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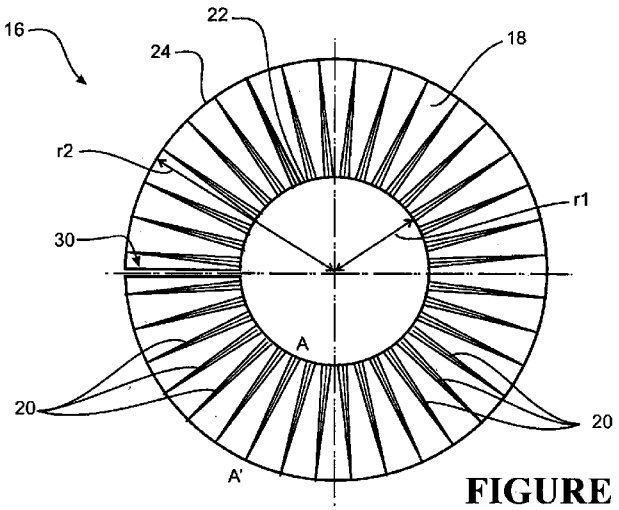

FIGURE 3

(57) **Abstract**: An industrial plant such as a disc dryer is constructed or retro-fitted with discs each comprising two annular plates connected to one another around their outer edges, each plate comprising one or more integral ribs extending between its inner edge and outer edge. The integral ribs may comprise folds in the annular plates, and each plate may be formed from a length of sheet material, by roll forming for example, so that the integral ribs are deeper towards the inner peripheral edge than the outer peripheral edge of the annular plates forming the disc.

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"DISC FOR INDUSTRIAL PLANTS"

FIELD OF THE INVENTION

The invention generally relates to discs for use in industrial applications such as dryers, cookers, coolers or other heat exchangers and particularly, although not exclusively, relates to a disc dryer.

BACKGROUND TO THE INVENTION

Disc dryers are large industrial dryers used for drying conveyable or flowable materials such as granular and liquid type products. They typically comprise a hollow shaft carrying hollow annular discs at intervals. Each disc comprises a pair of annular plates welded around the periphery to the shaft. The shaft is formed to have apertures through its wall to the hollow interior of each disc. In operation of the dryer steam is fed through the shaft and passes through the apertures into the hollow region formed by the discs heating the surface of the discs. Material to be dried moves through an inlet formed through an outer casing of the disc dryer and along the length of the shaft where it contacts the outer surfaces of the heated discs thereby drying the material.

As shown in figure 5, the discs 41 in a conventional disc dryer 40 have flat surfaces and can be fitted with cross pins 43 that span between the two annular plates 42 forming each disc to prevent the discs from deforming or bursting under steam pressure. At construction of the disc dryer or retrofitting of replacement discs, fitting cross pins to each disc requires drilling or cutting holes through the disc and pressing in and welding of many individual cross pins. This is labour intensive and is carried out when constructing a new disc dryer or retro-fitting an existing dryer with new discs when the existing discs have worn. Other methods for strengthening the discs other than fitting cross-pins are also known in the art but these are also generally labour intensive.

The annular plates for forming discs for disc dryers are typically formed by cutting one or more circular sheets from a square sheet of metal leading to significant scrap metal.

It is an object of the invention to provide an improved disc for use in industrial applications and/or improved disc dryer, or to at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

In a first aspect the invention broadly consists in a disc comprising two annular plates connected to one another at an angle around corresponding outer peripheral edges such that corresponding inner peripheral edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between its inner edge and outer edge.

In a second aspect the invention broadly consists in an industrial plant comprising:

a hollow shaft;

one or more hollow discs each comprising two annular plates connected to one another around their outer edges, each plate comprising one or more integral ribs extending between its inner edge and outer edge, the inner edge of each plate being coupled around the shaft and spaced apart from one another so that the disc is coupled to the shaft; and

one or more apertures along the length of the shaft provided between the plates of each disc so that the shaft is in fluid communication with each disc.

Preferably, the ribs are formed from folds in the annular plate.

Preferably in a first form, the ribs extend radially between the inner edge of the plate and the outer edge of the plate.

Preferably, each plate is formed from a length of a sheet of material. More preferably, the sheet of material is formed to integrally comprise the ribs. Even more preferably in a first form, the ribs are formed by rolling and are deeper towards one edge of the sheet of material than the other edge of the sheet of material such that the material curves greater around the deeper ends of the ribs in order to form an annular plate. Even more preferably in a second form, the ribs are formed by crimping or folding.

In a third aspect the invention broadly consists in a method of fitting a disc to an industrial plant comprising:

passing a hollow disc along a hollow shaft so that the interior of the disc is proximal to an aperture provided on the shaft, the disc comprising two annular plates connected to one another around their periphery edges, each plate comprising one or more integral ribs extending between its inner edge and periphery edge;

connecting the inner edge of the first annular plate to the shaft; and

connecting the inner edge of the second annular plate to the shaft and spaced apart from the inner edge of the first annular plate such that the aperture is provided between the inner edges of the annular plates so that the shaft is in fluid communication with the disc.

Preferably, each plate is formed from a length of a sheet of material. More preferably, the sheet of material is formed to integrally comprise the ribs. Even more preferably in a first form, the ribs are formed by rolling and are deeper towards one edge of the sheet of material than the other edge of the sheet of material such that the material curves greater around the deeper ends of the ribs in order to form an annular plate. Even more preferably in a second form, the ribs are formed by crimping or folding.

