CLAIMS

1. A refrigerated display unit, comprising:

an open-fronted cabinet containing a product display space accessible through an access opening defined by the open front;

a cooling means for introducing or producing cold air to refrigerate items in the product display space in use;

at least one forwardly-positioned discharge outlet communicating with a supply duct for, in use, projecting cold air as an air curtain across the access opening; and

at least one forwardly-positioned return inlet communicating with a return duct for, in use, receiving air from the air curtain;

wherein the air curtain is substantially unsupported by any supplementary cooling airflow supplied into the product display space separately from the air curtain.

2. The unit of Claim 1, wherein the mass flow rate of any supplementary cooling airflow is less then 5% of the mass flow rate of the cold air projected from the discharge outlet to form the air curtain.

3. The unit of Claim 1 or Claim 2, wherein substantially no supplementary cooling airflow is supplied into the product display space.

4. The unit of Claim 1 or Claim 2, wherein any supplementary cooling airflow is supplied into the product display space substantially only at a location spaced between the access opening and a back inner panel of the product display space.

5. The unit of Claim 4, wherein supplementary cooling airflow is supplied in the region of a side inner panel of the product display space.

6. The unit of Claim 5, wherein supplementary cooling airflow is supplied from a shelf in the cabinet.

7. The unit of any preceding claim, wherein the supply duct and the return duct together extend around the product display space to define a recirculation path between the return inlet and the discharge outlet.

8. The unit of Claim 7, wherein the supply duct and the return duct lie behind inner panels that define the product display space, to provide supplementary cooling to the product display space by cooling the inner panels.

9. The unit of Claim 8, wherein at least one inner panel is at least partially insulated, heated or of low conductivity to reduce local supplementary cooling to the product display space.

10. The unit of Claim 7 or Claim 8, wherein the cooling means comprises a cooling matrix in a duct behind an inner panel.

11. The unit of any of Claims 1 to 9, wherein the cooling means comprises a cooling matrix vertically spaced from the product storage space and cold air is ducted vertically from the cooling matrix to the discharge outlet.

12. The unit of any of Claims 1 to 9, wherein the cooling means comprises a cooling matrix remote from the unit and cold air is ducted to the unit.

13. The unit of any preceding claim, wherein the air curtain is spaced forwardly from the product display space by at least 20mm.

14. The unit of any preceding claim, wherein a plenum is above the discharge outlet and communicates with the supply duct at a level above a discharge face of the discharge outlet.

15. The unit of Claim 14, wherein a plenum is below the return inlet and communicates with the return duct at a level below an intake face of the return inlet.

16. The unit of any preceding claim and comprising at least one finisher extending laterally in front of the discharge outlet and/or the return inlet, the or each finisher being insulated, heated, of low-conductivity material and/or with a low-emissivity finish.

17. The unit of Claim 16, wherein a finisher supports lighting directed toward the product display space.

18. The unit of Claim 16 or Claim 17, wherein at least one finisher influences airflow discharged from the discharge outlet or received by the return inlet.

19. The unit of Claim 18, wherein a finisher in front of the discharge outlet has a lower edge that lies below a discharge face of the discharge outlet.

20. The unit of Claim 18 or Claim 19, wherein a finisher in front of the return inlet has an upper portion that extends above an intake face of the return inlet.

21. The unit of Claim 20, wherein the upper portion of that finisher is inclined upwardly and forwardly away from the product display space.

22. The unit of Claim 20 or Claim 21, and having an upstanding riser on a rear side of the return inlet.

23. The unit of Claim 22, wherein the riser and the opposed upper portion of the finisher cooperate to channel air from the air curtain into the return inlet.

24. The unit of Claim 20, wherein the upper portion of that finisher is inclined upwardly and rearwardly toward the product display space.

25. The unit of any preceding claim, wherein an intake face of the return inlet faces rearwardly.

26. The unit of Claim 25, wherein the intake face of the return inlet is inclined to face upwardly and rearwardly.

27. The unit of any preceding claim, wherein the width of the discharge outlet in a forward/rearward direction is 10mm to 200mm.

