

INTERSTAGE PLATE FOR A VACUUM PUMP

FIELD OF THE INVENTION

The present invention relates to an interstage plate system for forming an
5 interstage plate for a vacuum pump, a rotor assembly for a vacuum, and a
vacuum pump. The present invention relates to methods of assembly for a rotor
assembly and a vacuum pump.

BACKGROUND

10 Vacuum pumps comprising multiple pumping stages are known. Also,
compound vacuum pumps comprising multiple stages with different respective
pump types are known. For example, Roots-screw compound vacuum pumps
may comprise a first pumping stage housing intermeshed Roots rotors in fluid
communication with a second pumping stage housing intermeshed screw rotors.

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SUMMARY OF THE INVENTION

In an aspect, there is provided an interstage plate system comprising a
first plate portion comprising a first recess in a first mating surface of the first plate
portion, and a second plate portion comprising a second recess in a second
20 mating surface of the second plate portion. The first plate portion and the second
plate portion are configured to be coupled together so as to form an interstage
plate for a vacuum pump and such that: the first mating surface and the second
mating surface abut; and the first recess and the second recess are opposing,
contiguous recesses which together form an aperture through the interstage
25 plate.

The first plate portion may further comprise a third recess in the first mating
surface. The second plate portion may further comprise a fourth recess in the
second mating surface. The first plate portion and the second plate portion may
be further configured such that, when coupled together to form the interstage

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plate, the third recess and the fourth recess are opposing, contiguous recesses which together form a further aperture through the interstage plate.

The second plate portion may comprise a fifth recess, which may be formed in a surface of the second plate portion other than the second mating surface. For example, the fifth recess may be in a surface of the second plate portion that is opposite to the second mating surface.

In a further aspect, there is provided a rotor assembly for a vacuum pump. The rotor assembly comprises: an interstage plate formed by the interstage plate system of the preceding aspect, a first rotor, a second rotor, and a first shaft. The first rotor and the second rotor are coaxially aligned and fixed to the first shaft. The first shaft passes through the aperture in the interstage plate formed by the first and second recesses. The interstage plate is disposed between the first rotor and the second rotor.

The first rotor may be a Roots rotor. The second rotor may be a screw rotor.

The rotor assembly may further comprise a third rotor, a fourth rotor, and a second shaft. The interstage plate comprise a further aperture therethrough, which may be formed by the third recess and the fourth recess. The third rotor and the fourth rotor may be coaxially aligned and fixed to the second shaft. The second shaft may pass through the further aperture in the interstage plate. The interstage plate may be disposed between the third rotor and the fourth rotor. The second shaft may be substantially parallel with the first shaft.

The third rotor may be a Roots rotor. The fourth rotor may be a screw rotor. The first rotor and the third rotor may be intermeshed. The second rotor and the fourth rotor may be intermeshed.

In a further aspect, there is provided a vacuum pump comprising a stator having a pumping chamber, and the rotor assembly of any preceding aspect. The rotor assembly is at least partially disposed within the pumping chamber.

The stator may comprise a plate seat formed from one or more walls of the pumping chamber. The plate seat may be formed between a first pumping

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stage of the vacuum pump and a second pumping stage of the vacuum pump. The interstage plate may engage the plate seat. The interstage plate may be fixedly attached to the plate seat.

The interstage plate may be formed from the same material as the material
5 from which the stator is formed.

In a further aspect, there is provided a method of assembling a rotor assembly. The method comprises: providing a first rotor shaft assembly comprising a first rotor, a second rotor, and a first shaft, wherein the first rotor and the second rotor are coaxially aligned and fixed to the first shaft. The method
10 further comprises providing an interstage plate system comprising a first plate portion comprising a first recess, and a second plate portion comprising a second recess. The method further comprises clamping the first plate portion and the second plate portion about the first shaft such that: the first plate portion and the second plate portion together form an interstage plate disposed between the first
15 rotor and the second rotor; the first recess and the second recess are opposing, contiguous recesses which together form a first aperture through the interstage plate; and the first shaft passes through the first aperture.