In an fourth aspect the invention broadly consists in a method of constructing an industrial plant comprising:

for each of one or more hollow discs, passing the discs along a hollow shaft so that the interior of the disc is proximal to an associated aperture provided on the shaft, the disc comprising two annular plates connected to one another around their periphery edges, each plate comprising one or more integral ribs extending between its inner edge and periphery edge;

connecting the inner edge of the first annular plate to the shaft; and

connecting the inner edge of the second annular plate to the shaft and spaced apart from the inner edge of the first annular plate such that the aperture is provided between the inner edges of the annular plates so that the shaft is in fluid communication with the disc.

In one form of the second, third and fourth aspects the industrial plant is a disc dryer, cooker, cooler or a heat exchanger.

Preferably the industrial plant is a disc dryer.

In a fifth aspect the invention broadly consists in a method of forming a disc for use in an industrial application comprising connecting the outer periphery edges of two annular plates to one another at an angle around their outer edges such that the inner edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between its inner edge and periphery edge.

In a sixth aspect the invention broadly consists in a method of forming an annular plate for use in construction of a disc for an industrial application comprising:

rolling one or more ribs into a flat length of a sheet of material, the ribs being deeper at one edge of the material than the other edge of the material such that the material curves greater around the deeper ends of the ribs in order to form an annular plate; and

joining the two ends of the sheet of material.

Preferably in the fifth and sixth aspects the industrial application is an industrial plant. Preferably the industrial plant is a disc dryer.

In a seventh aspect the invention broadly consists in a disc for a disc dryer comprising two annular plates connected to one another at an angle around their outer edges such that the inner edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between its inner edge and outer edge.

In an eighth aspect the invention broadly consists in a disc dryer comprising:

a hollow shaft;

one or more hollow discs each comprising two annular plates connected to one another around their outer edges, each plate comprising one or more integral ribs extending between its inner edge and outer edge, the inner edge of each plate being coupled around the shaft and spaced apart from one another so that the disc is coupled to the shaft; and

one or more apertures along the length of the shaft provided between the plates of each disc so that the shaft is in fluid communication with each disc.

The first, fourth, fifth, sixth, seventh and eighth aspects of the invention may include any of the preferable features associated with the second or third aspects of the invention.

Preferably for all of the above aspects of the invention, each plate has a central aperture with a radius between 0.2 and 0.5m.

Preferably the radius of each plate is between 0.4 and 1.5m.

Preferably the thickness of each annular plate is between 6 and 12mm.

The term "comprising" as used in this specification means "consisting at least in part of". When interpreting each statement in this specification that includes the term "comprising", features other than that or those prefaced by the term may also be present. Related terms such as "comprise" and "comprises" are to be interpreted in the same manner.

The term "annular" as used in this specification in relation to the discs and plates includes same with a circular outer peripheral shape but also a non-circular outer peripheral shape such as an oval or square or rectangular outer peripheral shape (typically with radiused corners).

BRIEF DESCRIPTION OF THE DRAWING

Preferred embodiments of the invention will be described by way of example only and with reference to the drawings, in which:

Figure 1 is a cut-away, elevation view of a disc dryer of the invention;

Figure 2 is a cross-sectional close up view of a single disc element coupled to the shaft of the dryer of figure 1,

Figure 3 is a plan view of an annular plate used to form a disc of the disc dryer of Figure 1;

Figure 4 is a plan view of a partially formed annular plate of Figure 3;

Figure 5 is a perspective view of a partially formed annular plate of Figure 3; and

Figure 6 is a cross-sectional close up view of a disc in a conventional disc dryer.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention relates to a disc formed from annular plates having one or more integral ribs extending between an inner edge of the plate and an outer edge of the plate. The disc of the invention may be formed for use in a number of industrial applications including, but not limited to industrial plants such as disc dryers, cookers, coolers and other heat exchangers, and also paddle dryers. Such plants typically comprise a hollow shaft on which one or more of the discs of the invention are mounted about. A heating or cooling fluid source is introduced into the main shaft to heat or cool the surfaces of the discs respectively. Material, gas or fluid flowing through the plant (preferably external to but may be within the shaft) is appropriately heated or cooled by the discs before exiting the plant. In accordance with an aspect of the invention, the disc of the invention will be described in detail with reference to a disc dryer. It will be appreciated however that the disc may be used in any industrial application as mentioned.

Referring to Figure 1 and by way of example, a disc dryer 2 comprises a casing 4 arranged to hold a material 5 to be dried. The casing 4 may be made from a metal or alloy such as aluminium or steel, or any other suitable material. The material may be a pasty material, a sludge-like material, a particulate material, or any other suitable material that can flow through the casing 4 in order to be dried such as food material, grain or meal, coffee beans, chemicals, gluten, or waste-water sludge. The disc dryer 2 may comprise an inlet 6 so that the wet material 5 can enter the casing 4 in order to be dried, and an outlet 8 for removal of dried material 5. Alternatively, the casing may be provided with a lid or hatch through which material 5 may be introduced into and removed from the disc dryer 2.

The disc dryer comprises a drum, rotor, or shaft 10 extending through the casing 4. The shaft 10 may be arranged to rotate within the casing 4 for example through actuation from an electric motor coupled to one end. The shaft 10 is hollow so that a heating fluid may flow through the shaft. The shaft 10 may comprise a first connector 12 at one end arranged to be coupled to a heating fluid source, and a second connector 14 at the other end arranged to be coupled to a heating fluid sink. Heating

fluid may be may be introduced into the shaft 10 through the first connector 12 so that the heating fluid transfers heat to the shaft 10 which then transfers heat to the material 5. Preferably, the heating fluid is pressurised steam, however any other suitable heating fluid may be used such as a heated liquid that is pumped into the shaft. The heating fluid may travel the length of the shaft 10, transferring heat to it on the way, and then be removed at the second connector 14. The shaft 10 may be constantly replenished with heating fluid from a heating fluid source so that the shaft 10 may constantly provide heat to the material 5. In applications other than dryers such as in a cooler or heat exchanger the fluid may be a cooling fluid or a fluid which receives heat from the material passing through the plant.

