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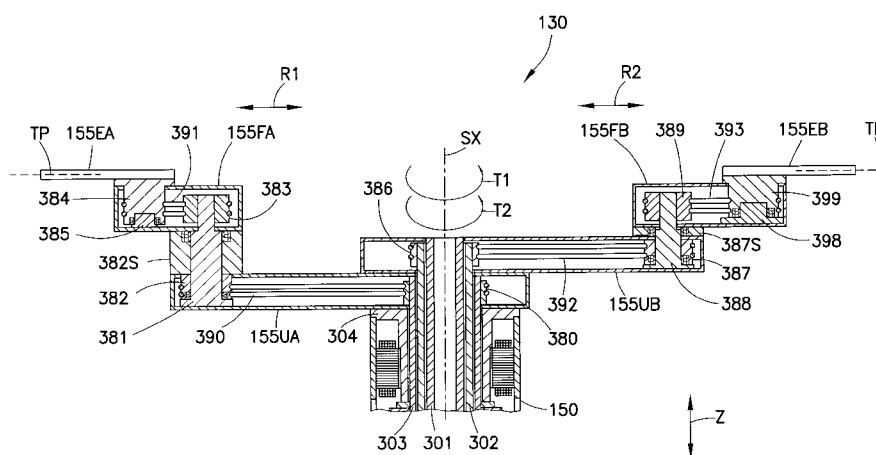


FIG. 3A

(57) Abstract: A substrate processing apparatus including a frame, including an end effector, configured to extend and retract along a first radial axis; a second SCARA arm connected to the frame, including an end effector, configured to extend and retract along a second radial axis, the SCARA arms having a common shoulder axis of rotation; and a drive section coupled to the SCARA arms is configured to independently extend each SCARA arm along a respective radial axis and rotate each SCARA arm about the common shoulder axis of rotation where the first radial axis is angled relative to the second radial axis and the end effector of a respective arm is aligned with a respective radial axis, wherein each end effector is configured to hold at least one substrate and the end effectors are located on a common transfer plane.

AMENDED CLAIMS

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1. A substrate processing apparatus comprising:

a frame;

a first SCARA arm connected to the frame, the first SCARA arm includes an end effector and is configured to extend and retract along a first radial axis;

a second SCARA arm connected to the frame, the second SCARA arm includes an end effector and is configured to extend and retract along a second radial axis, the first and second SCARA arms having a common shoulder axis of rotation;

a drive section coupled to the first and second arms, the drive section being configured to independently extend each of the first and second SCARA arms along a respective radial axis and rotate each of the first and second SCARA arms about the common shoulder axis of rotation where the first radial axis is angled relative to the second radial axis and the end effector of a respective arm is aligned with a respective radial axis; and

a controller connected to the drive section, the controller being configured to

control the drive section to drive the first and second SCARA arms, and

recognize when rotation of the first and second SCARA arms will result in interference between the first and second SCARA arms;

wherein each end effector is configured to hold at least one substrate and the end effectors are located on a common transfer plane.

2. The substrate processing apparatus of claim 1, wherein the controller is configured to effect operation of the drive section

to substantially prevent interference between the first and second SCARA arms during transport of the respective at least one substrate.

3. The substrate processing apparatus of claim 1, wherein the drive section comprises a four degree of freedom drive system.

4. The substrate processing apparatus of claim 1, wherein the drive section includes a coaxial drive shaft arrangement.

5. The substrate processing apparatus of claim 1, wherein:

the first SCARA arm includes an upper arm connected to the drive section at the common shoulder axis, a forearm connected to the upper arm at an elbow axis and the end effector is coupled to the forearm at a wrist axis; and

the second SCARA arm includes an upper arm connected to the drive section at the common shoulder axis, a forearm connected to the upper arm at an elbow axis and the end effector is coupled to the forearm at a wrist axis.

6. The substrate processing apparatus of claim 5, wherein the forearms are arranged relative to each other in an opposed configuration such that the forearm of the first SCARA arm is located on an upper surface of a respective upper arm and the forearm of the second SCARA arm is located on a bottom surface of a respective upper arm.

