

19



LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

11

N° de publication :

92841

12

BREVET D'INVENTION

B1

21

N° de dépôt: 92841

51

Int. Cl.:
F28D 19/04

22

Date de dépôt: 05/10/2015

30

Priorité:

72

Inventeur(s):
O'BOYLE JEFFREY – 14895 WELLSVILLE, NY (États-Unis)

43

Date de mise à disposition du public:

74

Mandataire(s):
DENNEMEYER & ASSOCIATES S.A. PATENT
DEPARTMENT – 1015 LUXEMBOURG (Luxembourg)

47

Date de délivrance: 02/05/2017

73

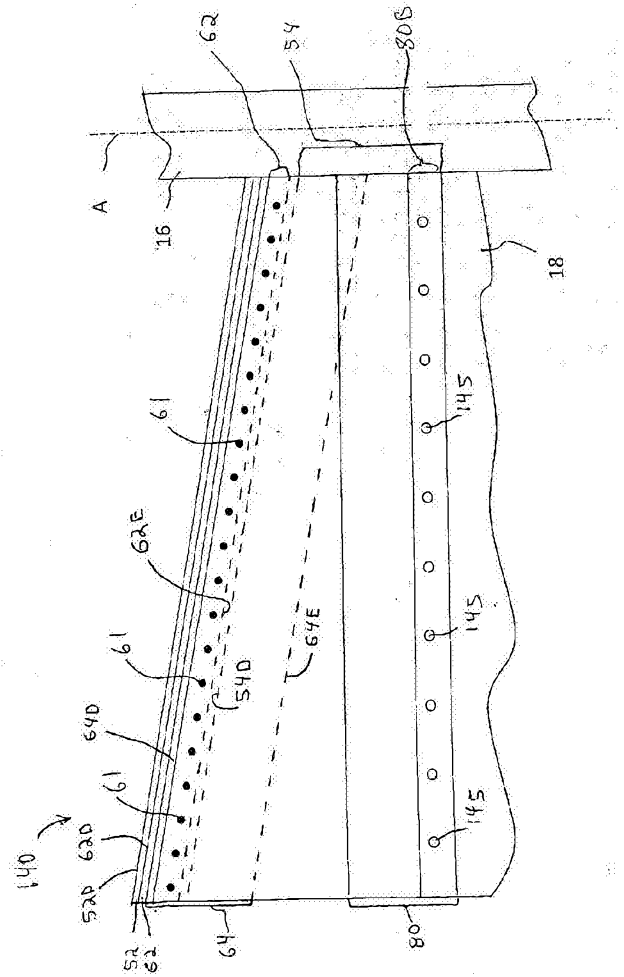
Titulaire(s):
ARVOS INC. – WELLSVILLE, NEW YORK 14895 (États-Unis)

54

Joint d'étanchéité flexible pour un dispositif de préchauffage rotatif régénératif.

- 57 A seal assembly includes a leaf assembly and a supplemental leaf assembly. The leaf assembly includes a first leaf having a first base section. The first base section defines a first fastening area for securing the first leaf to a diaphragm of the preheater. The first leaf has a first elongate section extending away from the first base section and terminating at a first distal end thereof. The leaf assembly further includes a second leaf that engages a portion of the first leaf. The second leaf has a second base section. The second base section defines a second fastening area for securing the second leaf to the diaphragm. The second leaf has a second elongate section extending away from the second base section and terminating at a second distal end thereof. The supplemental leaf assembly is secured to the first leaf and slidingly engaging the second leaf

FIG. 3



FLEXIBLE SEAL FOR A ROTARY REGENERATIVE PREHEATER

Technical Field

[0001] This invention relates to a flexible seal for a rotary regenerative preheater, and more particularly to a flexible seal having multiple leafs.

Background

[0002] As shown in FIG. 1, a rotary regenerative air preheater (hereinafter referred to as the "preheater") is generally designated by the numeral 10. The preheater 10 includes a rotor assembly 12 rotatably mounted on a rotor post 16. The rotor assembly 12 is positioned in and rotates relative to a housing 14. For example, the rotor assembly 12 is rotatable about an axis A of the rotor post 16 in the direction indicated by the arrow R. The rotor assembly 12 includes partitions 18 (e.g., diaphragms) extending radially from the rotor post 16 to an outer periphery of the rotor assembly 12. Adjacent pairs of the partitions 18 define respective compartments 20 for receiving a heat transfer assembly 1000. Each of the heat transfer assemblies 1000 include a plurality of heat transfer sheets 100 and/or 200 stacked upon one another.

[0003] As shown in FIG. 1, preheater 10 is a bisector configuration in which the housing 14 includes a flue gas inlet duct 22 and a flue gas outlet duct 24 for channeling the flow of heated flue gases through the preheater 10. The housing 14 further includes an air inlet duct 26 and an air outlet duct 28 for channeling the flow of combustion air through the preheater 10. The preheater 10 includes an upper sector plate 30A extending across the housing 14 adjacent to an upper face of the rotor assembly 12. The preheater 10 includes a lower sector plate 30B extending across the housing 14 adjacent to lower face of the rotor assembly 12. The upper sector plate 30A extends between and is joined to the flue gas inlet duct 22 and the air outlet duct 28. The lower sector plate 30B extends between and is joined to the flue gas outlet duct 24 and the air inlet duct 26. The upper and lower sector plates 30A, 30B, respectively, are joined to one another by a circumferential plate 30C. The upper sector plate 30A and the lower sector plate 30B divide the preheater 10 into an air sector 32 and a gas sector 34.

[0004] As illustrated in FIG. 1, the arrows marked 'A' indicate the direction of a flue gas stream 36 through the gas sector 34 of the rotor assembly 12. The arrows marked 'B' indicate the direction of a combustion air stream 38 through the air sector 32 of the rotor assembly 12. The

flue gas stream 36 enters through the flue gas inlet duct 22 and transfers heat to the heat transfer assembly 1000 mounted in the compartments 20. The heated heat transfer assembly 1000 is rotated into the air sector 32 of the preheater 10. Heat stored in the heat transfer assembly 1000 is then transferred to the combustion air stream 38 entering through the air inlet duct 26. Thus, the heat absorbed from the hot flue gas stream 36 entering into the preheater 10 is utilized for heating the heat transfer assemblies 1000, which in turn heats the combustion air stream 38 entering the preheater 10.

[0005] As shown in FIG. 2, a prior art seal 40 extends axially from (i.e., parallel to the axis A) and radially along an edge of each of the diaphragms 18 towards the sector plate 30A. Another seal 40 extends axially from and radially along an opposite side of each of the diaphragms 18 towards the sector plate 30B (only one seal 40 shown in FIG. 1). The seal 40 typically includes a flexible seal leaf 42 having a base portion 42B that is positioned between an L-shaped backing bar 43 and an elongate holding bar 41. A base portion 41B of the holding bar 41, the base portion 42B of the flexible seal 42 and a base portion 43B of the backing bar 43 are secured by a plurality of bolts 45 and nuts 46 between a spacer bar 44 and the diaphragm 18, radially along a length of the diaphragm 18.

[0006] During operation of the preheater 10, a surface 31' of the sector plates 30A and 30B is spaced apart from a distal end of the seal 40. However, during start-up conditions when the preheater 10 and ducts 22, 24, 26 and 28 are relatively cold, the surface 31 of the sector plates 30A and 30B slidingly engage the respective seal 40. Such sliding engagement causes the flexible seal leaf 42 to wear and results in bypass leakage between the air sector 32 and the gas sector 34. In addition, through laboratory testing, the inventors have surprisingly found that such sliding engagement of the seal 40 with the respective sector plate 30A and 30B results in oscillatory vibration of the seal 40, as indicated by the arrow V, causing fatigue failure thereof. In addition, the inventors have discovered that because the seal 40 is mounted on a leading edge of the diaphragm 18, the edge of the diaphragm 18 acts as an abrupt fulcrum 47 upon which the seal 40 is bent over and causes stress concentrations at the mating portion of the seal 40. Such stress concentrations cause premature failure of the seal 40.

Summary of the Invention

[0007] There is disclosed herein a seal assembly for a rotary preheater. The seal assembly includes a leaf assembly and a supplemental leaf assembly. The leaf assembly includes a first leaf having a first base section. The first base section defines a first fastening area for securing the first leaf to a diaphragm of the preheater. The first leaf has a first elongate section extending away from the first base section and terminating at a first distal end thereof. The leaf assembly further includes a second leaf that engages a portion of the first leaf. The second leaf has a second base section. The second base section defines a second fastening area for securing the second leaf to the diaphragm. The second leaf has a second elongate section extending away from the second base section and terminating at a second distal end thereof. The supplemental leaf assembly is secured to the first leaf and slidably engaging the second leaf.