The shaft 10 comprises one or more discs 16 provided along its length. The discs 16 are connected to the shaft 10 so that they may rotate with the shaft 10. For example, the discs 16 may be welded to the shaft 10 or connected to the shaft 10 in any other suitable manner. The shaft 10 and discs 16 may be made from a material with a high thermal conductivity such as a metal or alloy, or any other suitable material. Referring now also to figure 1a, the discs 16 are hollow. One or more apertures 17 are provided along the length of the shaft 10 so that the inside 10a of the shaft 10 is in fluid communication with the inside 16a of each disc 16 as shown by arrow A of figure 1a. The apertures 17 are provided so that the heating fluid can move from the shaft 10 to the discs 16 in order to heat the discs 16 and to provide a greater heating area to the material 5. Each disc coupled around the shaft may be able withstand internal pressure of for example 2- 3 Bar, or in some embodiments higher such as up to or over 6 Bar and for example up to 12 Bar without substantially deforming. A heat exchanger may operate at about atmospheric pressure, a cooler at the same or at 2-3 bar for example, and a disc dryer at an internal (steam) pressure of 6 Bar or over, up to 10-12 Bar for example. Preferably, the shaft 10 and discs 16 are closed to the material so that the heating fluid cannot contact the material 5 directly. The material 5 may be heated or dried through contact with the outside surfaces of the shaft 10 and discs 16.

Referring to Figures 1, 2, and 3 the discs 16 are formed from two or more annular plates 18. Each plate 18 comprises one or more integral ribs 20 on its surface. Preferably, the ribs 20 extend between the inner edge 22 of the annular plate 18 and

the outer edge 24 of the annular plate 18. The ribs 20 may extend radially between corresponding points AA' on the inner edge 22 and the outer edge 24. The ribs 20 may extend fully or partially between the inner edge 22 and outer edge 24. Alternatively, the integral ribs 20 may be provided between and substantially follow the circumferences of the edges 22, 24 or at any other orientation but most preferably radially between the inner 22 and outer edge 24 to provide maximum strength. The integral ribs 20 may be provided on the plates 18 in any suitable manner. Preferably, the integral ribs 20 are formed from crimps, bends, creases, stamps, or folds in the plates 18. However, the integral ribs 20 may be formed from metal strips or bars that are connected to the plates 18, or in any other suitable manner. The integral ribs 20 may provide structural strength or support to the plates 18 and discs 16. This may help prevent the discs 16 from deforming or bursting under pressure when in use. This may also mean that a lesser number of plugs, or no plugs, may be required to provide strength to hold the discs 16 together when a pressurised heating fluid is introduced to the disc dryer 2.

A disc 16 may be formed by connecting two plates 18 to one another around their outer edges 24. The outer edges 24 may be welded to one another, or connected to one another in any suitable manner. The outer edges 24 of the plates 18 are connected to one another at an angle around their entire circumference such that the inner edges 22 of the two plates 18 are spaced apart from one another when the connection is complete. Preferably, the angle is an acute angle. A disc 16 may then be connected to the shaft 10 by connecting each of the inner edges 22 to the shaft 10, with the inner edges 22 spaced apart from one another. The inner edges 22 may be welded to the shaft 10, or connected to the shaft 10 in any suitable manner. When a disc 16 is connected to the shaft 10, the disc 16 may appear convex when viewed from the side (as shown in Figure 1) due to the angle provided between the outer edges 24 of the two plates 18 and the inner edges 22 being spaced apart from one another. At least one aperture in the shaft 10 is provided between the two inner edges 22 of a disc 16 so that the shaft 10 is in fluid communication with a disc 16 and so that a heating fluid can move between them.

Referring to Figure 1, each disc 16 may have one or more shovels 26 connected to a side or periphery of the disc 16. The shovels 26 may rotate with the shaft 10 and discs

16. The shovels 26 may move, scoop or push the material 5 within the disc dryer 2 and towards the output 8 in order to dry the material 5. Alternatively, the discs 16 may be connected to the shaft 10 at a non-right angle so that a screwing effect from the rotating discs 16 encourages movement of the material 5.

Referring to Figures 4 and 5, in the preferred embodiment, each plate 18 may be formed from a length of a sheet of a suitable material 28 such as steel or any other suitable material. Preferably, the sheet of material 28 has a longer length L than width W. For example, the sheet of material 28 may be 6120mm long and 550mm wide. A plate 18 may be formed by rolling the sheet of material 28 in a roll forming mill. The integral ribs 20 may be rolled into the sheet of material 28 as it is passed through the roll forming mill. Each integral rib 20 may be relatively deeper at one long edge (becomes the inner edge 22 of the resultant annular plate 18) of the material than the other long edge (becomes the outer edge 24 of the resultant annular plate 18) of the material. This may cause the sheet of material 28 to curve greater around the deeper ends of the ribs 20 so that it is formed into an annular shape once it has been entirely passed through the rolling mill. The two ends of the sheet of material 28 may be connected to one another at a joint 30 (shown in Figure 3) in order to form the completed plate 18. The two ends may be welded to one another or connected to one another in any other suitable manner. This forms an annular plate 18 having a central aperture (defined by the inner edge 22) of sufficient size to fix around the shaft of the disc dryer.

