[0005] Each VAV box 11 controls a smaller area or group of offices within a floor as illustrated in Fig. 1A. As a result, it is not uncommon for a commercial building with approximately 30,000 square feet to require the installation of approximately 33 VAV boxes throughout the building floor. The purpose of each individual VAV box is to provide air conditioning, heating and ventilation and control to a small area of rooms (typically 1-6 rooms) or for example the four rooms 27, 29, 31 and 33 in Fig. 2A, each of which is supplied with air through a separate drop down damper 27a, 29a, 31a and 33a in Fig. 1. Temperature for each of the rooms is first controlled by a thermostat T which is located in master room 29 which primarily controls the temperature in slave rooms 27, 31 and 33. This prior art also requires an initial air balancing so that the temperature in master room 29 more or less corresponds to the temperature in slave rooms 27, 31 and 33 by adjusting the air flow from a separate duct with each damper 39, 41, 43 and 45. After the air balancer or technician has completed the air balancing work the temperature of slave rooms 27, 31 and 33 are controlled by thermostat T in master room 29. Thermostat T primarily controls the position of damper 19 in VAV box 11 to control temperature as shown in Fig. 1.

[0006] The prior art also includes VAV boxes with a single air handler (AH) inlet and multiple outlets to control temperature in different zones of a building. Examples of such prior art include Federspiel, et al. U.S. Patent 8,688,243, Ring U.S. Patent 4,917,174 and Ginn, et al. U.S. Patent 3,934,795 each of which have multiple outlets with dampers, separate reheat coils and separate cooling coils for each outlet. The reheat coils in one of the separate ducts in the VAV are connected by a separate heating duct to a drop down register while the separate cooling coils in

not provided, heat is only achieved by not cooling (closing the air volume to its minimum setting and allowing the internal space temperature load and residual heating from exterior spaces to slowly heat the space. This traditional VAV system design while relatively inexpensive, has many drawbacks which are as follows:

[0012] 1. VAV boxes do not provide individual room control unless an individual VAV box is provided for each room served. This invention solves the prior art inefficiency by replacing the manual balancing damper with an automated space control damper. By using this invention, a single hybrid VAV box with at least two air outlets can now provide individual room control without the expense of adding more VAV boxes. By adding more than one reheat coil to the hybrid VAV box and optionally a reheat coil for each outlet, each area served from the hybrid VAV box can have autonomous control from another served from the same VAV box.

[0013] 2. When a VAV box serves multiple offices and there is only one area occupied, the typical VAV has no ability to isolate (shut off) the unoccupied areas.

[0014] 3. Installation of each VAV box is expensive. This new design typically reduces the overall VAV count by 2/3. Using fewer, but larger VAV boxes with multiple outlets and re-heat coils served by a single set of balancing and isolation valves significantly reduces the cost of a building's mechanical infrastructure.

[0015] 4. Prior art VAV's use a central physical thermostat to control temperature by controlling the damper position in the VAV. The invention allows for each room to have either a physical or virtual thermostat (via a smartphone) which can be connected to the internet of things with many unique features that physical thermostats cannot provide.

[0016] 5. The new hybrid VAV allows for interior and exterior area's to be served by the same multi-coil VAV having a plurality of outlets. This makes for a more flexible overall system design, allowing easier and simpler floor alterations in the future.

[0032] FIG. 1 is a perspective view of a prior art VAV with single ducting to drop down dampers;

[0033] FIG. 1A is a perspective view of a partially cut away and exploded prior art VAV box;

[0034] FIG. 2 is a perspective prior art view of a typical heating plan using prior art VAV boxes;

[0035] FIG. 2A is a perspective view of a portion of a prior art heating plan;

[0036] FIG. 3 is a perspective prior art comparative heating plan illustrating the number and layout of prior art VAV boxes required to provide the advantages of the novel hybrid VAV and system of Fig. 6;

