(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 140 672**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **84307277.8**

(22) Date of filing: **23.10.84**

(51) Int. Cl.⁴: **B 04 B 1/20**

(30) Priority: **28.10.83 GB 8328894**

(43) Date of publication of application: **08.05.85 Bulletin 85/19**

(84) Designated Contracting States: **DE FR NL SE**

(71) Applicant: **THOMAS BROADBENT & SONS LIMITED, Queen Street South, Huddersfield West Yorkshire HD1 3EA (GB)**

(72) Inventor: **Grimwood, Geoffrey Luther, Shaley House Wooldale Holmfirth, Nr. Huddersfield West Yorkshire (GB)**
Inventor: **Wright, John, 38 Edgeware Road, Dalton Huttersfield West Yorkshire (GB)**

(74) Representative: **Huntingford, David Ian et al, W.P. THOMPSON & CO. Coopers Building Church Street, Liverpool L1 3AB (GB)**

(54) Improvements in decanting type centrifuges.

(57) A method and apparatus for removing carrier liquid from solids particles separated from a liquid slurry in a decanter-type centrifuge, a further liquid is introduced into the bowl which is both immiscible with and of higher specific gravity than the carrier liquid to establish at the periphery of the bowl a body (42) of this further liquid defining a transfer zone (46) disposed radially outwardly of the body (48) of carrier liquid, the solids separated from the carrier liquid by centrifugal action moving into said transfer zone (46) where carrier liquid adhering to the solids particles is displaced by the second liquid of higher specific gravity, the solids particles being scrolled through said transfer zone to the solids outlet of the bowl. For isolating the body of carrier liquid (48) from the frusto-conical portion (18) of the bowl, an annular disc (54) is mounted on the conveyor (20) with its outside periphery extending into the body of liquid (42) so that when the solids are scrolled from the transfer zone up the frusto-conical portion of the bowl to the solids discharge outlet. they are not recontaminated by carrier liquid.

EP 0 140 672 A2

0140672

DESCRIPTION

IMPROVEMENTS IN DECANTING-TYPE CENTRIFUGES

The present invention relates to decanting-type centrifuges.

Existing decanter-type centrifuges of both solid and screen bowl type accept an inflow of slurry consisting of a mixture of solid particles in a carrier liquid which the centrifuge separates. Normally a small quantity of the carrier liquid adheres to and contaminates the separated solids and very fine solids remain to contaminate the separated liquid (the centrate). The degree of contamination is a measure of the inefficiency of the separation. In some centrifuge applications the sub-division of solids is required, i.e. removing the fine solids (below the cut-size of the centrifuge) with the centrate, and separating the remaining solids from the carrier liquid.

In the application of some solid bowl decanting centrifuges, the contamination of the solids can be reduced by applying a wash liquid to the solids as they leave the carrier liquid. This is relatively ineffective, the wash liquid to solids contact time being short, the wash liquid being lost in the centrate and solids tending to be washed back into the carrier liquid.

In the application of some screen bowl decanting centrifuges, the contamination of the solids can be reduced by applying wash liquid to the solids whilst they pass over the screen section. Although the contact time is short, efficient washing is possible but some fine solids and carrier liquid are washed through the screen to contaminate the wash liquid. This contaminated wash liquid becomes an output of unseparated solids and liquids that either requires a secondary separation process or is re-circulated through the centrifuge, so increasing the fine solids loading.

It is an object of the present invention to improve the efficiency of the separation process provided by the aforegoing known techniques.

In accordance with the present invention, a further liquid is introduced into the bowl which is both immiscible with and of higher specific gravity than the carrier liquid to establish at the periphery of the bowl a body of this further liquid defining a transfer zone disposed radially outwardly of the body of carrier liquid, the solids separated from the carrier liquid by centrifugal action moving into said transfer zone where carrier liquid adhering to the solids particles is displaced by the second liquid of higher specific gravity, the solids particles being scrolled through said transfer zone to the solids outlet of the bowl.

Preferably, means are provided adjacent the solids discharge end of the bowl for isolating the body of carrier liquid from the frusto-conical portion of the bowl, so that when the solids are scrolled from the transfer zone up the frusto-conical portion of the bowl to the solids discharge outlet, they are not re-contaminated by carrier liquid.

