[39] A discussion by D. W. Haering (See p. 66 of Reference 14).

[40] Cyclohexylamine and Dicyclohexylamine, by T. S. Carswell and H. L. Morrill (*Industrial and Engineering Chemistry*, Vol. 29, 1937, p. 1247).

[41] Drinking Water Standards, etc. (Reprint No. 2440, *Public Health Reports*, Vol. 58, No. 3, January 15, 1943).

[42] Discussion of Ref. 21, by R. M. Palmer.

[43] Official Plumbing Code of the City of Detroit, Article V.

[44] Private Communication from H. S. Jordan, *A.W.W.A.*

CHAPTER 43

OWNING AND OPERATING COSTS

Fixed Charges: Amortization, Interest, Taxes, Insurance, Rent; Maintenance Costs; Labor for Operation; Energy and Water Costs: Operating Refrigerating Equipment, Condenser Water, Heating

THE total cost for the use of heating, ventilating, and air conditioning systems may be divided into two classifications. The first of these is the relatively fixed and unvarying expense of ownership, and the second is the variable and somewhat controllable expenditure for actual operation of the equipment. Owners and prospective purchasers of this equipment are particularly concerned with both since the actual expenditure is generally predicated upon the possible return on the investment resulting from increased patronage, greater efficiency on the part of the employees, meeting of competition, or the improvement and maintenance of quality in a manufactured product. These costs may be grouped under four headings: (1) *Fixed Charges*, (2) *Maintenance Costs*, (3) *Labor for Operation*, and (4) *Energy and Water Costs*.

FIXED CHARGES

Fixed charges are the annual expenses arising from the ownership of the installation, including use of the owner's money, and protection of the equipment in the form of insurance. Such costs are usually unchanged from year to year regardless of whether the equipment is in or out of service. Fixed charges may be grouped under five headings: (1) *Amortization*, (2) *Interest*, (3) *Taxes*, (4) *Insurance*, and (5) *Rent*.

Amortization

As air conditioning equipment becomes older, its ability or capacity to perform present and future service is reduced. Provision must be made for the owner to recover each year a portion of the initial value of the equipment as an expense to be charged against revenue, or to amortize the cost. This decrease in the value of property is usually determined by an accountant or engineer using some theoretical method and will depend upon (1) the total first cost, and (2) the amortization period.

The total first cost of an installation is the actual capital expenditure required to buy and install the air conditioning, heating, or ventilating system ready for operation. It represents the first cost of the equipment combined with additional costs incurred because of the installation of the system.

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

1. Heat producing equipment including boilers, burners, controls, 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 distribution system including ducts, outlets, grilles, etc.
5. Refrigerating equipment including piping, pumps, etc.
6. Water conservation devices including towers, evaporative condensers, etc.