STATE OF NEW JERSEY

DEPARTMENT OF LABOR & INDUSTRY

[redacted]

Commissioner Percy A. Miller, Jr.

ENGINEERING AND SAFETY STANDARD

Accident Prevention Series

RULES AND REGULATIONS

for the

USE, CARE AND PROTECTION OF ABRASIVE WHEELS

(American Standard B 7.1-1947)

DIVISION OF

ENGINEERING AND SAFETY

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Trenton, N. J.

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FOREWORD

No radical changes have been made in this, the 1947 revision of the Safety Code for the Use, Care and Protection of Abrasive Wheels. The few changes made are intended to bring the rules into line with current practice.

Rule 3.2 covers minimum spindle diameters for various sizes of wheels and includes two tables, one of which is very old. These tables are in the simplest possible form and the minimum spindle size is based on the diameter and thickness of the wheel alone without any regard to bearing design, or nature of the grinding operation. When used as a general guide these tables are quite satisfactory but there are a number of machines in regular use in which the spindles are somewhat smaller than the minimums specified in the tables. Experience has indicated that these machines are entirely satisfactory for the particular work for which they are designed.

In all previous editions Rule 3.2 has appeared in the mandatory form but generally it has not been observed as such. The wording has now been revised so that the tables may be used as a guide only. Smaller spindles than specified may be used where experience has indicated that this can be done safely.

Table 19 has been modified so that types 12 and 13 wheels may be operated at the same speeds as types 1 and 4. Also, classification 11 which covers diamond wheels, has been sub-divided into several groups with different speeds allowed for each. The new sub-division necessitated a new definition for diamond wheels which now appears as 1.2.7. The new speeds are in conformity with developments in the manufacture and use of diamond wheels which have taken place since 1943.

Two new tables (#22 and #26) have been added covering critical speeds for small mounted wheels and points using $\frac{3}{32}$" spindles. These were not included in the previous edition because there did not appear to be any need for them at that time. Since then, however, there has been an apparent increase in the use of very small mounted wheels and points and the tables now appearing as #22 and #26 were prepared under the supervision of the Safety Committee of the Grinding Wheel Manufacturers Association, at the request of a large user.

These three are the only changes in the body of the Code. They were submitted first by the Grinding Wheel Manufacturers Association to all members of the Sectional Committee for preliminary approval. The Sectional Committee was asked at the same time to review critically the entire Code to ascertain if any additional revisions were needed. No additional suggestions were received. This was in December of 1946.

This correspondence revealed the need for several changes in the personnel of the Sectional Committee as listed in the 1943 issue. The new appointments were all made by the organizations involved and were approved by both sponsors. The new appointments did not alter the balance of representation.

After the appointments were all made, the proposed revisions with detailed explanations were submitted to the entire Sectional Committee along with several proposed additions to the Appendix which had been suggested by the Grinding Wheel Manufacturers Association.

The additions to the Appendix include a set of sketches with notes describing the most common causes of failure of threaded hole wheels of the cone or plug types. Descriptions of an adaptor type of mounting for cup wheels on portable grinders and of rubber-faced protection washers are also included. No rules or specifications are included in these additions to the Appendix.

No meetings of the Sectional Committee were held in connection with the 1947 revision. All approvals were handled by correspondence and letter ballot. After approval by the Sectional Committee the revision was formally approved by both sponsors and submitted to the American Standards Association for final approval.

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SAFETY CODE FOR THE USE, CARE, AND PROTECTION OF ABRASIVE WHEELS

SECTION 1

SCOPE AND DEFINITIONS

1.1 Scope

Rules and specifications for safety in the use of abrasive wheels excluding natural sandstones, including specifications for protection hoods, flanges, chucks and revolving cup guards, and rules for the proper storage, handling and mounting of wheels.

1.2 Definitions

1.2.1 *Shall* and *Should*

The word "shall" where used is to be understood as mandatory and "should" as advisory.

1.2.2 *Abrasive Wheel*

An abrasive wheel is a power driven wheel consisting of abrasive particles held together by artificial or natural, mineral, metal or organic bonds. Diamond wheels (see separate definition 1.2.7) are included. Metal, wooden, cloth or paper wheels or discs having a layer or layers of abrasive on the surface are not included. Natural sandstones (quarried) are not included.

1.2.3 *Adaptors*

Adaptors are a form of flange used to mount wheels in which the holes are larger than the machine arbors.

1.2.4 *Band Type Hood*

(Formerly known as "Protection Band.") This is a type of protection hood designed especially for use where grinding is done only on the exposed flat side of the wheel and where the diameter of the wheel remains constant throughout its life. This type of hood differs from other protection hoods in that it consists solely of a properly supported peripheral member or "band." This band is continuous and completely surrounds the wheel, and as its diameter is only slightly larger than the outside of the wheel, it need not be as heavy as other types of hoods for wheels of given size.

1.2.5 *Cast Hood*

A Cast Hood is a protection hood which has the peripheral protecting member cast integral with one side member, and may be made of gray iron castings, malleable iron castings, steel castings or castings of any other suitable material. One side member and/or the peripheral member may also be an integral part of the base casting or wheelhead casting of the grinding machine.

1.2.6 *Cutting Wheels*

Cutting wheels are organic bonded wheels, the thickness of which is not more than $\frac{1}{48}$ of their diameter for those up to 20" diameter, and not more than $\frac{1}{60}$ of their diameter for those larger than 20 inches diameter and used for a multitude of operations variously known as cutting, cutting-off, grooving, slotting, coping and jointing, etc. They may be "solid" consisting entirely of organic bonded abrasive material throughout, "steel centered" consisting of a steel disc with a rim of organic bonded material moulded around the periphery, or of the "inserted tooth" type consisting of a steel disc with organic bonded abrasive teeth or inserts mechanically secured around the periphery.

1.2.7 *Diamond Wheels*

Diamond wheels are abrasive wheels in which the abrasive particles are diamond. Usually only those sections of the wheel which do the grinding or cutting contain diamonds. The diamond-bearing sections are made with a variety of bonds such as metal, resin and vitrified, which are attached to non-diamond-bearing cores, centers, backs, etc. The non-diamond-bearing sections are made of various materials such as steel, resins, metallic compounds, etc. Steel-centered diamond cutting-wheels have the diamond-bearing sections (either continuous or interrupted) secured to the periphery of a steel disc.

1.2.8 *Drawn Steel Hood*

A Drawn Steel Hood is a protection hood where the peripheral member and the fixed side member are formed from a single plate or sheet of steel. A cover, consisting of a side plate and a relatively narrow peripheral member, is similarly formed from a single plate or sheet of steel. The peripheral member of the cover fits over and outside of the peripheral member of the guard proper. The cover therefore adds strength to the guard proper, in addition to acting as a side guard.

1.2.9 *Fabricated Hood*

A Fabricated Hood is a protection hood which is built up or constructed by bolting, pinning, riveting, or welding the peripheral protecting member to the side members, and may be made of structural steel plate, wrought iron plate, or an assembly of either of these in combination with gray iron castings, malleable iron castings, or steel castings or a material possessing an equivalent tensile strength.

1.2.10 *Flanges*

Flanges are collars, discs, or plates between which wheels are mounted.

There are two main classes of flanges, namely, those intended for use in connection with protection hoods and those intended for use where protection hoods are not employed. The former serve only as a support and driving medium for the wheel while the latter serve as protection devices in addition. There is a separate definition for Protection Flanges.

1.2.11 *Inserted Nut Wheels*

Inserted Nut Wheels have several threaded metal nuts securely and permanently anchored in one flat side by cementing, casting or molding. The machines using this type of wheel have flat face plates or face plate adaptors with holes spaced to match the spacing of the inserted nuts in the wheel. The wheel is held in place and driven by screws passing through the holes in the face plate or adaptor and engaging the threads in the inserted nuts. The wheels may be either Type 1* (straight) or Type 2* (cylinder). Grinding is always done on the exposed flat side.

1.2.12 *Mounted Wheels*

(Sometimes called "Mounted Points.") Small wheels, usually 2 inches or less in diameter and of various shapes, which are securely and permanently mounted on the end of a steel spindle, mandrel or quill by cementing or other means. In use the spindle (mandrel or quill) is held in a chuck on the end of the grinding machine spindle.

1.2.13 *Overhung Wheel*

An Overhung Wheel is any wheel which is not supported between bearings.

1.2.14 *Plate Mounted Wheels*

Plate Mounted Wheels have plates of steel or other rigid material securely and permanently anchored to one side. The plate is provided either with a set of holes (threaded or clear) or with a set of projecting studs. The machines using this type of wheel have flat face plates or face plate adaptors with holes spaced to match the holes or studs of the wheel plate. The wheel is fastened to the face plate or adaptor by suitable screws or bolts, or in the case of the projecting stud type, by means of nuts. The wheel may be either Type 1* (straight) or Type 2* (cylinder). Grinding is always done on the exposed flat side.

1.2.15 *Precision Grinding*

This term includes grinding performed on types of machines commonly employed to produce perfection in dimensions and finish, as opposed to those grinding operations which are for the purpose of removing stock only.

1.2.16 *Protection Chuck*

A Protection Chuck is a chuck used for mounting cup, cylinder, or segmental ring wheels, so designed that in addition to supporting and driving the wheel it will also

*Type numbers refer to classifications listed in Bureau of Standards Simplified Practice Recommendation R45-47.

serve to retain effectively the pieces of the wheel should it break in operation.

1.2.17 *Protection Flanges*

Protection Flanges or Safety Collars are flanges used with abrasive wheels of special shape, so designed that in addition to the usual function of clamping the wheel to the spindle they will also serve to effectively retain the pieces of the wheel should it break in operation.

Protection flanges are of several types, of which the following are the most commonly used:

"Tapered Flanges," sometimes called safety, bevelled, or concave flanges or collars, which are used with wheels having convex sides.

"Hub Flanges," which are used with wheels having a raised hub or hubs.

"Ring Flanges," having concentric ring or rings projecting from the bearing sides of the flanges, which fit into corresponding grooves in the sides of the wheels.

1.2.18 *Protection Hood*

A Protection Hood is an enclosure for an abrasive wheel consisting of a peripheral member and usually two side members. (Band type hoods do not have side members.) Its main function is to effectively retain the pieces of the wheel should it break in operation. This is a general term and includes broadly all of the following specific types which are described in separate definitions.

Band Type Hood
Cast Hood
Drawn Steel Hood
Fabricated Hood

1.2.19 *Sleeves*

Sleeves are a form of flange used on precision grinding machines where the wheel hole is larger than the machine arbor. Usually the sleeve type of mount is so designed that the wheel, the sleeve, and the flange can be assembled as a unit, for convenience in changing wheels.

1.2.20 *Threaded Hole Wheels*

Threaded Hole Wheels have one central threaded metal bushing securely and permanently anchored in place by cementing, casting or molding. The machines using this type of wheel have relatively short threaded arbors and the wheels are mounted by being screwed on to the threaded arbor. No outside flange is required. Wheels are usually less than 8 inches diameter and of various shapes.

SECTION 2

HANDLING, STORAGE AND INSPECTION

2.1 HANDLING

All grinding wheels are breakable and some are very fragile. Great care shall be exercised in handling and storage to prevent damage which might cause a wheel to fly apart when brought up to speed. The following rules which are based on experience, shall always be observed.

(*a*) Handle wheels carefully to prevent dropping or bumping.

(*b*) Do not roll wheels (hoop fashion).

(*c*) Use trucks or suitable conveyors which will provide proper support for all transportation of wheels which cannot be carried by hand.

Exception to (b) and (c): Where it is impractical to comply with (b) and (c) because of large size of wheel, danger of damage when rolling the wheel will be minimized if floor is smooth, clean and free from obstructions. The use of a strip of rubber or cork matting will further reduce the danger.

(*d*) Stack wheels carefully on trucks. Do not pile heavy castings or tools on top of them, nor permit wheels to topple over.

2.2 STORAGE

Suitable racks, bins or drawers shall be provided to accommodate the various types of wheels used. Numerous helpful suggestions covering the design of suitable storage facilities are shown on pages 60 and 61 of the Appendix.

Wheel storage rooms should not be subject to extreme temperatures, and should always be kept dry.

2.3 Inspection

Immediately after unpacking, all wheels shall be closely inspected to make sure that they have not been injured in transit or otherwise. As an added precaution, wheels should be tapped gently (while suspended) with a light implement, such as the handle of a screw driver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked, they shall not be used.

Wheels must be dry and free from sawdust when applying the test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

SECTION 3

GENERAL MACHINE REQUIREMENTS

3.1 Rigidity, Supports

Grinding machines shall be sufficiently heavy and rigid so as to minimize vibration.

Where practical, the machines should be securely mounted on substantial floors, benches, foundations or other adequate structures.

3.2 Diameter of Spindle

The following tables show the minimum diameters of spindles for wheels of various sizes. Table 1 applies to machines where wheels are overhung. Table 2 applies to large wheels which are mounted between bearings.

These tables are intended to be used as a guide only. However, smaller spindles than indicated should not be used unless there is supporting evidence proving that smaller spindles have given satisfactory service on the particular class of work under consideration.

TABLE 1

MINIMUM DIAMETERS OF SPINDLES FOR OVERHUNG WHEELS OF VARIOUS DIAMETERS AND THICKNESSES OPERATING AT SPEEDS UP TO 7,000 PERIPHERAL FEET PER MINUTE

Diameter of Wheel	Thickness of Wheel, Inches																		
	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5
Inches	Diameter of Spindle — Inches																		
2	⅛	3/16	3/16	¼	¼	⅜	...	...	...	...	...	...	...	...	...	...	...	...	...
3	¼	¼	⅜	⅜	⅜	½	...	...	...	...	...	...	...	...	...	...	...	...	...
4	5/16	⅜	⅜	⅜	⅜	½	...	...	...	...	...	...	...	...	...	...	...	...	...
5	⅜	⅜	½	½	½	½	...	...	...	...	...	...	...	...	...	...	...	...	...
6	½	½	½	½	½	½	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1
7	½	½	½	½	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	1	1	1	1	1	1
8	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	1	1	1	1	1	1	1	1¼	1¼	1¼
9	⅝	⅝	⅝	⅝	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼
10	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½
12	¾	¾	¾	¾	¾	1	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½
14	⅞	⅞	⅞	⅞	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½
16	..	..	..	..	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1¾	1¾	1¾	1¾
18	..	..	..	..	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1⅞	1⅞
20	..	..	..	..	...	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1⅞	1⅞	1⅞	1⅞
24	..	..	..	..	...	1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2
26	..	..	..	..	...	...	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
30	..	..	..	..	...	...	...	1¾	1¾	2	2	2	2	2	2¼	2¼	2½	2½	2½
36	..	..	..	..	...	...	...	...	2	2¼	2¼	2¼	2½	2½	2½	2¾	2¾	3	3

Note: For speeds exceeding 7,000 peripheral feet per minute and for wheels with heavy mountings, the spindle sizes shown in the above table are usually not adequate. Inasmuch as the proper spindle size is dependent upon many factors, such as general design of the machine, type of bearings, quality of materials and workmanship, a simple table is not practicable. Wheels larger than specified by the machine manufacturer should not be used on any given machine.

TABLE 2

MINIMUM DIAMETERS OF SPINDLES FOR WHEELS OF VARIOUS DIAMETERS AND THICKNESSES MOUNTED BETWEEN BEARINGS AND OPERATING AT SPEEDS NOT EXCEEDING 5,000 PERIPHERAL FEET PER MINUTE

Wheel Diameter Inches	Wheel Thickness Inches	Distance between Bearings (Inches)		
		18	Over 18 to 24	Over 24 to 30
		Inches	Inches	Inches
36	3 and thinner	1¾	1⅞	2
	3⅛ to 6	1⅞	2	2⅛
	6⅛ to 8	2	2⅛	2¼
48	3 and thinner	2	2⅛	2¼
	3⅛ to 6	2⅛	2¼	2½
	6⅛ to 10	2½	2¾	3
60	3 and thinner	2	2¼	2½
	3⅛ to 6	2½	2¾	3
	6⅛ to 10	2¾	3	3¼

3.3 Limit Stop

Grinding machines should be provided with a stop or other means of limiting the maximum diameter of wheel which can be mounted. The hood if of correct size is satisfactory for this purpose on single speed machines, and if the hood is adjustable and mechanically connected with the speed shifting device, it is also acceptable on variable speed machines. (See Appendix C.12.)

3.4 Direction of Spindle Thread

If wheels are mounted by means of a central spindle nut, the direction of the thread shall be such in relation to the direction of rotation that the nut will tend to tighten as the spindle revolves. The following rule will assist in determining the proper relationship.

> "To remove the nut it must be turned in the direction that the spindle revolves when the wheel is in operation."

On double-end floor stands and bench grinders one end of the spindle must therefore have a right hand thread and the other a left hand. When reassembling such machines after repairs care shall be used to properly replace the spindle, with respect to direction of threads.

3.5 Length of Spindle Thread

If wheels are mounted by means of a central spindle nut and flanges, the spindle shall be of sufficient length and shall be threaded to a sufficient extent, so that after the wheel and flanges are mounted there will be room for a full nut on the spindle and the threading shall extend well inside the flange.

3.6 Size of Arbor or Mount

If wheels are mounted directly on the machine arbor or on wheel sleeves or adaptors, allowance for mounting fit shall be made in the wheel hole and not in the arbor or the wheel mount. The arbor or the wheel mount shall be made to nominal size plus zero minus .002 inches.

3.7 Threaded Hole Wheels

Machines on which Threaded Hole Wheels are mounted shall be provided with arbors which are so threaded or relieved as to allow the wheel to be screwed firmly against the flange. The flange shall be flat and unrelieved as it is important, with this type of mounting, that the end of the bushing bear against the flange, to prevent the tendency to pull it out of the wheel. No outside flange is required.

The direction of the thread shall be such that to remove the wheel it must be turned *in the same direction that it rotates when in use.*

If threaded hole wheels are of cone or plug shape with blind holes the length of the arbor and the depth of the hole shall be such that the end of the arbor will not touch bottom.

Threaded hole wheel mounting shall not be used with wheels larger than 8 inches diameter.

3.8 Inserted Nut Wheels

Machines on which Inserted Nut Wheels are mounted shall be provided with a face plate of approximately the same diameter as the wheel, and of sufficient thickness to provide proper support for the wheel and to resist the work pressure. Minimum face plate thicknesses for single spindle hand operated disc grinders are shown in Table 3.

TABLE 3

MINIMUM PLATE THICKNESSES FOR INSERTED NUT WHEELS

Wheel Diameter Inches	Minimum Plate Thickness Inches
8 to 14 inclusive.........	½
15 to 18 inclusive.........	⅝
19 to 26 inclusive.........	¾
27 to 36 inclusive.........	⅞
37 to 40 inclusive.........	1
41 to 72 inclusive.........	1⅛

Note: These thicknesses are not adequate for heavy duty disc grinders, where thicknesses must be specified by the grinder manufacturer.

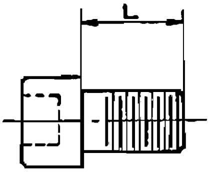


FIGURE 2

CORRECT

L = Length under head to end of screw

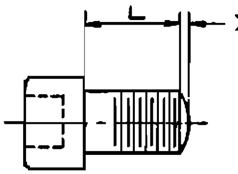


FIGURE 3

INCORRECT

L = Does not represent total length of screw. Projection X will cause trouble

Screw holes in face plate shall be accurately located to match the threaded holes in the inserted nuts in the wheel, and shall be large enough so that the screws will not bind.

Dimension X (Fig. 1) shall be uniform for all holes so that screws can be used interchangeably.

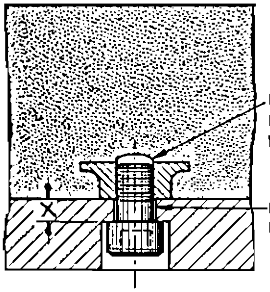


FIGURE 1

Screws shall be of sufficient length to properly engage the threads in the inserted nuts, yet not so long that there will be any possibility of the ends touching bottom. They should have square ends and should be threaded clear to the end. (See Figs. 2 and 3.)