28. The unit of Claim 27, wherein the width of the discharge outlet is 10mm to 200mm, or 20mm to 150mm, or 50mm to 150mm, or 50mm to 100mm, or 70mm to 100mm

29. The unit of any preceding claim, wherein the width of the return inlet is less than the width of the discharge outlet in a forward/rearward direction.

30. The unit of Claim 29, wherein the width of the return inlet is greater than two-thirds of the width of the discharge outlet in a forward/rearward direction.

31. The unit of any preceding claim, wherein the bulk mean discharge air velocity through the discharge outlet is 0.1 m/s to 2.0 m/s, or 0.1m/s to 1.5m/s, or 0.3 m/s to 1.5m/s, or 0.3 m/s to 1.0 m/s, or 0.4 m/s to 0.8 m/s, or 0.5 m/s to 0.8 m/s.

32. The unit of any preceding claim, wherein the height of the access opening between the discharge outlet and the return inlet is 100mm to 1000mm, or 150mm to 800mm, or 200mm to 800mm, or 200mm to 600mm, or 350mm to 600mm.

33. The unit of any preceding claim, wherein a ratio between the height of the access opening between the discharge outlet and the return inlet and the width of the discharge outlet in a forward/rearward direction is less than 20, or 2 to 12, or 5 to 8.

34. The unit of any preceding claim, wherein a storage temperature in the product display space is –26K to 18K, or –22K to 12K, or –18K to 8K.

35. The unit of any preceding claim, wherein ambient temperature is 4K to 44K, or 10K to 36K, or 18K to 28K.

36. The unit of any preceding claim, and being adapted to generate a velocity profile that varies across the thickness of the air curtain, with faster airflow on the side of the curtain facing the product display space.

37. The unit of any preceding claim, wherein the air curtain is discharged in a direction within +30° and -30° of a straight line connecting the discharge outlet and the return inlet.

38. The unit of Claim 37, wherein the discharge direction is substantially aligned with said straight line.

39. The unit of Claim 38, wherein the DAG is substantially directly over the RAG and the discharge direction is vertically downward.

40. The unit of any preceding claim, further comprising upright finishers that are disposed in front of the air curtain along sides of the air curtain and extend inwardly across the access opening.

41. The unit of any preceding claim, further comprising a differential pressure sensor arranged to compare pressures in the supply and return duct; and a controller responsive to a signal from the sensor to control the unit in accordance with the signal to modify relative pressures in the ducts.

42. The unit of any preceding claim, and comprising:

an open-fronted cabinet defining a cold-storage volume; and

at least one shelf disposed in the cold-storage volume for supporting refrigerated items in use;

wherein the shelf defines an upper access opening above the shelf and a lower access opening below the shelf affording access to refrigerated items in respective product display spaces in the cold-storage volume above and below the shelf, and the shelf has:

at least one forwardly-positioned discharge outlet communicating with a supply duct for, in use, projecting cold air as an air curtain across the lower access opening; and

at least one forwardly-positioned return inlet communicating with a return duct for, in use, receiving air from another air curtain discharged above the shelf across the upper access opening.

43. The unit of any preceding claim, wherein a plurality of shelves are disposed within the cabinet, each shelf having respective associated upper and lower access openings and a respective discharge outlet and return inlet being associated with each shelf.

44. The unit of Claim 42 or Claim 43, wherein the shelves are arranged in a vertical array.

45. The unit of Claim 44, wherein a plurality of vertical arrays of shelves are arranged into side-by-side columns.

46. The unit of Claim 45, and comprising at least one partition between shelves of adjacent columns.

47. The unit of Claim 46, wherein the partition is of variable height.

48. The unit of Claim 46 or Claim 47, wherein at least a front edge of the partition is insulated, heated, of low-conductivity material and/or with a low-emissivity finish.

49. The unit of any of Claims 42 to 48, wherein the cold-storage volume is bounded by at least one upright wall, wherein a supply duct and/or a return duct for the supply and/or return of air communicate with a plurality of ports spaced on the upright wall, and wherein the or each shelf is selectively locatable in the cold-storage volume at different positions on the upright wall and has a supply channel leading to a discharge outlet and/or a return channel leading from a return inlet, the supply channel and/or the return channel terminating in a coupling formation co-operable with at least one of the ports of the upright wall for communication with the supply duct and/or the return duct.