The method may further comprise providing a second rotor shaft assembly comprising a third rotor, a fourth rotor, and a second shaft. The third rotor and the
20 fourth rotor may be coaxially aligned and fixed to the second shaft. The first plate portion may further comprise a third recess. The second plate portion may further comprise a fourth recess. The clamping may be performed such that: the interstage plate is disposed between the first third and the fourth rotor; the third recess and the fourth recess are opposing, contiguous recesses which together
25 form a second aperture through the interstage plate; and the second shaft passes through the second aperture.

In a further aspect, there is provided a method of assembling a vacuum pump. The method comprises assembling a rotor assembly in accordance with any preceding aspect. The method further comprises providing a stator
30 comprising a pumping chamber, and a plate seat formed from one or more walls of the pumping chamber. The plate seat is formed between a first pumping stage

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of the vacuum pump and a second pumping stage of the vacuum pump. The method further comprises inserting the rotor assembly into the pumping chamber thereby moving the interstage plate into contact with the plate seat, and fastening the interstage plate to the plate seat.

- 5 The inserting the rotor assembly into the pumping chamber may comprise moving the rotor assembly in a vertical direction, e.g. vertically downwards.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration (not to scale) showing a perspective view of an embodiment of an interstage plate system for forming an interstage plate for use in a vacuum pump;

15 Figure 2 is a schematic illustration (not to scale) showing the interstage plate formed by the assembled together components of the interstage plate system;

Figure 3 is a schematic illustration (not to scale) showing an example rotor shaft assembly for a vacuum pump;

20 Figure 4 is a process flow chart showing certain steps of a method of assembling a vacuum pump;

Figure 5 is a schematic illustration (not to scale) depicting a certain stage of the method of assembling the vacuum pump;

Figure 6 is a schematic illustration (not to scale) of the assembled vacuum pump;

25 Figure 7 is a schematic illustration (not to scale) showing a perspective view of first and second rotor shafts assemblies positioned against a plate portion of the interstage plate system;

Figure 8 is a schematic illustration (not to scale) showing a perspective view of the interstage plate clamped around first and second rotor shafts;

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Figure 9 is a schematic illustration (not to scale) showing a perspective view of a portion of a stator of the vacuum pump; and

Figure 10 is a schematic illustration (not to scale) showing a perspective view of the rotor assembly inserted into the stator.

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DETAILED DESCRIPTION

It will be appreciated that relative terms such as above and below, horizontal and vertical, top and bottom, front and back, and so on, are used herein merely for ease of reference to the Figures, and these terms are not limiting as
10 such, and any two differing directions or positions and so on may be implemented rather than truly above and below, horizontal and vertical, top and bottom, and so on.

Figure 1 is a schematic illustration (not to scale) showing a perspective view of an embodiment of an interstage plate system 100 for forming an
15 interstage plate for use in a vacuum pump.

The interstage plate system 100 comprises a first plate portion 101 and a second plate portion 102.

In this embodiment, the first plate portion 101 is an approximately half-stadium shape plate of material. The first plate portion 101 comprises a first
20 mating surface 104, and a first outer surface 106 opposite to the first mating surface 104. The first plate portion 101 comprises two recesses formed in the first mating surface 104; these two recesses are hereinafter referred to as the "first recess" 108 and the "third recess" 110. The first recess 108 and the third recess 110 are substantially semi-circular in shape. The first recess 108 and the third
25 recess 110 are substantially the same size as each other. The first plate portion 101 comprises a first tab 112 that extends from a central portion of the first outer surface 106. The first plate portion 101 comprises two first fastener holes 114 that pass through the first tab 112 from a first side of the first plate portion 101 to a second side of the first plate portion 101 opposite to the first side. The first plate
30 portion 101 comprises two second fastener holes 116 that pass through the first

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plate portion 101 from the first outer surface 106 to the first mating surface 104. The first plate portion 101 comprises two first dowel holes 118 that extend into the first plate portion 101 from the first mating surface 104. The first plate portion 101 may be formed from any appropriate material, such as grey cast iron, or SG
5 iron, or Ni resist.

