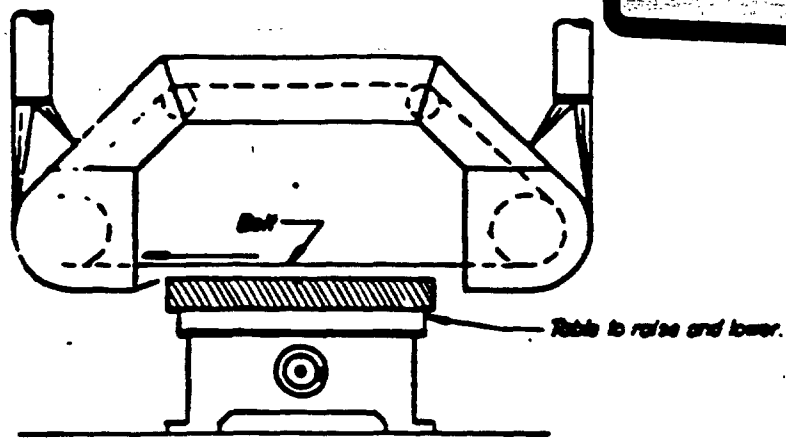
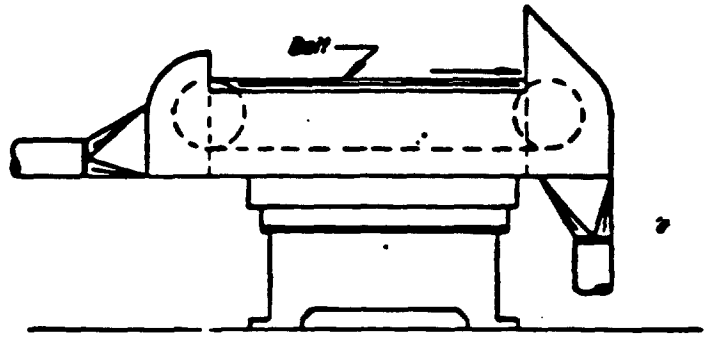
PLAINTIFF'S EXHIBIT
K-1208