The sheet material 28 and in particular the resultant plate 18 should have sufficient dimension for use in industrial applications. In the case of disc dryers, preferably the resultant plate 18 has an inner edge/central aperture radius r1 (shown in figure 3) of at least 0.2m but more preferably between 0.2 and 0.5 meters, an outer edge radius r2 (shown in figure 2) of at least 0.4m but more preferably between 0.4 and 1.5 meters, and a thickness t (shown in figure 1a) of at least 6 millimetres but more preferably between 6 and 12mm. It will be appreciated that other dimensions for the resultant plate or disc may be utilised in disc dryers or other industrial applications and the above dimensions are only exemplary and not intended to limit the scope of the invention.

In an alternative embodiment, the plates 18 may be formed from an annular shape cut from a flat sheet of material. The annulus of material may have one or more ribs 20 folded, crimped or punched into its surface in order to form a plate 18 such that the ribs 20 are integral with the plate 18.

The discs 16 and plates 18 may be of shapes other than circular, such as oval or square or rectangular in shape (typically with radiused corners), all of which are included within the term 'annular' in this specification and claims. Also, the shaft 10 may have a rectangular cross-section and the plates 18 and discs 16 having corresponding rectangular apertures for fitting the discs 16 around the shaft.

As referred to previously the discs in a conventional disc dryer or similar have flat surfaces and are fitted with cross pins that span between the two annular plates forming each disc to prevent the discs from deforming or bursting under steam pressure, as shown in figure 6. At construction of the disc dryer or retrofitting of replacement discs, fitting cross pins to each disc requires drilling or cutting holes through the disc and pressing in and welding of many individual cross pins which is labour intensive and is carried out when constructing a new disc dryer or retro-fitting an existing dryer with new discs when the existing discs have worn. The need for fitting or replacing such cross pins is removed or at least reduced wuth the construction of the invention.

The foregoing description of the invention includes preferred forms thereof. Modifications may be made thereto without departing from the scope of the invention.

CLAIMS

1. A disc comprising two annular plates connected to one another at an angle around corresponding outer peripheral edges such that corresponding inner peripheral edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between its inner edge and outer edge.

2. An industrial plant comprising:

a hollow shaft;

one or more hollow discs each comprising two annular plates connected to one another around their outer edges, each plate comprising one or more integral ribs extending between its inner edge and outer edge, the inner edge of each plate being coupled around the shaft and spaced apart from one another so that the disc is coupled to the shaft; and

one or more apertures along the length of the shaft provided between the plates of each disc so that the shaft is in fluid communication with each disc.

3. A disc or industrial plant according to either claim 1 or claim 2 wherein the integral ribs are formed from folds in the annular plate.

4. A disc or industrial plant according to any one of claims 1 to 3 wherein the integral ribs extend radially between the inner edge of the plate and the outer edge of the plate.

5. A disc or industrial plant according to any one of claims 1 to 4 wherein each plate is formed from a length of sheet material.

6. A disc or industrial plant according to claim 5 wherein the integral ribs are deeper towards one edge of the length of sheet material than the other edge of the length of sheet material such that the material curves greater around the deeper ends of the ribs to form the annular plate.

7. A disc or industrial plant according to claim 6 wherein the integral ribs have been formed by roll forming the length of sheet material.

8. A disc or industrial plant according to any one of claims 1 to 5 wherein the integral ribs have been formed by crimping, punching, or folding the length of a sheet of material.

9. A disc or industrial plant according to any one of claims 1 to 8 wherein each plate has a central aperture with a radius between 0.2 and 0.5m.

10. A disc or industrial plant according to any one of claims 1 to 9 wherein the radius of each plate is between 0.4 and 1.5m.

11. A disc or industrial plant according to any one of claims 1 to 8 wherein the thickness of each annular plate is between 6 and 12mm.

12. An industrial plant according to any one of claims 2 to 11 wherein each disc coupled around the shaft can withstand internal pressure of at least 6 Bar without substantially deforming.

13. An industrial plant according to any one of claims 2 to 12 wherein the industrial plant is a disc dryer.

14. A method of fitting a disc to an industrial plant comprising:

passing a hollow disc along a hollow shaft so that the interior of the disc is proximal to an aperture provided on the shaft, the disc comprising two annular plates connected to one another around their peripheral edges, each plate comprising one or more integral ribs extending between an inner peripheral edge and an outer peripheral edge;

connecting the inner edge of the first annular plate to the shaft; and

connecting the inner edge of the second annular plate to the shaft and spaced apart from the inner edge of the first annular plate such that the aperture is provided between the inner edges of the annular plates so that the shaft is in fluid communication with the disc.

15. A method of constructing an industrial plant comprising:

for each of one or more hollow discs, passing the discs along a hollow shaft so that the interior of the disc is proximal to an associated aperture provided on the shaft,

the disc comprising two annular plates connected to one another around their periphery edges, each plate comprising one or more integral ribs extending between an inner peripheral edge and an outer peripheral edge;

connecting the inner edge of the first annular plate to the shaft; and

connecting the inner edge of the second annular plate to the shaft and spaced apart from the inner edge of the first annular plate such that the aperture is provided between the inner edges of the annular plates so that the shaft is in fluid communication with the disc.

16. A method according to either claim 14 or claim 15 wherein the integral ribs are deeper towards an inner peripheral edge of each annular plate than an outer peripheral edge.

