CERTIFICATE

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Document Name: ANSI B7.1-1970: Safety Code for the Use, Care, and Protection of Abrasive Wheels.

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APPROVED

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OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

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ANSI B7.1-1970

American National Standard

SUPERSEDED

safety code for the use, care, and protection of abrasive wheels

Approved December 29, 1970

SPONSORS

International Association of Governmental Labor Officials

Grinding Wheel Institute

american national standards institute, inc.
430 broadway, new york, new york 10018

American National Standard

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DATES OF PREVIOUS REVISIONS
Originally issued as a Tentative American Standard in 1922.
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Revised in 1930, 1935, 1942, 1947, 1956, 1964 and 1970.

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CONTENTS (Continued)

FOREWORD

(This Foreword is not a part of the American National Standard Safety Code For the Use, Care and Protection of Abrasive Wheels, B7.1-1970)

In 1917 the Grinding Wheel Manufacturers and the Machine Tool Builders began to recognize a need for codification and standardization of the basic requirements of safe operation of abrasive grinding wheels. By 1922 these two groups had completed a tentative draft of requirements for an American Standard. It was reviewed, revised, and subsequently published in 1926 under the auspices of the American Standards Association (now the American National Standards Institute) as the "American Standard Safety Code For the Use, Care and Protection of Abrasive Wheels." The Code has been revised in 1930, 1935, 1943, 1947, 1956, 1964 and 1970.

The two groups which initiated the Code in 1917 have been expanded into a Standards Committee representing nationally recognized engineering, safety, abrasive wheel and grinding machine fabricators and user associations, labor organizations, insurance underwriter groups, and several interested government agencies.

Safety is indeed everybody's business in the "Use, Care and Protection of Abrasive Wheels."

Basic to a proper understanding of the Code is a thorough knowledge of the nature and characteristics of abrasive wheels and the grinding machines on which they are used. Their safety and protection devices can and must be used to limit, if not eliminate, injury or damage in case of accidental wheel breakage. Constant educational programs at all levels are the best insurance against those unforseen conditions or circumstances which result in an industrial accident.

This Code outlines the best known practices, tests, and safety devices for the protection of all personnel and equipment from injury or damage in case of accidental wheel breakage. USE THEM.

This, the "American National Standards Institute Safety Code For the Use, Care and Protection of Abrasive Wheels," is specifically dedicated to vigilant safety practice and education.

STANDARDS COMMITTEE

Members who compose the Standards Committee and the organizations they represent are as follows:

STANLEY W. GERNER, *Chairman*
National Bureau of Standards

ALLEN P. WHERRY, *Secretary*
Grinding Wheel Institute

Organization Represented	*Name and Business Affiliation*
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American Foundrymen's Society	Herbert J. Weber
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Department of Health, Education and Welfare Public Health Service	Jeremiah R. Lynch
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U. S. Department of Labor	Stanley J. Butcher, Bureau of Labor Standards James M. Meagher, Jr. (Alt.)

EXPLANATION OF CODE FORMAT

This 1970 revision of the B7 Safety Code continues the two-column format to provide supporting information for the regulations.

The material in the left column is confined to code regulations only and is so captioned. These regulations are printed in distinctive bold type to indicate their authority without question. Where a condensed document is required (e.g. for State Code adoption), the material in the left column together with supporting tables and sketches can be used as a complete code.

The right column, captioned "Explanatory Information," offers basic reasons for each rule to encourage compliance. Material appears in this second column only when it clarifies the regulation. *This column should not be construed as being a part of the American National Standard Safety Code For The Use, Care And Protection of Abrasive Wheels B7.1-1970.*

Operating rules (safe practices) are not included in either column of this Safety Code unless they are of such nature as to be vital safety requirements, equal in weight to other requirements included in the Code.

CODE REGULATIONS
Section 1
SCOPE AND DEFINITIONS

1.1 Scope

This code sets forth rules and specifications for safety in the use of abrasive wheels, excluding natural sandstone, including specifications for safety guards, flanges, chucks and rules for the proper storage, handling, mounting and use of grinding wheels.

Metal, wooden, cloth or paper discs, having a layer of abrasive on the surface, are not included.

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 cutting tool consisting of abrasive grains held together by organic or inorganic bonds. Diamond and reinforced wheels are included.

1.2.3 ORGANIC BONDED WHEELS

Organic wheels are wheels which are bonded by means of an organic material such as resin, rubber, shellac or other similar bonding agent.

1.2.4 INORGANIC BONDED WHEELS

Inorganic wheels are wheels which are bonded by means of inorganic material such as clay, glass, porcelain, sodium silicate, magnesium oxychloride, or metal. Wheels bonded with clay, glass, porcelain or related ceramic materials are characterized as "vitrified bonded wheels".

Explanatory Information
(NOT PART OF ANSI CODE)
Section 1
Scope and Definitions

1.1 Scope

This column will offer reasons for the rule, to encourage compliance. Material will appear in this column only when it will clarify the regulations. (Not including tables or sketches.)

1.2 Definitions

The sketches and photographs used in this publication are classified as "Figures" or "Illustrations." The items listed as "Figures" are applicable to the code regulations, while those listed as "Illustrations" apply to the explanatory information.

1.2.2 ABRASIVE WHEEL

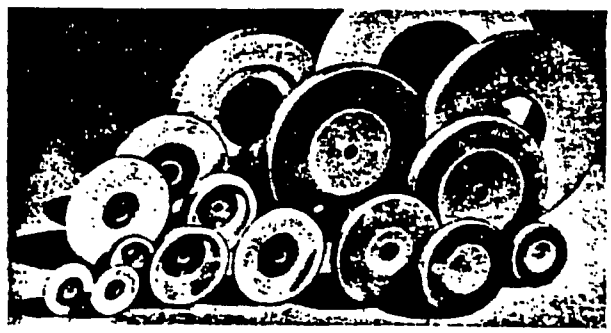


ILLUSTRATION No. 1
Examples of the various types of abrasive wheels included in this Code.

1.2.5 REINFORCED WHEELS

The term "Reinforced" as applied to grinding wheels shall define a class of organic wheels which contain strengthening fabric or filament.

The term "Reinforced" does not cover wheels using such mechanical additions as steel rings, steel cup backs or wire or tape winding. (See appendix A page 87 for additional protection devices.)

1.2.5 REINFORCED WHEELS

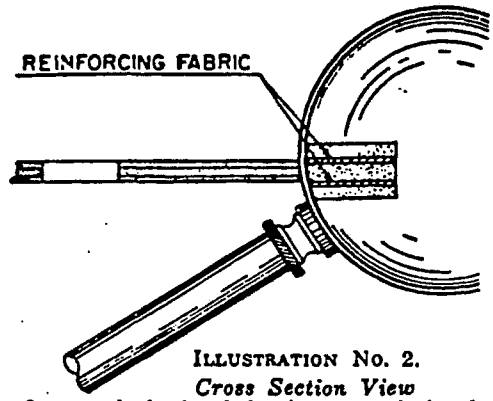
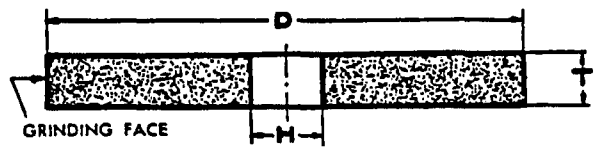


ILLUSTRATION No. 2.
Cross Section View
One method of reinforcing organic bonded wheels.

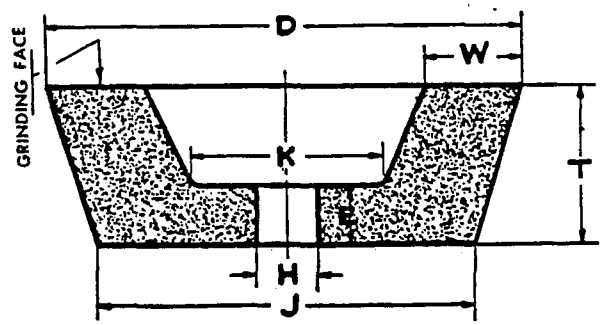
1.2.6 GRINDING SURFACE OR FACE

The grinding surface or face is the surface of the grinding wheel upon which grinding is performed.

1.2.6 GRINDING SURFACE OR FACE



Type 1—Straight wheel.



Type 11—Flaring-cup wheel.
ILLUSTRATION No. 3
Arrow indicates grinding face.

1.2.7 SAFETY GUARD

A safety guard is an enclosure designed to restrain the pieces of the grinding wheel and furnish all possible protection in the event that the wheel is broken in operation. See section 4 page 27 for full description.

1.2.7 SAFETY GUARD

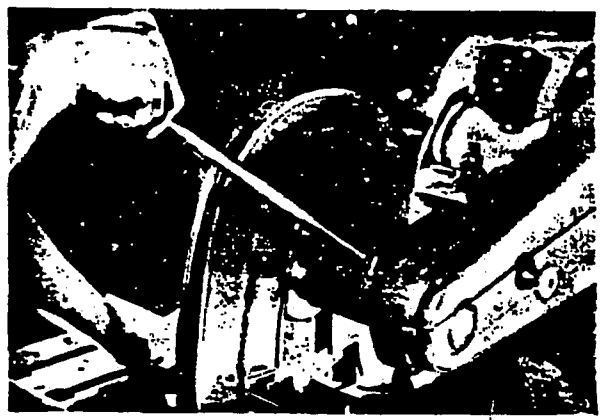


ILLUSTRATION No. 4
The safety guard affords operator protection in case of accidental breakage.

1.2.8 WHEEL SPEED

Wheel speed shall be computed from the free running speed of the machine spindle.

1.2.9 REVOLUTIONS PER MINUTE

Revolutions per minute (rpm) is the number of complete turns that a grinding wheel makes in one minute.

1.2.10 SURFACE FEET PER MINUTE

Surface feet per minute (sfpm) is the distance in feet any one abrasive grain on the peripheral surface of a grinding wheel travels in one minute.

$$\text{Surface Feet Per Minute} = \frac{3.1416 \times \text{diameter in inches} \times \text{r.p.m.}}{12}$$

or

.262 x diameter in inches x r.p.m.

Examples: (a) 24" diameter wheel, 1000 revolutions per minute
Surface Feet per minute .262 x 24 x 1000
6288 s.f.p.m.

(b) 12" diameter wheel, 1000 revolutions per minute
Surface Feet per minute .262 x 12 x 1000
3144 s.f.p.m.

1.2.11 FLANGES

Flanges are collars, discs or plates between which wheels are mounted and are referred to as adaptor, sleeve, or back up type. See section 5 page 42 for full description.

1.2.12 STEEL RINGS

Steel rings may be molded into certain organic bonded grinding wheels in manufacture. Where used, such rings act mainly to add rigidity to the wheel as it approaches discard size and to help retain the pieces of the wheel should accidental breakage occur at stub size. See Appendix A page 87.

1.2.8 WHEEL SPEED

In Table 20 page 59, wheel speeds are classified in surface feet per minute (sfpm). Machine spindle speeds, however, are usually indicated in revolutions per minute. Therefore, one must have a clear understanding of how these two are related.

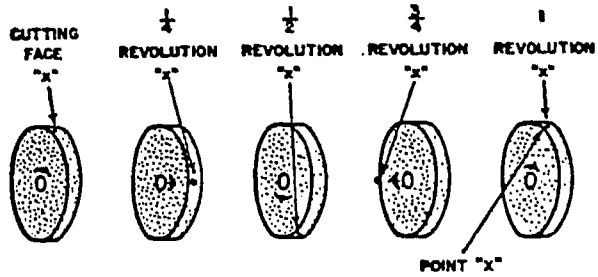


ILLUSTRATION No. 5
Point "X" has traveled a distance equal to the circumference of the wheel. (3.1416 x diameter)

1.2.10 SURFACE FEET PER MINUTE

Surface feet per minute (sfpm) is the distance in feet any one abrasive grain on the cutting face travels in one minute. In Illustration No. 5 the point "x" on the cutting face travels, for every complete turn, a distance equal to the circumference, (3.1416 x diameter). Since the diameter of a grinding wheel is usually indicated in inches, it is necessary to divide the result by 12 in order to obtain the number of "surface feet per minute".

1.2.13 THREADED BUSHINGS

Cup back, inserted type, round knurled and prong anchor bushings as shown in Illustration 6 are generally molded on types 6 and 11 organic bonded cup wheels.

Bushings of round, hexagonal, square or similar designs may be cemented or molded into the wheel holes, including cone and plug wheels.

Adequate safety guards shall always be used with these wheels unless specifically excepted by the code. See section 4 page 27 and Appendix A page 87.

1.2.14 REDUCING BUSHINGS

Reducing bushings are inserts or devices used to reduce the hole size in a grinding wheel so that it can be mounted correctly on a smaller diameter spindle. Reducing bushings shall be specifically designed, properly manufactured and fitted for use in grinding wheels as specified in paragraph 3.11, page 24. Minimum hole size as shown in Table 1 page 22 should not be violated nor should the bushing ends interfere with proper seating of the mounting flange or flanges. (See section 6 page 52.) Reducing bushings shall not be used to permit the operation of a grinding wheel in excess of its maximum operating speed.

1.2.15 TAPE OR WIRE WINDING

Tape or wire winding as used on the periphery of cylinder, cup or segmented disc wheels helps to retain the pieces of the wheel should accidental breakage occur. See Appendix A page 87.

1.2.16 CHUCK

A chuck is a fixture designed to hold abrasive segments or certain types of grinding wheels and is mounted on a machine spindle or machine face plate.

1.2.17 THE WHEEL MANUFACTURER

Any individual, partnership, corporation or other form of enterprise which manufactures any kind of abrasive wheel.

1.2.13 THREADED BUSHINGS

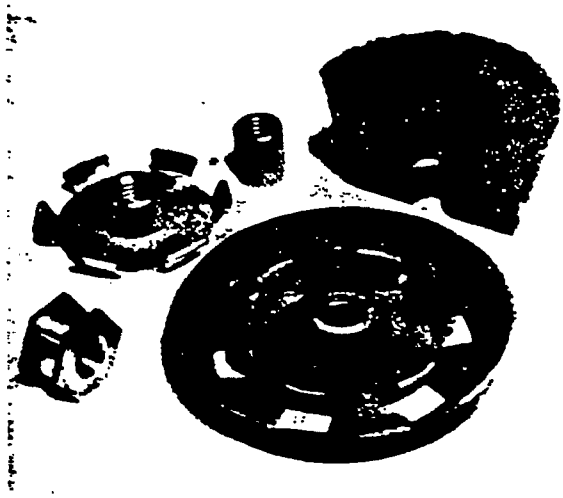


ILLUSTRATION No. 6
Hexagonal, prong anchor, round knurled and cup back bushings.

1.2.14 REDUCING BUSHINGS

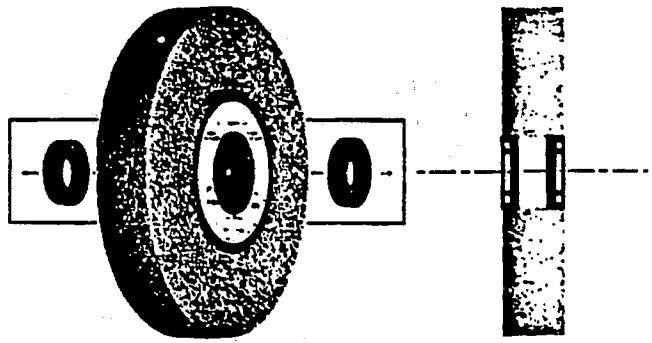


ILLUSTRATION No. 7
One type of reducing bushing commonly used to reduce a grinding wheel hole size.

1.2.18 THE MACHINE BUILDER

(a) Any individual, partnership, corporation or other form of enterprise which is engaged in the development and/or manufacture of any type of machine which uses an abrasive wheel.

(b) One who converts, changes or otherwise alters the original design of such machines.

1.2.19 THE USER OF WHEELS AND MACHINES

Any individual, partnership, corporation or other form of enterprise which uses abrasive wheels and machines.

1.3 Usage Definition

1.3.1 CENTERLESS O.D. GRINDING

The precision grinding of the outer surface of any cylindrical work piece which is rotated by a regulating wheel and supported by a work blade.

1.3.2 COPING

The sawing or grooving of any non-metallic material with an abrasive wheel.

1.3 Usage Definition

1.3.1 CENTERLESS O.D. GRINDING

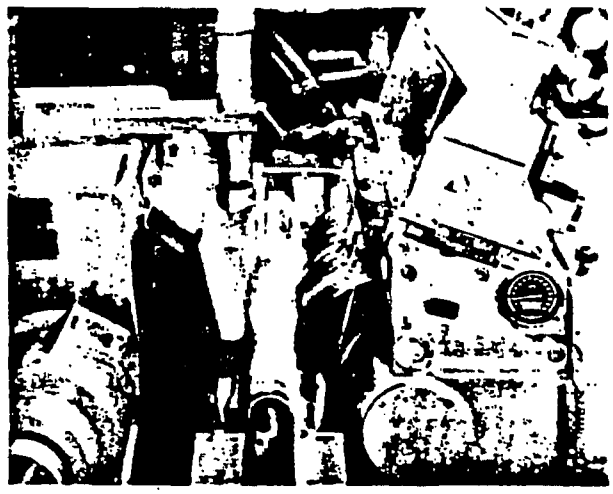


ILLUSTRATION No. 8
Typical through feed centerless grinding operation.

1.3.3 CUTTING OFF

The slicing or parting of any material or part.

1.3.4 CYLINDRICAL O.D. GRINDING

The precision grinding of the outer surface of any cylindrical work piece which is supported at one or both ends.

1.3.5 INTERNAL GRINDING

The precision grinding of the inside surface of the hole in a work piece.

1.3.6 OFF-HAND GRINDING

The grinding of any material or part which is held in the operator's hand.

1.3.7 PORTABLE GRINDING

A grinding operation where the grinding machine is designed to be hand held and may be easily moved from one location to another.

1.3.8 PRECISION GRINDING

Grinding operations performed by machines used to finish work parts to specified dimensions and finish requirements.

1.3.3 CUTTING OFF

ILLUSTRATION No. 9
Cutting ordinary bar stock, using a resinoid bonded cutting-off wheel mounted on a dry, chopper type cutting-off machine.

1.3.5 INTERNAL GRINDING

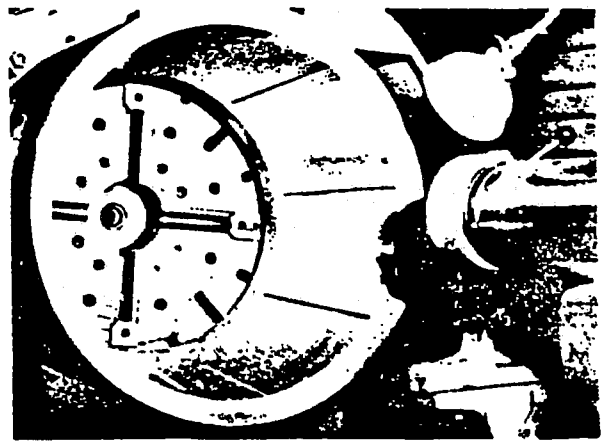


ILLUSTRATION No. 10
Internal grinding of a large bore cylinder.

1.3.6 OFF-HAND GRINDING

ILLUSTRATION No. 11
Offhand grinding on a double end pedestal grinder.

1.3.9 SAW GUMMING

The shaping and/or sharpening of saw teeth by grinding.

1.3.10 SLOTTING

The grinding of a slot or groove in any material or part.

1.3.11 SNAGGING

Grinding which removes relatively large amounts of material without regard to close tolerances or surface finish requirements.

1.3.12 SURFACE GRINDING

The precision grinding of a plane surface.

1.3.13 TOOL GRINDING

The precision grinding or sharpening of various types of cutting tools.

1.3.14 TUCK POINTING

Removal, by grinding, of cement, mortar or other non-metallic jointing material.

1.4 Definitions and Limitations of Wheel Shapes

The following wheel shape definitions and limitations are safety code recommendations for general use and should be used wherever possible. Wheel dimensions or shapes differing from the standard recommendations below may be used on specific machines with the approval of the wheel manufacturer.

1.3.9 SAW GUMMING

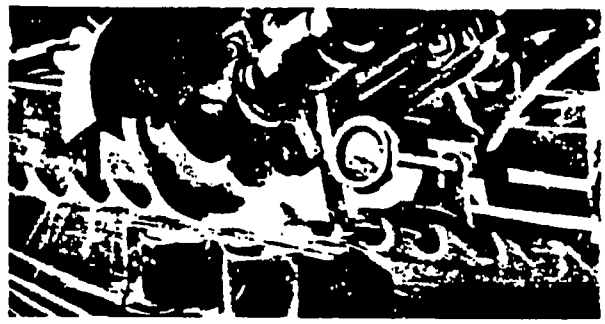


ILLUSTRATION No. 12
Sharpening the teeth (Saw Gumming) on a large band saw.

1.3.13 TOOL GRINDING

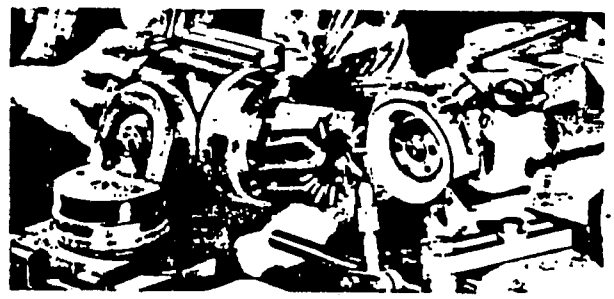


ILLUSTRATION No. 13
Grinding a shell end mill.

1.3.14 TUCK POINTING

ILLUSTRATION No. 14
Tuck pointing using a reinforced organic bonded grinding wheel.

1.4 Definitions and Limitations of Wheel Shapes

When using non-standard wheels, it is often advisable for the user to consult the machine builder concerning special problems in mounting and guarding.

1.4.1 TYPE 1 STRAIGHT WHEELS

Definition:

Type 1 straight wheels have diameter, thickness and hole size dimensions and should be used only on the periphery. Type 1 wheels shall be mounted between flanges, see section 5 page 42.

Limitation:

Hole dimension (H) should not be greater than two-thirds of wheel diameter dimension (D) for precision, cylindrical, centerless or surface grinding applications. Maximum hole size for all other applications should not exceed one-half wheel diameter. Inorganic wheels used in snagging operations should have a maximum hole size of not more than one quarter of the wheel diameter.

1.4.2 TYPE 2 CYLINDER WHEELS

Definition:

Type 2 cylinder wheels have diameter, wheel thickness and rim thickness dimensions. Grinding is performed on the rim face only, dimension W. Cylinder wheels may be plain, plate mounted, inserted nut or of the projecting stud type.

Limitation:

Rim height, T dimension, is generally equal to or greater than rim thickness, W dimension.

1.4.3 ABRASIVE DISC WHEELS

Definition:

Abrasive discs have diameter, thickness and hole size dimensions. They are used in a manner similar to type 2 cylinder wheels. (See section 3.13 page 25 and 3.14 page 26.)