Conveniently, the latter means comprises a disc carried by the conveyor and disposed adjacent the solids discharge end of the bowl, the outside diameter of said disc being such that it extends into said body of further liquid and the inside diameter being such that it extends radially inwardly of the radially inner surface of said body of carrier liquid.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a partial longitudinal section through a known solid bowl decanting centrifuge;

Fig. 2 is a partial longitudinal section through a known screen bowl decanting centrifuge;

Fig. 3 is a partial longitudinal section through a solid bowl decanting centrifuge embodying the present invention;

Fig. 4 is a partial longitudinal section through a second embodiment of a solid bowl decanting centrifuge in accordance with the invention;

Fig. 5 is a partial longitudinal section through a known concurrent flow decanter centrifuge; and

Fig. 6 is a partial longitudinal section through a concurrent flow decanting centrifuge embodying this invention.

Figures 1 and 2 show conventional decanting centrifuges in the solid bowl and screen bowl configurations for solid liquid separation duties wherein like parts are given the same reference numerals.

The centrifuge of Fig. 1 comprises essentially a solid bowl 10 which is adapted to be rotated about a horizontal axis 12 by drive means (not shown). The bowl 10 has a radial end wall 14, a cylindrical side wall portion 16 and a frusto-conical side wall portion 18. Coaxially mounted within the bowl, for rotation at a slightly different speed thereto, is a helical screw conveyor 20 which is adapted to scroll solids deposited on the inner periphery of the bowl towards a solids discharge outlet 22 disposed downstream of the frusto-conical portion 18 in the conveying direction. The radial wall 14 at the other end of the bowl contains a liquid discharge orifice 24.

Liquid slurry to be separated is introduced into the interior of the bowl by way of a feed pipe 26 and apertures 28 in the conveyor 20.

The bowl of Fig. 2 is similar to that of Fig. 1 except that it contains a cylindrical screen portion 30

between the frusto-conical portion and the solid discharge outlet 22.

Both of these decanting centrifuges subject the slurry to be separated to high radial acceleration or 'G' forces, thus separating the heavier solids 32 (which are moved to the periphery of the bowl by this 'G' force to be scrolled by the conveyor 20 to the solids discharge outlet 22) from the lighter carrier liquid that flows to the liquid outlet 24.

For the solid bowl decanting centrifuges (Fig. 1), the present "state of the art" washing is applied by a wash feed pipe 34 to deliver wash liquid to a wash zone 36 via outlet pipes 38, with the disadvantages described above.

For the screen bowl decanting centrifuge (Fig. 2), the present "state of the art" washing is applied by the wash feed pipe 34 to deliver wash liquid via outlet pipes 38a to the solids being scrolled across the screen 30, the contaminated wash liquid being collected in the screen section 40a of the outer casing 40.

In the embodiment in accordance with the present invention shown in Fig. 3, on start-up, with the centrifuge rotating and empty, wash liquid 42, which is of a higher specific gravity than the carrier liquid and immiscible therewith, is introduced via the wash feed pipe 34 through wash inflow pipes 44 and, under the resulting 'G' force, fills the bowl until excess wash liquid flows from the liquid outlet 24 (or is removed

by a rotating collector trough and skimmer pipe, or other known means). Thus with the decanting centrifuge rotating at or near design speed, a wash zone 46 is established at the periphery of the bowl. The slurry is then fed to the centrifuge via the slurry feed pipe 26 and feed ports 28, filling a slurry zone 48 to a depth X and reducing the wash liquid depth to Y as the centrate discharges through centrate outlet pipes 50 (the depths X and Y being functions of the respective specific gravities of the wash liquid and centrate). A radial separating disc 52, rigidly mouted to the conveyor trunnion for rotation therewith, has an outside diameter greater than the diameter of the bore of the cylindrical bowl portion 16 minus Y, and an inner diameter less than the bore diameter of the cylindrical bowl portion minus (X + Y), in order to maintain the separation of the wash liquid and centrate at the liquid discharge end of the bowl.

Solid particles in the slurry zone 48, subjected to the high 'G' forces, move radially outwards towards the bowl periphery and pass through the wash liquid zone 46 to the bowl wall so as to be scrolled by the conveyor 20 through the wash zone 46 towards the solids outlet 22 (not shown in Fig. 3). During this process, the denser wash liquid 42 displaces some of the carrier liquid held to the solids by surface tension - the

lighter displaced carrier liquid moving radially inwards to the slurry zone 48, eventually to be discharged as centrate. By this means, the solids are washed thoroughly during the entire residence time in the wash liquid 42 and are discharged relatively free of carrier liquid, i.e. the degree of carrier liquid contamination of the solids has been reduced and replaced by an acceptable level of contamination by wash liquid.