[0008] In one embodiment, the second distal end of the second leaf terminates between the first distal end and the first base section of the first leaf.

[0009] In one embodiment, the supplemental leaf assembly includes a spacer secured to the first leaf and a third leaf secured to the spacer, for example by one or more rivets or spot welds. The third leaf slidably engages the second leaf.

[0010] In one embodiment, the second distal end of the second leaf terminates between the first distal end and the first base section; the supplemental leaf assembly includes a spacer secured to the first leaf and a third leaf secured to the spacer, the third leaf slidably engages the second leaf; and the spacer is positioned between the first leaf and the third leaf, the spacer is spaced apart from the second distal end thereby defining a gap between the spacer and the second distal end to accommodate movement of the spacer relative to the second distal end.

[0011] In one embodiment, the seal assembly includes one or more displacement members. Each of the displacement members has a first engagement portion configured to displace a portion of the leaf assembly a predetermined distance. In one embodiment, each of the displacement members has an L-shaped configuration defining a first leg and a second leg. The first leg defines a third base portion that is secured to the diaphragm and the second leg has the engagement portion thereon. The displacement members are arranged to establish a predefined contour of the leaf assembly. The predetermined contour is configured to compensate for movement of the preheater during operation.

[0012] In one embodiment, the seal assembly includes a strip (e.g., guard and/or limiter) having fourth base section engaging the second base section such that the second base section is positioned between the first base section and the fourth base section. The strip defines a deflector section extending away from the fourth base section and away from the second leaf.

[0013] There is also disclosed herein a preheater assembly. The preheater assembly includes a rotor assembly rotatably mounted on a rotor post and disposed in a housing. The rotor assembly defines diaphragms extending radially from the rotor post to an outer periphery of the rotor assembly. Adjacent pairs of the diaphragms define respective compartments for receiving a heat transfer assembly. Each of the heat transfer assemblies include a plurality of heat transfer sheets stacked upon one another. The housing including a flue gas inlet duct and a flue gas outlet duct for channeling the flow of heated flue gases through the preheater. The housing also includes an air inlet duct and an air outlet duct for channeling the flow of combustion air through the preheater. The preheater includes an upper sector plate extending across the housing adjacent to an upper face of the rotor assembly and a lower sector plate extending across the housing adjacent to lower face of the rotor assembly. The upper sector plate extends between and is joined to the flue gas inlet duct and the air outlet duct; and the lower sector plate extends between and is joined to the flue gas outlet duct and the air inlet duct. The upper and lower sector plates, respectively, are joined to one another by a circumferential plate. The upper sector plate and/or the lower sector plate define a leading edge and a trailing edge. One or more of the leading edge and the trailing edge defines a ramped configuration. A seal assembly is positioned on an axial edge of each diaphragm. The seal assembly includes a leaf assembly and a supplemental leaf assembly. The leaf assembly includes a first leaf having a first base section. The first base section defines a first fastening area for securing the first leaf to a diaphragm of the preheater. The first leaf has a first elongate section extending away from the first base section and terminating at a first distal end thereof. The leaf assembly further includes a second leaf that engages a portion of the first leaf. The second leaf has a second base section. The second base section defines a second fastening area for securing the second leaf to the diaphragm. The second leaf has a second elongate section extending away from the second base section and terminating at a second distal end thereof. The supplemental leaf assembly is secured to the first leaf and slidably engages the second leaf. A portion of the first leaf slidably engages the leading edge and disengages the trailing edge.

[0014] In one embodiment, the second distal end terminates between the first distal end and the first base section.

[0015] In one embodiment, the supplemental leaf assembly includes a spacer secured to the first leaf and a third leaf secured to the spacer. The third leaf slidingly engages the second leaf.

Brief Description of the Drawings

[0016] FIG. 1 is a perspective view of a preheater shown in a partial cut away view;

[0017] FIG. 2 is a cross sectional view of a prior art seal secured to a diaphragm of a preheater;

[0018] FIG. 3 is a plan view of the seal assembly of the present invention viewed from a trailing side of the diaphragm;

[0019] FIG. 4 is a plan view of the seal assembly of the present invention viewed from a leading side of the diaphragm;

[0020] FIG. 5 is a top view of the seal assembly of FIG. 4 taken across line 5-5 of FIG. 4;

[0021] FIG. 6 is a cross sectional view of the seal assembly of FIG. 3 taken across line 6-6 of FIG. 4;

[0022] FIG. 7 is another embodiment of the seal assembly of FIG. 6 shown with a sector plate having a ramped configuration;

[0023] FIG. 8 is another embodiment of the seal assembly of FIG. 7 wherein the ramped configuration includes a ramp attachment secured to each of the leading and trailing edges of the sector plates;

[0024] FIG. 9 is a cross sectional view of a portion of another embodiment of the seal assembly of FIG. 6 and having one leaf extending outwardly from the other leaves;

[0025] FIG. 10 is a cross sectional view of a portion of another embodiment of the seal assembly of FIG. 6 wherein the spacer is formed by a bend in a first leaf;

[0026] FIG. 11 is a cross sectional view of a portion of another embodiment of the seal assembly of FIG. 6 wherein the spacer is formed by a rivets and spacer rings; and

[0027] FIG. 12 is a cross sectional view of a portion of another embodiment of the seal assembly of FIG. 6 wherein the spacer is formed by a bend in a second leaf.

Detailed Description

[0028] As shown in FIG. 6, a seal assembly of the present invention is generally designated by the numeral 140. One of the seal assemblies 140 is secured to opposing axially edges of each of the diaphragms 18 of the bisector type preheater of FIG. 1 by a suitable fastener system such as a plurality of bolts 145 and nuts 146. However, other methods of fastening the seal assemblies 140 to the diaphragms 18 may be employed such as but not limited to welding and brazing. Each of the seal assemblies 140 are a generally elongate member that extends between the rotor post 16 and a radially outward peripheral edge of the diaphragm 18, as shown in FIGS. 3 and 4. While the seal assembly 140 is described as being employed in a bisector type preheater, the present invention is not limited in this regard as the seal assembly may be employed in a tri-sector or quad sector preheater, without departing from the broader aspects disclosed herein.

[0029] Referring to FIG. 6, each of the seal assemblies 140 includes a leaf assembly 50 having a first leaf 52 having a first base section 52B. The first base section 52B defines a first fastening area, for example, a flat section and a bore extending therethrough for receiving one of the bolts 145 for securing the first leaf 52 to the diaphragm 18 of the preheater 10 of FIG. 1. The first leaf 52 has a first elongate section 52L extending away from the first base section 52B and terminating at a first distal end 52D thereof.

[0030] Referring to FIG. 6, each of the seal assemblies 140 includes a second leaf 54 engaging a portion of the first leaf 52 and having a second base section 54B. The second base section 54B defines a second fastening area, for example, a flat section and a bore extending therethrough for receiving one of the bolts 145 for securing the second leaf 54 to the diaphragm 18 of the preheater 10 of FIG. 1. The second leaf 54 has a second elongate section 54L extending away from the second base section 54B and terminating at a second distal end 54D thereof. The second distal end 54D terminates along a length of the first leaf 52 between the first distal end 52D and the first base section 52B of the first leaf 52.

[0031] As shown in FIG. 6, each of the seal assemblies 140 includes a supplemental leaf assembly 60 secured to (e.g., via suitable fastening structures 61 such as rivets or spot welds) the first leaf 52 and slidably engages the second leaf 54. The supplemental leaf assembly 60 includes a spacer 62 (e.g., a spacer leaf) secured to (e.g., via the fastening structures 61) the first leaf 52. The spacer 62 defines a distal end 62D. The supplemental leaf assembly 60 includes a

third leaf 64 secured to (e.g., via the fastening structures 61) the spacer 62. The third leaf 64 slidably engages a portion of the second leaf 54. The third leaf 64 defines a third distal end 64D. The spacer 62 is positioned between the first leaf 52 and the third leaf 64. The spacer 62 is spaced apart from the second distal end 54D thereby defining a gap G between the spacer 62 and the second distal end 54D to accommodate movement of the spacer 62 relative to the second distal end 54D. While the spacer 62 is described and shown in FIG. 6 as being a leaf, the present invention is not limited in this regard as other spacer configurations may be employed including but not limited to: 1) a spacer 162L formed as a leg as a result of a bend 152D in the first leaf 152 as shown in FIG. 10; 2) a spacer ring 262B disposed around a rivet 261 and positioned between the first leaf 252 and a third leaf 264 as shown in FIG. 11; and 3) a spacer 362L formed as a leg as a result of a bend 364D in the third leaf 364 as shown in FIG. 12. The inventors have surprisingly discovered that the sliding engagement of the sliding engagement of the third leaf 64 with the portion of the second leaf 54 increases the performance and life of the seal assembly 140 by reducing vibrations compared to prior art single leaf seals or improvements with only two leaves.