In this embodiment, the second plate portion 102 is an approximately half-stadium shape plate of material. The second plate portion 102 comprises a second mating surface 120, and a second outer surface 122 opposite to the second mating surface 120. The second plate portion 102 comprises two
10 recesses formed in the second mating surface 120; these two recesses are hereinafter referred to as the "second recess" 124 and the "fourth recess" 126. The second recess 124 and the fourth recess 126 are substantially semi-circular in shape. The second recess 124 and the fourth recess 126 are substantially the same size as each other. The second recess 124 and the fourth recess 126 are
15 substantially the same size as the first recess 108 and the third recess 110. The second plate portion 102 comprises a second tab 128 and a third tab 130 that extend from the second outer surface 106 opposite to the second recess 124 and the fourth recess 126 respectively. The second plate portion 102 comprises two third fastener holes 132, each of which passes through a respective one of the
20 second tab 128 and the third tab 130 from a first side of the second plate portion 102 to a second side of the second plate portion 102 opposite to the first side. The second plate portion 102 comprises two fourth fastener holes 134 that extend into the second plate portion 102 from the second mating surface 120. The second plate portion 102 comprises two second dowel holes 136 that extend into
25 the second plate portion 102 from the second mating surface 120. The second plate portion 102 further comprises a fifth recess 138 formed the second outer surface 122. More specifically, in this embodiment, the fifth recess 138 is formed in a central portion of the second outer surface 122 between the second tab 128 and the third tab 130. The second plate portion 102 may be formed from any
30 appropriate material, such as grey cast iron, or SG iron, or Ni resist.

The interstage plate system 100 further comprises two dowels 140 and two fasteners 142.

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The dowels 140 may be formed from any appropriate material such as high carbon steel.

The components of the interstage plate system 100 are configured to be coupled together to form an interstage plate for a vacuum pump.

5 Figure 2 is a schematic illustration (not to scale) showing the interstage plate 200 formed by the assembled together components of the interstage plate system 100.

 In this embodiment, the first plate portion 101 and the second plate portion 102 are coupled together such that the first mating surface 104 abuts the second
10 mating surface 120. In this configuration, the each of the dowels 140 is located in a respective pair of first and second dowel holes 118, 136. The dowels 140 tend to ensure accurate alignment of the first plate portion 101 and the second plate portion 102. The first plate portion 101 and the second plate portion 102 are fixedly attached together by the fasteners 142. Each of the fasteners 142 is fixed
15 through a respective pair of holes, specifically a second fastener hole 116 and a fourth fastener hole 134.

 In this embodiment, the first plate portion 101 and the second plate portion 102 are coupled together such that the first recess 108 is aligned with or opposite
20 to the second recess 124. Thus, in this configuration, the first recess 108 and the second recess 124 are opposing, contiguous recesses which together form a first aperture 201 through the interstage plate 200 from a first side of the interstage plate 200 to a second side of the interstage plate 200 opposite to the first side. In this embodiment, the first aperture 201 is a substantially circular aperture, i.e., is a substantially cylindrical passage through the interstage plate 200.

25 In this embodiment, the first plate portion 101 and the second plate portion 102 are coupled together such that the third recess 110 is aligned with or opposite to the fourth recess 126. Thus, in this configuration, the third recess 110 and the fourth recess 126 are opposing, contiguous recesses which together form a second aperture 202 through the interstage plate 200 from the first side of the
30 interstage plate 200 to the second side of the interstage plate 200. In this

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embodiment, the second aperture 202 is a substantially circular aperture, i.e., is a substantially cylindrical passage through the interstage plate 200.

Figure 3 is a schematic illustration (not to scale) showing an example rotor shaft assembly 300 for a vacuum pump, hereinafter referred to as the first rotor shaft assembly 300. The rotor shaft assembly 300 may be a composite or compound rotor.

In this example, the first rotor shaft assembly 300 comprises a first rotor 301, a second rotor 302, and a first shaft 304. The first rotor 301 and the second rotor 302 are coaxially aligned and fixed to the first shaft 304. Thus, the first rotor 301 and the second rotor 302 are coaxially coupled or connected together via the first shaft 304.