Limitation:

Wheel thickness, T dimension, must be less than rim thickness, W dimension.

1.4.4 TYPE 4 TAPER SIDED WHEELS
(Non Standard Shape)

Definition:

Type 4 taper sided wheels have diameter, wheel thickness, grinding face thickness and hole size dimensions. Type 4 wheels have the same limitations on hole size and usage as type 1 wheels, definition 1.4.1 page 8.

Limitation:

Grinding face, thickness dimension U, must be equal to or greater than one half T dimension. J dimension shall be large enough to accommodate suitable flanges. If tapered safety flanges are used, J dimension and degree of taper required shall be determined by the wheel manufacturer.

1.4.1 TYPE 1 STRAIGHT WHEELS

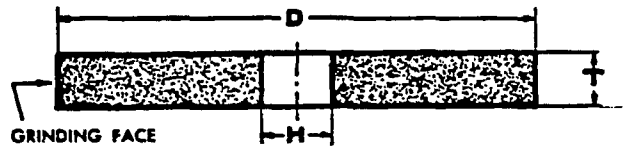


ILLUSTRATION No. 15
Type 1 — Straight Wheel
Peripheral grinding wheel having a diameter, thickness and hole.

1.4.2 TYPE 2 CYLINDER WHEELS

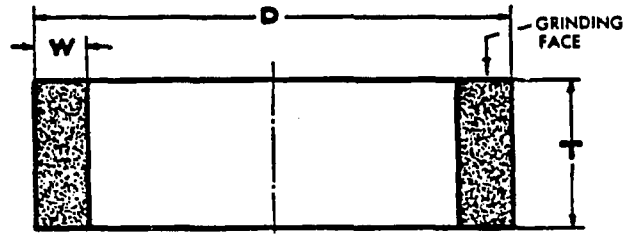


ILLUSTRATION No. 16
Type 2 — Cylinder Wheel
Side grinding wheel having a diameter, thickness and wall—wheel is mounted on the diameter.

1.4.3 ABRASIVE DISC WHEELS

ILLUSTRATION No. 17
Typical example of the various types of abrasive disc wheels.

1.4.4 TYPE 4 TAPER SIDED WHEELS
(Non Standard Shape)

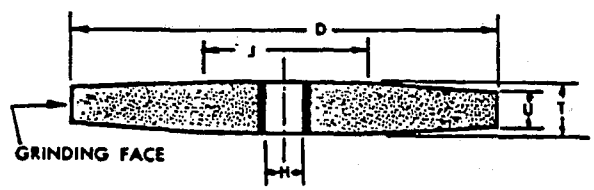


ILLUSTRATION No. 18
Type 4 — Taper Sided Wheel
Peripheral grinding wheel having a diameter, wheel thickness, grinding face thickness and hole size dimensions.

1.4.5 TYPE 5 RECESSED ONE SIDE WHEELS

Definition:

Type 5 recessed one side wheels have diameter, thickness and hole size dimensions and in addition also have a recess diameter and depth dimension. Type 5 wheels are subject to the same limitations of use and mounting as type 1 wheels definition 1.4.1 page 8 and section 6 page 52.

Limitation:

Type 5 wheels are subject to the same limitation of hole size as type 1 wheels definition 1.4.1 page 8. In addition recess depth, F dimension, should not exceed 50% of wheel thickness, T dimension, and diameter of recess, P dimension, shall be large enough to accommodate a suitable flange as recommended in section 5 page 42.

1.4.6 TYPE 6 STRAIGHT CUP WHEELS

Definition:

Type 6 cup wheels have diameter, thickness, hole size, rim thickness and back thickness dimensions. Grinding is always performed on rim face, W dimension.

Limitation:

Minimum back thickness, E dimension, should not be less than ¼ T dimension. In addition, when unthreaded hole wheels are specified, the inside flat, K dimension, must be large enough to accommodate a suitable flange, see flange recommendations, section 5 page 42.

1.4.7 TYPE 7 DOUBLE RECESSED WHEELS

Definition:

Type 7 double recessed wheels have diameter, thickness and hole size dimensions and in addition also have recess diameters and depth dimensions. Type 7 wheels are subject to the same limitations of use and mounting as type 5 wheels, definition 1.4.5 page 9 and section 6 page 52.

Limitation:

Type 7 wheels are subject to the same limitation of hole size as type 1 wheels, section 1.4.1 page 8. In addition the combined depths of recess, F and G dimensions, should not exceed 50% of wheel thickness, T dimension.

1.4.5 TYPE 5 RECESSED ONE SIDE WHEELS

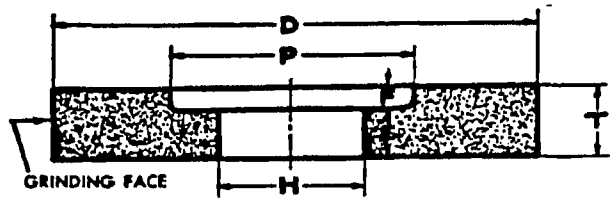


ILLUSTRATION No. 19

Type 5 — Wheel, recessed one side
Peripheral grinding wheel having one side straight or flat and the opposite side recessed. Recessed wheels allow a wider faced grinding wheel to be used when the available mounting thickness (E) is less than the required overall thickness (T). The recess allows grinding clearance for the nut and flange.

1.4.6 TYPE 6 STRAIGHT CUP WHEELS

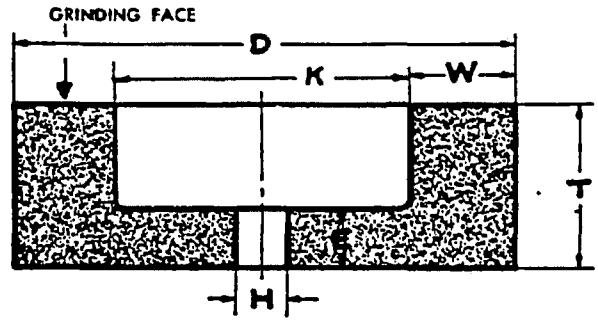


ILLUSTRATION No. 20

Type 6 — Straight-cup Wheel
Side grinding wheel having a diameter, thickness and hole with one side straight or flat and the opposite side recessed. This type, however, differs from Type 5 in that the grinding is performed on the wall of the abrasive created by the difference between the diameter of the recess and the outside diameter of the wheel. Therefore, the wall dimension "W" takes precedence over the diameter of the recess as an essential intermediate dimension to describe this shape type.

1.4.7 TYPE 7 DOUBLE RECESSED WHEELS

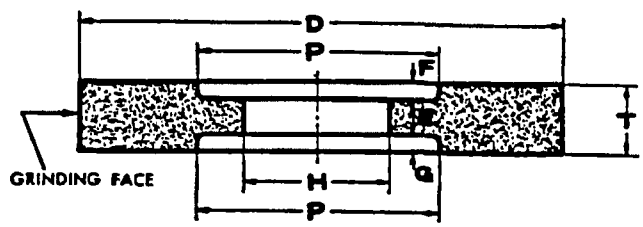


ILLUSTRATION No. 21

Type 7 — Wheel, recessed two sides
Peripheral grinding wheels having both sides recessed to allow grinding clearance for both flanges or recessed so that unusually wide faced wheels may be mounted when the available mounting thickness (E) is less than the overall thickness (T).

1.4.8 TYPE 11 FLARING CUP WHEELS

Definition:

Type 11 flaring cup wheels have double diameter dimensions D and J, and in addition have thickness, hole size, rim and back thickness dimensions. Grinding is always performed on rim face, W dimension. Type 11 wheels are subject to all limitations of use and mounting listed for type 6 straight sided cup wheels definition 1.4.6 page 9 and section 6 page 52.

Limitation:

Minimum back thickness, E dimension, should not be less than ¼ T dimension. In addition when unthreaded hole wheels are specified the inside flat, K dimension, shall be large enough to accommodate a suitable flange, see flange recommendations section 5 page 42.

1.4.8 TYPE 11 FLARING CUP WHEELS

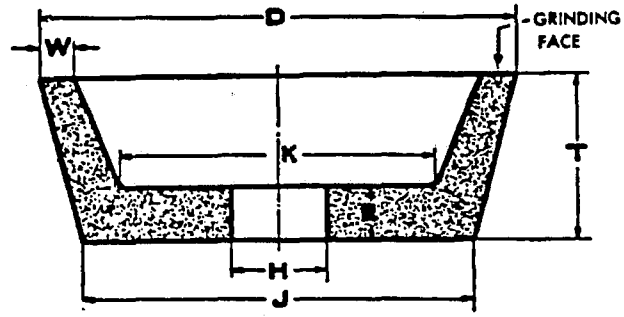


ILLUSTRATION No. 22

Type 11 — Flaring-cup Wheel

Side grinding wheel having a wall flared or tapered outward from the back. Wall thickness at the back is normally greater than at the grinding face (W).

1.4.9 TYPE 12 DISH WHEELS

Definition:

Type 12 dish wheels have diameter, thickness, rim thickness and back thickness dimensions. In addition type 12 wheels always have a face thickness, U dimension. Grinding may be performed on both A and U dimensions.

Limitation:

Minimum back thickness, E dimension, should be equal to or greater than ½ wheel thickness, T dimension. If unthreaded hole wheels are specified K dimension shall be large enough to accommodate a suitable flange, see flange recommendations section 5 page 42.

1.4.9 TYPE 12 DISH WHEELS

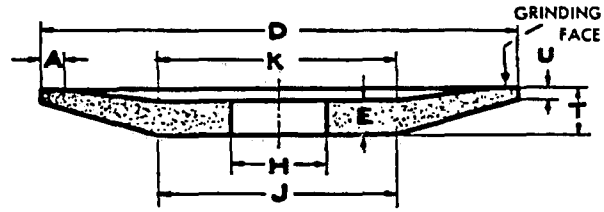


ILLUSTRATION No. 23

Type 12 — Dish Wheel

Side grinding wheel known as a dish, differing from a Type 11 in that Type 12 always has a "U" dimension. The "W" dimension of a Type 11 becomes the "A" dimension of a type 12. The grinding may be performed on the "U" face.

1.4.10 TYPE 13 SAUCER WHEELS

Definition:

Type 13 saucer wheels have diameter, thickness, hole size and back thickness dimensions. Grinding shall be performed on wheel periphery, U dimension, only.

Limitation:

Where unthreaded hole wheels are specified, J and K dimensions shall be large enough to accommodate suitable flanges, see section 5 page 42. In addition, wheel thickness shall be uniform throughout, U dimension should always equal E dimension.

1.4.10 TYPE 13 SAUCER WHEELS

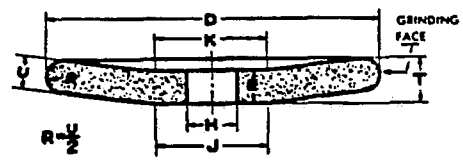


ILLUSTRATION No. 24

Type 13 — Saucer Wheel

Peripheral grinding wheel known as a saucer, differing from a Type 12 in that the cross-section is equal throughout (U=E).

The face is always half-round with $R = \frac{U}{2}$

1.4.11 TYPES 16, 17, 18, 18R and 19 CONE AND PLUG WHEELS

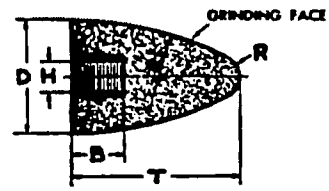
Definition:

Type 16 cones have a curved side with a nose radius. Type 17 cones have straight sides with or without a nose radius. Types 18 and 18R plug wheels are cylindrical in shape with either a square or curved grinding end. Type 19 cone wheels are a combination of cone and plug type shapes and are usually specified where base dimension D in a type 17 cone would not provide an adequate cross section of abrasive. All types of cone and plug wheels are manufactured with blind hole threaded bushings and may be used on all surfaces except the flat mounting surface D.

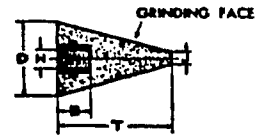
Limitation:

Cone and plug type wheels are mounted by being screwed onto a threaded machine spindle so that surface D seats firmly against an unrelieved, flat back-up flange. (See section 3.12 page 24.) It is recommended that the maximum size or mass of the above cones and plugs be not greater than that of a 3″ diameter by 5″ long type 18 plug wheel.

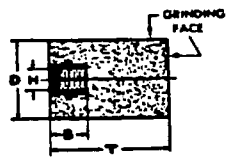
1.4.11 TYPES 16, 17, 18, 18R and 19 CONE AND PLUG WHEELS



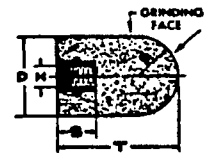
Type 16 — Cone, curved side
Curved sided cone with a radius nose sometimes referred to as "Bullet shape".



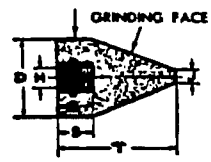
Type 17 — Cone, straight side, square tip
Cone with a straight side, square tip. When the cross-section of the abrasive at the bottom of the blind hole threaded bushing is inadequate, use Type 19.



Type 18 — Plug, square end.
Plug — cylindrical in shape with a square end.



Type 18R — Plug, round end.
Plug — cylindrical in shape with a radius nose.
$R = \frac{D}{2}$



Type 19 — Plugs, conical end, square tip.
Combination cone and plug with a square tip similar to Type 17 and the cylindrical portion similar to Type 18. The cylindrical portion "S" is normally equal to or greater than the depth of the blind hole threaded bushing "B".

ILLUSTRATION No. 25
Various types of cone and plug wheels.

.12 TYPES 20, 21, 22, 23, 24, 25, 26 RELIEVED AND/OR RECESSED WHEELS

ition:

s 20 through 26 relieved and/or recessed
's have diameter, thickness, hole size, re-
diameter and depth dimensions and in
ion may be concaved on one or both sides.
s 20 through 26 wheels are subject to the
limitations of use and mounting as type
eels, definition 1.4.5 page 9 and section 6
52.

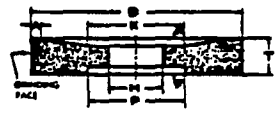
ition:

.ved relief depths shall be considered as
es and added to straight recess depth or
s for determination of total wheel recess
. Total recess depths should not exceed
of wheel thickness, T dimension.

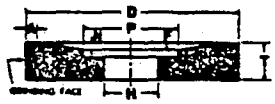
1.4.12 TYPES 20, 21, 22, 23, 24, 25, 26 RELIEVED AND/OR RECESSED WHEELS

Type 20 — Wheel, relieved one side.
Peripheral grinding wheel having one side straight or flat and the other side relieved to a flat.

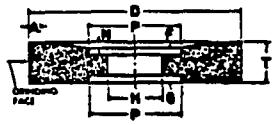
Type 21 — Wheel, relieved two sides.
Peripheral grinding wheel having both sides relieved to a flat.



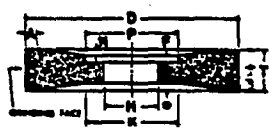
Type 22 — Wheel, relieved one side, recessed other side.
Peripheral grinding wheel having one side recessed and the other side relieved to a flat.



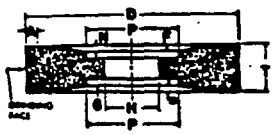
Type 23 — Wheel, relieved and recessed same side.
Peripheral grinding wheel having one side straight or flat and the other side relieved to a recess.



Type 24 — Wheel, relieved and recessed one side, recessed other side.
Peripheral grinding wheel having one side recessed and the other side relieved to a recess.



Type 25 — Wheel, relieved and recessed one side, relieved other side.
Peripheral grinding wheel having one side relieved to a flat and the other side relieved to a recess.



Type 26 — Wheel, relieved and recessed both sides.
Peripheral grinding wheel having both sides relieved to a recess.

ILLUSTRATION No. 26
Various types of relieved and/or recessed wheels.

1.4.13 TYPES 27 AND 28 DEPRESSED CENTER WHEELS

Definition:

Types 27 and 28, depressed center wheels, have diameter, thickness and hole size dimensions. Both types are reinforced, organic bonded wheels having off-set hubs which permit side and peripheral grinding operations without interference with the mounting. Type 27 wheels are manufactured with flat grinding rims permitting notching and cutting operations. Type 28 wheels have saucer shaped grinding rims.

Limitation:

Special supporting, back adaptor and inside flange nuts are required for the proper mounting of these types of wheels, see section 6.15 page 56.

Mounts which are affixed to the wheel by the manufacturer may not require an inside nut and shall not be reused.

1.4.14 TYPE 27A DEPRESSED CENTER WHEELS

Type 27A depressed center, cutting-off wheels have diameter, thickness and hole size dimensions. They are reinforced, organic bonded, off-set hub type wheels, usually 16″ diameter and larger, specially designed for use on cutting-off machines where mounting nut or outer flange interference cannot be tolerated.

Limitations

See section 5.1 page 42 and illustration 28 for mounting details.

1.4.13 TYPES 27 AND 28 DEPRESSED CENTER WHEELS

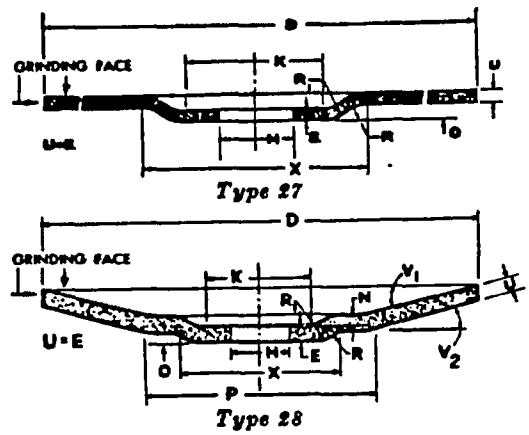


ILLUSTRATION No. 27

Types 27 and 28 — Wheels, depressed center. Peripheral grinding wheel having an offset center and used on right angle head portable grinders. Grinding may also be done on the side of the wheel.

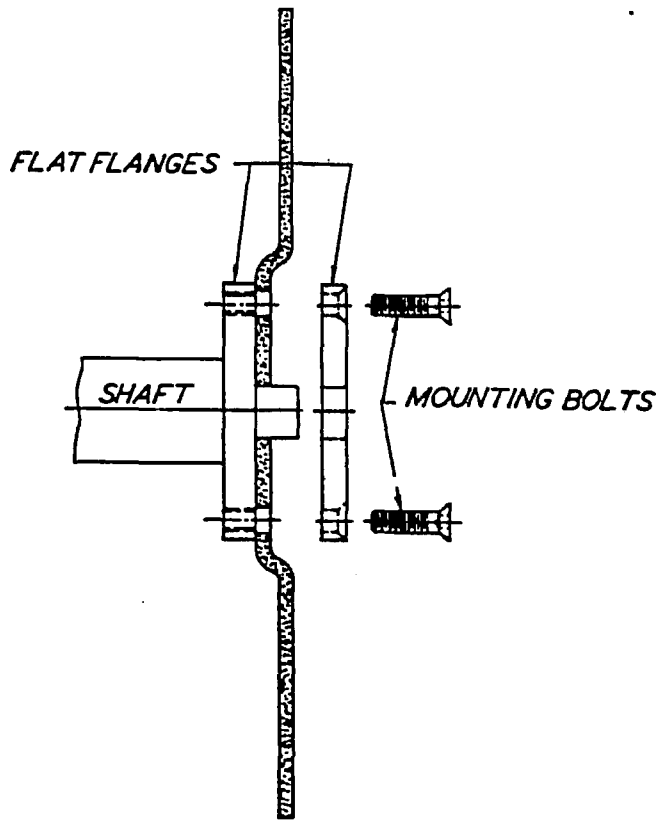


ILLUSTRATION No. 28

Type 27A wheel showing typical mounting details.

1.4.15 CUTTING OFF WHEELS

Definition:

Cutting off wheels have diameter, thickness and hole size dimensions and are subject to all limitations of mounting and use listed for type 1 wheels, definition 1.4.1 page 8 and section 6 page 52. They may be steel centered, diamond abrasive or organic bonded abrasive of the plain or reinforced type.

Limitation:

Cutting off wheels are recommended only for use on specially designed and fully guarded machines and are subject to the following maximum thickness and hole size limitations.

Wheel Diameter	Max. Thickness
6" and smaller	3/16"
Larger than 6" to 12"	1/4"
Larger than 12" to 23"	3/8"
Larger than 23"	1/2"

Maximum hole size for cutting-off wheels should not be larger than 1/4 wheel diameter.

1.4.16 COPING WHEELS

Definition:

Coping wheels are peripheral cutting wheels, and have diameter, thickness and hole size dimensions. They may be metal or organic bonded, solid or steel centered, and are subject to the same limitations of use and mounting as type 1 wheels, definition 1.4.1 page 8 and section 6 page 52.

Limitation:

Coping wheels are recommended for use only on specially designed and fully guarded machines.

1.4.17 TUCK POINTING WHEELS

Definition:

Tuck pointing wheels, usually type 1, reinforced organic bonded wheels have diameter, thickness and hole size dimension. They are subject to the same limitations of use and mounting as type 1 wheels definition 1.4.1 page 8 and section 6 page 52.

Limitation:

Wheels used for tuck pointing should be reinforced, organic bonded, (See paragraph 4.5.1, Exception B, page 32.)

1.4.15 CUTTING OFF WHEELS

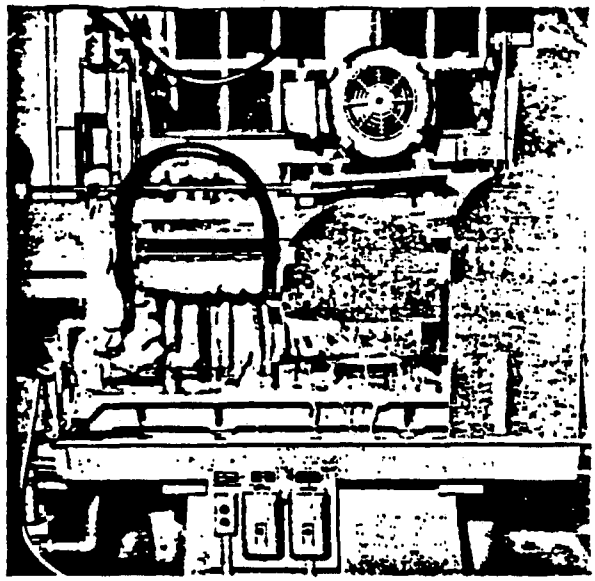


ILLUSTRATION No. 29
A wet machine with horizontal movement for slabbing.

1.4.16 COPING WHEELS

ILLUSTRATION No. 30
Slotting a block of marble to contour using a coping wheel.

1.4.17 TUCK POINTING WHEELS

ILLUSTRATION No. 31
Tuck pointing granite using a straight resinoid reinforced wheel.

1.4.18 MOUNTED WHEELS

Definition:

Mounted wheels, usually 2" diameter or smaller, and of various shapes, may be either organic or inorganic bonded abrasive wheels. They are secured to plain or threaded steel mandrels.

Limitation:

See section 10 page 69 for safe operation and speeds for mounted wheels.

