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UNITED STATES DEPARTMENT OF LABOR
WILLIAM N. DOAK, Secretary
BUREAU OF LABOR STATISTICS
ETHELBERT STEWART, Commissioner

BULLETIN OF THE UNITED STATES BUREAU OF LABOR STATISTICS . . . . No. 527

SAFETY CODE SERIES

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

INTERNATIONAL ASSOCIATION OF INDUSTRIAL ACCIDENT BOARDS AND COMMISSIONS AND GRINDING WHEEL MANUFACTURERS ASSOCIATION, SPONSORS

AMERICAN STANDARD
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NO. 527 WASHINGTON DECEMBER, 1930

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

INTRODUCTION

The 1926 edition of this code had a very wide distribution, and it was undoubtedly recognized as the most authoritative publication on the subject available. Since its issue much progress has been made in the grinding-wheel industry, particularly in relation to the development of the high-speed wheel and high-speed grinding. In 1926 the maximum speed for the vast majority of grinding wheels in use was 6,000 to 6,500 peripheral feet per minute. Synthetic resin and rubber bonded wheels were beginning to make themselves known, and it was recognized that they could be operated at higher speeds. Some provision for the guarding of high-speed grinding was made, but as the manufacture and use of this class of equipment grew it was realized that the specifications were not complete nor entirely satisfactory.

In order to keep pace with this progress it was necessary to revise certain sections of the code. Actual breakage tests were conducted to determine the suitability of steel castings for use in high-speed protection hoods. Other tests were made to determine the proper proportions for tapered flanges to be used with high-speed wheels. Other rules were carefully studied and notes made of those sections which needed revision or amendment.

A meeting of the sectional committee was held on February 5, 1930, at which all of these changes were discussed and put into definite form. A letter ballot of the entire sectional committee indicated unanimous approval of the suggested revisions. These were subsequently approved by both sponsors. The revised code was approved by the American Standards Association, June 25, 1930.

It is interesting to note that although a great many changes have been made they are all in detail only. In other words, the same general principles apply now as in the past. The importance of proper wheels, correct mounting, suitable machines, careful operation, and proper speed are recognized as means of preventing wheel breakage, but as all of these things are dependent on human control it is considered essential that some form of mechanical guard be employed at all times.

The sectional committee which approved the revised code consists of the following members:

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SECTION I.—SCOPE AND DEFINITIONS

1.1. Scope.

This code is intended to give rules and specifications which are necessary to insure safety in the use of abrasive wheels operating at peripheral speeds exceeding 2,000 feet per minute.

1.2. Definitions.

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

Abrasive wheel.—An abrasive wheel is a power-driven wheel consisting of abrasive particles held together by artificial or natural mineral or organic bonds. Metals, wooden, cloth, or paper wheels or discs having a layer or layers of abrasive on the surface are not included.

Protection hood.—A protection hood is an inclosure for an abrasive wheel consisting of a peripheral and two side members. Its main function is effectively to retain the pieces of the wheel should it break in operation.

Cast hood.—A cast hood is a protection hood which has the peripheral protecting member cast integral with at least one side member, and may be made of gray-iron castings, malleable-iron castings, or steel castings.

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.

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. A separate definition for protection flanges is given below.

Adaptors.—Adaptors are a form of flange used to mount wheels where the wheel hole is larger than the machine arbor.

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.

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, beveled, 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.

Protection band.—A protection band is a continuous band placed around a cup, cylinder, or sectional ring wheel to effectively retain the pieces of the wheel should it break in operation.

Protection chuck.—A protection chuck is a chuck used for mounting cup, cylinder, or sectional ring wheels, so designed that in addition to supporting and driving the wheel it will also serve to effectively retain the pieces of the wheel should it break in operation.

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.

SECTION II.—TYPES OF PROTECTION DEVICES

2.1. General requirements.

All abrasive wheels shall be provided with one of the following forms of protection.

(*a*) Protection hoods.
(*b*) Protection flanges.
(*c*) Protection bands.
(*d*) Protection chucks.

EXCEPTION.—This requirement shall not apply to wheels used for internal grinding, nor to wheels three inches or less in diameter running at a peripheral speed not exceeding 3,000 feet per minute.

Forms (*c*) and (*d*) apply to cups, cylinders, and sectional ring wheels; forms (*a*) and (*b*) to all other shapes of wheels.

SECTION III.—HANDLING AND STORAGE

3.1. Storage.

Extreme care should be exercised in the storage of wheels. Suitable racks or bins should be provided to accommodate the various types of wheels carried in stock.

Most straight and tapered wheels are best supported on edge in racks.

Thin rubber, shellac, and other organic bonded wheels should be laid flat on a plane surface to prevent warpage.