In this example, the first rotor 301 is a Roots rotor. In this example, the second rotor 302 is a screw rotor, specifically a clockwise screw rotor.

Figure 4 is a process flow chart showing certain steps of a method 400 of assembling a vacuum pump.

Figure 5 is a schematic illustration (not to scale) depicting a certain stage of the method 400 of assembling the vacuum pump.

Figure 6 is a schematic illustration (not to scale) of the assembled vacuum pump 600.

It should be noted that certain of the process steps depicted in the flowchart of Figure 4 and described below may be omitted or such process steps may be performed in differing order to that presented below and shown in Figure 4. Furthermore, although all the process steps have, for convenience and ease of understanding, been depicted as discrete temporally-sequential steps, nevertheless some of the process steps may in fact be performed simultaneously or at least overlapping to some extent temporally.

At step s402, the first rotor shaft assembly 300 is provided.

At step s404, a second rotor shaft assembly is provided. The second rotor shaft assembly is shown in Figure 5 and indicated by the reference numeral 500.

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In this embodiment, the second rotor shaft assembly 500 comprises a third rotor 501, a fourth rotor 502, and a second shaft 504. The third rotor 501 and the fourth rotor 502 are coaxially aligned and fixed to the second shaft 504. Thus, the third rotor 501 and the fourth rotor 502 are coaxially coupled or connected together via the second shaft 504.

In this example, the third rotor 501 is a Roots rotor. In this example, the fourth rotor 502 is a screw rotor, specifically an anti-clockwise screw rotor.

At step s406, first rotor shaft assembly 300 and the second rotor shaft assembly 500 are arranged such that the first rotor 301 and the third rotor 501 are intermeshed, and such that the second rotor 302 and the fourth rotor 502 are intermeshed.

At step s408, the first plate portion 101 and the second plate portion 102 are clamped around the first and second rotor shafts 304, 504. More specifically, the first plate portion 101 and the second plate portion 102 are clamped around the first and second rotor shafts 304, 504 at a position along the shafts 304, 504 between the intermeshed first and third rotors 301, 501 and the intermeshed second and fourth rotors 302, 502. The first plate portion 101 and the second plate portion 102 are fastened together so as to form the interstage plate 200 described in more detail earlier above with reference to Figure 2. Thus, the interstage plate 200 is disposed between the intermeshed Roots rotors 301, 501 and the intermeshed screw rotors 302, 502. Also, the first shaft 304 passes through the first aperture 201, and the second shaft 504 passes through the first aperture 202.

Thus, the interstage plate 200 couples together the first rotor shaft assembly 300 and the second rotor shaft assembly 500, thereby to form a rotor assembly 510 for the vacuum pump 600.

Figure 7 is a schematic illustration (not to scale) showing a perspective view of the first and second rotor shafts assemblies 300, 500 positioned against the second plate portion 102 prior to the attachment of the first plate portion 101 thereto. The first rotor shaft 304 is positioned within the second recess 124, and the second rotor shaft 504 is positioned within the fourth recess 126.

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Figure 8 is a schematic illustration (not to scale) showing a perspective view of the interstage plate 200 clamped around the first and second rotor shafts 304, 504 between the Roots rotors 301, 501 and the screw rotors 302, 502.

At step s410, a vacuum pump stator 512 is provided.

5 The stator 512 comprises: a first end wall 514 at a first end of the stator 512; a second end wall 516 at a second end of the stator 512, the second end of the stator 512 being opposite to the first end of the stator 512; and one or more side walls 518 disposed between the first end wall 514 and the second end wall 516. The first end wall 514, the second end wall 516, and the one or more side
10 walls 518 define a pumping chamber 520 therebetween. The first end wall 514 comprises a first opening 522 therethrough. This first opening 522 allows access to the pumping chamber 520. The second end wall 516 comprises a second opening 524 therethrough. This second opening 522 allows access to the pumping chamber 520.