1.4.18 MOUNTED WHEELS

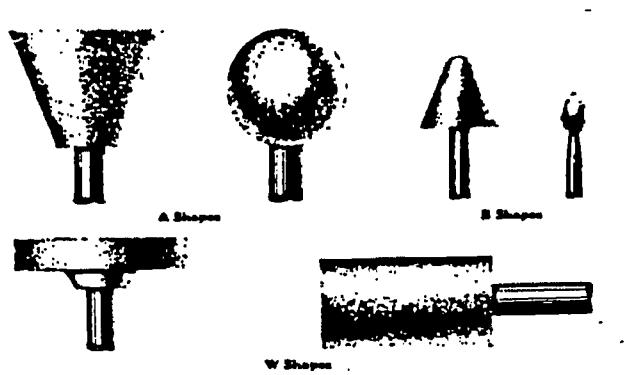


ILLUSTRATION No. 32

Typical examples of grinding wheels known as mounted wheels.

1.4.19 THREADED HOLE CUP WHEELS

Threaded hole cup wheels types 6 and 11 are designed for use on vertical, right angle head, or flexible shaft portable grinders. They have one central threaded bushing, securely anchored in place. They are mounted by being screwed onto a threaded machine spindle so that the wheel back seats firmly against an unrelieved flat back flange.

Limitation:

Threaded hole cup wheel mounting should not be used with wheels larger than 6" diameter. Back flanges used in mounting threaded hole cup wheels shall be flat and unrelieved.

1.4.19 THREADED HOLE CUP WHEELS

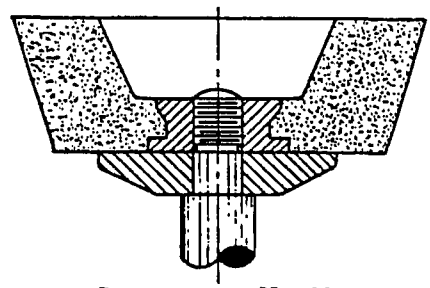


ILLUSTRATION No. 33

A cup wheel with an inserted bushing. Note the bushing and abrasive are in uniform contact with the back flange.

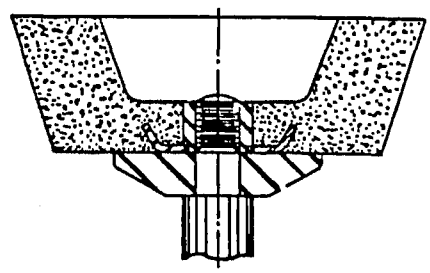


ILLUSTRATION No. 33A

A cup wheel with a prong anchor bushing. Note the bushing and abrasive are in uniform contact with the back flange.

1.4.20 MODIFIED TYPES 6 & 11 WHEELS (TERRAZZO)

Some type 6 & 11 cup wheels used in the terrazzo trade have tapered K dimensions to match a special tapered flange furnished by the machine builder.

Limitation:

These wheels shall be mounted only with a special tapered flange.

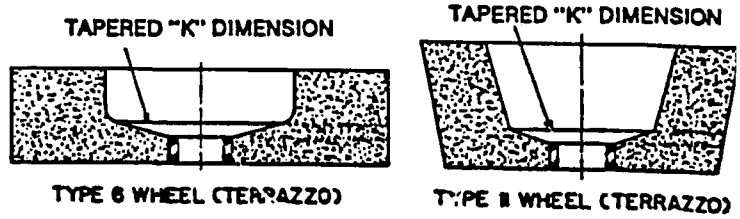


ILLUSTRATION No. 34

Typical examples of modified types 6 and 11 wheels (terrazzo) showing tapered K dimensions.

CODE REGULATIONS
Section 2
HANDLING, STORAGE AND INSPECTION

2.1 Handling

All grinding wheels are breakable and therefore care shall be exercised in handling and storage to prevent damage. 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 other suitable conveyances, which provide support and protection in transporting all wheels which cannot be carried by hand.

(d) Place wheels carefully on a shelf or rack or in bins, boxes or drawers.

2.2 Storage

Suitable racks, bins, drawers or boxes shall be provided to store the various types of wheels used. (See Figs. 1, 2 and 3 pages 17–18.)

Wheels shall not be stored subject to:

(a) Exposure to high humidity, water or other liquids.

(b) Freezing temperature.

(c) Any temperature low enough to cause condensation on the wheels when moving them from storage to an area of higher temperature.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 2
Handling, Storage and Inspection

2.1 Handling

All grinding wheels must be handled carefully.

It should be realized that grinding wheels are necessarily manufactured in varying strengths to grind properly.

Some grinding wheels are stronger than others, but all grinding wheels can be broken by mishandling.

2.2 Storage

Grinding wheels must be protected while awaiting use. Wheel storage should be arranged to allow for removal of wheels without disturbing or damaging other wheels. Storage and records should also be set up to allow for wheel use on a rotational basis so that wheels will be in storage a minimum length of time. This minimizes the possibility of damage from lengthy storage. Such suitable storage should be available for partly used wheels as well as new wheels.

FIGURE NO. 1
A well-designed grinding wheel storage area used by a large industrial plant.

Grinding wheel storage racks should be designed, constructed and located to fit the needs of the user. The following factors should be considered:

Location

All grinding wheels should be stored in a dry area in rooms not subject to extreme temperature changes since some bonds may be affected by excessive humidity, dampness and extreme temperature differentials. Racks should be located as near as practical to the grinding location, but never where there is danger of damage from passing trucks, crane handling or excessive vibration.

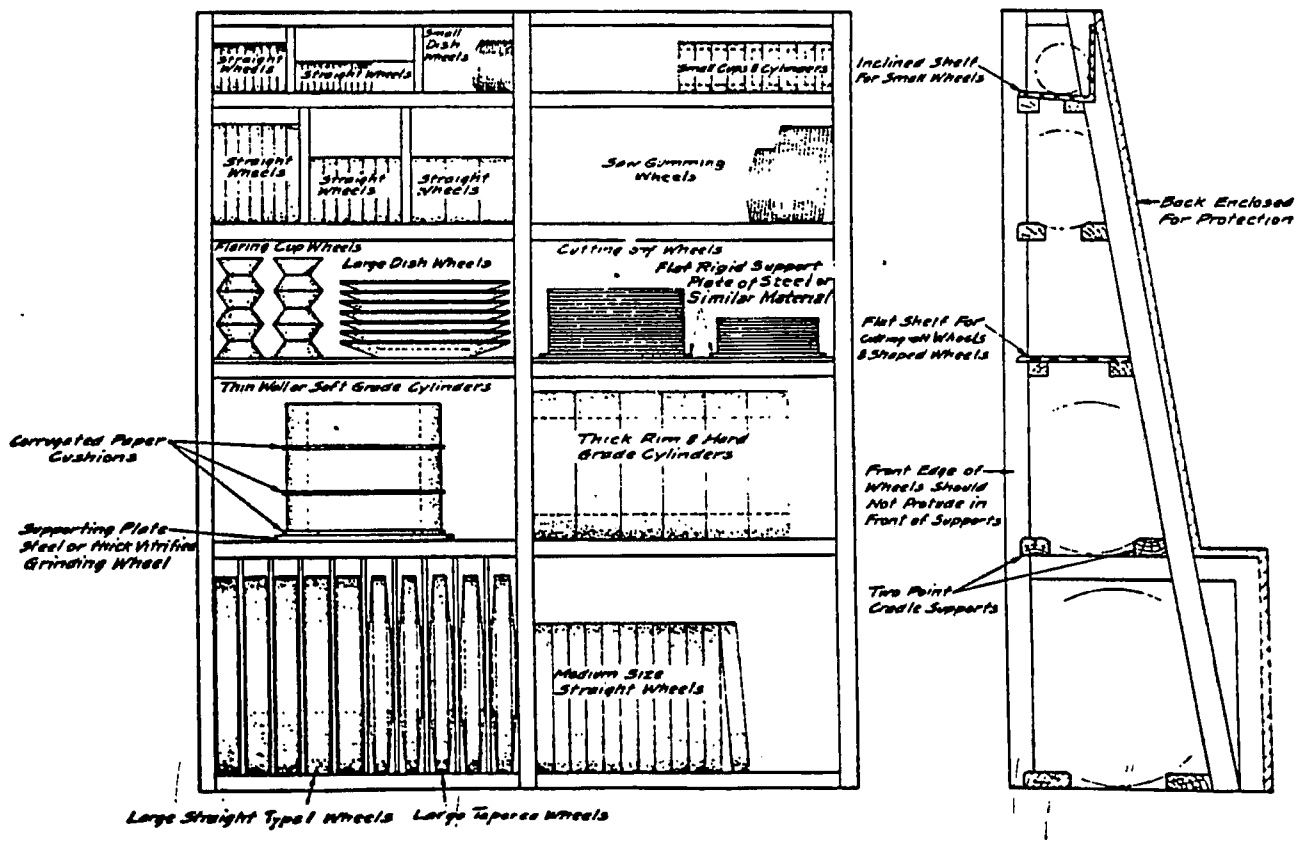


FIGURE NO. 2
This drawing illustrates a rack design which is suitable for handling a wide variety of grinding wheels.

FIGURE NO. 3
The various sizes and shapes of wheels are located in the racks so that they are easily accessible and protected from damage.

2.3 Inspection

Immediately after unpacking, all wheels shall be closely inspected to make sure that they have not been damaged from handling, shipping or other causes. As an added precaution, wheels should be tapped gently with a light non-metallic implement, such as the handle of a screw driver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked (dead), they shall not be used. This is known as the "Ring Test". (See Figs. 4 and 5 page 19.)

Storage Methods

The racks, bins or drawers should be constructed so that each of the various types of wheels can be stored in an orderly and safe manner. (See Fig. 2 page 17.) Wheel selection should be possible with a minimum of handling.

The selection of racks, bins, boxes or drawers for storage depends on the size and type of wheels. The following suggestions should be considered.

Thin organic bonded wheels such as those used for cutting-off should be laid flat on a flat surface of steel or similar rigid material away from excessive heat or moisture to prevent warpage. Not even blotters should be allowed between stacked thin wheels. If thin wheels are supplied with blotters attached, suitable separators should be used to preserve flatness.

Straight or tapered wheels (Types 1, 4, 5, 7, 13, 20, 21, 22, 23, 24, 25 and 26) of appreciable thickness are best supported in racks (see Fig. 2 page 17). Preferably the racks should provide a cushioned two-point cradle support to prevent the wheels from rolling. Partitions are helpful in facilitating wheel selection with a minimum of handling.

Cylinder wheels (Type 2), large straight cup wheels (Type 6), large dish wheels (Type 12) and large saucer wheels (Type 13) may be stacked on flat sides with some form of cushioning material between them; or they may be stored on edge like large straight wheels.

Flaring cup wheels (Type 11) are best stored as Illustrated in Fig. 2 page 17 to prevent chipping of edges.

Small wheels (approximately 4 inches or less in diameter), except flaring cup wheels (Type 11), are often stored in boxes, bins, or drawers.

2.3 Inspection

The first inspection should be made on the original shipping container. If there is visible evidence of damage to the container, special care must be used in the inspection of the wheels.

Wheels must be dry and free from sawdust when applying the ring 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.

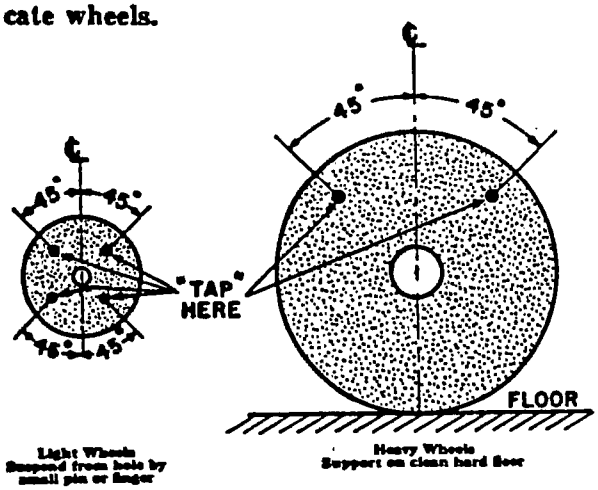


FIGURE NO. 4 FIGURE NO. 5

"Tap" wheels about 45 degrees each side of the vertical center line and about 1 or 2 inches from the periphery as indicated by the spots in Fig. 4 and Fig. 5.

Then rotate the wheel 45 degrees and repeat the test.

A sound and undamaged wheel will give a clear metallic tone. If cracked, there will be a dead sound and not a clear "ring."

"Ring Test"

If the wheel is not too heavy, it may be suspended from the hole on a small pin or the finger. (See Ill. No. 35.) Heavier wheels may be allowed to rest in a vertical position on a clean, hard floor.

"Tap" the wheel gently with a non-metallic implement such as a wooden screw driver handle for light wheels and a wooden mallet for heavy wheels. The best spot to "tap" a wheel for the ring test is about 45 degrees either side of the vertical center line and about 1 or 2 inches from the periphery. (See Figs. 4 and 5.)

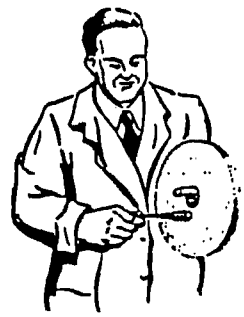


ILLUSTRATION No. 35

If struck directly along the vertical center line, the "ring", even in a sound wheel, is sometimes muffled and may give the erroneous impression that the wheel is cracked. This is especially true with large wheels which are supported on the floor when conducting this test. (See Fig. 5.) It is sometimes noticeable also when the wheel is suspended from the hole. It is recommended that the test be repeated after rotating the wheel 45 degrees to the right or left.

Repeat this "ring test" immediately before mounting either a new or used wheel on a machine, especially if the wheel has been in storage or out of service for a considerable time. In making this test it must be realized that wheels bonded with organic material do not give forth the same clear metallic sound as do vitrified and silicate wheels. Also wheels must be dry and free from sawdust when applying the test, otherwise the sound will be deadened.

Comparison of the sound with other wheels of the same lot and specification will allow rejection of any wheel with a suspiciously different ring before use.

CODE REGULATIONS
Section 3
GENERAL MACHINE CONDITIONS

3.1 Machine Design and Maintenance

It shall be the machine manufacturer's responsibility to design, and the user's responsibility to maintain, his machines for safe operating condition.

The following areas are important to fulfill these obligations.

3.2 Safety Guards

Grinding machines shall be equipped with safety guards in conformance with the requirements covered in section 4 page 27.

3.3 Power

Grinding machines should be supplied with sufficient power to maintain the rated spindle speed under all conditions of normal operation.

3.4 Exhaust Provision

Stationary machines used for dry grinding should have provision made for connection to an exhaust system.

For detailed recommendations. Reference is made to "American National Standard For Ventilation Control of Grinding, Polishing and Buffing Operations (Z43.1)." Copies may be obtained from The American National Standards Institute.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 3
General Machine Conditions

3.1 Machine Design and Maintenance

Grinding is a safe operation under normal conditions. Severe stresses can be set up in the wheel if established safe operating practices are not maintained. Only machines designed for the required spindle speed with suitable bearings to take the pressure and thrust of the grinding operation are recommended.
Proper maintenance of grinding machines is very important to insure safe operation. Grinding machine maintenance should be performed only by qualified personnel.

3.2 Safety Guards

Safety guards must be used on grinding machines to insure protection in case of an accidental wheel breakage. (See section 4.1 page 27 for exceptions.)

3.3 Power

If the grinding wheel speed is reduced materially under normal grinding pressure, its cutting ability is decreased and excessive heat and pressure often result. Adequate power will avoid this hazard.

3.4 Exhaust Provision

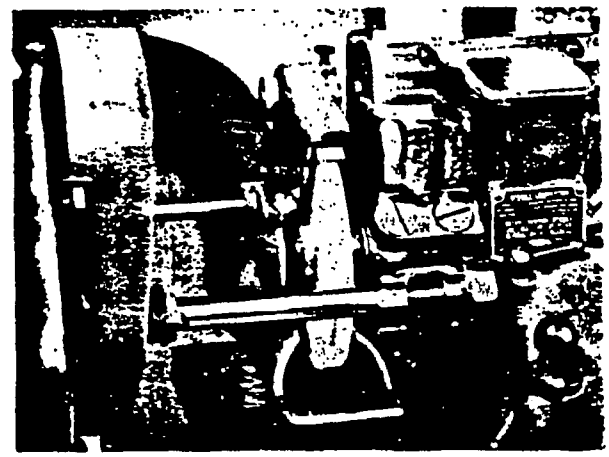


ILLUSTRATION No. 36
Note the excellent provisions employed to exhaust grinding dust.

3.5 Diameter of Spindle

Table 1 page 22 shows the minimum diameters of spindles which should be used for wheels of various sizes. It applies to machines where wheels are not mounted between bearings. The use of heavier spindles than those listed in this table is often desirable.

3.5 Diameter of Spindle

Standard machine design generally conforms to the minimum spindle diameter requirements in Table 1 page 22. Investigation has shown that requests for wheels with undersize holes often result from the desire to use larger diameter wheels than were originally intended for the machine.

3.6 Flanges

Grinding machines shall be equipped with flanges in accordance with the requirements listed in section 5 page 42.

3.6 Flanges

Proper selection, use and maintenance of flanges are all essential factors in the safe use of grinding wheels. See section 5 page 42.

3.7 Work Rests

On offhand grinding machines (see section 1.3.6 page 6), work rests shall be used to support the work. They shall be of rigid construction and designed to be adjustable to compensate for wheel wear.
Work rests shall be kept adjusted closely to the wheel with a maximum opening of ⅛" to prevent the work from being jammed between the wheel and the rest, which may cause wheel breakage. The work rest shall be securely clamped after each adjustment. The adjustment shall not be made with the wheel in motion.

3.7 Work Rests

ILLUSTRATION No. 37

This floor stand grinder has a work rest which is properly adjusted. Note the provisions for work-rest adjustment.

3.8 Limiting Wheel Diameter

Grinding machines should be provided with a means of limiting the diameter of wheel which can be mounted. The safety guard is generally satisfactory for this purpose on single speed machines.

On variable speed machines, the speed shifting device should be connected with an adjustable guard or another diameter limiting device to prevent the mounting of a wheel which might run at higher than the recommended surface speed.

3.8 Limiting Wheel Diameter

On variable speed machines, a positive mechanical or manual regulation check should be maintained to avoid overspeeding another or full size wheel after the original wheel stub has been removed.

TABLE 1

MINIMUM DIAMETERS OF MACHINE SPINDLES AT POINT OF MOUNTING FOR WHEELS OF VARIOUS DIAMETERS AND THICKNESSES OPERATING AT STANDARD SPEEDS AS LISTED IN TABLE 20

Diameter of Wheel	Thickness of Wheel, Inches: Less Than ¼"	¼	⅜	½	⅝	¾	1	1¼	1½	2	2¼	2½	2¾	3	3¼	3½	4	5	6
	← Diameter of Spindle — Inches →																		
2	⅛	⅛	1/16	1/16	¼	¼	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½	½	⅝	⅝
3	¼	¼	¼	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½	½	⅝	⅝	⅝	⅝	⅝
4	1/16	1/16	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½	⅝	⅝	⅝	⅝	⅝	¾	¾
5	⅜	⅜	⅜	½	½	½	½	½	½	½	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	¾
6	½	½	½	½	½	½	½	½	½	⅝	¾	¾	¾	¾	¾	¾	¾	¾	1
7	½	½	½	½	½	½	½	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	1	1	1
8	½	½	½	½	½	⅝	⅝	⅝	⅝	¾	¾	¾	¾	1	1	1	1	1	1
9	⅝	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	1	1	1	1	1	1	1¼	1¼	1¼
10	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	¾	¾	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼
12	⅝	¾	¾	¾	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1½	1½
14	¾	¾	¾	¾	¾	1	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½
16	⅞	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1¾
18	⅞	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾
20	1	1	1	1	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1¾	2
24	1	1	1	1	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	2	2	2
26	1	1	1	1	1¼	1¼	1½	1½	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2
30	1	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
36	1½	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2	2	2¼	2¼	2¼	2½	2½	2¾	2¾
40	1¾	2	2	2	2	2	2¼	2¼	2¼	2¼	2½	2½	2½	2½	2¾	2¾	2¾	2¾	2¾
44	2	2½	2½	2½	2½	2¾	2¾	2¾	2¾	3	3	3	3	3	3½	3½	3½	3½	3½
48	2¼	2¾	2¾	2¾	2¾	2¾	2¾	3	3	3	3½	3½	3½	3½	3½	3½	3½	3½	4
53	2½	3	3	3	3	3½	3½	3½	3½	3½	3½	3½	3½	3½	4	4	4	4	4½
60	2¾	3½	3½	3½	3½	3½	3½	4	4	4	4	4	4	4	4	4½	4½	5	5
72	3	3½	3½	3½	3½	3½	3½	4	4	4	4½	4½	4½	4½	4½	5	5	6	6

NOTE: *For speeds exceeding those listed in Table 20 page 59, for unusually severe operations and for wheels with heavy mountings (such as bolted-on abra- discs), the spindle sizes shown in the above table may not be adequat asmuch as the proper spindle size is dependent upon many factors, eneral design of the machine, type of bearings, quality of materials, w nship and application of wheel, a simple table is not practicable. W larger than specified by the machine manufacturer should not be used.*

3.9 Direction of Machine Spindle Thread

If wheels or flanges are secured by means of a central spindle nut, the direction of the thread shall be in such 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."

3.9 Direction of Machine Spindle Thread

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 thread. When re-assembling such machines after repairs, care shall be used to properly replace the spindle, with respect to direction of threads.

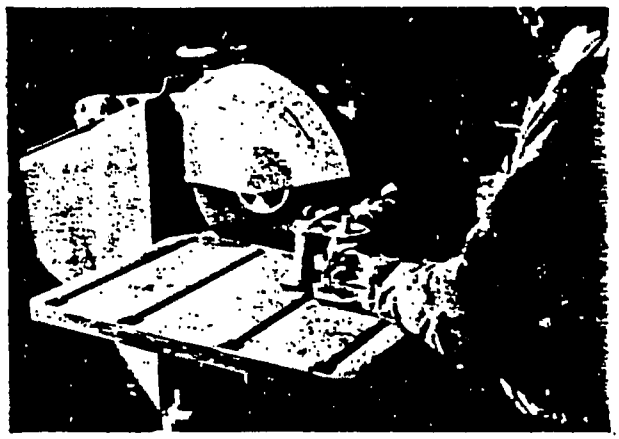


ILLUSTRATION No. 88
The direction of rotation of the cutting-off wheel is indicated by the arrow on the guard. This is also the direction the nut must be turned for removal.

