effective temperature difference of 15 F is being maintained at the maximum room sensible heat load, this temperature difference must be reduced by means of heating to 7.5 F at half of the sensible heat load. The room sensible heat usually is about 35 to 45 per cent of the total cooling load and thus the penalty imposed on the refrigeration cycle is not extremely large. When the outdoor wet-bulb temperature is less than the desired room wet-bulb temperature, all outdoor air should be passed through the conditioner and under these circumstances reheating does not impose a load on the refrigeration cycle since the heated air is not returned to the conditioner. Further, where the volume of outdoor air introduced to the system, which for all practical purposes is wasted after its work has been done, is sufficiently large in relation to the amount of reheat used (that is, if the heat required does not exceed that necessary to raise the outdoor air only from dew-point to room temperature) the use of reheat does not impose a load on the refrigeration cycle. This, of course, assumes that there is no economic penalty involved in the use of heat itself.

One of the best applications of reheating for summer purposes is in combination with other means of temperature control for the purpose of levelling off accentuated demands for temperature control. As an example, the by-pass can be applied to a certain extent, or the volume of supply air throttled to a limited degree, or both of these used in sequence, and reheating can be used as the final step in temperature control.

In the foregoing it has been assumed that summer reheating is derived from an extraneous source of heat such as steam, electric heaters or hot water. The economics of reheating as outlined may be improved by the use of sources of heat that are available within the equipment used.

Where certain types of refrigeration cycles are used, auxiliary refrigerant condensing coils can be placed in the air stream. At partial loads these can be used as additional refrigerant condensing surface and improve the performance of the refrigeration plant. This is generally known as hot gas reheating. Less effective is the use of coils in the air stream through which liquid refrigerant from the condenser is passed before being delivered to the evaporator, sub-cooling the liquid refrigerant and improving the performance of the refrigeration cycle. The use of refrigeration condenser water as a source of reheating provides definite economies. If the condenser water is passed through coils in the air stream before being used for refrigerant condensing purposes, the lowering of the condenser water temperature accomplished by reheating the air will result in savings in the refrigeration plant power consumption and increased refrigeration capacity. The latter two methods usually are at some disadvantage in that the amount of reheat available decreases as the need for reheating increases, particularly where evaporative condensers or cooling towers are used.

Zoning

Zoning consists of an arrangement of equipment or a division of equipment into sections that will permit individual control of the temperature and humidity of those spaces or groups of spaces that do not have simultaneous variations in sensible or latent heat load. The equipment is so arranged or divided that air can be supplied to spaces or groups of spaces

in accordance with the individual load requirements of that space or group of spaces.

Solar heat gain is one of the major causes of the zoning requirement since its effect and amount vary with the season, time of day and exposure. Other sources of heat gain, subject to variations, such as large changes in the number of occupants in one space with a constant occupancy in another indicate the necessity of zoning. Some of the various methods of zoning are:

1. Separate equipment.
2. Reheating or recooling. (See Figs. 4 and 5.)
3. Multiple fans with individual by-pass. (See Figs. 6 and 7.)
4. Volume control. (See Fig. 8.)
5. Dual duct system. (See Fig. 9.)
6. Combinations of the above methods.

Zoning by separate equipment represents the extreme in zoning. Individual conditioners, fans, heaters, controls, distributing duct work, etc., are provided for each zone and are separate from those of other zones. Each assembly of equipment is arranged to operate at full or partial load according to the requirements of that zone. In extreme cases an individual refrigeration plant may be provided for each zone. In general, this method of zoning is uneconomical since each piece of equipment is large enough to handle the full load requirements of that zone and no advantage can be taken of the fact that while one zone is at its full load others may be operating at considerably less than load capacity. This applies both to the initial cost of a system and the operating cost. There are, however, many cases where this method of zoning when used to a limited degree or combined with other methods is most desirable.

Zoning by reheat is one of the more simple methods of approaching the problem of differing variations in load. Reheating has been discussed in the foregoing. Heating coils located in the distributing duct work or apparatus connections which supply only those spaces having substantially the same load variations will, by adding heat when the cooling load falls off (or the reverse in the case of a heating load), maintain the desired temperature conditions. It has been shown previously that where the amount of reheating required is not excessive and that heat for this purpose is available from an economic standpoint this method of zoning may be entirely practical and even highly desirable.

Zoning by recooling is literally the reverse of zoning by reheating. It is not used often but there are many cases where it is desirable. Its most practical application is limited to a sensible heat removal function where the latent heat requirements are handled by another source such as a dehumidifier or dehydrator, and where the recooling equipment (usually cold water cooling coils) can be utilized for reheating (usually with hot water) in the heating season. In using this method of zoning, when the cooling load of a given space is reduced, the cooling effect produced by the recooler is also reduced.

The use of *multiple fans with individual by-passes* presents a simple and sometimes inexpensive method of zoning. Two or more fans may be arranged so that each draws its treated air from the same conditioner.