15 The stator 512 further comprises a seat for receiving the interstage plate 200, i.e. a plate seat 526. In this embodiment, the plate seat 526 is a ledge or step projecting from the internal surface of the one of more side walls 518 into the pumping chamber 520. In some embodiments, the plate seat 526 may be a rim, lip or flange extending into the pumping chamber 520 from one or more walls
20 of the stator 512.

Figure 9 is a schematic illustration (not to scale) showing a perspective view of a portion of the stator 512. Figure 9 shows the stator 512 from its first end, looking into the pumping chamber 520. In this embodiment, the plate seat 526 comprises a recess or offset 900. A plurality of fastener holes 902 are formed in
25 the plate seat 526.

At step s412, the rotor assembly 510 is inserted into the stator 512. More specifically, the rotor assembly 510 is slid into the pumping chamber 520 of the stator 512, second and fourth rotors 302, 502 first, via the first opening 522 until the interstage plate 200 engages the plate seat 526. The interstage plate 200
30 may be substantially sealingly engaged with the plate seat 526. The direction of

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movement of the rotor assembly 510 relative to the stator 512 is indicated in Figure 5 by dashed arrows and the reference numerals 528.

In this embodiment, when the rotor assembly 510 is inserted into the stator 512, the first and second shafts 304, 504 extend beyond the ends of the stator 512, through the first and second openings 522, 524.

In this embodiment, the plate seat 526 defines an opening within the pumping chamber 520 that is large enough to allow passage therethrough of the second and fourth rotors 302, 502, but small enough to prevent passage therethrough of the interstage plate 200.

Preferably, the stator 512 and the rotor assembly 510 are oriented such that the movement of the rotor assembly 510 into the stator 512 is vertically downwards, and may be assisted by gravity. Thus, when the rotor assembly is released from any insertion device, gravity acts to keep the interstage plate 200 engaged with the plate seat 526.

In this embodiment, when the interstage plate 200 is engaged with the plate seat 526, the fifth recess 138 is aligned with the plate seat recess 900. The fifth recess 138 and the plate seat recess 900 form channel for the flow of a pumped fluid from a first side of the interstage plate 200 (i.e. from a first pumping stage which comprises the first and third rotors 301, 501) to a second side of the interstage plate 200 (i.e. to a second pumping stage which comprises the second and fourth rotors 302, 502). Said another way, the fifth recess 138 and the plate seat recess 900 form a discharge port of the first pumping stage and inlet to the second pumping stage. The interstage plate 200 defines and separates the first and second pumping stages.

Figure 10 is a schematic illustration (not to scale) showing a perspective view of the rotor assembly 510 inserted into the stator 512; the first rotor shaft assembly 300 is omitted for ease of depiction and clarity.

At step s414, the interstage plate 200 is fixedly attached to the plate seat 526. In this embodiment, a plurality of fasteners is used to fasten the interstage plate 200 to the plate seat 526. Each fastener is positioned through a respective

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one of the first fastener holes 114 and the third fastener holes 132 an into a respective fastener hole 902 in the plate seat 526.

At step s416, as depicted schematically in Figure 6, first and second headplates of support members 601, 602 are arranged to support the first and second shafts 304, 504 at the ends of the stator 512.
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More specifically, a first support member 601 is arranged to mount or support the first and second shafts 304, 504 at the first end of the stator 512. The first support member 601 comprises bearings on which the first and second shafts 304, 504 are mounted. A first sealing gasket 603 is disposed between the first support member 601 and the first wall 514 of the stator 512 to form a seal therebetween.
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Also, a second support member 602 is arranged to mount or support the first and second shafts 304, 504 at the second end of the stator 512. The second support member 602 comprises bearings on which the first and second shafts 304, 504 are mounted. A second sealing gasket 604 is disposed between the second support member 602 and the second wall 516 of the stator 512 to form a seal therebetween.
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Thus, a method 400 of assembling a vacuum pump 600 is provided. The method comprises providing axially aligned rotor assemblies. The interstage plates are positioned between the Roots and screw stages and fastened (e.g. screwed) together. The twin rotor assembly together with interstage plate is then slid into the screw stator, preferably vertically. The interstage plate is then secured into the stator using a plurality of fasteners. The Roots stage rotors are then sat on the interstage plate leaving no gap. This location face will become the rotor set face as assembly of the pump proceeds.
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In some embodiments, the interstage plate 200 may be formed from the same material as the material from which the stator 512 is formed.