3.10 Length of Machine Spindle Thread

If wheels are mounted by means of a central spindle nut and flanges, two conditions shall be maintained:

1. **Spindles shall be of sufficient length to allow a full nut mounting.**
2. **Threaded portion shall be of sufficient extent so that the threading shall extend well inside the flange but not more than half way within the hole of the wheel.**

3.10 Length of Machine Spindle Thread

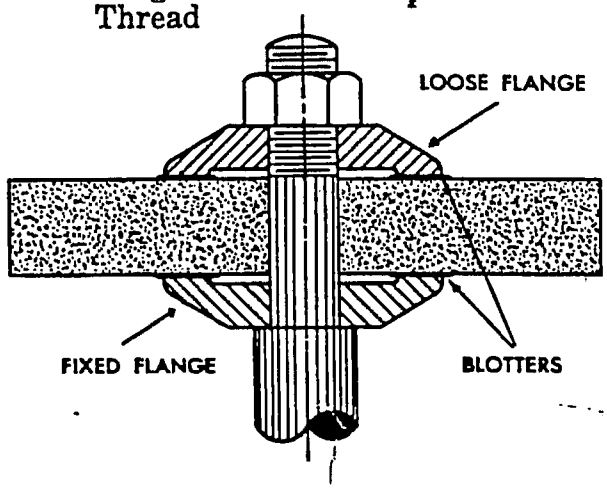


ILLUSTRATION No. 89
The spindle is of sufficient length to accommodate the wheel and flanges.

3.11 Size of Spindle or Mount

Grinding wheels shall fit freely on the spindle (wheel sleeves or adaptors) and remain free under all grinding conditions.

To accomplish this, the spindle or wheel mount shall be made to nominal (standard) size plus .000 minus .002 inches. The wheel hole shall be made suitably oversize to assure safety clearance under the conditions of operating heat and pressure.

3.11 Size of Spindle or Mount

To avoid rupturing pressure in the wheel hole, the diameter of the spindle or wheel mount shall be kept within the limits of plus zero, minus .002 inches. The hole in the wheel must be suitably oversize so that the wheel fits freely but not loosely under all operating conditions, to allow for expansion of the wheel spindle or mount caused by the heat of operation.

3.12 Threaded Hole Wheels

Machines on which threaded hole wheels are mounted shall be provided with spindles which are so threaded as to allow the wheel to be screwed firmly and flat against the back flange. (See Figs. 6 and 7.)

The back flange shall be flat, unrelieved, securely fastened and square to the spindle axis. (See Ill. 40.) The fixed back flange shall be of sufficient diameter to insure proper support to the wheel. (See Table 13 page 48.)

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 spindle and the depth of the hole shall be such that the end of the spindle shall not touch the bottom of the wheel hole.

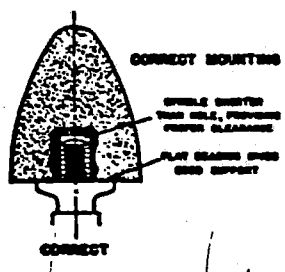


FIGURE NO. 6

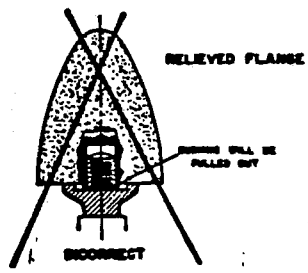


FIGURE NO. 7

3.12 Threaded Hole Wheels

A relieved back flange shall not be used. If made with a relief, the flange will cause the bushing to be pulled out of the wheel, as shown in Illustration 40.

The fixed back flange should be perfectly flat and heavy enough to prevent distortion.

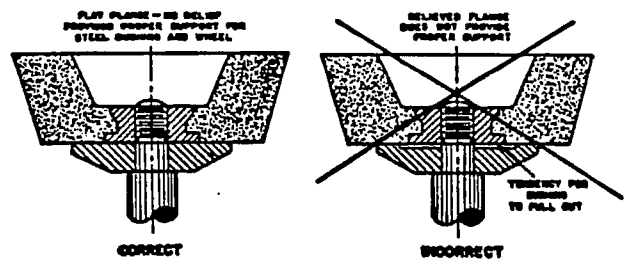


ILLUSTRATION No. 40
Unrelieved and relieved flange.

If the spindle stops quickly when power is shut off, the energy stored in the spinning wheel may cause the wheel to unscrew from the spindle and "Spin Off" the machine.

To help prevent "spinning off" the threads on the machine spindle should be maintained in good condition and the wheel should be held in contact with the work piece until the wheel has stopped.

3.13 Mounting of Abrasive Discs (Inserted Nut, Inserted Washer and Projecting Stud Type)

Machines on which inserted nut wheels are mounted shall be provided with a steel disc wheel (machine face plate) of approximately the same diameter as the wheel, and of sufficient thickness to provide necessary support. Minimum steel disc wheel (machine face plate) thicknesses for disc grinders are shown in Table 2.

TABLE 2
MINIMUM THICKNESS OF STEEL DISC WHEELS (MACHINE FACE PLATE) FOR MOUNTING ABRASIVE DISCS

Diameter Inches	Minimum 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

Screw holes in steel disc wheel (machine face plate) should 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. 8) shall be uniform for all holes so that screws can be used interchangeably.

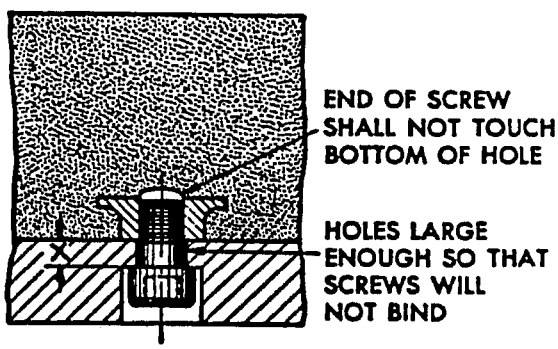


FIGURE NO. 8

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.

3.13 Mounting of Abrasive Discs (Inserted Nut, Inserted Washer and Projecting Stud Type)

The following illustrations (Nos. 41, 42 and 43) will serve to clarify the differences which exist between the three types of mountings for abrasive discs, i.e. the inserted nut type, the inserted washer type, and the projecting stud type.

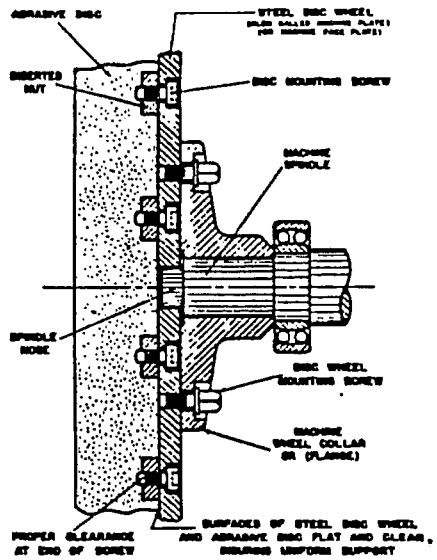


ILLUSTRATION No. 41
Inserted nut type abrasive disc.

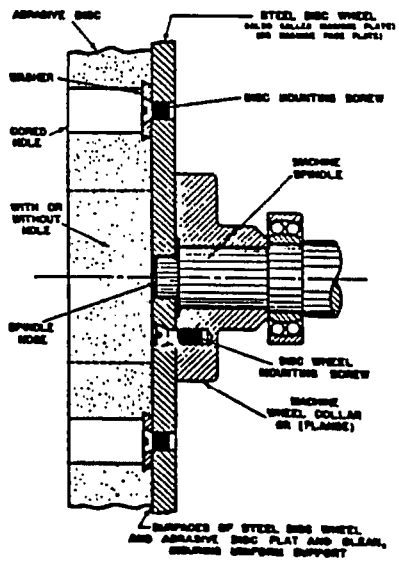


ILLUSTRATION No. 42
Inserted washer type abrasive disc.

Steel disc wheels (machine face plates) shall be flat concentric and at a 90° angle as mounted to the machine spindle.

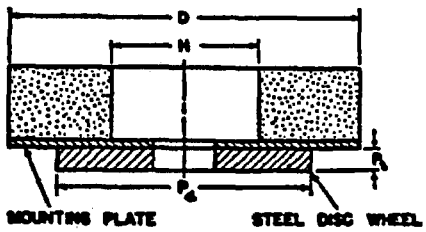
3.14 Mounting of Plate Mounted Type Wheels

If the plates attached to the wheel are as thick or thicker than shown in Table 2 page 25, there are no special requirements as to the diameter and thickness of the steel disc wheel (machine face plate) on the machine.

If the plates attached to the wheel are thinner than shown in Table 2 page 25, the machine shall be equipped with a steel disc wheel (machine face plate) of sufficient diameter and thickness to provide adequate additional support. Minimum specifications are given in Table 3 for disc grinders.

TABLE 3

MINIMUM THICKNESS OF STEEL DISC WHEELS FOR MACHINES USING PLATE MOUNTED WHEELS HAVING THIN MOUNTING PLATES



(Machine Face Plate)

P_d shall never be less than $\frac{D + H}{2}$ nor shall the difference between D and P_d exceed 2 inches. It is recommended that P_d equal D wherever practical.

Abrasive Disc Diameter D (Inches)	Minimum Thickness Pt (Inches)
12 and smaller.....	⅜
14 to 16 inclusive	½
17 to 18 inclusive.....	⅝
19 to 26 inclusive.....	¾
27 to 36 inclusive.....	⅞

Machine face plate and the mounting surface of the abrasive disc shall be maintained true, flat and clean. This is the user's responsibility.

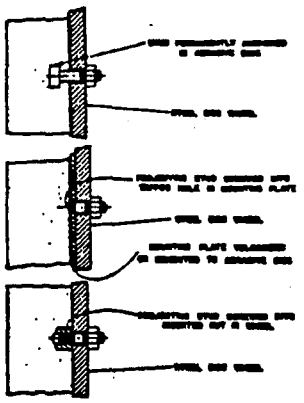


ILLUSTRATION No. 43
Various methods of mounting projecting stud or stud mounted type abrasive discs.

3.14 Mounting of Plate Mounted Type Wheels

A typical method of mounting a plate mounted type wheel is shown in Illustration No. 44. Note the additional reinforcement given the abrasive disc and the mounting plate by the steel disc wheel (machine face plate).

Even when plate mounted wheels are used, the machine face plate (steel disc wheel) should be the full diameter of the wheel where possible. The original thickness of the machine face plate should be thicker than minimum in Table 3 to allow for remachining to correct for wear.

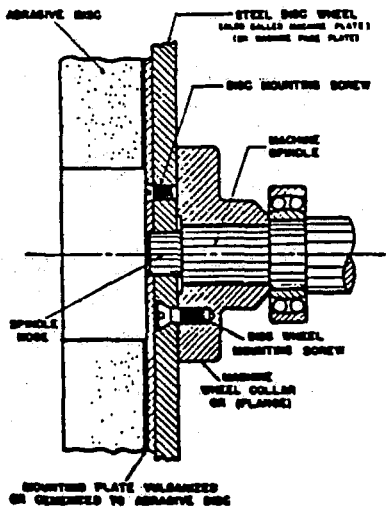


ILLUSTRATION No. 44
Plate mounted type wheels.

CODE REGULATIONS
Section 4
SAFETY GUARDS

4.1 General Requirements

All abrasive wheels shall be used only on machines provided with Safety Guards as defined in the following paragraphs of this section.

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) Mounted wheels used in portable operations (see definition Sec. 1.4.18 page 15) 2 inches and smaller in diameter.
(3) Types 16, 17, 18, 18R and 19 cones and plugs and threaded hole pot balls where the work offers protection.

Note: For additional forms of operator protection see Appendix A page 87.

4.2 Cup Wheels

Cup wheels (Types 6 and 11) shall be protected by

(a) Safety Guards as specified in Sections 4.1 page 27 to 4.10 page 37 inclusive or

(b) Band Type Guards as specified in Sections 4.11 page 40 and 4.12 page 40 or

(c) Special "Revolving Cup Guards" which mount behind the wheel and turn with it. They shall be made of steel or other material with adequate strength and shall enclose the wheel sides upward from the back for ⅓ of the wheel thickness. The mounting features shall conform with all Code regulations. (See section 6 page 52.)

It is necessary to maintain clearance between the wheel side and the guard. This clearance shall not exceed 1/16 inch.

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

Explanatory Information
(NOT PART OF ANSI CODE)
Section 4
Safety Guards

4.1 General Requirements

Exceptions to the use of safety guards are based on the impossibility of using these classes of wheels with conventional guards in place. In these cases, the work often forms a guard and the mass of the wheel is small. Face protection is particularly important when using this class of wheel.

4.2 Cup Wheels

Cup wheels are available with either a threaded or unthreaded hole. Guards are available for each of these types. The following illustrations Nos. 45, 46 and 47, show the typical types manufactured. Each is shown mounted in conjunction with a guard.

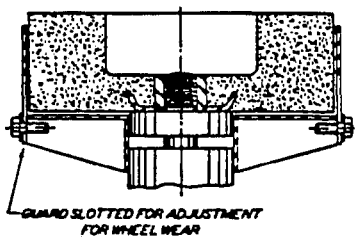


ILLUSTRATION No. 45
Type 6 cup wheel showing band type guard.

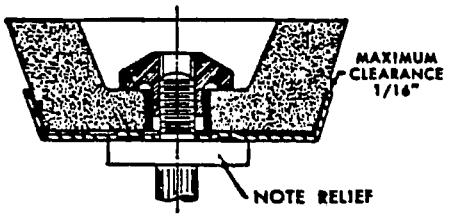


ILLUSTRATION No. 46
An unthreaded hole cup wheel and revolving cup guard assembly. Note relief in guard which acts as a flange.

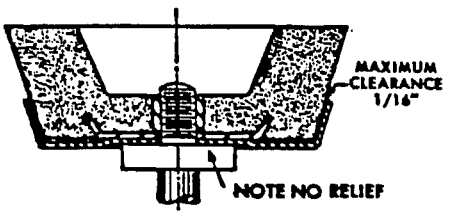


ILLUSTRATION No. 47
Type II cup wheel showing threaded prong-anchor bushing molded into back, and revolving cup guard. Note there is no relief between guard and wheel bushing.

4.3 Guard Exposure Angles

The maximum exposure angles specified in the following paragraphs shall not be exceeded.

Visors or other accessory equipment shall not be included as a part of the guard when measuring the guard opening, unless such equipment has strength equal to that of the guard.

4.3.1 BENCH AND FLOOR STANDS

The angular exposure of the grinding wheel periphery and sides for safety guards 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 Figs. 9 and 10 and section 4.4 page 31.)

FIGURE NO. 9

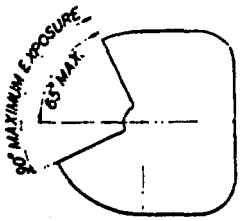


FIGURE NO. 10

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. (See Figs. 11 and 12.)

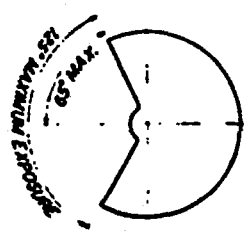


FIGURE NO. 11

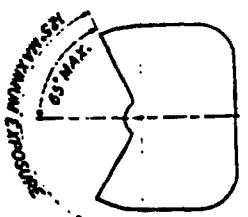


FIGURE NO. 12

4.3 Guard Exposure Angles

Maximum guard openings are based on the fact that the line of flight of broken wheel pieces will be tangential in the direction of rotation of the wheel. The maximum exposure angles must not be exceeded.

4.3.1 BENCH AND FLOOR STANDS

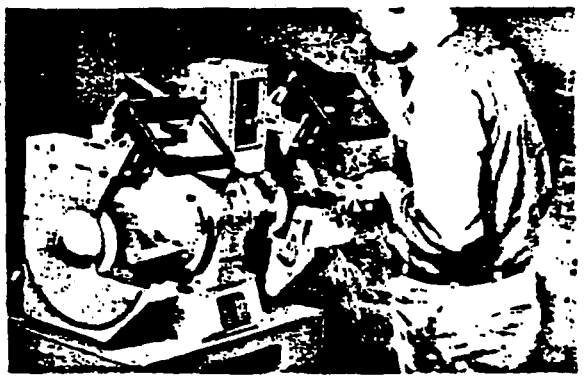


ILLUSTRATION No. 48

An example of a well-designed guard for a bench grinder. Note that exposure does not exceed the 90° maximum stipulated.

4.3.2 CYLINDRICAL GRINDERS

The maximum angular exposure of the grinding wheel periphery and sides for safety guards 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 Figs. 13 and 14 and section 4.4 page 31.)

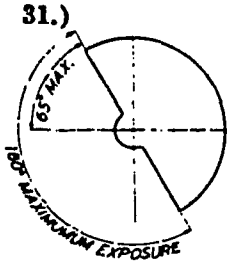


FIGURE NO. 13

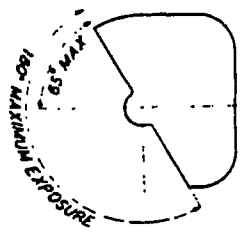


FIGURE NO. 14

4.3.3 SURFACE GRINDERS AND CUTTING-OFF MACHINES

The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on cutting-off 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 Figs. 15 and 16.)

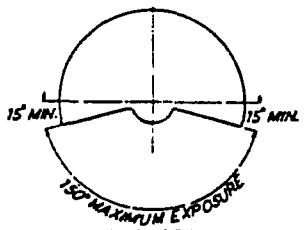


FIGURE NO. 15

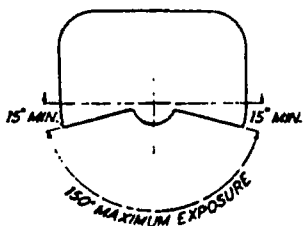


FIGURE NO. 16

4.3.4 SWING FRAME GRINDERS

The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on machines known as swing frame grinding machines shall not exceed 180 degrees, and the top half of the wheel shall be enclosed at all times. (See Figs. 17 and 18.)

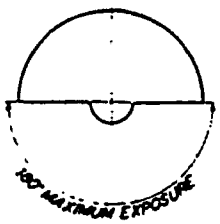


FIGURE NO. 17

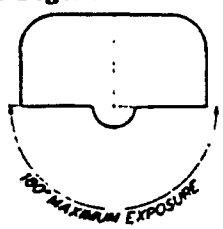


FIGURE NO. 18

4.3.2 CYLINDRICAL GRINDERS

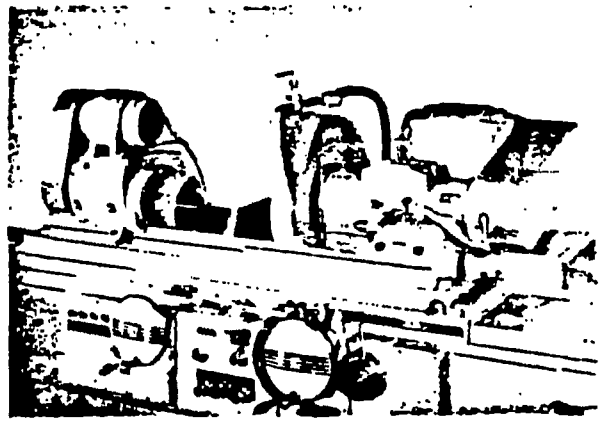


ILLUSTRATION No. 49

A cylindrical grinding machine employing a well-designed guard.

4.3.3 SURFACE GRINDERS AND CUTTING-OFF MACHINES

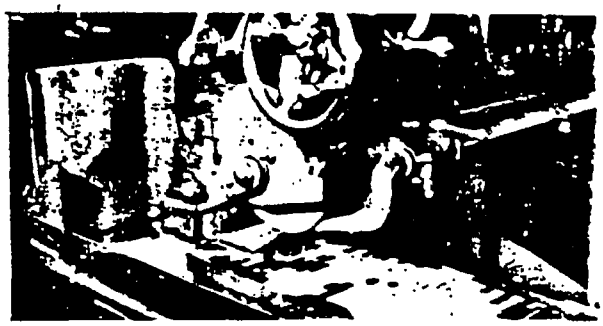


ILLUSTRATION No. 50

This surface grinder has a well-designed guard conforming to basic requirements. The guard is so designed as to allow easy access to the wheel.

4.3.4 SWING FRAME GRINDERS

ILLUSTRATION No. 51

This swing frame grinder has an excellent guard. Note that the guard encloses at least 180° of the wheel.

4.3.5 AUTOMATIC SNAGGING MACHINES

The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on grinders known as automatic snagging machines shall not exceed 180 degrees and the top half of the wheel shall be enclosed at all times. (See Figs. 17 and 18.)

4.3.6 TOP GRINDING

Where the work is applied to the wheel above the horizontal center line, the exposure of the grinding wheel periphery shall be as small as possible and shall not exceed 60 degrees. (See Figs. 19 and 20.)

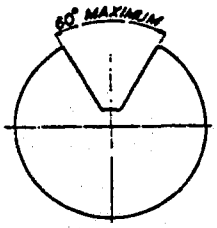


FIGURE NO. 19

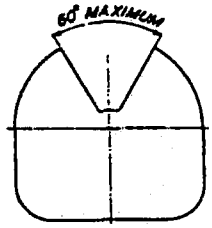


FIGURE NO. 20

4.3.7 PORTABLE GRINDERS

4.3.7.1 Right Angle Head or Vertical Portable Grinders for use with Type 27 and 28 Wheels

Safety guards used on machines known as right angle head or vertical portable grinders shall have a maximum exposure angle of 180 degrees, and the guard shall be so located so as to be between the operator and the wheel during use. Adjustment of guard shall be such that pieces of an accidentally broken wheel will be deflected away from the operator. (See Fig. 39, page 39.)

4.3.7.2 Other Portable Grinders

The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on other portable grinding machines shall not exceed 180 degrees and the top half of the wheel shall be enclosed at all times. (See Figs. 17 and 18.)

4.3.5 AUTOMATIC SNAGGING MACHINES

ILLUSTRATION No. 52
The operator of a semi-automatic snagging machine easily controls movements of the grinder in all directions.

4.3.7 PORTABLE GRINDERS

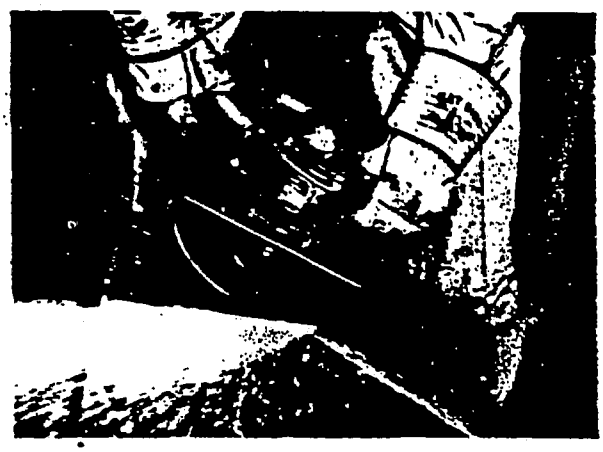


ILLUSTRATION No. 53
A Type 27 reinforced wheel properly mounted and guarded on a vertical portable grinder.

4.4 Exposure Adjustment

Safety guards of the types described in Rules 4.3.1 page 28 and 4.3.2 page 29 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 4.3.1 page 28 and 4.3.2 page 29 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. (See Figs. 21, 22, 23, 24, 25 and 26.)