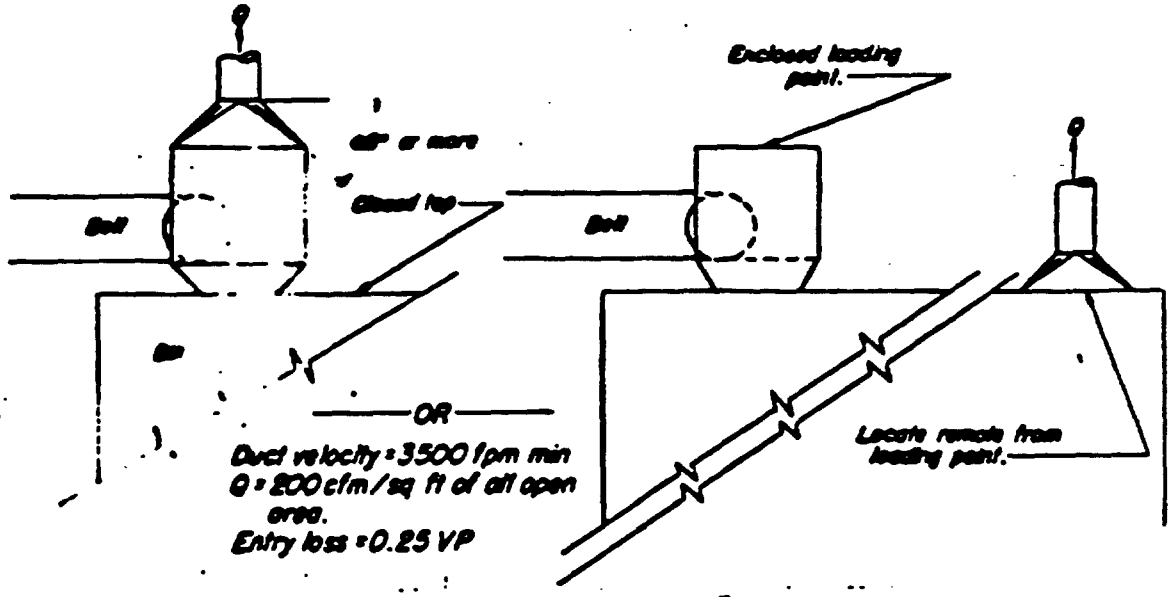


HORIZONTAL BELT SANDERS

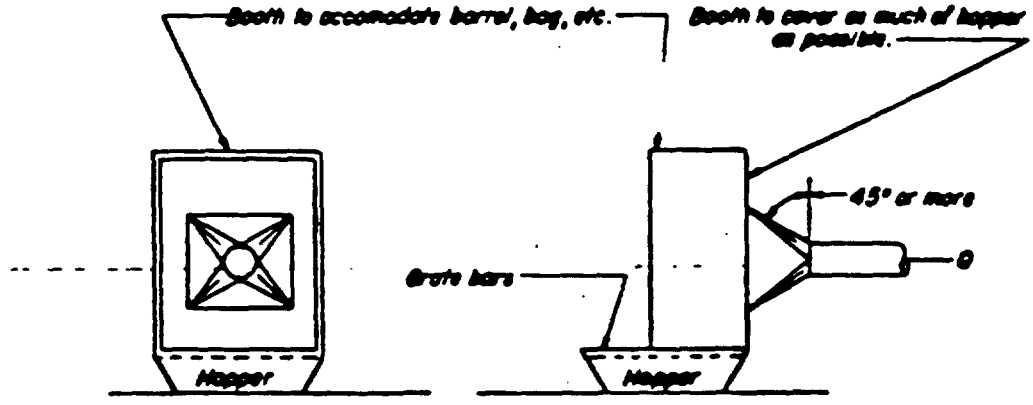
Belt width, inches	Exhaust volume, cfm		
	Head end	Tail end	Total
Up to 6 incl	440	350	790
over 6 to 9 incl	550	350	900
over 9 to 14 incl	800	440	1240
over 14	1100	550	1650

Duct velocity = 3500 fpm
Entry losses = 0.40 VP for tapered take-off