Machine plates shall be maintained true and flat so as to provide even support over entire contact area between wheel and plate.

3.9 Plate Mounted Wheels

Some types of Plate Mounted Wheels are made with plates of sufficient thickness to provide adequate self-support. Other types are made with relatively thin plates.

If the plates attached to the wheel are as thick or thicker than shown in Table 3 there are no special requirements as to the diameter and thickness of the face plate on the machine.

If the plates attached to the wheel are thinner than shown in Table 3 the machine shall be equipped with a face plate of sufficient diameter and thickness to provide adequate additional support. Minimum specifications are given in Table 4 for single spindle hand operated disc grinders.

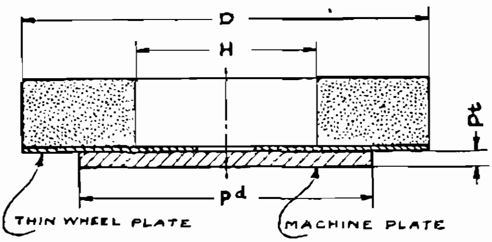


FIGURE 4

TABLE 4

MINIMUM DIAMETERS OF MACHINE PLATES FOR PLATE MOUNTED WHEELS HAVING THIN WHEEL PLATES

Pd shall never be less than $\frac{D + H}{2}$ nor shall the difference between D and Pd exceed 2 inches.

It is recommended that Pd equal D wherever practical.

MINIMUM THICKNESSES OF MACHINE PLATES FOR PLATE MOUNTED WHEELS HAVING THIN WHEEL PLATES

Wheel Diameter D Inches	Minimum Machine Plate Thickness Pt Inches
12 and smaller....	3/8
14 to 16 inclusive.......	1/2
17 to 18 inclusive......	5/8
19 to 26 inclusive......	3/4
27 to 36 inclusive......	7/8

Note: These thicknesses are not adequate for heavy duty disc grinders, where thicknesses must be specified by the grinder manufacturer.

Screw holes in face plate shall be accurately located to match either the tapped holes in the wheel plate or the projecting studs as the case may be, and shall be large enough so that the screws or studs will not bind.

If screws are used they shall be of sufficient length to properly engage the threads in the wheel plate, yet not so long that there will be any possibility of the ends touching bottom. They should have square ends and should be threaded clear to the end. (See Figs. 2 and 3.)

3.10 Work Rests

On floor stands, bench grinders or disc grinders where Work Rests or plain tables are used either to support the work or to guide the dresser, they shall be of rigid construction and rigidly supported. They shall be readily adjustable to compensate for wheel wear. (See Rule 11.14.)

They shall be maintained in good condition and when worn they shall be repaired or replaced.

SECTION 4

TYPES OF PROTECTION DEVICES

4.1 General Requirements

All abrasive wheels shall be provided with one of the following forms of protection, specifications for which appear elsewhere in this code.

(a) Protection Hoods
(b) Protection Flanges
(c) Protection Chucks

Exceptions: This requirement shall not apply to the following classes of wheels and conditions.

(1) Wheels used for internal work while within the work being ground.

(2) Wheels 3 inches or less in diameter running at a peripheral speed not exceeding 3000 ft. per min.

(3) Mounted wheels (see definition) 2 inches and smaller in diameter.

(4) Threaded hole wheels (except cup type) i.e., pot balls and other shapes such as cones or plugs having a blind threaded hole, operating at normal speed and used for offhand cleaning of holes and corners.

Note: See Rule 5.12.2 for additional protection for solid Cutting Wheels.

4.2 Peripheral Grinding Wheels

Grinding Wheels where grinding is done on the periphery of same shall be protected by

(a) Protection Hoods as specified in Rules 5.1 to 5.18 inclusive or

(b) Protection Flanges as specified in Rule 7.9.

4.3 Discs and Cylinders

Disc wheels and cylinder wheels where

grinding is done on the exposed flat side of same shall be protected by

(*a*) Protection Hoods as specified in Rules 5.1 to 5.18 inclusive.

(*b*) Band Type Hoods as specified in Rule 5.19 and 5.20 or

(*c*) Protection Chucks as specified in Section 6.

4.4 Cup Wheels

Cup Wheels where grinding is done on the flat side of the rim shall be protected by

(*a*) Protection Hoods as specified in Rules 5.1 to 5.18 inclusive or

(*b*) Band Type Hoods as specified in Rule 5.19 and 5.20 or

(*c*) Some other form of guard that will insure as good protection as that provided by the guards specified in (*a*) and (*b*).

SECTION 5

PROTECTION HOODS

5.1 General Requirements

Refer to Section 4 for general requirements.

5.2 Mounting and Fastenings

Hoods shall be so mounted as to maintain proper alignment with the wheels, and the strength of the fastenings shall exceed the strength of the hood.

5.3 Dust Exhaust Provision

Hoods on machines used for dry grinding and other operations where dust is produced shall have provision made for connection to an exhaust system.

For detailed recommendations reference is made to "American Standard for Grinding, Polishing and Buffing Equipment Sanitation (Z43)." Copies may be obtained from the American Standards Association.

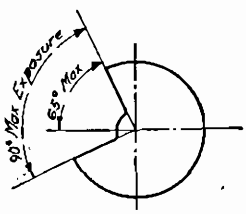


Figure 5

5.4 Exposure—Bench and Floor Stands

The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as bench and floor stands should not exceed 90 degrees or one-fourth of the periphery. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. (See Fig. 5.)

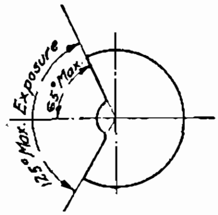


Figure 6

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125 degrees. This exposure shall begin at a point not more than 65 degrees above and extend to a point not more than 60 degrees below the horizontal plane of the wheel spindle. (See Fig. 6.)

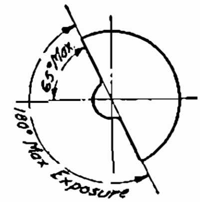


Figure 7

5.5 Exposure—Cylindrical Grinders

The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cylindrical grinding machines shall not exceed 180 degrees. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. (See Fig. 7.)

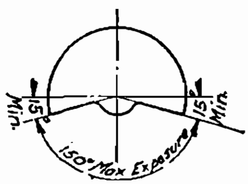


Figure 8

5.6 Exposure—Surface Grinders and Cutting Machines

The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cutting machines and on surface grinding machines which employ the wheel periphery shall not exceed 150 degrees. This exposure shall begin at a point not less than 15 degrees below the horizontal plane of the wheel spindle. (See Fig. 8.)

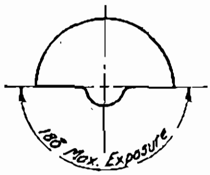


FIGURE 9

5.7 Exposure—Swing Frame and Portable Grinders

The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as swing frame and portable grinding machines shall not exceed 180 degrees, and the top half of the wheel shall be protected at all times. (See Fig. 9.)

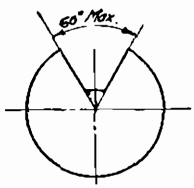


FIGURE 10

5.8 Exposure—Top Grinding

In operations where the work is ground on the top of the wheel, the exposure of the grinding wheel periphery shall be as small as practicable, with a maximum exposure of 60 degrees. (See Fig. 10.)

5.9 Exposure Adjustment

Hoods of the types described in Rules 5.4 and 5.5 where the operator stands in front of the opening, shall be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in Rules 5.4 and 5.5 shall never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top shall never exceed ¼ inch.

Figs. 11 and 12 illustrate two satisfactory methods of accomplishing this. These sketches are for purposes of illustration only. Other methods that agree with the basic rule are also acceptable. Fig. 13 illustrates a condition that does not comply with the requirements.

5.10 Exposure—High Speeds

The maximum exposure allowances specified in Rules 5.4 to 5.8 are designed to provide satisfactory protection when peripheral speeds do not exceed 9500 fpm. If wheels break when running at higher speeds there is a tendency for them to break into smaller pieces. Smaller openings would therefore be required to provide the same degree of protection.

No data are available from which specifications can be compiled, but this feature shall be taken into consideration in any special cases where hoods are being designed for use with wheels operating at higher peripheral speeds than 9500 fpm. This is especially important in connection with hoods of the types where operator stands in front of the opening.

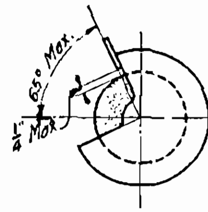


FIGURE 11

CORRECT

Showing adjustable tongue giving required angular protection for all sizes of wheels used

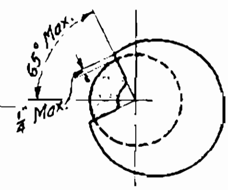


FIGURE 12

CORRECT

Showing movable hood with opening small enough to give required protection for smallest size wheel used

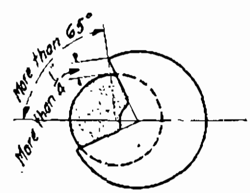


FIGURE 13

INCORRECT

Showing movable hood with size of opening correct for full size wheel, but too large for smaller wheels

5.11 Fixed Members

Hoods shall be constructed so that it is not necessary when changing wheels to detach the peripheral protecting member from the side member which is connected to the machine.

5.12 ENCLOSURE REQUIREMENTS

5.12.1 The hood shall enclose the spindle end, nut, and flange projections, if any.

Exception: Protection hoods on cylindrical grinding machines, in all operations where the work provides a suitable measure of protection to the operator, may be so constructed that the spindle end, nut, and flanges are exposed; and where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted.

5.12.2 *Additional Enclosure*

Many cutting machines, especially those used in the stone and building industries for cutting, grooving, slotting or coping stone and other materials, are so designed that the material being cut travels under the wheel or the wheel travels above the material being cut. On machines of this type, the hood guard seldom affords sufficient protection. All machines of this type which permit a relative horizontal traverse between wheel and work greater than 10 inches, and using solid cutting wheels 10 inches or more in diameter, shall be provided with an auxiliary enclosure so arranged that it surrounds the working parts of the machine when the latter is in operation.

This auxiliary enclosure shall be in addition to the protection hood. The enclosure may consist of a set of heavy screen panels suspended from above and extending from a level approximately 8 feet above the floor, downward to a level at or below that of the table on which the work is placed. The screen for such panels should be of ½ inch mesh or smaller and the wire ⅛ inch diameter or more. The framework for the panels should be of 1 x ¼ inch or heavier structural steel angles or channels. Other forms affording equal or greater protection are also acceptable.

5.13 MATERIAL REQUIREMENTS AND MINIMUM DIMENSIONS

Table 5 specifies minimum basic thicknesses of peripheral and side members for various types of hoods and classes of service.

5.13.1 Steel casting hoods, structural steel or wrought iron fabricated hoods or drawn steel hoods as specified in the table shall be used where operating speed of wheels is faster than 7000 peripheral feet per minute up to a maximum of 10,000 peripheral feet per minute.

5.13.2 If operating speed does not exceed 7000 peripheral feet per minute cast iron hoods, malleable iron hoods or other hoods as described in paragraph 5.13.1 shall be used.

5.13.3 If materials other than those listed in the table are used, the thickness of the peripheral and side members shall be such that the resultant hood will be as strong or stronger.

5.13.4 *Exceptions:*

(1) For cutting wheels 16 inches diameter and smaller and where speed does not exceed 16,000 peripheral feet per minute, cast iron or malleable iron hoods as specified in Table 5 or other hoods providing equal or better protection shall be used.

(2) For cutting wheels larger than 16 inches diameter and where speed does not exceed 14,000 peripheral feet per minute, fabricated hoods as specified in Table 6 or other hoods providing equal or better protection shall be used.

(3) For thread grinding wheels not exceeding 1 inch in thickness, cast iron or malleable iron hoods as specified in Table 5, or other hoods providing equal or better protection shall be used.

5.14 MATERIAL SPECIFICATIONS

The thickness specifications shown in Tables 5 and 6 are based on the following material specifications of the American Society for Testing Materials.

(*a*) Gray Iron Castings—A 48

(*b*) Malleable Iron Castings—A 47

(*c*) Steel Castings—A 27 (Class B)

(*d*) Structural Steel Plate—A 7 (excluding specifications for rivet steel)

(*e*) Wrought Iron Plate—A 42

Note: Copies of the above listed specifications may be procured at a nominal price from the American Society for Testing Materials, Philadelphia, Pennsylvania.

Other materials having at least equal strength properties and which lend themselves equally well to the desired type of construction may also be used.

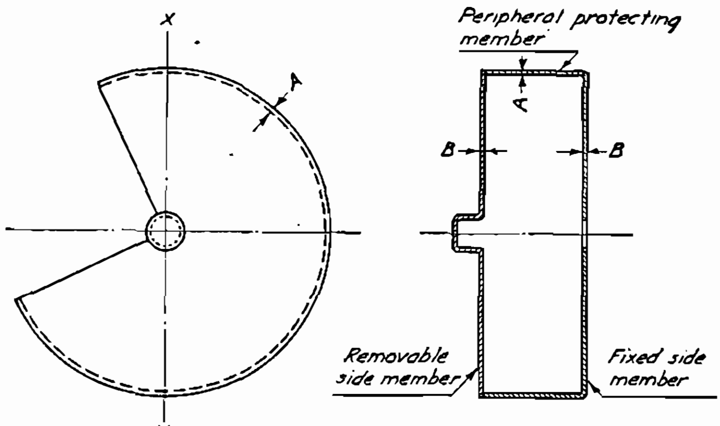


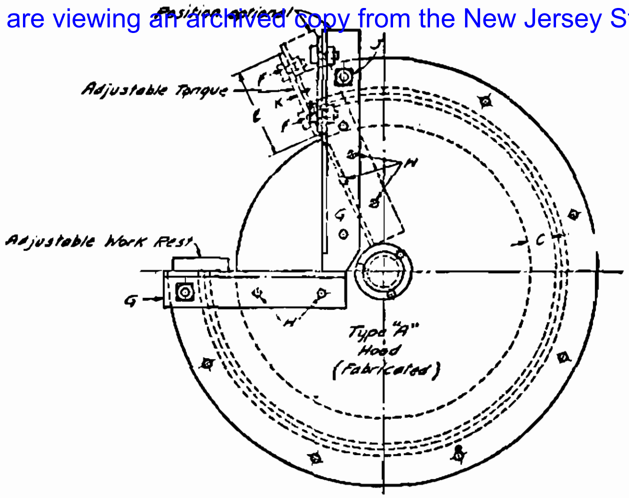
FIGURE 14

TABLE 5

Material Used in Construction of Guard		Maximum Thickness of Grinding Wheel	Grinding Wheel Diameters: 3 to 6 Inches A	3 to 6 Inches B	7 to 12 Inches A	7 to 12 Inches B	13 to 16 Inches A	13 to 16 Inches B	17 to 20 Inches A	17 to 20 Inches B	21 to 24 Inches A	21 to 24 Inches B	25 to 30 Inches A	25 to 30 Inches B	31 to 48 Inches A	31 to 48 Inches B
		Inches	Inches		Inches		Inches		Inches		Inches		Inches		Inches	
Materials satisfactory for speeds up to 7,000 ft. per min.	Cast Iron	2	1/4	1/4	3/8	5/16	1/2	3/8	5/8	1/2	7/8	5/8	1	3/4	1 1/4	1
		4	5/16	5/16	3/8	5/16	1/2	3/8	3/4	5/8	1	5/8	1 1/8	3/4	1 3/8	1
		6	3/8	5/16	1/2	7/16	5/8	1/2	1	5/8	1 1/8	3/4	1 1/4	7/8	1 1/2	1 1/8
	Malleable Iron	2	1/4	1/4	3/8	5/16	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1	7/8
		4	5/16	5/16	3/8	5/16	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1 1/8	7/8
		6	3/8	5/16	3/8	5/16	5/8	1/2	3/4	5/8	7/8	5/8	1	3/4	1 1/4	7/8
Materials satisfactory for speeds up to 10,000 ft. per min.	Steel Castings	2	1/4	1/4	1/4	1/4	3/8	3/8	1/2	7/16	5/8	1/2	3/4	5/8	7/8	3/4
		4	1/4	1/4	1/4	1/4	3/8	3/8	1/2	7/16	5/8	1/2	3/4	5/8	1	3/4
		6	3/8	1/4	3/8	1/4	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1 1/8	3/4
	Structural Steel	2	1/8	1/16	3/16	1/8	3/16	3/16	1/4	1/4	5/16	1/4	3/8	5/16	1/2	3/8
		4	1/8	1/16	3/16	1/8	3/16	3/16	1/4	1/4	5/16	1/4	3/8	5/16	1/2	3/8
		6	3/16	1/16	1/4	1/8	1/4	3/16	3/8	1/4	3/8	1/4	7/16	5/16	5/8	3/8
	Wrought Iron	2	1/8	1/16	3/16	1/8	1/4	3/16	5/16	1/4	3/8	1/4	7/16	5/16	1/2	3/8
		4	1/8	1/16	1/4	1/8	1/4	3/16	5/16	1/4	3/8	1/4	7/16	5/16	5/8	3/8
		6	3/16	1/16	1/4	1/8	5/16	3/16	3/8	1/4	7/16	1/4	1/2	5/16	11/16	7/16

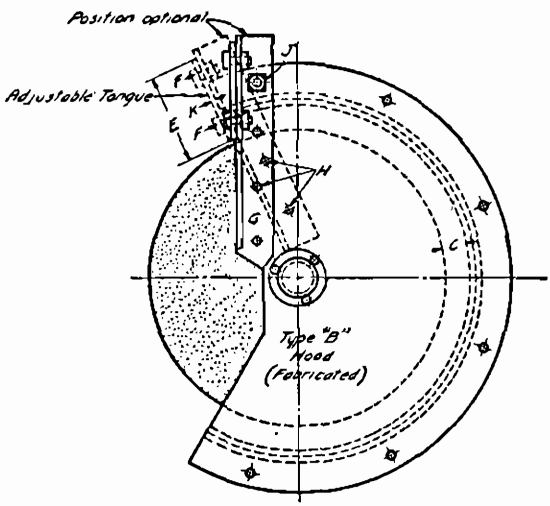
TABLE 6

Material Used in Construction of Guard		Maximum Thickness of Cutting Wheel	Cutting Wheel Diameters: 12 to 16 Inches A	12 to 16 Inches B	17 to 20 Inches A	17 to 20 Inches B	21 to 24 Inches A	21 to 24 Inches B	25 to 30 Inches A	25 to 30 Inches B	32 to 36 Inches A	32 to 36 Inches B		
		Inches	Inches		Inches		Inches		Inches		Inches			
Cutting Wheels 14,000 ft. per min.	Structural Steel	1/2 and less	1/8	1/8	1/8	1/8	3/16	1/8	3/16	1/8	1/4	3/16		



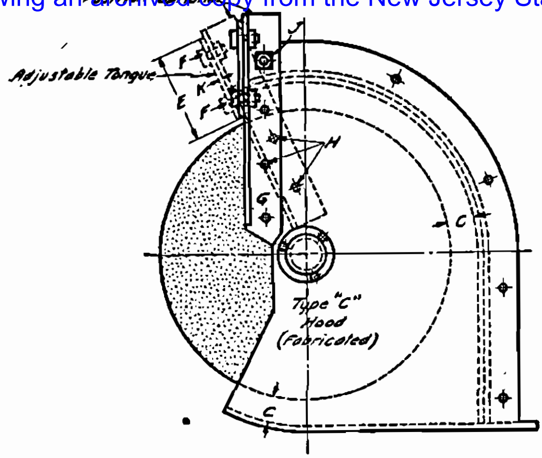
See Rule 5.3 for Dust Exhaust Provision

FIGURE 15



See Rule 5.3 for Dust Exhaust Provision

FIGURE 16



See Rule 5.3 for Dust Exhaust Provision

FIGURE 17

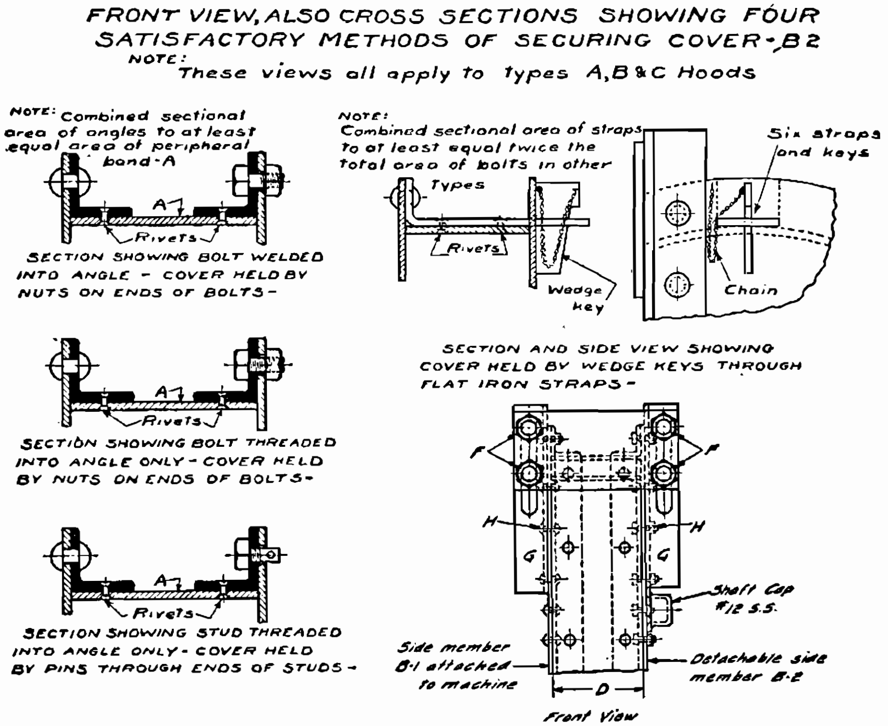


FIGURE 18

5.15 Construction Guide for Fabricated Hoods

As a guide for the construction of fabricated hoods of structural steel or wrought iron, Figures 15 to 18 inclusive and Table 7 have been prepared. Other designs affording equal or better protection are also acceptable.