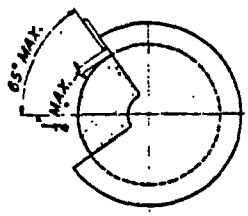


FIGURE NO. 21

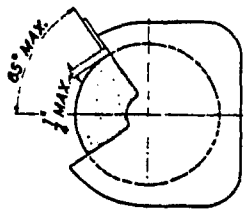


FIGURE NO. 22

CORRECT

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

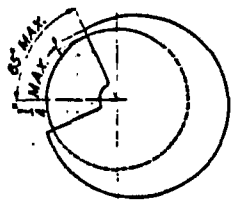


FIGURE NO. 23

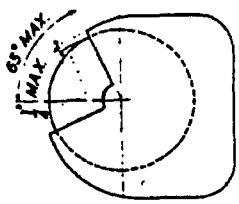


FIGURE NO. 24

CORRECT

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

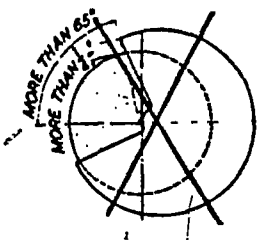


FIGURE NO. 25

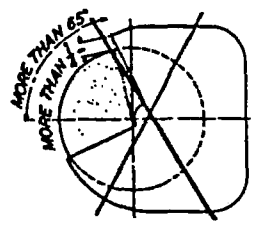


FIGURE NO. 26

INCORRECT

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

4.4 Exposure Adjustment

Figures 21, 22, 23 and 24 show two satisfactory methods of accomplishing exposure adjustment. These sketches are for purposes of illustration only. Other methods that agree with the basic rule are also acceptable. Figures 25 and 26 show a condition that does not comply with the requirements.

4.5 Enclosure Requirement

4.5.1 SAFETY GUARD

The safety guard shall cover the spindle end, nut, and flange projections. The safety guard shall be mounted so as to maintain proper alignment with the wheel, and the strength of the fastenings shall exceed the strength of the guard.

Exception A — Safety guards on all operations where the work provides a suitable measure of protection to the operator, may be so constructed that the spindle end, nut, and outer flange 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.

Exception B — The spindle end, nut and outer flange may be exposed on machines designed as portable saws. (See paragraph 1.4.17, page 14.)

4.5 Enclosure Requirement

4.5.1 SAFETY GUARD

ILLUSTRATION No. 54

An example of a well-designed guard for a bench grinder. Note the side member of the guard is readily removed for access to wheel.

4.5.2 ADDITIONAL ENCLOSURE

The nature of many operations requires that adjacent personnel other than the operator be afforded protection.

Such protection should take the form of an enclosure which isolates the operation from the remaining working area.

Heavy wire screen, corrugated iron, steel sheet or other suitable material may be used in its construction.

4.5.2 ADDITIONAL ENCLOSURE

ILLUSTRATION No. 55

Notice the protective screen placed around the grinding area. This auxiliary enclosure isolates the grinding area from the remainder of the plant.

4.6 Material Requirements and Minimum Dimensions

See Figures 33 and 34 and Table 5 page 36 for minimum basic thickness of peripheral and side members for various types of safety guards and classes of service.

4.6.1 FOR SPEEDS UP TO 8,000 S.F.P.M.

If operating speed does not exceed 8,000 surface feet per minute cast iron safety guards, malleable iron guards or other guards as described in paragraph 4.6.2 shall be used.

4.6.2 FOR SPEEDS UP TO 16,000 S.F.P.M.

Cast steel, or structural steel, safety guards as specified in Table 5 page 36 shall be used where operating speeds of wheels are faster than 8,000 surface feet per minute up to a maximum of 16,000 surface feet per minute.

4.6.3 OPTIONAL MATERIALS

If materials other than those listed in Table 5 page 36 are used, the thickness of the peripheral and side members shall be such that the resultant safety guard will be as strong or stronger than a similar guard constructed according to Table 5 page 36.

4.6.4 EXCEPTIONS:

1. For cutting-off wheels* 16 inches diameter and smaller and where speed does not exceed 16,000 surface feet per minute, cast iron or malleable iron safety guards as specified in Table 5 page 36 or other safety guards providing equal or better protection shall be used.

2. For cutting-off wheels* larger than 16 inches diameter and where speed does not exceed 14,200 surface feet per minute, fabricated safety guards as specified in Table 6 page 37 or other safety guards providing equal or better protection shall be used.

3. For thread grinding wheels not exceeding 1 inch in thickness cast iron or malleable iron safety guards as specified in Table 5 page 36 or other safety guards providing equal or better protection shall be used.

*See section 1.4.15 page 14 for cutting-off wheel definition.

4.6 Material Requirements and Minimum Dimensions

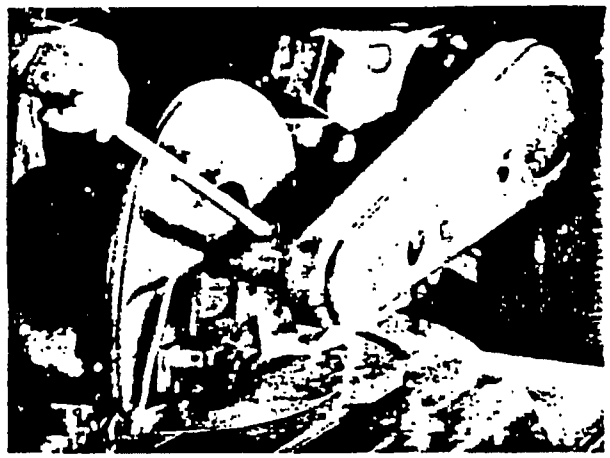


ILLUSTRATION No. 56

This cutting-off machine is employing a wheel less than 16 inches in diameter and is operating at a speed less than 16,000 surface feet per minute Note excellent cast iron guard.

ILLUSTRATION No. 57

This cutting-off machine has a wheel larger than 16 inches diameter and is operating at a speed less than 14,200 surface feet per minute. Note complete enclosure of wheel by the fabricated safety guard.

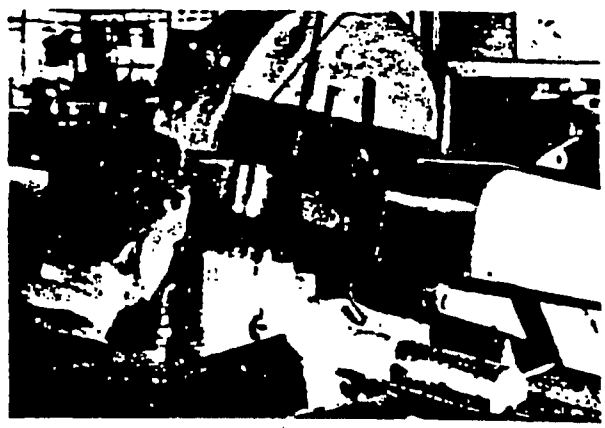


ILLUSTRATION No. 58

Note the heavy cast iron safety guard completely enclosing the cutting-off wheel.

4.7 Material Specifications

The minimum thickness specifications shown in Tables 5 page 36 and 6 page 37 are based on the following material specifications of the American Society for Testing Materials.

(a) Gray Iron Castings—A 48-48

(b) Malleable Iron Castings—A 47-52

(c) Steel Castings—A 27-52T

(d) Structural Steel Plate—A 7-53T

(Excluding specifications for rivet steel.)

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.

4.8 Construction Guide for Fabricated Guards

Guides for the construction of fabricated guards of structural steel are shown in Figs. 27 to 32 inclusive and in Table 4 page 35. Two designs are shown. Other designs affording equal or better protection are also acceptable.

The requirements given in Column A of Table 4 page 35 shall apply also to cast guards and in such cases, where the tongue is held by bolts, Column B shall also apply.

4.9 Specifications for Rivets, Bolts, Welds and Studs for Fabricated Guards

Table 7 page 38 may be used as a guide in determining the spacings and size of rivets, bolts and studs to provide satisfactory connections. Any means of fastening shall be considered satisfactory if, when assembled, it has strength at least equal to the tensile strength of the members being joined.

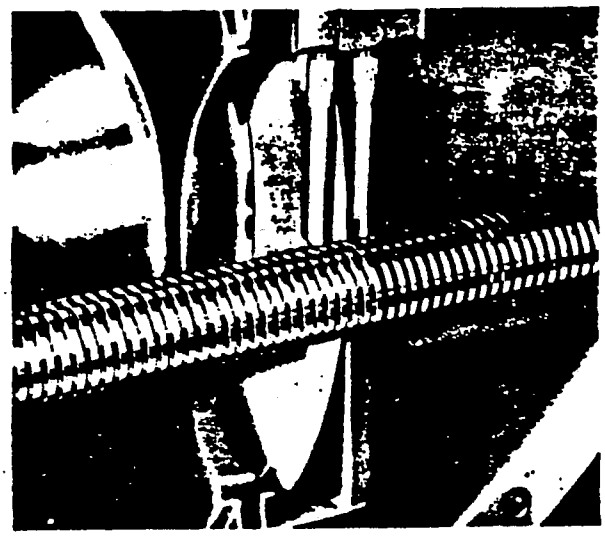


ILLUSTRATION No. 59
Close-up view of thread grinding wheel. Note the excellent safety guard.

4.9 Specifications for Rivets, Bolts, Welds and Studs for Fabricated Guards

ILLUSTRATION No. 60
The fabricated safety guard is easily identifiable by the rivets, bolts and welds used in its assembly.

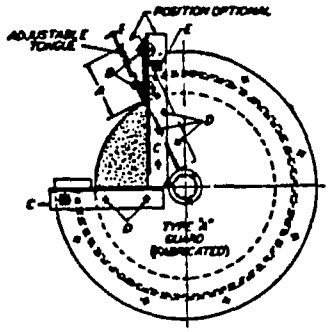


FIGURE NO. 27

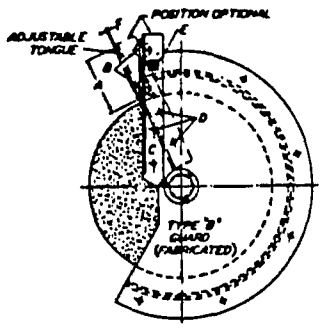


FIGURE NO. 29

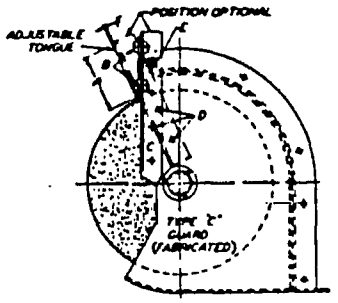


FIGURE NO. 31

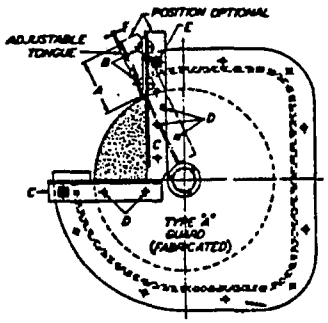


FIGURE NO. 28

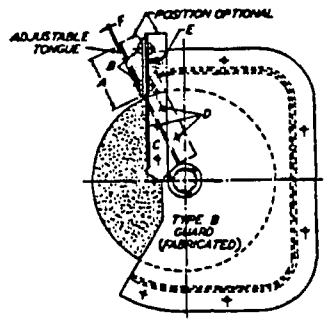


FIGURE NO. 30

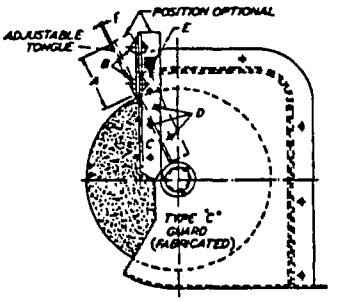


FIGURE NO. 32

See Section 3.4 Page 20 for Exhaust Provision.

TABLE 4

DIMENSIONAL REQUIREMENTS FOR CONSTRUCTION OF FABRICATED GUARDS

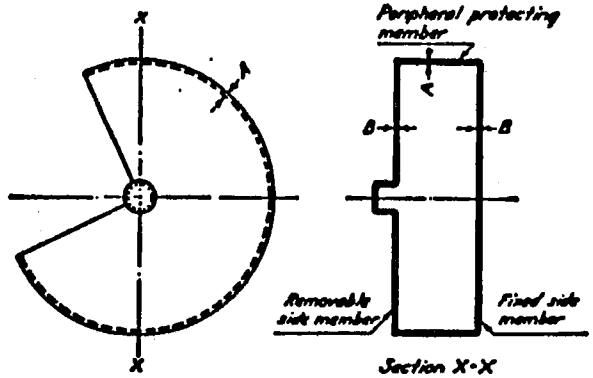
MAXIMUM WHEEL SPEED 10,000 SFPM

	A	B	C	D	E	F	G*	H*
Diameter of Wheel Inches	Length of Tongue Inches	Diameter of Bolts Medium-Carbon Quenched & Tempered Inches	Size of Angle Supports Tongue and Rest Inches	Diameter of Rivets for Supports Inches	Diameter of End Connecting Bolts Inches	Thickness of Tongue Inches	Maximum Space between New Wheel and Guard at Periphery Inches	Maximum Inside Width of Guard Inches
Under 12	3½	5/16	1½ x 1½ x 5/16	4 ea @ ½	½	¼	1½	1½ wider than wheel
16	5	⅝	2 x 2 x 5/16	4 ea @ ⅝	5/16	⅜	1½	2 wider than wheel
24	6	¾	2 x 2 x ½	6 ea @ ⅝	⅝	½	1½	2 wider than wheel
30	7	11/16	2½ x 2½ x ½	6 ea @ 11/16	11/16	½	1½	2 wider than wheel

Note: Column D assumes low carbon steel (38000 PSI tensile) rivets. Two rivets per bar 12 and 16" diameter. Four rivets per bar 24 and 30" diameter.

**Limitations in Columns G and H refer only to guards the shape of which is similar to those shown in figures 27, 29 and 31.*

FIGURE NO. 33



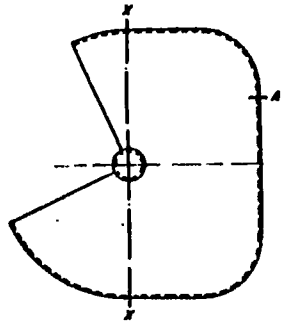


FIGURE NO. 34

TABLE 5

MINIMUM BASIC THICKNESSES OF PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS

Material Used in Construction of Guard	Maximum Thickness of Grinding Wheel	Grinding Wheel Diameters													
		3 to 6 inches		Over 6 to 12 inches		Over 12 to 16 inches		Over 16 to 20 inches		Over 20 to 24 inches		Over 24 to 30 inches		Over 30 to 48 inches	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Inches	Inches		Inches		Inches		Inches		Inches		Inches		Inches	
Material Satisfactory[a] for speeds up to 8,000 SFPM — Cast Iron (Min. Tensile Strength 20,000 PSI) Class 20	2	¼	¼	⅜	5/16	½	⅜	⅝	½	⅞	⅝	1	¾	1¼	1
	4	5/16	5/16	⅜	5/16	½	⅜	¾	⅝	1	⅝	1⅛	¾	1⅜	1
	6	⅜	5/16	½	7/16	⅝	½	1	⅝	1⅛	¾	1¼	⅞	1½	1⅛
	8			⅝	9/16	⅞	¾	1	¾	1⅛	¾	1¼	⅞	1½	1⅛
	10			¾	11/16	⅞	¾	1	¾	1⅛	¾	1¼	⅞	1½	1⅛
	16					1⅛	1	1¼	1	1 5/16	1	1 7/16	1 1/16	1¾	1⅜
	20							1⅜	1⅛	1⅜	1⅛	1½	1⅜	2	1⅝
Material Satisfactory[a] for speeds up to 9,000 SFPM — Malleable Iron (Min. Tensile Strength 50,000 PSI) Grade 32510	2	¼	¼	⅜	5/16	½	⅜	⅝	½	¾	⅝	⅞	¾	1	⅞
	4	5/16	5/16	⅜	5/16	½	⅜	⅝	½	¾	⅝	⅞	¾	1⅛	⅞
	6	⅜	5/16	½	7/16	⅝	½	¾	⅝	⅞	⅝	1	¾	1¼	⅞
	8			½	7/16	⅝	½	¾	⅝	⅞	⅝	1	¾	1¼	⅞
	10			½	7/16	⅝	½	¾	⅝	⅞	⅝	1	¾	1¼	⅞
	16					13/16	11/16	13/16	11/16	1	¾	1⅛	⅞	1⅜	1
	20							⅞	¾	1	¾	1⅛	⅞	1½	1⅛
Materials Satisfactory[a] for speeds up to 16,000 SFPM — Steel Castings Min. Tensile Strength 60,000 PSI) Grade V60-30	2	¼	¼	5/16	5/16	⅜	⅜	½	7/16	⅝	½	⅝	⅝	⅞	¾
	4	¼	¼	½	½	½	½	9/16	½	⅝	½	⅝	⅝	1	¾
	6	⅜	¼	⅝	⅝	¾	⅝	¾	⅝	13/16	11/16	13/16	11/16	1⅛	¾
	8			⅞	¾	⅞	¾	⅞	¾	⅞	¾	15/16	13/16	1⅜	1
	10			1	⅞	1	⅞	1	⅞	1⅛	15/16	1⅛	1	1 7/16	1 1/16
	16					1¼	1⅛	1¼	1⅛	1¼	1⅛	1¼	1⅛	1 13/16	1 7/16
	20							1⅜	1¼	1⅜	1¼	1 7/16	1 5/16	2 1/16	1 11/16
	2	1/8	1/16	5/16	¼	5/16	¼	5/16	¼	5/16	¼	⅜	5/16	½	⅜
	4	1/8	1/16	⅜	5/16	⅜	5/16	⅜	5/16	⅜	5/16	⅜	5/16	½	⅜
Structural Steel (Min. Tensile Strength 60,000 PSI)	6	3/16	1/16	½	⅜	7/16	⅜	7/16	⅜	7/16	⅜	7/16	⅜	⅝	½
	8			½	⅜	9/16	7/16	9/16	7/16	9/16	7/16	⅝	½	⅝	½
	10			9/16	7/16	[illegible]	½	⅝	½	⅝	½	⅝	½	⅞	[illegible]
	16						9/16	⅝	⅝	⅝	⅝	13/16	11/16	1 1/16	[illegible]
	20							13/16	11/16	13/16	11/16	⅞	⅝	1 3/16	[illegible]

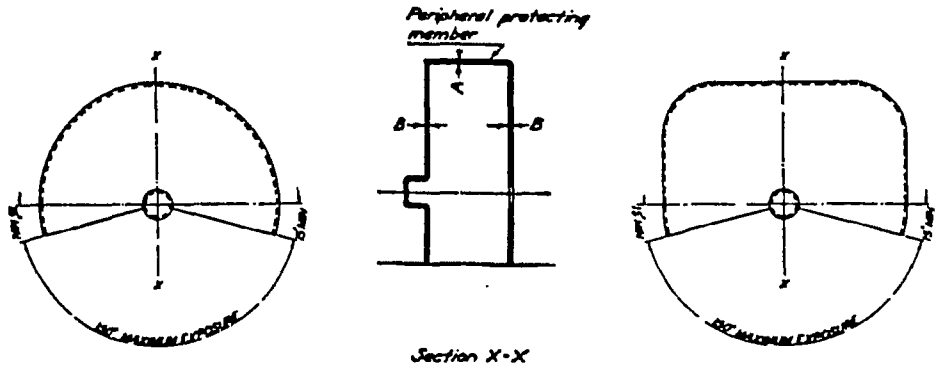


FIGURE NO. 35

FIGURE NO. 36

TABLE 6

MINIMUM BASIC THICKNESSES FOR PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS USED WITH CUTTING-OFF WHEELS

Material Used in Construction of Guard	Maximum Thickness of Cutting Off Wheel	Speed Not to Exceed	Cutting Off Wheel Diameters									
			6 to 11 inches		Over 11 to 20 in.		Over 20 to 30 in.		Over 30 to 48 in.		Over 48 to 72 in.	
			A	B	A	B	A	B	A	B	A	B
Structural Steel (Min. Tensile Strength 60,000 PSI)	⅛ inch or less	14,200 SFPM	inches 1/16	1/16	1/16	1/16	⅛	⅛	1/16	1/16	¼	¼
	⅛ inch or less	16,000 SFPM	inches 1/16	¼	⅛	⅛	1/16	⅛	¼	1/16	1/16	¼

4.10 Construction Guide for Drawn Steel Guards

As a guide for the construction of drawn steel guards for wheel 8 inches diameter and smaller, Figure 38 and Table 8 page 39 have been prepared. Other designs affording equal or better protection are also acceptable.

Special design drawn steel guards for use with Types 27 and 28 abrasive wheels on portable machines are shown in Fig. 39 page 39. An essential feature of design is the lip on the outer edge which curls inward to deflect pieces if a wheel is broken in the 180° arc next to the operator and to provide necessary strength with light sheet steel.

Dimension B shall be sufficient to allow the lip to curl outside the wheel.

4.10 Construction Guide for Drawn Steel Guards

ILLUSTRATION No. 61

A typical application of the drawn steel safety guard.