In operation, the rotor shafts 304, 504 and thus the rotors 301, 501, 302, 302 are rotated by a motor. Rotation of the Roots rotors (i.e. the first and third rotors 301, 501) by the motor causes process gas to be drawn into a first pumping stage of the pumping chamber 520 in which the Roots rotors 301, 501 are rotating
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via a gas inlet formed in the stator 512. Continued rotation of the rotors 301, 501, 302, 502 moves the process gas through the first stage of pumping chamber 520 from the gas inlet of the vacuum pump 600 to the discharge port of the first pumping stage formed by the fifth recess 138 and the plate seat recess 900. The process gas is subsequently forced out of the discharge port, and into the second pumping stage of the pumping chamber 520 in which the screw rotors 301, 501 (i.e. the second and fourth rotors 302, 502) are rotating. Continued rotation of the screw rotors 302, 502 by the motor moves the process gas through the second stage of pumping chamber 520, from the inlet of the second stage (formed by the fifth recess 138 and the plate seat recess 900) and out of the vacuum pump 100 via a gas outlet formed in the stator 512.

Advantageously, the above-described system and method tend to facilitate the accurate positioning and securing of the interstage plate. Positive location of the interstage plate tends to be provided.

Advantageously, one-piece rotor and one-piece stator designs tend to be facilitated. For example, the first end walls of the stator may comprise respective openings via which the pumping chamber may be accessed, e.g. by a human or tool (such as a machining tool) during fabrication, servicing, or repair of the stator. A one-piece stator tends to provide for improved heat transfer between the inlet and exhaust ends of the pump stator.

Advantageously, the above-described system and method tend to allow for the securing of the interstage plate within the stator without using any form of radial fixings through the walls of the stator.

In the above embodiments, the tip diameters of the Roots rotors are larger than those of the screw rotors' outside diameters. This tends to enable an axial location surface for the interstage plate (i.e., the plate seat) to be formed.

The doweling together of the first and second plate portions tends to provide accurate alignment of said portions.

The interstage plate portions may comprise machined surfaces that are suitable for plating.

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In the above embodiments, the first and second plate portions are approximately half-stadium in shape. However, in other embodiments, one or both of the first and second plate portions have a different shape.

In the above embodiments, the first and second plate portions each
5 comprise two recesses formed in their respective mating surfaces. However, in other embodiments, one or both of the first and second plate portions comprise a different number of recesses for in their respective mating surfaces.

In the above embodiments, the recesses formed in the mating surfaces of the first and second plate portions are substantially semi-circular in shape and
10 are substantially the same size as each other. However, in other embodiments, one or more of these recesses has a different appropriate shape and/or size.

In the above embodiments, the first plate portion and the second plate portion each have a respective one or more tabs through which first fastener holes are formed. However, in other embodiments, one or both of the first and
15 second plate portions comprise a different number and/or arrangement of tabs and/or first fastener holes to that described above. In some embodiments, tabs may be omitted and one or more first fastener holes may be formed through a body of the plate portion.

In the above embodiments, the first plate portion and the second plate
20 portion each comprises two dowel holes. However, in other embodiments, the first plate portion and the second plate portion each comprises a different number of dowel holes, e.g. three or more dowel holes. The interstage plate system may comprise a different number of dowels, e.g. more than two.

In the above embodiments, the first plate portion and the second plate
25 portion each comprises two second fastener holes via which the plate portions are securely fastened together. However, in other embodiments, the first plate portion and the second plate portion each comprises a different number of second fastener holes, e.g. three or more second fastener holes. The interstage plate system may comprise a different number of fasteners for fastening the first plate
30 portion and the second plate portion together.