7. The substrate processing apparatus of claim 1, wherein the drive section comprises a three degree of freedom drive system connected to the first and second SCARA arms such that an angle between an upper arm of the first SCARA arm and an upper arm of the second SCARA arm is substantially fixed when the arms are rotated about the common shoulder axis.

8. The substrate processing apparatus of claim 1, wherein each of the end effectors is mounted to a respective arm such that an angle between the end effectors substantially matches an angle between radially adjacent substrate holding stations accessible by each arm.

9. The substrate processing apparatus of claim 1, further comprising a controller connected to at least the drive section and at least one sensor connected to the controller, the controller being configured to obtain substrate detection signals from the at least one sensor and apply an offset to a position of an end effector of one of the first and second arms, wherein the offset is calculated depending on thermal expansion of at least the substrate transport apparatus.

10. The substrate processing apparatus of claim 1, wherein the first arm is configured to allow the second arm to pass between an upper arm and forearm of the first arm.

11. The substrate processing apparatus of claim 1 wherein:

the first SCARA arm includes an upper arm, a forearm rotatably coupled to the upper arm and the end effector is rotatably coupled to the forearm where the upper arm and forearm have unequal lengths; and

the second SCARA arm includes an upper arm, a forearm rotatably coupled to the upper arm and the end effector rotatably coupled to the forearm where the upper arm and forearm have unequal lengths.

12. The substrate processing apparatus of claim 11, wherein the drive section comprises a three degree of freedom drive system connected to the first and second SCARA arms such that an angle between an upper arm of the first SCARA arm and an upper arm of

the second SCARA arm is substantially fixed when the arms are rotated about the common shoulder axis.

13. The substrate processing apparatus of claim 11, wherein each of the end effectors is mounted to a respective arm such that an angle between the end effectors substantially matches an angle between radially adjacent substrate holding stations accessible by each arm.

14. The substrate processing apparatus of claim 11, further comprising a controller connected to the drive section and configured to effect operation of the drive section to substantially prevent interference between the first and second SCARA arms during transport of the respective at least one substrate.

15. The substrate processing apparatus of claim 11, wherein the drive section comprises a four degree of freedom drive system.

16. The substrate processing apparatus of claim 1 wherein:

the drive section is capable of driving the first and second SCARA arms through more than three-hundred-sixty degrees of rotation about the common shoulder axis of rotation; and

the controller is configured to control the drive section to drive the first and second SCARA arms through more than three-hundred-sixty degrees of rotation about the common shoulder axis of rotation and for extending and retracting the first and second SCARA arms, the controller being further configured to

position at least one of the first and second SCARA arms so that an axis of extension and retraction of at least one of the first and second SCARA arms is within a region substantially without interference with another of the first and second SCARA arms, and

provide nearly simultaneous picking and placing of substrates with the first and second SCARA arms.

17. The substrate processing apparatus of claim 16, wherein the controller is configured to rotate the arms as a unit about the common shoulder axis of rotation.

18. The substrate processing apparatus of claim 16, wherein the drive section is a four degree of freedom drive having four concentric drive shafts.

19. The substrate processing apparatus of claim 18, wherein the four concentric drive shafts are radially and axially supported by a nested bearing arrangement where at least a portion of one bearings is mounted to a portion of another one of the bearings.

20. The substrate processing apparatus of claim 16, wherein each SCARA arm includes an upper arm link and a forearm link wherein the upper arm links are a different length than the forearm links.

21. The substrate processing apparatus of claim 16, wherein the first arm is configured to allow the second arm to pass between an upper arm and forearm of the first arm.

22. The substrate processing apparatus of claim 17, wherein each arm includes an upper arm link and a forearm link wherein the upper arm links are a different length than the forearm links.

23. The substrate processing apparatus of claim 17, wherein each arm includes an end effector configured to support at least one substrate.

24. The substrate processing apparatus of claim 17, wherein the first arm is configured to allow the second arm to pass between an upper arm and forearm of the first arm.