TABLE 7

	C	D	E	F	G	H	J	K
Diameter of Wheel	Maximum Space between New Wheel and Hood at Periphery	Maximum Inside Width of Hood	Length of Tongue	Diameter of Bolts for Tongue	Size of Angle Supports for Tongue and Rest	Diameter of Rivets for Supports	Diameter of End Connecting Bolts	Thickness of Tongue
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Under 12	1½	1½ wider than wheel	3½	½	1½ x 1½ x ¼	7/16	7/16	¼
12 to 16	1½	2 wider than wheel	5	9/16	2 x 2 x 3/16	½	½	5/16
17 to 24	1½	2 wider than wheel	6	9/16	2 x 2 x ½	½	9/16	½
Over 24	1½	2 wider than wheel	7	⅝	2½ x 2½ x ½	9/16	⅝	½

The requirements given in columns C, D and E of Table 7 shall apply also to cast hoods; and in such cases, where the tongue is held by bolts, column F shall also apply.

5.16 Strength of Connections

Connections between the peripheral and side members, or between parts of a fabricated hood, shall have a strength in a radial direction at least equal to the strength of the members.

5.17 Specifications for Rivets, Bolts and Studs for Fabricated Hoods

Table 8 may be used as a guide in determining the spacing and size of rivets, bolts and studs to provide connections that will comply with the basic requirement of Rule 5.16. Other spacings and sizes of rivets, bolts and studs are acceptable, if the resultant connections are as strong or stronger.

TABLE 8
MINIMUM SIZES AND SPACING OF RIVETS, BOLTS AND STUDS FOR CONNECTING PERIPHERAL AND SIDE MEMBERS IN FABRICATED HOODS OF WROUGHT IRON AND STEEL PLATE

Thickness of Plates being Connected	For Side Plate (B-1) Attached to Machine		For Detachable Side Plate (B-2)	
	Diameter of Rivets	Maximum Distance between Centers	Diameter of Bolts or Studs	Maximum Distance between Centers
Inches	Inches	Inches	Inches	Inches
⅛ and 1/16	5/16	3	7/16	6
3/16 " 1/16	5/16	3	7/16	6
3/16 " ⅛	5/16	3	7/16	6
3/16 " 3/16	5/16	3	7/16	6
¼ " ⅛	⅜	4	9/16	8
¼ " 3/16	⅜	3½	9/16	7
¼ " ¼	⅜	3	9/16	6
5/16 " 3/16	9/16	4	11/16	8
5/16 " ¼	9/16	4	11/16	8
⅜ " ¼	9/16	4	11/16	8
⅜ " 5/16	9/16	3½	11/16	7
7/16 " ¼	9/16	3	11/16	6
7/16 " 5/16	9/16	3	11/16	6
½ " 5/16	9/16	3	11/16	6
½ " ⅜	9/16	3	11/16	6
⅝ " ⅜	⅝	3	⅞	6
11/16 " 7/16	⅝	3	⅞	6

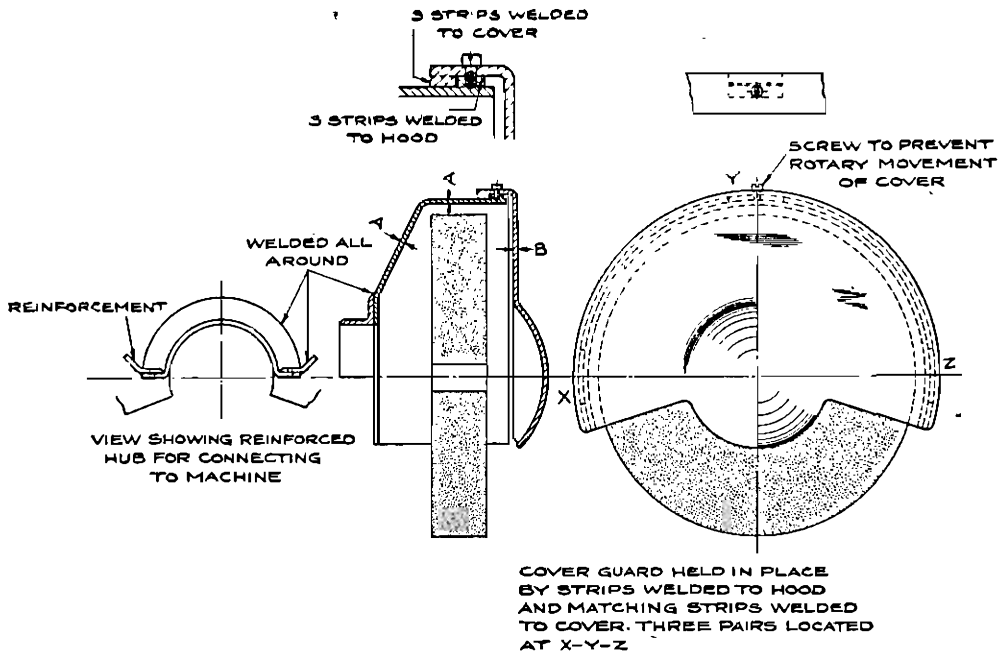


FIGURE 19

5.18 CONSTRUCTION GUIDE FOR DRAWN STEEL HOODS

As a guide for the construction of drawn steel hoods for wheels 8 inches diameter and smaller, Figure 19 has been prepared. Other designs affording equal or better protection are also acceptable.

TABLE 9

Material Used in Construction of Guard		Maximum Thickness of Wheel	WHEEL DIAMETER			
			2 to 5 Inches		6 to 8 Inches	
			A	B	A	B
Material satisfactory for speeds up to 10,000 ft per min.	Hot Rolled Steel SAE 1008	Inches 2	Inches $\frac{1}{16}$	$\frac{1}{16}$	Inches $\frac{3}{32}$	$\frac{1}{16}$

5.19 BAND TYPE HOODS—GENERAL SPECIFICATIONS

Band type hoods shall conform to the following general specifications.

(*a*) The bands shall be of wrought iron or steel plate or other material of equal or greater strength. They shall be continuous, the ends being either riveted, bolted or welded together in such a manner as to leave the inside free from projections.

(*b*) The inside diameter of the band shall not be more than 1 inch larger than the outside diameter of the wheel, and shall be mounted as nearly concentric with the wheel as practical.

(*c*) The band shall be of sufficient width and its position kept so adjusted that at no time will the wheel protrude beyond the edge of the band a distance greater than indicated in Table 10; nor the wall thickness (W) whichever of these is the lesser:

TABLE 10

Overall Thickness of Wheel (T) Inches	Maximum Exposure of Wheel (C) Inches
1/2	1/4
1	1/2
2	3/4
3	1
4	1 1/2
5 and over	2

(See Fig. 20.)

5.20 Construction Guide for Band Type Hoods

As a guide for the construction of band type hoods, Figure 20 and Table 12 have been prepared. Other designs affording equal or better protection are also acceptable.

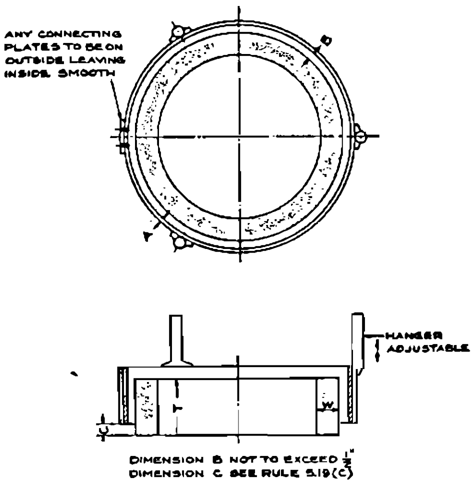


Figure 20

TABLE 12

Diameter of Wheel	Minimum Thickness of Band A	Minimum Diameter of Rivets	Maximum Distance between Centers of Rivets
Inches	Inches	Inches	Inches
Under 8	1/16	3/16	3/4
8 to 24	1/8	1/4	1
25 to 30	1/4	3/8	1 1/4

SECTION 6

PROTECTION CHUCKS

6.1 General Requirements

Where cylinders, discs or segmental ring wheels are not protected by hoods the chuck in which the wheel is mounted shall be a protection chuck and shall comply with the following specifications.

6.2 Peripheral Member

The peripheral member which surrounds the wheel shall be continuous.

6.3 Exposure

The chuck shall be so designed that it will be capable of properly supporting and protecting the wheel and the position shall be kept so adjusted that at no time will the wheel protrude beyond the end of the chuck a distance greater than (C) as indicated in Table 13 nor the wall thickness (W) whichever of these is the lesser.

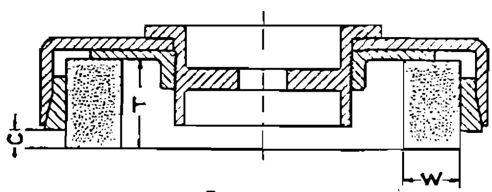


Figure 21

TABLE 13

Overall Thickness of Wheel (T) Inches	Maximum Exposure of Wheel (C) Inches
2	3/4
3	1
4	1 1/2
5 and over	2

This requirement may be accomplished by means of adjustable back plates or other supports within the chuck.

6.4 Retention

The method of holding the wheel shall be such that in case the wheel should break when in use, the pieces will be retained within the chuck.

SECTION 7

FLANGES

7.1 General Requirements

All abrasive wheels, with the following exceptions, shall be mounted between flanges.

Mounted Wheels and Points
Threaded Wheels
Inserted Nut Wheels
Plate Mounted Wheels
Cylinder, Cup or Segmental Wheels that are mounted in chucks

There are two general classifications of flanges namely (1) straight flanges, and (2) protection flanges.

(1) Straight flanges are not protection devices and shall be used only where some standard form of protection is employed. Straight flanges may be either simple flanges of the "collar" type or may be integral parts of wheel sleeves or adaptors.

(2) Protection flanges shall be used where no other standard form of protection is employed. They shall be used only with wheels designed to fit the flanges. Protection flanges are usually of the tapered type described in Rule 7.9, but may be of any other type affording equal or better protection.

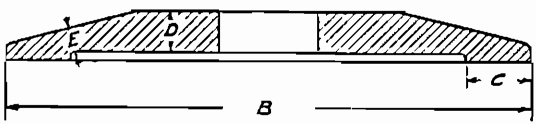


Figure 22

Driving flange secured to spindle. See Rule 7.7

TABLE 14

(These are not protection flanges)

A	B	C		D	E
Diameter of Wheel	Minimum Outside Diameter of Flanges	Radial Width of Bearing Surface		Minimum Thickness of Flange at Bore	Minimum Thickness of Flange at Edge of Recess
		Minimum	Maximum		
Inches	Inches	Inches	Inches	Inches	Inches
1	3/8	1/16	1/8	1/16	1/16
2	3/4	1/8	3/16	1/8	3/32
3	1	1/8	1/4	3/16	3/32
4	1 1/4	3/16	3/8	3/16	1/8
5	1 1/2	3/16	3/8	1/4	1/8
6	2	1/4	1/2	3/8	3/16
8	3	1/4	1/2	3/8	3/16
10	3 1/2	5/16	5/8	3/8	1/4
12	4	5/16	5/8	1/2	5/16
14	4 1/2	3/8	3/4	1/2	5/16
16	5 1/2	1/2	1	1/2	5/16
18	6	1/2	1	5/8	3/8
20	7	5/8	1 1/4	5/8	3/8
22	7 1/2	5/8	1 1/4	5/8	7/16
24	8	3/4	1 1/4	5/8	7/16
26	8 1/2	3/4	1 1/4	5/8	1/2
28	10	7/8	1 1/2	3/4	1/2
30	10	7/8	1 1/2	3/4	5/8
36	12	1	2	7/8	3/4

7.2 Material

All protection flanges over 10 inches diameter shall be of steel. All other flanges shall be made of cast iron or other material of equal or greater strength.

7.3 Finish and Balance

Flanges shall be finished all over, correct to dimensions and shall be in good balance. There shall be no exposed rough or sharp edges or surfaces. (*The requirement for balance does not apply to so-called balancing flanges which are purposely made out of balance.*)

7.4 Uniformity of Diameter

Both flanges, whether straight or tapered, between which a wheel is mounted, shall be of the same diameter.

7.5 Recess

Straight flanges made according to Fig. 22 and tapered flanges made according to Fig. 25 shall be recessed at least one sixteenth of an inch ($\frac{1}{16}$") on the side next to the wheel for a distance as specified in the respective tables of dimensions for straight and tapered flanges.

Straight flanges of the adaptor and sleeve types (Figs. 23 and 24) shall be recessed so that there will be no bearing on the sides of the wheel within 1/8 inch of the hole.

7.6 Contact

Flanges shall be so designed with respect to rigidity that when tightened up the full area of the contact surface will bear against the wheel with uniform pressure.

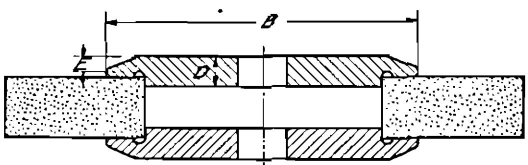


Figure 23

Driving flange secured to spindle. See Rule 7.7

TABLE 15

Note: These adaptors may be clamped together by means of a central nut, or by a series of bolts or some other equivalent means of fastening.

(These are not protection flanges)

Wheel Diameter	Hole Diameter	B Minimum Flange Diameter	D Minimum Thickness of Flange at Bore	E Minimum Thickness of Flange at Edge of Recess
Inches	Inches	Inches	Inches	Inches
12 to 14	4 5 6	6 7 8	5/8 5/8 5/8	3/8 3/8 3/8
Larger than 14 to 18	4 5 6 7 8	6 7 8 9 10	5/8 5/8 5/8 5/8 5/8	3/8 3/8 3/8 3/8 3/8
Larger than 18 to 24	6 7 8 10 12	8 9 10 12 14	3/4 3/4 3/4 3/4 3/4	1/2 1/2 1/2 1/2 1/2
Larger than 24 to 36	12	15	3/4	1/2

7.7 Fit

The driving flange shall be keyed, screwed, shrunk, pressed or otherwise secured to the spindle, and the bearing surface shall run true with the spindle.

7.8 Dimensions

7.8.1 *Straight Flanges*

Table 14 shows minimum dimensions for straight flanges for use with wheels with small holes that fit directly on the machine spindle. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made considerably thicker to allow for truing when they become worn through use.

7.8.2 *Straight Adaptor Flanges*

Table 15 shows minimum dimensions for straight adaptor flanges for use with wheels having holes larger than the machine arbor. Dimensions of such adaptor flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new adaptor flanges be made considerably thicker to allow for truing when they become worn through use.

Note: Adaptor flanges are designed especially for use with organic bonded wheels. Large hole vitrified wheels are not regularly recommended for snagging or any rough heavy grinding. (See page 53 in Appendix.)

7.8.3 *Sleeve Flanges*

Table 16 shows minimum dimensions for straight flanges that are an integral part of wheel sleeves such as are frequently used on precision grinding machines. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made thicker to allow for truing when they become worn through use.

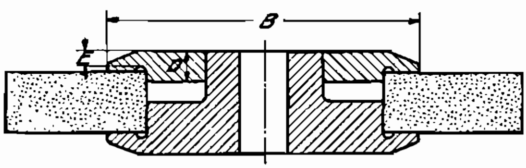


Figure 24

Driving flange secured to spindle. See Rule 7.7

TABLE 16

Note: These flanges may be clamped together by means of a central nut, or by a series of bolts or some other equivalent means of fastening.

(These are not protection flanges)

Wheel Diameter	Wheel Hole	B Minimum Outside Diameter of Flange	D Minimum Thickness of Flange at Bore	E Minimum Thickness of Flange at Edge of Recess
Inches	Inches	Inches	Inches	Inches
12 to 14	5	7	½	7/16
Larger than 14 to 20	5	7	⅝	7/16
	6	8	⅝	7/16
	8	10	⅝	7/16
	10	11½	⅝	7/16
	12	13½	⅝	7/16
Larger than 20 to 30	8	10	¾	½
	10	11½	¾	½
	12	13½	¾	½
	16	17½	¾	½
Larger than 30 to 42	12	13½	¾	½
	16	17½	¾	½
	18	19½	¾	½
	20	21½	¾	½

7.9 Tapered Protection Flanges

7.9.1 *Degree of Taper*

Tapered wheels used with tapered protection flanges should be tapered at least ¾ inch per foot on each side.

Tapered flanges or collars made according to Fig. 25 and Fig. 26 shall have the same degree of taper as the wheels.

Tapered flanges or collars made according to Fig. 27 and Fig. 28 shall be tapered 1/32 inch per foot more than the taper of the wheel.

7.9.2 *Dimensions for Slow Speed*

Fig. 25 and Fig. 27 illustrate two satisfactory styles of tapered protection flanges for use where wheel speed does not exceed 6500 peripheral feet per minute. Minimum dimensions covering both styles are shown in Table 17. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made thicker to allow for truing when flanges become worn through use.

