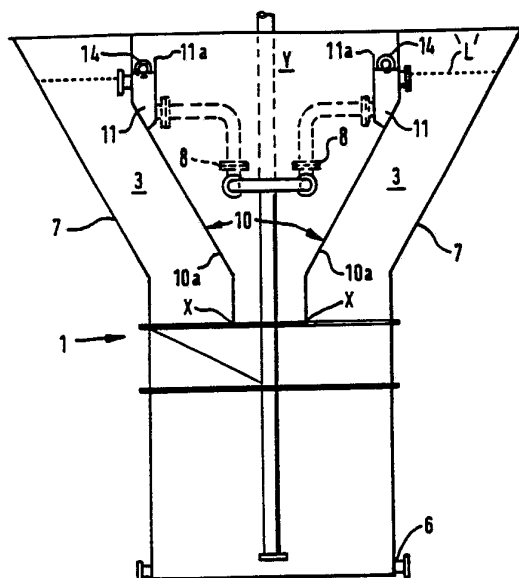




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>5</sup> : <b>B01D 21/00, 21/24</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 92/00131</b> (43) International Publication Date: 9 January 1992 (09.01.92)</p>
<p>(21) International Application Number: PCT/GB91/01013 (22) International Filing Date: 24 June 1991 (24.06.91) (30) Priority data: 9014014.6 22 June 1990 (22.06.90) GB (71) Applicant (for all designated States except US): THAMES WATER UTILITIES LIMITED [GB/GB]; Spencer House, Manor Farm Road, Reading, Berkshire RG2 0JN (GB). (72) Inventor; and (75) Inventor/Applicant (for US only) : MARSH, Philip [GB/GB]; 104 Swinburne Avenue, Hitchin, Hertfordshire SG5 2QT (GB). (74) Agent: JOHNSON, Terence, Leslie; Edward Evans &amp; Co., Chancery House, 53-64 Chancery Lane, London WC2A 1SD (GB).</p>		<p>(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.</p> <p><b>Published</b> With international search report.</p>

## (54) Title: SEDIMENTATION DEVICE



## (57) Abstract

The invention relates to apparatus (1) for separating constituents of a liquid containing solids, for example for the primary sedimentation of sewage, comprising an inlet (2) for a fluid mixture, a flow path which splits into a plurality of flow path sections in each of which there is separator means (3) having a plurality of baffle plates (4) through which the respective flow path sections are arranged to flow in an upwardly inclined path whereby to separate heavier constituents from lighter constituents of the mixture, both flow path sections leading to an outlet (5) for lighter constituents downstream of the separator means and to a common outlet (6) for heavier constituents upstream of the separator means (3).

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland	KR	Republic of Korea	SN	Senegal
CI	Côte d'Ivoire	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	US	United States of America
DK	Denmark				

- 1 -

## SEDIMENTATION DEVICE

The invention relates to sedimentation apparatus, particularly primary and final sedimentation in wastewater treatment.

At present, sedimentation is usually carried out in large tanks, 5 suitably of concrete, of various shapes, designed to retain liquid flow for periods of between two to six hours and where the particles must settle through depths of 2.5 to 4.5 metres.

The construction of such tanks requires considerable land area and excavation. Also the large volumes required tend to preclude the 10 use of construction materials other than concrete. All of these factors make for a high cost on installation and maintenance.

It is accordingly an object of the invention to seek to provide an improved separation apparatus.

According to the invention there is provided apparatus for separ- 15 ating constituents of a liquid containing solids, comprising an inlet for a fluid mixture, a flow path which splits into a plurality of flow path sections in each of which there is separator means having a plurality of baffle plates through which the respective flow path sections are arranged to flow in an upwardly 20 inclined path whereby to separate heavier constituents from lighter constituents of the mixture, both flow path sections leading to an outlet for lighter constituents downstream of the separator means and to a common outlet for heavier constituents upstream of the separator means.

25 The separator means may each comprise an array of substantially spaced apart parallel plates arranged to provide a laminar flow therebetween. This provides for separation of the constituents.

- 2 -

The plate separation may suitably be in the range 50-100 mm. This provides for efficient separation of constituents of the mixture.

The angle of inclination of the plates may be in the range 55°-60° to the horizontal, to provide for sufficient contact time during separation.

The ratio of plate length to plate separation may preferably be approximately 20. This provides for a sufficient contact area.

The array may have a honeycomb-like configuration in end elevation. This provides for construction using a plurality of 10 corrugated plate members.

Each array of plates may be removably mounted in the apparatus.

The inlet may comprise a plurality of separate feed means whereby to feed the mixture to the apparatus in a direction away from the common outlet. This provides for a passage through the apparatus 15 without substantial turbulence.

The inlet may provide a conduit comprising the outlet for the lighter constituents, which conduit may comprise a blanked off part of an inlet pipe.

The outlet for the lighter constituents also may comprise a collector for those constituents intermediate the downstream end of the separator means and the conduit.