[0032] As shown in FIG. 6, in one embodiment the distal ends 52D, 62D and 64D are aligned with one another. In the configuration shown in FIG. 6, the distal end 52D of the first leaf 52 is shown slidably engaging the surface 31 of the sector plate 30A during reduced (e.g., 30 percent load or less) or zero load operation. Another of the spacers 62 of a seal assembly 140, positioned on an opposite side of the diaphragm 18, slidably engages the surface 31 of the sector plate 30B. For loads greater than 30 percent the distal end 54D is spaced apart from the surface 31' of the sector plate 30A by a gap G1 that reduces hot end radial seal gap by fifty percent at full load compared to the prior art seal assemblies 40.

[0033] While in FIG. 6 the distal ends 52D, 62D and 64D are aligned with one another, the present invention is not limited in this regard as one or more of the distal ends 52D, 62D and 64D may extend outwardly from one another, as shown in FIG. 9 wherein the distal end 62D extends outwardly from the distal ends 52D and 64D. In one embodiment portions of the spacer 62 on and adjacent to the distal end 62 D are formed of a wear resistant configuration such as but not limited to a surface hardfacing weld overlay (e.g., a cobalt based weld material), a case hardened layer (e.g., nitriding, carburizing or other diffusion type hardening) and a precipitation hardened material. The spacer 62 of slidably engages the surface 31 of the sector plate 30A.

[0034] In one embodiment, the first leaf 52, the second leaf 54, the third leaf 62 and/or the fourth leaf 64 are manufactured from an austenitic stainless steel, for example a 301 stainless steel. In one embodiment the first leaf 52, the second leaf 54, the third leaf 62 and/or the fourth leaf 64 are about 0.02 to 0.025 inches thick.

[0035] As shown in FIG. 4, the seal assembly 140 includes three displacement members 70 having side edges 70E that abut one another. While three displacement members 70 are shown the present invention is not limited in this regard as the displacement members 70 may be formed in one integral piece or any number of segments to facilitate installation. In one embodiment illustrated in FIG. 6, each of the plurality of displacement members 70 has an L-shaped configuration defining a first leg 71 and a second leg 72. The first leg defines a third base section 71B. The third base section 71B defines a third fastening area, for example, a flat section and a bore extending therethrough for receiving one of the bolts 145 for securing the displacement member 70 to the diaphragm 18 of the preheater 10 of FIG. 1.

[0036] As shown in FIG. 5, each of second legs 72 defines an engagement portion 72T configured to engage a surface 52F of the first leaf 52 and to displace a portion of the leaf assembly 50 a predetermined distance, as described further herein. Each of the engagement portions 72T have a contoured edge configuration. For example, the engagement portion 72T of the two radially outwardly positioned displacement members 70 have a linear tapered edge; and the engagement portion 72T' of the radially inner most positioned displacement member 70 has an arcuate edge that is complementary in shape to the surface 52F of the first leaf 52. However, any of the displacement members 70 may employ an arcuate edge and/or a linear tapered edge.

[0037] As shown in FIG. 6 the second leg 72 has a length LN (e.g., L7 shown in FIG. 6, L1-L10 shown in FIG. 5) extending between the first leg 71 and the engagement portion 72T. As shown in FIG. 5 each of L1-L10 are of a different magnitude and displace the leaf assembly 50 a different magnitude. For example, the lengths L1-L10 progressively increase (i.e., L10 is greater than L9, L9 is greater than L8, L8 is greater than L7, L7 is greater than L6, L6 is greater than L5, L5 is greater than L4, L4 is greater than L3, L3 is greater than L2, L2 is greater than L1). The displacement members 70 are arranged to establish a predefined contour of the leaf assembly 50. The predetermined contour is configured to compensate for movement of the preheater 10 during operation. As shown in FIG. 3, the first leaf 52 and the second leaf 54 have a trapezoidal shape.

[0038] Referring to FIG. 6, when the distal end 52D of the seal assembly 140 engages the surface 31 of the sector plate 30A' a pressure P1 (shown on a left hand side of the leaf assembly 50 in FIG. 6) is present in the air outlet duct 28 of the air sector 32 of FIG. 1; and a pressure P2 (shown on a right hand side of the leaf assembly in FIG. 6) is present in the flue gas inlet duct 22 of the gas sector 34 of FIG. 1. The pressure P1 is greater than the pressure P2, thereby creating a pressure differential ΔP across the seal assembly 140. When the seal assembly 140 is in the area of the sector plate 30A', without the displacement members 70 properly set, the differential pressure ΔP causes the leaf assembly 50 to deflect in the direction indicated by the arrow XX tending to open up a leakage gap between the distal end 52D of the seal assembly 140 and the surface 31 of the sector plate 30A'. However, the displacement members 70 apply a preload or predetermined deflection to the leaf assembly 50 so that the leaf assembly remains in a generally upright position with the distal end 52D of the seal assembly 140 engaging the surface 31 of the sector plate 30A' and thereby overcoming the differential pressure ΔP induced deflection.

[0039] When the seal assembly rotates about 180 degrees into the area of the sector plate 30A a pressure P1' (shown on a right hand side of the leaf assembly 50 in FIG. 6) is present in the air outlet duct 28 of the air sector 32 of FIG. 1; and a pressure P2' (shown on a left hand side of the leaf assembly in FIG. 6) is present in the flue gas inlet duct 22 of the gas sector 34 of FIG. 1. The pressure P1' is greater than the pressure P2' thereby creating a differential pressure $\Delta P'$ across the leaf assembly 50. When the seal assembly 140 is in the area of the sector plate 30A the differential pressure $\Delta P'$ tends to cause the leaf assembly 50 to deflect in the direction indicated by the arrow YY. When the seal assembly 140 is in the area of the sector plate 30A the displacement members 70 hold the leaf assembly 50 in a predetermined position in which the distal end 52D of the seal assembly 140 engages the surface 31 of the sector plate 30A to minimize leakage between the air sector 32 and the gas sector 34.

[0040] As shown in FIGS. 3 and 6, the seal assembly 140 includes a strip 80 having fourth base section 80B that engages the second base section 54B of the second leaf 54. The fourth base section 80B defines a fourth fastening area, for example, a flat section and a bore extending therethrough for receiving one of the bolts 145 for securing the strip 80 to the diaphragm 18 of the preheater 10 of FIG. 1. The second base section 54B is positioned between the first base section 52B and the fourth base section 80B. The strip 80 defines a deflector section 80L extending away from the fourth base section 80B and away from the second leaf 54. The

deflector section 80L terminates at a distal end 80D. For example, the strip 80 has a bend 80Y so that the deflector section 80L is set at an angle Q away from the second leaf 54. The strip 80 has utility in protecting the leaf assembly 50 from potential obstructions such as soot blowing equipment projecting into the preheater 10. In addition, the strip 80 is a limit stop for limiting the amount of deflection of the leaf assembly 50.

[0041] As shown in FIGS. 4 and 6 a bar 90 (e.g., a spacer bar, or elongate washer) is aligned with a portion of the first base section 52B and the second base section 54B. The bar 90 extends along a length of the leaf assembly 50 and is positioned between the nuts 146 and the diaphragm 18. The bar 90 provides structural stability and helps uniformly secure the first leaf 52, second leaf 54 and the strip 80 to the diaphragm 18.

[0042] As shown in FIG. 6, the sector plate 31 defines a sharp leading edge 31L and a sharp trailing edge 31T. The leading edge 31L is defined by an angle $\emptyset 1$; and the trailing edge 31T is defined by an angle $\emptyset 2$. In one embodiment, the angle $\emptyset 1$ and/or the angle $\emptyset 2$ is about 90 degrees.

[0043] Through analysis and experimentation, the inventors have surprisingly discovered that as the seal assembly 50 rotates with the rotor assembly 12, the first distal end 52D of the first leaf 52 abruptly and scrapingly engages the leading edge 31L in a scissor-like operation; and abruptly and scrapingly disengages the trailing edge 31T in the scissor-like operation, which causes premature wear of the seal. Contrary to engineering intuition, the inventors have found that the wear is more prominent radially inward towards the rotor post 16.