The wash liquid zone level is maintained by providing the required flow of wash liquid to the wash feed pipe 34 - the supply being either fresh wash liquid or wash liquid re-circulated (by tank, pump or similar known means) from used overflow wash liquid recovered from a wash section of the casing - or a combination of both.

This embodiment of the invention has the disadvantage that the solids pass briefly through the carrier liquid (slurry) zone 48 again as they are scrolled through the conical bowl section 18 to the solids discharge outlet 22 and some re-contamination by the carrier liquid can therefore occur. Tests show, however, that this level of re-contamination is low and a substantial improvement in washing occurs by this method - which is added to the advantages that the wash liquid does not mix with the carrier liquid, is not lost to the centrate and can be re-circulated and re-used.

Fig. 4 shows a preferred embodiment in accordance with this invention that overcomes the disadvantage of re-contamination of the solids which can happen with the embodiment of Fig. 3. A second liquid separating disc 54 again rigidly attached to the conveyor 20, is fitted near to the solids discharge end of the centrifuge. The disc 54 is dimensioned so that its outside diameter is greater than the diameter of the interface between the wash and carrier liquids in the bowl end and its inner diameter is less than the diameter of the free surface of rotation of the carrier liquid. Wash liquid is introduced during start-up via the wash input pipes 44 to the final wash zone 46a near the solids discharge end of the centrifuge as described above, to establish the washing zones 46 and 46a. Slurry is then introduced to the slurry separation zone 48 between the separating discs 52 and 54, with the liquid levels maintained as shown and as described above at levels X and Y. Separation and the discharge of centrate is also as described above, but in addition the solids are scrolled by the conveyor between the liquid separating disc 54 and the bowl through the final wash zone 46a to the solids outlet 22. The separating disc 54, by isolating the slurry zone 48 from the final wash zone 46a, avoids any re-contamination of the solids and lengthens the contact period between solids and wash liquid to a maximum.

The descriptions above all refer to what are known in the art as "counter-current" solid and screen bowl decanting centrifuges, i.e. centrifuges in which the flow of the carrier liquid towards the liquid discharge end of the bowl is in the opposite direction to the flow of solids to the solids discharge end of the bowl. An alternative and known arrangement of con-current flow decanting centrifuge, in which the solids and the carrier liquid flow in the same direction during separation, is shown in Fig. 5.

In this known apparatus, the slurry passes via a feed pipe 26 and feed port 28 to the bowl near the liquid discharge end of the centrifuge, with the carrier liquid flowing (left to right) towards the solids discharge end con-currently with the scrolling of the solids in the same direction by the conveyor 20. After separation, the centrate returns (right to left) via axial channels 60 to discharge via the liquid outlet 24. A separating disc 62 separates the centrate from the slurry zone 64.

This type of centrifuge in the solid bowl configuration has, in the present "state of the art", the disadvantages of the counter current design shown in Fig. 1, plus further restrictions caused by the flow pattern of the centrate to the axial channels when wash liquid is applied to the wash zone.

The present invention is applicable also to this type of con-current flow centrifuge and overcomes the disadvantages of the present known methods of washing.

Fig. 6 shows one embodiment in accordance with this invention applied to a con-current flow decanting centrifuge. As in Fig. 4, separating discs 52 and 54 are fitted near the liquid discharge and solids discharge ends of the decanter and are fixed to the conveyor 20 to define the wash zone 46 and to isolate the final wash zone 46a from the slurry zone 48. In the arrangement shown, a containment disc 66 is fitted to the bowl to provide compartments for the wash liquid 42 and centrate, the former discharging from the wash liquids outlet pipes 68 and the latter from the liquid outlet 24 (the liquid outlets now having opposite roles to those shown in Fig. 4).

Start-up is as described above in connection with Figs. 3 and 4, with the wash zones 46 and 46a established by the introduction of wash liquid via the wash feed pipe 34 and wash inflow pipes 44, followed by the introduction of slurry.