The collector may comprise a tube with longitudinally spaced inlet ports formed therein.

The apparatus may include a channel for collecting scum from the 25 liquid, and, suitably, means periodically to allow scum to pass to the scum channel. This helps to obviate the build-up of scum in the apparatus.

- 3 -

The means may comprise a valve operable to raise the level of the liquid in the apparatus whereby to allow scum to pass to the scum channel.

There may be a stirrer device to stir heavier constituents adjacent the outlet. This helps to ensure smooth flow through the apparatus.

There may also be a further device for urging scum towards the scum channel, which further device may comprise a reciprocable blade member.

The further device may comprise the reciprocable blade member and a cam to which the blade member is attached, and the cam may be mounted on a rotatable rod of the stirrer device.

Apparatus for separating constituents of a liquid containing solids is hereinafter described, by way of example, with reference to the accompanying drawings.

15 Fig. 1 is a side elevational view of the apparatus according to the invention, in the form of a primary sedimentation tank or vessel for separating solids from sewage;

Fig. 2 is an elevational view of the apparatus of Fig. 1 as seen in the direction of arrow "Z" in Fig. 1;

20 Fig. 3 is a top plan view of the apparatus of Figs. 1 and 2;

Fig. 4 is a schematic side elevational view of the apparatus of Figs. 1-3, with parts omitted for clarity;

Fig. 5 is a schematic top plan view of the apparatus Figs. 1-4, with parts omitted for clarity;

25 Figs. 6A and 6B show respectively a side elevational and plan view of a collector for lighter constituents; and

**SUBSTITUTE SHEET**

- 4 -

Fig. 7 shows a perspective view of one embodiment of a lamella plate separator of the apparatus.

Referring to the drawings there is shown apparatus 1 for separating constituents of a liquid containing solids, for example for the primary sedimentation of sewage, comprising an inlet 2 for a fluid mixture, a flow path which splits into a plurality of flow path sections in each of which there is separator means 3 having a plurality of baffle plates 4 through which the respective flow path sections are arranged to flow in an upwardly inclined path whereby to separate heavier constituents from lighter constituents of the mixture, both flow path sections leading to an outlet 5 for lighter constituents downstream of the separator means and to a common outlet 6 for heavier constituents upstream of the separator means 3.

The apparatus 1 shown is essentially an open-topped vessel, tank or container, the inlet 2 for raw sewage to be separated into its lighter and heavier (sludge) constituents comprising a riser feed 2a which splits at the upper (as viewed) open end of the vessel into two transverse pipes 2b which extend across the open top of the vessel, which is rectangular with inclined sides 7 and leads to a circular bottom part which has the outlet 6 at the bottom for sludge. The transverse pipes 2b are substantially horizontal in use and each has a bifurcated upstand 2c in the form of two open pipes which point in a direction away from the outlet and out of which the sewage passes into the vessel. The four entry pipes point upwards just below the surface. The surface area at this point is large so velocities are low and enables light "scum" particles to float to the surface.

The sewage then flows downwards accelerating to a maximum at the bottom of the stilling chamber. The flow then splits into two to flow up the plate arrays.

- 5 -

Because the flow area through the plate arrays is twice that through the bottom of the stilling chamber the velocity is halved. Also there is a change in direction of flow from downwards to upwards which produces a momentary zero velocity. Because of the low velocities in this region and by virtue of their momentum, larger particles carry on down to the sludge hopper. Because the majority of larger particles do not enter the plate arrays blockages are not a problem.

The horizontal transverse pipes 2b are blanked off as by plate inserts 8 downstream of the respective bifurcated upstand 2c and receive separated light constituents of the sewage from collectors 9 thereof (only one is shown in Fig. 5), the light constituents then passing to a common down pipe 5a for removal for further processing, there being an air bleed 5b at the top of the down pipe.

The walls 7 of the upper part taper downwardly towards one another at an angle of inclination in the embodiment of  $60^\circ$ , though the angle may be in the range  $55-60^\circ$ .

Internally of the top part of the vessel there are internal walls 10 which are transverse and extend into the vessel 1 to the position "X" shown. The walls have an inclined part 10a parallel to the external walls, and which form two housings, each open at the top and bottom as viewed and in which is received respectively a separator 3 in the form of an array of spaced apart parallel plates 4 substantially parallel to each other and to the walls 7, 10a. The array 3 comprises an assembly of corrugated plastic plates like roofing plate lights which abut at "hills" and "valleys" where they are jointed as by means such as nuts and bolts to form a stable array. The array may be mounted in a frame of say metal whereby it can be removably mounted in the vessel.

Adjacent the top (as viewed) or downstream end of each separator there is the respective collector 9 for the lighter constituents of

- 6 -

the sewage, comprising a transverse pipe of say plastic which has longitudinally spaced apart ports 9a through which the lighter constituents enter the collectors 9. The collectors 9 in turn are connected by suitable conduiting with the blanked off parts 2d of 5 the transverse pipes 2b.

