CLAIMS

1. A substrate transport apparatus for transferring substrates in a transport chamber, the substrate transport apparatus comprising:

a frame disposed in the transport chamber where the transport chamber has chamber ends and chamber lateral sides extending between the chamber ends, each chamber lateral side having at least four processing station openings extending therethrough;

a drive section connected to the frame; and

an articulated arm having at least one articulated arm link operably connected to the drive section so that the articulated arm rotates, about a pivot axis, relative to the frame and extends and retracts relative to the pivot axis to effect transfer of substrates to and from each of the at least four processing station openings of each of the chamber lateral sides;

wherein the articulated arm has an end effector pivotally mounted to the at least one articulated arm link forming a joint between the end effector and the at least one articulated arm link with an arm joint pivot axis disposed so that the end effector rotates relative to the at least one articulated arm link about the arm joint pivot axis, and wherein the articulated arm has a drive band transmission with drive and driven pulleys where the driven pulley is connected to the end effector, wherein at least one band of the drive band transmission is wrapped around at least one of the connected pulleys so the at least one band is overwrapped relative to itself so the transmission is capable of generating rotation of the end effector well in excess of 180° in either direction so as to position the end effector at each of the at least four processing station openings of each of the chamber lateral sides to effect the transfer of the substrates to and from each of the at least four processing station openings of each of the chamber lateral sides; and

wherein the end effector has one or more substrate holding location disposed on a single side of the arm joint pivot axis.

2. The substrate transport apparatus of claim 1, wherein the rotation of the end effector between a maximum extension stroke and a maximum retraction stroke is at least +/- 300° in either direction of an end effector midstroke rotation position.

3. The substrate transport apparatus of claim 1, wherein the at least one band is overwrapped relative to itself.

4. The substrate processing apparatus of claim 3, wherein the at least one band is overwrapped so that the band wrap spirals over itself on the pulley.

5. The substrate processing apparatus of claim 3, wherein the at least one band is overwrapped so that the band wrap laps over itself.

6. The substrate processing apparatus of claim 3, wherein the at least one band is overwrapped so that the band wrap spirals alongside itself with the band being wrapped having coil edges juxtaposed along a pulley axis.

7. The substrate transport apparatus of claim 1, wherein at least one pulley of the connected pulleys is an idler pulley coupled to the end effector so that idler pulley rotation rotates the end effector about the joint pivot axis.

8. The substrate transport apparatus of claim 7, wherein the at least one band is overwrapped relative to itself around the idler pulley.

9. The substrate transport apparatus of claim 7, wherein the idler pulley is non-circular pulley.

10. The substrate transport apparatus of claim 7, wherein the idler pulley has a band seating surface with a non-circular radial periphery on which the at least one band seats as the band is wound and dispensed from the idler pulley.

11. The substrate transport apparatus of claim 7, wherein another of the at least one pulley of the connected pulleys is a drive pulley, where the drive pulley is a non-circular pulley.

12. The substrate transport apparatus of claim 11, wherein the idler pulley and the drive pulley have pulley profiles that engage respective opposing bands winding and unwinding so as to

maintain a substantially constant reduction ratio between the idler pulley and the drive pulley in each rotation direction throughout the end effector extension and retraction strokes.

13. The substrate transport apparatus of claim 1, wherein the end effector has a substrate holding station thereon.

14. The substrate transport apparatus of claim 1, wherein the end effector has more than one substrate holding stations, at least two of the more than one substrate holding stations being on opposite ends of the end effector.

15. A substrate transport apparatus for transferring substrates in a transport chamber, the substrate transport apparatus comprising:

a frame disposed in the transport chamber where the transport chamber has chamber ends and chamber lateral sides extending between the chamber ends, each chamber lateral side having at least four processing station openings extending therethrough;

a drive section connected to the frame; and

an articulated arm having at least one articulated arm link operably connected to the drive section so that the articulated arm rotates, about a pivot axis, relative to the frame and extends and retracts relative to the pivot axis to effect transfer of substrates to and from each of the at least four processing station openings of each of the chamber lateral sides;

wherein the articulated arm has an end effector pivotally mounted to the at least one articulated arm link forming a joint between the end effector and the at least one articulated arm link with an arm joint pivot axis disposed so that the end effector rotates relative to the at least one articulated arm link about the arm joint pivot axis, and wherein the articulated arm has a drive band transmission, with pulleys and dual opposing bands connecting the pulleys, that extends and retracts the articulated arm through an arm motion stroke extending or retracting the articulated arm and moving the end effector through a corresponding end effector stroke; and

wherein the dual opposing bands have a winding geometry on at least one of the pulleys that determines rotation of the end effector about the joint pivot axis that provides more

than 300° end effector rotation from end to end of the end effector stroke so as to position the end effector at each of the at least four processing station openings of each of the chamber lateral sides to effect the transfer of the substrates to and from each of the at least four processing station openings of each of the chamber lateral sides; and

wherein the end effector has one or more substrate holding location disposed on a single side of the arm joint pivot axis.