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HORIZONTAL BELT SANDERS	
DATE 1-64	VS-702



MECHANICAL LOADING*



Duct velocity = 3500 fpm minimum
Q = 150 cfm/sq ft face
Entry loss = 0.25 VP

MANUAL LOADING

*BELT SPEED — VOLUME

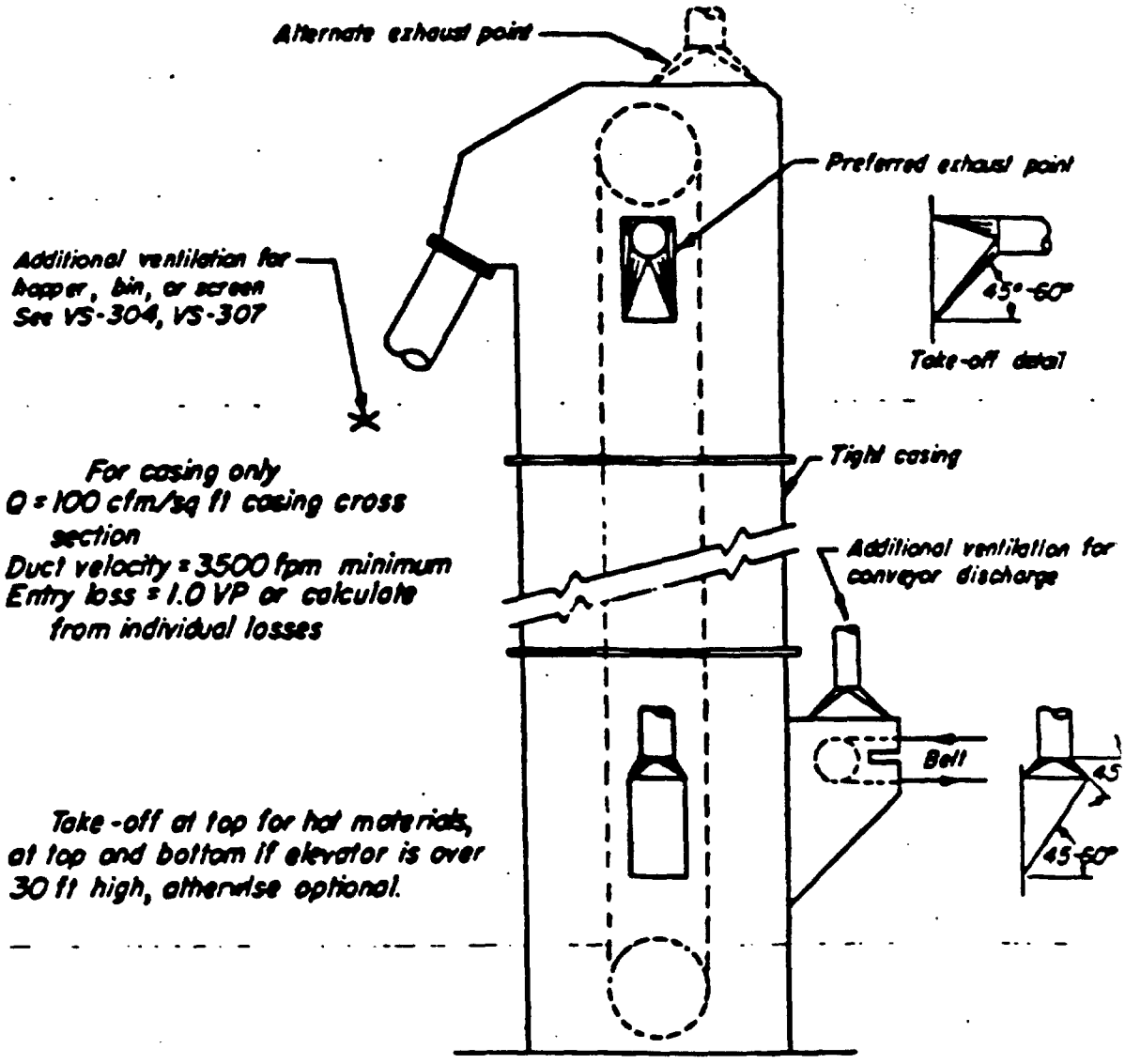
Less than 200 fpm - 350 cfm/ft of belt width. Not less than 150 cfm/ft of opening.