There are also scum channels 11 extending transversely of the vessel and having a weir or lip 11a slightly higher than the normal liquid level "L" and over which scum can pass in a manner to be described. The weirs or lips 11a may be castellated and/or variable 10 in inclination, though vertical ones as shown are preferred.

Passing centrally down the vessel, between the pipes 2b, 2d, is a rotatable rod 12 which supports at its lower end (as viewed) a stirrer device (not shown) in the form of a picket fence which helps to obviate stratification in the sludge adjacent the outlet.

15 Adjacent the surface "L" of the liquid is a scum separator or sweep device which reciprocates across the surface in order to "sweep" scum into the scum channels. The device is in the form of a blade carried by an eccentric cam device mounted on the rotatable rod 12 of the stirrer device so that as the rod rotates, the sweep device 20 reciprocates across the surface as described.

The plates in the array of plates comprising each separator have a separation of 60 mm, and the ratio of plate length to plate separation is 20.

It will be understood that the area Y between the separators and 25 leading to the circular part is a stilling chamber.

In use to separate heavier, sludge, constituents from sewage, crude sludge enters the vessel via the four pipes 2c and fills the vessel up, the liquid sewage settling out into the lower part. As the volume of liquid in the vessel increases, the crude sludge is 30 forced upwardly through both separators 3, in other words the flow

**SUBSTITUTE SHEET**



- 7 -

splits into two flow sections and passes upwardly through the two separators. The spacing of the plates is such that laminar flow is maintained. During the flow through the separators, heavier sludge constituents separate out and fall under gravity downwardly against the flow of sewage and drop into the lower sludge tank. As they fall down the plates they pick up and carry with them smaller sludge particles entering the arrays. The lighter constituents, usually liquid with only finer suspended solids, is able to pass out of the top of the separators 3 where, downstream thereof, it passes through the ports 9a into the tubes 9 for passage via the blanked off parts 2d of the pipes 2 to the exit pipes 5.

From time to time there is a build up of scum on the surface, which has to be removed. This is achieved by automatically closing a valve (not shown) at the outlet of the sludge for a minute or two so that on continued flow of crude sewage into the vessel, the liquid "L" level rises high enough for the scum, which floats on the surface, to pass into the scum channels 11 over the respective weirs 11a for carriage away through pipes 14. The valve is opened when the scum has been cleared, to lower the liquid level again. It will be understood too that the scum sweep device assists by urging the scum to the sides, adjacent the channels prior to removal; in this regard, operation is not continuous as the stirrer is not operated continuously, but only when the sludge is pumped out of the exit using a pump.

Using the invention, it is possible to remove 3% of sludge from the sewage as a primary sedimentation step, at a rate of  $30 \text{ m}^3 \text{ h}^{-1}$ , which is about three times the rate for conventional concrete tanks.

It will also be understood the apparatus embodying the invention and defined herein is of a modular construction and can be erected as desired where a treatment vessel is required.

CLAIMS

1. Apparatus for separating constituents of a liquid containing solids, comprising an inlet for a fluid mixture, a flow path which splits into a plurality of flow path sections in each of which there is separator means having a plurality of baffle plates through which the respective flow path sections are arranged to flow in an upwardly inclined path whereby to separate heavier constituents from lighter constituents of the mixture, both flow path sections leading to an outlet for lighter constituents downstream of the separator means and to a common outlet for heavier constituents upstream of the separator means.
2. Apparatus according to Claim 1, the separator means each comprising an array of substantially spaced apart parallel plates arranged to provide a laminar flow therebetween.
3. Apparatus according to Claim 2, the plate separation being in the range 50-100 mm.
4. Apparatus according to Claim 3, the angle of inclination of the plates being in the range 55°-60° to the horizontal.
5. Apparatus according to any of Claims 2 to 4, the ratio of plate length to plate separation being approximately 20.
6. Apparatus according to any of Claims 2 to 5, the array having an honeycomb-like configuration in end elevation.
7. Apparatus according to any of Claims 2 to 6, each array of plates being removably mounted in the apparatus.

