additional heat exchangers and a variable speed pump to recover energy used to dehumidify that is not required to satisfy the dry bulb conditions of the conditioned space. Psychrometrically, the improved air conditioning system of the present invention provides controlled separation from the saturation curve.

The present invention provides, in one aspect, an air conditioning system, the air conditioning system being ~~that is~~ capable of treating a conditioned space by treating outdoor air from outside the conditioned space and return air from inside the conditioned space, and mixing the outdoor air with the return air to form supply air for the conditioned space, the air conditioning system including:

- an outdoor air latent cooling treatment stage configured to provide parallel airflow with a return air sensible cooling treatment stage, and
- a means for mixing outdoor air with return air to form conditioned space supply air,

wherein the outdoor air latent cooling treatment stage includes at least a dehumidification heat exchanger, combination pre-cooling and heat reclaim heat exchangers, and a heat transfer pump, and the return air sensible cooling treatment stage includes at least a sensible cooling heat exchanger, and
wherein the heat exchange medium for the sensible cooling heat exchanger is passed in series with the dehumidification heat exchanger.

The reference to "parallel airflow" above, and throughout this specification, is to be understood to mean that the two treatment stages are configured so that the latent cooling is conducted upon the outdoor air prior to it being mixed with treated return air(treated in the sense of the return air having undergone sensible cooling) - it does not similarly require that the sensible cooling be conducted upon the return air prior to it being mixed with treated outdoor air. Indeed, in one form of the present invention, it is envisaged that the treated outdoor air may be mixed with untreated return air, following which the sensible cooling may be conducted upon the mixed airflow (being the treated outdoor air and the untreated return air), to thereafter produce the conditioned space supply air. The reference to "parallel" is also of course not to be read as a geometric limitation related to the physical location or arrangement of any equipment utilised in the system of the present invention.

In a preferred form though, the configuration of the outdoor air latent cooling treatment stage and the return air sensible cooling treatment stage will be such that both treatments are conducted on their respective airflows prior to mixing, the mixing means thus being capable of mixing treated outdoor air with treated return air to form the conditioned space supply air.

~~We claim~~The claims defining the invention are as follows:

1. An air conditioning system, the air conditioning system being capable of treating a conditioned space by treating outdoor air from outside the conditioned space and return air from inside the conditioned space, and mixing the outdoor air with the return air to form supply air for the conditioned space, the air conditioning system including:

   - an outdoor air latent cooling treatment stage configured to provide parallel airflow with a return air sensible cooling treatment stage, and
   - a means for mixing outdoor air with return air to form conditioned space supply air,

   wherein the outdoor air latent cooling treatment stage includes at least a dehumidification heat exchanger, combination pre-cooling and heat reclaim heat exchangers, and a heat transfer pump, and the return air sensible cooling treatment stage includes at least a sensible cooling heat exchanger; and wherein the heat exchange medium for the sensible cooling heat exchanger is passed in series with the dehumidification heat exchanger.

2. An air conditioning system according to claim 1, wherein the configuration of the outdoor air latent cooling treatment stage and the return air sensible cooling treatment stage will be such that both treatments are conducted on their respective airflows prior to mixing, the mixing means thus being capable of mixing treated outdoor air with treated return air to form the conditioned space supply air.

~~3. An air conditioning system according to claim 1, wherein the heat exchange medium for the sensible cooling heat exchanger is passed in series with the dehumidification heat exchanger.~~

43. An air conditioning system according to claim 1, wherein the outdoor air latent cooling treatment stage includes at least a dehumidification heat exchanger, combination pre-cooling and heat reclaim heat exchangers, and a heat transfer pump to deliver a dehumidified air stream with variable dry bulb separation from the saturation curve.

54. An air conditioning system according to claim 1, which includes at least one variable return air bypass damper, a variable supply-air speed controller, and a variable return-air speed controller in order to satisfy multiple variable sensible load requirements to maintain a general conditioned space relative humidity requirement.

65. An air conditioning system according to claim 1, wherein the outdoor air latent cooling treatment stage includes three dehumidification heat exchangers that can satisfy low absolute humidity requirements with the use of two primary cold generators, a heat reclaim heat exchanger to shift energy from the low absolute dehumidification process to the pre-cooling, and a heat reclaim heat exchanger to reheat, when necessary, from either of the cold generators' heat of rejection condenser water systems.

76. An air conditioning system according to claim 65, wherein the flow temperature of each cold generator is modulated to minimize energy consumption.