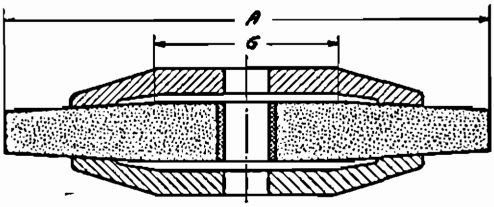


Figure 25
Driving flange secured to spindle. See Rule 7.7

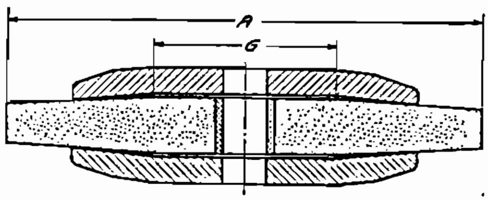


Figure 27
Driving flange secured to spindle. See Rule 7.7

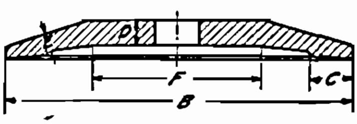


Figure 26
For degree of taper see Rule 7.9.1

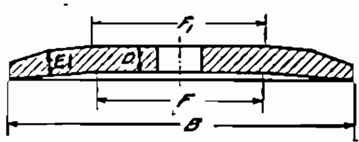


Figure 28
For degree of taper see Rule 7.9.1

TABLE 17

A Diameter of Wheel	B Minimum Outside Diameter of Flanges	C Radial Width of Bearing Surface Fig. 26 Only Minimum	 Maximum	D Minimum Thickness of Flange at Bore	E Minimum at Edge of Recess Fig. 26 Only	E₁ Minimum Thickness at Bevel Fig. 28 Only	F Maximum Flat Spot at Center of Flange Inside	F₁ Diameter of Flat Area Outside Fig. 28 Only	G Maximum Diameter of Flat Spot or Hub of Wheel
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
6	3	¼	½	⅜	3/16	..	0	..	1
8	4	5/16	⅝	⅜	¼	..	0	..	1
10	5	½	1	½	¼	..	0	..	2
12	6	½	1	⅝	5/16	½	4	5	4½
14	8	⅝	1¼	⅝	⅜	½	4	5	4½
16	10	¾	1½	⅝	⅜	½	4	6	6
18	12	1	2	¾	½	⅝	4	6	6
20	14	1¼	2½	¾	½	⅝	4	7	6
22	16	1⅜	2¾	¾	9/16	⅝	4	7	6
24	18	1½	3	¾	9/16	⅝	4	8	6
26	20	1½	3¼	¾	⅝	⅝	4	8	6
28	22	1¾	3¾	⅞	⅝	⅝	4	8	6
30	24	2	4	⅞	¾	¾	4	8	6
36	28	2	4	1	⅞	..	4	..	6

7.9.3 *Dimensions for High Speed*

Fig. 29 illustrates a style of tapered protection flanges for use where wheel speed exceeds 6500 but does not exceed 9500 peripheral feet per minute. Minimum dimensions are shown in Table 18. Dimensions of flanges used for this class of service shall not be less than indicated.

Note: It should be noted that flanges made to these dimensions are extremely large and heavy, and it is not practical to use them on ordinary floor stand grinders. For the larger sizes it is usually advisable to use outboard bearings.

7.10 Repairs and Maintenance

All flanges whether straight or tapered shall be maintained in good condition. When the bearing surfaces become worn they should be trued or refaced. When refacing, care shall be exercised to make sure that proper relief is maintained as specified in Rules 7.5 and 7.6. This is especially important in connection with flanges of the adaptor and wheel-sleeve types, otherwise flange pressure around the edge of the hole of the wheel is apt to result.

All flanges should be frequently inspected for compliance with this rule.

For degree of taper see Rule 7.9.1

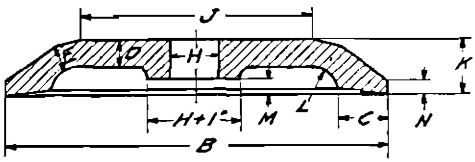


Figure 29

Driving flange secured to spindle. See Rule 7.7

TABLE 18

Diameter of Wheel	Thickness of Wheel	B	C		D	E	J	K	L	M	N
			Maximum	Minimum							
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
16	4	10	1½	1	¾	¾	6	1½	¾	5/16	⅜
18	4	12	2	1½	⅞	⅞	6	2	⅞	⅜	⅜
20	4	14	3	2	1	1	7	2¼	1	7/16	⅜
24	4	18	4	3	1¼	1¼	8	3	1½	9/16	⅜
30	4	24	5	3½	1½	1½	10	4	2	¾	⅜

SECTION 8

MOUNTING

8.1 Inspection

Before mounting, all wheels shall again be closely inspected to make sure that they have not been injured in transit, storage, or otherwise. (See Rule 2.3.)

8.2 Fit

Grinding wheels shall fit freely on the spindles; they should not be forced on, nor should they be too loose. (See Rule 3.6.)

8.3 Surface Condition

All surfaces of wheels, washers, and flanges in contact with each other should be free from foreign material.

8.4 Bushing

The soft metal bushing shall not extend beyond the sides of the wheel.

8.5 Washers

Washers or flange facings of compressible material shall be fitted between the wheel and its flanges If blotting paper is used, it should not be thicker than 0.025 inch. If rubber or leather is used, it should not be thicker than ⅛ inch. If flanges with babbitt or lead facings are used, the thickness of the babbitt or lead should not exceed ⅛ inch. The diameter of the washers shall not be smaller than the diameter of the flanges.

8.6 Tightening of Nut

When tightening spindle end nuts, care should be taken to tighten same only enough to hold the wheel firmly; otherwise, the clamping strain is liable to damage the wheel or associated parts.

SECTION 9

SPEED

9.1 Operating Speeds

Table 19 indicates maximum peripheral speeds which have long been considered standard for various classes of wheels. The first seven classifications (excluding references to plate mounted and inserted nut wheels) have been in effect since 1935 or earlier. The higher speeds indicated for thread grinding, crank grinding and cam grinding have become common practice under certain restricted conditions, during more recent years.

TABLE 19

Classification Number	Types of Wheels	Vitrified and Silicate Bonds			Organic Bonds		
		Low Strength	Medium Strength	High Strength	Low Strength	Medium Strength	High Strength
		FPM	FPM	FPM	FPM	FPM	FPM
1	*Type 1—Straight Wheels (Including plate mounted and inserted nut wheels) *Type 4—Taper Wheels *Type 12—Dish Wheels Type 13—Saucer Wheels	5,500	6,000	6,500	6,500	8,000	9,500
2	*Types 5 and 7—Recessed Wheels	5,500	6,000	6,500	6,500	8,000	9,500
3	*Type 2—Cylinder Wheels (Including plate mounted and inserted nut wheels)	4,500	5,500	6,000	6,000	8,000	9,500
4	**Dovetail Wheels *Type 11—Flaring Cups	4,500	5,500	6,000	6,000	8,000	9,500
5	*Type 6—Deep Recessed Cup Wheels	4,500	5,000	5,500	6,000	7,500	9,000
6	‡‡Cutting Wheels Larger than 16" diameter						7,500 to 14,000‡
7	‡‡Cutting Wheels 16" and smaller						10,000 to 16,000‡
8	Thread Grinding Wheels	5,500 to 8,000‡	6,000 to 10,000‡	6,500 to 12,000‡			9,500 to 12,000‡
9	Automotive and Aircraft Crank Grinding	5,500	6,000 to 7,300‡	6,500 to 8,500‡			
10	Automotive and Aircraft Cam Grinding	5,500	6,000 to 8,000‡	6,500 to 8,500‡			
11	Diamond Wheels	Cutting Wheels (a) Metal bonded with Steel center (b) Metal bonded with Metallic compound center (c) Resin bonded with Resin or Metallic compound center All other types					 14,000 fpm 7,500 fpm 7,500 fpm 6,500 fpm

Note: When wheels of unusual and extreme shapes such as deep cups with thin walls or backs, long drums or with large center holes are required, consult wheel manufacturer for speeds recommended.

Note: Maximum speeds indicated are based on the strength of the wheels and not on their cutting efficiency. Best speeds may sometimes be considerably lower.

*Standard Shapes (See Appendix E, page 62).
**Non-Standard Shapes.
‡See conditions (a), (b), (c), and (d), page 32.
‡‡See Definition (page 10).

Plate mounted and inserted nut wheels and diamond wheels for best grinding results are commonly operated at speeds lower than the indicated maximums, but are sometimes operated at the indicated maximums.

Higher speeds than indicated in Table 19 may be used under conditions (*a*) (*b*) (*c*) and (*d*) only. All of these conditions apply also to the use of speeds in excess of the minimums indicated for classifications 6, 7, 8, 9 and 10.

Condition (*a*) The machine shall be of suitable design with particular reference to spindle bearings. Machine maker's approval of the higher speed shall be assured and machine shall be maintained in satisfactory condition.

Condition (*b*) The wheels shall be of adequate strength and shall have been tested by the wheel manufacturer at a suitable overspeed (See Rule 9.2), and shall bear the wheel manufacturer's approval of the higher speed.

Condition (*c*) The machine shall be equipped with an approved protection device. (See specifications in Section 5 for wheel speeds up to 10,000 peripheral feet per minute.)

Condition (*d*) Due consideration shall be given to the operation with particular regard to pressure from side grinding, and to the design and shape of the wheel used.

Note: Hood specifications are not available for speeds higher than 10,000 peripheral feet per minute (excepting for cutting wheels and thread grinding wheels). Where higher speeds are to be used the machine shall be equipped with a hood that will provide an equal degree of protection to that specified in Section 5 for speeds up to 10,000 peripheral feet per minute. Suitable evidence shall be available that this has been verified by tests that include the breaking of wheels within similar hoods at the higher speeds.

The peripheral speed approved by the wheel manufacturer shall not be exceeded, even though it is lower than the standard speed in the table.

Note I: The number of revolutions per minute may be increased as the diameter of a wheel is reduced through wear, provided the original peripheral speed is never exceeded. (The speed table on page 48 should be of help in converting rpm to peripheral speed in feet per minute.)

9.2 Manufacturers Test

All wheels shall be tested by the wheel manufacturer in accordance with Table 20.

Exceptions:

The following wheels need not be tested unless the peripheral operating speed exceeds 6500 fpm for vitrified and 9500 fpm for organic wheels.

(*a*) *Wheels less than 8 inches diameter where product of square of diameter in inches and thickness is less than 80.*

(*b*) *Wheels less than 6 inches diameter.*

(*c*) *Diamond wheels.*

Note I: Where wheels are to be operated at the higher speeds and it is found impractical for mechanical reasons to speed test them at the prescribed overspeed the wheel manufacturer shall establish the operating speed by calculations from available data.

9.3 Speed Check

Speed of wheel spindle on grinding machines shall be frequently checked to make sure that it is correct for the size and type of wheels used. A suitable record of the speed check should be maintained.

9.4 Speed Adjustment Control

If speed of wheel spindle is adjustable to compensate for wheel wear or for other reasons, the speed adjustment shall be in control of authorized persons only. (See C.12, page 58.)

TABLE 20

Class of Wheel	Peripheral Operating Speed Feet per Minute	Minimum Test Factor*
Cutting Wheels	Up to 16,000	1.2
Resinoid Rubber and Shellac (Except Cutting Wheels)	Up to 5,000 Faster than 5,000	1.25 1.5
Vitrified and Silicate Wheels (Wet Grinding)	Up to 5,000 Faster than 5,000	1.25 1.5
Vitrified Wheels (Dry Grinding)	Up to 5,000 5,001 to 6,500 Faster than 6,500	1.25 1.5 1.75

*Actual operating speed shall be multiplied by this test factor to establish minimum speed at which wheels shall be tested by the wheel manufacturer.

SECTION 10

MOUNTED WHEELS AND POINTS

10.1 Maximum Safe Operating Speed

To determine the maximum safe operating speed for mounted wheels (see definition) and points, two factors shall be considered (1) critical speed, and (2) limit of wheel strength.

(1) Establish safe percentage of critical speed according to Rule 10.2.

(2) Establish maximum speed according to Rule 10.3.

Whichever of these is the lower shall be considered the maximum safe operating speed.

10.2 Critical Speeds

(See Appendix B, page 49, for a detailed discussion of critical speed and the relationship of critical speed to safety.)

Tables 22 to 29 indicate the critical speeds for various standard mounted wheels and points in combination with standard spindle sizes and various overhangs. These are for smooth unthreaded spindles.

(*a*) Mounted wheels and points with smooth unthreaded spindles shall be operated at a speed not more than 85 per cent and preferably not more than 75 per cent of the critical speed indicated in the tables.

(*b*) Mounted wheels and points with ⅛ inch threaded spindles shall be operated at a speed not more than 55 per cent and preferably not more than 50 per cent of the critical speed indicated in the tables.

(*c*) Mounted wheels and points with ¼ inch threaded spindles shall be operated at a speed not more than 65 per cent and preferably not more than 60 per cent of the critical speed indicated in the tables.

Exception: Under certain ideal conditions of trueness and balance it may be permissible, where necessary, to operate at a speed higher than the indicated critical speed, provided the speed shown in Rule 10.3 is not exceeded.

10.3 Maximum Speed

(See Appendix B.5, page 50, for discussion of maximum speed based on the strength of the wheels.) Table 21 shows the maximum operating speed for various diameters of mounted points and wheels. This speed shall not be exceeded even though it be lower than the safe percentage of the critical speed, as defined in Rule 10.2.

TABLE 21

Outside Diameter of Wheel Inches	Maximum Speed (RPM)
¼	152,700
5/16	122,200
⅜	101,856
½	76,392
⅝	61,120
¾	50,928
⅞	43,648
1	38,196
1¼	30,560
1½	25,464
1¾	21,824
2	19,098

These speeds are based on the strength of vitrified mounted wheels and points of average grade. If for any special reason it is necessary to use wheels coarser than 60 grit or of unusually soft grade, the maximum speed recommended by the wheel manufacturer shall not be exceeded.

10.4 Work Pressure

Pressure between wheel and work shall at no time be so heavy that any considerable springing of the spindle will result. It is particularly important to observe this rule in connection with small wheels and points where the end of the mandrel that enters the wheel is of reduced diameter.

OVERHANG

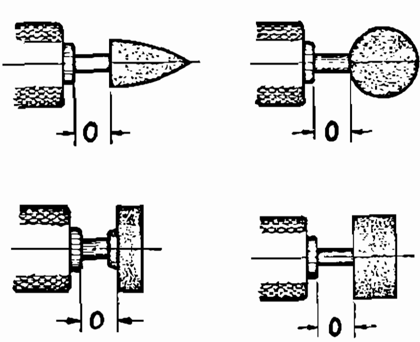


Figure 30

Examples illustrating what is meant by "overhang"

TABLE 22

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR 3/32" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			1/2"	1"	1 1/2"	2"	2 1/2"
W 141	3/32	5/32	125,000	71,000	50,000	34,000	22,000
W 142	3/32	1/4	125,000	71,000	50,000	34,000	22,000
W 143	1/8	1/8	125,000	71,000	50,000	34,000	22,000
W 144	1/8	1/4	125,000	71,000	50,000	34,000	22,000
W 145	1/8	3/8	118,000	66,000	47,000	32,000	21,000
W 146	1/8	1/2	108,000	61,000	42,000	30,000	20,000
W 147	5/32	1/32	125,000	71,000	50,000	34,000	22,000
W 148	5/32	1/16	125,000	71,000	50,000	34,000	22,000
W 149	5/32	1/4	121,000	67,000	48,000	33,000	21,000
W 150	3/16	1/16	125,000	71,000	50,000	34,000	22,000
W 151	3/16	1/8	125,000	71,000	50,000	34,000	22,000
W 152	3/16	1/4	111,000	63,000	44,000	31,000	20,000
W 153	3/16	3/8	98,000	56,000	38,000	28,000	18,000
W 154	3/16	1/2	88,000	51,000	34,000	25,000	17,000
W 155	13/64	1/4	104,000	59,000	41,000	29,000	19,000
W 156	1/4	1/32	125,000	71,000	50,000	34,000	22,000
W 157	1/4	1/16	125,000	71,000	50,000	34,000	22,000
W 158	1/4	1/8	125,000	71,000	50,000	34,000	22,000
W 159	1/4	3/16	104,000	59,000	41,000	29,000	19,000
W 160	1/4	1/4	92,000	56,000	37,000	25,000	18,000
W 161	1/4	5/16	88,000	53,000	33,000	23,000	17,000
W 162	1/4	3/8	76,000	46,000	31,000	22,000	15,000
W 165	5/16	1/16	124,000	69,000	50,000	34,000	22,000
W 166	5/16	1/8	113,000	65,000	38,000	26,000	19,000
W 167	5/16	1/4	82,000	52,000	33,000	24,000	16,000
W 168	5/16	5/16	75,000	45,000	30,000	22,000	16,000
W 169	5/16	3/8	64,000	38,000	27,000	20,000	15,000
W 170	5/16	1/2	53,000	35,000	22,000	17,000	13,000
W 171	5/16	3/4	37,000	26,000	18,000	14,000	11,000
W 172	3/8	1/16	114,000	65,000	45,000	32,000	20,000
W 173	3/8	1/8	95,000	62,000	40,000	26,000	17,000
W 174	3/8	1/4	72,000	43,000	28,000	20,000	14,000
W 175	3/8	3/8	55,000	32,000	24,000	17,000	13,000
W 176	3/8	1/2	45,000	28,000	21,000	16,000	12,000

TABLE 23

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR 1/8" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.*	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			1/2"	1"	1 1/2"	2"	2 1/2"
W 143	1/8	1/8	140,000	86,000	62,200	43,200	28,500
W 144	1/8	1/4	140,000	86,000	62,200	43,200	28,500
W 145	1/8	3/8	140,000	86,000	62,200	43,200	28,500
W 146	1/8	1/2	140,000	86,000	62,200	43,200	28,500
W 151	3/16	1/8	140,000	86,000	62,200	43,200	28,500
W 152	3/16	1/4	140,000	86,000	62,200	43,200	28,500
W 153	3/16	3/8	107,800	70,000	50,000	35,000	23,500
W 154	3/16	1/2	94,000	60,800	42,000	29,300	20,300
W 157	1/4	1/16	164,000	87,500	63,700	44,200	29,000
W 158	1/4	1/8	140,000	86,000	62,200	43,200	28,500
W 159	1/4	3/16	123,200	76,500	52,500	37,200	25,200
W 160	1/4	1/4	108,500	68,000	45,500	32,000	22,500
W 161	1/4	5/16	103,000	61,300	41,200	30,000	21,500
W 162	1/4	3/8	91,200	56,500	38,500	27,800	20,000
W 163	1/4	1/2	80,000	50,700	35,000	25,000	18,500
W 164	1/4	3/4	61,200	40,000	29,000	21,200	15,800
W 165	5/16	1/16	143,200	83,300	55,000	39,000	27,000
W 166	5/16	1/8	129,300	76,000	47,500	33,500	24,000
W 167	5/16	1/4	100,000	61,000	41,500	30,000	21,000
W 168	5/16	5/16	91,200	55,700	38,200	28,000	20,000
W 169	5/16	3/8	82,200	50,300	36,000	26,500	19,000
W 170	5/16	1/2	70,000	44,000	30,700	22,200	16,800
W 171	5/16	3/4	49,500	34,000	25,000	19,500	14,700
W 172	3/8	1/16	132,500	79,000	54,700	39,000	27,000
W 173	3/8	1/8	116,800	71,000	47,000	33,000	23,000
W 174	3/8	1/4	92,000	55,000	37,000	27,200	20,000
W 175	3/8	3/8	72,000	44,000	32,200	24,000	18,000
W 176	3/8	1/2	60,500	38,000	28,000	21,200	16,200
W 177	3/8	3/4	45,000	31,000	23,500	18,200	13,800
W 178	3/8	1	35,000	25,000	19,000	14,500	11,000

TABLE 23—(Continued)

