c. Elbows and angles should have an inside or throat radius of two pipe diameters whenever possible, but the radius shall never be less than one pipe diameter. Large radii are recommended for heavy concentrations of highly abrasive dusts. Construct elbows 6 in. or less in diameter of at least five sections, over 6 in. diameter of seven sections. Angles shall be pieced proportionately.

d. Hoods must be free of sharp edges or burrs and shall be reinforced to provide necessary stiffness.

e. Provide dead end caps within 6 in. from last branch of all mains and sub-mains.

f. Provide cleanouts every 10 ft and near each elbow, angle, or duct junction in horizontal sections.

g. Support ducts sufficiently to prevent placing of any load on connecting equipment and to carry weight of system if plugged with material. Use maximum supporting interval 12 ft for 8 in. or smaller ducts and 20 ft for larger ducts.

h. Provide 6 in. minimum clearance between ducts and ceiling, wall, or floor.

i. Rectangular ducts can be used only when clearances prevent the use of round construction. Rectangular ducts must be as nearly square as possible. Weight of metal, lap and other construction details are to be the equal of round duct construction whose diameter equals the longest side.

j. All branches shall enter the main at the large end of the transition at an angle not to exceed 45 deg (30 deg is recommended). Connect branches only to top or sides of main, with no two branches entering diametrically opposite.

System Details

a. Connect duct to fan inlet with split sleeve drawband one pipe diameter long but not less than 5 in.

b. Transitions in mains and sub-mains are to be tapered; taper 5-in. long for each 1-in. change in diameter is recommended.

c. Place blast gates for adjustment of system near connection of branch to main. Provide means for locking gates after adjustments have been made.

d. Fire dampers, explosion vents, etc., should be installed in accordance with *NFPA* Codes or local fire ordinances.

Deviation From Specifications

Where State or local laws conflict with the specifications given, the more stringent regulation shall be followed. Any other deviation must be approved before installation.

AIR FLOW PRODUCING EQUIPMENT

The principal types of air moving equipment are centrifugal fans, axial flow fans, and venturi ejectors. Chapter 33 includes information on fan types, arrangements, and application. Gravity stacks have application for some systems handling higher air temperatures or steam where no air cleaning equipment is installed.

Centrifugal fans are most frequently used for the bulk of exhaust system applications due to the system pressures involved. Where air cleaning equipment is included, fans are usually located on the clean air side. The paddle wheel or modified paddle wheel designs are heavily constructed and have few blades to make them more suitable if wear, corrosion, or accumulations are a factor. The higher efficiency backward curved blade designs find application where relatively clean, non-corrosive air is handled. Forward curved blade designs have limited application due to the number, shape, and metal thickness of the short curved blades.

Belt driven fans are recommended by many designers because a change in fan speed is often needed where future changes of the system may be involved, where added pressure losses from air cleaning equipment improvements are anticipated, or where the fan may be used at some later date for another application.

The axial flow fan is used for systems having low pressure losses. Propeller or disc designs develop pressures under 1 in., the vane-axial designs develop higher pressures but seldom are used where pressures exceed 3 in.

The venturi ejector[39] is an inefficient method of air movement, but has the advantage of causing air flow without the exhaust air passing through the air flow producing equipment. It minimizes the explosion or corrosion potentialities in certain types of system.

Fans, motors, and drives should be located so that safe and easy access for periodic inspection, servicing, and maintenance is possible.

AIR CLEANING EQUIPMENT

As discussed in detail in Chapter 34, air cleaning equipment should be considered in all systems to prevent property damage, neighborhood pollution, re-entry to the working space; to salvage usable material, reduce fire and explosion hazards or to make possible some recirculation of air to the working spaces. The present growing emphasis on air pollution control makes it desirable to remove all contaminants to the greatest practical degree based on reasonable cost and maintenance.

MAKE-UP AIR REQUIREMENTS

A correctly designed exhaust system may be ineffective during periods when windows and doors are closed. This condition should be anticipated and prevented by making provision for an adequate air supply. Poor performance of exhaust hoods is caused by: absence of air supply systems; cold drafts due to high indraft velocities through cracks and openings in building construction especially at windows and doors; reverse air flow through low pressure systems of roof ventilators or general ventilation systems; downflow through heater vent stacks preventing exhaust of flue gases to the outside. Systems for conditioning make-up air do not necessarily increase heating requirements for the space, as cold air due to infiltration from the outside must be heated somehow to maintain comfortable temperatures in the area. The cost will depend on the ratio of exhaust air to that required for ventilation of the space occupied.

MAINTENANCE OF PERFORMANCE

Periodic inspection and checking of exhaust systems are necessary if control is to be maintained at the effective level of the original installation. Continued effectiveness depends on maintained design air volume flowing through the exhaust hoods. A checking procedure, therefore, must include some data to indicate at least relative air flow through the hoods. The static pressure or hood suction measurement will prove useful for such checking if data are available on air volumes and pressures at the time the system was installed. Testing and recording of such data for each new installation are of the utmost importance.

While hood suction readings have rightfully been discarded as a means of measuring air flow, they do offer a quick and accurate method of measuring relative air flow. If the hood suction is known while an exhaust system is functioning properly, its continued effectiveness can be assured so long as the hood suction is not reduced from its original value.

Unless the hood design is altered or there are accumulations in the hood or branch pipe between hood and point of hood suction reading, the air volume