GUIDE SHOWING CORRECT FASTENING PROCEDURE FOR SIDE MEMBERS (See Section 4.8 page 34)

FRONT VIEW, ALSO CROSS SECTIONS SHOWING FOUR SATISFACTORY METHODS OF SECURING COVER-B2

NOTE: These views all apply to Types A, B & C Guards

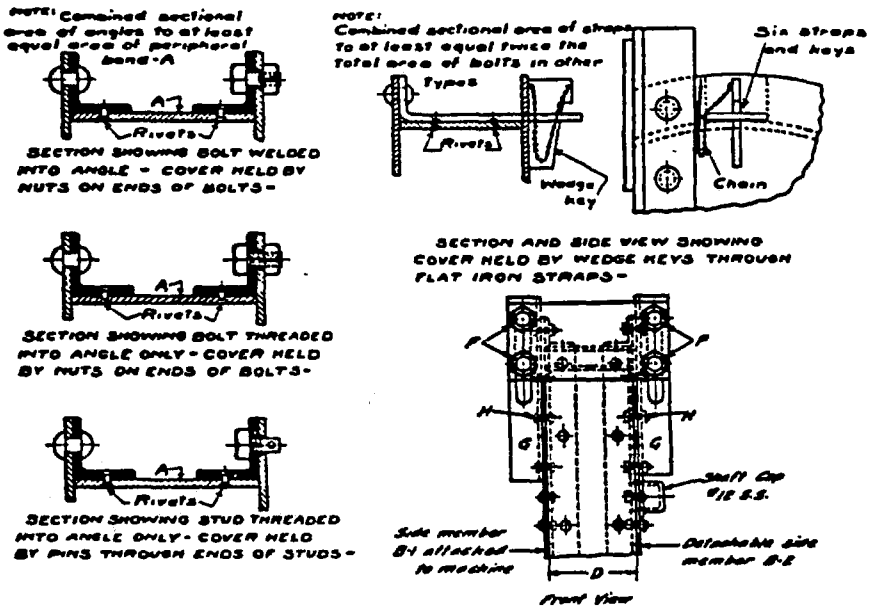


FIGURE NO. 37

TABLE 7

MINIMUM SIZES AND SPACING OF RIVETS, BOLTS AND STUDS FOR CONNECTING PERIPHERAL AND SIDE MEMBERS IN FABRICATED GUARDS OF 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
1/8 and 1/16	5/16	3	7/16	6
3/16 " 1/16	5/16	3	7/16	6
3/16 " 1/8	5/16	3	7/16	6
3/16 " 3/16	5/16	3	7/16	6
1/4 " 1/8	3/8	4	9/16	8
1/4 " 3/16	3/8	3 1/2	9/16	7
1/4 " 1/4	3/8	3	9/16	6
5/16 " 3/16	9/16	4	13/16	8
5/16 " 1/4	9/16	4	13/16	8
3/8 " 1/4	9/16	4	13/16	8
3/8 " 5/16	9/16	3 1/2	13/16	7
7/16 " 1/4	9/16	3	13/16	6
7/16 " 5/16	9/16	3	13/16	6
1/2 " 5/16	9/16	3	13/16	6
1/2 " 3/8	9/16	3	13/16	6
5/8 " 3/8	5/8	3	7/8	6
11/16 " 7/16	5/8	3	7/8	6

TYPICAL DRAWN STEEL GUARD FOR WHEELS
8 Inches Diameter and Smaller (See Section 4.10 page 37)

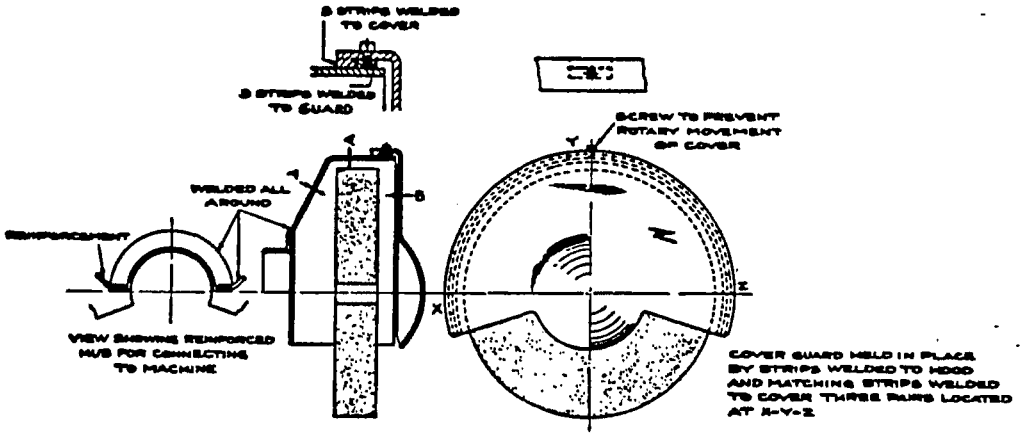


FIGURE NO. 38

TABLE 8

GUIDE FOR CONSTRUCTION OF DRAWN STEEL GUARDS FOR WHEEL 2" THICK AND LESS, 8" AND LESS IN DIAMETER

Material Used in Construction of Guard Hot Rolled Steel SAE 1008 Min. Tensile Strength 60,000 PSI For Speeds Up to (SFPM)	Maximum Thickness of Wheel, Inches	2 to 5 Inches		Above 5 to 8 Inches	
		A	B	A	B
		Inches		Inches	
9,500	2	1/16	1/16	3/32	1/16
12,500	2	3/32	1/16	3/32	3/32
17,000	1	3/32	1/16	1/8	3/32

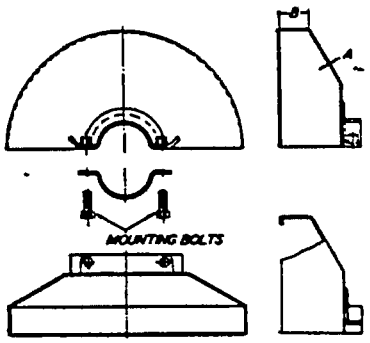


FIGURE NO. 39

TABLE 9

DRAWN STEEL GUARD FOR PORTABLE GRINDERS USED WITH TYPES 27 AND 28 WHEELS

Material Used in Construction of Guard		Thickness of Wheel	Wheel Diameter Inches	A Inches	B Inches
For speeds up to 14,200 SFPM	Hot Rolled Steel SAE 1008 min. tensile strength 60,000 PSI	3/4 inches or less	2 to 9	1/16	1/8
		Over 3/4 to 1 inch	7 to 9	1/8	1 1/16

4.11 Band Type Guards — General Specifications

Band type guards shall conform to the following general specifications:

(a) The bands shall be of 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 page 41; nor the wall thickness (W) whichever of these dimensions is smaller.

4.11 Band Type Guards — General Specifications

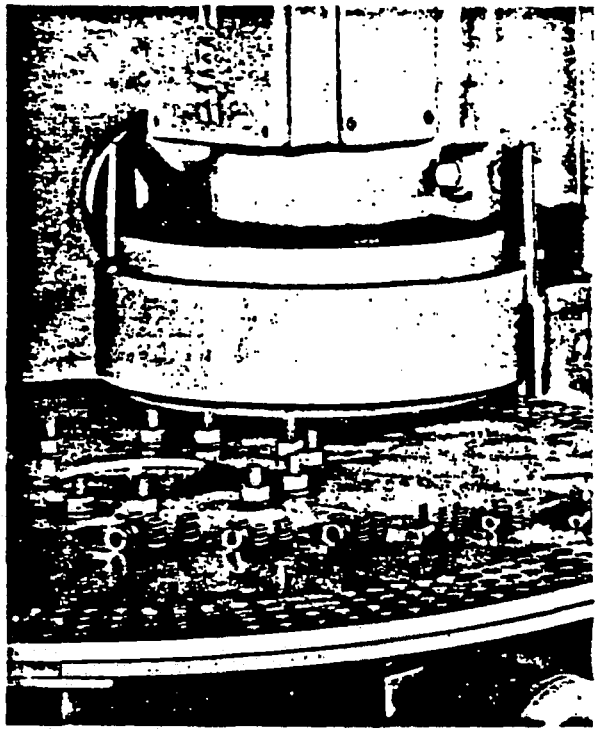


ILLUSTRATION No. 62

A properly constructed band type guard. Notice that the exposure of the abrasive wheel is in conformance with the requirements listed in Table 11.

4.12 Construction Guide For Band Type Guards

As a guide for the construction of band type guards, Figure 40 and Table 11 page 41 have been prepared. Other designs affording equal or better protection are also acceptable.

4.12 Construction Guide For Band Type Guards

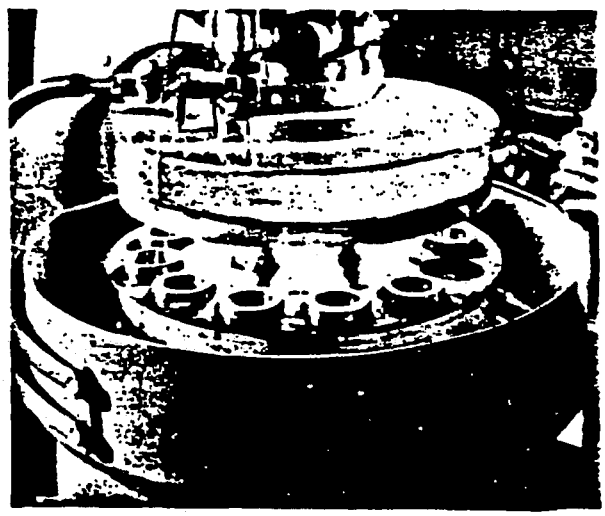


ILLUSTRATION No. 63

Another example of a well constructed band type guard.

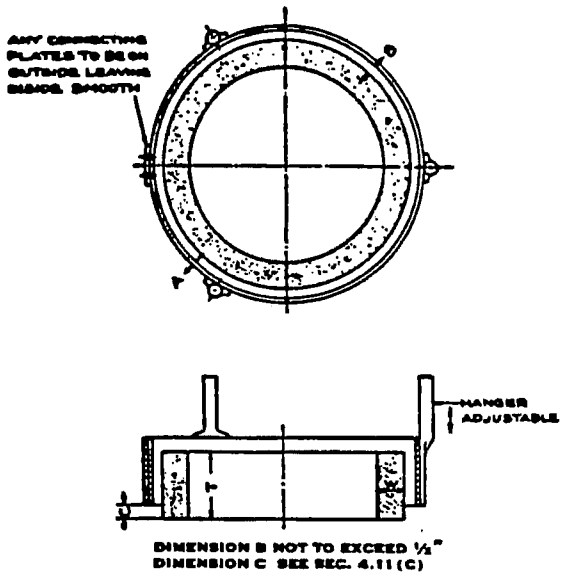


FIGURE NO. 40

TABLE 10
EXPOSURE VERSUS WHEEL THICKNESS

Overall Thickness of Wheel (T) Inches	Maximum Exposure of Wheel (C) Inches
½	¼
1	½
2	¾
3	1
4	1½
5 and over	2

TABLE 11
GUIDE FOR CONSTRUCTION OF BAND TYPE GUARDS
Maximum Wheel Speed 7000 SFPM

Minimum Material Specifications	Diameter of Wheel	Minimum Thickness of Band A	Minimum Diameter of Rivets	Maximum Distance between Centers of Rivets
Hot Rolled Steel SAE 1008	Inches Under 8	Inches 1/16	Inches 3/16	Inches ¾
	8 to 24	⅛	¼	1
	Over 24 to 30	¼	⅜	1¼

CODE REGULATIONS
Section 5
FLANGES

5.1 General Requirements

All abrasive wheels shall be mounted between flanges which shall not be less than one-third the diameter of the wheel.

Exceptions:

A) Mounted Wheels

B) Portable Wheels with threaded inserts or projecting studs

C) Abrasive Discs (Inserted Nut, Inserted Washer and Projecting Stud Type)

D) Plate Mounted Wheels

E) Cylinders, Cup or Segmental Wheels that are mounted in chucks

F) Types 27 and 28 Wheels (see section 5.4 page 43)

G) Certain Internal Wheels

H) Modified Types 6 and 11 Wheels (Terrazzo)

I) Cutting-Off Wheels, Types 1 and 27A (See section 5.1.1 and 5.1.2)

5.1.1 Type 1 Cutting-Off Wheels

Type 1 cutting-off wheels are to be mounted between properly relieved flanges which have matching bearing surfaces. Such flanges shall be at least one-fourth the wheel diameter.

5.1.2 Type 27A Cutting-Off Wheels

Type 27A cutting-off wheels are designed to be mounted by means of flat, not relieved, flanges having matching bearing surfaces and which may be less than one-third but shall not be less than one-fourth the wheel diameter. See Illustration 77 page 56 for one such type of mounting.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 5
Flanges

5.1 General Requirements

The major stresses produced in an operating grinding wheel tend to combine and become greatest at the hole. It is, therefore, important that stresses due to mounting and driving, act as far from the hole as practicable.

This is best accomplished by using flanges at least as large as those listed in Tables 12, 13, 14, 15, 16, 17, 18 and 19, pages 47, 48, 49, 50 and 51.

Flanges should be at least minimum diameters specified, identical in diameter and radial bearing surface to avoid cross bending pressures and stresses in the wheel structure. Cutting-off wheel flange diameter equal to ¼ the wheel diameter is a minimum requirement. In many cutting-off operations, better results may be obtained through the use of larger flanges.

Blotters (Compressible Washers) should always be used between metal flanges and abrasive wheel surfaces for uniform distribution of flange pressure.

See Sec. 5.6 page 44 for exceptions regarding the use of blotters.

Flanges shall be checked periodically for flatness, burrs or wear.

5.1.3 Flange Types

There are three general types of flanges: straight relieved flanges (see Figure 41 page 47); straight unrelieved flanges (see Figure 42 page 48); adaptor flanges (see Figures 44 and 45, page 49).

Regardless of flange type used, the wheel shall always be guarded. (See section 4 page 27.) Blotters shall be used as listed in section 5.6 page 44.

5.2 Design and Material

Flanges shall be of such design as to satisfactorily transmit the driving torque from the spindle to the grinding wheel.

Flanges may be made of steel, cast iron or other material of equal or greater strength and rigidity.

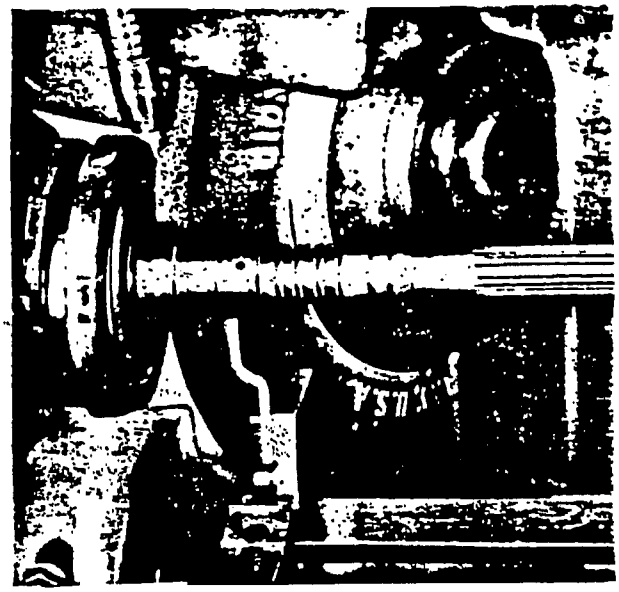


ILLUSTRATION No. 64
Note the flanges used here are at least ⅓ diameter of wheel; finished all over, and free of rough or sharp edges.

5.3 Finish and Balance

Flanges shall be dimensionally accurate and in good balance. There shall be no rough surfaces or sharp edges.

5.4 Uniformity of Diameter

Both flanges, of any type, between which a wheel is mounted, shall be of the same diameter and have equal bearing surface.
Exception: Types 27 and 28 wheels are designed to be mounted by means of a special adaptor (see Illus. No. 65 for one type of adaptor). Modified types 6 and 11 wheels (terrazzo) with tapered K dimension (see section 1.4.20 page 15). Equivalent or better mounting techniques may also be used. (See section 6.15 page 56.)

5.4 Uniformity of Diameter

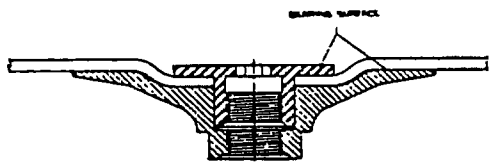


ILLUSTRATION No. 65
One type of adaptor for a Type 27 wheel.

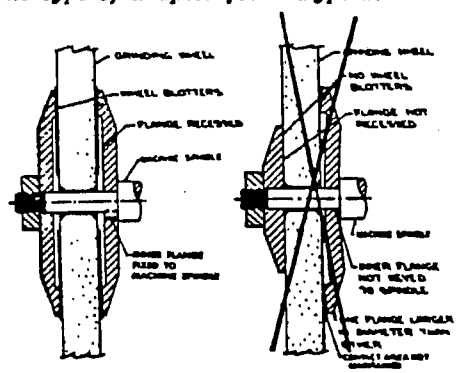


ILLUSTRATION No. 66
Proper and improper methods of mounting wheels having small holes.

5.5 Recess and Undercut

Straight relieved flanges made according to Fig. 41 page 47 shall be recessed at least $\frac{1}{16}$" on the side next to the wheel for a distance as specified in the respective tables of dimensions for these flanges.

Straight flanges of the adaptor or sleeve type (Figs. 44 and 45 page 49) shall be undercut so that there will be no bearing on the sides of the wheel within ⅛ inch of the arbor hole.

5.6 Contact

(A) Flanges shall be designed with respect to rigidity so that when tightened, the radial width of bearing surface of contact on the wheel is maintained.

See Table 12 page 47.

Note: See Sec. 5.9 page 46 for Maintenance of Flanges.

(B) Blotters (compressible washers) shall always be used between flanges and abrasive wheel surfaces to insure uniform distribution of flange pressure. See Sec. 6.5 page 53.

Exception:

1. **Mounted wheels**
2. **Abrasive discs (inserted nut, inserted washer and projecting stud type)**
3. **Plate mounted wheels**
4. **Cylinders, cups or segmental wheels that are mounted in chucks**
5. **Types 27 and 28 wheels**
6. **Certain Type 1 and Type 27A cutting-off wheels**
7. **Certain internal wheels**
8. **Type 4 tapered wheels**
9. **Diamond wheels, except certain vitrified diamond wheels.**
10. **Modified Types 6 and 11 wheel (terrazzo) — blotters applied flat side of wheel only.**

5.6 Contact

(A) Flanges must be at least minimum diameter specified, identical in diameter and radial bearing surface to avoid cross bending pressures and stresses in the wheel structure. Flanges must be of sufficient rigidity to resist "springing" from mounting pressure. This "springing" can be detected by inserting a feeler gauge between bearing area of the flange and the wheel.

(B) Care must be taken to clean the flanges thoroughly before mounting a wheel. On certain operations, blotters have a tendency to adhere to the flange.

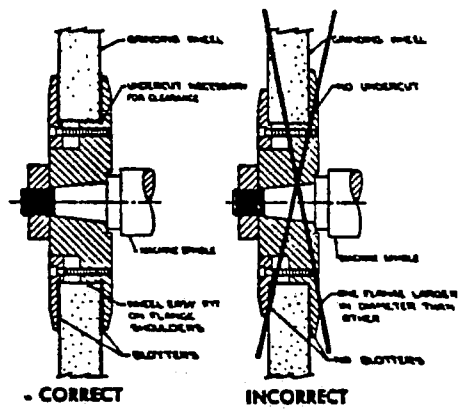


ILLUSTRATION No. 67
Proper and improper methods of mounting wheels having large holes.

5.7 Driving Flange

The driving flange shall be securely fastened to the spindle and the bearing surface shall run true.

5.7.1 FLANGES, MULTIPLE WHEEL MOUNTING

When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. (See section 6.7, page 53.)

5.8 Dimensions

5.8.1 STRAIGHT FLANGES, RELIEVED AND UNRELIEVED (See Figs. 41 and 42, Tables 12 and 13, pages 47 and 48)

The tables show minimum dimensions for straight relieved and unrelieved 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 practicable.

5.8.2 STRAIGHT ADAPTOR FLANGES HEAVY DUTY GRINDING

Table 14 page 48 and table 15 page 49 shows minimum dimensions for straight adaptor flanges for use with wheels having holes larger than the spindle. Dimensions of such adaptor flanges shall never be less than indicated and should be greater where practicable.

Note: Inorganic wheels with large holes are not recommended for snagging. (See section 9.13 page 68.)

5.7 Driving Flange

The driving flange shall be checked on a regularly maintained schedule for any damage or run-out.

5.7.1 FLANGES, MULTIPLE WHEEL MOUNTING

In certain multiple wheel operations where wheel slippage may be a problem it may be necessary to key or otherwise securely fasten both the spacers and the outside flange to the spindle.

5.8 Dimensions

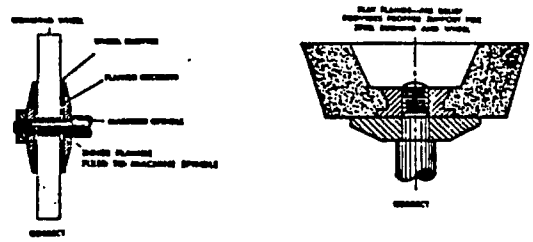


ILLUSTRATION No. 68
The proper flange assemblies for Type 1 and Type 11 wheels.

5.8.2 STRAIGHT ADAPTOR FLANGES HEAVY DUTY GRINDING

Flanges of this type are frequently used with organic bonded snagging wheels having large holes.

Inorganic wheels with large holes are not recommended for rough snagging operations. These wheels are not suitable for current methods of reinforcement and therefore, it is necessary for the wheels to have small holes and be used with straight relieved or tapered safety flanges.

5.8.3 SLEEVE FLANGES (See Fig. 51)

Table 19 page 51 shows minimum dimensions for straight flanges that are an integral part of wheel sleeves which are frequently used on precision grinding machines. Dimensions of such flanges shall never be less than indicated and should be greater where practicable.

5.8.3 SLEEVE FLANGES

In mounting large hole wheels, it is most important that equipment and mounting procedures are satisfactory to avoid distorting of flanges. Careful mounting procedures, using new clean blotters and gradual criss-cross tightening of the mounting screws, are important. Excessive tightening beyond that necessary to drive the wheel without slippage results in abnormal stresses near the hole. This must be avoided.

5.9 Repairs and Maintenance

All flanges shall be maintained in good condition. When the bearing surfaces become worn, warped, sprung or damaged they should be trued or refaced. When refacing or truing, care shall be exercised to make sure that proper relief and rigidity is maintained as specified in Sections 5.5 and 5.6 page 44 and they shall be replaced when they do not conform to these Sections and Tables 12, 13, 14, or 19 pages 47, 48 and 51. Failure to observe these rules might cause excessive flange pressure around the hole of the wheel. This is especially true of wheel-sleeve or adaptor flanges.

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

5.9 Repairs and Maintenance

A Standard Inspection Frequency Schedule should be adopted by each grinding wheel user depending on his experience and severity of use.

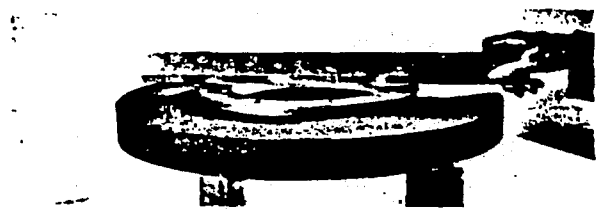


ILLUSTRATION No. 69

Check flanges with straight edge to be sure they are not warped or sprung.

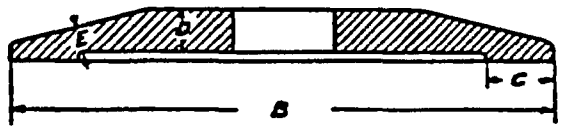


FIGURE NO 41

Driving flange secured to spindle. See Section 5.7 Page 45.

TABLE 12

MINIMUM DIMENSIONS FOR STRAIGHT RELIEVED FLANGES

A* Diameter of Wheel	B (1) 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	Inches	Inches	Inches	Inches
1	5/8	1/16	1/8	1/16	1/16
2	1 1/16	1/8	3/16	1/8	3/16
3	1	1/8	5/16	1/16	3/16
4	1 3/8	1/8	5/16	1/16	1/8
5	1 11/16	1/16	1/4	1/4	1/8
6	2	1/4	1/2	5/16	1/16
7	2 3/8	1/4	1/2	5/16	1/16
8	2 11/16	1/4	1/2	5/16	1/16
10	3 3/8	1/16	5/16	5/16	1/4
12	4	1/16	5/16	1/2	1/16
14	4 11/16	3/16	3/4	1/2	1/16
16	5 3/8	1/2	1	1/2	1/16
18	6	1/2	1	5/16	3/16
20	6 11/16	5/16	1 1/4	5/16	3/16
22	7 3/8	5/16	1 1/4	5/16	1/16
24	8	3/4	1 1/4	5/16	1/16
26	8 11/16	3/4	1 1/4	5/16	1/2
28	9 3/8	7/16	1 1/2	3/4	1/2
30	10	7/16	1 1/2	3/4	5/16
36	12	1	2	7/16	3/4
42	14	1	2	7/16	3/4
48	16	1 1/4	2	1 1/2	1
60	20	1 1/4	2	1 1/4	1 1/8
72	24	1 1/2	2 1/2	1 5/8	1 1/4

**Flanges for wheels under 2 inches diameter may be unrelieved and shall be maintained flat and true.*

(1) For exceptions to minimum outside diameter of flanges, see paragraph 5.1 and 5.1.1. Dimensions listed are rounded to + 1/16 inches.

