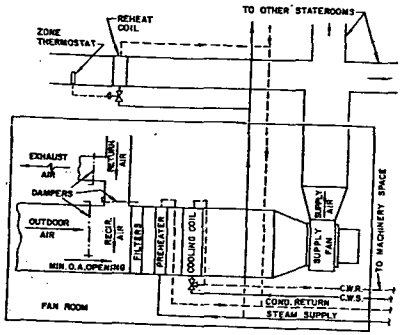


Fig. 2 .... Multi-Zone Central (*Type C*) System

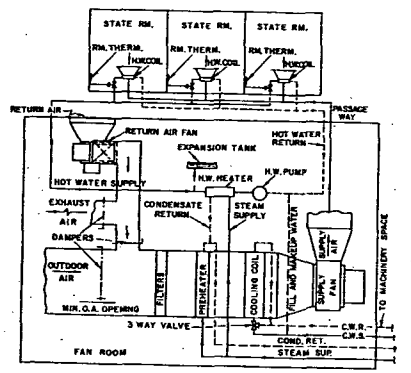


Fig. 3 .... Terminal Reheat (*Type D*) System

system, conditioned air is supplied to each space in accordance with its maximum design load requirements. The room dry-bulb temperature is controlled by means of reheat in which a room thermostat automatically controls the volume of warm water or steam passing through the reheat coil which is provided for each controlled space. In this system a mixture of outdoor and recirculated air is circulated through the ductwork to the conditioned spaces. A minimum of outdoor air is mixed with return or recirculated air in a central station system where it is filtered, dehumidified and cooled by the chilled water cooling coils, and distributed by the supply fan through conventional ductwork to the spaces treated. Automatic dampers are frequently provided to increase the outdoor air to a maximum of 100 percent as the load falls off. In accordance with usual practice, no recirculated air is permitted for operating rooms and hospital spaces. When 100 percent outdoor, air only is used, the system is designated as *Type D1*. When heating is required, the conditioned air is heated at the central station to a predetermined temperature. In addition, hot water or steam is circulated to the reheat coil

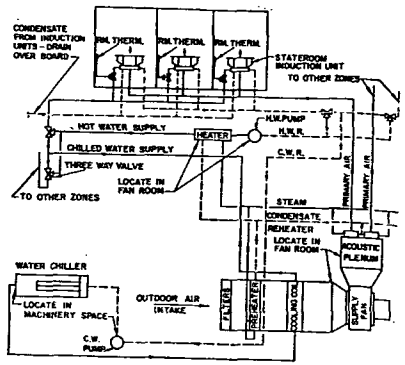


Fig. 4 .... Air-Water Induction Unit (*Type E*) System

to provide additional heating capacity, as required to maintain the desired room temperature.

Air-Water Induction System

A second type of system for passenger staterooms and other small spaces is the air-water induction system (see Chapter 2) sometimes designated as the *Type E* system. In this system, shown in Fig. 4, a central station is provided for conditioning (dehumidifying and cooling) the primary air only. The primary air is distributed to induction units located in each of the spaces to be conditioned. Nozzles in the induction units, through which the primary air passes, induces a fixed ratio of room (secondary) air to flow through a water coil and mix with the primary air. The mixture of treated air is then discharged to the room through the supply grille. The room air is either heated or cooled by the water coil. The flow of water (chilled or hot) to the coil can be controlled either manually or automatically to maintain the desired room conditions. In this system, no return or recirculated air ducts are required, since only a fixed amount of outdoor (primary) air need be conditioned at the central station equipment. This relatively small amount of conditioned air must be cooled to a sufficiciently low dew point to take care of the entire latent load. It is distributed at relatively high velocity and pressure and thus requires relatively little space for air distribution ducts. However, this space saving is offset to some degree by the additional space required for water piping, hot water converters, secondary water pumps, induction cabinets in staterooms and drainpiping from same.

Any heating required with outdoor temperature above changeover point is accomplished by the primary air heated in the central system according to a predetermined temperature schedule. Chilled water is distributed to the induction units at this time. Below the changeover point hot water is circulated to the induction units to provide heating, as required to maintain the desired room temperature. Cool primary air is distributed to the induction units at this time.

