ineffective. Fine cloth filters are very effective, except that they also clog rapidly and soon become impervious to air. These considerations led many years ago to the development of the air-washer types of air cleaners which use water. With the advent of the automobile and the increased industrial activities of city life, the character of air impurities changed from one which was soluble in water to soot, carbons, etc., which are almost totally unaffected by water. To meet these conditions various types of viscous and dry filters were developed.

To fulfill the essential requirements of clean air, an air cleaner should:

1. Be efficient in the removal of harmful and objectionable impurities in the air, such as dust, dirt, pollens, bacteria, etc;
2. Be efficient over a considerable range of air velocities;
3. Have a low frictional resistance to air flow;
4. Have a large dust-holding capacity without excessive increase of resistance or have ability to operate so as automatically to keep the resistance constant;
5. Be easy to clean and handle or clean itself automatically; and
6. Leave the air passing through the cleaner, free from entrained moisture or charging liquids used in the cleaner.

Air cleaners are rated as follows:

1. Capacity in cubic feet of air handled per minute.
2. Resistance in inches of water at rated capacity.
3. Percentage of dust removal at rated capacity.

TYPES OF AIR CLEANERS

Air cleaners may be classified as follows:

1. According to principle of air cleaning.
   - a. Air washers.
   - b. Viscous air filters.
     - (1) Unit type.
     - (2) Automatic type.
   - c. Dry air filters.
2. According to application.
   - a. For central fan systems of ventilation and air conditioning. Filters of the automatic or semi-automatic type are usually recommended and are installed in a central plenum chamber.
   - b. For unit ventilators. Filters of viscous unit or dry type; installed at inlet of individual units.
   - c. For window installations. Self-contained units consisting of fan and filter, usually dry type; adapted to be placed in the ordinary window.
   - d. For warm air furnaces. Unit type viscous or dry filters placed in small plenum chamber of warm air house heating systems.
   - e. For compressor and diesel engines. Unit type viscous or dry filters, installed at air intake of compressors and diesel engines.
   - f. For compressed air lines. Unit type viscous or dry filters.

VISCOUS CELL FILTERS

Viscous-coated air filters are distinguished from air washers in that they clean the air without the use of water. Thus the temperature and

moisture content of the air are not changed by passing through a viscous filter.

The principle of air cleaning used in these filters is that of *adhesive impingement.* Dust and dirt in the air, especially soot and carbons, are trapped and retained by successive impingements on oil coated surfaces. While the arrangement of filtering media and the kind of materials used are almost unlimited, there are certain rather definite requirements for a practical commercial filter.

In order to secure maximum efficiency it is necessary to divide the air into innumerable fine streams; the more intimately and freely the air is brought into contact with the viscous-coated media the better the cleaning will be. As the dirt and dust particles are leached out of the air and collected on the adhesive-coated surfaces, additional supplies of viscous liquid are required in order to bind further layers of dirt. For this reason the filter medium in *unit filters* is usually designed to hold, somewhere within the cell, additional supplies of viscous liquid, capable of distribution by capillary attraction.

Investigations in this country and abroad demonstrate that the first impingement of dust laden air on a viscous coated surface removes about 60 per cent of the dust, the next impingement takes 60 per cent of what then remains—that is, 24 per cent—the next impingement removes 9.6 per cent, etc. This tendency to eliminate progressively smaller amounts of dust at each impingement, even though finer dust particles are caught at each successive impingement, has led to progressively packed filter media in practically all unit filters. Such an arrangement provides relatively large spaces for the collection of dirt in the front part of the filter, where the bulk of solids is taken out, without undue increase in resistance, while at the back of the filter the openings are smaller and finer dust particles are removed.

The binding liquid used with viscous filters should have the following properties:

1. Its surface tension should be such as to produce a homogeneous film-like coating on the filter medium.
2. The viscosity should vary only slightly with normal changes of temperature.
3. It should be germicidal in its action to prevent the development of mold spores, bacteria, etc., on the filter media.
4. The liquid should flow freely at low temperatures.
5. Evaporation should not exceed 1 per cent.
6. It should be fireproof.
7. It should be odorless.

The viscous-cell filter takes its name from the manner in which the filter medium is subdivided into small units to facilitate easy handling. Each unit consists of a frame and interchangeable cells. These cells fit into the frame and may be locked in place, a felt gasket assuring airtight contact at all points. An installation is built up of the required number of units, arranged in the form of a wall between the source of dusty air and the supply fan.

The resistance of a unit filter of the adhesive-impingement type depends upon the velocity at which the air is handled and the condition of the unit, that is, whether it is clean or dirty. The resistance of a commercial