[0044] As prompted by the results of the experimentation and testing, the inventors have modified the sharp leading edge 31L and trailing edge 31T to a ramped configuration as shown in FIG. 7. The ramped configuration includes a ramped leading edge 31L' and a ramped trailing edge 31T'. The ramped leading edge 31L' defines a ramp angle $\theta 1$, and the ramped trailing edge defines a ramp angle $\theta 2$. In one embodiment the ramp angles $\theta 1$ and/or $\theta 2$ are between about 15 and 25 degrees relative to the surface 31 of the sector plate 30A or 30B. In one embodiment the ramp angles $\theta 1$ and/or $\theta 2$ are between about 25 and 45 degrees relative to the surface 31 of the sector plate 30A or 30B. While the ramped leading edge 31L' and the ramped trailing edge 31T' is shown as a chamfer in the sector plate 30A the present invention is not limited in this regard as similar configurations may be employed in the sector plate 30B (or other sector plates in tri-sector and quad sector preheaters) and/or other ramp configurations may be employed such as

but not limited to ramp attachments 131L and 131T secured to the sector plate 30A and/or 30B as shown in FIG. 8. As shown in FIG. 8, the ramp attachment 131L has a leading surface 131LA and a trailing surface 131LB each oriented at a ramp angle θ_1 relative to the surface 31 of the sector plate 30A. Likewise, the ramp attachment 131T has a leading surface 131TA and a trailing surface 131TB each oriented at a ramp angle θ_2 relative to the surface 31 of the sector plate 30A. The ramp attachments 131L and 131T are secured to the sector plates 30A and/or 30B by a suitable fastening configuration such as but not limited to bolting and welding. The ramp attachments 131L and 131T are configured to be installed as original equipment as part of a new preheater installation or retrofitting of an existing preheater.

[0045] As a result of laboratory test simulations of preheater operation, the inventors have found that the ramped configuration having a 20 degree ramp angle results in a total wear rate of the seal assembly 50 of less than 0.0016 inches per hour at less than 30 percent load operation at locations along the seal assembly between 50 and 150 inches from the axis A; and less than 4×10^{-4} inches per hour at less than 30 percent load operation at locations along the seal assembly between radially outward of 150 inches from the axis A. While the wear rates are based upon laboratory testing, the inventors expect that they are a reasonable prediction of wear during operation.

[0046] Although this invention has been shown and described with respect to the detailed embodiments thereof, it will be understood by those of skill in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed in the above detailed description, but that the invention will include all embodiments falling within the scope of the appended claims.

Revendications

1. Assemblage d'étanchéité pour un dispositif de préchauffage rotatif, l'assemblage d'étanchéité comprenant:

un assemblage à lame comprenant:

une première lame ayant une première section de base et la première section de base définissant une première zone de fixation pour fixer la première lame à un diaphragme du dispositif de préchauffage, la première lame ayant une première section allongée étendant à partir de la première section de base et se terminant à une première extrémité distale;

une seconde lame en prise avec une portion de la première lame et ayant une seconde section de base, la seconde section de base définissant une deuxième zone de fixation pour fixer la seconde lame au diaphragme, la seconde lame ayant une seconde section allongée étendant à partir de la deuxième section de base et se terminant à une seconde extrémité distale; et

un assemblage à lame supplémentaire fixée à la première lame et venant en prise de manière coulissante avec la deuxième lame.

2. Assemblage d'étanchéité selon la revendication 1, dans lequel la seconde extrémité distale se termine entre la première extrémité distale et la première section de base.

3. Assemblage d'étanchéité selon la revendication 1, dans lequel l'assemblage à lame supplémentaire comprend une entretoise fixée à la première lame et une troisième lame fixée à l'entretoise, la troisième lame engageant la deuxième lame de manière coulissante.

4. Assemblage d'étanchéité selon la revendication 1, dans lequel :

la deuxième extrémité distale se termine entre la première extrémité distale et la première section de base;

l'assemblage à lame supplémentaire comprend une entretoise fixée à la première lame et une troisième lame fixée à l'entretoise, la troisième lame engageant la deuxième lame de manière coulissante ; et

dans lequel l'entretoise est positionnée entre la première lame et la troisième lame, l'entretoise étant espacée de la seconde extrémité distale définissant ainsi un espace entre l'entretoise et la seconde extrémité distale pour permettre le mouvement de l'entretoise par rapport à la deuxième extrémité distale.

5. Assemblage d'étanchéité selon la revendication 1, comprenant en outre au moins un élément de déplacement, ledit au moins un élément de déplacement ayant une première partie de mise en prise configurée pour déplacer une première partie de l'assemblage à lame d'une première distance et ledit au moins un élément de déplacement ayant une seconde partie d'engagement configurée pour déplacer une seconde partie de l'assemblage à lame d'une seconde distance, dans lequel la première distance et la deuxième distance sont différentes.

6. Assemblage d'étanchéité selon la revendication 5, dans lequel chacun desdits au moins un élément de déplacement comporte une configuration en forme de L définissant une première branche et une deuxième branche, la première branche définissant une troisième partie de base qui est configurée pour être fixée au diaphragme et la seconde branche comprenant l'une de la première partie de l'engagement et de la deuxième partie d'engagement.

7. Assemblage d'étanchéité selon la revendication 5, dans lequel ledit au moins un élément de déplacement est disposé pour établir un contour prédéfini de l'assemblage à lame.

8. Assemblage d'étanchéité selon la revendication 7, dans lequel le contour prédéterminé est configuré pour compenser le mouvement du dispositif de préchauffage pendant le fonctionnement.

9. Assemblage d'étanchéité selon la revendication 3, dans lequel l'élément d'espacement fait saillie vers l'extérieur à partir d'au moins l'une des première lame et deuxième lame.

10. Assemblage d'étanchéité selon la revendication 1, comprenant en outre une bande ayant une quatrième section de base engageant la seconde section de base, la

seconde section de base étant positionnée entre la première section de base et la quatrième section de base et la bande définissant une section de déflecteur se prolongeant à partir de la quatrième section de base et à partir de la deuxième lame .

11. Assemblage d'étanchéité selon la revendication 1, comprenant en outre une barre alignée avec une partie de la première section de base et de la seconde section de base.

12. Assemblage d'étanchéité selon la revendication 3, dans lequel l'entretoise comprend au moins l'un d'une matière durcie, une soudure, un rivet, une lame et un pli à l'une de la première lame et de la troisième lame .

13. Un assemblage de préchauffage comprenant:

un assemblage de rotor monté à rotation sur une tige de rotor et disposé dans un boîtier, l'assemblage de rotor définissant des diaphragmes s' étendant radialement à partir de la tige de rotor à une périphérie extérieure de l' assemblage de rotor, des paires adjacentes des diaphragmes respectifs définissant des compartiments pour recevoir un assemblage de transfert de chaleur, chacun des assemblages de transfert de chaleur comprenant une pluralité de lames de transfert de chaleur empilées les unes sur les autres, le boîtier comprenant un conduit d'entrée des gaz de combustion et un conduit de sortie de gaz de fumée pour canaliser le flux des gaz de fumée chauds à travers le dispositif de préchauffage, le boîtier comprenant un conduit d'entrée d'air et un conduit de sortie d'air pour canaliser l'écoulement d'air de combustion à travers le dispositif de préchauffage, le dispositif de préchauffage comportant une plaque de secteur supérieure du boîtier s'étendant à travers l'extension adjacente à une face supérieure de l'assemblage de rotor et une plaque de secteur inférieure du boîtier s'étendant à travers l'extension adjacente à une face inférieure de l'assemblage de rotor, dans lequel la plaque de secteur supérieure s' étend entre et est reliée à la conduite d'entrée de gaz de combustion et le conduit de sortie d'air, la plaque de secteur inférieure s' étend entre et est reliée à la conduite de sortie des gaz de combustion et le conduit d'entrée d'air, les plaques de secteur supérieure et inférieure, respectivement, sont reliées entre elles par une plaque circonférentielle;

au moins une de la plaque de secteur supérieure et la plaque de secteur inférieure définissant un bord d'attaque et un bord de fuite, et dans lequel au moins l'un du bord d'attaque et le bord de fuite définissent une configuration en rampe; et

un assemblage d'étanchéité positionné sur un bord axial de chaque diaphragme, l'assemblage d'étanchéité comprenant:

un assemblage à lame comprenant:

une première lame ayant une première section de base et la première section de base définissant une première zone de fixation pour fixer la première lame à un diaphragme du dispositif de préchauffage, la première lame ayant une première section allongée s'étendant à partir de la première section de base et se terminant à une première extrémité distale;

une seconde lame étant en prise avec une portion de la première lame et ayant une seconde section de base, la seconde section de base définissant une deuxième zone de fixation pour fixer la seconde lame au diaphragme, la seconde lame ayant une seconde section allongée s'étendant à partir de la deuxième section de base et se terminant à une seconde extrémité distale; et

un assemblage à lame supplémentaire fixé à la première lame et venant en prise de manière coulissante avec la deuxième lame ; et

dans lequel une partie de l'assemblage d'étanchéité est en prise avec le bord d'attaque et se désengage du bord de fuite.

