Such units are usually designated as filters or unit filters. A typical unit filter may be 20 in. square and from one to several inches thick, depending on the manufacture and proposed use. In large systems, a number of such units are installed adjacent to each other and collectively are called a bank of filters.

Air cleaners are commonly installed in the outdoor air intake ducts of buildings and, often, in the recirculating air ducts as well. The cleaner is logically placed ahead of heating or cooling coils and other air conditioning equipment in the system to protect them from dust. The character of the dust arrested by the filters in an air intake duct is commonly quite different from the dust removed by filters located in the recirculation ducts. The dust from outside is likely to be mostly particulate matter of a greasy nature, while lint may predominate in that from within the building.

Settling chambers, air washers and electrostatic precipitators are also air cleaners. Settling chambers are used in boiler plants for capturing cinders, but they occupy too much space for general use in heating, air conditioning or ventilating systems. Unless they are inordinately large, they are not effective in capturing small particles, since the air velocity is not sufficiently reduced to permit such particles to settle.

Air washers have generally become recognized for the purpose of adjusting the temperature and humidity of the air, and not so much for cleaning air. It happens that insofar as dirtiness is concerned, carbon is the most troublesome dust. Carbon particles are likely to be greasy and since there is a natural repulsion between grease and water, the water spray in an air washer is not effective to a desirable degree in capturing them. However, air washers do capture considerable amounts of dust and lint which become sludge in the sump. Much of the cleaning action occurs at the eliminator plates where the dust particles are thrown against the film of water on the plates by their momentum.

The electrostatic precipitator is considered at present an effective available means of capturing the finer dust particles. This device does not entirely displace other types of air cleaners at the present time because of its relatively high cost, large space requirements, and due to the fact that the air must enter and leave the apparatus in substantially parallel and straight flow.

Dust and Lint

Air-borne solid matter may fall into two classifications, namely, lint and dust or particulate matter. Some lint originates outdoors, as animal hair, vegetable fibers, etc., but much is generated within buildings by the wear and brushing of fabrics in the form of clothes, draperies, carpets, etc. Lint is comparatively easy to capture in an air filter on account of its comparatively great length. So far as air filter performance and testing are concerned, lint is chiefly important on account of its tendency to impede or stop the flow of air through the filter. In general, lint, if not captured, will accumulate in corners and under furniture in a building in areas of slight air motion and in some cases may seriously obstruct heating and cooling coils. Dust settles, or is precipitated by heat or air motion, upon furniture, fixtures and walls and the only satisfactory treatment is washing or re-painting. Dust is more difficult to capture than lint, and obviously, small particles are more difficult to capture than large ones. The air cleaning problem is complicated by the vast difference in size of dust particles, the range of which is shown in Fig. 1, Chapter 28.

Even if the discussion is limited to the range from 0.1 micron to 50 microns, that is between the smallest particle observable in the microscope and the smallest particle distinguishable to the naked eye, this range is so far outside the usual experience that it is difficult to visualize. If particles could be examined through a super microscope having a magnification of 250,000 diameters, a tobacco smoke particle of 0.1 micron would appear to be 1 in. in diameter, or approximately the size of a golf ball; a soft coal smoke particle 0.3 micron in diameter would appear like a baseball; a ragweed pollen grain 20 microns in diameter would appear 16.5 ft in diameter, while the 50 micron particle, just visible to the naked eye and able to pass through a 270 mesh screen, would appear to be 50 ft in diameter. Picturing this range in particle size from a golf ball to a sphere 50 ft in diameter may aid in appreciating the problem of cleaning air and the difficulty of devising any single test to adequately measure the performance of air cleaning devices under all conditions of service.

It may be contended that the removal of the finer particles from ventilating air is relatively unimportant insofar as cleanliness in a house or building is concerned, since it is possible that such particles may remain suspended in the air and in large part be removed from the building without settling by the circulating air. However, the fact that some of the particles are undoubtedly deposited by contact and by the phenomenon of thermal precipitation makes the ability to remove small particles desirable in an air cleaner.

The fact that dust particles migrate from a warm region toward a cool surface, to which they will adhere, is called thermal precipitation[2]. This fact is responsible for the *lath marks* often observed on walls or ceilings. The laths form barriers to the passage of heat so that the surface of the plaster in front of them is warmer than the surface between them. Dust is therefore deposited more rapidly between joists or laths than it is in front of them, resulting in the streaks observed. If the entire ceiling or wall is insulated, the differences in temperature across the surfaces cease to exist. Under this condition the lath marks do not form and the deposition of dust is much slower.

A laboratory apparatus has been designed in which thermal precipitation is employed to capture dust particles for microscopic examination[3]. So far as is known thermal precipitation has not yet been used as a practical means of cleaning air.

CLASSIFICATION OF AIR CLEANING MEDIA

Air cleaners of such a variety of types have been used in the past that a single classification is difficult. Considering the wide diversification of materials and particle sizes to be removed and the varying requirements

[2]Dirt Patterns on Walls, by R. A. Nielsen (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1941, p. 247).
[3]Industrial Dust, by Philip Drinker and Theodore Hatch (McGraw-Hill Co., New York, N. Y.).