The connection between the conditioner and fans is divided or partitioned in such a manner that a by-pass connection can be made to each fan. See Fig. 6. In this way the amount of by-pass air can be regulated according to the requirements of the zone served by that fan. In this application a face damper must be used for each segment of the conditioner, arranged to close as the individual by-passes open or an unbalanced system may result. A much better adaptation of this principle, though slightly higher in initial cost, is obtained by using a single conditioner or dehumidifier, having a central conditioned air fan delivering the treated air to the necessary zone fans where the conditioned air is mixed with return air according to the requirements of the zone. See Fig. 7. With this method of zoning, the zone fans are provided with casings to which both return air and conditioned air are delivered, their proportions being regulated by dampers working in opposite directions. If conditioned air is delivered to the casing at slight positive pressure the return air damper may be omitted. Reheating can be effectively combined with either of these for year 'round use or for winter use only. The reheater is usually located in the air stream to the zone fan. Where a central conditioned air fan is used to deliver conditioned air to a number of zones, a static pressure regulator controlling a volume damper or inlet vanes on this fan should be installed to prevent unbalancing the system, when one or more zone fan conditioned air dampers are throttling. This is one of the better methods of zoning and is particularly effective when used in combination with reheating for winter or year 'round conditioning as previously outlined.

Volume control is the least expensive and most frequently used method of zoning. It is usually obtained by placing a throttling damper in the supply duct feeding a particular zone and operating the damper to restrict a flow of air as the heating or cooling load is reduced. The damper may be operated manually or automatically. Volume control, however, has two serious disadvantages. The first of these is that any large reduction in the quantity of air supplied may impair the ventilation. The second is that a large reduction of the air supply may entirely upset the distribution from the room outlets causing dead pockets, stratification, lack of air motion, or the reverse—undesirable drafts. Where the degree of volume control is large or the system extensive and where volume control is applied to one portion of a system and not to another, the use of a static pressure regulator controlling a fan discharge damper or fan inlet vanes is indicated. Its best application is in combination with some other method of zoning such as reheat or by-pass where it is used as one step in a control sequence, and the reduction in volume limited to a proper amount.

The *dual duct method* of zoning, sometimes referred to as the schoolhouse system, can be successfully applied to comfort air conditioning though certain precautions must be observed. Essentially this method employs a source of warm air and a source of cold air both of which are delivered to a common point where either or a mixture of both are 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