Cylinder wheels and large cup wheels should be stacked on the flat sides with corrugated paper or other cushioning material between them.

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

Very large wheels can well be stored in original containers.

3.2. Inspection.

Immediately upon receipt, all wheels should 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 should not be used.

NOTE.—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 IV.—GENERAL MACHINE REQUIREMENTS

4.1. Rigidity, supports.

Grinding machines should be sufficiently heavy and rigid so as to minimize vibration. They should be securely mounted on substantial floors, benches, foundations, or other adequate structures.

4.2. Diameter of spindle.

No wheel of larger diameter or greater thickness than specified in the following table shall be used on any machine of given spindle diameter.

Minimum diameters of spindles for wheels of various diameters and thicknesses operating at speeds up to 7,000 peripheral feet per minute

Diameter of wheel in inches	Thickness of wheel—inches																	
	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5
	Diameter of spindle—inches																		
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, 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.

4.3. Limit stop.

Grinding machines should be provided with a stop or other means of limiting the maximum diameter of wheel which can be mounted.

4.4. Direction of spindle thread.

Ends of spindles shall be so threaded that the nuts on both ends will tend to tighten as the spindles revolve. Care should be taken in setting up machines that the spindles are mounted so that they will revolve in the proper direction, else the nuts on the ends will loosen.

NOTE.—To remove the nuts, they should both be turned in the direction that the spindle revolves when the wheel is in operation.

4.5. Length of spindle thread.

When the wheel is mounted the thread on the spindle shall extend beyond the nut both inside and outside.

4.6. Size of wheel holes.

Allowance for mounting fit shall be made in the wheel hole and not in the wheel mount. The wheel mount shall be made to nominal size within commercial limits.

SECTION V.—PROTECTION HOODS

5.1. General requirements.

Hoods shall always be used with wheels which are not provided with protection flanges, bands, or chucks.

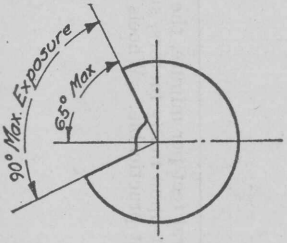

FIGURE 1

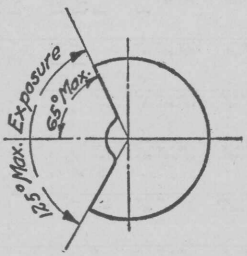

FIGURE 2

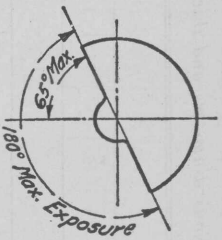

FIGURE 3

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. 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° or one-fourth of the periphery. This exposure shall begin at a point not more than 65° above the horizontal plane of the wheel spindle. (See fig. 1.)

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125°. This exposure shall begin at a point not more than 65° above and extend to a point not more than 60° below the horizontal plane of the wheel spindle. (See fig. 2.)

5.4. 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°. This exposure shall begin at a point not more than 65° above the horizontal plane of the wheel spindle. (See fig. 3.)

5.5. Exposure—Surface grinders.

The maximum angular exposure of the grinding wheel periphery and sides for hoods used on surface grinding machines which employ the wheel periphery shall not exceed 150°. (See fig. 4.)

5.6. 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°, and the top half of the wheel shall be protected at all times. (See fig. 5.)

5.7. 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°. (See fig. 6.)

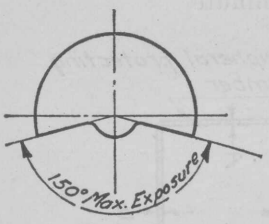

FIGURE 4

FIGURE 5

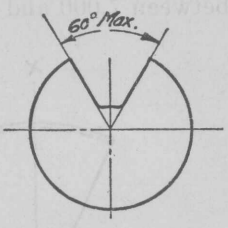

FIGURE 6

5.8. Exposure adjustment.

Hoods shall be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel by means of an adjustable tongue, or its equivalent, so that the angular protection specified in rules 5.3 to 5.7 will be maintained throughout the life of the wheel, and the maximum distance between the wheel periphery and tongue or end of peripheral band at top of opening will not exceed one-fourth inch. (See figs. 7, 8, and 9.)

5.9. 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.

5.10. Inclosure requirements.

The hood shall inclose 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.

5.11. Minimum dimensions for the peripheral and side members. All members specified in this table may be used with wheels running up to 7,000 peripheral feet per minute.