Separation takes place as described above, contact time between solids and wash liquid is a maximum, the wash liquid being recovered for re-use from the casing section (not shown) and re-circulated if required, and separation efficiency being increased by replacing carrier liquid contamination of the solids by wash liquid contamination. In addition, whilst the carrier liquid and solids flow is con-current for separation, the

wash liquid and solids flow is counter-current with the inflowing wash liquid washing the solids just prior to discharge - thus giving enhanced washing of the solids.

One application for this invention is the washing of cuttings from oil and gas wells, particularly those drilled with oil based drilling fluids. The disposal of oil wet cuttings represents a loss of oil and an environmental hazard (particularly offshore). The removal of the surplus oil on the surface of the cuttings and the replacement of this by a wash liquid (e.g. sea water) is both economic and environmentally sound.

The aforegoing embodiments of the present invention enable fundamental additions to both solid and screen bowl decanting centrifuges to be obtained, namely to:-

(i) improve the efficiency of separation by reducing the amount of carrier liquid that contaminates the solids,

(ii) apply wash liquid in the solid bowl decanting centrifuge that has a long contact time with the solids, is recovered and re-circulated without mixing with, or being lost to, the carrier liquid,

(iii) apply wash liquid to the screen bowl decanting centrifuge as (i) and (ii) above, either in place of or in addition to the screen wash.

CLAIMS

1. A method of removing carrier liquid from solids particles separated from a liquid slurry in a decanter-type centrifuge, characterised by introducing a further liquid (42) into the bowl (10) which is both immiscible with and of higher specific gravity than the carrier liquid to establish at the periphery of the bowl a body of this further liquid defining a transfer zone (46) disposed radially outwardly of the body of carrier liquid, the solids (32) separated from the carrier liquid by centrifugal action moving into said transfer zone (46) where carrier liquid adhering to the solids particles is displaced by the second liquid (42) of higher specific gravity, the solids particles (32) being scrolled through said transfer zone (46) to the solids outlet (22) of the bowl.

2. A decanter-type centrifuge for performing the method of claim 1, comprising a solid bowl having a cylindrical portion (16) and a frusto conical portion (18) and adapted to be rotated about a horizontal axis, a helical conveyor (20) disposed coaxially within the bowl for rotation at a different speed to the bowl, a liquid discharge outlet (24) at the cylindrical end of the bowl, and a solids discharge outlet (22) at the frusto-conical end of the bowl, characterised by means (54) disposed adjacent the solids discharge end of the bowl for

isolating said body of carrier liquid from the frusto-conical portion (18) of the bowl, so that when the solids (32) are scrolled from the transfer zone (46) up the frusto-conical portion (18) of the bowl to the solids discharge outlet (22), they are not re-contaminated by carrier liquid.

3. A decanter-type centrifuge as claimed in claim 2 wherein said isolating means comprises a first annular disc (54) carried by the conveyor (20) for coaxial rotation therewith and disposed adjacent the solids discharge end of the bowl, the outside diameter of said first disc (54) being such that it extends into said body of further liquid (42) and the inside diameter being such that it extends radially inwardly of the radially inner surface of said body of carrier liquid.

4. A decanter-type centrifuge as claimed in claim 2 or 3 including a second annular disc (52) carried by the conveyor (20) for coaxial rotation therewith and disposed adjacent the liquid discharge end of the bowl, the outside diameter of said second disc (52) being such that it extends into said body of further liquid (42) and the inside diameter being such that it extends radially inwardly of the radially inner surface of said body of carrier liquid, and outlet pipe means (50) for removing carrier liquid from the bowl and defining

the radially inner surface level of the body of carrier liquid.

5. A decanter-type centrifuge for performing the method of claim 1, comprising a solid bowl (10) having a cylindrical portion (16) and a frusto-conical portion (18) and adapted to be rotated about a horizontal axis, a helical conveyor (20) disposed coaxially within the bowl for rotation at a different speed to the bowl, a liquid discharge outlet (24) at the cylindrical end of the bowl, a solids discharge outlet (22) at the frusto-conical end of the bowl, and an annular disc (52) carried by the conveyor for coaxial rotation therewith and disposed adjacent the liquid discharge end of the bowl, the outside diameter of said disc (52) being such that it extends into said body of further liquid and the inside diameter being such that it extends radially inwardly of the radially inner surface of said body of carrier liquid, and outlet pipe means (50) for removing carrier liquid from the bowl and defining the radially inner surface level of the body of carrier liquid.