50. The unit of any of Claims 42 to 49, wherein the or each shelf is bounded to the sides by at least one partition and/or by at least one side wall of the cabinet, and wherein the partition or side wall extends forwardly beyond the shelf.

51. The unit of Claim 50, wherein a finisher that is insulated, heated, of low-conductivity material and/or with a low-emissivity finish on front of the shelf extends from the partition or side wall on one side of the shelf to the partition or side wall on the other side of the shelf.

52. The unit of any preceding claim, wherein the direction of airflow in the or each air curtain is substantially parallel to the open front of the cabinet.

53. The unit of any preceding claim, wherein the cooling means is at least partially accommodated in a void in a base of the cabinet.

54. The unit of any preceding claim, wherein the cabinet defines a rear airflow void for ducting supply and/or return airflow substantially vertically from or to the cooling means.

55. The unit of Claim 54, wherein supply and return airflow ducts are laterally offset from each other in the rear airflow void.

56. The unit of any preceding claim, wherein the cooling means comprises a fan coil unit.

57. A refrigerated display unit comprising:

an open-fronted cabinet defining a cold-storage volume;

a cooling means for introducing or producing cold air to refrigerate items in the cold-storage volume in use; and

a plurality of shelves disposed in the cold-storage volume for supporting refrigerated items in use, the shelves being arranged in side-by-side columns;

wherein each shelf defines an upper access opening above the shelf and a lower access opening below the shelf affording access to refrigerated items in respective product display spaces in the cold-storage volume above and below the shelf, and each shelf has:

at least one forwardly-positioned discharge outlet communicating with a supply duct for, in use, projecting cold air as an air curtain across the lower access opening; and

at least one forwardly-positioned return inlet communicating with a return duct for, in use, receiving air from another air curtain discharged above the shelf across the upper access opening.

58. The unit of Claim 57, wherein at least one shelf is adjustable in height.

59. The unit of Claim 57 or Claim 58, wherein at least one partition is between the shelves of side-by-side columns.

60. The unit of any of Claims 57 to 59, wherein the cold-storage volume is bounded by at least one upright wall, wherein a supply duct and/or a return duct for the supply and/or return of air communicate with a plurality of ports spaced on the upright wall, and wherein at least one shelf is selectively locatable in the cold-storage volume at different positions on the upright wall and has a supply channel leading to a discharge outlet and/or a return channel leading from a return inlet, the supply channel and/or the return channel terminating in a coupling formation co-operable with at least one of the ports of the upright wall for communication with the supply duct and/or the return duct.

61. A refrigerated display unit, comprising:

an open-fronted cabinet defining a product display space bounded by at least one upright wall;

a cooling means for introducing or producing cold air to refrigerate items in the product display space in use;

at least one shelf for, in use, supporting refrigerated items to be displayed for viewing and access, the shelf being selectively locatable at different positions on the upright wall;

wherein the or each shelf has airflow supply and return channels connectable to supply and return ducts through ports spaced on the upright wall; and

at least one upright partition divides the cold-storage volume into two or more columns within which shelves can be moved vertically between selected positions.

CLAIMS

1. A refrigerated display unit, comprising:

an open-fronted cabinet containing a product display space accessible through an access opening defined by the open front;

a cooling means for introducing or producing cold air to refrigerate items in the product display space in use;

at least one forwardly-positioned discharge outlet communicating with a supply duct for, in use, projecting cold air with a discharge velocity as an air curtain across the access opening, which discharge outlet has an effective width that determines air curtain thickness; and

at least one forwardly-positioned return inlet communicating with a return duct for, in use, receiving air from the air curtain, such that spacing between the discharge outlet and the return inlet determines air curtain height;

in which the discharge velocity, as measured at a point 25 mm below the discharge outlet, is between 0.1 m/s and 1.5 m/s;

air curtain height is less than ten times the air curtain thickness;

the air curtain is substantially unsupported by any supplementary cooling airflow supplied into the product display space separately from the air curtain.