- 9 -

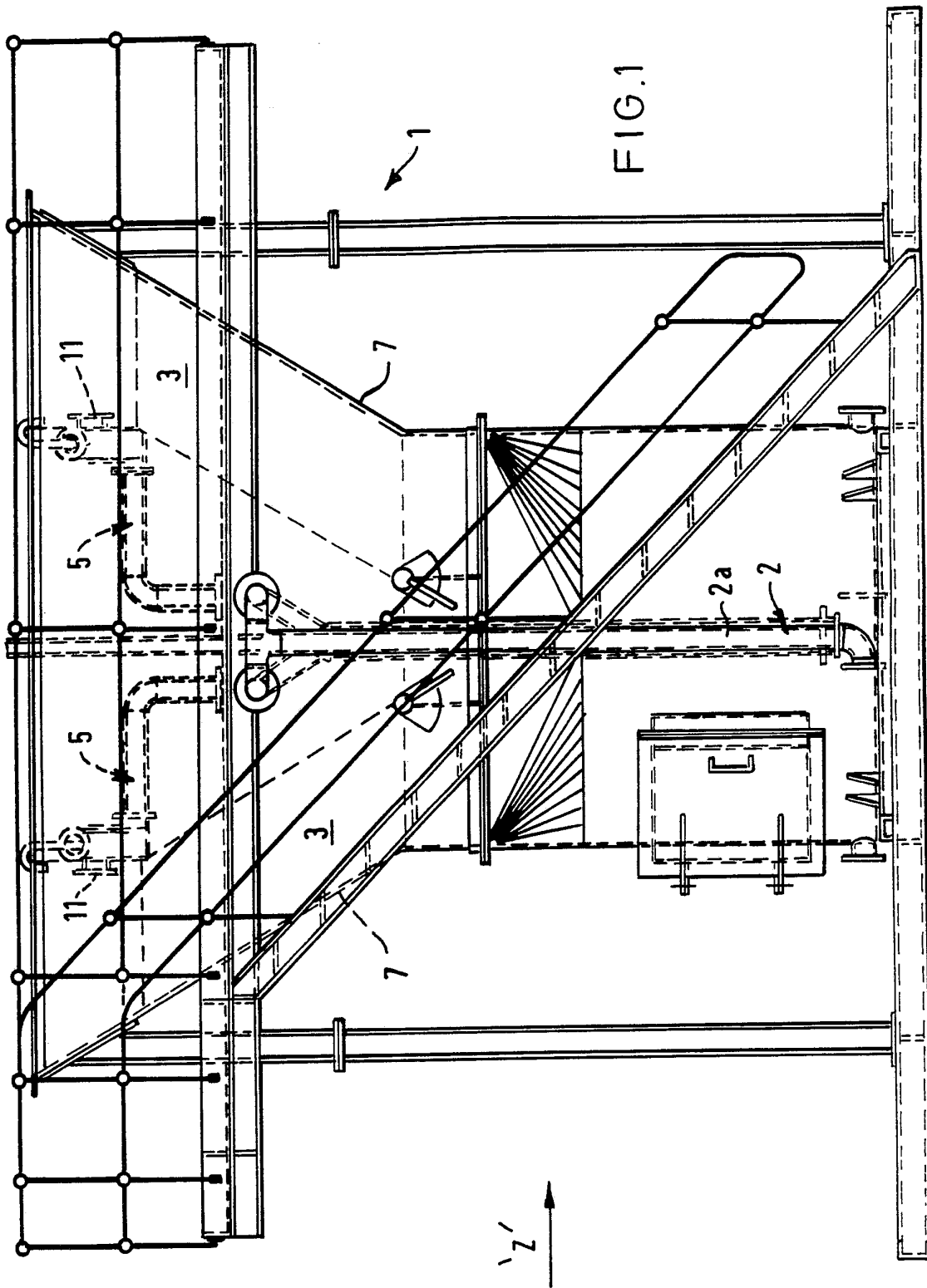
8. Apparatus according to any preceding Claim, the inlet comprising a plurality of separate feed means whereby to feed the mixture to the apparatus in a direction away from the common outlet.
- 5 9. Apparatus according to any preceding Claim, the inlet providing a conduit comprising the outlet for the lighter constituents.
10. Apparatus according to Claim 9, the conduit comprising a blanked off part of an inlet pipe.
- 10 11. Apparatus according to Claim 10, the outlet for the lighter constituents also comprising a collector for those constituents intermediate the downstream end of the separator means and the conduit.
12. Apparatus according to Claim 11, the collector comprising a  
15 tube with longitudinally spaced inlet ports formed therein.
13. Apparatus according to any preceding Claim, including a channel for collecting scum from the liquid.
14. Apparatus according to Claim 13, including means periodically to allow scum to pass to the scum channel.
- 20 15. Apparatus according to Claim 14, the means comprising a valve operable to raise the level of the liquid in the vessel whereby to allow scum to pass to the scum channel.
16. Apparatus according to any preceding Claim, including a stirrer device to stir heavier constituents adjacent the outlet.
- 25 17. Apparatus according to any of Claims 13 to 16, including a further device for urging scum towards the scum channel.