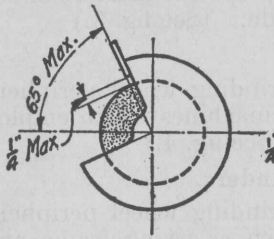

FIGURE 7.—Correct

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

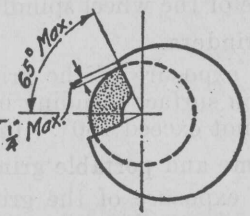

FIGURE 8.—Correct

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

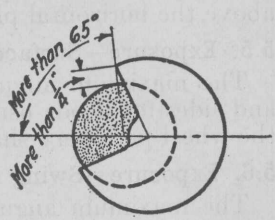

FIGURE 9.—Incorrect

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

Steel casting hoods or hoods fabricated from structural steel, wrought iron, or steel castings as specified, or other types of construction affording equal protection, shall be used with wheels running between 7,000 and 10,000 peripheral feet per minute.

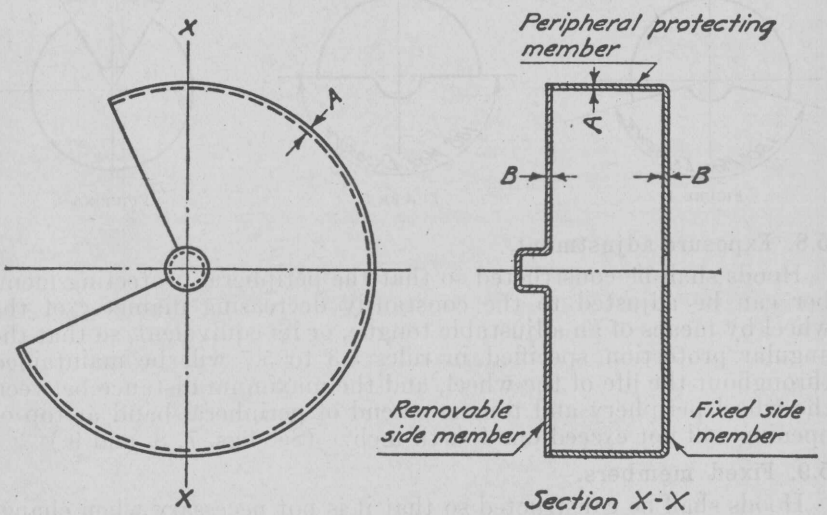

FIGURE 10

EXCEPTION.—For cutting-off wheels (less than one-fourth inch in thickness) cast hoods made according to the following table may be used, even though the speed exceeds 7,000 feet per minute.

Material used in construction of guard	Maximum thickness of grinding wheel	Grinding wheel diameters											
		3 to 6 inches		7 to 12 inches		13 to 16 inches		17 to 20 inches		21 to 24 inches		25 to 30 inches		31 to 48 inches	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B
Materials satisfactory for speeds up to 7,000 peripheral feet per minute:	*Inches*	*Inch*		*Inch*		*Inch*		*Inches*		*Inches*		*Inches*		*Inches*	
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
Do	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
Do	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
Do	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
Do	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 peripheral feet per minute:															
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
Do	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
Do	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
Do	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
Do	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
Do	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
Do	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

5.12. Material specifications.

Materials used in the construction of hoods shall conform to and be in accordance with the following 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 medium).
(*d*) Structural steel plate—A 9 (excluding specifications for rivet steel).
(*e*) Wrought iron plate—A 42 (class A).

NOTE.—Copies of these specifications may be procured at a nominal price from the American Society for Testing Materials, Philadelphia, Pa.

5.13. Construction guide.

As a guide for the construction of fabricated hoods of steel plate or wrought iron the following drawings have been prepared. Other types affording equal protection are also acceptable.

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

Diameter of wheel (inches)	C	D	E	F	G	H	J	K
	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*	*Inch*	*Inches*	*Inch*	*Inch*	*Inch*
Under 12	1½	[1] 1½	3½	½	1½ x 1½ x ¼	7/16	7/16	¼
12 to 16	1½	[1] 2	5	9/16	2 x 2 x 5/16	½	½	5/16
17 to 24	1½	[1] 2	6	9/26	2 x 2 x ½	½	9/16	½
Over 24	1½	[1] 2	7	⅝	2½ x 2½ x ½	9/16	⅝	½

[1] Wider than wheel.

