of equipment. It is furthermore vital that the calculation of a cooling load be based on an accurate survey before the selection of the equipment is made.

COSTS

Due to the rapid development of the air conditioning industry and the great progress that is being made each year, it is impossible to give any cost figures that will be of value. There are, however, certain factors that influence the cost of unit air conditioning installations.

1. Since the cost of the total job involves material cost plus installation labor and since through the use of unitary equipment, material costs can be kept to a minimum, every effort should be made to simplify installation.

2. Self-contained units in the small sizes now available, probably represent the lowest cost individual installations. They have, however, their limitations.

3. The floor type all-year-round air conditioning units for the occupied space with a remotely controlled compressor, heating sources being either the existing heat system or steam connections to the unit, probably afford the lowest cost all-year-round service for most individual rooms. This is particularly true in the case of residences. With offices, this will probably be true if the compressor can be located immediately adjacent to the conditioned space, as for example in a closet or nearby storeroom. The expenses increase rapidly as the distance from the unit increases.

4. For multiple rooms or offices, the remotely located unit with connecting ducts probably represents the most economical installation. Such installations are also particularly adaptable to stores, residences and small commercial installations.

Costs of operation vary widely depending entirely upon the cost of power and water. Water costs in the larger installations are being materially reduced through the use of cooling towers and special types of condensers. The normal expense of operating the cooling system is considerably in excess of that of winter heating both as to the first cost and as to operation. Consequently, the more rapid growth of air conditioning has been along commercial lines where it has represented an actual profitable investment resulting in increased business returns rather than along the lines of residential comfort cooling where it still represents a luxury in comfort.

MISCELLANEOUS UNITARY EQUIPMENT

There are a number of units available which were not covered in the previous discussion that accomplish only one or two of the functions of air conditioning.

Attic Fans

Attic fans, used during the warm months of the year to draw large volumes of outside air through a house, offer a means of using the comparative coolness of outside evening and night air to bring down the inside temperature of a house.

Because the low static pressures involved are usually less than $\frac{1}{8}$ in. of water, disc or propeller fans are generally used instead of the blower or housed types. The fans should have quiet operating characteristics, and

they should be capable of giving about twenty air changes per hour. The two general types of attic fan installations in common use are:

Open attic fans, in which the fan is installed in a gable or dormer and one or more grilles are provided in the ceilings of the rooms below. Fresh air, which enters the house through open windows, is drawn into the attic through the grilles, and is discharged out-of-doors by the fan. An attic stairway may be used in place of the central grille. It is essential that the roof and the attic walls be free from air leaks.

Boxed in fans, in which the fan is installed within the attic in a box or housing directly over a central ceiling grille, or in a bulkhead enclosing an attic stair. The fan may be connected by a duct system to the grilles in individual rooms. Fresh air entering through the windows of the rooms below is discharged into the attic space and escapes to the outside through louvers, dormer windows, or screened openings under the eaves.

The locations of the fan, the outlet openings, and the grilles should be selected after consideration of the room and attic arrangement in order to give uniform air distribution in the individual rooms served. If the outlet for the air is not on the side away from the direction of the prevailing wind, openings should be provided on all sides. Kitchens should be separately ventilated because of the fire hazard, and to prevent the spread of cooking odors.

The operating routine which will secure best results with an attic fan is an important consideration. A typical routine might require that in the late afternoon when the outdoor temperature begins to fall, the windows on the first floor and the grilles in the ceiling or the attic floor should be opened, and the second story windows should be kept closed. This will place the principal cooling effect in the living rooms. Shortly before bedtime, the first floor windows may be closed and those on the second floor opened, to transfer the cooling effect to the sleeping rooms. A time clock may shut off the fan before waking time, or the fan may be stopped manually at a later hour.

A disadvantage arising from the passing of a great amount of outside air through a house is the dust nuisance, which varies considerably in different locations. Persons suffering from allergic diseases caused by airborne pollens will have their troubles increased with attic type coolers.

Some typical data on an attic fan installation in an average six-room house of frame construction containing 14,000 cu ft and located in the southern part of this country are:

Installation cost	$75 to $400, average $250
Fan data	9000 cfm average, 280 rpm if belt driven, 570 rpm if direct connected, 500 watts input
Operating period	April 15 to October 15, intermittently as weather conditions demand
Power consumption	500 kwh per year for 8 months' operation