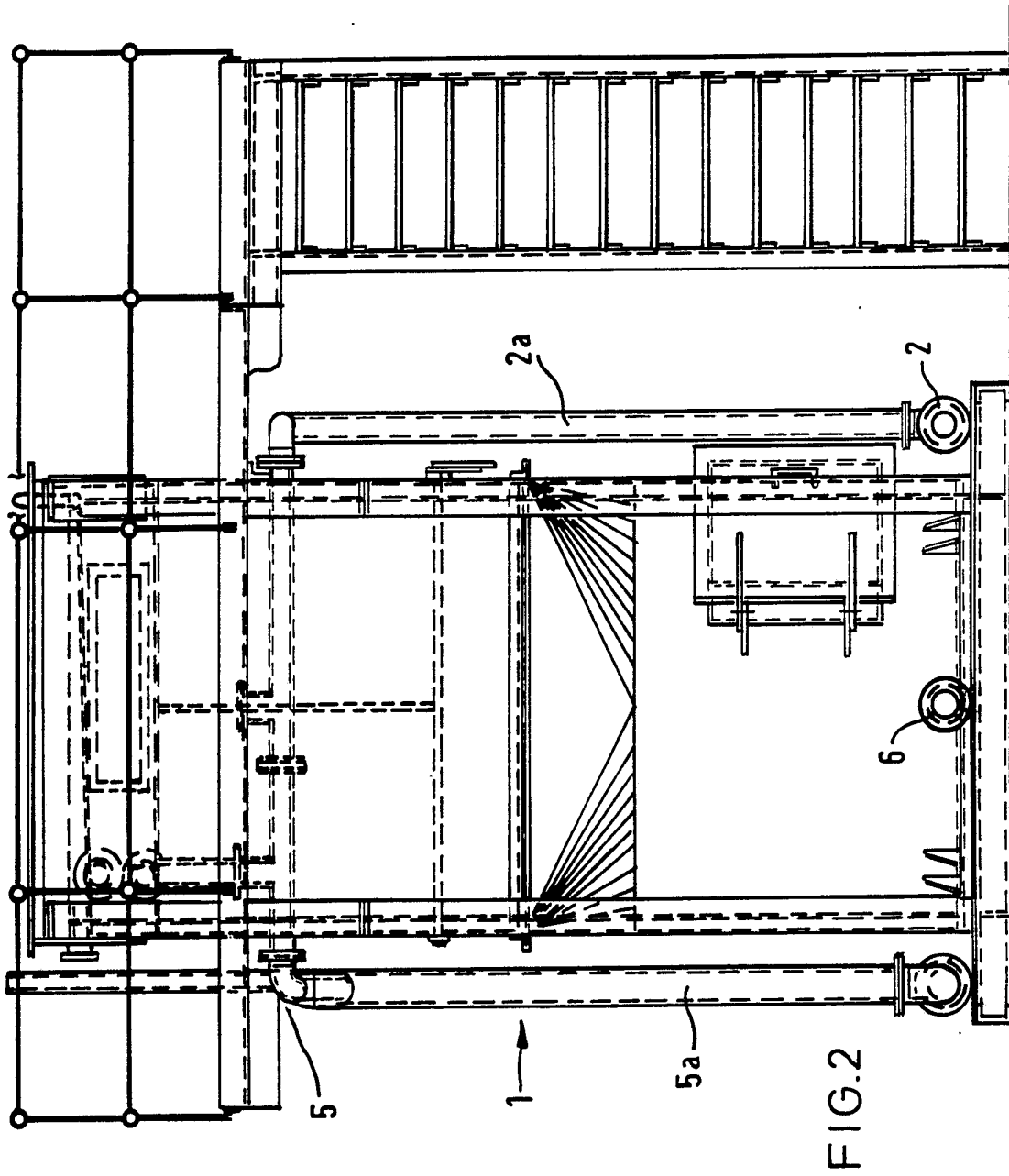
**SUBSTITUTE SHEET**

- 10 -

18. Apparatus according to Claim 17, the further device comprising a reciprocable blade member.

19. Apparatus according to Claim 18, the further device comprising the reciprocable blade member and a cam to which the blade member is attached, the cam being mounted on a rotatable rod of the stirrer device.