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In the above embodiments, the second plate portion comprises a fifth recess formed in a central portion of the second outer surface between the second tab and the third tab. However, in other embodiments, the fifth recess is formed at a different position on either the second or the first plate portion. The
5 plate seat may comprise a correspondingly located recess that aligns with the fifth recess.

In the above embodiments, the first and third rotors are Roots rotors. However in other embodiments, the first and third rotors are a different type of rotor.

10 In the above embodiments, the second and fourth rotors are screw rotors. However in other embodiments, the second and fourth rotors are a different type of rotor.

In the above embodiments, the vacuum pump comprises two rotor shaft assemblies. However in other embodiments, the vacuum pump comprises a
15 different number of rotor shaft assemblies.

In the above embodiments, the vacuum pump comprises two pumping stages. However in other embodiments, the vacuum pump comprises a different number of pumping stages. A respective interstage plate of the type described herein may be disposed between each pair of successive pumping stages.

20 Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiment and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and
25 their equivalents.

Reference numeral list

	100 - interstage plate system
	101 - first plate portion
	102 - second plate portion
5	104 - first mating surface
	106 - first outer surface
	108 - first recess
	110 - third recess
	112 - first tab
10	114 - first fastener holes
	116 - second fastener holes
	118 - first dowel holes
	120 - second mating surface
	122 - second outer surface
15	124 - second recess
	126 - fourth recess
	128 - second tab
	130 - third tab
	132 - third fastener holes
20	134 - fourth fastener holes
	136 - second dowel holes
	138 - fifth recess
	140 – dowels
	142 – fasteners
25	200 - interstage plate

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	201 – first aperture
	202 – second aperture
	300 - first rotor shaft assembly
	301 - first rotor
5	302 - second rotor
	304 - first shaft
	400 – method
	s402-s416 – method steps
	500 - second rotor shaft assembly
10	501 - third rotor
	502 - fourth rotor
	504 - second shaft
	512 – stator
	514 - first end wall
15	516 - second end wall
	518 - one or more side walls
	520 - pumping chamber
	522 - first opening
	524 - second opening
20	526 – plate seat
	528 - direction
	600 - vacuum pump
	601 - first headplate
	602 - second headplate
25	603 - first sealing gasket

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604 - second sealing gasket

900 – offset

902 - fastener holes

CLAIMS

1. An interstage plate system comprising:
- a first plate portion comprising a first recess in a first mating surface of the
- 5 first plate portion; and
- a second plate portion comprising a second recess in a second mating surface of the second plate portion; wherein
- the first plate portion further comprises a third recess in the first mating surface; and
- 10 the second plate portion further comprises a fourth recess in the second mating surface; and
- the first plate portion and the second plate portion are configured to be coupled together so as to form an interstage plate for a vacuum pump and such that:
- 15 the first mating surface and the second mating surface abut;
- the first recess and the second recess are opposing, contiguous recesses which together form an aperture through the interstage plate; and
- the third recess and the fourth recess are opposing, contiguous recesses which together form a further aperture through the interstage plate; and
- 20 wherein
- the first plate portion and the second plate portion are fixedly attached together by fasteners passing through a respective pair of fastener holes extending through the first and second mating surfaces.
- 25 2. The interstage plate system of claim 1, wherein:
- the first plate portion comprises two first dowel holes that extend into the first plate portion from the first mating surface; and

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the second plate portion comprises two second dowel holes that extend into the second plate portion from the second mating surface; and the system further comprises:

two dowels located in a respective pair of the first and second dowel holes.

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3. The interstage plate system of any preceding claim, wherein the first plate portion comprises a first outer surface opposite to the first mating surface and a first tab extending from the first outer surface, the first tab including a first tab fastener hole passing through the first tab from a first side of the first plate portion to a second side of the first plate portion.

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4. The interstage plate system of any preceding claim, wherein the second plate portion comprises a second outer surface opposite to the second mating surface and a second tab and a third tab extending from the second outer surface, each of the second and third tabs including a respective second tab fastener hole passing through the respective one of the second and third tab from a first side of the second plate portion to a second side of the second plate portion.