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR ⅛″ SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33) ½″	1″	1½″	2″	2½″
W 181	½	1/16	115,000	74,000	49,000	34,000	23,800
W 182	½	⅛	98,000	58,200	38,800	27,700	20,600
W 183	½	¼	69,000	42,500	30,000	23,000	17,200
W 184	½	⅜	54,700	35,200	26,000	20,000	15,200
W 185	½	½	46,000	30,000	22,500	17,500	13,200
W 186	½	¾	35,000	23,200	17,000	13,000	10,700
W 187	½	1	27,500	18,500	13,500	10,500	8,500
W 190	⅝	1/16	106,000	64,000	42,000	30,200	22,500
W 191	⅝	⅛	78,500	46,000	33,500	25,200	19,000
W 192	⅝	¼	57,500	36,500	26,500	20,300	15,500
W 193	⅝	⅜	47,000	30,700	22,000	16,700	13,000
W 194	⅝	½	39,200	25,500	18,000	14,000	11,000
W 195	⅝	¾	29,500	19,000	13,500	10,200	8,200
W 196	⅝	1	23,500	15,500	10,800	8,200	6,800
W 199	¾	1/16	101,800	59,700	40,000	29,000	21,000
W 200	¾	⅛	73,200	44,700	31,800	23,800	17,800
W 201	¾	¼	51,000	32,500	23,200	17,700	13,300
W 202	¾	⅜	40,800	26,000	18,000	13,500	10,400
W 203	¾	½	34,000	21,200	14,500	11,000	8,800
W 204	¾	¾	25,200	16,000	11,200	8,300	7,000
W 210	⅞	1/16	80,000	47,000	34,300	25,200	19,100
W 211	⅞	⅛	60,800	37,200	27,200	21,100	16,300
W 212	⅞	¼	45,000	27,200	19,200	14,700	12,000
W 213	⅞	⅜	36,000	22,500	15,000	11,000	8,800
W 215	1	⅛	54,800	33,200	24,000	18,500	14,000
W 216	1	¼	40,700	24,800	17,000	12,700	10,000

TABLE 24

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR 3/16" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½"	1"	1½"	2"	2½"
W 158	¼	⅛	162,000	89,000	64,000	48,000	35,000
W 159	¼	3/16	150,000	84,000	63,000	46,200	33,500
W 160	¼	¼	138,000	80,000	59,000	44,000	32,000
W 161	¼	5/16	125,000	77,500	57,000	42,500	30,000
W 162	¼	⅜	119,000	75,000	55,000	40,000	29,000
W 163	¼	½	105,000	70,000	52,000	38,500	27,500
W 164	¼	¾	83,000	53,000	40,000	31,000	22,000
W 166	5/16	⅛	158,000	87,000	63,000	47,000	34,000
W 167	5/16	¼	134,000	78,000	58,000	43,500	31,000
W 168	5/16	5/16	124,000	76,000	56,000	41,000	29,500
W 169	5/16	⅜	116,500	73,800	54,500	38,500	28,000
W 170	5/16	½	102,000	63,000	46,000	34,000	25,000
W 171	5/16	¾	76,000	50,000	37,000	29,000	21,000
W 173	⅜	⅛	158,000	87,000	62,000	46,000	33,000
W 174	⅜	¼	131,800	77,000	57,000	43,000	31,000
W 175	⅜	⅜	109,000	67,500	49,000	37,000	27,000
W 176	⅜	½	89,000	57,500	41,800	31,500	23,200
W 177	⅜	¾	72,000	48,000	35,000	27,000	20,000
W 178	⅜	1	56,000	39,000	30,000	23,000	17,200
W 182	½	⅛	123,000	75,000	52,500	39,000	29,000
W 183	½	¼	100,000	63,200	44,500	33,200	25,000
W 184	½	⅜	77,000	53,000	39,000	29,000	21,000
W 185	½	½	66,500	45,000	34,000	26,000	19,500
W 186	½	¾	52,000	37,500	28,500	21,000	16,000
W 187	½	1	43,000	31,000	24,500	18,000	14,000
W 188	½	1½	30,500	23,500	18,500	15,000	......
W 189	½	2	23,000	18,000	14,000	11,500	......
W 191	⅝	⅛	111,000	68,500	48,500	36,000	27,000
W 192	⅝	¼	89,000	58,000	41,000	31,200	24,000
W 193	⅝	⅜	70,000	46,500	34,000	25,000	20,000
W 194	⅝	½	59,200	41,500	31,200	24,000	18,000

TABLE 24—(Continued)

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½″	1″	1½″	2″	2½″
W 195	⅝	¾	46,000	32,000	24,500	19,000	14,000
W 196	⅝	1	34,500	25,200	20,000	15,500	12,500
W 197	⅝	2	19,700	15,700	11,600	9,700	......
W 200	¾	⅛	103,000	65,000	45,000	34,000	26,000
W 201	¾	¼	79,000	50,000	37,200	28,500	22,000
W 202	¾	⅜	61,000	42,000	32,500	24,000	18,500
W 203	¾	½	53,000	36,500	27,500	21,200	16,000
W 204	¾	¾	39,000	27,000	20,000	16,000	12,500
W 205	¾	1	33,000	23,000	17,000	14,000	11,500
W 206	¾	1¼	26,000	19,000	15,000	12,000	9,000
W 207	¾	1½	22,000	16,500	13,000	10,500	......
W 208	¾	2	17,000	12,500	10,000	8,000	......
W 211	⅞	⅛	97,500	60,000	42,500	32,000	24,500
W 212	⅞	¼	72,000	46,000	34,500	26,500	19,500
W 213	⅞	⅜	56,500	37,500	28,500	22,000	16,500
W 215	1	⅛	93,000	59,000	41,500	31,500	24,000
W 216	1	¼	68,000	45,000	33,000	25,500	19,000
W 217	1	⅜	52,500	36,000	26,500	21,000	16,000
W 218	1	½	43,700	29,500	22,500	17,200	13,800
W 219	1	¾	33,500	23,500	17,200	13,200	11,200
W 220	1	1	26,000	19,000	15,000	11,500	9,500
W 221	1	1½	17,500	12,500	9,500	8,000	......
W 222	1	2	12,000	9,500	7,500	6,500	......
W 225	1¼	¼	57,400	38,500	28,300	21,700	16,400
W 226	1¼	⅜	44,400	29,500	21,800	17,000	13,700
W 227	1¼	½	37,000	25,500	18,600	14,200	11,600
W 228	1¼	¾	27,500	19,500	14,700	11,700	9,500
W 229	1¼	1	22,000	16,000	11,500	9,200	7,700
W 230	1¼	1¼	17,700	12,200	9,300	7,600	......
W 231	1¼	1½	13,700	9,700	8,000	6,800	......
W 232	1¼	2	10,000	8,000	6,500	6,000	......
W 235	1½	¼	51,500	33,200	25,200	20,200	15,700
W 236	1½	½	36,300	25,000	18,500	14,000	11,500
W 237	1½	1	21,000	15,000	10,500	8,500	7,500
W 238	1½	1½	13,200	9,300	7,300	6,500	......

TABLE 25

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR ¼″ SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½″	1″	1½″	2″	2½″
W 176	⅜	½	108,000	72,500	56,000	44,000	34,000
W 177	⅜	¾	88,000	62,000	47,000	36,500	28,000
W 178	⅜	1	73,600	54,000	40,000	31,000	23,000
W 179	⅜	1¼	61,000	45,000	34,300	26,300	......
W 182	½	⅛	145,000	83,200	61,000	47,200	36,700
W 183	½	¼	111,200	73,000	54,000	41,500	32,000
W 184	½	⅜	95,000	63,500	46,700	36,000	27,800
W 185	½	½	82,000	56,000	42,000	32,000	24,500
W 186	½	¾	68,000	48,500	37,000	28,300	21,500
W 187	½	1	54,000	40,000	32,000	25,000	19,000
W 188	½	1½	40,500	32,000	25,200	20,000	......
W 189	½	2	32,000	25,000	20,000	16,200	......
W 190	⅝	1/16	161,500	87,500	64,000	50,000	38,700
W 191	⅝	⅛	135,200	80,000	59,000	46,000	36,000
W 192	⅝	¼	108,000	69,000	51,200	39,700	31,000
W 193	⅝	⅜	89,500	60,000	44,500	34,500	26,800
W 194	⅝	½	75,200	53,000	39,200	30,300	23,200
W 195	⅝	¾	62,000	43,200	33,200	26,300	20,500
W 196	⅝	1	47,000	36,000	28,400	22,500	17,500
W 197	⅝	2	28,000	22,000	17,200	14,500	......
W 198	⅝	2½	22,000	17,200	14,500	....	......
W 201	¾	¼	106,000	68,700	50,800	38,700	30,000
W 202	¾	⅜	86,000	58,800	43,200	33,500	25,800
W 203	¾	½	73,800	48,500	37,000	29,000	22,500
W 204	¾	¾	57,000	41,000	31,000	24,000	18,700
W 205	¾	1	46,000	34,500	26,000	20,000	16,000
W 206	¾	1¼	38,300	28,700	22,700	18,000	......
W 207	¾	1½	32,000	24,700	19,500	16,000	......
W 208	¾	2	25,000	20,500	16,000	13,200	......
W 209	¾	2½	20,000	16,200	14,000	....	......
W 211	⅞	⅛	130,000	80,000	57,200	44,000	35,000
W 212	⅞	¼	99,000	63,000	46,800	36,800	28,500
W 213	⅞	⅜	81,500	54,500	39,200	31,200	24,500

TABLE 25—(Continued)

GROUP W—(PLAIN WHEELS)

CRITICAL SPEEDS (R P M) FOR ¼" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½"	1"	1½"	2"	2½"
W 215	1	⅛	126,000	78,500	58,000	45,000	34,000
W 216	1	¼	95,200	61,000	45,000	35,000	27,000
W 217	1	⅜	76,000	51,000	38,000	30,000	23,200
W 218	1	½	64,000	43,700	33,200	26,000	19,800
W 219	1	¾	46,800	32,700	25,000	20,000	16,000
W 220	1	1	34,000	25,500	21,000	16,500	14,000
W 221	1	1½	25,500	19,500	16,000	14,000	......
W 222	1	2	21,200	16,500	13,000	11,500	......
W 223	1	2½	16,500	13,200	11,500	....	......
W 225	1¼	¼	86,000	57,200	42,200	32,000	25,000
W 226	1¼	⅜	68,200	47,000	35,000	26,800	21,000
W 227	1¼	½	54,700	39,500	30,200	24,000	18,800
W 228	1¼	¾	40,700	30,000	23,800	19,000	15,200
W 229	1¼	1	32,000	25,000	20,500	16,000	13,200
W 230	1¼	1¼	27,200	21,200	17,000	14,000	......
W 231	1¼	1½	23,500	18,000	14,200	12,000	......
W 232	1¼	2	19,000	14,200	12,000	10,000	......
W 235	1½	¼	67,000	48,500	38,300	30,300	23,500
W 236	1½	½	48,200	36,200	29,000	23,000	18,200
W 237	1½	1	30,000	23,500	17,700	14,500	12,700
W 238	1½	1½	20,800	16,000	13,000	11,000	......

TABLE 26

GROUP B—(SHAPED WHEELS)
CRITICAL SPEEDS (R P M) FOR 3/32" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33) ½"	1"	1½"	2"	2½"
B 43	1/4	5/16	90,000	55,000	36,000	25,000	17,000
B 44	7/32	3/8	76,000	46,000	30,000	22,000	15,000
B 45	3/16	5/16	115,000	67,000	47,000	32,000	20,000
B 46	1/8	5/16	116,000	70,000	49,000	33,000	22,000
B 47	1/8	5/32	116,000	70,000	49,000	33,000	22,000
B 53	1/4	5/8	66,000	41,000	27,000	19,000	14,000
B 55	1/8	1/4	116,000	70,000	49,000	33,000	22,000
B 63	1/4	3/16	102,000	62,000	41,000	29,000	19,000
B 64	1/4	1/16	116,000	70,000	49,000	33,000	22,000
B 65	1/8	1/8	116,000	70,000	49,000	33,000	22,000
B 71	5/8	3/32	88,000	52,000	33,000	23,000	17,000
B 72	1/2	1/8	81,000	47,000	31,000	22,000	16,000
B 73	1/2	1/8	81,000	47,000	31,000	22,000	16,000
B 74	7/32	3/32	116,000	70,000	49,000	33,000	22,000
B 81	3/4	3/16	77,000	45,000	29,000	21,000	15,000
B 82	1/2	1/4	90,000	55,000	36,000	25,000	17,000
B 83	3/8	1/8	97,000	58,000	37,000	26,000	17,000
B 84	5/16	3/16	116,000	70,000	49,000	33,000	22,000
B 92	1/4	1/4	90,000	55,000	36,000	25,000	17,000
B 93	3/16	3/16	116,000	70,000	49,000	33,000	22,000
B 94	11/64	3/32	116,000	70,000	49,000	33,000	22,000
B 95	1/8	3/16	116,000	70,000	49,000	33,000	22,000
B 96	1/8	1/4	116,000	70,000	49,000	33,000	22,000
B 97	3/32	3/8	116,000	70,000	49,000	33,000	22,000
B 98	3/32	1/4	116,000	70,000	49,000	33,000	22,000
B 104	5/8	11/16	76,000	46,000	30,000	22,000	15,000
B 105	5/8	1/2	115,000	67,000	47,000	32,000	20,000
B 106	1/8	7/64	116,000	70,000	49,000	33,000	22,000
B 112	3/8	1/2	50,000	31,000	22,000	17,000	12,000
B 113	1/4	1/4	90,000	55,000	36,000	25,000	17,000
B 114	7/32	3/8	76,000	46,000	30,000	22,000	15,000
B 115	3/32	1/8	116,000	70,000	49,000	33,000	22,000
B 122	3/8	3/8	68,000	41,000	28,000	20,000	14,000
B 123	3/16	3/16	115,000	67,000	47,000	32,000	20,000
B 124	1/8	1/8	116,000	70,000	49,000	33,000	22,000

TABLE 27

GROUP B—(SHAPED WHEELS)

CRITICAL SPEEDS (R P M) FOR ⅛″ SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33) ½″	1″	1½″	2″	2½″
B 41	⅝	⅝	45,000	31,000	23,500	18,200	13,800
B 42	½	¾	45,000	31,000	23,500	18,200	13,800
B 43	¼	5/16	108,500	68,000	45,500	32,000	22,500
B 44	7/32	⅜	91,200	56,500	38,500	27,800	20,000
B 45	3/16	5/16	139,000	82,500	59,500	41,200	27,000
B 46	⅛	5/16	140,000	86,000	62,200	43,200	28,500
B 47	⅛	5/32	140,000	86,000	62,200	43,200	28,500
B 51	7/16	¾	60,500	38,000	28,000	21,200	16,200
B 52	⅜	¾	60,500	38,000	28,000	21,200	16,200
B 53	¼	⅝	80,000	50,700	35,000	25,000	18,500
B 54	¼	½	80,000	50,700	35,000	25,000	18,500
B 55	⅛	¼	140,000	86,000	62,200	43,200	28,500
B 61	¾	5/16	51,000	32,500	23,200	17,700	13,300
B 62	½	⅜	54,700	35,200	26,000	20,000	15,200
B 63	¼	3/16	123,200	76,500	52,500	37,200	25,200
B 64	¼	1/16	140,000	86,000	62,200	43,200	28,500
B 65	⅛	⅛	140,000	86,000	62,200	43,200	28,500
B 71	⅝	3/32	106,000	64,000	42,000	30,200	22,500
B 72	½	⅛	98,000	58,200	38,800	27,700	20,600
B 73	½	⅛	98,000	58,200	38,800	27,700	20,600
B 74	7/32	3/32	140,000	86,000	62,200	43,200	28,500
B 81	¾	3/16	92,000	55,000	37,000	27,200	20,000
B 82	½	¼	108,500	68,000	45,500	32,000	22,500
B 83	⅜	⅛	116,800	71,000	47,000	33,000	23,000
B 84	5/16	3/16	140,000	86,000	62,200	43,200	28,500
B 91	½	⅝	46,000	30,000	22,500	17,500	13,200
B 92	¼	¼	108,500	68,000	45,500	32,000	22,500
B 93	3/16	3/16	140,000	86,000	62,200	43,200	28,500
B 94	11/64	3/32	140,000	86,000	62,200	43,200	28,500
B 95	⅛	3/16	140,000	86,000	62,200	43,200	28,500
B 96	⅛	¼	140,000	86,000	62,200	43,200	28,500
B 97	3/32	⅜	140,000	86,000	62,200	43,200	28,500

TABLE 27 —(Continued)

GROUP B—(SHAPED WHEELS)

CRITICAL SPEEDS (R P M) FOR ⅛″ SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½″	1″	1½″	2″	2½″
B 98	3/32	¼	140,000	86,000	62,200	43,200	28,500
B 101	⅝	11/16	45,000	31,000	23,500	18,200	13,800
B 102	⅝	½	60,500	38,000	28,000	21,200	16,200
B 103	⅝	3/16	92,000	55,000	37,000	27,200	20,000
B 104	5/16	⅜	91,200	56,500	38,500	27,800	20,000
B 105	¼	¼	139,000	82,500	59,500	41,200	27,000
B 106	⅛	7/64	140,000	86,000	62,200	43,200	28,500
B 111	7/16	11/16	45,000	31,000	23,500	18,200	13,800
B 112	⅜	½	60,500	38,000	28,000	21,200	16,200
B 113	¼	¼	108,500	68,000	45,500	32,000	22,500
B 114	7/32	⅜	91,200	56,500	38,500	27,800	20,000
B 115	3/32	⅛	140,000	86,000	62,200	43,200	28,500
B 121	½	½	60,500	38,000	28,000	21,200	16,200
B 122	⅜	⅜	82,200	50,300	36,000	26,500	19,000
B 123	3/16	3/16	139,000	82,500	59,500	41,200	27,000
B 124	⅛	⅛	140,000	86,000	62,200	43,200	28,500
B 131	½	½	46,000	30,000	22,500	17,500	13,200
B 132	⅜	½	60,500	38,000	28,000	21,200	16,200
B 133	⅜	⅜	72,000	44,000	32,200	24,000	18,000
B 134	5/16	⅜	82,200	50,300	36,000	26,500	19,000
B 135	¼	½	80,000	50,700	35,000	25,000	18,500
B 136	¼	5/16	103,000	61,300	41,200	30,000	21,500

TABLE 28

GROUP B—(SHAPED WHEELS)

CRITICAL SPEEDS (R P M) FOR ¼" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)				
			½"	1"	1½"	2"	2½"
B 41	⅝	⅝	88,000	62,000	47,000	36,500	28,000
B 42	½	¾	88,000	62,000	47,000	36,500	28,000
B 51	7/16	¾	108,000	72,500	56,000	44,000	34,000
B 52	⅜	¾	108,000	72,500	56,000	44,000	34,000
B 61	¾	5/16	106,000	68,700	50,800	38,700	30,000
B 62	½	⅜	95,000	63,500	46,700	36,000	27,800
B 71	⅝	3/32	161,500	87,500	64,000	50,000	38,700
B 72	½	⅛	145,000	83,200	61,000	47,200	36,700
B 73	½	⅛	145,000	83,200	61,000	47,200	36,700
B 74	7/32	3/32	....	....	....	....	......
B 91	½	⅝	82,000	56,000	42,000	32,000	24,500
B 101	⅝	11/16	88,000	62,000	47,000	36,500	28,000
B 102	⅝	½	108,000	72,500	56,000	44,000	34,000
B 111	7/16	11/16	88,000	62,000	47,000	36,500	28,000
B 112	⅜	½	108,000	72,500	56,000	44,000	34,000
B 121	½	½	108,000	72,500	56,000	44,000	34,000
B 131	½	½	82,000	56,000	42,000	32,000	24,500
B 132	⅜	½	108,000	72,500	56,000	44,000	34,000

TABLE 29

GROUP A—(SHAPED WHEELS)

CRITICAL SPEEDS (R P M) FOR ¼" SPINDLES

These are Critical Speeds not Safe Operating Speeds

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	Overhang—Dimension O (See Fig. 30—Page 33)					
			½"	1"	1½"	2"	2½"	3"
A 1	¾	2½	26,400	22,000	17,500	14,200	12,000	9,000
A 2	1	1¼	59,000	43,500	34,000	27,500	22,500	18,000
A 3	⅞	2¾	24,000	19,500	16,000	13,000	10,000	7,000
A 4	1¼	1¼	43,000	33,000	27,000	21,500	17,500	14,000
A 5	¾	1⅛	60,000	45,000	36,000	28,000	22,000	18,000
A 6	¾	1⅛	52,000	39,600	32,000	25,300	20,000	16,000
A 11	13/16	1¾	36,700	29,200	24,000	19,500	16,000	12,500
A 12	11/16	1¼	64,000	47,000	36,500	29,000	23,000	18,000
A 13	1⅛	1⅛	57,000	43,000	34,000	27,500	22,000	17,000
A 14	11/16	⅞	76,000	54,000	41,000	32,500	26,000	20,000
A 15	¼	1 1/16	97,000	63,500	46,000	35,000	26,500	18,500
A 21	1	1	46,000	35,000	28,000	23,000	18,500	14,500
A 22	¾	⅝	76,000	54,000	41,000	32,500	26,000	20,000
A 23	¾	1	52,500	40,500	32,500	26,000	20,000	16,000
A 24	¼	¾	102,000	66,000	48,500	36,000	27,000	20,500
A 25	1	1	47,500	36,500	29,500	24,000	19,000	15,000
A 26	⅝	⅝	92,000	62,000	47,000	37,000	28,500	21,000
A 31	1⅜	1	45,000	35,000	28,000	23,000	18,000	14,500
A 32	1	⅝	72,000	52,000	40,000	32,000	25,200	20,000
A 33	1	½	72,000	52,000	40,000	32,000	25,200	20,000
A 34	1½	⅜	64,000	46,000	36,000	29,300	24,000	18,500
A 35	1	⅜	79,000	56,000	42,000	34,000	27,000	21,200
A 36	1⅝	⅜	64,000	45,000	35,500	29,000	23,500	18,500
A 37	1¼	¼	88,000	62,000	47,000	37,500	30,000	24,000
A 38	1	1	46,000	35,000	28,000	22,700	18,000	14,200
A 39	¾	¾	63,000	47,000	37,000	29,500	23,000	17,500

GENERAL OPERATING RULES

11.1 Responsibility

Competent persons shall be assigned to the mounting, care, and inspection of grinding wheels and machines.