16. The substrate transport apparatus of claim 15, wherein the winding geometry provides beyond 180° end effector rotation from midstroke to either end of the end effector stroke.

17. The substrate transport apparatus of claim 15, wherein the winding geometry effects asymmetric winding and unwinding rates of respective opposing bands for common rotation of the at least one of the pulleys.

18. The substrate transport apparatus of claim 17, wherein another pulley of the at least one of the pulleys connected to each other by the opposing bands is configured with a compensator arranged to compensate for the asymmetric winding and unwinding of the respective opposing bands so as to maintain substantially constant tension on each band of the opposing bands throughout the end effector stroke.

19. The substrate transport apparatus of claim 18, wherein the compensator has a geometry that generates, for a common rotation of the another pulley, asymmetric unwinding rates and winding rates of the respective opposing bands on the another pulley commensurate with asymmetric winding rates and unwinding rates of the respective opposing bands on the at least one of the pulleys.

20. The substrate transport apparatus of claim 18, wherein the another pulley has respective non-circular pulley profile with a cam lobe for each of the respective opposing bands, the respective cam lobes of the respective non-circular pulley profiles form the compensator.

21. The substrate transport apparatus of claim 20, wherein the respective cam lobes of the respective non-circular pulley profiles are disposed on the pulley periphery out of phase by a degree that defines the compensator geometry.

22. The substrate transport apparatus of claim 18, wherein the at least one of the pulleys is an idler pulley, and the another pulley is a drive pulley.

23. The substrate transport apparatus of claim 22, wherein the idler pulley and the drive pulley have pulley profiles that engage the respective opposing bands winding and unwinding so as to maintain a substantially constant reduction ratio between the idler pulley and the drive pulley in each rotation direction throughout the end effector stroke.

24. The substrate transport apparatus of claim 22, wherein the idler pulley has a band seating surface with a non-circular radial periphery on which the at least one band seats as the band is wound and dispensed from the idler pulley.

25. The substrate transport apparatus of claim 24, wherein another of the at least one pulley of the connected pulleys is a drive pulley, where the drive pulley is a non-circular pulley.

26. The substrate transport apparatus of claim 15, wherein each of the opposing bands is overwrapped relative to itself.

27. The substrate transport apparatus of claim 26, wherein each of the opposing bands is overwrapped so that the band wrap spirals over itself on the pulley.

28. The substrate transport apparatus of claim 26, wherein each of the opposing bands is overwrapped so that the band wrap laps over itself.

29. The substrate transport apparatus of claim 26, wherein each of the opposing bands is overwrapped so that the band wrap spirals alongside itself with the band being wrapped having coil edges juxtaposed along a pulley axis.

30. The substrate transport apparatus of claim 15, wherein the at least one of the pulleys is an idler pulley coupled to the end effector so that idler pulley rotation rotates the end effector about the joint pivot axis.

31. The substrate transport apparatus of claim 30, wherein each of the opposing bands is overwrapped relative to itself around the idler pulley.

32. A method for transferring substrates, the method comprising:

providing a substrate transport apparatus for transferring substrates in a transport chamber that has chamber ends and chamber lateral sides extending between the chamber ends, each chamber lateral side having at least four processing station openings extending therethrough, where the substrate transport apparatus includes

a frame;

a drive section connected to the frame;

an articulated arm having at least one articulated arm link operably connected to the drive section so that the articulated arm rotates, about a pivot axis, relative to the frame and extends and retracts relative to the pivot axis; and

an end effector pivotally mounted to the at least one articulated arm link forming a joint between the end effector and the at least one articulated arm link with an arm joint pivot axis disposed so that the end effector rotates relative to the at least one articulated arm link about the arm joint pivot axis;

moving the end effector respectively through an extension stroke and a retraction stroke with a drive band transmission with pulleys and at least one band connecting the pulleys that extends and retracts the articulated arm effecting transfer of substrates to and from each of the at least four processing station openings of each of the chamber lateral sides; and

wherein the at least one band is wrapped around at least one of the connected pulleys so the at least one band is overwrapped relative to itself so the transmission generates rotation of the end effector, relative to the at least one articulated arm link, about the joint pivot axis that is more than 180° from an end effector midstroke rotation position of the end effector to a maximum stroke rotation position of the end effector so as to position the end effector at each of the at least four processing station openings of each of the chamber lateral sides to effect the transfer of the substrates to and from each of the at least four processing station openings of each of the chamber lateral sides; and

wherein the end effector has one or more substrate holding location disposed on a single side of the arm joint pivot axis.

33. The method for transferring substrates of claim 32, wherein the rotation of the end effector between a maximum extension stroke and a maximum retraction stroke is at least +/- 300° in either direction of the end effector midstroke rotation position.