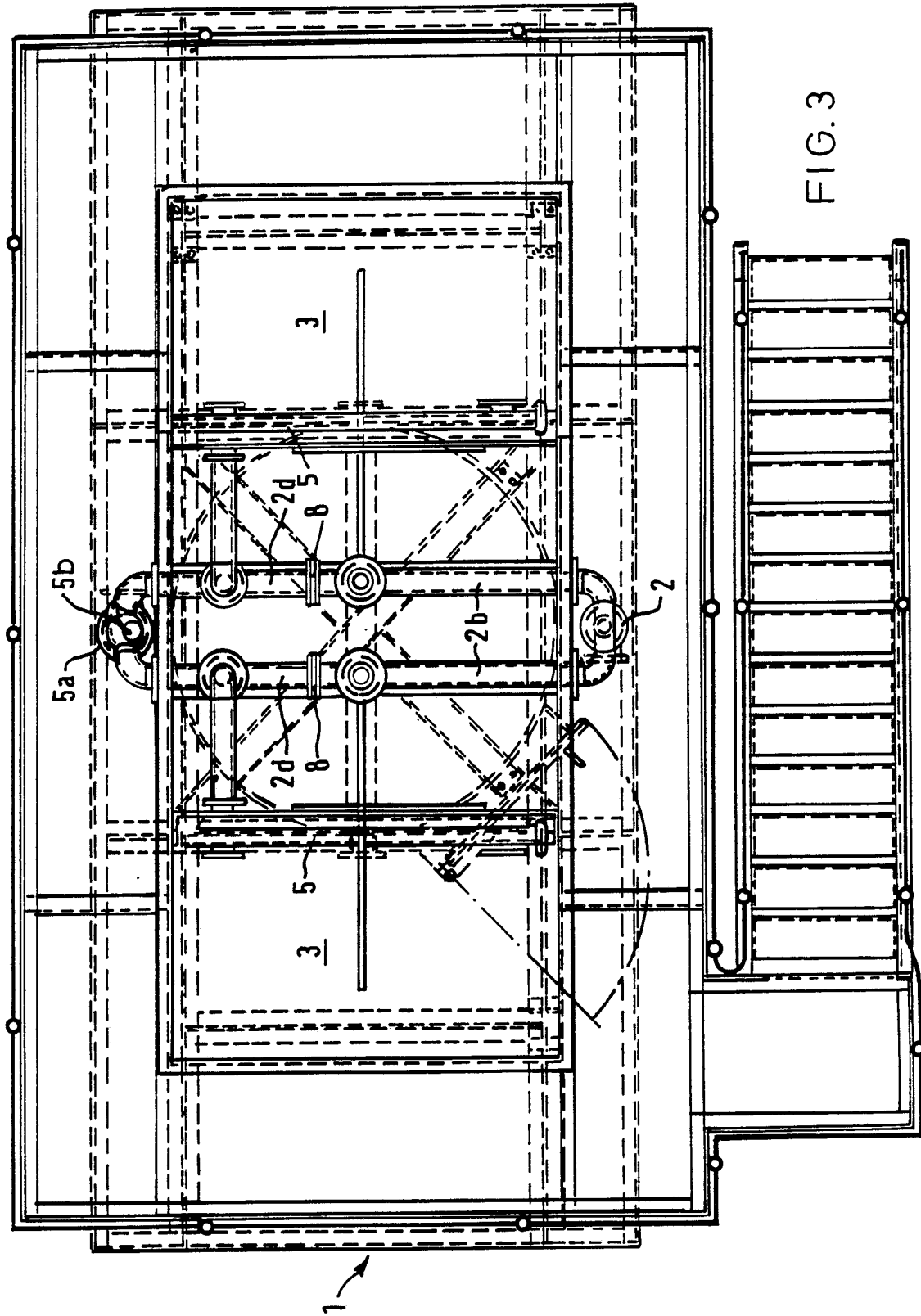
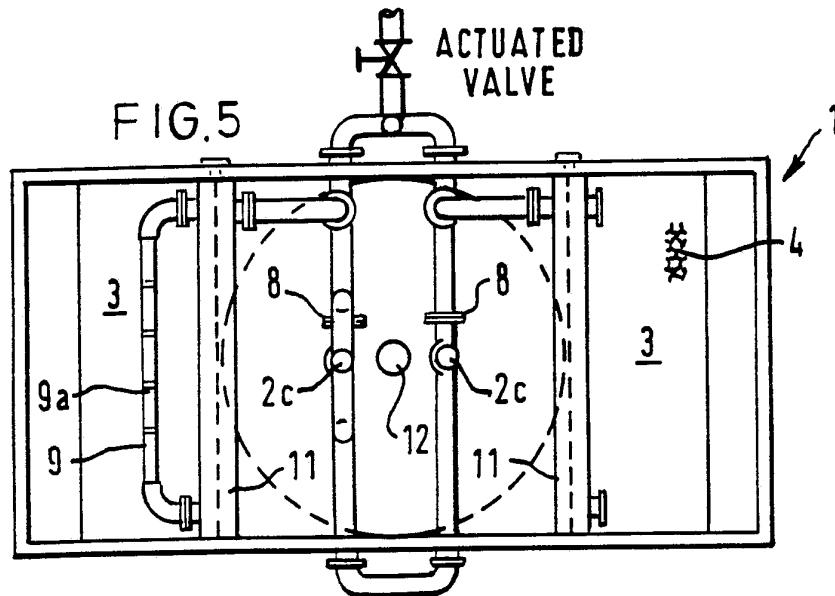