5.14. Connections.

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

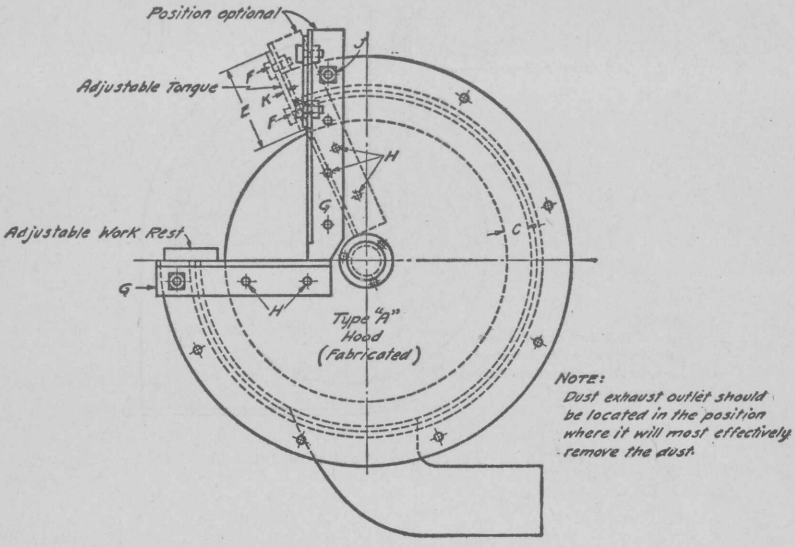

FIGURE 11.—For suction pipe sizes see rule 5.16

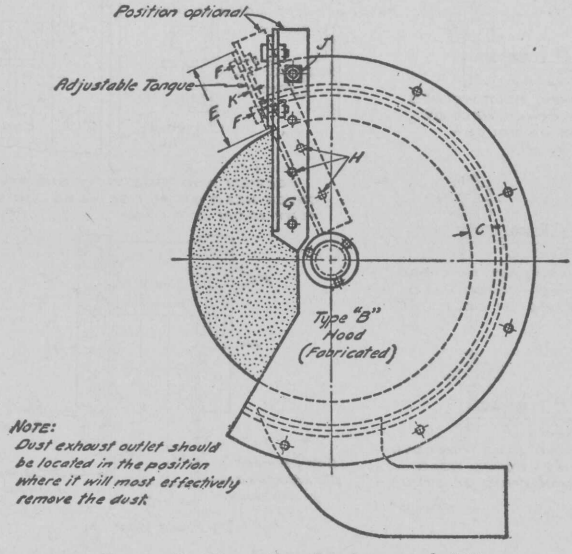

FIGURE 12.—For suction pipe sizes see rule 5.16

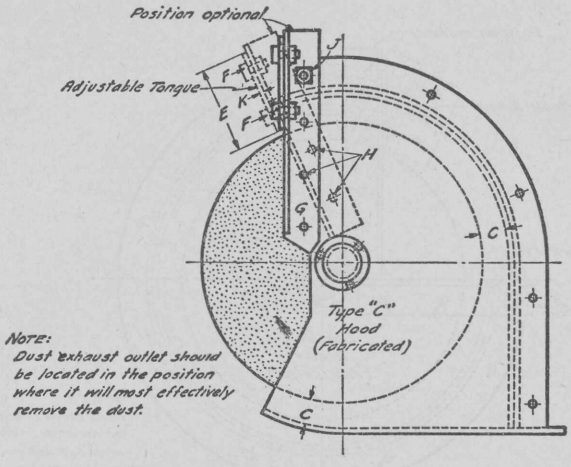

FIGURE 13.—For suction pipe sizes see rule 5.16

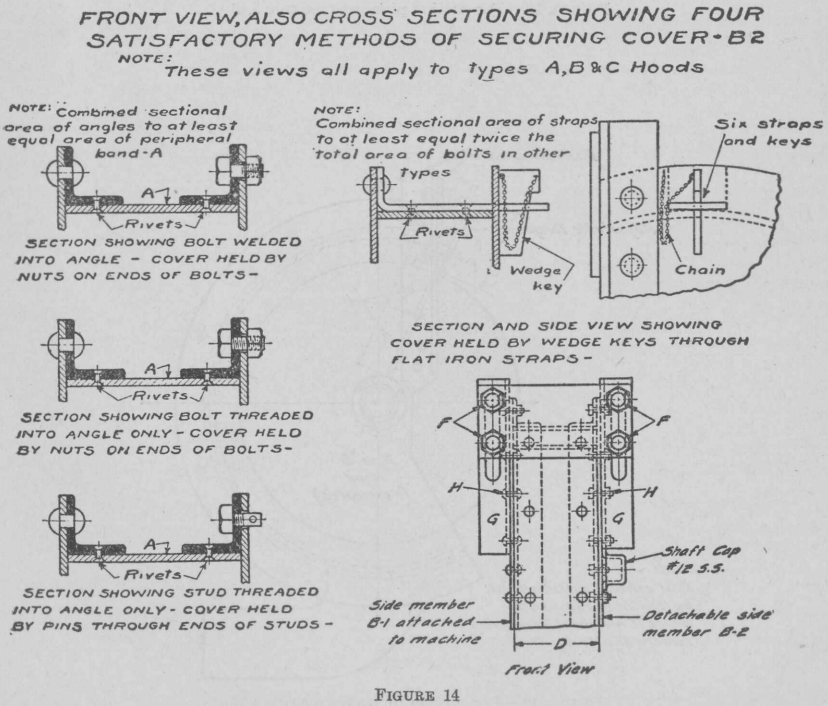

FIGURE 14

5.15. Connecting members (specifications).

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	*Inch*	*Inches*	*Inch*	*Inches*
1/8 and 1/16	5/16	3	7/16	6
3/16 and 1/16	5/16	3	7/16	6
3/16 and 1/8	5/16	3	7/16	6
3/16 and 3/16	5/16	3	7/16	6
1/4 and 1/8	3/8	4	9/16	8
1/4 and 3/16	3/8	3 1/2	9/16	7
1/4 and 1/4	3/8	3	9/16	6
5/16 and 3/16	9/16	4	13/16	8
5/16 and 1/4	9/16	4	13/16	8
3/8 and 1/4	9/16	4	13/16	8
3/8 and 5/16	9/16	3 1/2	13/16	7
7/16 and 1/4	9/16	3	13/16	6
7/16 and 5/16	9/16	3	13/16	6
1/2 and 5/16	9/16	3	13/16	6
1/2 and 3/8	9/16	3	13/16	6
5/8 and 3/8	5/8	3	7/8	6
11/16 and 7/16	5/8	3	7/8	6

5.16. Dust exhaust provision.

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

The size of such connections should be in conformity with the following specified dimensions:

Diameter of wheel	Minimum diameter of branch pipe
6 inches or less	3 inches
7 inches to 16 inches	4 inches
17 inches to 24 inches	5 inches
25 inches to 30 inches	6 inches

A modification of the above requirements will be allowed in the case of narrow wheels used for light work where very little dust is generated and where a smaller pipe will satisfactorily remove it.

The requirements in this paragraph shall not apply to swing frame and portable grinding machines.

SECTION VI.—WORK RESTS

6.1. Construction.

Work rests shall be rigid in construction.

On operations where they are not used, they shall be removed from the operating position.

6.2. Adjustment.

The work rest should be kept adjusted close to the wheel, with a maximum distance of one-eighth inch, to prevent the work from being caught between the wheel and rest, and should be securely clamped after each adjustment. This adjustment shall not be made while the wheel is in motion.

The rest should be maintained in good condition.

SECTION VII.—PROTECTION FOR CUPS, CYLINDERS, AND SECTIONAL RING WHEELS

7.1. General requirements.

