particle count method is not used for efficiency evaluation, except in investigation of filter performance on specific particles such as pollen, or on certain industrial dusts harmful to health. Dust particles can be captured on microscope slides by means of one of the various kinds of impingement devices. The process is useful if inspection and analysis of dust are desired, but particle counting is not sufficiently precise for evaluating the efficiency of a cleaner operating on a heterogeneous dust.

The weight method of evaluating efficiency has found wide utility, and was recognized by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and incorporated in a code.[4] For this test, a known weight of a prepared dust is injected into air supplied to the filter, and the quantity of dust in the cleaned air is determined by extracting and weighing the dust from a known volume of the cleaned air. Dust extraction from the air is accomplished by drawing the air through a porous crucible or thimble by means of a high vacuum.

Caution is to be exercised in interpreting published air filter arrestance data, since the test efficiency may be somewhat higher than that which will be obtained in an installation with respect to the ventilated space.

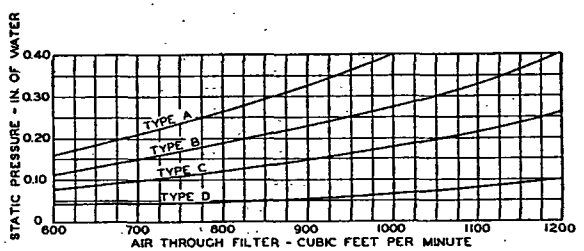


FIG. 3. RESISTANCE TO AIR FLOW OF TYPICAL UNIT AIR FILTERS

The *dust-spot* or *blackness* test for cleaner efficiency was developed at the *National Bureau of Standards.*[5] The test consists of drawing samples of cleaned air and of uncleaned air through filter papers simultaneously. The ratio of the areas of paper through which the air samples are drawn, and the ratio of the amount of air drawn through the papers, are adjusted during successive trials to yield spots of approximately equal blackness on the papers. The ratios of the areas and of the volumes of the air samples are then indicators of the filter effectiveness. A special photometer is provided for comparing the blackness or opacity of the papers by transmitted light. For tests of ordinary air filters by this method, a dust is injected into the air stream. The dust consists of precipitated smoke particles from a Cottrell precipitator used in a local power plant for smoke abatement. For tests of electrostatic air cleaners, no dust is added to the air. Tests are commonly made with the dust existing in the air at the location of the installation on a clear day.

Dust-holding capacity is defined as the amount of dust which a filter can retain and have a resistance less than some arbitrary value. The term applies only to non-automatic air cleaners. Determination of dust-holding capacity is an objective of each test under the A.S.H.V.E. Standard Code.[4] Curves are obtained during such tests to show the relation between dust load and resistance.

Fig. 3 indicates the general range of resistance to air flow through unit



air filters. Type A is a dense pack used in bacterium control; Type B is a medium pack used for general ventilation work; Type C is a low resistance unit, for use where low resistance is the important factor and maximum cleaning efficiencies are not essential; and Type D is a high-velocity viscous-impingement filter.

At the *National Bureau of Standards* two injectors are provided on the air cleaner testing apparatus. One injector is used to contaminate the air stream with Cottrell precipitate, previously described. This dust is used to make both efficiency determination and dust-holding capacity tests. The other injector contaminates the air stream with cotton linters with which lint-holding capacity tests are made. The curves in Fig. 4 illustrate the difference in the characteristics of two filters, one a viscous-impingement type and the other a dry filter with a cellulose fiber medium. The two injectors can be operated either separately or simultaneously.

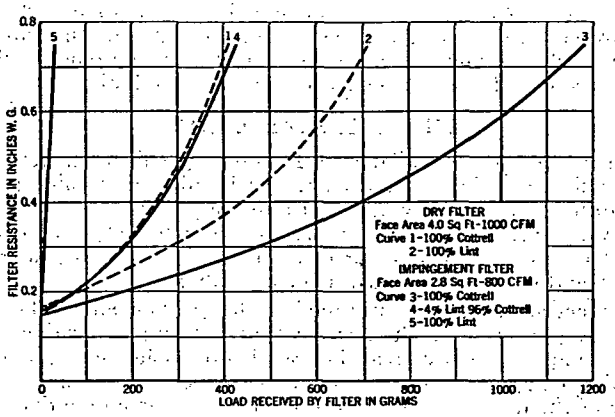


FIG. 4. DUST AND LINT HOLDING CAPACITY OF TWO FILTERS

## SELECTION AND MAINTENANCE

For removing fine dust or liquid particles which show no gravitational settling tendency, electrical precipitators are highly effective in air cleaning applications. The electrostatic equipment is comparatively expensive to install and maintain. However, in many applications where the cleanest air possible is needed, this expense is justified by the results obtained with properly installed and operated electrostatic air filters. While the charged media type of electrostatic precipitator is less expensive to install and maintain than other types, it is still substantially more costly than the mechanical types of filters.

The advantage of the automatic impingement type filter consists in the small amount of attention which it requires. Such devices are therefore to be recommended where labor is scarce, or where reliable and frequent attention to filters cannot be assumed. The constant pressure drop of this type of filter is an advantage. The first cost is substantially greater than that of unit filters, and the dust arrestance may not be any higher.

Unit filters constitute the majority of air cleaners now in use, and some choice is possible between the types available. Where lint in an eminently dry state predominates, a dry filter obviously may be preferable to other types because of its lint-holding capacity. If the lint is greasy, or if oil