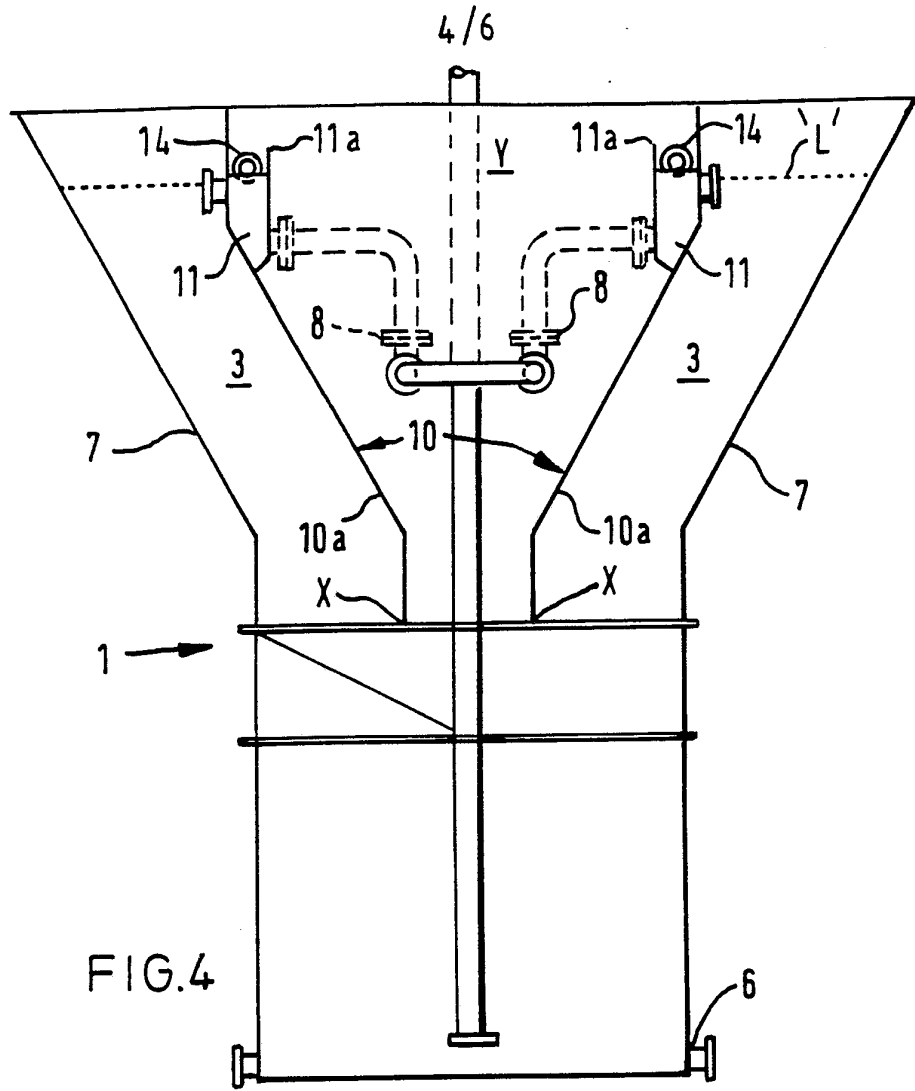