2. A unit according to Claim 1, in which the mass flow rate of any supplementary cooling airflow is less than 5% of the mass flow rate of the cold air projected from the discharge outlet to form the air curtain.

3. A unit according to Claim 1 or Claim 2, in which substantially no supplementary cooling airflow is supplied into the product display space.

4. A unit according to Claim 1 or Claim 2, in which any supplementary cooling airflow is supplied into the product display space substantially only at a location spaced between the access opening and a back inner panel of the product display space.

5. A unit according to Claim 4, in which supplementary cooling airflow is supplied in the region of a side inner panel of the product display space.

6. A unit according to Claim 5, in which supplementary cooling airflow is supplied from a shelf in the cabinet.

7. A unit according to any preceding claim, in which the supply duct and the return duct together extend around the product display space to define a recirculation path between the return inlet and the discharge outlet.

8. A unit according to Claim 7, in which the supply duct and the return duct lie behind inner panels that define the product display space, to provide supplementary cooling to the product display space by cooling the inner panels.

9. A unit according to Claim 8, in which at least one inner panel is at least partially insulated, heated or of low conductivity to reduce local supplementary cooling to the product display space.

10. A unit according to any preceding claim and comprising at least one finisher extending laterally in front of the discharge outlet and/or the return inlet, the or each finisher being insulated, heated, of low-conductivity material and/or with a low-emissivity finish.

11. A unit according to Claim 10, in which at least one finisher influences airflow discharged from the discharge outlet or received by the return inlet.

12. A unit according to Claim 11, in which a finisher in front of the discharge outlet has a lower edge that lies below a discharge face of the discharge outlet.

13. A unit according to Claim 11 or Claim 12, in which a finisher in front of the return inlet has an upper portion that extends above an intake face of the return inlet.

14. A unit according to Claim 13, in which the upper portion of that finisher is inclined upwardly and forwardly away from the product display space.

15. A unit according to Claim 13 or Claim 14, and having an upstanding riser on a rear side of the return inlet.

16. A unit according to Claim 15, in which the riser and the opposed upper portion of the finisher cooperate to channel air from the air curtain into the return inlet.

17. A unit according to Claim 14, in which the upper portion of that finisher is inclined upwardly and rearwardly toward the product display space.

18. A unit according to any preceding claim, and being adapted to generate a velocity profile that varies across the thickness of the air curtain, with faster airflow on the side of the curtain facing the product display space.

19. A unit according to any preceding claim, further comprising upright finishers that are disposed in front of the air curtain along sides of the air curtain and extend inwardly across the access opening.

20. A unit according to any preceding claim, further comprising a differential pressure sensor arranged to compare pressures in the supply and return duct; and a controller responsive to a signal from the sensor to control the unit in accordance with the signal to modify relative pressures in the ducts.

21. A unit according to any preceding claim, and comprising:

an open-fronted cabinet defining a cold-storage volume; and

at least one shelf disposed in the cold-storage volume for supporting refrigerated items in use;

in which the shelf defines an upper access opening above the shelf and a lower access opening below the shelf affording access to refrigerated items in respective product display spaces in the cold-storage volume above and below the shelf, and the shelf has:

at least one forwardly-positioned discharge outlet communicating with a supply duct for, in use, projecting cold air as an air curtain across the lower access opening; and

at least one forwardly-positioned return inlet communicating with a return duct for, in use, receiving air from another air curtain discharged above the shelf across the upper access opening.

22. A unit according to Claim 21, in which a plurality of vertical arrays of shelves are arranged into side-by-side columns.

23. A unit according to Claim 22, and comprising at least one partition between shelves of adjacent columns.

24. A unit according to Claim 23, in which at least a front edge of the partition is insulated, heated, of low-conductivity material and/or with a low-emissivity finish.

25. A unit according to any of Claims 21 to 24, in which the or each shelf is bounded to the sides by at least one partition and/or by at least one side wall of the cabinet, and in which the partition or side wall extends forwardly beyond the shelf.

26. A unit according to Claim 25, in which a finisher that is insulated, heated, of low-conductivity material and/or with a low-emissivity finish on front of the shelf extends from the partition or side wall on one side of the shelf to the partition or side wall on the other side of the shelf.