16. A method according to any one of claims 14 to 16 including first forming the integral ribs as folds in a length of sheet material to form each annular plate.

17. A method according to claim 16 including forming the integral ribs by roll forming the length of sheet material.

18. A method according to claim 16 including forming the integral ribs by crimping, punching, or folding the length of a sheet of material.

19. A method according to any one of claims 14 to 18 wherein each plate has a central aperture with a radius between 0.2 and 0.5m.

20. A method according to any one of claims 14 to 19 wherein the radius of each plate is between 0.4 and 1.5m.

21. A method according to any one of claims 41 to 8 wherein the thickness of each annular plate is between 6 and 12mm.

21. A method according to any one of claims 14 to 20 wherein each disc around the shaft can withstand internal pressure of at least 6 Bar without substantially deforming.

22. A method according to any one of claims 14 to 21 wherein the industrial plant is a disc dryer.

23. A method of forming a disc for use in an industrial application comprising connecting outer peripheral edges of two annular plates to one another at an angle around the outer peripheral edges such that inner peripheral edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between its inner peripheral edge and outer peripheral edge.

24. A method of forming an annular plate for use in construction of a disc for use in an industrial application comprising:

rolling one or more ribs into a flat length of a sheet of material, the ribs being deeper at one edge of the material than the other edge of the material such that the material curves around the deeper ends of the ribs in order to form an annular plate; and

joining the two ends of the sheet of material.

25. A method according to either claim 23 or claim 24 wherein the integral ribs are deeper towards an inner peripheral edge of each annular plate than an outer peripheral edge.

26. A method according to any one of claims 23 to 25 including first forming the integral ribs as folds in a length of sheet material to form each annular plate.

27. A method according to claim 26 including forming the integral ribs by roll forming the length of sheet material.

28. A method according to claim 26 including forming the integral ribs by crimping, punching, or folding the length of a sheet of material.

29. A disc for a disc dryer comprising two annular plates connected to one another at an angle around their outer edges such that the inner edges of the plates are spaced apart from one another, each plate comprising one or more integral ribs extending between an inner peripheral edge and an outer peripheral edge.

30. A disc dryer comprising:

a hollow shaft;

one or more hollow discs each comprising two annular plates connected to one another around their outer edges, each plate comprising one or more integral ribs extending between an inner peripheral edge and an outer peripheral edge, the inner edge of each plate being coupled around the shaft and spaced apart from one another so that the disc is coupled to the shaft; and

one or more apertures along the length of the shaft provided between the plates of each disc so that the shaft is in fluid communication with each disc.

31. A disc or disc dryer according to either claim 29 or claim 30 wherein the integral ribs are formed from folds in the annular plate.

32. A disc or disc dryer according to any one of claims 29 to 31 wherein the integral ribs extend radially between the inner edge of the plate and the outer edge of the plate.

33. A disc or disc dryer according to any one of claims 29 to 32 wherein each plate is formed from a length of sheet material.

34. A disc or disc dryer according to claim 33 wherein the integral ribs are deeper towards one edge of the length of sheet material than the other edge of the length of sheet material such that the material curves greater around the deeper ends of the ribs to form the annular plate.

35. A disc or disc dryer according to claim 34 wherein the integral ribs have been formed by roll forming the length of sheet material.

36. A disc or disc dryer according to any one of claims 29 to 35 wherein the integral ribs have been formed by crimping, punching, or folding the length of a sheet of material.