11.2 Inspection after Breakage

Whenever a wheel breaks, a careful inspection shall be made to make sure that the hood has not been damaged, nor the flanges bent or sprung out of true or out of balance. The spindle and nuts shall also be carefully inspected.

11.3 Replacing Hood

After mounting a new wheel, care should be taken to see that the hood is properly replaced.

11.4 Starting New Wheels

All new wheels shall be run at full operating speed for at least one minute before applying work, during which time the operator shall stand at one side.

11.5 Applying Work

Work should not be forced against a cold wheel, but applied gradually, giving the wheel an opportunity to warm and thereby minimize the chance of breakage. This applies to starting work in the morning in cold rooms, and to new wheels which have been stored in a cold place.

11.6 Test for Balance

Wheels should be occasionally tested for balance, and rebalanced if necessary.

11.7 Truing

Wheels worn out of round shall be trued by a competent person. Wheels out of balance through wear, which cannot be balanced by truing or dressing, shall be removed from the machine.

11.8 Wet Grinding Wheels

Wheels used in wet grinding shall not be allowed to stand partly immersed in the water. The water-soaked portion may throw the wheel dangerously out of balance.

All wet tool grinders which are not so designed as to provide a constant supply of fresh water shall be thoroughly drained at the end of each day's work and a fresh supply provided just before starting.

11.9 Side Grinding

Grinding on the flat sides of straight wheels is often hazardous and should not be allowed on such operations when the sides of the wheel are appreciably worn thereby or when any considerable or sudden pressure is brought to bear against the sides.

11.10 Dresser Guards

Wheel dressers, excepting the diamond type, shall be equipped with guards over the tops of the cutters to protect the operator from flying pieces of broken cutters or wheel particles.

11.11 Grinding Room

The space about the machine should be kept light, dry and as free as possible from obstructions.

11.12 Lubrication

Care should be exercised so that the spindle will not become sufficiently heated to damage the wheel.

11.13 Check for Wear

All arbors, adaptors, or other machine parts on which wheels fit, should be periodically inspected and maintained to size. (See Rule 3.6.)

11.14 Work Rests

Work rests (or plain tables) shall be kept adjusted close to the wheel with a maximum distance of ⅛ inch to prevent the work from being caught between the wheel and the rest. The work rest shall be securely clamped after each adjustment. The adjustment shall not be made while the wheel is in motion.

APPENDICES

APPENDIX A

REVOLUTIONS PER MINUTE FOR VARIOUS DIAMETERS OF GRINDING WHEELS TO GIVE PERIPHERAL SPEED IN FEET PER MINUTE AS INDICATED

Diameter of Wheel in Inches	Peripheral Speed in Feet per Minute																Diameter of Wheel in Inches
	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500	10,000	12,000	14,000	16,000	
	Revolut	ions per	Minute		Revolut	ions per	Minute		Revolut	ions per	Minute		Revolut	ions per	Minute		
1	15,279	17,189	19,098	21,008	22,918	24,828	26,737	28,647	30,558	32,467	34,377	36,287	38,196	45,836	53,474	61,116	1
2	7,639	8,594	9,549	10,504	11,459	12,414	13,368	14,328	15,278	16,238	17,188	18,143	19,098	22,918	26,737	30,558	2
3	5,093	5,729	6,366	7,003	7,639	8,276	8,913	9,549	10,186	10,822	11,459	12,115	12,732	15,278	17,826	20,372	3
4	3,820	4,297	4,775	5,252	5,729	6,207	6,685	7,162	7,640	8,116	8,595	9,072	9,549	11,459	13,368	15,278	4
5	3,056	3,438	3,820	4,202	4,584	4,966	5,348	5,730	6,112	6,494	6,876	7,258	7,640	9,168	10,696	12,224	5
6	2,546	2,865	3,183	3,501	3,820	4,138	4,456	4,775	5,092	5,411	5,729	6,048	6,366	7,639	8,913	10,186	6
7	2,183	2,455	2,728	3,001	3,274	3,547	3,820	4,092	4,366	4,538	4,911	5,183	5,456	6,548	7,640	8,732	7
8	1,910	2,148	2,387	2,626	2,865	3,103	3,342	3,580	3,820	4,058	4,297	4,535	4,775	5,729	6,685	7,640	8
10	1,528	1,719	1,910	2,101	2,292	2,483	2,674	2,865	3,056	3,247	3,438	3,629	3,820	4,584	5,348	6,112	10
12	1,273	1,432	1,591	1,751	1,910	2,069	2,228	2,386	2,546	2,705	2,864	3,023	3,183	3,820	4,456	5,092	12
14	1,091	1,228	1,364	1,500	1,637	1,773	1,910	2,046	2,182	2,319	2,455	2,592	2,728	3,274	3,820	4,366	14
16	955	1,074	1,194	1,313	1,432	1,552	1,672	1,791	1,910	2,029	2,149	2,268	2,387	2,865	3,342	3,820	16
18	849	955	1,061	1,167	1,273	1,379	1,485	1,591	1,698	1,803	1,910	2,016	2,122	2,546	2,970	3,396	18
20	764	859	955	1,050	1,146	1,241	1,337	1,432	1,528	1,623	1,719	1,814	1,910	2,292	2,674	3,056	20
22	694	781	868	955	1,042	1,128	1,215	1,302	1,388	1,476	1,562	1,649	1,736	2,084	2,430	2,776	22
24	637	716	796	875	955	1,034	1,115	1,194	1,274	1,353	1,433	1,512	1,591	1,910	2,228	2,546	24
26	588	661	734	808	881	955	1,028	1,101	1,176	1,248	1,322	1,395	1,468	1,762	2,056	2,352	26
28	546	614	682	750	818	887	955	1,023	1,092	1,159	1,228	1,296	1,364	1,637	1,910	2,182	28
30	509	573	637	700	764	828	891	955	1,018	1,082	1,146	1,210	1,274	1,528	1,782	2,036	30
32	477	537	597	656	716	776	836	895	954	1,014	1,074	1,134	1,194	1,432	1,672	1,910	32
34	449	505	562	618	674	730	786	843	898	955	1,011	1,067	1,124	1,348	1,572	1,796	34
36	424	477	530	583	637	690	742	795	848	902	954	1,007	1,061	1,273	1,484	1,698	36
38	402	452	503	553	603	653	704	754	804	854	904	955	1,006	1,206	1,408	1,608	38
40	382	430	478	525	573	620	669	716	764	812	860	908	956	1,146	1,338	1,528	40
42	366	409	454	500	545	591	636	682	732	775	818	863	908	1,090	1,272	1,464	42
44	347	390	434	478	521	564	608	651	694	737	780	824	868	1,042	1,216	1,388	44
46	333	375	416	458	500	541	582	624	666	708	750	791	832	1,000	1,164	1,332	46
48	318	358	398	438	478	517	558	597	636	676	716	756	796	956	1,116	1,272	48
53	288	324	360	395	432	468	503	539	576	612	648	683	720	864	1,006	1,152	53
60	255	287	319	350	387	414	446	478	510	542	574	606	638	774	892	1,020	60
72	212	239	265	291	318	345	371	398	424	451	477	504	530	637	742	849	72

Note: "Centrifugal Force," which is the force that tends to rupture a given wheel when overspeeding, increases as the square of the velocity of that wheel. For example, the centrifugal force in a wheel running at 5,500 surface feet per minute is 49 per cent greater than in the same wheel running at 4,500 surface feet per minute, although the speed is actually only 22 per cent greater.

APPENDIX B

MOUNTED WHEELS AND POINTS

B.1 Critical Speed of Spindles

Proper recognition of the "critical speed" is the most important factor in the safe operation of mounted points and mounted wheels. Operation at the critical speed is very apt to result in failure of the spindle, either through severe bending or fracture. A general understanding of what is meant by "critical speed" is therefore important.

Every spindle with a wheel or point mounted on it has a certain critical speed at which vibration due to deflection or whip tends to become excessive. This critical speed varies with the following conditions:

1. Dimensions of wheel—
2. Diameter of spindle—
3. Distance from support to base of wheel—

1. Increasing the size of the wheel (either diameter or thickness) will lower the critical speed. Reducing the size of the wheel (either diameter or thickness) will raise the critical speed.

2. Increasing the diameter of the spindle will raise the critical speed. Reducing the spindle diameter will lower the critical speed.

3. Increasing the overhang (distance from end of support to base of wheel) will lower the critical speed. Reducing the overhang (pushing the spindle back into the chuck) will raise the critical speed.

The kind of steel of which the spindle is made has very little influence on the critical speed and this factor may therefore be ignored.

The critical speed is not measurably affected by the short taper and reduced diameter at the end of the spindle to which wheels of very small size are attached. See shapes B 43 to 47, etc., on page 65. For all practical purposes the critical speed for this type of spindle can be considered the same as if the spindle were of uniform diameter throughout its length.

It has also been established that the critical speed of the spindle is usually not influenced by the type or style of machine used. However, the condition of the machine spindle and bearings may to some extent modify the critical speed. Also, greater run-out and out-of-balance of the wheel as mounted, will decrease the critical speed.

B.2 Operating Rules

Tables 22 to 29 indicate the critical speeds for various standard mounted wheels and points in combination with several standard spindle sizes and various overhangs. These are for smooth unthreaded spindles. For many common combinations the critical speeds can be read directly from the tables. For intermediate wheel and spindle sizes and overhangs not shown, the critical speed can be estimated accurately enough by interpolation.

Operation at or near the critical speed must be avoided. It is recommended that the wheels be operated at a speed not higher than 75% of the critical speed. (*Note: This recommendation of 75% is arbitrarily established to insure a good factor of safety. Under certain conditions it may be permissible to operate up to 85% of the critical speed.*) If it is found that the desired combination of conditions would result in operation at or too near the critical speed, a slight change in any one of the individual conditions may be all that is necessary to eliminate the danger of operating at the critical speed.

For instance, it is desired to operate a ⅜ x ⅜" wheel mounted on a ⅛" spindle at 30,000 rpm with the wheel projected about 1½" beyond the end of the chuck. Reference to Table 22 will show that the critical speed of the spindle is 32,200 rpm. Hence it would be unsafe to operate under these conditions. Assuming that the speed of the machine cannot be reduced, obviously some other change must be made if operation at the critical speed is to be avoided. The following possibilities are suggested:

1. Reduce length of projection to 1" which raises critical speed to about 44,000 rpm
2. Reduce diameter of wheel to ¼" which raises critical speed to 38,500 rpm
3. Increase diameter of spindle to $\frac{3}{16}$" which raises critical speed to 49,000 rpm

It will be noted that any one of these changes should make it safe to operate at 30,000 rpm, although the margin of safety by method No. 2 may not be as wide as desirable. Where possible a wider margin of safety should be provided.

B.3 Threaded Spindles

The critical speed of mounted wheels and points with threaded spindles is lower than for similar wheels with smooth unthreaded spindles. Since the tables show the critical speeds for smooth spindles, the safe operating speeds for threaded spindles are considerably lower. For ⅛" threaded spindles the operating speed should not exceed 50% of the speed shown in the tables and for ¼" threaded spindles it should not exceed 60%. (*Note: These recommended percentages are also arbitrarily established and under certain conditions it may be permissible to operate up to 55% and 65% respectively of the critical speed.*)

B.4 Actual Speed of Machine

With most high speed machines and where overhang exceeds ½", it is usually not possible to increase the speed beyond the critical speed of the wheel spindle regardless of the rated speed of the machine. When the critical speed is reached vibration due to deflection or whip puts such a load on the machine that it cannot reach its rated speed when the rated speed is higher than the critical. This tends to hasten failure of the spindle and should be stopped as soon as noticed, and the conditions altered as required. Occasionally it is possible to increase the speed through and beyond the critical speed of the spindle, and it is then found that the mounted wheel or point operates smoothly at a speed considerably higher than the critical. This condition is seldom achieved, and cannot be predicted. Therefore, it is recommended that the operating speed be maintained at some point lower than the critical. However, under certain ideal conditions of trueness and balance it may be permissible, where necessary, to operate at a speed higher than the critical provided the speed shown in Rule 10.3 is not exceeded.

B.5 Strength of Wheels

Mounted wheels and points are seldom made coarser than 60 grit and soft grades are seldom required. Hence the wheels and points themselves are usually strong enough to operate safely at a speed high enough to be highly efficient. However, under certain conditions, particularly where wheel is mounted with little or no overhang and where the larger wheel diameters are involved, it is possible to attain a speed considerably under the critical that might be high enough to be unsafe.

Table 21 shows the maximum speed that should be used for various sizes of wheels even though this be lower than the critical. This is based on the strength of average wheels commonly used. If for some special reason it is necessary to use wheels coarser than 60 grit or of unusually soft grades, the speeds shown in the table may be too high, and the maximum recommended by the wheel manufacturer should not be exceeded.

B.6 Chucks and Mounting

Worn chucks and lack of care in mounting sometimes result in considerable initial run-out. This may result in spindle failure or in wheel breakage when the wheel is brought into contact with the work.

B.7 Work Pressure

Work pressure, if excessive, can be the cause of trouble and a source of danger, through bending or fracture of the spindle even at speeds below the critical. Since it would be very difficult to measure the work pressure, it is not practical to set up any definite limitations. Ordinarily the work pressure will not be excessive unless an attempt is made to force the wheel beyond its cutting capacity. An experienced operator can tell whether or not a wheel or point is cutting free. If the wheel causes burning of the work, it is quite likely that excessive pressure is being used, especially if the spindle is of very small diameter. A softer grade of wheel may permit the desired rate of stock removal without using excessive pressure. If trouble is still encountered it may be necessary to reduce the rate of feed.

If the machine speed is safely below the critical speed as determined by Rule 10.2, and if the wheel runs smoothly when free, but not so smoothly when under load, it is quite likely that excessive pressure is being used, and this should be reduced as soon as the condition is noted.

APPENDIX C

GRINDING WHEEL SAFETY

The text on pages 52 to 58 is taken from a "Safety Manual" prepared in 1938 by the Safety Committee of the Grinding Wheel Manufacturers Association for the use of salesmen, distributors and other field representatives of grinding wheel manufacturers. It was felt that these representatives should have a more comprehensive understanding of the many conditions affecting the safe use of grinding wheels than could be gleaned from the formal rules in the 1935 Safety Code.

If this information was of value to the wheel makers representatives in helping them understand and interpret the Safety Code rules, the Committee felt that it might similarly be of help to grinding wheel users. It is therefore included here in the Appendix in order that it may receive widespread distribution amongst those who are most vitally concerned with the subject.

C.1 FACTOR OF SAFETY

It is customary for all wheel makers to test all wheels larger than a certain minimum size, at a speed somewhat higher than the known or the recommended operating speed. For the largest percentage of wheels the testing speed is 50% faster. Since the stresses from centrifugal force increase as the square of the velocity it is frequently assumed that this test factor establishes a "factor of safety" of 2¼. If centrifugal force were the only thing to consider this would be true, but there are frequently many other stresses in a wheel while grinding. Uneven heat, vibration, side pressure, sudden impact, uneven or excessive mounting pressures all contribute their share. When added together these stresses frequently cancel the established factor of safety entirely. In other words, unless the actual breaking speed be considerably higher than the established testing speed, breakage in operation might frequently result.

This leads us to a study of the "true factor of safety." The common use of a relatively low testing speed has created the rather general impression that most wheels, or at least all wheels within a wide general classification are of approximately equal strength. If a wheel which has been tested at a certain speed stands up satisfactorily under a given set of conditions it is frequently assumed that any wheel which has been tested at the same speed is equally strong and can be safely operated at the same speed.

This is decidedly erroneous. The first wheel might be so strong that the established testing speed is far below the actual breaking speed, while the breaking speed in the second case might be *only slightly higher than the established testing speed. In other words, the "true factor of safety"* in the first case is much higher than in the latter.

The true factor of safety represents the relationship between the ultimate strength of a wheel and the sum total of all the stresses in that wheel while in operation. The established factor of safety merely represents the relationship between the stresses from centrifugal force while running free at an established testing speed and while running free at a certain operating speed. There may at times be a vast difference between the two.

In good engineering practice a factor of safety of 5 is not considered excessive when calculating proper proportions for machine parts, and for parts that are likely to be subjected to shock a higher factor is recommended. This is mentioned here merely to dispel the popular impression that for grinding wheels a factor of safety of 2¼ is liberal and that it might be satisfactory to "shade" this occasionally. It is actually a minimum figure, and unless it is known that the "true factor" is higher it is very unwise to increase the operating speed of any wheel.

C.2 Variation in Strength of Wheels

The fact that a wheel can be easily broken is not necessarily an indication of poor quality. We must have "weak" wheels as well as "strong" ones in order to perform the multitudinous grinding operations with which we are confronted. All of the scientific research and development work carried on by the grinding wheel industry can truly be said to be in some way concerned with varying (under control) the various strength properties of wheels. Few who are not very close to the problem realize how great this difference in strength really is. Many may be surprised to know that with a single type of bond the strength of wheels within a practical usable range may vary as much as ten to one. Yet this is actually the case.

The modulus of rupture of a 60 grit, Hard grade, Medium structure, vitrified wheel is 6800 lbs. per square inch, while that of a 16 grit, Soft grade, Open structure, wheel of the same bond is only 700 lbs. per square inch. Yet the 16 grit, Soft grade, is a perfectly good wheel and exactly adapted to the machine and work for which it is intended. If it were stronger it would not be suitable for the operation. Obviously, however, it would not be safe to operate both of these wheels at the same speed and under the same conditions. Testing them at the same speed does not equalize their strength.

What has been said here about vitrified wheels is equally true of wheels made with other bonds. Many people have the decidedly erroneous opinion that any organic bonded wheel may be safely operated at higher speeds than any vitrified wheel. It is important that the actual strengths of the specific wheels be compared when considering relative permissible speeds.

