possible to use precooling coils with refrigeration, well water or a cooling tower as the basic source of cooling to lower the wet-bulb temperature (by sensible heat removal) of the air before it enters the air washer. Where internal heat loads are high, this may be more economical than using return air. Under other conditions where the required supply air dew-point is too low to permit straight evaporative cooling and the sensible heat load not too great, intentional partial saturation may be employed. That is, the low dew-point of the outdoor air is utilized by permitting some of it to pass through the humidifying sprays untreated or pass around the humidifier. All of these remarks with regard to evaporative cooling are based, as indicated, on the assumption that the supply air will consist entirely of outside air. Provision should be made for the return of air from the conditioned spaces for control purposes as well as for winter use in all cases.

Precooling

Where sufficiently cold water from wells or streams is available a saving in the refrigeration cycle may be obtained by the use of precooling. Cooling coils are placed ahead of the dehumidifier or conditioner and the cold water from a well or stream circulated through the coils. The resultant cooling of the air decreases the load to be carried by the dehumidifier and refrigeration plant. In normal practice the water after passing through the precooling coils is delivered to the refrigeration plant for condensing purposes. The economic advantages of this scheme are apparent and it is frequently used.

Sensible Cooling with Dry Cooling Coils

Under certain atmospheric conditions where a large wet-bulb depression exists and the dew-point of the outdoor air is sufficiently low at all times, proper inside conditions may be obtained by removing sensible heat only from the outdoor air and supplying it to the spaces. Under this condition of a high wet-bulb depression a cooling coil may be located in the air stream and this coil supplied with water from a cooling tower of one type or another. When humidity control is desired sprays to saturate or partially saturate the air may be used after the dry cooling coil. Saturation or partial saturation after the dry air cooler will further reduce the dry-bulb temperature of the supply air and reduce the supply air quantity required. This system has very definite application in hot dry climates and in general is most economical.

Run-Around System

An interesting method of control is found in the use of combined reheating and precooling usually termed the *run-around system.* Coils are placed in the air stream before and after the conditioner and water or brine is circulated around the conditioner from one coil to the other. The water passing through the reheating coil is cooled by the air leaving the dehumidifier and the air is heated by the water. The cooled water is then circulated through the precooling coil where the entering air is cooled by the water and the heated water sent back to the reheating coil. The run-around has the advantage of permitting a higher supply air dew-point temperature than would be possible otherwise. This is due to the fact that continual reheating is available which is not a large penalty on the refrigeration plant since it provides precooling at the same time. This reheating at peak load creates an artificial sensible heat gain which increases the ratio of room sensible heat to room total heat and for a given room temperature results in a higher apparatus dew-point. Thus, while

the volume of supply air is increased, the low side temperature level of the refrigeration plant is raised and this may effect savings in initial and operating costs. This system has the disadvantage of providing a decreasing amount of heat for reheating as the demand for reheating increases.

RELATION TO BUILDING TYPE

Few buildings or spaces are physically identical and those that are similar in this respect may have marked differences in internal loading, zoning requirements, and economic limitations. Consequently it is virtually impossible to establish fixed rules governing the type of system to be used. Each case must be considered on its own merits with due regard to all engineering and economic factors. However, some generalizations are possible.

In small single spaces the use of an elaborate system is undesirable from an initial cost standpoint. Zoning may be often eliminated. This also applies to large single spaces except that in very large spaces the necessity of providing adequate zoning is encountered more frequently. If the spaces are extremely large, physical and economic limitations such as the size of equipment, size and length of ducts, may require the division of the space into sections. Whether these sections are to be made according to zones or whether each section is to be zoned will depend on the particular case.

Where groups of spaces or small buildings are encountered, simple systems still prove the most economical. A single central station with zoning by means of volume control and reheat combined may be entirely satisfactory. If the perimeter of the building is large with regard to the area, induction units of the low or high pressure type may be employed, particularly if it is a multi-room application. Occasionally the dual duct system may be considered, but is infrequently used due to its complications.

Low buildings with large floor areas, such as large department stores and large general offices, may have to be divided into sections for treatment. In the case of large department stores it may be possible to provide a single conditioner with a fan delivering the conditioned air to recirculating fans which supply the various departments or spaces. This application is limited by practicability of running the large conditioned air ducts to the various recirculating fans. In some cases the use of separate systems for each section will be indicated with the added necessity of dividing into horizontal as well as vertical sections. If the latter is required, each vertical section may be handled by a separate system consisting of a single conditioner and fan delivering conditioned air to recirculating fans supplying the horizontal sections. Zoning is obtained by proper allocation of the recirculating fans or other conventional methods used in conjunction with the recirculating fans. For general offices in particular, or types of buildings having a large perimeter, the use of one of the induction type units for perimeter treatment, combined with a conventional system for the treatment of the interior portions, offers possibilities.

High buildings having large floor areas may be successfully handled in many ways. Horizontal or vertical sectionalizing or both may be required, as determined by economic factors and physical limitations. Where vertical sections only are required, the use of a single conditioner and fan for each section delivering conditioned air to zone fans at various floors may be used. These zone fans can be so arranged that one recirculating