Over 200 fpm - 500 cfm/ft of belt width. Not less than 200 cfm/ft of opening.

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BIN & HOPPER VENTILATION

DATE 1-72 | VS-304

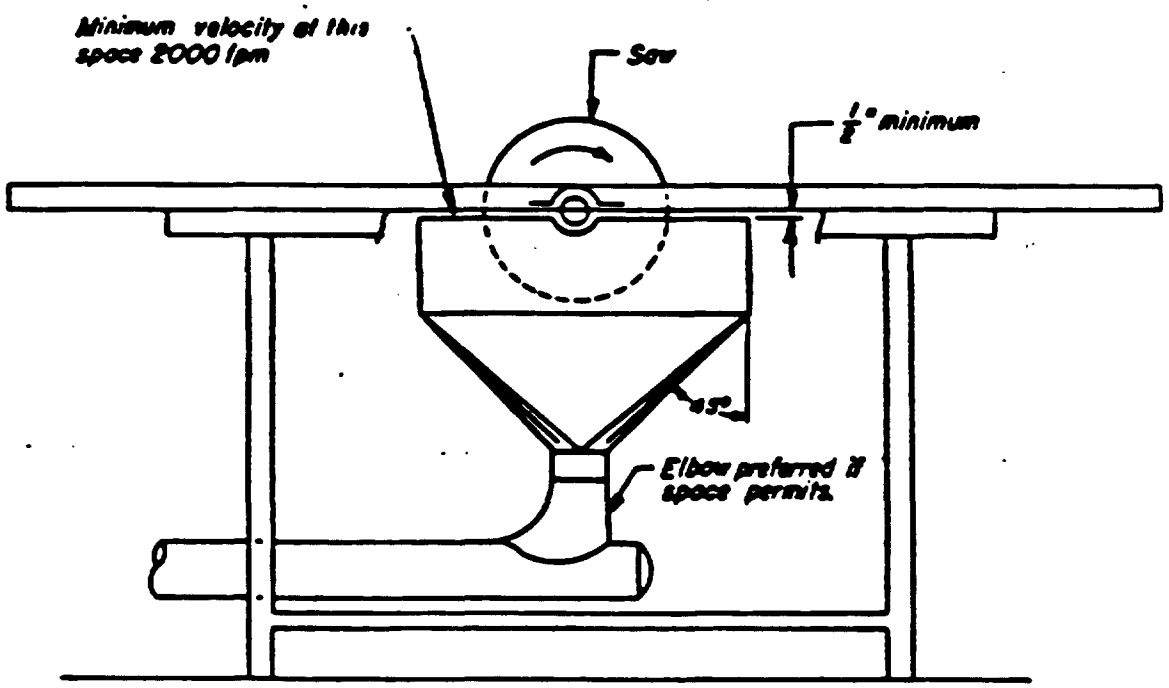


Belt speed	Volume
Less than 200 fpm	— 350 cfm/ft of belt width. Not less than 150 cfm/ft of opening
Over 200 fpm	— 500 cfm/ft of belt width. Not less than 200 cfm/ft of opening

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BUCKET ELEVATOR VENTILATION

DATE 1-66 | VS-305

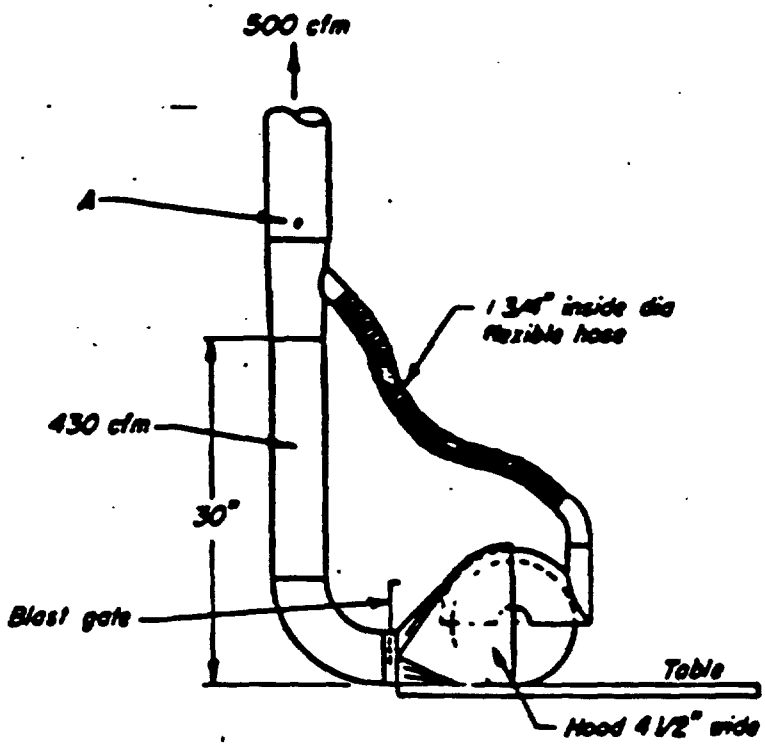


Table, rip, mitre and variety saws

Saw diameter, inches	Exhaust volume, cfm
Up to 16 incl.	350
over 16 to 24 incl.	440
over 24	550
variety with dado	550

Duct velocity = 3500 fpm
Entry loss = 1.0 slot VP + 0.25 duct VP

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TABLE SAW	
DATE 1-68	VS-708



Duct velocity = 3500 fpm
Entry loss = 3.5 VP in duct riser (Point A)

For booth enclosure, see VS-401

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RADIAL SAW	
DATE 1-68	VS-709

LOW VOLUME-HIGH VELOCITY EXHAUST SYSTEMS

The low volume high velocity exhaust system is the unique application of exhaust which uses small volumes of air at relatively high velocities to control dust from portable hand tools and machining operations. Control is achieved by exhausting the air directly at the point of dust generation using close-fitting, custom-made hoods. Capture velocities are relatively high but the exhaust volume is low due to the small distance required. For flexibility, small diameter, light-weight plastic hoses are used with portable tools resulting in very high duct velocities. This method allows the application of local exhaust ventilation to portable tools which otherwise would require relatively large air volumes and large ductwork when controlled by conventional exhaust methods.

