supplied with chilled water in summer and with hot water in winter. The chilled water removes a large portion of the sensible heat in summer and the hot water supplies the sensible heat loss in winter. The primary air is delivered at a sufficiently low dew point to compensate for the latent heat gain in summer. In winter the primary air is supplied at a sufficiently high dew point to take care of latent heat losses. Control of temperature is obtained by throttling the water quantity supplied to the secondary coil. The required flow of primary air is greatly reduced due to the fact that a portion of the sensible heat load is carried by the secondary air stream. Since the primary quantity is small, very high velocities can be maintained in the supply ducts without requiring fan power in excess of that for a conventional system. Therefore, the supply ducts or pipes can be very small and can be run in chases, or furred in at columns

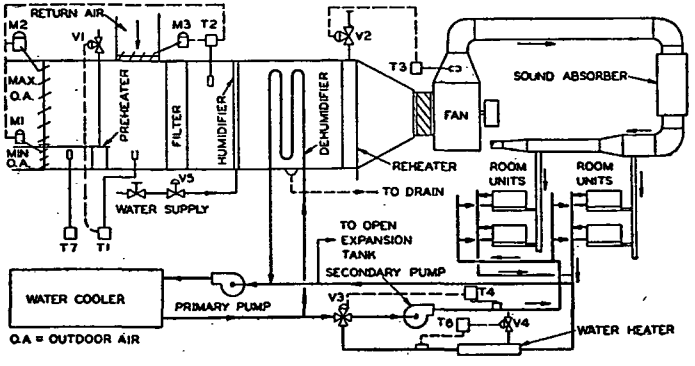

FIG. 6. TYPICAL INDUCTION UNIT SYSTEM

along with the water pipes. The primary air is treated in the usual manner to reach the required dew point and 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.

Fig. 6 shows the general arrangement and control of the system. The operation of the controls is as follows:

The final temperatures in the spaces are controlled by individual valves, either automatic or manual, which throttle the flow of secondary water to the unit coils. Where automatic valves are used, the thermostats are of the heating-cooling type so that a rise in room temperature opens the valve when cold water is circulated and closes the valve when hot water is being supplied. Thermostat T1 controls the preheater steam valve V1 to maintain a temperature of about 45 F leaving the preheater. Thermostat T2 controls the maximum outdoor-air and return-air dampers so that the air entering the dehumidifier is maintained at 50 F whenever outdoor air conditions permit.

During the heating cycle, thermostat T3 and valve V2 are inoperative so that cool primary air is supplied to the units but at the same time thermostat T6 operates valve V4 so that the secondary water is heated. Thus the combination of cool primary air and hot secondary water can provide heating or cooling as required. The primary pump and water cooler are inoperative.

When the outdoor air is no longer suitable to provide sufficient cooling through the primary air system (typically about 50 F) the system is changed from heating to cooling operation. The primary pump is started and supplies chilled water to the dehumidifier. Thermostat T4 controls mixing valve V3 so as to maintain the secondary water at temperatures in the range of 50 to 55 F. At outdoor temperatures

below 80 F thermostat T3 regulates reheater valve V2 so that warm primary air is supplied at the same time that cold secondary water is fed to the units. The changeover from heating to cooling is usually manual and the exact time is not too important because both heating and cooling are available in either case. During the cooling cycle, thermostat T7 acting through thermostat T3 readjusts the primary air temperature downward as the outdoor air temperature increases from the changeover point to about 80 F so that above this temperature the primary air is equal to the apparatus dew point.

In some buildings the primary air system and water circuits are zoned according to exposure, but because both heating and cooling are available at the units whenever either is needed, such zoning is not always used.

Dual-Duct System

The dual-duct system conditions all the air in a central apparatus and distributes it to the conditioned areas through two parallel mains or dual

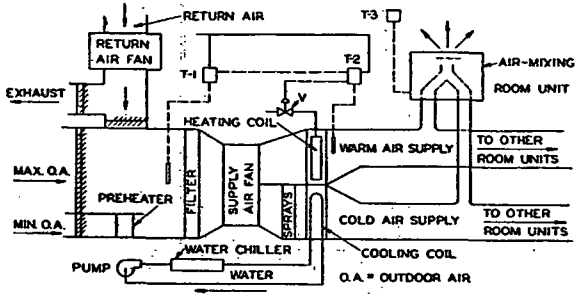

FIG. 7. SCHEMATIC ARRANGEMENT OF DUAL DUCT SYSTEM

ducts. The air supply fan, return-air fan, filters, heating and cooling means, outdoor-air equipment, dampers, and controls are located in the apparatus space. One air distribution main carries cold air while the other carries warm air at approximately room temperature in summer and at a higher temperature in winter.

The general arrangement of a typical dual-duct system is shown in Fig. 7. In some arrangements, two supply-air fans are used with one fan supplying the cold-air duct and the other the hot-air duct. The warm-air fan handles only recirculated air so that operating economy is slightly improved.

The maximum outdoor-air damper and the preheater are controlled as in Fig. 1 so that when the temperature of the outdoor air is favorable it is used increasingly instead of return air.

The warm-air supply-duct temperature is controlled by a thermostat, T2, Fig. 7, in the air leaving the heating coil. Thermostat T2 is reset by thermostat T1 in accordance with variations in outdoor-air temperature. Whenever outdoor-air temperature is not low enough to accomplish the required cooling, the cold-air supply-duct temperature is regulated by the cooling coil. The final temperature in the conditioned areas is controlled by the individual air-mixing units.

Air-mixing room units under control of the room thermostat draw warm and cold air from the ducts in accordance with the room requirements, affording individual room control without zoning. Fig. 8 shows schematically one type of room unit designed for dual-duct systems. The warm and cold air pass through the three-way mixing damper which delivers air at