Terminal Reheat System with Induction Units

A third type of system, known as the *Type F* system and used to a limited extent for small individual spaces, employs reheat with induction units (Fig. 5). The primary air,

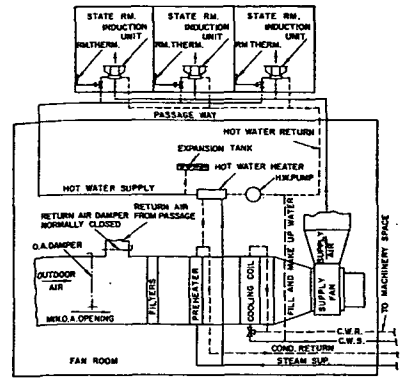


Fig. 5 .... Terminal Reheat System with Induction Units (*Type F*) System

which is filtered, cooled and dehumidified to a relatively low dew point in the central station system, is distributed through a duct system at moderately high velocities and pressures to the staterooms or individual spaces which are equipped with induction units. The primary air may be all fresh air or a mixture of fresh air and recirculation air. The primary air, in passing through the nozzle in the induction unit, induces room air to pass over a hot water reheat coil. A room thermostat automatically controls the flow of hot water to the heating coils to maintain the desired room temperature. In this system, as in the terminal reheat system, the conditioned air must be cooled sufficiently to maintain the required room conditions under the maximum design load. Therefore, reheat is required when the load is less than the maximum design. With this system, the primary air may be cooled to a relatively low temperature, since it is mixed with warmed room air at the induction unit before the mixture is discharged into the room. Accordingly, the quantity of air circulated through the ductwork can be substantially reduced, resulting in the use of smaller duct sizes. When heating is required, the primary air is tempered in the central station system to a predetermined temperature by the preheater. In addition, hot water is circulated to the induction units to provide additional heating capacity as may be required to maintain the desired room temperature.

High-Velocity Dual-Duct System

During the past few years this system also known as the *Type G* system has gained considerable popularity in the marine field.

In this system all the air is filtered, cooled and dehumidified in the central units (see Fig. 6). Blow-through coil arrangements usually are essential to efficient design. A high pressure fan is used to circulate the air through a system of two ducts or pipes at high velocities approaching 6000 fpm. One duct (or pipe) carries cold air while the other handles warm air. A steam reheater in central unit heats the air according to requirements of the outdoor air temperature. The supply of warm and cold air is delivered to a mixing box provided in each space served. Each mixing unit has a control valve which proportions hot and cold air from the two pipes

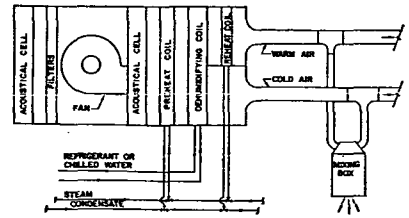


Fig. 6 .... Dual-Duct (*Type G*) System

to satisfy the demand of the room thermostat. Any desired temperature within the limits of the capacity of the equipment can be quickly obtained and maintained with this arrangement regardless of load variations in adjacent spaces. The air mixing units incorporate self-contained regulators which maintain a constant volume of total air delivery to each space regardless of adjustments in the air supplied to rooms down the line.

Some of the advantages of this arrangement are:

1. All conditioning equipment is centrally located, simplifying maintenance and operation.
2. The system can heat and cool adjscent spaces simultaneously without cycle changeover and a minimum of automatic controls.
3. Since only air is distributed from fans rooms, there is a complete absence of water and steam piping, electrical equipment or wiring in conditioned spaces.
4. With all conditioning equipment centrally located, direct expansion cooling using halocarbon refrigerants is possible, eliminating all intermediary water chilling equipment.

The application of high velocity air distribution which is now possible as a result of advanced techniques in noise attenuation offers many advantages to the naval architect, shipbuilder and ship owner. The use of unitary central air handling equipment and a flexible system of small diameter prefabricated piping, clamps, and fittings facilitates the installation for both new construction and conversions. Substantial space saving is possible as compared to the conventional low velocity sheet metal duct system. Maintenance is also reduced.

AIR DISTRIBUTION METHODS

Good air distribution in staterooms and public spaces is particularly difficult because of low ceiling heights and compact space arrangements. Consideration in design should be given to the following conditions: room dimensions, ceiling height, volume of air handled, air temperature difference between supply and room air, location of berths and allowable noise level. On important installations mock-up tests are often used to establish the exacting design criteria required for satisfactory performance.

Supply Outlets

Because of low ceiling heights and small spaces prevalent on ships, the selection of the proper supply outlet requires careful attention to prevent objectionable drafts. Before the advent of high induction type diffusers, it was the practice to limit the terminal temperature differential to 20 F deg. The difference between the supply air temperature and that of room (dry bulb) is referred to as *terminal temperature differential*. High induction type diffusers, however, permit terminal temperature differentials of 30 F deg and even