any parts of the apparatus that are subject to wear, deterioration or damage, whether it may be filter, fanwheel, motor, pump, impeller or heat transfer surface.

DESIGN PROCEDURE

The customary design procedure is outlined herewith. For simplification the procedure is set up on the basis of a year-round system. For systems designed only for winter or summer, the unrelated parts may be omitted.

1. Selection of design conditions (inside and outside).
   a. Summer.
   b. Winter.
2. Determination of outside air requirements.
3. Determination of cooling load.
   a. Room sensible heat gain.
   b. Room latent heat gain.
   c. Room total heat gain.
   d. Grand total heat gain.
4. Determination of heating load.
   a. Room sensible heat loss.
   b. Room moisture loss.
   c. Humidification requirement.
   d. Total heating requirement.
5. Determination of apparatus dew-point and dehumidified or humidified air quantity.
   a. Summer (full load and part load).
   b. Winter.
6. Supply air temperature difference and quantity.
   a. Summer.
   b. Winter.
7. Equipment selection.
8. Equipment layout.

The foregoing steps are merely typical. Many applications will require at least a preliminary investigation of some of the latter steps before proceeding with the earlier steps. A permanent record of all design assumptions and computations should be made and preserved for comparison with the performance of the installation.

Chapter 44

OWNING AND OPERATING COSTS

Fixed Charges: Amortization, Interest, Taxes, Insurance, Rent; Maintenance Costs, Service Costs: Operating Refrigeration Equipment, Condenser Water, Heating

THE purpose of this chapter is to discuss the owning and operating costs of heating, ventilating, air conditioning and refrigeration systems for buildings from an economic standpoint so that owners or prospective purchasers may compare the operating economics of one system with another and evaluate properly the over-all costs of the systems instead of considering only the first cost.

There are cases in which it may be desirable to study the possibilities of installing a system for the purpose of obtaining a substantial increase in income or a better return on the investment due to: increased patronage in theaters, stores, or hospitals; increased occupancy in office buildings; improved efficiency of employees in offices or factories; or improvement in a manufactured product or a decrease in its cost of production.

Owning and Operating Costs may be grouped under three headings: (1) *Fixed Charges*, (2) *Maintenance Costs*, and (3) *Service Costs*.

FIXED CHARGES

Fixed Charges, which are the costs of owning the system, include: (1) Amortization, (2) Interest, (3) Taxes, (4) Insurance, and (5) Rent.

Amortization

Amortization cost will depend on: (1) the total first cost, and (2) the amortization period.

The *total first cost* of an installation is the actual dollar outlay or capital expenditure required to buy and install the air conditioning, or heating and ventilating system ready for operation. It can be divided into two parts: (*a*) The first cost of the air conditioning or heating and ventilating system itself, and (*b*), other first costs incurred because of the installation of the air conditioning or heating and ventilating system.

The *first cost* of air conditioning or heating and ventilating systems includes the following:

1. Heat producing equipment including boilers, burners, etc.
2. Heat distributing equipment including direct radiation, piping, etc.
3. Air handling equipment including fans, air heaters, air conditioners, filters, controls, etc.
4. Air distributing equipment including ducts, outlets, grilles, etc.
5. Refrigerating equipment including piping, pumps, etc.
6. Water conservation devices including towers, evaporative condensers, etc.

The best procedure for establishing the first cost of any system is to select the various parts after thorough engineering study, and then to estimate the installed costs of same. When such detailed work is not warranted or when only rough comparisons are desired between several types, approximate unit costs are of value as time savers.

Approximate installed prices of the various parts are shown in Tables 1, 2, and 3 and, as indicated, vary with the size or capacity of the equip-