14. L'assemblage de préchauffage selon la revendication 13, dans lequel la seconde extrémité distale se termine entre la première extrémité distale et la première section de base.

15. L'assemblage de préchauffage selon la revendication 13, dans lequel l'assemblage à lame comprend une entretoise supplémentaire fixée à la première lame et une troisième lame fixée à l'entretoise, la troisième lame engageant la deuxième lame de manière coulissante.

1/9

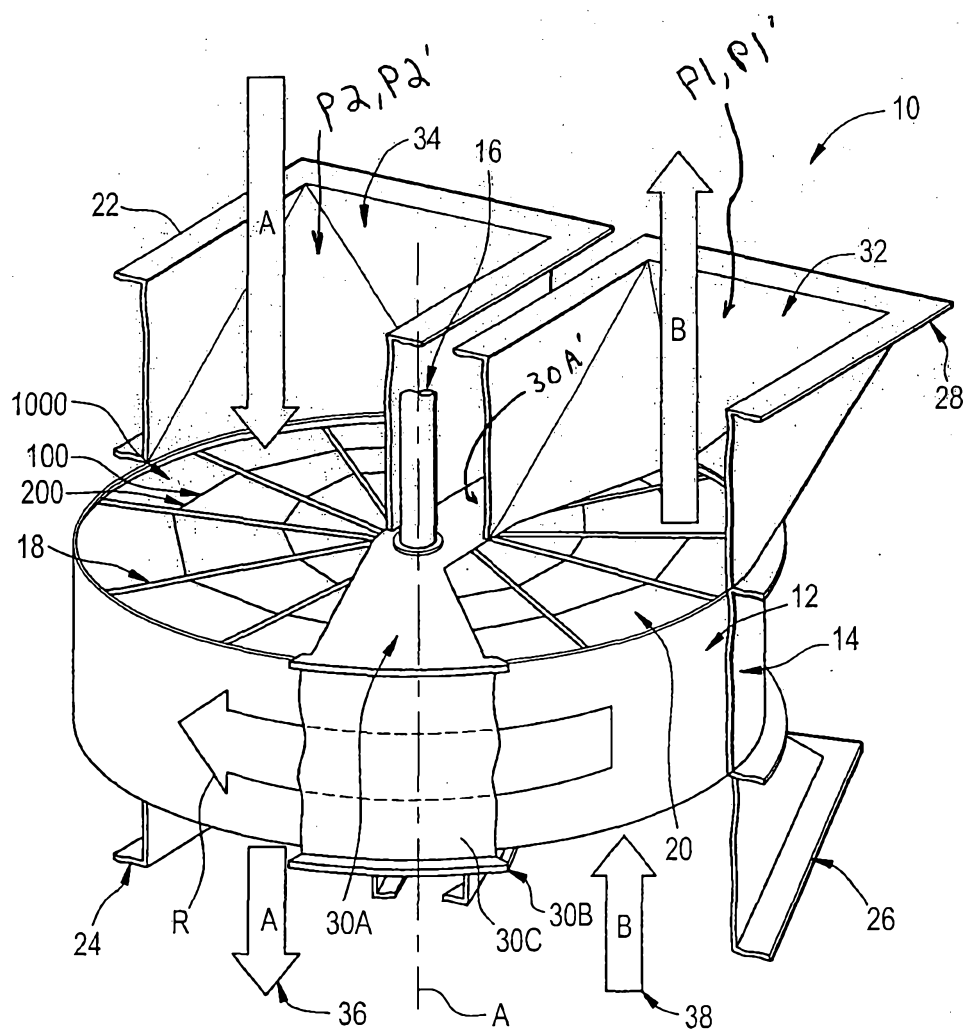
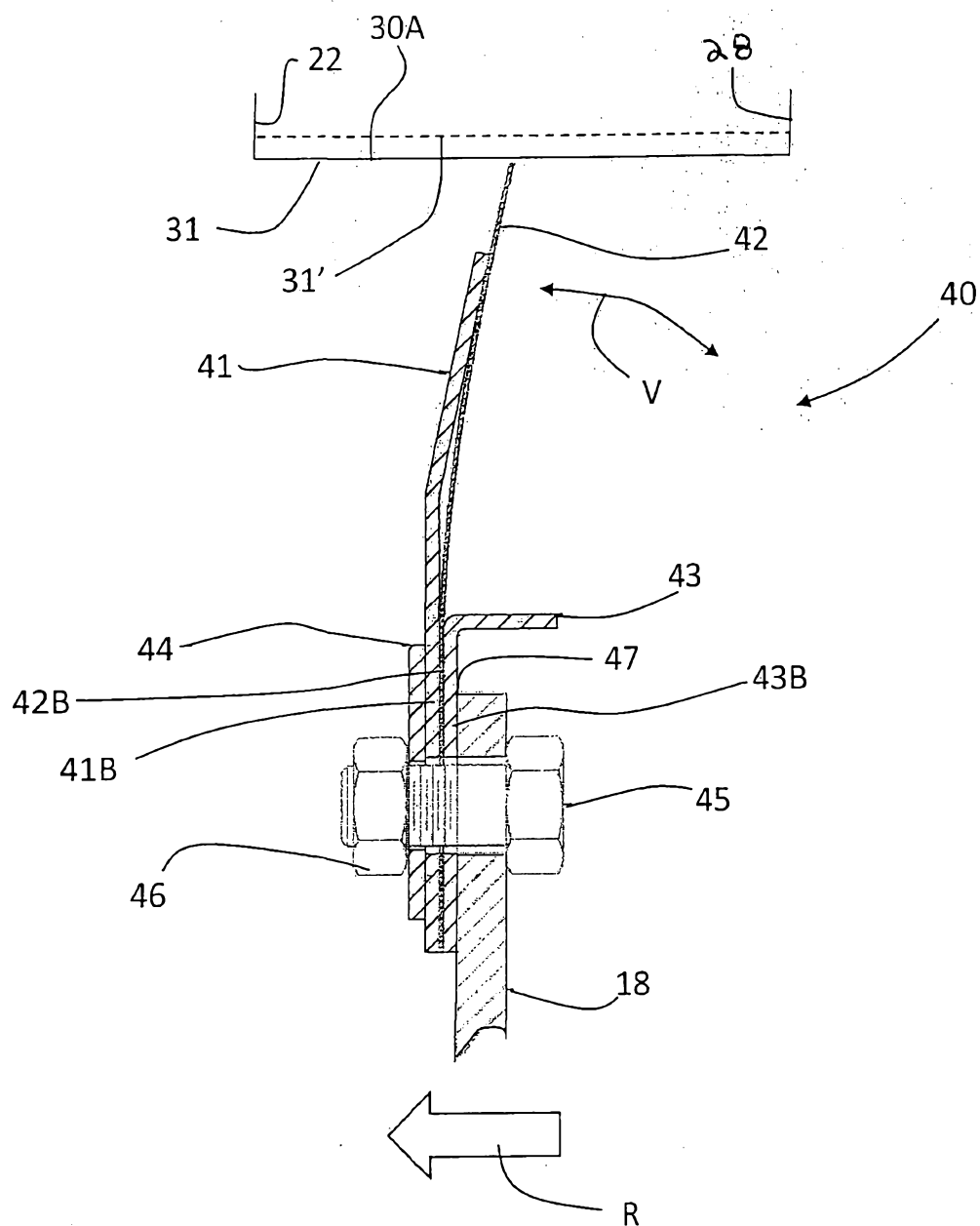