Cups, cylinders, and sectional ring wheels shall be either protected with hoods, inclosed in protection chucks, or surrounded with protection bands. Not more than one quarter of the original height of such grinding wheels shall protrude beyond the provided protection. Where the thickness of the rim of such wheels is less than 2 inches, the maximum distance which the wheel may protrude beyond the provided protection shall not exceed a dimension equal to the thickness of the rim. If the thickness of the rim is 2 inches or more, the wheel may protrude 2 inches beyond the protection but shall not exceed this amount.

7.2. Hoods.

Where hoods are used, they shall conform to the specifications given in rules 5.1 to 5.16, inclusive, in this code.

7.3. Chucks.

Where the chuck which holds the wheel is the only protection provided, it shall be so designed that the jaws will at all times protect the wheel up to the point specified in rule 7.1.

7.4. Bands.

Where protection bands are used, they shall conform to the following specifications:

(*a*) They shall be made of wrought iron or steel plate or other material of equal strength, shall be continuous and bent to conform as closely to the periphery of the wheel as practical. The ends shall either be riveted, bolted, or welded together in such a manner as to leave the inside of the band free from projections.

(*b*) The bands shall be of sufficient width to provide the protection specified in rule 7.1.

(*c*) The thickness of the band shall be made according to the following table, which also shows the size and spacing for riveted joints. If bolting or welding is used, the strength of the connections shall be at least equal to the riveted joints specified in this table.

Diameter of wheel	Thickness of band	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 VIII.—FLANGES

GENERAL

8.1. General requirements.

All abrasive wheels shall be mounted between flanges, excepting those which are mounted in chucks, cemented to metal backs, or otherwise securely and adequately mounted on spindles. These flanges (sometimes called collars) may be of the straight type (rule 8.8), the tapered type (rule 8.11) or of some other design affording at least equal support and protection.

8.2. Material.

All tapered flanges over 10 inches in diameter shall be of steel. All other flanges may be made of cast iron, or other material of equal strength.

8.3. Finish and balance.

Flanges shall be finished all over correct to dimensions and in balance. (The requirement for balance does not apply to so-called balancing flanges which are purposely made out of balance.)