This technique has found a variety of applications although its use is not common. Rock drilling dust has been controlled by using hollow core drill steel with suitable exhaust holes in the drill bits. Air is exhausted either by a multi-stage turbine of the size generally used in industrial vacuum cleaners or, in the case of one manufacturer (71), by the exhaust air from the pneumatic tool which operates a Venturi to withdraw air from the drill. Application has been made with flexible connections to a central vacuum system to aid in the control of graphite dust at conventional machining operations. One to two inch diameter flexible hose was used with simple exhaust hoods mounted directly at the cutting tool. In a similar application for the machining of beryllium (72), a central vacuum system using 1 1/2" I.D. flexible hoses was employed. The exhaust hoods were made of lucite or transparent material and were tailor-made to surround the cutting tools and much of the work. Exhaust volumes vary from 120 to 160 cfm with inlet velocities of 11,000 to 14,000 fpm. In another application (73), a portable orbital sanding machine has been fitted with a small exhaust duct surrounding the edge of the plate. A fitting has been provided to connect this to the flexible hose of a standard domestic vacuum cleaner.

VS-801 to VS-806, 802, 803 and 804 illustrate a custom-made line of exhaust hoods available (74). The required air volumes range from 8 cfm for pneumatic chisels to 300 cfm for swing grinders. (See Table 5-8-1) Due to the high entering velocities involved, static pressures are in the range of 5" mercury (68" water gauge). This high pressure is necessary to create the high capture velocities at the dust source to control the dust.

TABLE 5-8-1. EXHAUST VOLUMES REQUIRED FOR LOW VOLUME-HIGH VELOCITY SYSTEM

	cfm	I.D. Plastic Hose Size
Pneumatic chisels	8- 60	3/8"-1 1/2"
Radial grinders	10- 45	5/8"- 7-8"
Surface grinders	10- 50	5/8"-1 1/2"
Disc sander, 5-8 inch diameter	10- 30	5/8"-1 1/2"
Vibratory Sander	100-200	1"-3"
Spindle grinding cone, 1-3 inch diameter	10- 40	5/8"-1 1/2"
Swing frame grinders	250-300	3"
Hand wire brushes	25- 30	5/8"
Surface wire brushes	35	3/4"
Internal grinders, 1 1/2 inch diameter	25	5/8"
Internal grinders, 4 inches diameter	37.5	3/4"

The dust is conveyed at high velocities in small diameter flexible hoses ranging from 3/8" to 2" I.D. The dust laden air is passed into primary and secondary cyclone collectors and through a fabric filtering unit (See Figure VS-807). Exhaust is provided by a multi-stage centrifugal turbine capable of producing static pressures of about 8" mercury (109" water) below atmospheric pressure. The fabric collector can be cleaned by a simple, manual valve which admits air into the clean side of the fabric bringing this side of the fabric to atmospheric pressure. Since the dirty side of the fabric is at a pressure far below atmospheric, this causes rapid air flow through the fabric and provides reverse cleaning.

Design Calculations

With the exception of the proprietary system mentioned, which can be purchased as a "package," the design calculations for these systems are largely empirical. In normal ventilation practice, air is considered to be