FIG. 1

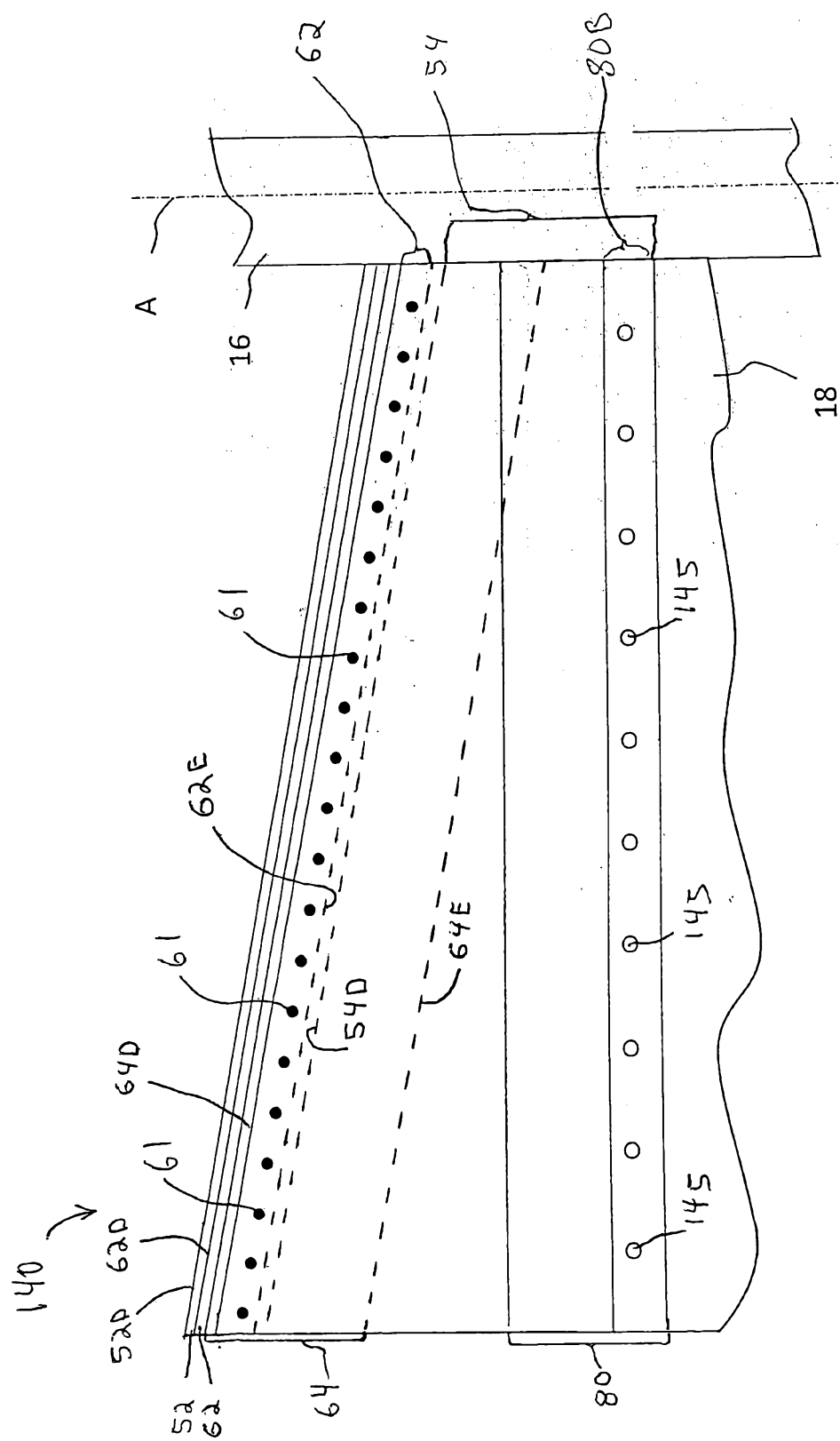
2/9

FIG. 2



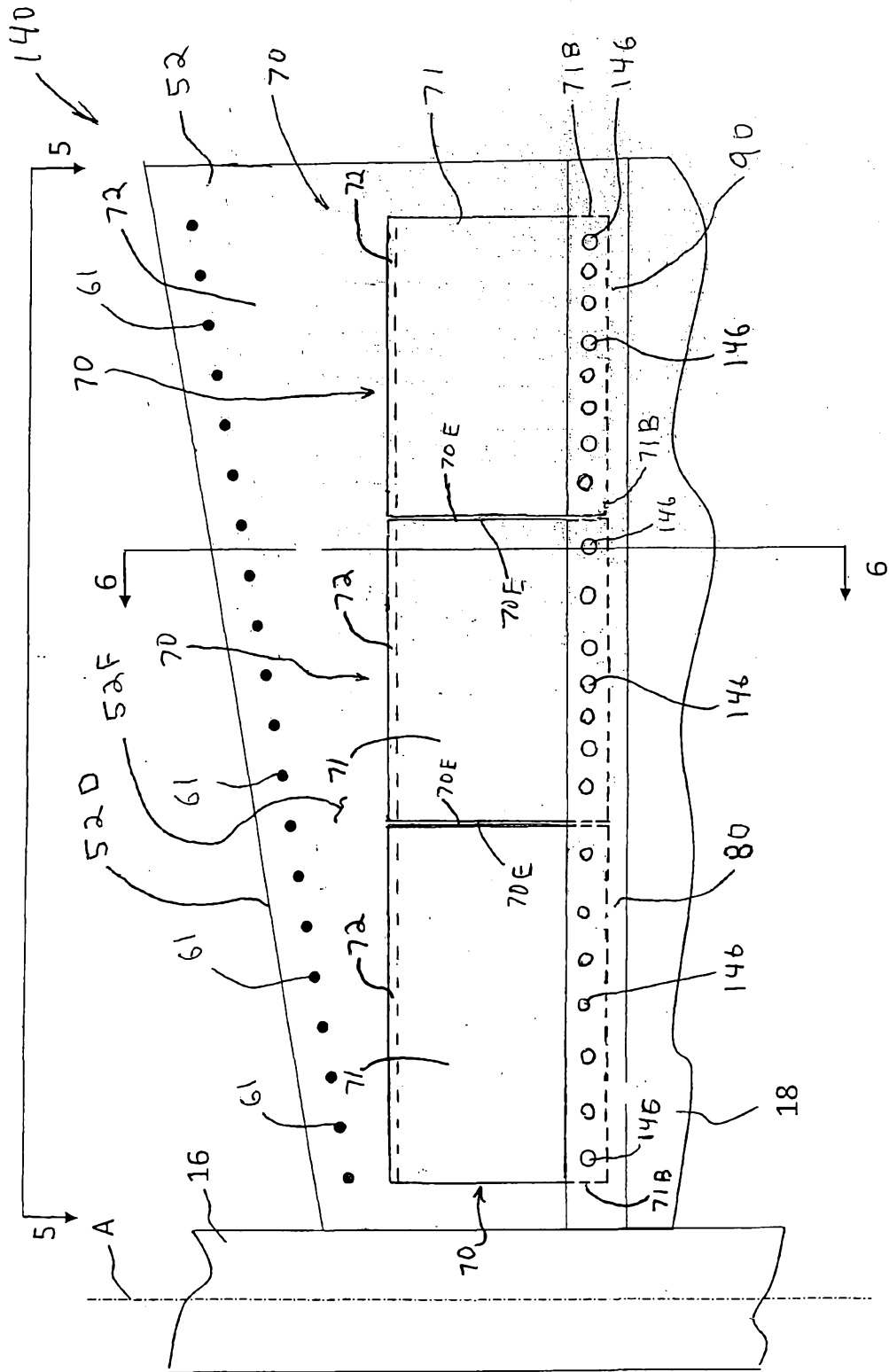
PRIOR ART

FIG. 3



4/9

FIG. 4



6/9

FIG. 6

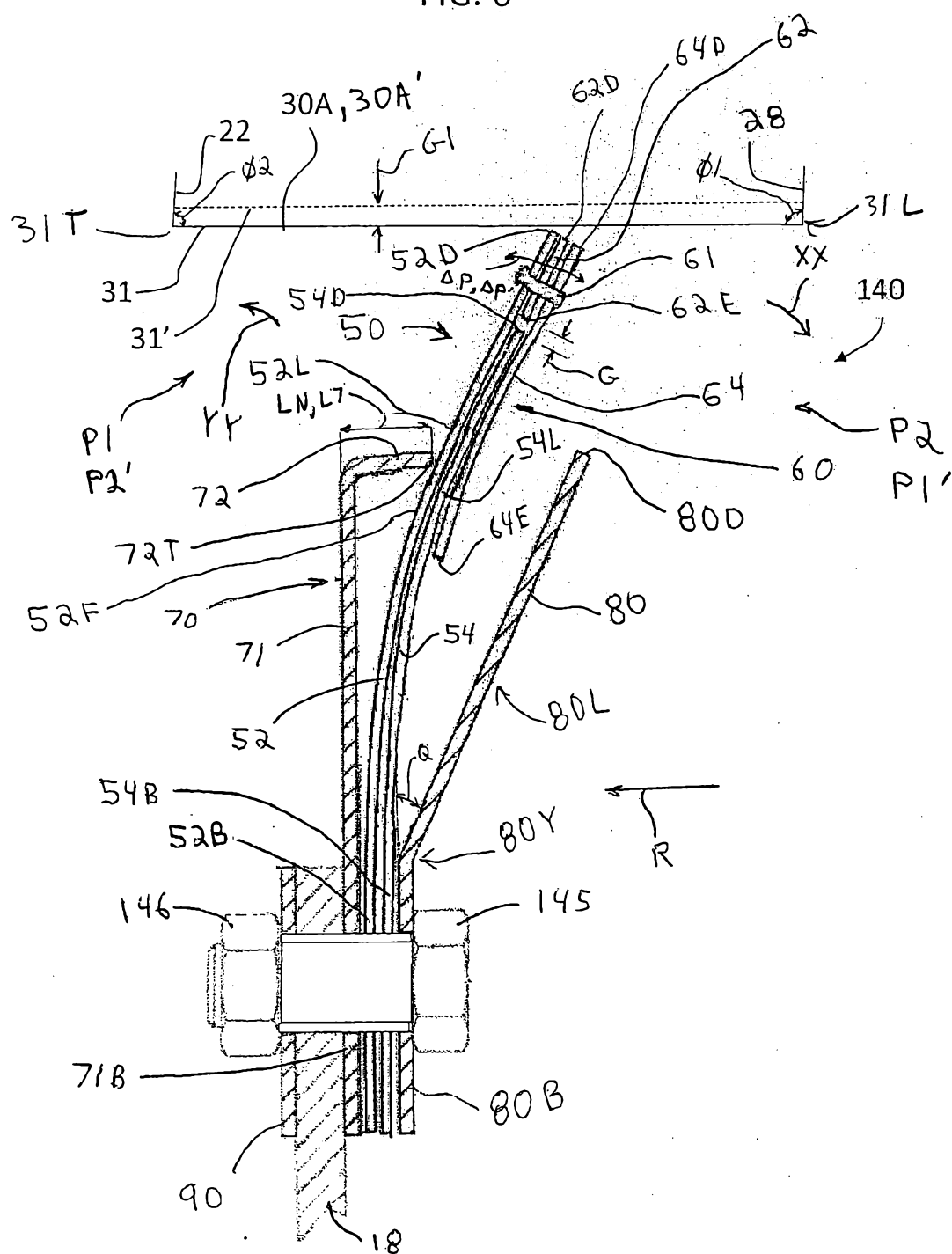
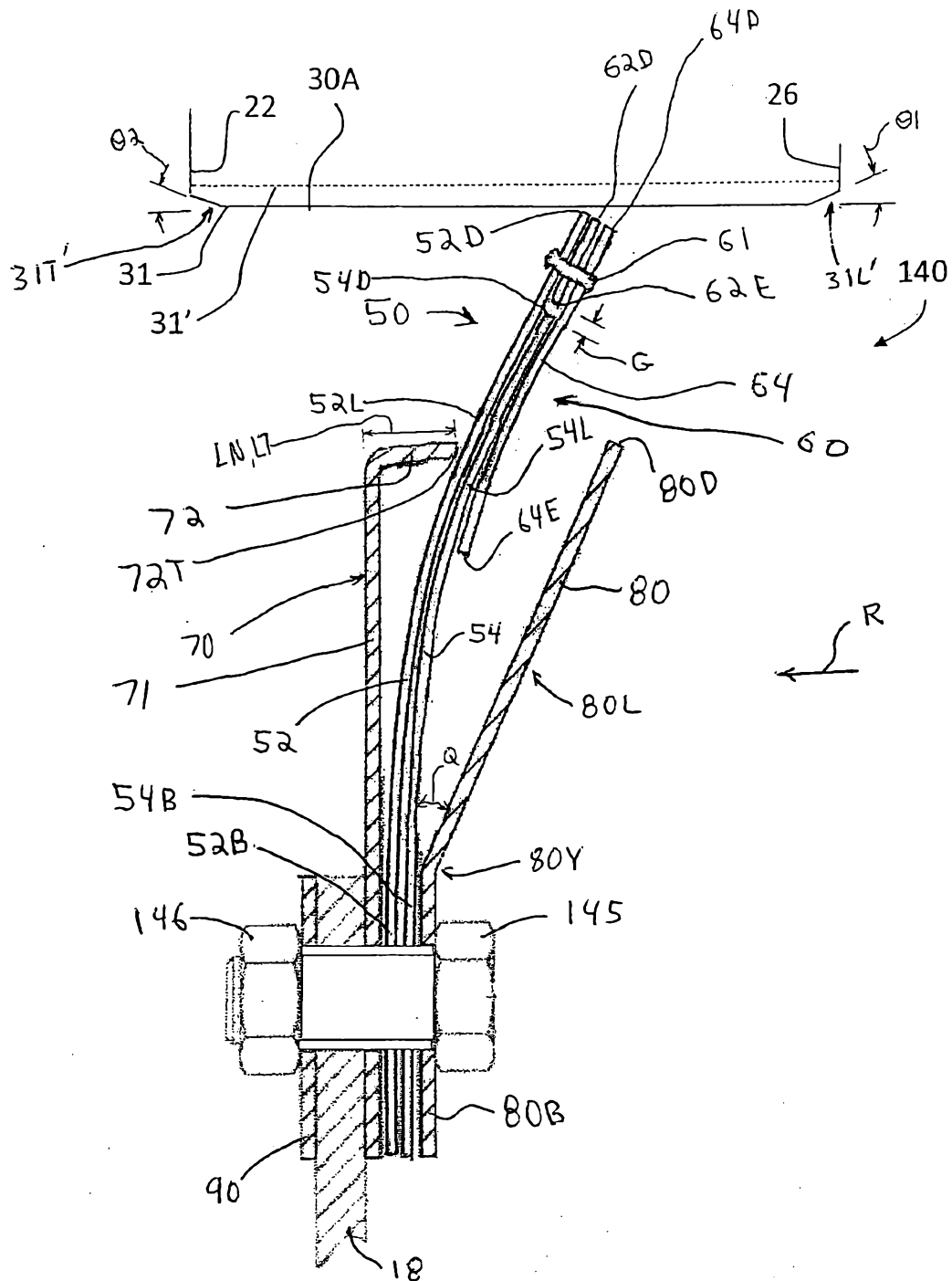


FIG. 7



9/9

92841

FIG. 9

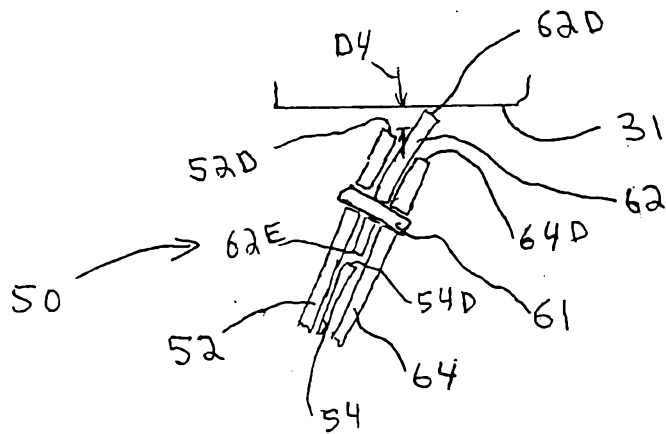


FIG. 10

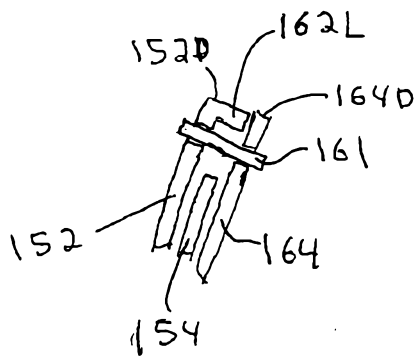


FIG. 11

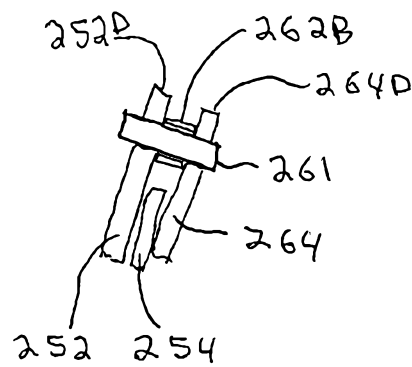
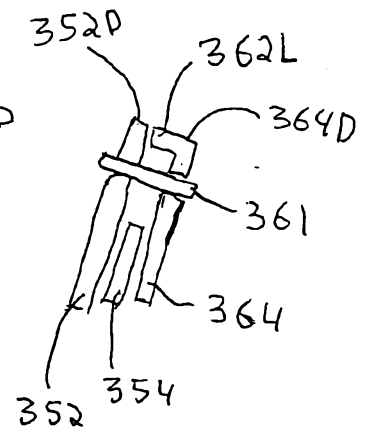


FIG. 12



Abstract

A seal assembly includes a leaf assembly and a supplemental leaf assembly. The leaf assembly includes a first leaf having a first base section. The first base section defines a first fastening area for securing the first leaf to a diaphragm of the preheater. The first leaf has a first elongate section extending away from the first base section and terminating at a first distal end thereof. The leaf assembly further includes a second leaf that engages a portion of the first leaf. The second leaf has a second base section. The second base section defines a second fastening area for securing the second leaf to the diaphragm. The second leaf has a second elongate section extending away from the second base section and terminating at a second distal end thereof. The supplemental leaf assembly is secured to the first leaf and slidably engaging the second leaf.