6. A decanter centrifuge as claimed in claim 2 of the con-current flow type, having passage means (60) for leading separated carrier liquid from a location adjacent the solids discharge end of the cylindrical portion of the bowl to the liquids discharge

outlet at the other end of said cylindrical portion, the liquid slurry being introduced to the cylindrical portion of the bowl adjacent the liquids discharge outlet end whereby solids and separated carrier liquid move generally in the same direction along the cylindrical portion of the bowl during the separation process, characterised in that said isolating means comprises a first solid annular disc (54) carried by the conveyor (20) for coaxial rotation therewith and disposed adjacent the solids discharge end of said cylindrical portion of the bowl, a second solid annular disc (52) carried by the conveyor (20) for coaxial rotation therewith and disposed adjacent the liquids discharge end of said cylindrical portion of the bowl, the outside diameters of said first and second discs being such that they extend into said body of further liquid (42), a third annular disc (66) extending radially inwardly from the periphery of said cylindrical portion of the bowl at a location between said second annular disc (52) and said liquid discharge end of the bowl, and outlet pipe means (68) for removing said further liquid (42) from the bowl and defining the radially inner surface level of said further liquid in the region between the second and third annular discs (66, 52).

0140672

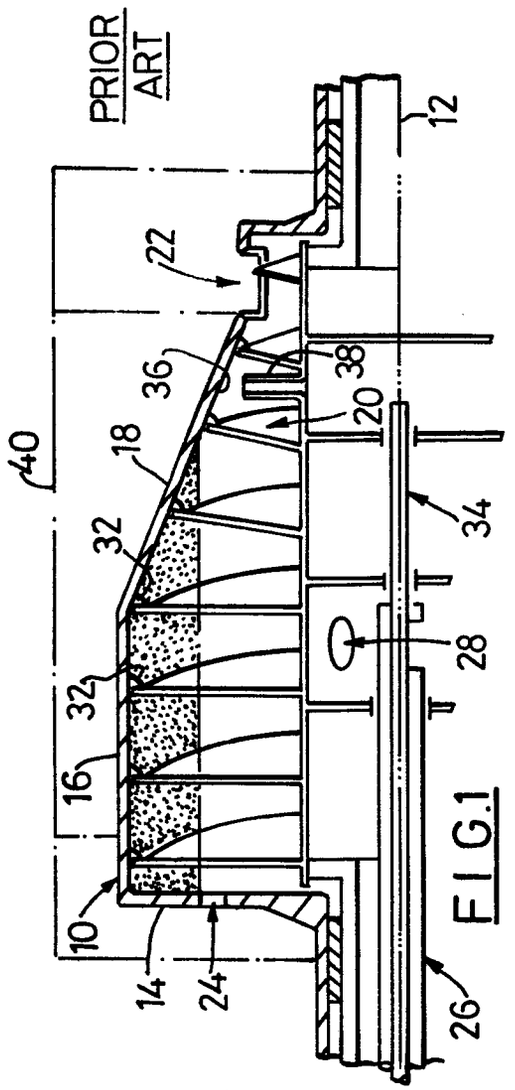

FIG.1

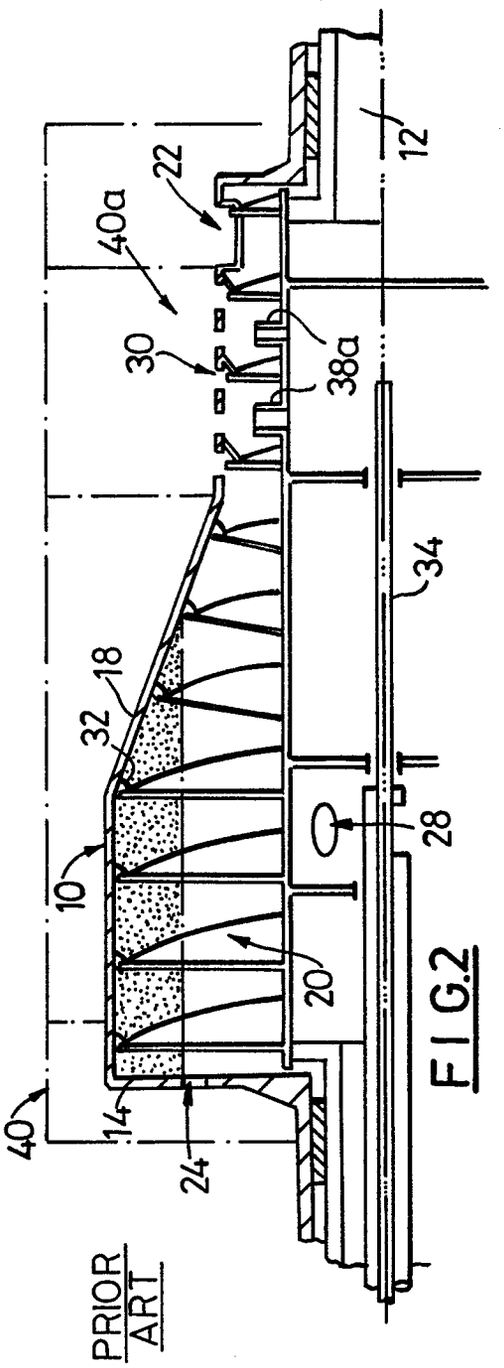

FIG.2

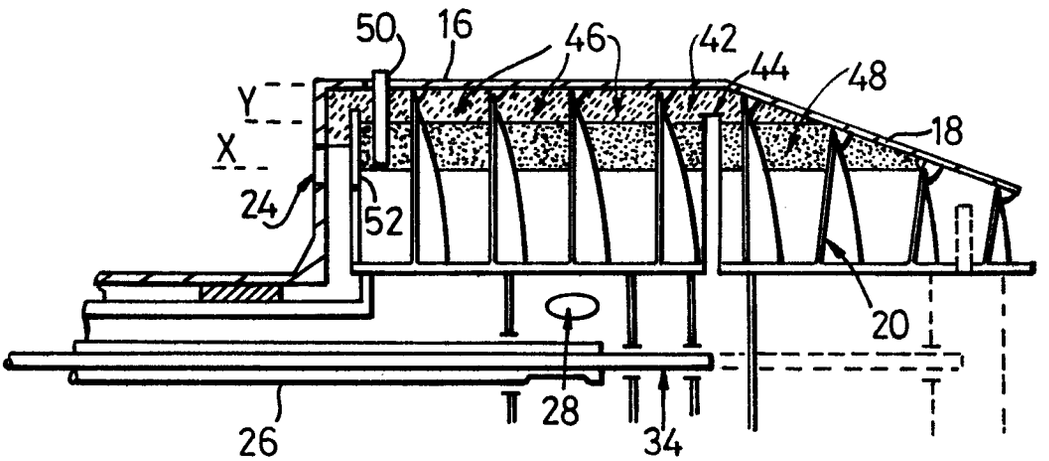
50
16
46
42
44
48
18
Y
X
24
52
20
28
34
26

FIG.3

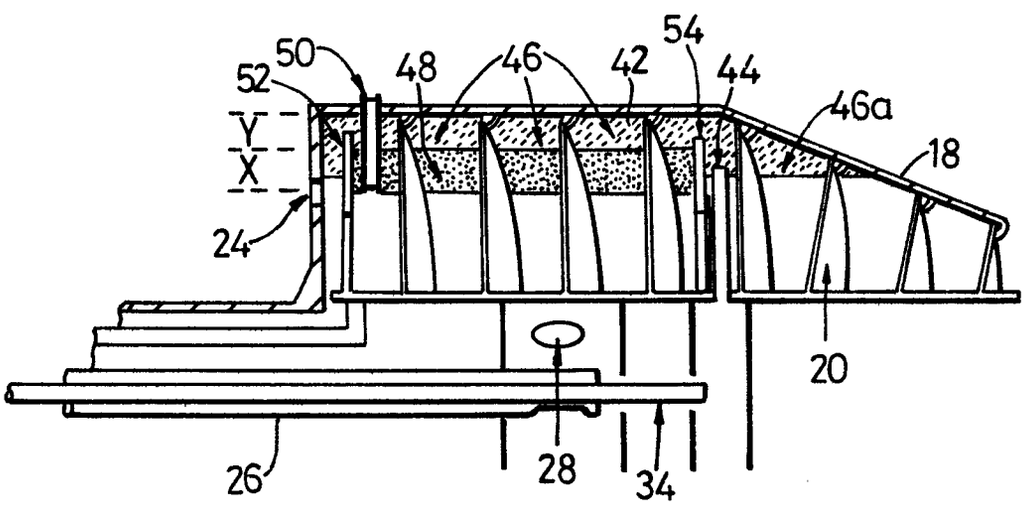
54
50
52
48
46
42
44
46a
18
Y
X
24
20
28
34
26