8.4. Uniformity of diameter.

Both flanges, whether straight or tapered, in contact with wheel, shall be of the same diameter.

8.5. Recess.

Straight flanges made according to Figure 15 and tapered flanges made according to Figure 19 shall be recessed at least one-sixteenth of an inch 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. 16 and 17) shall be recessed so that there will be no bearing on the sides of the wheel within one-eighth of the hole.

8.6. Contact.

Bearing surfaces of flanges shall be so designed that when tightened up full contact with wheel will be insured.

8.7. Fit.

The driving flange shall be keyed, screwed, shrunk, or pressed onto the spindle, and the bearing surface shall run true and at right angles with the spindle.

STRAIGHT FLANGES (Where protection hoods are employed)

8.8. Dimensions.

Where protection hoods are used, sizes of straight flanges for straight wheels shall not be less than shown in the following tables. (figs. 15, 16, and 17.)

Figure 15 shows the minimum dimensions for so-called straight flanges for use with straight sided wheels with small holes which fit directly on the machine arbor. (These are not protection flanges and shall only be used in connection with protection hoods which comply with Sec. V.)

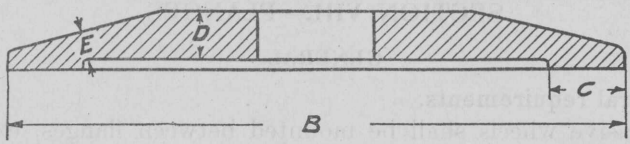

FIGURE 15

A Diameter of wheel	B Minimum outside diameter of flanges	C Radial width of bearing surface		D Minimum thickness of flange at bore	E Minimum thickness of flange at edge of recess
		Minimum	Maximum		
Inches	*Inches*	*Inch*	*Inches*	*Inch*	*Inch*
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

Figure 16 shows the minimum dimensions for so-called adaptor flanges for use with straight-sided wheels with holes larger than the machine arbor. (These are not protection flanges and shall only be used in connection with protection hoods which comply with Sec. V.)

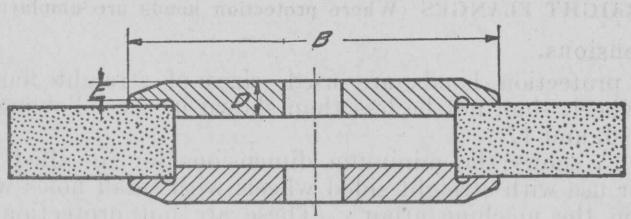

FIGURE 16.—Driving flange secured to spindle. See rule 8.7

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.

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*	*Inch*	*Inch*
12 to 14	4	6	5/8	3/8
	5	7	5/8	3/8
	6	8	5/8	3/8
Larger than 14 to 18	4	6	5/8	3/8
	5	7	5/8	3/8
	6	8	5/8	3/8
	7	9	5/8	3/8
	8	10	5/8	3/8
Larger than 18 to 24	6	8	3/4	1/2
	7	9	3/4	1/2
	8	10	3/4	1/2
	10	12	3/4	1/2
	12	14	3/4	1/2
Larger than 24 to 36	12	15	3/4	1/2

Figure 17 shows the minimum dimensions for so-called sleeve flanges used on precision grinding machines for mounting wheels with holes larger than the machine arbor. (These are not protection flanges and shall only be used in connection with protection hoods which comply with Sec. V.)

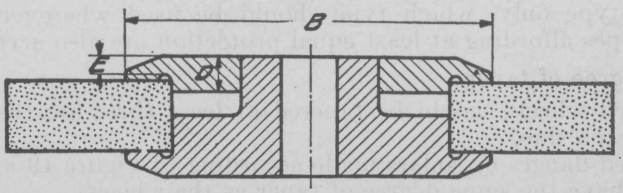

FIGURE 17.—Driving flange secured to spindle. See rule 8.7

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.

Wheel diameter	Wheel hole	B Minimum outsize diameter of flange	D Minimum thickness of flange at bore	E Minimum thickness of flange at edge of recess
Inches	*Inches*	*Inches*	*Inch*	*Inch*
12 to 14	5	7	1/2	7/16
Larger than 14 to 20	5	7	5/8	7/16
	6	8	5/8	7/16
	8	10	5/8	7/16
	10	11 1/2	5/8	7/16
	12	13 1/2	5/8	7/16
Larger than 20 to 30	8	10	3/4	1/2
	10	11 1/2	3/4	1/2
	12	13 1/2	3/4	1/2
	16	17 1/2	3/4	1/2
Larger than 30 to 36	12	14 1/2	3/4	1/2
	16	17 1/2	3/4	1/2
	18	19 1/2	3/4	1/2
	20	21 1/2	3/4	1/2

PROTECTION FLANGES (Where hoods are not employed)

8.9. General requirements.

Protection flanges (also called safety collars) shall always be used with wheels 6 inches and larger which are not provided with hoods, chucks, or bands. (See rule 5.1.) Specifications follow for the tapered type only, which type should be used wherever possible. Other types affording at least equal protection are also acceptable.