C.3 Heat Factor

It should not be inferred from the above discussion that it would be safe under all conditions to operate a 60 grit, Hard grade, Medium structure, vitrified wheel at a speed 3.16 times as fast as a 16 grit, Soft grade, Open structure, vitrified wheel. If the work is light in both cases and little heat is generated this might be true because the stresses due to centrifugal force would be the only important stresses to consider. If, however, the harder wheel is used on a dry grinding operation where much heat is generated it might not be safe to operate it any faster than the 16 grit, Soft grade, and if the heat is very severe it might even fail at the lower speed.

The heat factor is frequently neglected when establishing speeds for various grinding operations. It is extremely important that it be taken into consideration especially in connection with vitrified wheels.

Heat stresses in vitrified wheels brought about by severe dry grinding are similar to stresses from centrifugal force. When a grinding operation rapidly increases the temperature of the periphery of a vitrified wheel, that wheel will break at a lower speed than if the job is less severe. Likewise if a wheel is operating at excessive speed (so that the true factor of safety is low) less peripheral heat will be required to break it than if it were operating at a lower speed. Therefore, when considering permissible speeds for any wheel it is important to know whether it will be subjected to sudden or severe heating.

The matter of heat is not one of a general hot condition but rather one of local spots or areas or rapid changes.

C.4 Large Holes

Resinoid and rubber wheels used for snagging, and vitrified wheels used on precision machines are frequently made with large holes. Vitrified and silicate wheels used for light cutlery grinding are also made with large holes. Many users of vitrified snagging wheels, therefore, find it difficult to understand why it is not practical to make this class of wheels with large holes too.

Snagging operations are usually severe and the wheel is apt to be subjected to heavy and sudden pressure or shock. The structure of a vitrified wheel is rigid and non-yielding, and in order to withstand this kind of service it is necessary that the wheel at all times will have ample cross section. A 24 x 3 x 12″ vitrified snagging wheel of proper grain and grade could undoubtedly stand considerable abuse when new or only slightly worn, but the situation would be quite different as it approached discarding size. At 16″ diameter the remaining cross section would measure only 2″ in a radial direction and unless the work is unusually light it could hardly be considered safe. It would, therefore, be necessary to make absolutely sure that the wheel was discarded at 16″ or larger, and when discarded at this size the economy of the large hole is very doubtful.

This reasoning does not apply to resinoid or rubber snagging wheels. The structure of these wheels is better able to resist shock, and it is safe to wear them down closer to the hole, particularly as they can be made with steel reenforcing rings.

With large hole vitrified and silicate wheels used for precision work and cutlery grinding the situation is also different. These classes of operations require wheels of large size and wheels cannot be used when worn below a certain diameter. It is not possible for instance to grind crankshafts nor cams with small diameter wheels, nor can certain classes of cutlery work be done on small wheels. Therefore, it is customary to establish the minimum diameter which can be used to advantage and to calculate from this the most economical hole size, leaving sufficient cross section for safety. Fortunately this work is not so severe as snagging and it is not necessary to leave such a large cross section. On precision operations this has been established through experience by the machine builders, and wheel sleeves and flanges are usually properly designed. On cutlery jobs there is sometimes a tendency to wear the wheels down too close to the hole. This can be guarded against by the use of flanges of adequate size.

C.5 Inadequate Hole (Small Spindle Diameter)

There are times when a hole of inadequate size may be an indication of a dangerous situation. The small hole in itself does not weaken the wheel in any way, but it is, of course, a gauge of the size of the spindle on which the wheel is to be mounted and may be a means of learning that a user is planning to use a larger wheel on a certain machine than was intended by the machine maker thus introducing a number of possible sources of danger. Let us cite a typical example.

An order is received for a 12 x 1 x ½″ wheel. Reference to Table 1 shows that the minimum hole size for such a wheel is 1″. Investigation discloses the fact that the machine is a small bench stand designed to use 6 x 1 x ½″ wheels. The flanges are 2″ diameter and the spindle runs at 3600 rpm. Obviously this speed is entirely too fast for a 12″ wheel and the flanges are too small. The light spindle and inadequate power will also aggravate the unsatisfactory conditions.

The slowing down of the wheel due to inadequate power is also apt to cause the wheel to develop "flat spots," leading the operator to believe that the wheel has hard and soft spots. The bumping action resulting from the flat spots may ultimately cause breakage.

C.6 Hard Wheels

As indicated in preceding paragraphs, wheels of hard grade are stronger than soft wheels of otherwise similar characteristics. It is a mistake to assume, however, that harder wheels are always less liable to break even at similar speeds.

Hard wheels naturally wear less rapidly than softer ones and as maximum wheel life is always desirable there is often a tendency for customers to request harder and still harder wheels. This is desirable up to a point but if a wheel is supplied which is too hard, not only will it be inefficient and less economical than the correct wheel, but may also be less safe.

A wheel which is too hard will generate more heat and if great enough in the case of vitrified wheels, this in itself may cause breakage.

A wheel which is too hard does not cut as readily as the correct wheel, and to compensate for this the operator is very apt to use more pressure. This in turn will generate still more heat and unless there is unlimited power available, there will be a tendency for the wheel to slow down. All of these things combined are very apt to set up stresses which may result in breakage.

C.7 Adequate Power

Wheels can be broken by lack of adequate power. If a wheel slows down materially when the work is being applied it is an indication that sufficient power is not being transmitted to the wheel spindle. This may be due to belt slippage or the use of too small a motor. When the wheel slows down its cutting ability is also lowered and not infrequently an operator tries to compensate for the inefficiency by using more pressure. This is particularly true on offhand work such as snagging and if the pressure is at all sidewise or if the wheels are of thin cross section, breakage is apt to result.

The size of a wheel does not determine the amount of power needed. A 12 x $\frac{3}{32}$" cut-off wheel on average work requires a 7½ hp motor to keep the wheel from slowing down in the cut and causing breakage when it is pulled through the work at a reasonably economical rate. On the other hand a 60 x 4" cutlery wheel, once it gets in motion, would probably require not more than one horse power to keep it going on light cutlery grinding. The amount of work done per unit of time is the most important factor. In the case of the cut-off wheel a tremendous amount of material is removed during the few seconds of contact time as compared with the very small amount of stock removal spread over a longer contact time in the case of the cutlery wheel.

Many other factors such as the suitability of the wheel for the work and operating conditions have an influence on the amount of power required. As these factors are apt to vary from time to time it is well to insure a margin of safety by providing a margin of reserve power.

As a general rule it is well to remember that it may be dangerous to try to force a wheel beyond its capacity with respect to the amount of power available.

C.8 Mounting

Mounting in its broad sense, including the equipment used and the methods employed, is probably responsible for more wheel breakages than any other single cause. With the assistance of the specifications given in Section 7, it is simple to determine if the flanges and wheel sleeves are of adequate proportions. It should be remembered that the dimensions there shown are *minimum* requirements and in no case is it advisable to use smaller nor thinner cross sections.

A very common fault is to tighten the flanges more than necessary and unless the flanges are made much heavier than the minimum dimensions shown in Section 7, serious springing and distortion may result. Few people realize how little pressure is required to spring flanges of even normal proportions. The following simple experiment will often prove to be a revelation.

Where it is suspected that flanges are being tightened excessively a wheel should be mounted and the flanges brought up just enough to hold the wheel. An attempt should then be made to insert a thin feeler gauge at various points between the wheel and the flanges. If the wheel and the flanges are perfectly flat the feeler gauge should not enter. The man who usually mounts the wheels should then be asked to tighten the flanges according to his usual custom. When this has been done the feeler gauge test should be repeated. The thickness of the gauge which can be inserted will indicate the degree of springing. (This experiment cannot always be satisfactorily conducted with blotters between the wheel and flanges.)

When flanges are thus sprung, the effective area of contact is reduced and the pressure is moved nearer the hole. (Blotters or other gaskets, though useful, should not be depended upon to equalize the pressure in cases like this.) If the flange has a pilot which fits into the hole of the wheel, this tends to spring outward causing outward pressure inside the hole, a very likely cause of breakage. The remedy is less pressure or heavier flanges or both.

Wrinkles or "scurfed" areas on blotters or gaskets cause uneven pressure and are also apt to make the wheel run out of true. Care should be taken to avoid this as well as to prevent any foreign material from coming between the flanges and the wheel.

Proper fit of hole on arbor or wheel sleeve is very important. If fit is so tight that it is necessary to "wring" the wheel on, or otherwise force it into place, the wheel is very apt to be damaged thereby.

Section 8 in the Code is devoted to the subject of Mounting, and should be carefully studied as it contains a number of important rules, which, because of their simplicity, are sometimes ignored or overlooked.

C.9 Protection Devices

All of the preceding paragraphs are written in the hope that they will eventually result in a reduction of the number of grinding wheel breakages. It should not be assumed, however, that this in any way reduces the need for suitable protection devices. Occasional breakages will undoubtedly continue to occur due to human errors of judgment or omission. Because of the potential severity of injuries which might result, it is essential that proper protection be provided at all times, even though every possible precaution has been taken to prevent breakages. We always hope that the protection devices will never be called upon to function but if breakage occurs, it is essential that they be in position.

C.10 Use of Wheels on Makeshift Equipment

Grinding wheels are intended to be used on regular grinding machines which have been designed with due regard for the safety of the operators. All too frequently attempts are made to use grinding wheels on makeshift equipment or equipment not intended for grinding wheels at all and where little or no attention is paid to safety. Sometimes this presents a very serious hazard.

The following examples describe some of the more common classes of unsatisfactory equipment.

C.10.1 *Cutting-off Wheels*

Thin cutting-off wheels are frequently requested for use on a regular woodworking circular saw table. Speed is usually high and flanges are often of inadequate size and improper design. Provision to take care of end play is seldom good enough for requirements of abrasive cutting and the means for accurately controlling the plane of work traverse is often very poor. Last but most important, the matter of a protection hood is usually overlooked entirely.

The widespread use of cutting-off wheels without injury to workmen has helped create the general impression that such wheels are so safe that they can almost be considered foolproof. As a matter of fact, the true factor of safety in such wheels while operating at the usual cutting-off speeds is frequently less than in other classes of wheels operating at their normal speeds. Rule 9.2 in the Code even permits a lower test factor than for other classes of wheels. The reason for this is that the efficiency of the modern cut-off machine depends upon high wheel speed and many wheels in satisfactory use today are not strong enough to be tested at a speed 50% higher, as is customary with other types of wheels.

This need not, however, give rise to alarm when such wheels are used on properly guarded machines. Wheel breakages on the modern cutting machines are not uncommon, but the machines are so well guarded that no one is hurt, and outside of the loss of the wheel, no one is very much concerned over an occasional breakage.

Therefore, instead of stating that high speed cutting wheels are perfectly safe, it would be much better to say that *abrasive cutting* on modern high speed cutting-off machines is a perfectly safe operation. The use of the same wheels at the same or even lower speeds on a circular saw table intended for woodworking might be very dangerous.

C.10.2 *High Speed Polishing Jacks*

Nearly every wheel maker has been called upon at some time or other to supply ordinary grinding wheels for use on high speed polishing jacks. The machines are usually light, being intended for lightweight polishing wheels only; spindles are made with long overhang; flanges are too small; and guards if available at all are of light construction, being intended merely as dust deflectors. When these things are considered it is not difficult to conceive what might happen if a heavy solid grinding wheel intended for much lower speed is mounted on such a machine.

C.10.3 *Sandstone Replacement*

Another example is the introduction of large grinding wheels on stands (they can hardly be called machines) which were built to accommodate sandstones. The bearings are frequently of the open "trough" type and the foundations are usually nothing but timbers. Flanges are often small and unrelieved and hoods are seldom more than wooden splash guards. In addition to the inadequate and improper equipment, there is seldom anyone in a shop where sandstones are used who is familiar with the proper technique of mounting solid grinding wheels.

C.10.4 *High Speed Snagging on Light Machines*

When resinoid bonded high speed snagging wheels were introduced several years ago, it was soon discovered that most of the lightweight, plain bearing machines then in use were not suitable for the new requirements. It was found necessary to design and build new machines for the new high speed, heavy duty service and several machine makers turned themselves to the task.

Suitable high speed machines are now procurable from several reliable machine builders, but every once in a while a wheel user is still encountered who believes that all that is necessary to change to high speed snagging is to change the pulleys on his old slow speed machine and then buy some resinoid wheels.

This practice is almost sure to cause trouble. Wheels are apt to break because of lack of rigidity and improper bearings, and the increased weight of resinoid and rubber wheels, and in addition the hoods are seldom strong enough to hold the pieces.

A machine may be entirely satisfactory for low speed snagging, but not at all suitable and even dangerous for high speed, heavy duty service.

C.11 Speed Variation Due to Wear of Sheaves and Pulleys

The importance of avoiding excessive operating speeds has been stressed many times. As a rule, machine builders design their machines to operate at the correct speed, and it is usually assumed that this speed will remain constant throughout the life of the machine. There are cases, however, where wear may cause a change in the wheel speed.

During the investigation of a wheel breakage on a swing frame grinder it was discovered that the wheel speed was much higher than it should be, and this was undoubtedly one of the contributing factors to the breakage. Although the machine ran at the right speed when new, something had happened. Investigation showed that the vee belt sheaves had worn to the point where the belts became too slack. In order to correct this a new motor sheave was procured a little larger than the original. This took up enough of the belt slack to permit operation of the machine, and the sheave on the wheel spindle was not replaced, although it also was worn undersize. This changed the ratio of sheave diameters to the point where the wheel speed was much too high.

It is not difficult to understand how the changing of one pulley can bring about a change in wheel speed. Ordinary care and thoughtfulness should have prevented it in this case. It is quite possible, however, for sheave wear alone to change the ratio of the effective pitch diameters and thereby alter the wheel speed. If the sheaves are of different diameters, the same total wear will probably result in a greater reduction in the pitch diameter of the smaller sheave. A difference in the materials of which the sheaves are made would also result in a different rate of wear. Thus a change in wheel speed could be brought about so gradually that no one would suspect it, and even measuring the outside diameter of the sheave pulleys would not disclose it.

When checking wheel speeds, old machine ratings are not dependable, nor are calculations made from measurements of the outside pulley diameters. It is recommended that a simple speed counter and stop watch or a tachometer applied directly to the wheel spindle be used where practical. This should be done periodically.

C.12 Speed Adjustment

Many grinding machines are made with adjustable wheel speeds to compensate for wheel wear or for other reasons such as modification of grinding action. This adjustment is accomplished by several different methods such as changing of pulleys or sheaves, shifting of belts from one set of fixed pulleys to another, or the adjustment of a rheostat controlling the speed of a direct current motor. All of these methods are satisfactory if under proper control but proper supervision is usually necessary to prevent the use of speeds that might be unsafe.

Rule 3.3 recommends that some mechanical means be provided to limit the maximum diameter of a wheel which can be mounted. This rule is not in mandatory form because there are cases where it is not practical to comply with the rule. In some cases of this kind, machine builders attach a metal warning plate to a conspicuous part of the machine indicating the maximum size of wheel (and sometimes the type of wheel) that should be used for the various available speeds. This is often very helpful.

Rule 9.4 specifies that if speed of wheel spindle is adjustable, the speed adjustment shall be in control of authorized persons only. Some installations are equipped with locks to render this rule enforceable. This method is recommended wherever practical, particularly where more than one operator uses a machine and where different sizes or types of wheels might be used.

The use of direct current motors with rheostat control is generally quite satisfactory. There have been a few isolated instances where electrical failures in direct current motors have resulted in severe overspeeding. It is, therefore, recommended that where grinding wheels are driven by direct current motors, electric interlocks be considered which will prevent overspeed in case of failure of the motor field circuit. While the chance of such failure is extremely remote, experience has shown that it has occurred, and usually with at least potentially serious results.

C.13 Threaded Hole Wheels—Common Causes of Failure

Threaded hole wheels such as illustrated in Figure 31 (and other shapes similarly mounted), sometimes fail in service from lack of attention to mounting details. Figure 31 shows the correct mounting. Figures 32 to 36 inclusive illustrate the most common causes of failure.

Figure 32 illustrates what happens if the length of the threaded spindle is greater than the depth of the tapped hole. The top of the wheel will be pushed off.

Figure 33 illustrates why the flange or backing plate for this type of mounting should not be relieved. If relieved, there will be a tendency to pull the bushing out of the wheel.

Figure 34 shows a wheel mounted on a spindle which is not threaded back far enough to permit screwing the wheel against the backing plate or flange. The wheel is not properly supported and the bushing is likely to work loose.

Figure 35 shows a wheel mounted on a spindle that is not long enough. Load is concentrated on a few threads only and bushing may break off.

Figure 36 shows a condition similar to Figure 35. Here the spindle is long enough but its effective length has been reduced by introducing a disc or washer between the flange and the base of the wheel.

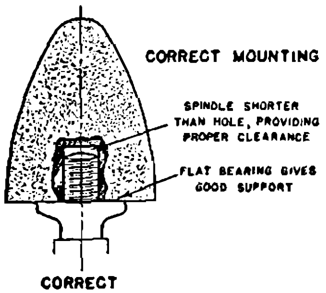


Figure 31

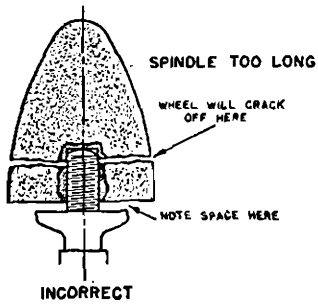


Figure 32

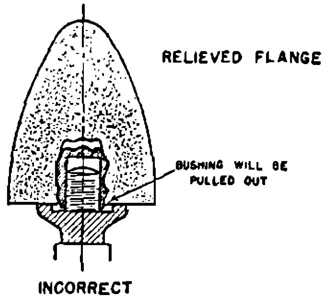


Figure 33

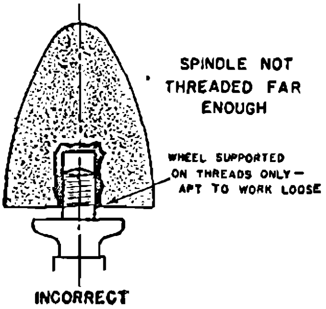


Figure 34

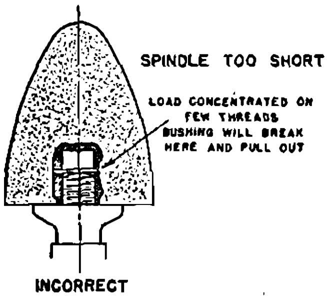


Figure 35

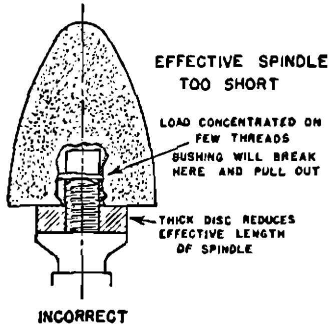


Figure 36

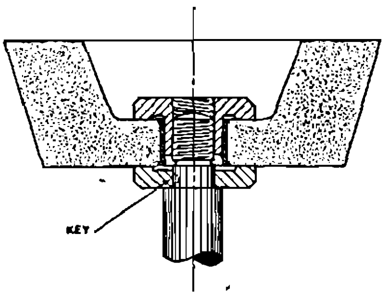


Figure 37

C.14 Adaptor Type of Mounting for Types 6 and 11 Wheels

Types 6 and 11 wheels are commonly mounted on portable grinders of the sander or angle-drive type, by means of a central threaded metal bushing which is in effect a permanent part of the wheel itself. The wheel is merely screwed onto the short threaded arbor and against the fixed flange.

Another satisfactory method of mounting such wheels on this type of machine is illustrated by Figure 37. In this case the wheel is made with a plain unthreaded hole, and a flanged adaptor is used to secure the wheel to the machine. The diameter of the adaptor and the fixed flange on the machine are alike and both are relieved in accordance with the specifications in Table 14.

C 15 Protection Washers

Protection washers, consisting of a thin sheet of resilient rubber vulcanized to a thin metal disc, are not recognized in the Code as an independent protection device. However, if properly applied, they can be used as a valuable auxiliary protection, which might be especially desirable on certain jobs where it is difficult to use a hood offering as complete protection as might be desired.