87. An air conditioning system according to claim 1, wherein the system includes a first chilled water heat exchanger in the outdoor air stream to provide latent cooling to achieve upper limit humidity control, and a second chilled water heat exchanger in the return air stream to provide additional sensible cooling to satisfy conditioned space dry bulb conditions.

98. An air conditioning system according to claim 87, wherein the dehumidification sensible heat transfer stage includes two heat exchangers partnered to the outdoor air dehumidification heat exchanger to regulate the amount of sensible cooling provided as part of the dehumidification process.

109. An air conditioning system according to claim 87, wherein sensible cooling that is required to depress the outdoor air to achieve dehumidification is reclaimed by an additional heat exchanger and a circulating pump in a closed circuit and is transferred to the pre-cooling heat exchanger.

1110. An air conditioning system according to any one of claims 8-7to 109, wherein a control system manages the conditioned space conditions as follows:

- the outdoor air dehumidification heat exchanger provides the required latent cooling;

- the return air heat exchanger provides additional sensible cooling beyond that provided by the dehumidification process; and
- when the dehumidification process provides more sensible cooling than the conditioned space requires, the heat reclaim system transfers the surplus sensible cooling post dehumidification (saturation separation) to cooling required to initiate the dehumidification process.

~~12~~11. An air conditioning system according to claim 1, wherein variable volume boxes are used to satisfy the requirements for two or more thermal sensible zones in the conditioned space.

~~13~~12. An air conditioning system according to claim ~~12~~11, where, when the outdoor air has the ability to provide cooling to the conditioned space, additional outdoor air is regulated by the use of a bypass damper to satisfy the conditioned space load.

~~14~~13. An air conditioning system according to claim ~~13~~12, wherein a return air fan operating in response to conditioned space loads functions in conjunction with ~~a~~ the bypass damper to introduce additional return air and to maintain conditioned space conditions.

~~15~~14. An air conditioning system according to claim ~~14~~13, wherein ~~a~~ the return air fan operates to achieve a differential between the supply air and the return air that is equivalent to the minimum required minimum outdoor air quantity.

~~16~~15. An air conditioning system according to claim ~~15~~14, including multiple sub zones for the delivery of air to multiple variable air volume (VAV) boxes to manage the conditioned space, a control system manages the conditioned space conditions as follows:

- when the outdoor air dry bulb temperature and absolute humidity level are both less than the desired conditioned space condition, the quantity of outdoor air is varied to satisfy the conditioned space dry bulb conditions;
- the outdoor air dehumidification heat exchanger provides latent cooling to satisfy the general conditioned space requirements;
- when the outdoor air latent cooling treatment stage provides insufficient sensible cooling to satisfy the conditioned space sensible cooling

requirements, the return air fan is employed with the return air sensible cooling heat exchanger providing additional sensible cooling; and

- when the dehumidification process provides more sensible cooling than the conditioned space requires, the heat reclaim system transfers the surplus sensible cooling post dehumidification (saturation separation) to cooling required to initiate the dehumidification process.

~~17~~16. An air conditioning system according to claim 1, including chilled water as a primary heat exchange medium, brine as a secondary heat exchange medium, and a chilled water heat exchanger and a brine heat exchanger in the outdoor air stream to provide latent cooling to achieve upper limit humidity control.

~~18~~17. An air conditioning system according to claim ~~17~~16, including a further chilled water heat exchanger in the return air stream to provide additional sensible cooling to satisfy conditioned space dry bulb conditions.

~~19~~18. An air conditioning system according to claim ~~18~~17, wherein, where a low absolute humidity is required for the conditioned space, a control system manages the conditioned space conditions as follows:

- a first stage outdoor air dehumidification heat exchanger provides an initial dehumidification process to satisfy the conditioned space latent cooling requirements, utilising cold energy produced by a chilling plant with a high coefficient of performance;
- a second stage outdoor air dehumidification heat exchanger provides the final dehumidification process to satisfy the conditioned space latent cooling requirements, utilising cold energy produced by a chilling plant with a coefficient of performance less than the first stage dehumidification process chilling plant;
- a return air heat exchanger provides additional sensible cooling beyond that provided by the first and second stage dehumidification processes;
- when the dehumidification process provides more sensible cooling than the conditioned space requires, the heat reclaim system transfers the surplus sensible cooling post dehumidification (saturation separation) to cooling required to initiate the dehumidification process; and
- when the potential to reclaim heat is not sufficient, supplementary heating can be provided by a higher energy source, heat being

transferred from the heat of rejection (condenser water) of a refrigeration plant or from a conventional combustion fuel type system.

~~20~~19. An air conditioning system according to claim 1, substantially as herein described in relation to the accompanying drawings.