8.10. Degree of taper.

Tapered wheels should be tapered at least three-fourths inch per foot on each side.

Tapered flanges or collars made according to Figure 19 and Figure 22 shall have the same degree of taper as the wheels.

Tapered flanges or collars made according to Figure 21 shall be tapered one thirty-second inch per foot more than the taper of the wheel.

8.11. Dimensions.

Where no hoods are used, the dimensions of tapered flanges or collars shall not be less than shown in the following tables.

Two satisfactory types are illustrated (fig. 19 and fig. 21) for use with wheels operating not faster than 6,500 peripheral feet per minute.

A	B	C		D	E	E1	F	F1	G
Diameter of wheel	Minimum outside diameter of flanges	Radial width of bearing surface, fig. 19 only		Minimum thickness of flange at bore	Minimum at edge of recess, fig. 19 only	Minimum thickness at bevel, fig. 21 only	Maximum flat spot at center of flange inside	Diameter of flat area outside, fig. 21 only	Maximum diameter of flat spot or hub of wheel
		Minimum	Maximum						
Inches	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*
6	3	1/4	1/2	3/8	3/16	------	0	------	1
8	4	5/16	5/8	3/8	1/4	------	0	------	1
10	5	1/2	1	1/2	1/4	------	0	------	2
12	6	1/2	1	5/8	5/16	1/2	4	5	4 1/2
14	8	5/8	1 1/4	5/8	3/8	1/2	4	5	4 1/2
16	10	3/4	1 1/2	5/8	3/8	1/2	4	6	6
18	12	1	2	3/4	1/2	5/8	4	6	6
20	14	1 1/4	2 1/2	3/4	1/2	5/8	4	7	6
22	16	1 3/8	2 3/4	3/4	9/16	5/8	4	7	6
24	18	1 1/2	3	3/4	9/16	5/8	4	8	6
26	20	1 1/2	3 1/4	3/4	5/8	5/8	4	8	6
28	22	1 3/4	3 3/4	7/8	5/8	5/8	4	8	6
30	24	2	4	7/8	3/4	3/4	4	8	6
36	28	2	4	1	7/8	------	4	------	6

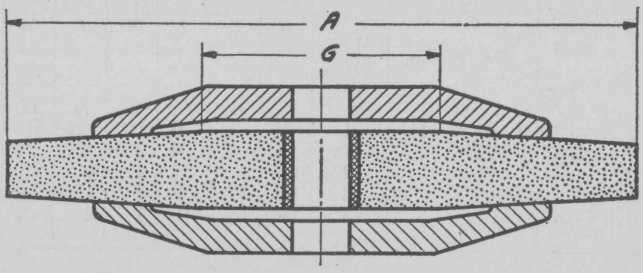

FIGURE 18.—Driving flange secured to spindle. See rule 8.7

FIGURE 19.—For degree of taper see rule 8.10

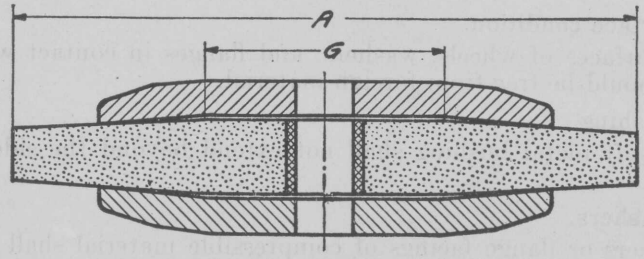

FIGURE 20.—Driving flange secured to spindle. See rule 8.7

FIGURE 21.—For degree of taper see rule 8.10

Figure 22 shows the minimum dimensions of protection flanges for use with wheels operating faster than 6,500 peripheral feet per minute up to 9,500 peripheral feet per minute.

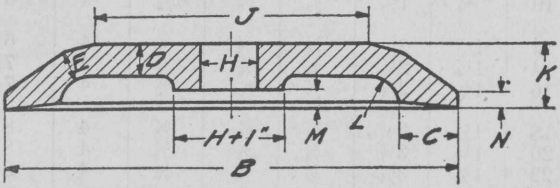

FIGURE 22.—Driving flange secured to spindle. See rule 8.7. For degree of taper see rule 8.10

Diameter of wheel	Thickness of wheel	B	C		D	E	J	K	L	M	N
			Maximum	Minimum							
In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
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 IX.—MOUNTING

9.1. 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 3.2.)

