air cleaners. Settling chambers are used in boiler plants for capturing cinders, but they occupy too much space for general use in 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, rather than 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 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 relatively high cost, large space requirements, and the fact that the air must enter and leave the apparatus in substantially parallel and straight flow.

Dust and Lint

Air-borne solid matter from the viewpoint of air cleaning is considered as lint and dust. 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 because of its comparatively great length. So far as air filter performance and testing are concerned, lint is chiefly important because 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 10.

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 will emphasize the difficulty of cleaning air or 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, since some of the particles are undoubtedly deposited by contact and by thermal precipitation, the ability to remove small particles is desirable in an air cleaner.

The migration of dust particles 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 surfaces 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, lath marks do not form, and deposition of dust is much slower.

A laboratory apparatus has been designed employing thermal precipitation in capturing 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 which have to be met in the field, it is natural that many kinds of air cleaning devices are used which cannot be shown satisfactorily in a simple outline. Classifications on three different bases are enumerated herewith:

1. Principle of air cleaning.
   - a. Viscous-impingement filters.
   - b. Dry filters.
   - c. Washers.
   - d. Centrifugal devices.
   - e. Electrical precipitators.
2. Methods of servicing.
   - a. Automatic.
   - b. Non-automatic.
     - (1) Throw-away (replaceable elements).
     - (2) Manually cleaned in place (including one type of electrostatic).
     - (3) Removable for cleaning.
3. Classification according to application.
   - a. General air conditioning.
     - (1) Central cleaning system.
     - (2) Unit ventilator.
     - (3) Window installation.
     - (4) Warm air furnace.
   - b. Removal of smoke and fumes from stack gases.
   - c. Collection of dusts from exhaust systems.

VISCOUS IMPINGEMENT TYPE CLEANERS

The medium in a viscous impingement type filter is usually a fiber pack for non-automatic types or a series of metal plates for automatic self-cleaning types. In either case, the medium is treated with a viscous substance, often an oil or grease, called the *adhesive* or the *saturant*,