FIG. 3





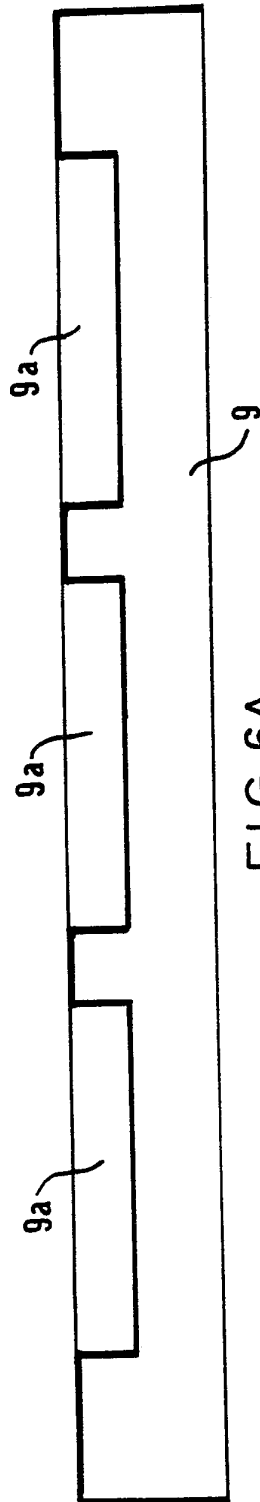


FIG. 6A

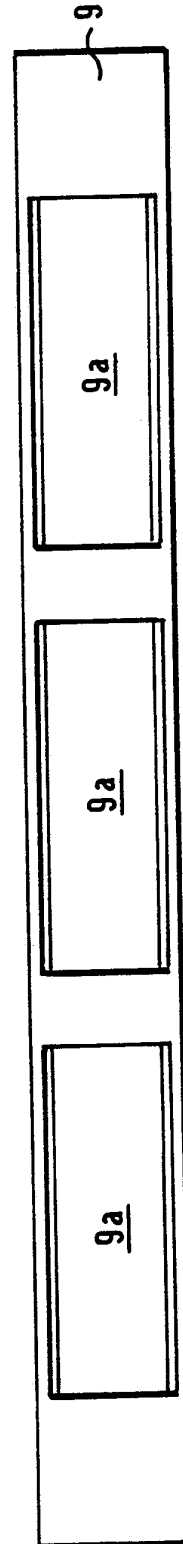
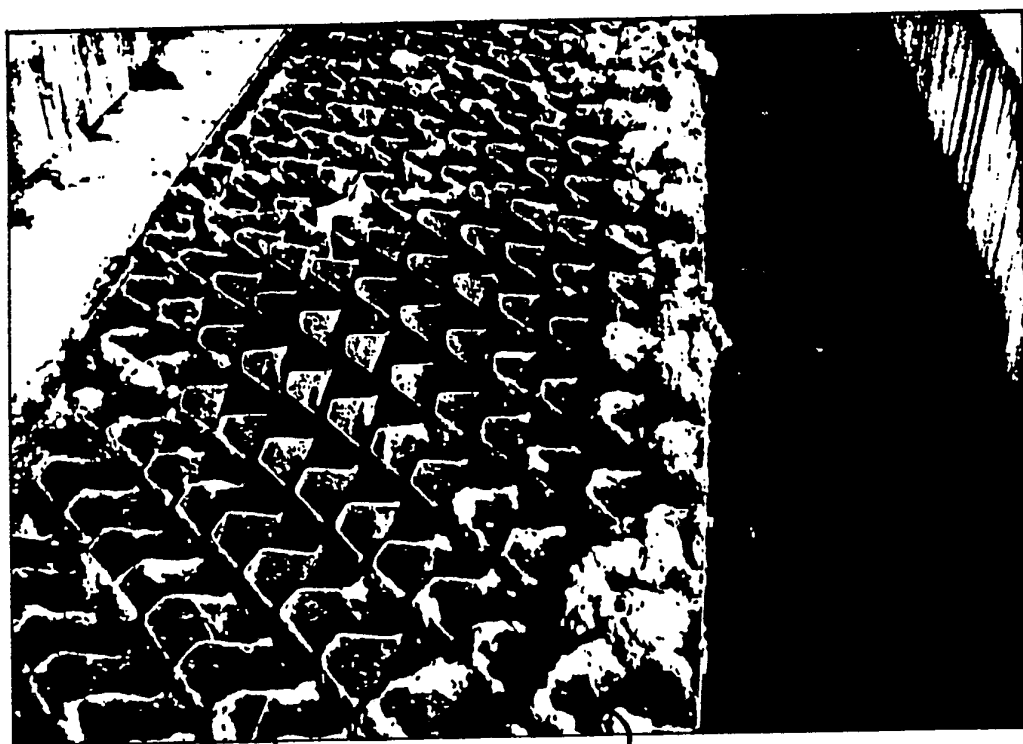


FIG. 6B



4 3

FIG.7

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 91/01013

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5                      B01D21/00 ; B01D21/24		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	B01D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X Y	CH,A,242 594 (SEAILLES) October 16, 1946 see page 2, line 91 - page 3, line 16; figures 1-3 ---	1,2 3-8,13, 14,16-18
Y	KORRESPONDENZ ABWASSER vol. 31, February 1984, pages 104 - 111; H. SCHADE ET AL.: 'PARALLELPLATTENABSCHIEDER '	3-5,8
A	see page 106, left column, paragraph 2; figure 6; tables 2,3 ---	6,7
Y	FR,A,994 118 (SEAILLES) November 12, 1951 COMPLETE DOCUMENT ---	6,7
A	US,A,4 290 887 (BROWN ET AL.) September 22, 1981 ABSTRACT ---	11,12
-/--		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> 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> </div> <div style="width: 45%;"> <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</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>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
05 SEPTEMBER 1991	04 OCT 1991	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	MARZENKE J.	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	DE,B,1 253 674 (CORNELISSEN) November 9, 1967 see column 3, line 58 - column 4, line 22; figures 1,2 ---	7,13,14
Y	FR,A,2 400 939 (FIVES-CAIL BABCOCK) March 23, 1979 see page 4, line 19 - line 30; figure ---	16
Y	US,A,4 634 526 (SALKELD ET AL.) January 6, 1987 see column 6, line 57 - line 68; figure 7 ---	17,18
A	GB,A,2 039 873 (SYDLO INC.) August 20, 1980 COMPLETE DOCUMENT ---	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9101013  
SA 48805

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05/09/91

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
-----			
CH-A-242594		BE-A- 456719 CH-A- 242596 FR-E- 55765 FR-A- 905595 FR-A- 982912	
-----			
FR-A-994118		BE-A- 465066 CH-A- 252745 FR-E- 56202 FR-E- 56203 FR-E- 56208 FR-A- 997816 GB-A- 635611 US-A- 2573615	
-----			
US-A-4290887	22-09-81	AU-B- 538870 AU-A- 5138279	30-08-84 17-04-80
-----			
DE-B-1253674		NL-C- 131521 NL-A- 6608881	25-08-66
-----			
FR-A-2400939	23-03-79	None	
-----			
US-A-4634526	06-01-87	None	
-----			
GB-A-2039873	20-08-80	CA-A- 1139679 US-A- 4303517	18-01-83 01-12-81
-----			