delivered to a particular zone according to the requirements of that zone. See Fig. 9. Several variations of this method are possible, some of which do not employ dual ducts as denoted by the name but which utilize the principle. An example of this is found in a blow-through system where the fan is located on the entering side of the conditioner and the conditioned air passes from the conditioner into a plenum from which distributing ducts for the various zones are taken. A by-pass connection around the conditioner from the fan to the zone duct is made and dampers provided so that conditioned or untreated air, or a mixture of both is passed into the zone supply duct. In this method of zoning and in most of the variations of this method, the matter of by-passing untreated or outdoor air presents itself. This has been discussed earlier in this chapter. If a return air fan is used and the by-pass connection made from the return fan to the zone supply duct, then the by-passing of outdoor air does not need to be considered. Complication of ducts and connections should be avoided since it may result in difficult sheet metal work with accompanying leakage of air and waste of cooling or heating effect.

Combinations of these several methods of zoning usually provide the most effective zoning. It is then possible to use each method to its greatest advantage without incurring operative or economic penalties which may be inflicted by the exclusive use of any one. Thus, where wide variations in load occur, volume control can be used to reduce the air quantity a limited amount, then as the load continues to fall off, reheat, or by-pass, or both can be used. By-pass and reheat can be used in series very effectively. Many combinations are possible and each case should be considered with regard to its particular requirements when deciding on the method of zoning.

Induction Units—Low pressure type

Induction units are essentially induction type convectors. These units utilize a jet of conditioned air (or primary air) to induce into the unit a flow of room or secondary air which mixes with the primary air. The mixture is discharged into the room through a grille at the top of the unit. Heating coils are located in the secondary air stream for use in heating. Control is obtained by either manually or automatically throttling the jet, and, in addition, heat may be supplied to the secondary coils in summer as well as winter to provide control by reheating. The use of these induction units presents several advantages. Since the secondary air stream is thoroughly mixed with the high velocity low temperature air stream before leaving the discharge of the unit, the resultant temperature of the mixture is satisfactory even though the primary air is introduced at a temperature too low for ordinary methods of distribution. A unit is usually provided under each window in place of the customary direct radiation, and combines the air distribution system with the heating system. With a conventional system it may be necessary to provide supplementary heating in the form of direct radiation. These induction units may be selected so that their heating coils will have sufficient capacity under gravity conditions (that is, with the fan system off and no primary air entering the unit) to maintain the building or spaces at a reasonable temperature. The use of low temperature dehumidified air which has not been reheated or mixed with room air before delivery to the room results in a reduction in fan capacity and smaller sized duct work. In some cases the use of the by-pass may be desirable in order to keep the primary air volume up and provide additional control. This system can provide a degree of zoning that is usually impossible with conventional

systems since each unit can be put under manual or automatic volume control and reheat control. The selection of units should be made with regard to noise level when related to the noise level of the spaces. The inductive capacity of the unit increases with the jet velocity but too high jet velocities result in a high noise level.

Induction Units—High pressure type

A recent development of the induction unit as previously outlined is the high pressure type of unit. This unit employs nozzles which produce a high velocity jet quietly. The term, high pressure type of unit, is to some extent inaccurate since the pressure at the nozzles, while several times that of the low pressure unit, is still less than the total resistance pressure of a conventional central system. The high velocity jet of primary air induces a flow of secondary room air through coils located in the secondary air stream. The coil in the secondary air stream is supplied with chilled water in summer and hot water in winter and thus handles a large portion of the room sensible heat gain in summer and of the room sensible heat loss in winter. The primary air is supplied at a sufficiently low dew-point to take care of room latent heat gain in summer. In winter, it is supplied at a sufficiently high dew-point to take care of room latent heat losses. Control of temperature is obtained by throttling the water quantity supplied to the secondary coils. The quantity of primary air is greatly reduced due to the fact that a portion of the room sensible heat load is carried by the secondary air stream coil. Since the primary quantity is small, very high velocities can be carried in the supply ducts without requiring fan power in excess of that required for a conventional system. This means that the supply ducts or pipes can be very small and can be run in chases, or furred in at columns with the water pipes. The primary air is treated in the usual manner to provide air at the required dew-point and either a surface or spray dehumidifier or a dehydrator may be used. The primary air quantity is sufficient for ventilation purposes, and frequently consists entirely of outdoor air. The water piping for the units can be so arranged and valved that hot water can be supplied to one zone that may require heating while cold water may be supplied to a zone that requires cooling.

This system is usually limited in application to hotels, apartments, office buildings and other multi-room installations having a large perimeter with relation to the floor area. The units are usually installed beneath the windows, replacing direct radiation or convectors. Where the spaces to be conditioned extend a large distance from the outer wall into the interior of the building, a separate system or zone for the conditioning of the interior portions may be required.

Evaporative Cooling

In climates where on design maximum days, the outdoor wet-bulb depression is relatively high it may be possible to dispense with refrigeration or other cooling sources by use of the evaporative cooling effect. A well designed air washer using recirculating sprays will reduce the entering dry-bulb temperature to within a degree or two of the entering wet-bulb condition. Thus, it may be possible that with air entering at 100 F dry-bulb and 60 F wet-bulb temperature a leaving condition of 62 F dry-bulb, nearly saturated can be obtained. Under some conditions of latent and sensible heat load the results may be entirely satisfactory.

Under those conditions when the outdoor wet-bulb temperature is not quite low enough to permit the use of straight evaporative cooling it is