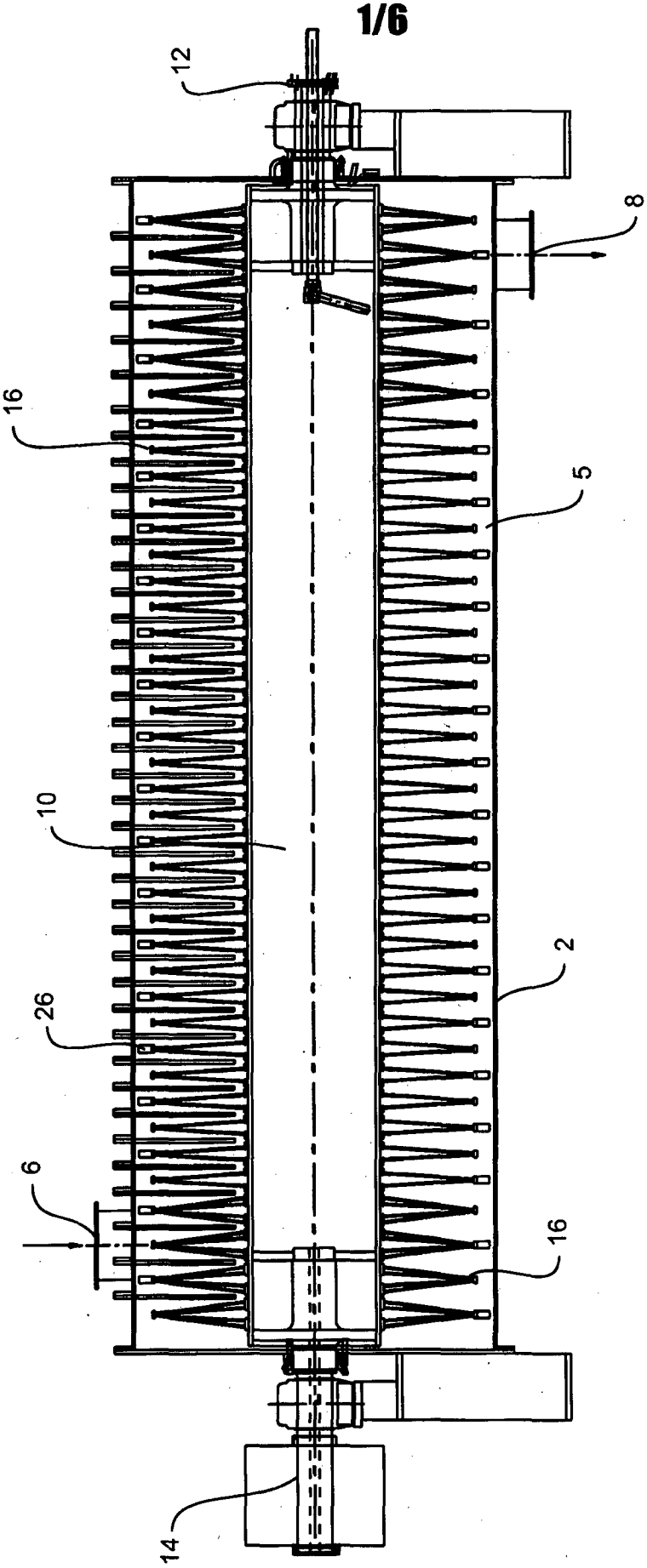

FIGURE 1

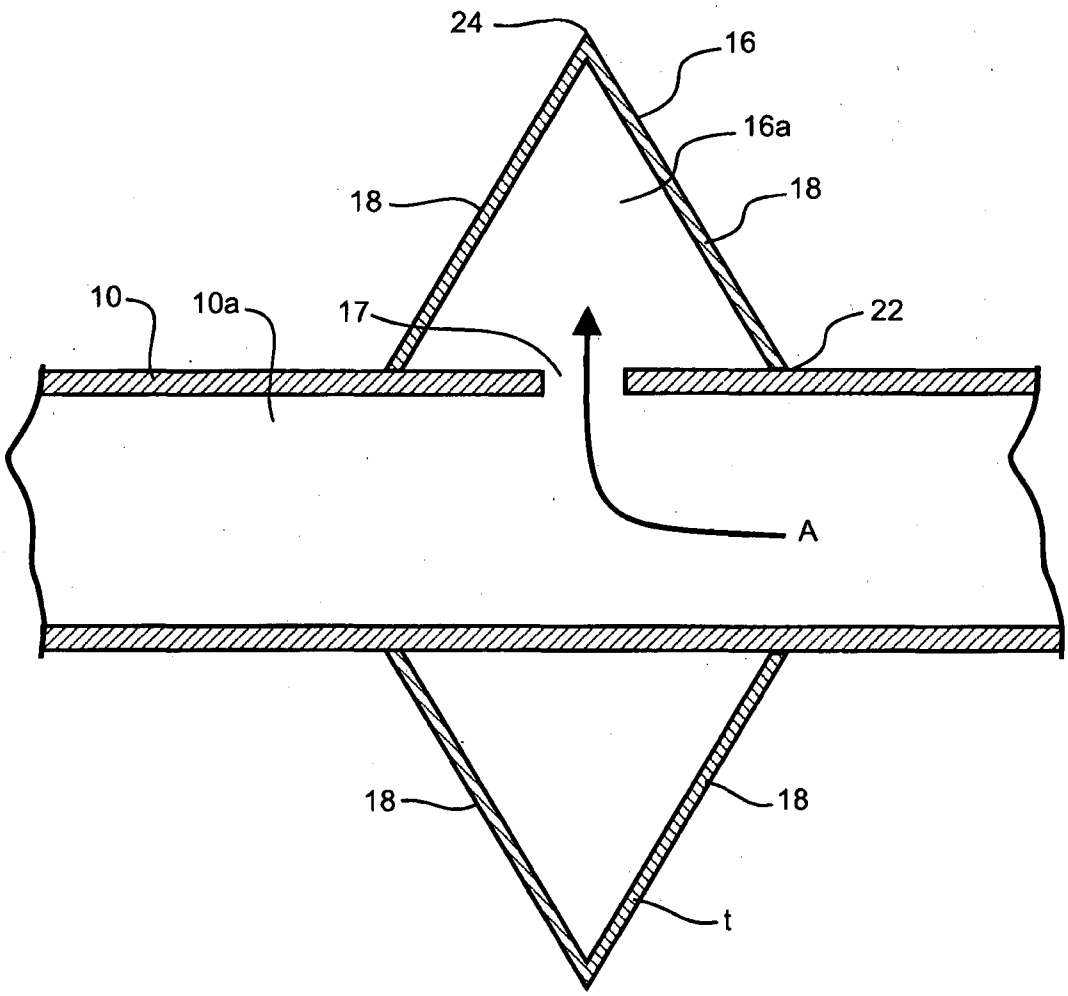

FIGURE 2

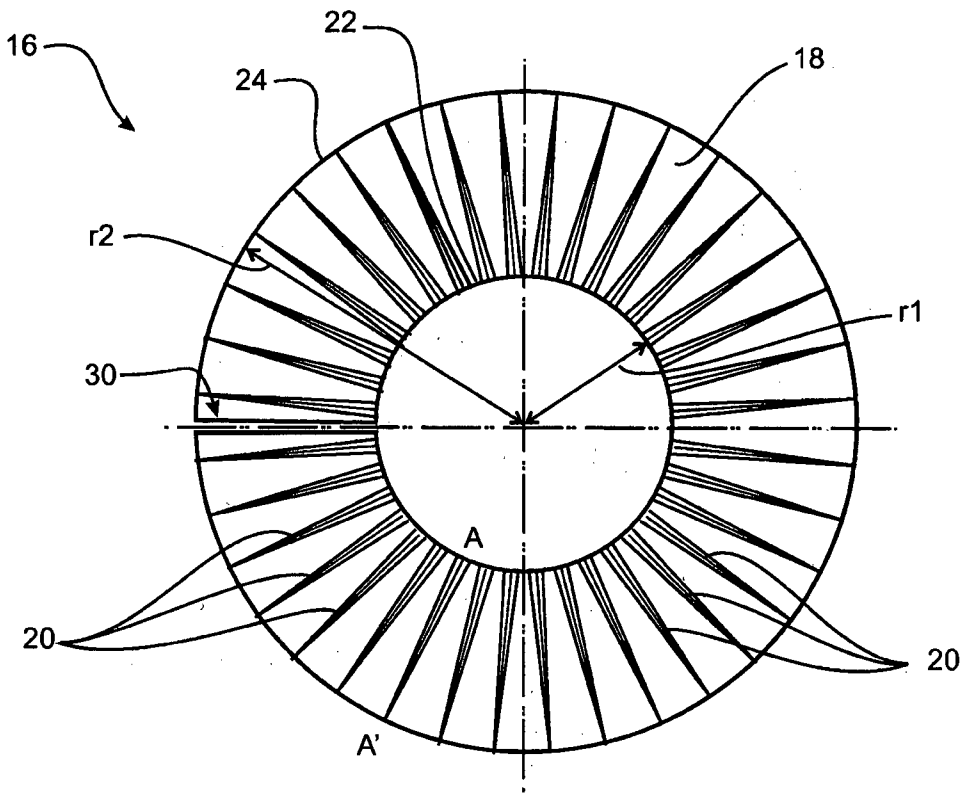

FIGURE 3

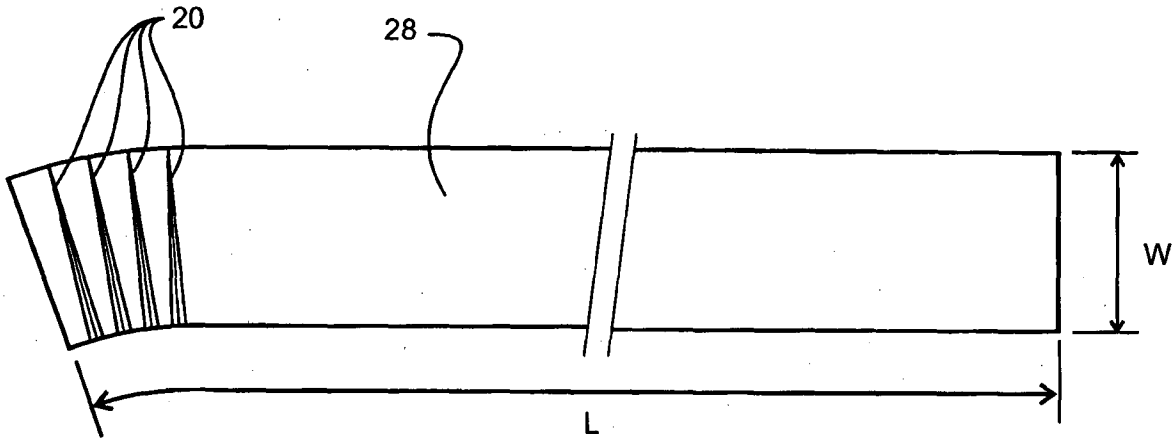

FIGURE 4

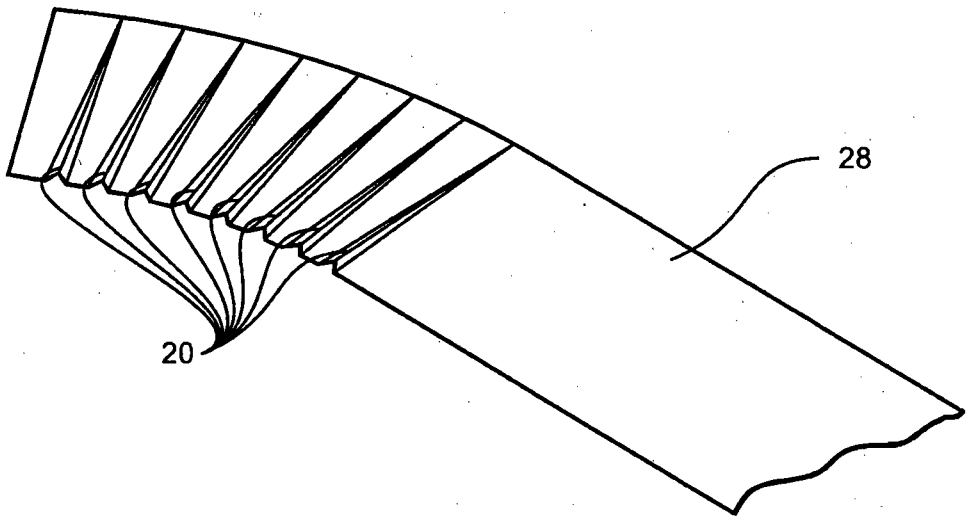

FIGURE 5

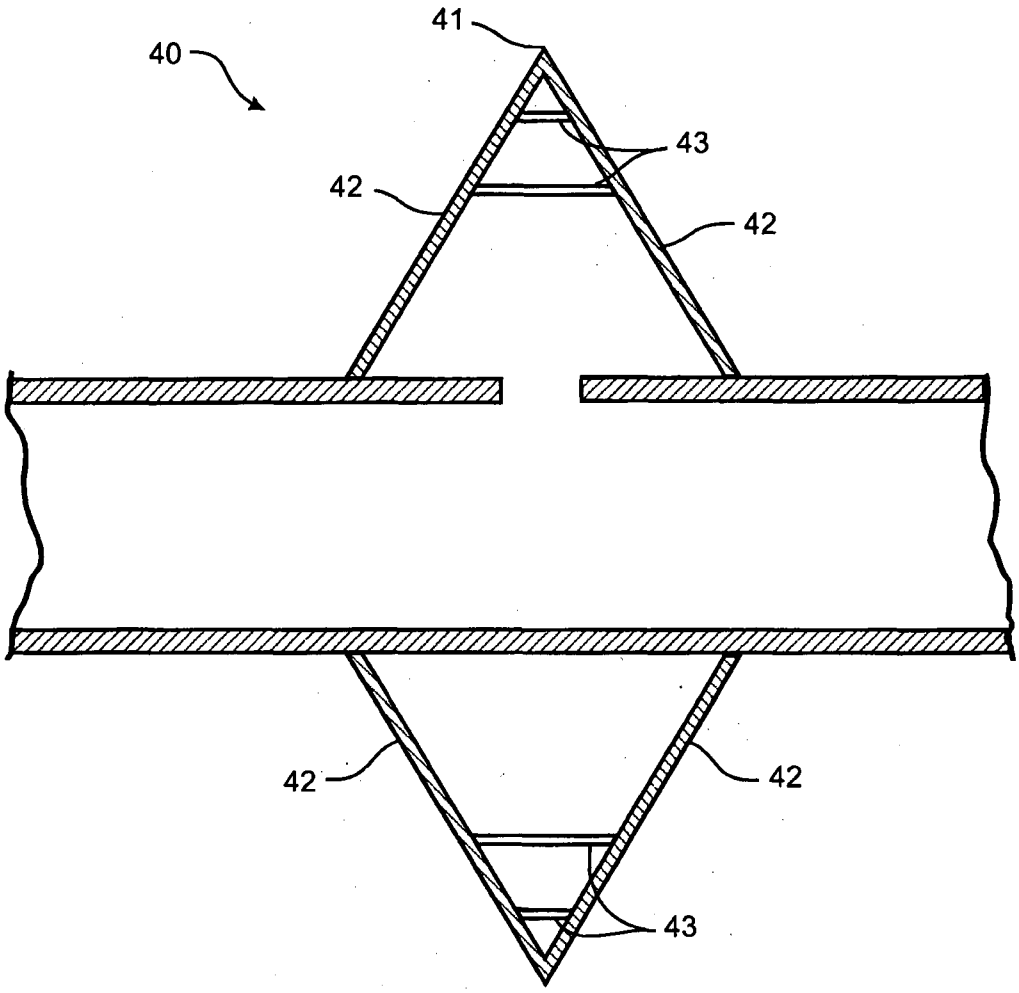

FIGURE 6
(Prior Art)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000687

A. CLASSIFICATION OF SUBJECT MATTER

F26B 25/00 (2006.01) F26B 23/10 (2006.01)

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)

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)

EPODOC/WPI: keywords disc+, plate+, protru+, project+, rib+, fin+, ridge+, edge+, end?, perimeter+, peripher+, boundar+, circumferen+, rim+, dryer+, cooker+, industr+, heat exchang+, reactor+, cooler+, plant+, mill+, cylinder+, bed+, annular, annulus, etc.. Espacenet search: F26B and/or disc*, dryer*, cooker*, drier*, etc.. Google Patent keyword search with like keywords as above

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2012	28 August 2012

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2012/000687**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 201748779 U (XINYU HU) 16 February 2011 Abstract, Figures, page 2	1-36