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5. The interstage plate system of claim 4, wherein the second plate portion comprises a fifth recess formed in a central portion of the second outer surface between the second tab and the third tab.

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6. The interstage plate system of any of claims 1 to 4, wherein the second plate portion comprises a fifth recess in a surface of the second plate portion other than the second mating surface.

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7. A rotor assembly for a vacuum pump, the rotor assembly comprising:
an interstage plate formed by the interstage plate system of any preceding claim;

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a first rotor;

a second rotor; and

a first shaft; wherein

the first rotor and the second rotor are coaxially aligned and fixed to the
5 first shaft;

the first shaft passes through the aperture in the interstage plate formed
by the first and second recesses; and

the interstage plate is disposed between the first rotor and the second
rotor; and

10 a third rotor;

a fourth rotor; and

a second shaft; wherein

the third rotor and the fourth rotor are coaxially aligned and fixed to the
second shaft;

15 the second shaft passes through the further aperture in the interstage plate
formed by the third and fourth recesses;

the interstage plate is disposed between the third rotor and the fourth rotor;
and

the second shaft is substantially parallel with the first shaft.

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8. The rotor assembly of claim 7, wherein the first rotor and the third rotor are
a Roots rotor and the second rotor and the fourth rotor are a screw rotor.

9. The rotor assembly of claim 7 or 8, wherein the first rotor and the third rotor
25 are intermeshed, and the second rotor and the fourth rotor are intermeshed.

10. A vacuum pump comprising:

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a stator having a pumping chamber; and

the rotor assembly of any of claims 7 to 9 at least partially disposed within the pumping chamber.

5 11. The vacuum pump of claim 10, wherein:

the stator comprises a plate seat formed from one or more walls of the pumping chamber, the plate seat being formed between a first pumping stage of the vacuum pump and a second pumping stage of the vacuum pump; and

the interstage plate engages and is fixedly attached to the plate seat.

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12. The vacuum pump of any of claims 10 or 11, wherein the interstage plate is formed from the same material as the material from which the stator is formed.

13. A method of assembling a rotor assembly, the method comprising:

15 providing a first rotor shaft assembly comprising:

a first rotor;

a second rotor; and

a first shaft; wherein

the first rotor and the second rotor are coaxially aligned and fixed

20 to the first shaft;

providing a second rotor shaft assembly comprising:

a third rotor;

a fourth rotor; and

a second shaft;

25 the third rotor and the fourth rotor are coaxially aligned and fixed to the second shaft;

providing an interstage plate system comprising:

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a first plate portion comprising a first recess and a third recess in a first mating surface of the first plate portion; and

a second plate portion comprising a second recess and a fourth recess in a second mating surface of the second plate portion; and

5 clamping the first plate portion and the second plate portion about the first and second shafts such that:

the first plate portion and the second plate portion together form an interstage plate disposed between the first rotor and the second rotor and between the third and fourth rotor;

10 the first recess and the second recess are opposing, contiguous recesses which together form a first aperture through the interstage plate;

the third recess and the fourth recess are opposing, contiguous recesses which together form a second aperture through the interstage plate;

the first shaft passes through the first aperture; and

15 the second shaft passes through the second aperture;

wherein the step of clamping comprises:

abutting the first and second mating surfaces; and

fastening the first plate portion to the second plate portion using fasteners passing through a respective pair of fastener holes extending through the first
20 and second mating surfaces.

14. A method of assembling a vacuum pump, the method comprising:

assembling a rotor assembly in accordance with the method of claim 13;

providing a stator comprising:

25 a pumping chamber; and

a plate seat formed from one or more walls of the pumping chamber, the plate seat being formed between a first pumping stage of the vacuum pump and a second pumping stage of the vacuum pump;

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inserting the rotor assembly into the pumping chamber thereby moving the interstage plate into contact with the plate seat; and

fastening the interstage plate to the plate seat.

- 5 15. The method of claim 14, wherein the inserting the rotor assembly into the pumping chamber comprises moving the rotor assembly in a vertical direction.