HIGH SPEED, COMPACT CENTRIFUGE FOR USE WITH SMALL SAMPLE VOLUMES

BACKGROUND

[0001] Traditional centrifuges are excessively large and inefficient for handling centrifugation of small volumes of liquid samples. They also fail to include certain features that would be desired when processing small sample volumes.

~~INCORPORATION BY REFERENCE~~

[0002] ~~All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.~~

SUMMARY

[0003] It should be understood that embodiments in this disclosure may be adapted to have one or more of the features described herein.

[0004] In one nonlimiting example, an automated system is provided for separating one or more components in a biological fluid. The system may comprise of: (a) a centrifuge comprising one or more buckets configured to receive a container to effect said separating of one or more components in a fluid sample; and (b) the container, wherein the container includes one or more shaped features that is complementary to a shaped feature of the bucket.

It should be understood that embodiments herein may be adapted to have one or more of the following features. In one nonlimiting example, the system may have one or more buckets that is a swinging bucket that is at or near a vertical position when the centrifuge is at rest and that is at or near a horizontal position when the centrifuge is spinning. Optionally, the system may have a plurality of swinging buckets that are spaced radially symmetrically on the centrifuge. Optionally, the fluid sample is a biological fluid. Optionally, the biological fluid is blood. Optionally, the container is configured to contain 100 uL or less of sample fluid. Optionally, the container is configured to contain 50 uL or less of sample fluid. Optionally, the container is configured to contain 25 uL or less of sample fluid. Optionally, the container is closed on one end and open at an opposing end. Optionally, the container is a centrifugation vessel. Optionally, the centrifugation vessel has a rounded end with one or more interior nubs.

Optionally, the system includes an extraction tip with one or more shaped features that is complementary to a shaped feature of the centrifugation vessel, and that is configured to fit within the centrifugation vessel. Optionally, the shaped feature of the bucket includes one or more shelves upon which a protruding portion of the container is configured to rest. Optionally, the bucket is configured to be capable of accepting a plurality of containers having different configurations, and wherein the shaped feature of the bucket includes a plurality of shelves, wherein a first container having a first configuration is configured to rest upon a first shelf, and a second container having a second configuration is configured to rest upon a second shelf.

[0006] In an embodiment described herein, a compact high speed centrifuge for use with low volume sample containers is provided. The centrifuge comprises a centrifuge housing; a centrifuge rotor having a perimeter; a motor for rotating the centrifuge rotor; ~~and~~ a detector integrated with the motor and configured to determine at least a rotational position of a rotating portion of the motor, wherein the detector uses at least two different types of encoder information to determine the rotational position; a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing; wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information.

[0007] It should be understood that embodiments herein may be adapted to have one or more of the following features. In one nonlimiting example, the detector uses at least optical encoder and Hall-effect techniques to determine rotational position. Optionally, the detector uses at least optical encoder and Hall-effect techniques to determine at least rotational position and rotational velocity. Optionally, the detector has a first surface directed towards detecting one type of encoder information and a second surface directed towards detecting another type of encoder information. Optionally, the first surface and the second surface are oriented in different directions. Optionally, the first surface and the second surface are oriented in the same direction Optionally, the motor includes a plurality of detectors for determining rotational position. Optionally, the motor includes a first encoder disc providing the first type of encoder information and a second encoder disc providing the second type of encoder information. Optionally, Optionally, the motor includes a first encoder disc providing optical encoder information and a second encoder disc providing magnetic encoder information. Optionally, the motor includes an encoder disc providing the first type of encoder information and the second type of encoder information. Optionally, the motor includes an encoder disc providing both optical encoder information and magnetic encoder information. It should be understood that although the motor with integrated encoder components is described in the context of a centrifuge, the motor may

also be adapted for use in other scenarios that desires to have position and/or velocity detector features integrated into the motor.

[0008] In yet another embodiment described herein, a method is provided comprising: providing a motor; integrating a first type of encoder into the motor; integrating a second type of

encoder into the motor; determining rotational position of a rotating portion of the motor using the first type of encoder, ~~and~~ determining rotational velocity of the rotating portion of the motor using the second type of encoder; wherein the first type of encoder and the second type of encoder are on the same detector and wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; coupling the motor to a centrifuge rotor with a perimeter; placing the centrifuge rotor in a centrifuge housing; using a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and using a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0009] It should be understood that embodiments herein may be adapted to have one or more of the following features. In one nonlimiting example, the first type of encoder provides optical encoder information. Optionally, the first type of encoder provides magnetic encoder information. Optionally, the first type of encoder provides Hall-effect encoder information. Optionally, the first type of encoder and the second type of encoder provide different types of encoder information.