SEARCH REPORT
in accordance with Article 35.1 a)
of the Luxembourg law on patents
dated 20 July 1992

LO 1202
LU 92841

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 97/37186 A1 (AIR PREHEATER ABB [US]) 9 October 1997 (1997-10-09) * figures 4,5 *	1-15	INV. F28D19/04
A	JP S59 231396 A (GADELIUS KK) 26 December 1984 (1984-12-26) * abstract *	1-15	
A	US 2013/105105 A1 (O'BRIEN HARLOD L [US]) 2 May 2013 (2013-05-02) * figure 7 *	1-15	
A	US 4 593 750 A (FINNEMORE HARLAN E [US]) 10 June 1986 (1986-06-10) * figures *	1-15	
A	GB 2 515 531 A (POWER SYSTEM SERVICES LTD [GB]) 31 December 2014 (2014-12-31) * figures *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28D F24F
The present search report has been drawn up for all claims			
Date of completion of the search		Examiner	
17 June 2016		Mellado Ramirez, J	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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

LO 1202
LU 92841

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European 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.

17-06-2016

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9737186	A1	09-10-1997	BR	9708410 A	03-08-1999
			CA	2250720 A1	09-10-1997
			CN	1214766 A	21-04-1999
			EP	0891527 A1	20-01-1999
			JP	3239141 B2	17-12-2001
			JP	2000508052 A	27-06-2000
			KR	20000005138 A	25-01-2000
			US	5697619 A	16-12-1997
			WO	9737186 A1	09-10-1997

JP S59231396	A	26-12-1984	NONE		

US 2013105105	A1	02-05-2013	NONE		

US 4593750	A	10-06-1986	CA	1269096 A	15-05-1990
			JP	H0527038 B2	19-04-1993
			JP	S6241589 A	23-02-1987
			MX	162815 A	27-06-1991
			US	4593750 A	10-06-1986

GB 2515531	A	31-12-2014	NONE		



SEARCH REPORT

in accordance with Article 35.1 a)
of the Luxembourg law on patents
dated 20 July 1992

LO 1202
LU 92841

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 97/37186 A1 (AIR PREHEATER ABB [US]) 9 October 1997 (1997-10-09) * figures 4,5 *	1-15	INV. F28D19/04
A	JP S59 231396 A (GADELIUS KK) 26 December 1984 (1984-12-26) * abstract *	1-15	
A	US 2013/105105 A1 (O'BRIEN HARLOD L [US]) 2 May 2013 (2013-05-02) * figure 7 *	1-15	
A	US 4 593 750 A (FINNEMORE HARLAN E [US]) 10 June 1986 (1986-06-10) * figures *	1-15	
A	GB 2 515 531 A (POWER SYSTEM SERVICES LTD [GB]) 31 December 2014 (2014-12-31) * figures *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28D F24F
The present search report has been drawn up for all claims			
Date of completion of the search		Examiner	
17 June 2016		Mellado Ramirez, J	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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

LO 1202
LU 92841

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European 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.

17-06-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9737186	A1	09-10-1997	BR 9708410 A 03-08-1999
			CA 2250720 A1 09-10-1997
			CN 1214766 A 21-04-1999
			EP 0891527 A1 20-01-1999
			JP 3239141 B2 17-12-2001
			JP 2000508052 A 27-06-2000
			KR 20000005138 A 25-01-2000
			US 5697619 A 16-12-1997
			WO 9737186 A1 09-10-1997

JP S59231396	A	26-12-1984	NONE

US 2013105105	A1	02-05-2013	NONE

US 4593750	A	10-06-1986	CA 1269096 A 15-05-1990
			JP H0527038 B2 19-04-1993
			JP S6241589 A 23-02-1987
			MX 162815 A 27-06-1991
			US 4593750 A 10-06-1986

GB 2515531	A	31-12-2014	NONE



WRITTEN OPINION

File No. LO1202	Filing date (day/month/year) 05.10.2015	Priority date (day/month/year)	Application No. LU92841
International Patent Classification (IPC) INV. F28D19/04			
Applicant ARVOS Inc.			

This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Form LU237A (Cover Sheet) (January 2007)	Examiner Mellado Ramirez, J
--	--------------------------------



WRITTEN OPINION

File No. LO1202	Filing date (day/month/year) 05.10.2015	Priority date (day/month/year)	Application No. LU92841
International Patent Classification (IPC) INV. F28D19/04			
Applicant ARVOS Inc.			

This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Form LU237A (Cover Sheet) (January 2007)	Examiner Mellado Ramirez, J
--	--------------------------------

WRITTEN OPINION

Application No.

LU92841

Box No. I Basis of the opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the application as filed.
 - ☐ filed together with the application in electronic form.
 - ☐ furnished subsequently.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	1-15
	No: Claims	
Inventive step	Yes: Claims	1-15
	No: Claims	
Industrial applicability	Yes: Claims	1-15
	No: Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Application No.

LU92841

Box No. VII Certain defects in the application

The following defects in the form or contents of the application have been noted:

see separate sheet

WRITTEN OPINION

Application No.

LU92841

Box No. I Basis of the opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the application as filed.
 - ☐ filed together with the application in electronic form.
 - ☐ furnished subsequently.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	1-15
	No: Claims	
Inventive step	Yes: Claims	1-15
	No: Claims	
Industrial applicability	Yes: Claims	1-15
	No: Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Application No.

LU92841

Box No. VII Certain defects in the application

The following defects in the form or contents of the application have been noted:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

- 1 Reference is made to the following documents:
 - D1 WO 97/37186 A1 (AIR PREHEATER ABB [US]) 9 October 1997 (1997-10-09)
 - D2 JP S59 231396 A (GADELIUS KK) 26 December 1984 (1984-12-26)
 - D3 US 2013/105105 A1 (O'BRIEN HARLOD L [US]) 2 May 2013 (2013-05-02)
- 2 Any of D1-D3 could be regarded as being the prior art closest to the subject-matter of claim 1.
 - 2.1 The subject-matter of claim 1 differs from this known seal assemblies in a supplemental leaf assembly secured to the first leaf and slidingly engaging the second leaf. The subject-matter of claim 1 is therefore new.
 - 2.2 The problem to be solved by the present invention may be regarded as how to diminish stress concentrations and therefore provide a more reliable seal.
 - 2.3 The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step because to provide a supplemental leaf assembly secured to the first leaf and that is *slidingly engaging* the second leaf is nowhere disclosed nor suggested by the available prior art.
- 3 Claims 2-15 are dependent on one or more independent claims whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claims also meet the requirements of novelty and inventive step.

Re Item VII

Certain defects in the application

- 4 Independent claim 1 should be in the two-part form, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble and the remaining features being included in the characterising part.

- 5 Claim 1 should be clarified and simplified by defining that the leaf assembly is as defined in claim 1 to make explicitly clear the dependency of claim 13 on claim 1.
- 6 The features of claims should be provided with reference signs placed in parentheses.
- 7 Documents D1-D3 should be identified in the description.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

- 1 Reference is made to the following documents:
 - D1 WO 97/37186 A1 (AIR PREHEATER ABB [US]) 9 October 1997 (1997-10-09)
 - D2 JP S59 231396 A (GADELIUS KK) 26 December 1984 (1984-12-26)
 - D3 US 2013/105105 A1 (O'BRIEN HARLOD L [US]) 2 May 2013 (2013-05-02)
- 2 Any of D1-D3 could be regarded as being the prior art closest to the subject-matter of claim 1.
 - 2.1 The subject-matter of claim 1 differs from this known seal assemblies in a supplemental leaf assembly secured to the first leaf and slidingly engaging the second leaf. The subject-matter of claim 1 is therefore new.
 - 2.2 The problem to be solved by the present invention may be regarded as how to diminish stress concentrations and therefore provide a more reliable seal.
 - 2.3 The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step because to provide a supplemental leaf assembly secured to the first leaf and that is *slidingly engaging* the second leaf is nowhere disclosed nor suggested by the available prior art.
- 3 Claims 2-15 are dependent on one or more independent claims whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claims also meet the requirements of novelty and inventive step.

Re Item VII

Certain defects in the application

- 4 Independent claim 1 should be in the two-part form, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble and the remaining features being included in the characterising part.

- 5 Claim 1 should be clarified and simplified by defining that the leaf assembly is as defined in claim 1 to make explicitly clear the dependency of claim 13 on claim 1.
- 6 The features of claims should be provided with reference signs placed in parentheses.
- 7 Documents D1-D3 should be identified in the description.