most dry filters are cleaned by replacing an inexpensive filter sheet, the useful life of these sheets often may be lengthened by vibrating or vacuum cleaning.

## AIR WASHERS

Air washers, originally designed as the name implies to wash air, are now used for humidification (see Chapter 26). Their ability to cleanse air depends upon the nature of the dust; fine particles, especially those having no affinity for water, are not efficiently removed.

## ELECTRICAL PRECIPITATORS

Electrostatic precipitation has long been used for the precipitation of smokes and fumes from smoke stacks, but until recently such equipment was unsuited to air conditioning and ventilation applications. The operating principles are as follows: A discharge takes place from a small wire to grounded electrodes and as the air passes through this discharge the dust particles receive an electrical charge. The air then passes between parallel plates with a high potential difference between plates. The resulting electric field attracts the dust particles to one set of plates.

The electric force is effective in depositing the particle on the plate, but does not hold it there. Some dusts stick to the plates, but in general there should be a coating of adhesive. The dust is removed by washing. As this device is sensitive to air velocities, care should be taken to avoid any local currents that exceed rated velocity. An advantage of electrostatic precipitation is the ability to remove fine particles at high efficiency and with a low pressure drop, and thus with little change in the volume of air delivered. This feature must be balanced against the greater first cost.

## CLEANING OF GASES FROM EXHAUST SYSTEMS

The gases from exhaust systems vary widely, but in general contain heavy concentrations of dust as compared to ventilation practice. A dust loading of one grain per cubic foot of air is not unusual, which is about 1000 times the dirt usually found in ventilating air. For this reason even though the cleaning efficiency is high it is still usually desirable to discharge the exhaust out of doors. The purpose of the cleaning is then to prevent a nuisance in the neighborhood or to collect valuable material.

### Gravitational Settling Chambers

Settling chambers are simple but effective only in removing large particles. The rate of fall of various particles is given in Fig. 1 of Chapter 4. Even though the vertical height is kept small to reduce the time of fall, limitations of space and volume of air to be handled usually allow time for only the larger particles to settle, even if the flow is perfectly streamline. Actually, eddies retard the settling of particles so that the full velocity of fall is not realized.

### Cyclones or Centrifugal Separators

The force causing settling can be increased many times that of gravitation by giving the air a whirling motion and introducing centrifugal





force. The settling rate then becomes dependent upon the peripheral air velocity and the radius of curvature as well as upon the other factors.

In cyclone separators, air is introduced tangentially into a vertical cylinder and passes out from the center of the top. The gas velocity and curvature of the cylinder cause whirling which throws the particles to the surface. The particles slide down this surface and are removed through a hopper in the cone bottom, or are thrown through slits in the periphery.

Assumptions regarding streamline flow and turbulence make general calculations of centrifugal settling rate quite involved and rough. Centrifugal separators have wide application in connection with industrial operations such as grinding, screening and combustion, but have little or no effect upon the finer particles.

When a high collection efficiency is desired, or the material is unusually fine, multicyclones may be used. These are merely small cyclones arranged in parallel which utilize the principle of high centrifugal velocity to attain separation.

### Cloth Filters

Filters are used when the material collected by an exhaust system is valuable or cannot be separated efficiently from the air with an ordinary cyclone. They are also employed when it is desirable to recirculate the air drawn from a room by the exhaust system, which otherwise might entail considerable loss in heat. Bag filters which are properly housed may be operated under suction. Bag houses used in manufacture of zinc oxide and other chemical products are operated on the positive side of the fan.

Wool, cotton and asbestos cloths are commonly used as filtering mediums. When woolen cloths are employed, the filtering capacities vary from ½ to 10 cfm per square foot of filtering surface, depending on the character of the material collected. The rates for cotton and asbestos cloths are lower. The type of filter cloth and the rates of filtration depend, of course, on the material to be collected and the fan capacity. The collected dust particles themselves aid in agglomerating and retaining others. Periodic shaking with the fans off or reversed, at intervals of a few hours drops the excess dust into a lower header or hopper for removal.

Readily removed filters built in small sections in which filter mediums can be replaced are of distinct advantage where deterioration is rapid. Various styles of construction are available which combine quick interchangeability and large filtering area per square foot cross-sectional area. Use of several independent units in parallel is important for the reconditioning of each unit separately. Both continuous and intermittent shaking and sweeping devices remove excess dust and maintain a low resistance.

Such filters should be frequently inspected for leaks and the bags or screens should be in readily replaceable units. General practice in this field is to use a low flow per square foot of cloth and a high pressure drop, giving a relatively high efficiency as compared to general ventilation practice. However, because of the high dust loading, the discharged air may still carry excessive dust for ventilating purposes.