[0010] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge rotor with a perimeter defined by a first portion comprising a thermally insulating material; a second portion comprising a thermally conductive material; wherein containers are arranged such that the containers are located in areas with the thermally insulating material; wherein the thermally conductive material is configured to channel heat in a direction leading away from the containers; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0011] In another embodiment described herein, a compact high speed centrifuge for use with sample containers that are located in areas with reduced thermal exposure is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; an active cooling unit for minimizing heat transfer to the sample; ~~wherein containers are arranged such that the containers are located in areas with reduced thermal exposure;~~ the active cooling unit configured to cool the drive mechanism; wherein stator is located coaxially within a rotor of a motor in the drive mechanism; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface

for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0012] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; ~~and~~ a position detector for use in determining rotational position of the centrifuge body; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0013] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; ~~and~~ autobalancing weights coupled to the centrifuge body, wherein such weights are configured to move under centrifugal force to a location to minimize off-balance rotation of the centrifuge body with uneven amounts of load in sample holders of the centrifuge; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0014] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive

mechanism for rotating the centrifuge body; ~~and~~ at least one air bearing configured to operably support the centrifuge; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0015] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; ~~and~~ at least one air bearing configured to operably support the centrifuge, wherein at least a portion of the air bearing is a part of the centrifuge housing; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0016] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; a force detector configured to detect rate changes in force outside a range of pre-determined force conditions; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0017] It should be understood that embodiments herein may be adapted to have one or more of the following features. In one nonlimiting example, the centrifuge vessel holders pivot inward toward a center axis of the centrifuge rotor under centrifugal force. Optionally, the centrifuge vessel holders form a flush surface with rotor body to minimize aerodynamic drag. Optionally, the centrifuge vessel holder is configured to retract downward under centrifugal force. Optionally, wherein electrical connections are not disrupted to centrifuge body cooling elements, even if such elements are in motion during centrifuge operation.

[0018] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body, wherein the centrifuge body extends downward to cover at least a portion of the drive mechanism; wherein the drive mechanism comprises a stator and a rotor; wherein the rotor is concentric about the stator; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0019] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body, wherein the centrifuge body extends downward to cover at least a portion of the drive mechanism; wherein the drive mechanism comprises a stator and a rotor; wherein the stator is concentric about the rotor; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0020] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; one or more swing holders on the centrifuge body for containing a centrifuge vessel; wherein a maximum dimension of the swing holders or the sample containers does not exceed about 10mm; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0021] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; one or more swing holders on the centrifuge body for containing a centrifuge vessel; wherein the swing holders, during centrifuge operation, move from a first orientation to a second orientation more horizontal than the first orientation; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0022] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; a drive mechanism for rotating the centrifuge body; one or more swing holders on the centrifuge body for containing a centrifuge vessel; wherein width of the sample container is greater than a length of the sample container; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0023] In another embodiment described herein, a compact high speed centrifuge for use with sample containers is provided. The centrifuge may comprise a centrifuge housing; a centrifuge body having a perimeter; ~~and~~ a drive mechanism for rotating the centrifuge body; a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information; a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

[0024] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Figures 1 to 3 show various views of embodiments of a centrifuge described herein.

[0026] Figures 4 to 5 show various views of embodiments of a centrifuge described herein.

[0027] Figures 6 to 8 show various views of embodiments of vessel holders as described herein.

[0028] Figures 9 to 12 show various embodiments of a centrifuge described herein.

[0029] Figures 13 to 16 show various views of embodiments of centrifuges with thermal control features as described herein.

[0030] Figures 17A to 17G show various embodiments of devices and methods for position and/or velocity control as described herein.

[0031] Figures 18A to 18C show various embodiments of self-balancing features described herein.

[0032] Figures 19 to 21 show various embodiments of devices and methods as described herein,

WHAT IS CLAIMED IS:

1. A compact high speed centrifuge for use with low volume sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge rotor having a perimeter;

a motor for rotating said centrifuge rotor; ~~and~~

a detector integrated with the motor and configured to determine at least a rotational position of a rotating portion of the motor, wherein the detector uses at least two different types of encoder information to determine said rotational position;

a first bearing a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing;

wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information.

2. A centrifuge as in claim 1 wherein the detector uses at least an optical encoder technique and a Hall-effect technique to determine rotational position.

3. A centrifuge as in claim 1 wherein the detector uses at least an optical encoder technique and a Hall-effect technique to determine at least rotational position and rotational velocity.

4. A centrifuge as in claim 1 wherein the first surface and the second surface are oriented in different directions.

5. A centrifuge as in claim 1 wherein the first surface and the second surface are oriented in the same direction.

6. A centrifuge as in claim 1 comprising a plurality of detectors for determining rotational position.

7. A centrifuge as in claim 1 further comprising a first encoder disc providing the first type of encoder information and a second encoder disc providing the second type of encoder information.

8. A centrifuge as in claim 1 further comprising a first encoder disc providing optical encoder information and a second encoder disc providing magnetic encoder information.

9. A centrifuge as in claim 1 further comprising an encoder disc providing the first type of encoder information and the second type of encoder information.

10. A centrifuge as in claim 1 further comprising an encoder disc providing both optical encoder information and magnetic encoder information.

