Insulation is an important factor in air conditioning systems. Its economy with regard to steam and water or brine piping are well known and need no comment. The insulation of duct work is not merely a matter of economics but sometimes is a necessity from the standpoint of limiting the temperature rise of the air even when the ducts are in conditioned spaces. This temperature rise of the air should always be taken into account when apportioning the air and sizing the ducts and will indicate the necessity for insulation. In some cases, leakage of air from the duct where the duct is in a furred space or chase will eliminate the need for insulation by maintaining a reasonable temperature surrounding the duct.

There are practically no items of equipment associated with central air conditioning systems that are not subject to economic limitations as well as those of performance and duty and all of them should be considered in the selection.

ARRANGEMENT OF EQUIPMENT

A proper arrangement of equipment is essential for the proper functioning of any system. Where systems are to be installed in existing buildings the arrangement of equipment may be limited by structural or space considerations, but no compromises that may prevent satisfactory operation or maintenance should be considered.

The location of the apparatus room is often determined by building construction or available space. The closer the apparatus room to the conditioned space, the less expensive is the duct-work. On the other hand if the equipment generates noises it may be necessary to locate the room some distance from the spaces or provide adequate sound and vibration treatment. The scattering of wet apparatus throughout a building is to be avoided unless suitable precautions are taken. It must be remembered that encroachment on spaces that are otherwise usable can be charged against the system as an operating cost.

In general the apparatus should be arranged to have straight line air flow. This is desirable but not always possible. Each change in direction is the source of air resistance, and in addition may cause eddy currents resulting in stratification. The usual order of equipment, beginning at the outside air intake is: outside air screen, outside air louvers, maximum and minimum outside air dampers, preheaters, return air connection, filters, conditioner, by-pass connection with or without reheaters, reheaters, fan and distributing ductwork. See Figs. 1, 2 and 3 for typical arrangements. Use of one or more of the methods of zoning may require a modification of this order but usually only after the dehumidifier or conditioner.

Outside air screens prevent the entry of large foreign matter, birds, etc. The use of louvers or a hood at the outside air intake prevents the entry of rain and snow. Both of these should be used on all systems. As pointed out earlier, the louvers and screens should be of sufficient size to permit the passage of the entire conditioned air quantity.

The minimum outside air damper usually covers the entire face of the preheater, which in turn is selected for the minimum outside air quantity. The maximum outside air damper is designed for the difference between the dehumidified air quantity and the minimum outside air. Its size can be such that its air resistance when open will equal the air resistance of the open minimum outside air damper plus that of the preheater if used. Where the spaces conditioned are very tight against air leakage, some type of relief or positive exhaust may be necessary when all outdoor air is introduced to the system to provide some means of egress for the air. Such reliefs require back-draft dampers to prevent infiltration when all outdoor air is not being used. A return fan properly dampered as indicated later is sometimes used.

The return air from the conditioned spaces usually is brought into the apparatus between the preheater and the filter. Just as it is necessary to make provision for using all outdoor air it is necessary to make provision for using all return air. Heating an unoccupied building or cooling it after a shut-down is easier if all the air used is return air. Consequently the return connections should be ample for this. In many cases higher velocities can be carried in the return ducts during such times, since the fan will exert a pull at the return connection nearly equal to the resistance of the outside air connection and the return ducts need not be larger than for normal return air quantities at normal velocities. In other cases it is possible that a reduced quantity of air due to the increased resistance of the return duct system may be satisfactory during the starting period. Where the return air system is extensive or complicated a return air fan is desirable. This fan can serve as a combination exhaust and return fan by arranging dampers in its discharge so that the necessary return air can be delivered back into the system and the remainder discharged outdoors. When all outdoor air is passed through the conditioner the entire return air quantity is discharged outdoors.

The by-pass connection normally connects the return air duct system into the apparatus casing between the conditioner and fan. Usually it is sized to handle about 50 per cent of the fan capacity where a variable by-pass is used though extreme load variations may require a greater amount. It is at times good design to locate the reheater in the by-pass connection using a certain amount of by-pass air when heating is required. Since the relatively high resistance of the conditioner is to be balanced by the heating coil and by-pass connection, enough heating surface can be provided to raise the temperature of the by-pass air to the point where the mixture of by-pass air and conditioned air will have the required temperature. When a variable by-pass is used a damper working in opposition to the by-pass damper should be placed across the face of the dehumidifier, for unless the resistances of the two are most carefully balanced at all operating points the proper mixtures of air will not be obtained. The avoidance of by-passing outside air is again stressed. Where the by-pass is made a part of the dehumidifier or conditioner and located on the top or side of it, the return air connection should be made in such a way that stratification of return air is insured, baffles being provided to accomplish this purpose if necessary. Where return air and by-pass air connections are taken off a return duct system it may be necessary to install a back-draft damper between the return air connection and the by-pass connection, if the return duct system is extensive and the connections simple. In this instance, when the by-pass damper is at maximum opening it may be much easier for outside air to pass through the return damper, into the return duct connection and through the by-pass than for return air to pass through the by-pass connection into the fan. Air always takes the easiest path and if the dehumidifier resistance is high, and the return duct resistances low, this situation is apt to occur unless precautions are taken. A return fan instead of a back-draft damper may be required for this case if the failure of return air to reach the dehumidifier or conditioner is a serious matter under reduced load conditions.