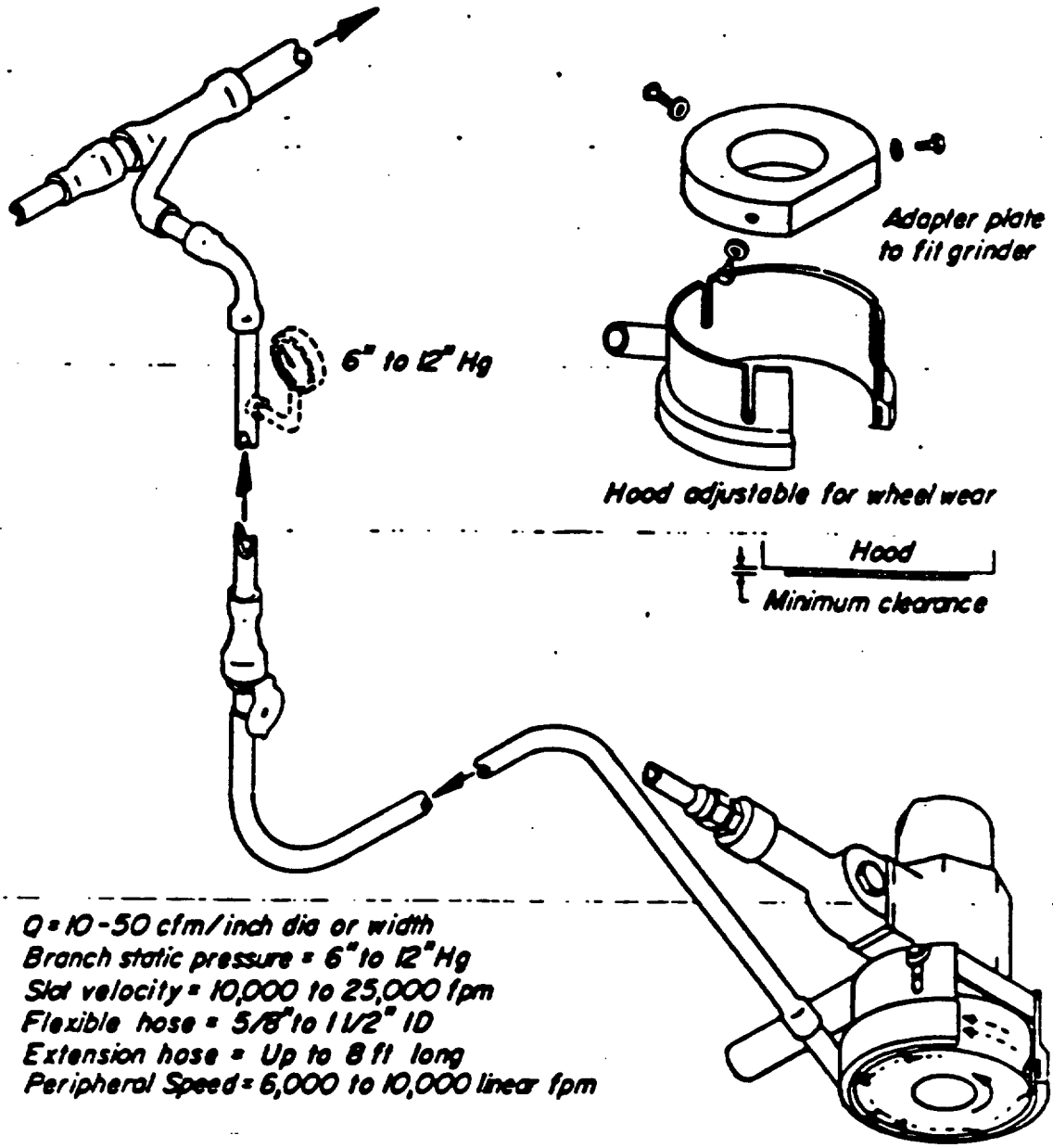
incompressible since static pressures vary only slightly from atmospheric pressure. However, in these systems the extreme pressures required introduce problems of air density, compressibility and viscosity which are not easily solved. Also, pressure drop data for small diameter pipe, especially flexible tubing, is not commonly available. For practical purposes, the turbine exhauster should be selected for the maximum simultaneous cfm exhaust required. Resistance in the pipe should be kept as low as possible; flexible tubing of less than 1" to 1 1/2" diameter should be limited to 10 feet or less. In most applications this is not a severe problem.

The main consideration in piping for such systems is to provide smooth internal configuration so as to reduce pressure loss at the high velocities involved, and to minimize abrasion. Ordinary screwed-fitting piping is to be avoided because the lip of the pipe or male fitting, being of smaller diameter than the female thread, presents a discontinuity which increases pressure loss and may be a point of rapid abrasion.

If a screwed-fitting system is to be used, cast-iron drainage fittings and Schedule 40 pipe should be provided. Fittings of this type are recessed so that the I.D. of the pipe and fitting is the same. Tubing systems of 16 gauge wall thickness up to and including 4 inch diameter, and 14 gauge for 5 inch and above, provide for 10 per cent less pressure loss than a Schedule 40 piping system and offer a lower installed cost in most cases. Commercially available tube fittings and clamps may be used, or a slip-on flange system, so that internal discontinuities are eliminated. In all cases, long-sweep elbows and bends should be provided.

For dust exhaust systems, a good collector should be mounted ahead of the exhauster to minimize erosion of the precision blades and subsequent loss in performance. Final balance of the system can be achieved by varying the length and diameters of the small flexible hoses.