9.2. Fit.

Grinding wheels shall fit freely on the spindles; they should not be forced on, nor should they be too loose. (See rule 4.6.)

9.3. Surface condition.

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

9.4. Bushing.

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

9.5. 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 one-eighth inch. If flanges with babbitt or lead facings are used, the thickness of the babbitt or lead should not exceed one-eighth inch. The diameter of the washers shall not be smaller than the diameter of the flanges.

9.6. 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 X—SPEED

10.1. Operating speed.

The following table indicates maximum peripheral speeds for various types and grades of wheels. These speeds shall not be exceeded except upon the distinct recommendation of the grinding wheel manufacturer for each specific case, and then only if the user maintains his equipment in a condition satisfactory to the wheel manufacturer.

Types of wheels	Vitrified and silicate bonds			Organic bonds		
	Soft	Medium	Hard	Soft	Medium	Hard
	F.p.m.	*F.p.m.*	*F.p.m.*	*F.p.m.*	*F.p.m.*	*F.p.m.*
Type 1—Straight wheels [1]	5, 500	[2] 6, 000	6, 500	6, 500	8, 000	9, 500
Type 4—Taper wheels [1]						
Types 5 and 7—Recessed wheels [1]	5, 500	[2] 6, 000	6, 500	6, 500	8, 000	9, 500
Type 2—Cylinder wheels [1]	4, 500	5, 500	6, 000	6, 000	8, 000	9, 500
Dovetail wheels [3]	4, 500	5, 500	6, 000	6, 000	8, 000	9, 500
Types 11 and 12—Dish and flaring cup wheels. [1]						
Type 13—Saucer wheels						
Type 6—Deep recessed cup wheels	4, 500	5, 500	5, 500	6, 000	7, 500	9, 000
Coping wheels (solid and steel centers) [3]				6, 000	7, 500	9, 000
Type 1—Cut-off wheels (ordinary) [1]					10, 000	12, 000
Type 1—Cut-off wheels (special) (depending on *stability* and *design* of machine)						12, 000 to 16, 000

[1] Standard shapes (Department of Commerce—Simplified Practice Recommendation R45-28).
[2] On precision machines, vitrified and silicate wheels in medium grades may be operated at 6,500 peripheral feet per minute.
[3] Nonstandard shapes.

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.

10.2. Testing of high-speed wheels.

No wheels shall be operated at speeds exceeding 6,500 peripheral feet per minute, which have not been tested at a speed at least 50

per cent faster than the operating speed, with the following exceptions:

(*a*) Cut-off wheels.

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

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

When wheels of unusual and extreme shapes such as deep cups with thin walls or backs, long drums and so forth are required, consult the wheel manufacturer for speeds recommended.

10.3. Speed test.

Machine spindle speeds shall be tested and determined correct for size of wheel to be operated, before the wheel is mounted and shall never be changed as wheel is reduced in diameter, except by men assigned for such duties.

10.4. Speed adjustment control.

Where speed of wheel spindle is adjustable, speed adjustment shall be in control of authorized persons only.

10.5. Table of speeds.

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											
	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500
	R. p. m.	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*	*R. p. m.*
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
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
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
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
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
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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
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
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
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
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
16	955	1, 074	1, 194	1, 313	1, 432	1, 552	1, 672	1, 791	1, 910	2, 029	2, 149	2, 268
18	849	955	1, 061	1, 167	1, 273	1, 379	1, 485	1, 591	1, 698	1, 803	1, 910	2, 016
20	764	859	955	1, 050	1, 146	1, 241	1, 337	1, 432	1, 528	1, 623	1, 719	1, 814
22	694	781	868	955	1, 042	1, 128	1, 215	1, 302	1, 388	1, 476	1, 562	1, 649
24	637	716	796	875	955	1, 034	1, 115	1, 194	1, 274	1, 353	1, 433	1, 512
26	588	661	734	808	881	955	1, 028	1, 101	1, 176	1, 248	1, 322	1, 395
28	546	614	682	750	818	887	955	1, 023	1, 092	1, 159	1, 228	1, 296
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32	477	537	597	656	716	776	836	895	954	1, 014	1, 074	1, 134
34	449	505	562	618	674	730	786	843	898	955	1, 011	1, 067
36	424	477	530	583	637	690	742	795	848	902	954	1, 007

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.

SECTION XI.—OPERATING RULES AND GENERAL DATA

11.1. Responsibility.

Competent men 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 man. Wheels out of balance through wear, which can not be balanced by truing or dressing, shall be removed from the machine.

11.8. Wet grinding wheels.

Wheels used in wet grinding should 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 in which wheels fit, should be periodically inspected and maintained to size. (See rule 4.6.)

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