CLAIMS

1. A wearable breast pump system including:

(a) a housing that encloses a rechargeable battery and a closed loop air pump and has a front surface that is shaped, in use, at least in part to fit inside a bra and to contact an inner surface of the bra;

(b) a breast shield including (i) a flange shaped to fit comfortably against a breast and (ii) a substantially transparent or optically clear, protruding nipple tunnel, shaped to receive a nipple, with a closed end and a milk opening through which, in use, expressed milk flows under gravity, providing to the mother placing the breast shield onto her breast a clear and unobstructed view of the nipple when positioned inside the nipple tunnel, to facilitate correct nipple alignment; and where the flange and the nipple tunnel are a single, integral item with no joining stubs, and the breast shield is insertable against, and removable from, a rear surface of the housing;

(c) a flexible diaphragm that is seated against a diaphragm holder that is formed as a recess in the rear surface of the housing, the flexible diaphragm flexing in response to changes in air pressure caused by the closed loop air-pump to create negative air pressure in the nipple tunnel;

(d) a rigid, re-useable milk container made of substantially transparent or optically clear material, and configured to be attachable to and removable from the housing.

2. The wearable breast pump of Claim 1 in which the diaphragm is a flexible generally planar diaphragm.

3. The wearable breast pump of Claim 1 or 2 in which the nipple tunnel is shaped to guide the breast shield and the casing of the housing into engagement.

4. The wearable breast pump of any preceding Claim in which the breast shield is, in use, configured to be adjusted by a user until correct nipple alignment is achieved and the flexible diaphragm is oriented uppermost with respect to the breast shield.

5. The wearable breast pump of any preceding Claim in which the flange and nipple tunnel are configured to be rotated by a user until the flexible diaphragm is uppermost; and the flexible diaphragm is configured to be locked in position between two opposing diaphragm holders, one being formed as a recess in the rear surface of the housing, only once the breast shield is fully slid into an aperture or recess in the housing with a sliding action.

6. The wearable breast pump system of any preceding Claim in which the milk container attaches to the housing using magnets.

7. The wearable breast pump system of any preceding Claim in which the milk container includes a pouring spout for pouring milk and a teat is attachable to the pouring spout.

8. The wearable breast pump system of any preceding Claim in which the milk container includes a flexible pouring spout that self-seals against an aperture in the nipple tunnel through which milk flows in use.

9. The wearable breast pump system of any preceding Claim in which the milk container includes a flexible valve that self-seals against an aperture in the nipple tunnel through which milk flows in use.

10. The wearable breast pump system of any preceding Claim in which a portion of the milk container forms part of the rear surface of the breast pump system that contacts in use the mother's skin.

11. The wearable breast pump system of any preceding Claim in which the lower surface of the milk container is flat and provides a base that enables the entire system to stand upright.

12. The wearable breast pump system of any preceding Claim in which the breast shield is a single moulding that presents in use a single continuous surface to the nipple and breast.

13. The wearable breast pump system of any preceding Claim in which the breast shield is configured to attach to the housing with a single, sliding push action and to latch against the housing using magnets.

14. The wearable breast pump system of any preceding Claim in which the housing is configured to slide onto the breast shield, when the breast shield has been placed onto a breast, using guide members.

15. The wearable breast pump system of any preceding Claim in which the nipple tunnel

includes visual guide lines that define the correct spacing of the nipple from the side walls of the nipple tunnel.

16. The wearable breast pump system of any preceding Claim in which the breast shield is a single moulding that includes (a) a nipple tunnel configured to receive a nipple and (b) a flange to rest against the breast, and presents in use a single continuous surface to the breast and nipple.

17. The wearable breast pump system of any preceding Claim in which the breast shield is a single moulding that presents in use a single continuous surface to the breast and nipple and covers at least some of the milk container that in use faces the breast.

18. The wearable breast pump system of any preceding Claim in which the flexible diaphragm self-seals against the diaphragm holder.

19. The wearable breast pump system of any preceding Claim in which the air-pump is fitted in the housing and forms part of a closed loop system that drives the flexible diaphragm to generate negative pressure, that diaphragm not being mounted on any side or surface of the breast shield flange but instead being mounted on a diaphragm holder that is itself distanced from, or positioned away from, the side or surface of the breast shield flange.

20. The wearable breast pump system of any preceding Claim in which the breast shield is a single moulding that includes (a) a nipple tunnel configured to receive a nipple and (b) a flange to rest against the breast, and the diaphragm holder is spaced apart from the breast shield and positioned so that the diaphragm does not at least partially surround the nipple tunnel.

21. The wearable breast pump system of any preceding Claim in which the diaphragm is arranged on a holder that is positioned a distance from, or away from, the milk opening and not on any side of this opening.

22. The wearable breast pump system of any preceding Claim in which the diaphragm is a generally circular, flexible membrane.

23. The wearable breast pump system of any preceding Claim in which the housing includes a piezo air-pump system fitted in the housing and forming part of a closed loop system that

drives the flexible diaphragm, which is located at a distance from the air-pump and is not part of the air-pump, to generate negative air pressure in the nipple tunnel.

24. The wearable breast pump system of Claim 23 in which the piezo air-pump system comprises two series or parallel connected piezo air-pumps.

25. The wearable breast pump system of Claim 23 or 24 in which the piezo air-pump system produces no more than 30dB at maximum power.

26. The wearable breast pump system of Claim 23 - 25 in which the piezo air-pump system is a lightweight air pump that enables the total weight of the system, unfilled with milk, to be less than 250gm.

27. The wearable breast pump system of Claim 23- 26 in which the piezo air-pump system is a lightweight air pump system that enables the centre of gravity of the breast pump system to be, when the milk container is empty, substantially at or below (i) the half-way height line of the housing measured from the base, including the milk container, or (ii) the horizontal line that passes through the nipple tunnel or filling point on a breast shield, so that the breast pump system is not top-heavy for a woman using the breast pump system.

28. The wearable breast pump system of any preceding Claim in which the housing includes a visual and/or haptic indicator that indicates whether milk is flowing or not flowing into the milk container and in which the haptic and/or visual indicator automatically indicates if the pumping mechanism is operating correctly to pump milk, based on whether the quantity and/or the height of the liquid in the container above its base is increasing above a threshold rate of increase.

29. The wearable breast pump system of any preceding Claim in which the housing including a sensor, such as an accelerometer, that measures or determines the movement and/or tilt angle of the housing to detect spillage risk conditions, during a pumping session and automatically affects or adjusts the operation of the system depending on the output of the sensor if a spillage risk condition is detected.

30. The wearable breast pump system of any preceding Claim in which the housing includes at least one light emitter, configured to direct radiation towards the surface of the milk; and at least

one light detector, configured to detect reflected radiation from the surface of the milk; wherein the light emitters and detectors operate as part of a sub-system that measures the height of, or infers the quantity of, the milk in the container.

31. The wearable breast pump system of any preceding Claim, which includes only two parts that are directly removable from the housing in normal use or normal dis-assembly: the breast shield and a rigid, non-collapsible milk container.

32. The wearable breast pump system of any preceding Claim, including a control interface that the user selects to indicate or record if milk is being expressed from the left or the right breast.

33. The wearable breast pump system of any preceding Claim, including (i) an air pressure sensor configured to measure the negative pressure and (ii) a measurement sub-system that measures or infers milk flow or milk volume.