11. A method comprising:

providing a motor;

integrating a first type of encoder into the motor;

integrating a second type of encoder into the motor;

determining rotational position of a rotating portion of the motor using the first type of encoder;

determining rotational velocity of the rotating portion of the motor using the second type of encoder;

wherein the first type of encoder and the second type of encoder are on the same detector and wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

coupling the motor to a centrifuge rotor with a perimeter;

placing the centrifuge rotor in a centrifuge housing;

using a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

using a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

12. ~~A~~ The method as in claim ~~1~~ 11 wherein the first type of encoder provides optical encoder information.

13. ~~A~~ The method as in claim ~~1~~ 11 wherein the first type of encoder provides magnetic encoder information.

14. ~~A~~ The method as in claim ~~1~~ 11 wherein the first type of encoder provides Hall-effect encoder information.

15. ~~A~~ The method as in claim ~~1~~ 11 the first type of encoder and the second type of encoder provide different types of encoder information.

16. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge rotor with a perimeter defined by a first portion comprising a thermally insulating material;

a second portion comprising a thermally conductive material;

wherein containers are arranged such that the containers are located in areas with the thermally insulating material;

wherein the thermally conductive material is configured to channel heat in a direction leading away from the containers;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge rotor, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge rotor, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

17. A compact high speed centrifuge for use with sample containers that are located in areas with reduced thermal exposure, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

an active cooling unit for minimizing heat transfer to the sample;

~~wherein containers are arranged such that the containers are located in areas with reduced thermal exposure;~~

said active cooling unit configured to cool the drive mechanism;

wherein stator is located coaxially within a rotor of a motor in the drive mechanism;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

18. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body; ~~and~~

a position detector for use in determining rotational position of the centrifuge body;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

19. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body; ~~and~~

autobalancing weights coupled to the centrifuge body, wherein such weights are configured to move under centrifugal force to a location to minimize off-balance rotation of the centrifuge body with uneven amounts of load in sample holders of the centrifuge;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

20. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body; ~~and~~

at least one air bearing configured to operably support the centrifuge;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

21. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body; ~~and~~

at least one air bearing configured to operably support the centrifuge, wherein at least a portion of the air bearing is a part of the centrifuge housing;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

22. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

a force detector configured to detect rate changes in force outside a range of pre-determined force conditions;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

23. The ~~device~~ compact high speed centrifuge of any one of ~~the foregoing~~ claims 1-10 or 16, ~~wherein the~~ the centrifuge further comprising centrifuge vessel holders that are configured to pivot inward toward a center axis of the centrifuge rotor under centrifugal force.

24. The ~~device~~ compact high speed centrifuge of any one of ~~the foregoing~~ claims 1-10 or 16, ~~wherein the~~the centrifuge further comprising centrifuge vessel holders that are configured to form a flush surface with a rotor body to minimize aerodynamic drag.

25. The ~~device~~ compact high speed centrifuge of any one of ~~the foregoing~~ claims 1-10 or 16, ~~wherein the~~the centrifuge further comprising a centrifuge vessel holder ~~is~~ configured to retract downward under centrifugal force.

26. The ~~device~~ compact high speed centrifuge of any one of ~~the foregoing~~ claims 1-10 or 16-22, ~~wherein~~ further comprising electrical connections that are not disrupted to centrifuge body cooling elements, even if such elements are in motion during centrifuge operation.

27. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body, wherein said centrifuge body extends downward to cover at least a portion of the drive mechanism;

wherein the drive mechanism comprises a stator and a rotor;

wherein the rotor is concentric about the stator;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

28. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body, wherein said centrifuge body extends downward to cover at least a portion of the drive mechanism;

wherein the drive mechanism comprises a stator and a rotor;

wherein the stator is concentric about the rotor;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

29. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

one or more swing holders on the centrifuge body for containing a centrifuge vessel;

wherein a maximum dimension of the swing holders or the sample containers does not exceed about 10mm;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

30. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

one or more swing holders on the centrifuge body for containing a centrifuge vessel;

wherein the swing holders, during centrifuge operation, move from a first orientation to a second orientation more horizontal than the first orientation;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

31. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

one or more swing holders on the centrifuge body for containing a centrifuge vessel;

wherein width of the sample container is greater than a length of the sample container;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.

32. A compact high speed centrifuge for use with sample containers, the centrifuge comprising:

a centrifuge housing;

a centrifuge body having a perimeter;

a drive mechanism for rotating said centrifuge body;

a detector integrated with a motor of the centrifuge wherein the detector has a first surface for detecting a first type of encoder information and a second surface for detecting a second type of encoder information different from the first type of encoder information;

a first air bearing configured to operably support an underside surface of the centrifuge body, wherein at least a portion of the first air bearing is defined by the centrifuge housing; and

a second air bearing configured to operably support an lateral surface of the centrifuge body, wherein at least a portion of the second air bearing is defined by the centrifuge housing.