FIG.4

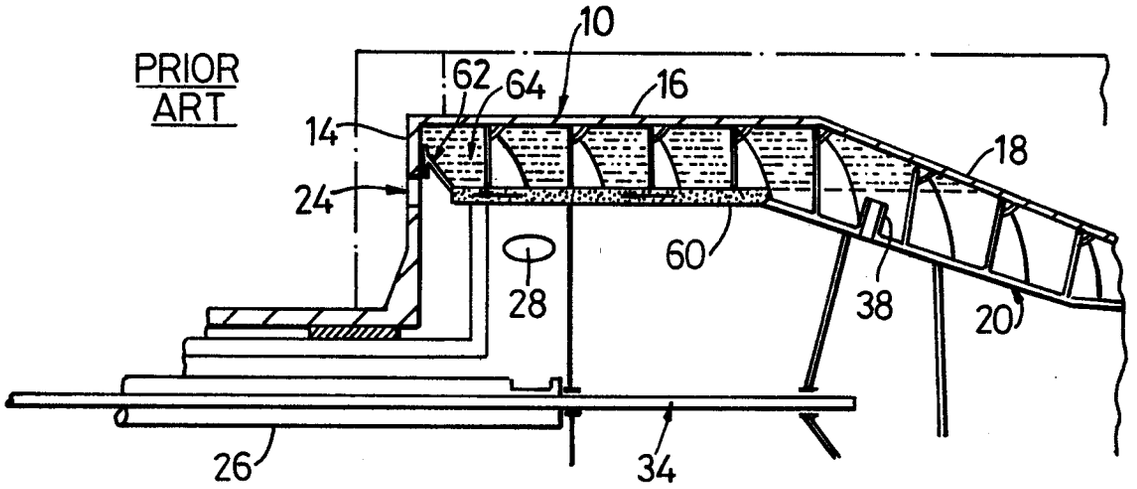
PRIOR
ART
10
62
64
16
14
18
24
60
28
38
20
26
34

FIG.5

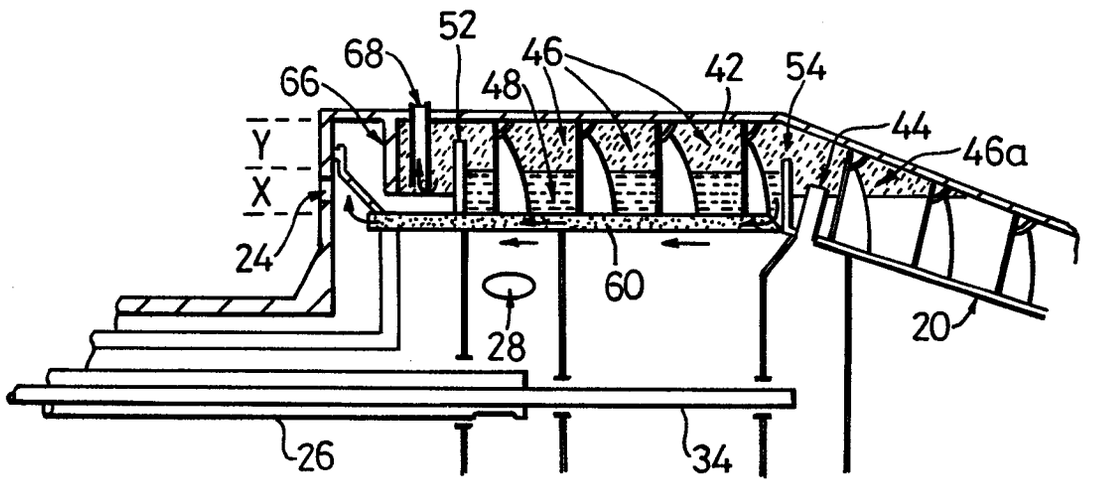
52
68
46
66
48
42
54
44
46a
Y
X
24
60
20
28
26
34

FIG.6