FIGURE NO. 42

Driving flange secured to spindle for use only on portable wheels with threaded inserts or projecting studs.

TABLE 13
MINIMUM DIMENSIONS FOR STRAIGHT UNRELIEVED FLANGES FOR WHEELS WITH THREADED INSERTS OR PROJECTING STUDS

A Diameter of Wheel	B* Minimum Outside Diameter of Flange	T Minimum Thickness of Flange
Inches	Inches	Inches
1	⅝	⅛
2	1	⅛
3	1	3/16
4	1⅜	3/16
5	1⅜	¼
6	2	⅜

**NOTE: Must be large enough to extend beyond the bushing. Where prong anchor or cupback bushing are used, this footnote does not apply.*

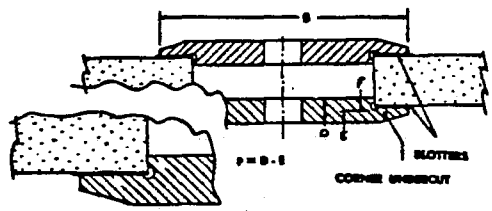


FIGURE NO. 43

TABLE 14
MINIMUM DIMENSIONS FOR STRAIGHT ADAPTOR FLANGE—FOR ORGANIC BONDED WHEELS OVER 1¼ INCH THICK*

Wheel Diameter	Wheel Hole Diameter	B Minimum Flange Diameter	D Minimum Thickness of Flange at Bore	E Minimum Thickness of Flange at Edge of Undercut	F* (D-E) Minimum Thickness
Inches	Inches	Inches	Inches	Inches	Inches
12	4	6	⅞	⅝	½
to	5	7	⅞	⅝	½
14	6	8	⅞	⅝	½
Larger than	4	6	⅞	⅝	½
14	5	7	⅞	⅝	½
to	6	8	⅞	⅝	½
18	7	9	⅞	⅝	½
	8	10	⅞	⅝	½
Larger than	6	8	1	½	½
18	7	9	1	½	½
to	8	10	1	½	½
24	10	12	1	½	½
	12	14	1	½	½
Larger than 24 to 30	12	15	1	½	½
Larger than 30 to 36	12	15	1⅛	⅝	½

**For wheels under 1¼ inch thick F dimension shall not exceed 40% of wheel thickness.*

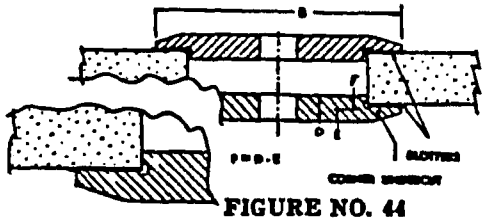


FIGURE NO. 44
Central Nut Mounting
Driving flange secured to spindle.
See Section 5.7 Page 45.

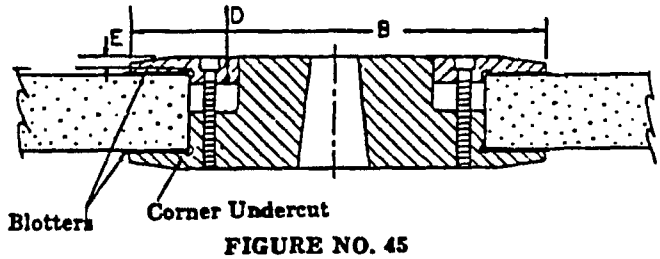


FIGURE NO. 45
Multiple Screw Mounting
Driving flange secured to spindle. See Section 5.7 Page 45.

TABLE 15

MINIMUM DIMENSIONS FOR STRAIGHT FLANGES—FOR MECHANICAL GRINDERS

12,500 S.F.P.M. to 16,500 S.F.P.M.(1)

Wheel Diameter	Wheel Hole Diameter	"B" Minimum Flange Diameter	"D" Minimum Thickness of Flange at Bore	"E" Minimum Thickness of Flange at Edge of Undercut	F*(D–E) Minimum Thickness
20	6	8	1	½	½
20	8	10	1½	¾	¾
24	12	15	2	1	1
30	12	15	2	1	1
36	12	15	2	1	1

(1)FLANGES shall be of steel, quality SAE 1040 or equivalent, annealed plate, heat treated to R_c 25-30.

**For wheels under 1¼ inch thick F dimension shall not exceed 40% of wheel thickness.*

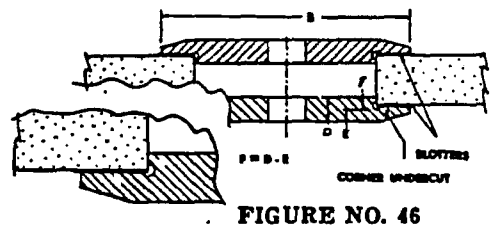


FIGURE NO. 46
Driving flange secured to spindle. See Section 5.7 Page 45.

TABLE 16

MINIMUM DIMENSIONS FOR STRAIGHT ADAPTOR FLANGE—FOR ORGANIC BONDED WHEELS USED ON SWING FRAME GRINDERS AT

12,500 S.F.P.M. to 16,500 S.F.P.M.(1)

Wheel Diameter	Wheel Hole Diameter	"B" Minimum Flange Diameter	"D" Minimum Thickness of Flange at Bore	"E" Minimum Thickness of Flange at Edge of Undercut	F*(D–E) Minimum Thickness
20	6	8	1	½	½
20	8	10	1	½	½
24	12	15	1¼	¾	½
30	12	15	1¼	¾	½

(1)FLANGES shall be of steel, quality SAE 1040 or equivalent, annealed plate, heat treated to R_c 25-30.

**For wheels under 1¼ inch thick F dimension shall not exceed 40% of wheel thickness.*

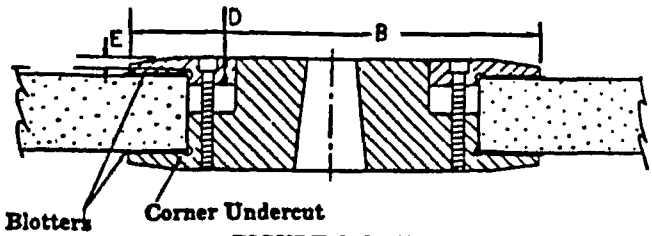


FIGURE NO. 47
Multiple Screw Mounting
Driving flange secured to spindle. See Section 5.7 Page 45.

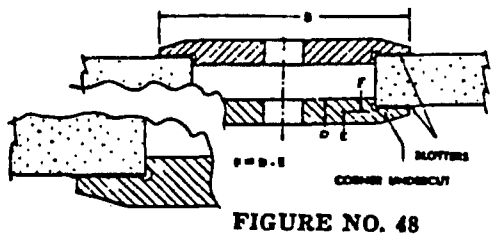


FIGURE NO. 48
Central Nut Mounting
Driving flange secured to spindle.
See Section 5.7 Page 45.

TABLE 17

MINIMUM DIMENSIONS FOR STRAIGHT FLANGES FOR HEAVY DUTY, HIGH SPEED FLOOR STAND GRINDERS(1)
12,500 S.F.P.M to 16,500 S.F.P.M.

Wheel Diameter	Hole Diameter	"B" Minimum Flange Diameter	"D" Minimum(2) Thickness of Flange at Bore
20	6 thru 10	8 thru 12	1
24	12	15	1¼
30	12	15	1½

(1)FLANGES shall be of steel, quality SAE 1040 or equivalent, annealed plate, heat treatsd to Rc 25-30.
(2)For central nut mounting, increase "D" dimension by ½ in. for each wheel size shown. For flanges not heat treated, increase "D" dimension by ½ in. for each wheel size shown.

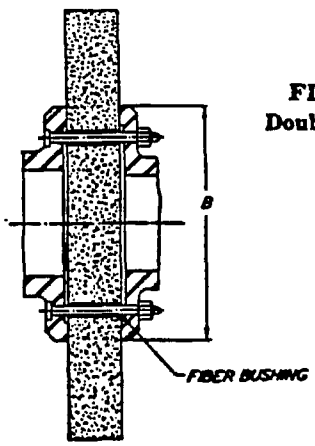


FIGURE NO. 49
Double End Spindle

FIGURE NO. 50
Open End Spindle

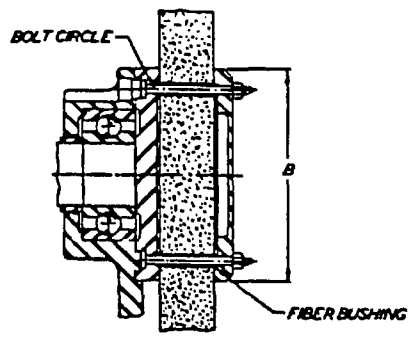


TABLE 18

MINIMUM DIMENSIONS FOR FLANGES FOR ARBORLESS WHEELS—ORGANIC BOND

Wheel Diameter	Bolt Circle Diameter	"B" Minimum Flange Diameter	Torque Used in Mounting Ft. Lbs.	Mounting Hole Size Dimensions. (8 holes) (holes equally spaced)
16	6½	8¾	30–40	All mounting holes shall be ¼" inside diameter, with a fiber bushing in place, not to exceed ½" outside diameter.
20	8	10¾	30–40	
24	9¾	12	40–60	
30	12	14¾	40–60	

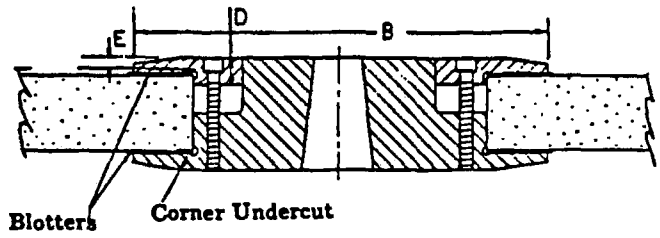


FIGURE NO. 51

Driving flange secured to spindle. See Section 5.7 Page 45.

TABLE 19
MINIMUM DIMENSIONS FOR STRAIGHT FLANGES USED AS WHEEL SLEEVES
FOR PRECISION GRINDING ONLY

Wheel Diameter	Wheel Hole Diameter	B Minimum Outside Diameter of Flange	D Minimum Thickness of Flange at Bore	E Minimum Thickness of Flange at Edge of Undercut
Inches	Inches	Inches	Inches	Inches
12 to 14	5	7	½	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	11½	5/8	7/16
	12	13½	5/8	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
Larger than 42 to 60	16	20	1	¾
	20	24	1	¾
	24	29	1⅛	⅞

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. For hole sizes smaller than shown in this table, use table 12.

CODE REGULATIONS
Section 6
MOUNTING

6.1 Inspection

Immediately before mounting, all wheels shall be closely inspected and sounded by the user (ring test, see section 2.3 page 18) to make sure they have not been damaged in transit, storage or otherwise. The spindle speed of the machine shall be checked before mounting of the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel.

6.2 Arbor Size

Grinding wheels shall fit freely on the spindle and remain free under all grinding conditions. A controlled clearance between the wheel hole and the machine spindle (or wheel sleeves or adaptors) is essential to avoid excessive pressure from mounting and spindle expansion.

To accomplish this, the machine spindle shall be made to nominal (standard) size plus zero minus .002 inches, and the wheel hole shall be made suitably over size to assure safety clearance under the conditions of operating heat and pressure. The spindle diameter should not be less than listed in section 3.5 page 21 and Table 1 page 22.

6.3 Surface Condition

All contact surfaces of wheels, blotters and flanges shall be flat and free of foreign matter.

6.4 Bushing

When a bushing is used in the wheel hole it shall not exceed the width of the wheel and shall not contact the flanges. Loose reducing bushing (not mechanically held) should not be used with wheels less than ⅛ inch in thickness.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 6
Mounting

6.1 Inspection

A cracked wheel is unsafe and must not be used. If any evidence of damage is found, the information should be reported to the manufacturer and arrangements made for inspection.

ILLUSTRATION No. 70
"Ring test"

6.2 Arbor Size

The machine spindle or adaptor size must be maintained by the user. Worn or undersize spindles or adaptors can cause an out-of-balance condition, contributing to wheel failure.

6.3 Surface Condition

Flanges can be distorted by excessive tightening or burred by dropping and should be checked periodically. (See section 5.9 page 46 Repairs and Maintenance.) Inspection for foreign particles should be made on wheels, blotters and flanges.

Presence of foreign particles in these areas can result in uneven pressure against the sides of the wheel causing stresses that can lead to wheel failure. Scuffed or damaged blotters should be replaced.

6.4 Bushing

If a bushing is wider than the wheel in which it is used it will interefere with proper tightening of the flanges against the wheel.

The power required to drive a grinding wheel is transferred through the flanges. If this power is partially or completely transferred through the bushing, wheel failure may result.

6.5 Blotters

When blotters or flange facings of compressible material are required, they shall cover entire contact area of wheel flanges.

Highly compressible material such as blotting paper as normally used should not exceed .025 inches in thickness.

If material of lower compressibility is used, greater thickness may be necessary.

Blotters need not be used with the following types of wheels:

1. **Mounted wheels.**
2. **Abrasive discs (inserted nut, inserted washer and projecting-stud type).**
3. **Plate mounted wheels.**
4. **Cylinders, cups or segmental wheels that are mounted in chucks.**
5. **Types 27 and 28 wheels.**
6. **Certain Type 1 and Type 27A cutting-off wheels.**
7. **Certain internal wheels.**
8. **Type 4 tapered wheels.**
9. **Diamond wheels, except certain vitrified diamond wheels.**

6.6 Flanges

All abrasive wheels shall be mounted between flanges which should not be less than one-third the diameter of the wheel. For exceptions and further explanation see section 5 page 42.

6.7 Multiple Wheel Mounting

When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. When mounting wheels which have not been cemented together, or ones which do not utilize separating spacers, care must be exercised to use wheels specially manufactured for that purpose. (See section 5.7.1, page 45.)

6.5 Blotters

Blotters are used for several reasons. They tend to cushion the pressure of the flanges against high points or uneven surfaces and distribute the pressure evenly. They prevent damage to the surfaces of the flanges from the abrasive surface of the wheel. They provide a better coefficient of friction than would be obtained between the flange and the wheel, thereby providing better transmission of the driving power to the wheel.

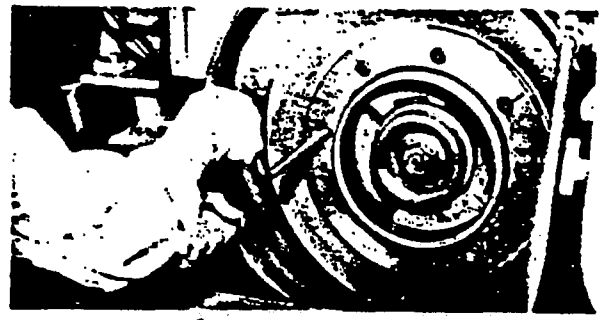


ILLUSTRATION No. 71
Note the blotter between the abrasive wheel and the flange.

6.6 Flanges

Flanges drive the wheel and must have sufficient contact area. They must be of proper design to prevent distortion causing damaging stresses in the wheel.

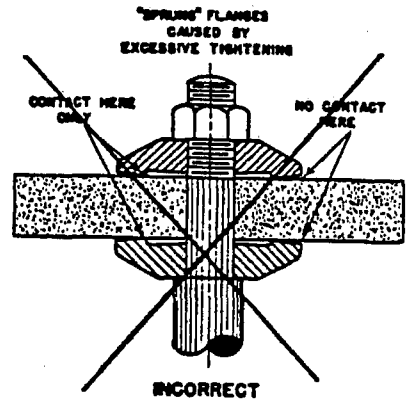


ILLUSTRATION No. 72
The above clearly illustrates the results encountered when the spindle end nut is excessively tightened.

6.7 Multiple Wheel Mounting

Soft compressible blotter material is not generally satisfactory for use as a spacer. Spacers should be of material rated as of low compressibility such as soft copper or brass.

6.8 Tightening of the Mounting Nut

6.8.1 SINGLE END NUT

The spindle end nut shall only be tightened sufficiently to drive the wheel and prevent slippage.

6.8.2 MULTIPLE SCREWS

Multiple screw flanges shall be tightened uniformly to prevent springing of the flanges and to insure even distribution of mounting pressure over entire surface of the flanges.

6.9 Direction and Length of Thread on Machine Spindle

If flanges are tightened by means of a central nut, three conditions shall be maintained.

1. **Spindles shall be of sufficient length to allow a full nut mounting.**
2. **Threaded portion shall be of sufficient extent so that the threading shall extend well inside the flange but not more than half way within the hole of the wheel.**
3. **The direction of the thread shall be such that to remove wheel the nut must be turned the same direction as the wheel rotates when in use.**

6.10 Threaded Hole Wheels

Special consideration other than listed above must be given to threaded hole wheels of the following types: 5, 6, 11, 16, 17, 18, 18R and 19.

The machine spindle for such wheels shall be provided with an unrelieved flat fixed back flange to allow the wheel to be screwed firmly against it.

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

The length of the spindle shall be such that it shall not bottom in blind threaded hole type wheels.

6.8.2 MULTIPLE SCREWS

The gradual tightening of screws on multiple screw type flanges by use of a torque wrench is recommended. The tightening should proceed from one screw to one diametrically opposite and then in a criss cross manner until sufficient pressure is applied uniformly to prevent slippage. Care must be taken to avoid excessive tightening as it may cause springing of the flanges resulting in wheel breakage. Torque pressure of 15 to 20 foot pounds is common with single wheel mounting, however, some exceptionally severe operations require greater pressure.

6.9 Direction and Length of Thread on Machine Spindle

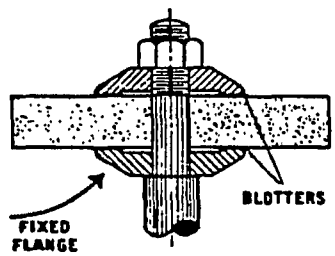


ILLUSTRATION No. 73
The spindle is of sufficient length to accommodate the wheel and flanges.

6.10 Threaded Hole Wheels

When threaded hole wheels are used, as in cups, cones and plugs, the size and mass of threaded hole wheels shall be kept within limits which have been found safe by experience for this mounting procedure.

With this type of mounting, a relieved back flange shall not be used. If made with a relief, it can pull the bushing out of the wheel. See Illustration No. 74.

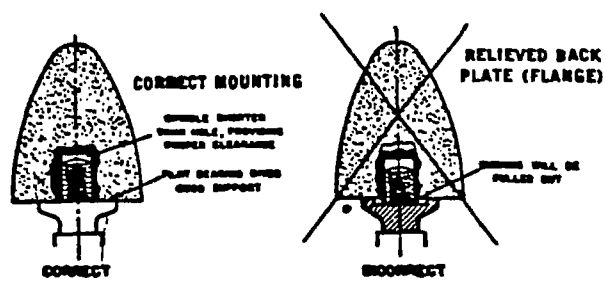


ILLUSTRATION No. 74
Mounting of threaded hole wheels.

Threaded hole wheel mounting should not be used with wheels larger than 6 inches diameter.

Threads in threaded hole wheels should be of class 2B fit and should be relieved on the side fitting against the flange so as to allow the wheel to be screwed firmly and flat against the back flange.

6.11 Mounting of Abrasive Discs (Inserted Nut, Inserted Washer and Projecting Stud Type)

For requirements for mounting of abrasive discs see section 3.13 page 25.

6.12 Mounting of Plate Mounted Type Wheels

For requirements for mounting plate mounted type wheels see section 3.14 page 26.

6.13 Safety Guards

At the completion of wheel mounting the safety guard should be checked for condition and adjustment if necessary. All abrasive wheels shall be provided with safety guards. (See section 4 page 27 for full information and exceptions.)

6.14 Mounted Wheels

The maximum safe operating speed for mounted wheels shall be determined by the following factors:

1. Shape and size of mounted wheel.
2. Size of mandrel.
3. Overhang of mandrel.
4. Wheel specifications.

(See section 10 page 69 for explanation, and Tables 23 through 31 pages 72 through 85 for speeds.)

6.13 Safety Guards

ILLUSTRATION No. 75
Note the well designed cup wheel guard.

6.14 Mounted Wheels

Since the overhang of the mandrel of a mounted wheel is a factor in determining the maximum allowable operating speed, care should be taken to assure the overhang conforms to the limitations set forth in section 10 page 69.

6.15 Type 27 and Type 28 Wheels

Type 27 and Type 28 wheels, because of their shape and usage, require specially designed adaptors. The back flange shall extend beyond the central hub or raised portion and contact the wheel to counteract the side pressure on the wheel in use. The adaptor nut which is less than the minimum one third diameter of wheel fits in the depressed side of wheel to prevent interference in side grinding and serves to drive the wheel by its clamping force against the depressed portion of the back flange. The variance in flange diameters, the adaptor nut being less than one third wheel diameter, and use of side pressure in wheel operation limits the use to reinforced organic bonded wheels.

Mounts which are affixed to the wheel by the manufacturer shall not be reused.

Type 27 and Type 28 wheels shall be used only with a safety guard located between wheel and operator during use. (See section 4.3.7.1. page 30 and Figure 39, page 39.)

6.15 Type 27 and Type 28 Wheels

Type 27 and 28 wheels are designed for specific usage on right angle head grinders. Type 27 with flat outer area is better suited for notching and cutting operations as well as flat area grinding. Type 28 with saucer-shaped outer area is better suited for corner cleaning work. When these wheels are supplied with a throw-away type adaptor (mounting flange attached by the manufacturer), the adaptor should not be reused. It is important when mounting Type 27 and Type 28 wheels that proper contact is made with the larger back flange.

Flanges should be checked for flatness since a warped flange will cause vibration and possible wheel failure.

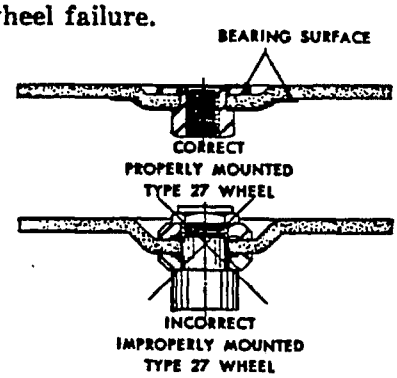


ILLUSTRATION No. 76

Types 27 and 28 wheels, because of their shape, require specially designed adaptors.

