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. Some specifications for this type cleaner have required that in dust spots of equal area the downstream spot shall not be any dirtier than the upstream spot when 10 times as much air is drawn through it as is drawn through the upstream spot. When this condition is met the cleaner is said to have an efficiency or arrestance of 90 per cent or better on atmospheric air.

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. Typical curves are shown in Fig. 2. Type A is a dense pack used in bacterium control; Type B is a medium pack used for general ventilation work; and Type C is a low

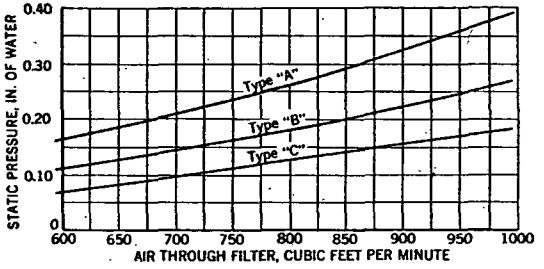

FIG. 2. RESISTANCE TO AIR FLOW OF TYPICAL UNIT AIR FILTERS

resistance unit, for use where low resistance is the important factor and maximum cleaning efficiencies are not essential.

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. 3 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. A total dust deposit of 4 per cent cotton linters and 96 per cent Cottrell precipitate gives a deposit on a filter closely resembling those that occur in Washington, D. C.

SELECTION AND MAINTENANCE

If effectiveness in arresting dust were always the primary consideration, an electrostatic cleaner might be used for all air cleaner installations. Where the dust load is heavy, a filter bank may be installed ahead of the precipitator. At the present time electrostatic equipment is comparatively expensive and bulky and is therefore only used when the expense is justified by the need for the cleanest air possible.

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. This type of equipment is not any better in dust arrestance than some unit filters, and it ranks next to precipitators in first cost.

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 on account of its lint-holding capacity. If the lint is greasy or if oil vapor exists in the air, the dry filter, if it is of the cleanable type, may be troublesome, since grease tends to make it difficult to clean. The cleaning difficulty is avoided if a throw-away type of medium is used. Some dry filters are capable of high efficiencies, compared to other unit

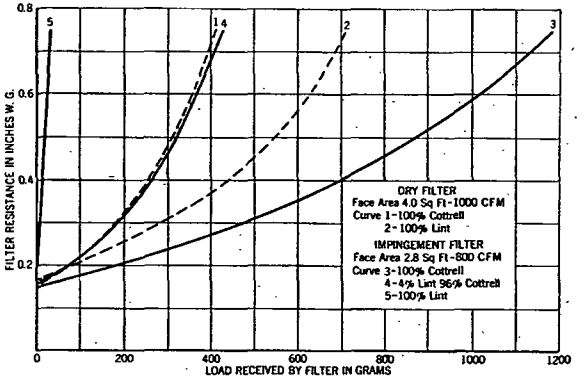

FIG. 3. DUST AND LINT HOLDING CAPACITY OF TWO FILTERS

filters on fine particles, but their dust-holding capacity for such dust may be inferior to that of the viscous impingement type.

Viscous impingement unit filters represent the general type of air cleaner now in use. They have approached standards in size and their over-all dimensions are small when compared with their ratings.

Throw-away units are often installed in series so that the one in front, which usually becomes plugged with lint, can be discarded after which the downstream unit is moved to the front and replaced by a new unit.

Viscous impingement unit filters do not have efficiencies as high as can be expected with some other types of unit filters, but their first cost and upkeep are generally lower, whether of the cleanable or the throw-away type. They require more careful attention than the automatic oil type if the resistance is to be maintained within reasonable limits.

Safety Requirements

An investigation of safety ordinances should be made by the engineer when the installation of an air cleaner of any considerable size is contemplated. It is possible that a combustible filtering media may not be permitted in accordance with some existing local regulations. Combus-