The effectiveness of these washers is dependent on their proper application. The rubber side must be in direct contact with the abrasive surface of the wheel. For this reason all orders for wheels which are to be mounted between safety washers of this type should specify that "blotters" be omitted.

APPENDIX D

HANDLING AND STORAGE

As pointed out in Rule 2.1 all grinding wheels are breakable and some are very fragile. Hence it is very important that great care be exercised in handling and storage to prevent damage that might cause a wheel to fly apart when brought up to speed.

There are many satisfactory ways to store wheels safely, hence any mandatory rules which are anything more than general in character might at times prove to be an unnecessary hardship. The following suggestions and the sketch on page 61 are based on methods in common use in the plants of many large users of grinding wheels, as well as in the stock rooms of grinding wheel manufacturers themselves and their distributors. They should be of help to anyone desiring to build suitable storage facilities.

(a) Most straight and tapered wheels are best supported on edge in racks. Such racks should preferably be made to provide two-point cradle support for the wheels to prevent rolling, and with a sufficient number of partitions to prevent wheels from tipping over.

(b) Thin organic bonded wheels should be laid flat on a flat horizontal surface, away from excessive heat, to prevent warpage. A heavy steel plate or a thick straight vitrified grinding wheel makes a good foundation for stacking.

(c) Cloth backed thin discs should be supported as described in paragraph (b) and should be stacked cloth against cloth to avoid damaging the cloth backing and to prevent warpage.

(d) Cylinder wheels and large straight cup wheels may be stacked on the flat sides with corrugated paper or other cushioning material between them, or they may be stored in racks similar to those used for large straight wheels.

(e) A satisfactory method of storing large flaring cup wheels is to place them flat on a horizontal shelf, alternating their positions so that they will be stacked base against base and face against face.

(f) Small cup and other shape wheels, also small internal wheels may be stored in boxes, bins or drawers.

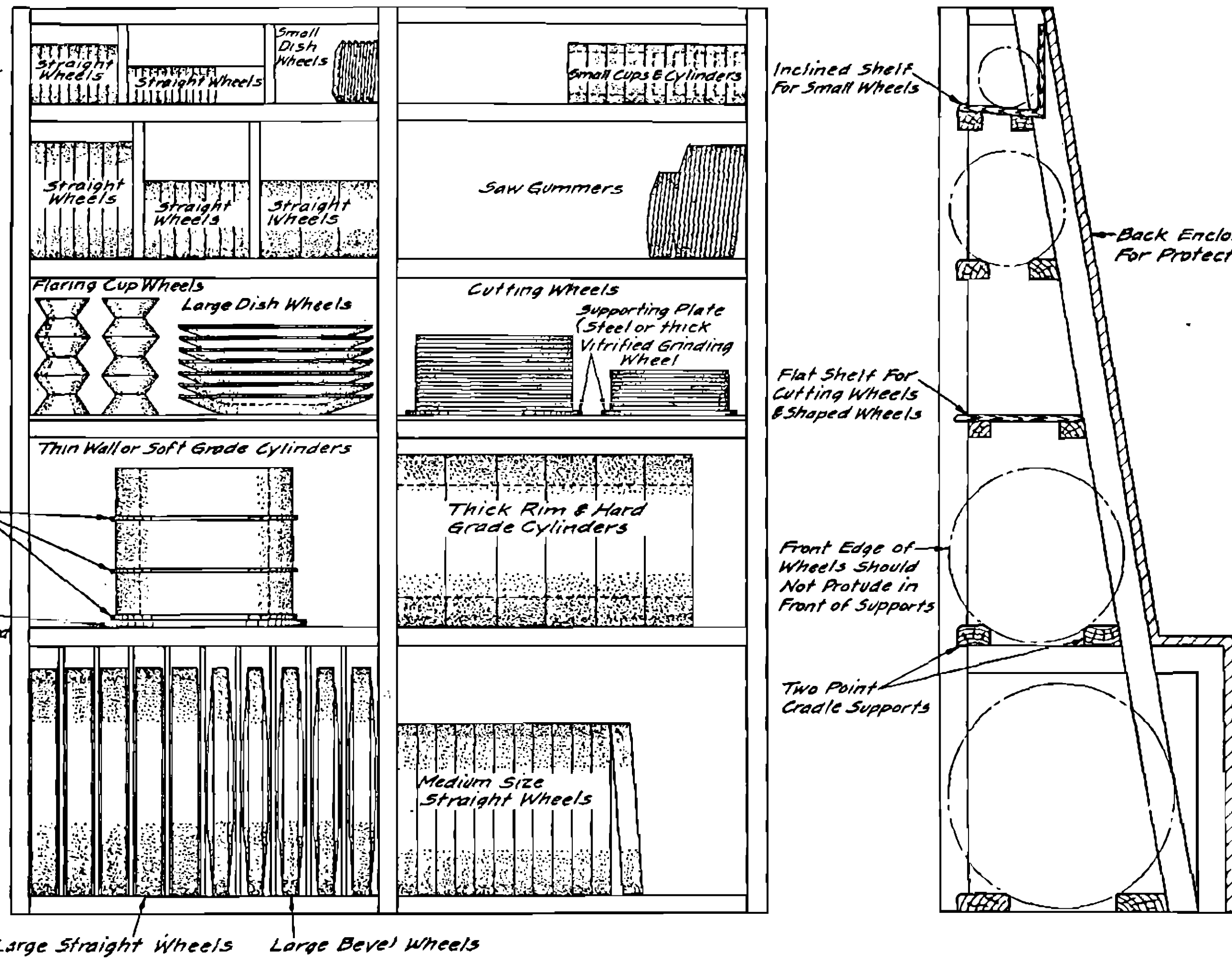

Straight Wheels
Straight Wheels
Small Dish Wheels
Small Cups & Cylinders
Straight Wheels
Straight Wheels
Straight Wheels
Saw Gummers
Flaring Cup Wheels
Large Dish Wheels
Cutting Wheels
Supporting Plate (Steel or thick Vitrified Grinding Wheel
Thin Wall or Soft Grade Cylinders
Thick Rim & Hard Grade Cylinders
Corrugated Paper Cushions
Supporting Plate Steel or thick Vitrified Grinding Wheel
Medium Size Straight Wheels
Large Straight Wheels
Large Bevel Wheels
Inclined Shelf For Small Wheels
Back Enclosed For Protection
Flat Shelf For Cutting Wheels & Shaped Wheels
Front Edge of Wheels Should Not Protude in Front of Supports
Two Point Cradle Supports

FIGURE 38

APPENDIX E

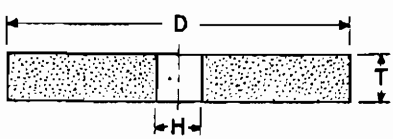
STANDARD WHEEL SHAPES

TABLE 1. SHAPE TYPES OF GRINDING WHEELS

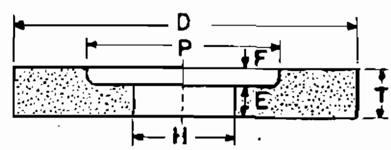
The following cuts and classifications are copied from Simplified Practice Recommendation R45-47 of the National Bureau of Standards, Division of Simplified Practice.

Type No. 1	Wheels	Straight
Type No. 2	"	Cylinder
Type No. 4	"	Tapered Two Sides
Type No. 5	"	Recessed One Side
Type No. 6	"	Straight Cup
Type No. 7	"	Recessed Two Sides
Type No. 11	"	Flaring Cup
Type No. 12	"	Dish
Type No. 13	"	Saucer
Type No. 16	Cones	Curved Side
Type No. 17	"	Square Tip
Type No. 17R	"	Round Tip
Type No. 18	Plugs	Square End
Type No. 18R	"	Round End
Type No. 19	"	Conical End, Square Tip
Type No. 19R	"	Conical End, Round Tip
Type No. 20	Wheels	Relieved One Side
Type No. 21	"	Relieved Two Sides
Type No. 22	"	Relieved One Side, Recessed Other Side

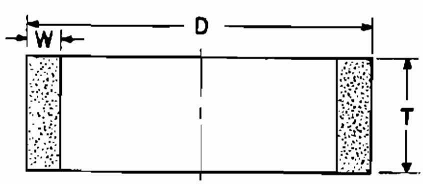
The above shape types cover the vast majority of grinding wheels used. These type numbers, when used with dimensions corresponding to the applicable letter symbols, make it possible to describe completely and accurately the shape and size of any standard wheel without the necessity of submitting a drawing, thereby simplifying ordering and record keeping.



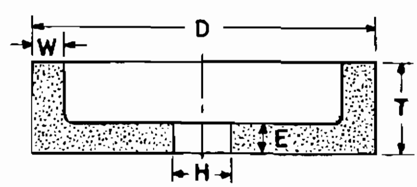
Type No. 1—Straight Wheel



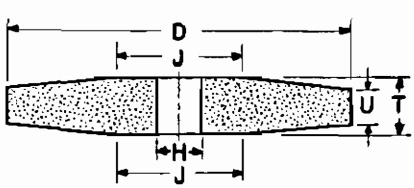
Type No. 5—Wheel, Recessed One Side



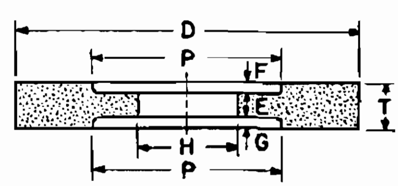
Type No. 2—Cylinder Wheel



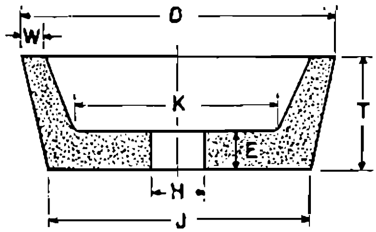
Type No. 6—Straight Cup Wheel



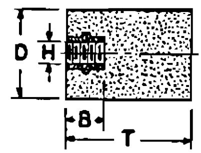
Type No. 4—Wheel, Tapered Two Sides



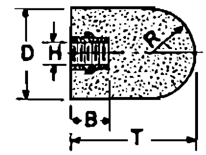
Type No. 7—Wheel, Recessed Two Sides



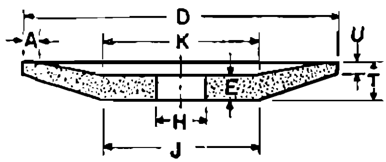
Type No. 11—Flaring Cup Wheel



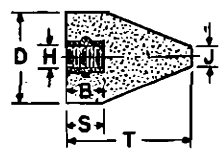
Type No. 18
Plug, Square End



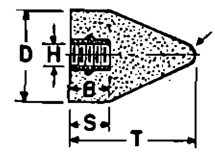
Type No. 18R
Plug, Round End



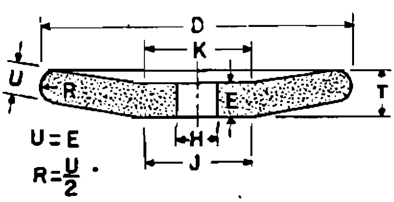
Type No. 12—Dish Wheel



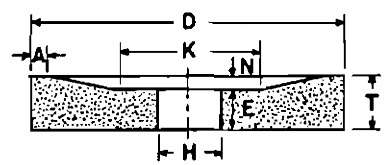
Type No. 19
Plug, Conical End,
Square Tip



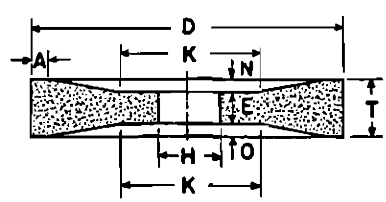
Type No. 19R
Plug, Conical End,
Round Tip



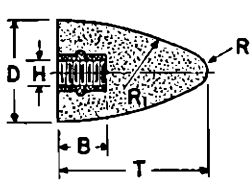
Type No. 13—Saucer Wheel



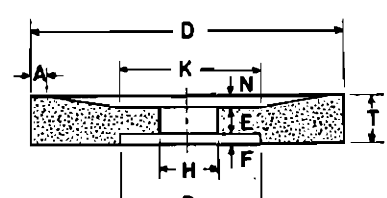
Type No. 20—Wheel, Relieved One Side



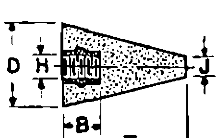
Type No. 21—Wheel, Relieved Two Sides



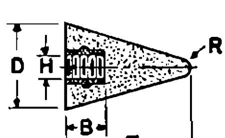
Type No. 16—Cone, Curved Side



Type No. 22—Wheel,
Relieved One Side, Recessed Other Side



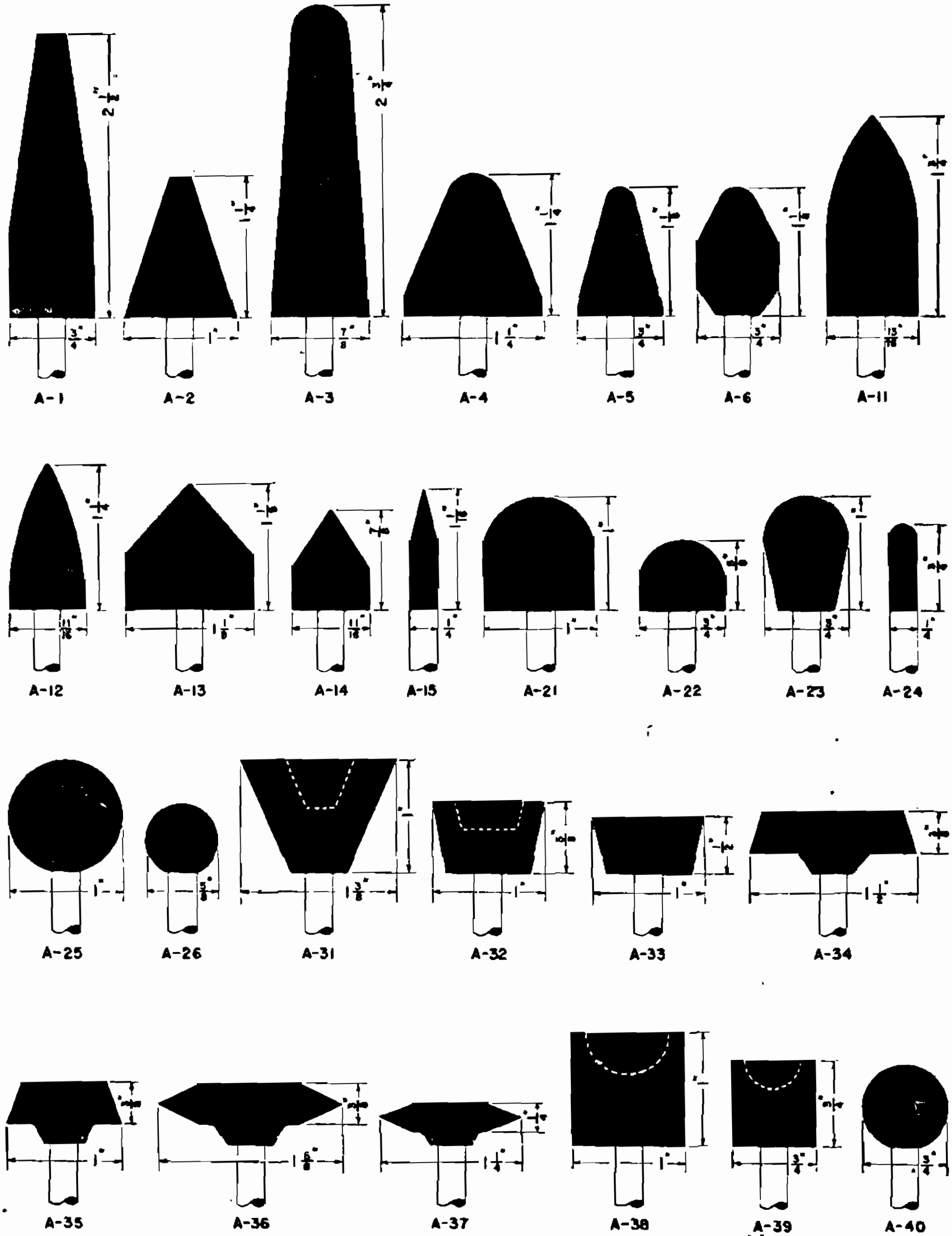
Type No. 17
Cone, Square Tip



Type No. 17R
Cone, Round Tip

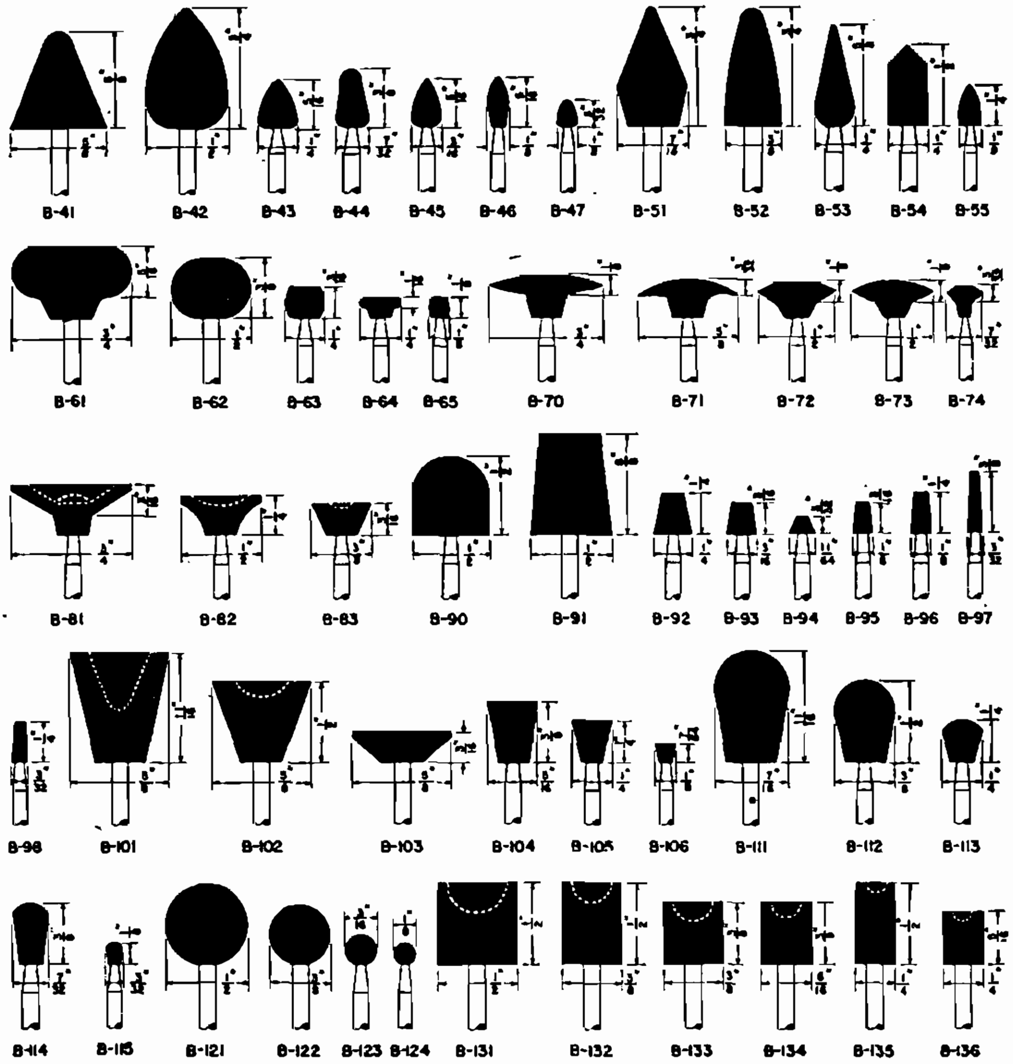
MOUNTED WHEELS AND POINTS

Group "A"—Standard Shapes



MOUNTED WHEELS AND POINTS

Group "B"—Standard Shapes



Group "W"—Plain Shapes