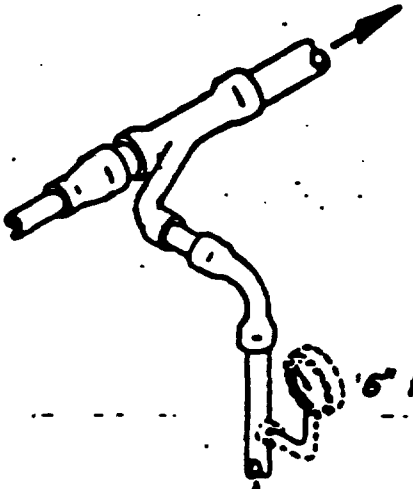
It must be emphasized that although data are empirical, these systems require the same careful design as the more conventional ones. Abrupt changes of direction, expansions and contractions must be avoided and care must always be taken to minimize pressure losses.



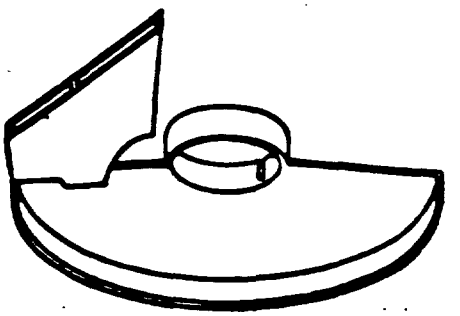
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HOOD FOR CUP TYPE SURFACE GRINDERS AND WIRE BRUSHES

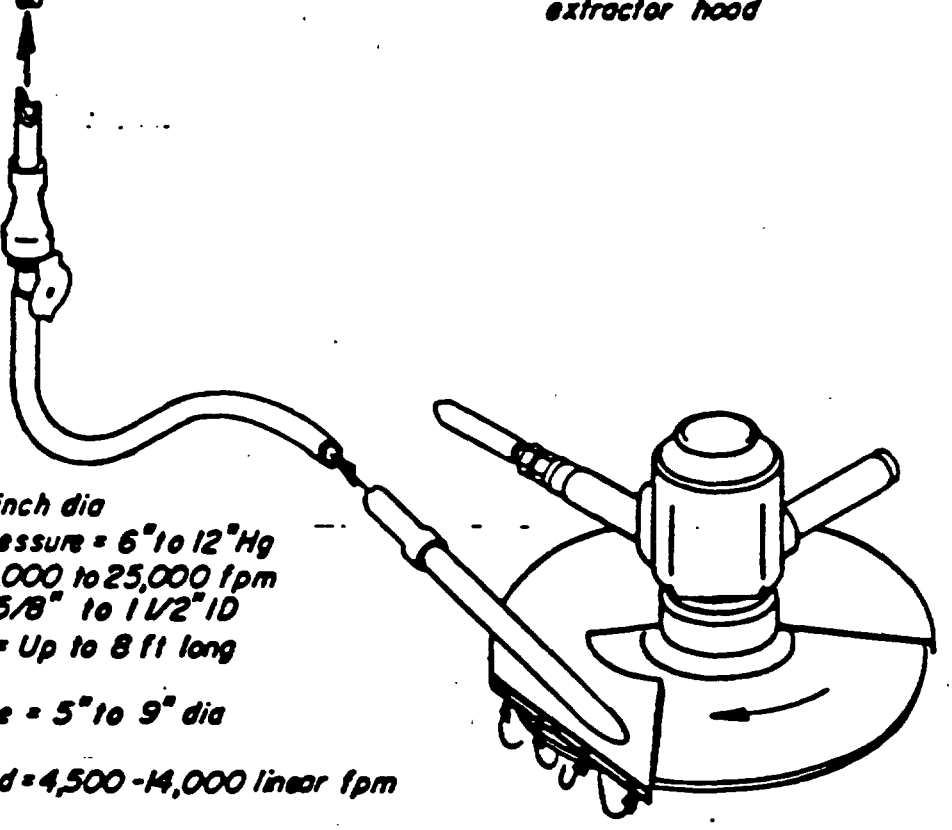
DATE	1-72	VS-802



6" to 12" Hg



Bottom view of extractor hood



Q = 10 - 30 cfm/inch dia
Branch static pressure = 6" to 12" Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 5/8" to 1 1/2" ID
Extension hose = Up to 8 ft long

Sanding disc size = 5" to 9" dia

Peripheral speed = 4,500 - 14,000 linear fpm

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EXTRACTOR HOOD FOR DISC SANDER	
DATE 1-72	VS-805