[0037] FIG. 4A is a perspective partially cut away view of a novel hybrid VAV with one inlet and two outlets with heater coils;

[0037A] Fig. 4A1 is a perspective partially cut away view identical to Fig. 4A except for the absence of the optional damper;

[0038] FIG. 4B is a perspective top removed view of a novel hybrid VAV with one inlet and three outlets;

[0039] FIG. 4C is a perspective top removed view of a novel hybrid VAV with one inlet and four outlets;

[0040] FIG. 4D is a perspective top removed view of a novel polygonal hybrid VAV with one inlet and five outlets;

[0041] FIG. 4E is a perspective top removed view of a novel circular hybrid VAV with one inlet and six outlets;

the invention. The following detailed description including best mode is not to be taken in a limiting sense, since the scope of the invention is defined in the appended claims.

[0072] In certain embodiments of the invention, the novel hybrid variable air volume terminal system comprises one or more of the following components alone or in combination: (1) a hybrid VAV Box with or without a sub plenum; (2) Dual heating coils; (3) First air distribution duct or a plurality of distribution ducts; (4) Second air distribution duct; (5) Room control dampers for the first duct; and (6) Room control dampers and preferably automated space control dampers (ASCD) for the second duct.

[0073] Referring now to FIG. 4A a novel hybrid VAV 10 is illustrated having an inlet duct 12 and two outlet ducts 14 and 16. An air velocity flow sensor 18 is provided at the inlet along with an optional damper 20. The novel hybrid VAV 10 differs from prior art VAV box 11 (FIG. 1A) in having an optional damper 20 that is not adjusted to control temperature of air leaving hybrid VAV box 10. Fig. 4A1 illustrates the hybrid VAV 10 without the optional damper 20. The temperature of the conditioned air leaving hybrid VAV box is determined not by damper 20 but instead by an automated space control damper ASCD 40A – Fig. 6A and heating coils 22A and 22B. Heating coils 22A and 22B can be either water heating coils or electric heating coils with water the preferred implementation. A heating coil actuator with sensor 24, 26 is provided for each of the outlets, 14 and 16 respectively of the novel VAV 10.

[0074] Hybrid VAV 10 includes a sub plenum 30 disposed between the plurality of outlets and a terminal wall 36 opposite inlet 12 to equalize air flow and reduce noise. The size of the sub plenum is approximately 10% to 20% of the interior space of the

balance); (5) hybrid VAV box static pressure setpoint calibration (created during balance); (6) Automated hybrid VAV two point CFM calibration to precision flow hood; and (7) Automated balance report.

[0084] The novel hybrid and ASCD combination not only provides for a dynamic balancing but also provides a database as illustrated in FIG. 19-23 for periodic rebalancing as well as for comfort index for each area zone or room served by an ASCD damper 40A-40F as illustrated in FIG. 10. Each area 1-6 is provided with a desired temperature setting by changing airflow through each ASCD damper which are set from between 15% to 55% to provide a comfort index of 100% in areas 1-3 and around 99.7 in area 4 and 99.2% in area 5 and 99.4% in area 6 with all areas being occupied.

[0085] Referring now to FIG. 7 each ASCD damper 40A to 40G can be set remotely by either a physical thermostat T in the area room or zone as well as by a communication device such as a smart tablet or cellphone connected to the IoT. In certain embodiments the comfort provided by the ASCD may be augmented by the addition of a separate portable plug in heater cartridge 62 as illustrated in FIG. 6B.

[0086] The advantages of the embodiments are further enhanced with an energy saving building management system BMS as illustrated in FIGs. 11 and 12 and as described in FIGs. 31-40. In the energy saving embodiment occupancy sensors may be provided or connected to a light switch or an entry exit card system. As illustrated in FIG. 11 the energy saving embodiment may be achieved by maintaining offices at the most efficient temperature for a particular area for example 68 to 70 ºF or 20 to 25 ºC and then activating service for an individual