A	KR 100987573 B1 (PARK YOUNG BUM) 12 October 2010 English Abstract retrieved from Espacenet, Figures	1-36
A	JP 2009-045525 A (MITSUBISHI MATERIALS TECHNO CO) 05 March 2009 English Abstract retrieved from Espacenet, Figures	1-36
A	CA 1040419 A1 (A/S ATLAS) 17 October 1978 Abstract, Figures, claims	1-36

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000687

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2012/000687

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

Claims 1-23, 29-36 are directed to a disc, an industrial plant, a method of fitting the disc to the industrial plant, a method of forming an industrial plant, and a disc dryer containing the disc. The feature of two annular plates connected together around their outer edges such that their inner edges are spaced apart from one another, with each plate comprising ribs extending between its inner and outer edges is specific to this group of claims.

Claims 24-28 are directed to a method of forming an annular plate for making a disc. The feature of rolling ribs into a sheet material such that the ribs are deeper at one edge of the material than the other edge thereof to make the material curve around the deeper ends of the ribs to form an annular plate is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is an annular plate having ribs extending between the inner and outer edges. However this feature does not make a contribution over the prior art because it is disclosed in CN 201748779 U (see page 2).

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

The International Searching Authority believes that a search and examination for the second invention will not involve more than negligible additional search and examination effort over that for the first invention and so no additional search fee is required in order to search and examine that invention.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2012/000687**

This Annex lists known 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/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
CN 201748779 U	16 Feb 2011	None	
KR 100987573 B1	12 Oct 2010	KR 100987573 B1	12 Oct 2010
JP 2009-045525 A	05 Mar 2009	JP 2009045525 A	05 Mar 2009
CA 1040419 A1	17 Oct 1978	CA 1040419 A1	17 Oct 1978

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.