6.16 Type 27A Wheels

Type 27A cutting-off wheels are designed to be mounted by means of flat non-relieved flanges, having matching bearing surfaces not less than one-fourth the wheel diameter. See Illustration No. 77.

6.16 Type 27A Wheels

Type 27A wheels are designed for cutting-off on specially designed machines to provide side relief or clearance when used.

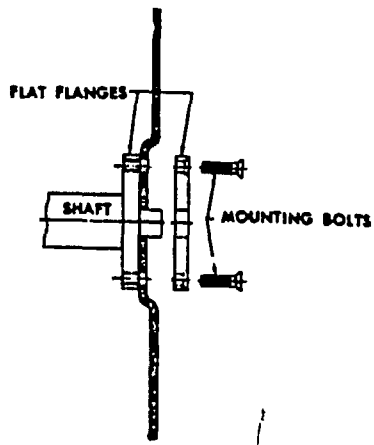


ILLUSTRATION No. 77

The Type 27A Wheel is mounted between flat non-relieved flanges of equal bearing surfaces.

6.17 Type 2 Cylinder Wheels

Type 2 Cylinder wheels have diameter, wheel thickness and rim thickness dimensions. The wheel is mounted on the diameter with grinding performed on (wall) rim. The wheel is chucked or cemented directly to the machine face plate which is securely attached to machine spindle. The machine face plate shall be flat, concentric and at 90 degree angle as mounted to machine spindle. (See section 3 page 20, Table 2 page 25 for minimum thickness of machine face plate.) Cylinder wheels shall be used only on machines equipped with band type safety guards that conform to general specifications outlined in section 4.11 and 4.12 page 40.

6.17 Type 2 Cylinder Wheels

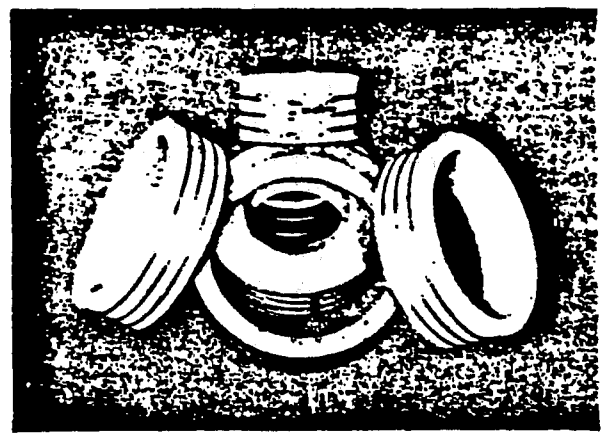


ILLUSTRATION No. 78
Examples of Type 2 cylinder wheels.

6.18 Segments

Segments individually chucked in suitable holding mechanisms to form a grinding unit shall be mounted in a manner prescribed by manufacturer of the chucking device. The safety guard should conform to that used for Cylinder Wheels, see section 6.17 and specifications outlined in section 4.11 and 4.12 page 40.

6.18 Segments

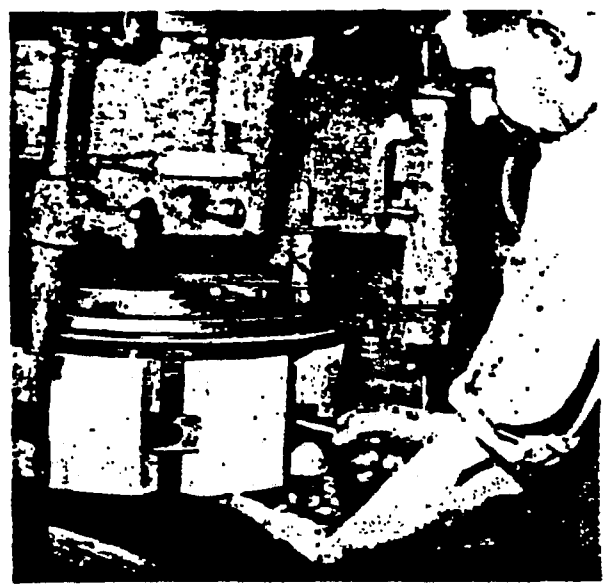


ILLUSTRATION No. 79
A segmental wheel assembly.

CODE REGULATIONS
Section 7
SPEEDS

7.1 Standard Speeds

7.1.1 STANDARD MAXIMUM SPEEDS
The maximum operating speed of each wheel shall be established by the wheel manufacturer. Table 20 page 59 indicates maximum surface feet per minute (SFPM) for various classes of wheels. (See Sec. 1 page 1.)

The number of revolutions per minute may be increased as the diameter of a wheel is reduced through wear, provided the original surface feet per minute (SFPM) is never exceeded. (The speed table on page 86 will be helpful in converting RPM to SFPM.) It shall be the user's responsibility not to exceed these maximum operating speeds.

7.1.2 MACHINE BUILDER'S RESPONSIBILITY

All wheels classified for use under Table 20 page 59 of this Code shall be used on grinding machines designed and equipped in accordance with the following Code sections:

- **a. Sec. 3 page 20—General Machine Conditions**
- **b. Sec. 4 page 27—Safety Guards**
- **c. Sec. 5 page 42—Flanges**

7.1.3 WHEEL USER'S RESPONSIBILITY

All grinding wheels shall be used in conformance with instructions given in:

- **a. Sec. 1 page 1—Definitions**
- **b. Sec. 3 page 20—General Machine Conditions**
- **c. Sec. 4 page 27—Safety Guards**
- **d. Sec. 5 page 42—Flanges**
- **e. Sec. 6 page 52—Mounting**
- **f. Sec. 7 page 58—Speeds**
- **g. Sec. 9 page 66—General Operating Rules**

and shall be handled, stored and inspected in accordance with Section 2 page 16.

Grinding wheels used at speeds higher than those shown in Table 20 page 59 shall be subject to the additional requirements outlined in Section 8 page 62 Special Speeds.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 7
Speeds

7.1 Standard Speeds

7.1.1 STANDARD MAXIMUM SPEEDS

The maximum operating speeds established in Table 20 page 59 have proven satisfactory for the wheels as classified.

Under no condition should a wheel be operated faster than the maximum operating speed established by the manufacturer. This is the responsibility of the wheel user.

The maximum operating speed as determined by the manufacturer is dependent on the wheel shape and strength. The strength of a bonded abrasive wheel may be defined as the ability of the wheel to withstand rotational stress.

The maximum operating speed is not necessarily the most efficient grinding speed. Better results are frequently obtained at lower than maximum operating speeds.

7.1.2 MACHINE BUILDER'S RESPONSIBILITY

The repeated references to other applicable Code Sections and Regulations are important. All designers of grinding machinery should be familiar with these sections. Their proper application has a direct relationship to the safe use of grinding wheels.

7.1.3 WHEEL USER'S RESPONSIBILITY

The repeated references to other applicable Code Sections and Regulations are important. All users of grinding wheels should be familiar with these sections. Their proper application has a direct relationship to the safe use of grinding wheels.

STANDARD MAXIMUM SPEEDS IN SURFACE FEET PER MINUTE

Classification Number	Types of Wheels (See Section 1 for Definitions)	Inorganic Bonds			Organic Bonds		
		Low Strength	Medium Strength	High Strength	Low Strength	Medium Strength	High Strength
		OPERATING SPEED SHALL NOT EXCEED:					
		SFPM	SFPM	SFPM	SFPM	SFPM	SFPM
1	Type 1—Straight Wheels—except classifications 6, 7, 9, 10, 11, 12 and 13 below. Type 4*—Taper Side Wheels Types 5, 7, 20, 21, 22, 23, 24, 25, 26 Recessed, Dovetailed and/or relieved wheels. (Except Classification 7 below.) Type 12—Dish Wheels Type 13—Saucer Wheels Types 16, 17, 18, 19—Cones and Plugs	5,500	6,000	6,500	6,500	8,000	9,500
2	Type 2—Cylinder Wheels including plate mounted, inserted nut and projecting stud—Segments	5,000	5,500	6,000	5,000	6,000	7,000
3	Cup Shape Tool Grinding Wheels (For Fixed Base Machines) Type 6—Straight Side Cups Type 11—Flaring Cups	4,500	5,000	6,000	6,000	7,500	8,500
4	Cup Shape Snagging Wheels (For Portable Machines) Type 6—Straight Side Cups Type 11—Flaring Cups	4,500	5,500	6,500	6,000	8,000	9,500
5	Abrasive Discs: Plate Mounted Inserted Nut and Projecting Stud: Solid or Segmental	5,500	6,000	6,500	5,500	7,000	8,500
6 †	Reinforced Wheels Type 1 Max. Dia. 4" Max. Thickness ¼"	X	X	X	9,500	12,500	16,000
	Max. Dia. 10" Max. Thickness ½"	X	X	X	9,500	12,500	14,200
	All Other Dias. and Thicknesses	X	X	X	9,500	12,500	12,500
	Reinforced Wheels—Types 27 and 28 Max. Dia. 9" Max. Thickness ⅝"	X	X	X	9,500	12,500	14,200
	Max. Dia. 9"—Over ⅝" Thick	X	X	X	X	9,500	11,000
7	Type 1 Wheels for Bench and Pedestal Grinders and Types 1 and 5 for Surface Grinders in following sizes only. 7" dia. up to 2" thick and up to 2" hole	5,500	6,325	6,600	6,500	8,000	9,500
	8" dia. up to 2" thick and up to 2" hole	5,500	6,325	7,550	6,500	8,000	9,500
8	Diamond Wheels Cutting-Off—IAI, IAIR, IAIRS**	X	X	16,000	X	X	16,000
	Metal Bond	X	X	12,000	X	X	X
	Resin Bond	X	X	X	X	X	9,500
	Vitrified Bond	X	X	6,500	X	X	X
9	Cutting Off Wheels Type 1 and 27A Larger than 16" dia., Including Reinforced Organic	X	X	X	9,500	12,000	14,200
10	Cutting Off Wheels Type 1 and 27A 16" dia., and Smaller—Including Reinforced Organic	X	X	X	9,500	12,000	16,000
11	Thread and Flute Grinding Wheels	8,000	10,000	12,000	8,000	10,000	12,000
12	Crankshaft and Camshaft Grinding Wheels	5,500	8,000	8,500	6,500	8,000	9,500
13	Type 1 Snagging Wheels 16" dia. and Larger, Organic Bond, Non Reinforced Used on Specially Designed Swing Frame and Mechanical Grinders	X	X	X	X	X	12,500
14	Internal Wheels—Type 1 and 5 Maximum dia. 6"	5,500	8,000	8,500	6,500	8,500	9,500

*Non-standard Shape †Classification 6 excludes cut-off wheels.

**Standard Diamond Wheel Shapes. For definition see ANSI B74.1, Identification code for Diamond Wheel Shapes.

Note: For converting surface feet per minute (SFPM) to revolutions per minute (RPM) see Conversion Table page 86.

Note: See section 3, page 20 — General Machine Conditions; Section 4, page 27 — Safety Guards; section 5, page 42 — Flanges.

7.1.4 WHEEL MANUFACTURER'S RESPONSIBILITY

All wheels shall be tested in accordance with Table 21. In some cases the shape, size, construction, or use conditions of the wheel make the speed test impractical or unnecessary. Examples of wheels which need not be speed tested are:

Wheels less than 6" diameter;
Diamond wheels, metal and organic bonds;
Ball grinding wheels;
Segments, segmental disc wheels and disc wheels;
Regulating wheels (for centerless type grinders);
Mounted wheels.

7.1.4 WHEEL MANUFACTURER'S RESPONSIBILITY

The test speed subjects a grinding wheel to significantly greater forces than does the safe maximum operating speed. This test establishes an adequate factor of safety provided the wheels are used in accordance with safe practices outlined in this Code and have not been altered, damaged or abused after speed testing.

The speed test does not justify operation of the wheel at higher than the safe maximum operating speed established by the wheel manufacturer. The maximum safe speed should never be exceeded because the additional tested strength covers other normal grinding stresses.

TABLE 21

WHEEL MANUFACTURERS TESTING SPEEDS

Class of Wheel	Operating Speed Surface Feet Per Minute	Minimum Test Factor*
Cutting-off Wheels	All speeds	1.20
All Bonds and Wheel Types (Except Cutting-off wheels)	Up to 5,000	1.25
All Bonds and Wheel Types (Except Cutting-off wheels)	Faster than 5,000	1.50

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

7.2 Speed Check of Machines — User's Responsibility

The speed of the wheel spindle on grinding machines shall be frequently checked with suitable instruments, by competent user personnel, to make sure that the speed is correct for the size and type of wheels used. A suitable record of such speed checks should be maintained by the user.

7.2 Speed Check of Machines — User's Responsibility

It is of special importance that portable air grinders should be checked to be sure that proper air pressure is maintained and that the machine governor mechanism is clean, in good operating condition, and functioning properly. This reference to air grinders is not intended to overlook the necessity for a regular check of the speed of wheel spindles on all types of grinding machines. The user should assign this responsibility to competent personnel using equipment properly designed for such speed check purposes. The user should also keep a regular inspection record of such speed checks.

7.3 Speed Adjustment Control — User's Responsibility

If the speed of the machine wheel spindle is adjustable to compensate for wheel wear, the speed adjustment shall be under the supervision and control of competent and authorized persons only.

7.3 Speed Adjustment Control — User's Responsibility

Certain machines are designed with adjustable speeds to permit maintenance of efficient surface speeds by increasing the wheel spindle speed to compensate for wheel wear. Special care must be exercised under proper supervision, to be certain that the present operating speed of the machine conforms to and does not exceed the peripheral speed in surface feet per minute as established for a new wheel. (See conversion table, page 86.)

CODE REGULATIONS
Section 8
SPECIAL SPEEDS

8.1 Introduction

This section of the Code is designed to recognize the importance of continuing development in the science of grinding with bonded abrasive wheels. In such development it is well to restate the fact that the maximum safe operating speed marked on a wheel is not necessarily the most efficient grinding speed. Better results may be obtained at lower speeds. Constant reference to and a knowledge of the regulations of this Code will be helpful in planning the development of new equipment.

This section also defines the responsibilities of the Wheel Manufacturers; the Machine Builders (including one who converts, changes or otherwise alters a grinding or cut off machine from the design or purpose originally supplied by the builder); and the Users of wheels and machines. It shall be understood that these areas of responsibility apply to those wheels and machines operated at Special Speeds in excess of those listed in Table 20 page 59.

8.2 Requirements for Special Speeds

Wheels used on special applications at speeds higher than those listed in Table 20 (Section 7 page 58) shall only be used subject to the following three conditions: (A), (B) and (C), on effectively guarded, fully protected machines.

8.2.1 CONDITION A—THE WHEEL MANUFACTURER

The wheel manufacturer shall make certain that the wheels are of adequate strength, have been tested at a suitable overspeed in accordance with Section 7.1.4 page 60, and bear the wheel manufacturer's approval of the higher speed. See Section 1.2.17 page 4 for definition of "The Wheel Manufacturer".

Explanatory Information
(NOT PART OF ANSI CODE)
Section 8
Special Speeds

8.1 Introduction

The grinding or cutting-off operations performed with bonded abrasive wheels on many different types of machines are extremely important factors in the industrial productivity of our country. It is essential that wheels be operated and that machines be designed in accordance with the sections of this Code and that the users of wheels and machines observe the safety measures applicable to them in this Code. The cooperation of all three parties should materially aid in promoting the safe use, care and protection of abrasive wheels.

8.2 Requirements for Special Speeds

When wheels are used at speeds in excess of standard speeds listed in Table 20 page 59 extra precautions should be observed to assure safe operation of the abrasive wheel.

8.2.1 CONDITION A—THE WHEEL MANUFACTURER

The wheel manufacturer should do such testing as he deems necessary to establish an adequate factor of safety before approving the wheel for the higher speed. The wheel should be marked that it has been approved for high speed application under specific conditions of use.

8.2.2 CONDITION B—THE MACHINE BUILDER

The machine builder shall make certain at time of manufacture that the machine is of suitable design and adequately guarded for the operation in question. See Section 1.2.18 page 5 for definition of "The Machine Builder."

It shall be the machine builder's responsibility to consult with a wheel manufacturer to determine that a wheel for the special speed application can be manufactured and tested in accordance with the requirements established in Section 7.1.4 page 60.

8.2.3 CONDITION C—THE USER

The machine user shall make certain that the machine is operated with approved safety guards and that the machine is maintained in a satisfactory condition, as defined in Sections 3 and 4, page 20 and page 27. See Section 1.2.19 page 5 for definition of "the User".

8.3 Wheel Manufacturer's Responsibility

It shall be the wheel manufacturer's responsibility to speed test wheels required for special speeds and so identify them as follows:

8.3.1 MANUFACTURER'S TEST

It shall be the wheel manufacturer's responsibility to speed test wheels in accordance with Table 21 page 60 to determine their suitability for safe application. Some wheels that need not be speed tested are as listed in Section 7.1.4 page 60.

8.3.2 IDENTIFICATION

It shall be the wheel manufacturer's responsibility to identify wheels which may be run at special speeds.

8.4 Machine Builder's Responsibility

It shall be the responsibility of the machine builder to design and construct those machine components which are concerned with the proper and safe operation of the grinding or cutting-off wheels for the speed and the type of operation for which the machine is intended. Particular attention shall be given to the design of the wheel safety guards, wheel flanges and wheel mounting spindle as indicated in the following paragraphs:

8.2.2 CONDITION B—THE MACHINE BUILDER

The machine builder should be sure the components of the machine such as spindle, bearings, guards, flanges, horsepower, etc., are adequate for the grinding operation in question.

Because of design and composition limitations, certain grinding wheels will not be suitable for special speed operations. It is, therefore, important that the machine builder and grinding wheel manufacturer cooperate to make certain a wheel of adequate strength can be manufactured for the operation in question.

8.2.3 CONDITION C—THE USER

The minimum guard requirements of Section 4 page 27 should be met. Where guard data for the wheel size and operating speed to be used is not available, requirements should be established by actual test. The machine user should also maintain machines in good condition for continuing safety (see Section 3 page 20).

8.3 Wheel Manufacturer's Responsibility

It is important that wheels used at special speeds be tested and identified for use at the proper maximum operating speed.

8.3.1 MANUFACTURER'S TEST

Accepted industry practice for speed testing grinding wheels is outlined in Section 7.1.4 page 60.

8.3.2 IDENTIFICATION

Wheels approved for special speed applications should have the special speed indicated on the wheels, blotters, accompanying tags, stickers or container.

8.4 Machine Builder's Responsibility

The machine builder should decide upon the fitness of the machine for the proposed operation. If it becomes necessary or desirable to convert, change or alter the machine from the design or purpose for which it was originally made by the builder it is important that the components involved with the use of the abrasive wheel be designed in accordance with the appropriate sections of this Code.

8.4.1 GENERAL MACHINE CONDITIONS

If an existing machine is to be adapted for use at a special speed, the general machine conditions of Section 3 page 20 shall be observed and all component parts of the grinding machine shall be checked and, if necessary, modified or adjusted prior to operating at the special speed.

8.4.2 SAFETY GUARDS

Grinding and cutting off machines shall be equipped with safety guards in conformance with the requirements contained in Section 4 page 27 when applicable. When the operation is beyond the conditions for which guards in Section 4 page 27 were designed, the machine builder shall establish by test or calculation the adequacy of the guard.

8.4.3 FLANGES

Flanges shall be of such design as to satisfactorily transmit the driving torque from the spindle to the grinding wheel and conform to all requirements of Section 5 page 42.

8.5 User Responsibility

The user shall be responsible for the proper handling, storage, and inspection of grinding wheels after receipt, in accordance with the requirements of Section 2 page 16.

It shall be the responsibility of the user to maintain his grinding equipment in a safe operating condition at all times. Rules of safe operation of this equipment submitted by the machine builder shall be observed, as well as those rules specified in other sections of this Code.

When an existing machine is altered by the user to operate at special speeds, the user shall assume all of the responsibility of a machine builder as outlined in Section 3 page 20.

The user shall fully inform all operating personnel that only wheels identified for operation at special speeds shall be used and that at no time shall the maximum speed of the wheel be exceeded.

Protection to operating personnel, as well as adjacent areas, shall be maintained at all times.

8.4.1 GENERAL MACHINE CONDITIONS

It is important to remember that the grinding wheel is only one part of the grinding operation. When the speed of the wheel is increased, changes may be necessary in the machine (bearings, table traverse rates, guards, sensing devices, power, etc.), so that the entire unit will operate safely at the special speed.

8.4.2 SAFETY GUARDS

Guards built in conformance with instructions contained in Section 4 page 27 will have a safety factor which satisfies good engineering practice. When speeds in excess of those shown in Section 4 page 27 are used, either a stronger guard material or thicker guard members must be used. The increase in strength should be sufficient to maintain the proper safety factor.

8.4.3 FLANGES

The driving torque is transmitted from the spindle through the flange to the wheel. Therefore, the minimum bearing area specified in Section 5 page 42 may be inadequate in these cases. The machine builder should determine by test that his design is adequate to perform its intended operation.

8.5 User Responsibility

The maximum operating speed as determined by the manufacturer is dependent on the wheel shape and strength. The strength of a bonded abrasive wheel may be defined as the ability of the wheel to withstand rotational stress.

Under no condition should a wheel be operated faster than the maximum operating speed established by the manufacturer. This is the responsibility of the wheel user.

It is an important responsibility of the user to maintain grinding machines in a safe operating condition. Machine builders usually issue rules for the safe operation of their equipment or fasten warning signs to their machines calling attention to areas that could be unsafe if the rules or signs are disregarded. The user should recognize the importance of instructing personnel concerning these safety warnings.

Furthermore, grinding machines are usually designed to perform certain specific operations. It is strongly recommended that the machines be used only on those types of operations for which they are designed.

8.5.1 HANDLING, STORAGE AND INSPECTION

It shall be the user's responsibility to adhere to all parts of Section 2 page 16.

8.5.2 GENERAL MACHINE CONDITIONS

It shall be the user's responsibility to see that the machine is maintained in such condition that all requirements of Section 3 page 20 will continue to be adequate.

8.5.3 SAFETY GUARDS

It shall be the user's responsibility to maintain the guards and other protection devices in good condition. The user shall also make provision for adequate protection of the personnel in the operating area. (See Section 4.5.2 page 32.)

8.5.4 FLANGES

It shall be the user's responsibility to maintain flanges in good condition according to Section 5 page 42.

8.5.5 MOUNTING

It shall be the users responsibility to see that all rules of Section 6 page 52 which apply to the particular operation are observed.

8.5.6 GENERAL OPERATING RULES

It shall be the user's responsibility to see that all General Operating Rules (see Section 9 page 66) that are applicable to the special high speed operation are observed. It shall also be the user's responsibility to follow any special operating instructions furnished by the machine builder.

8.5.1 HANDLING, STORAGE AND INSPECTION

It is important that all wheels be handled and stored correctly, and inspected carefully. It is recommended that wheels for special high speeds be stored in a separate or special area so that personnel will be aware they are for special applications.

8.5.2 GENERAL MACHINE CONDITIONS

It is important that the maintenance of the machine be such that the equipment remains in the same condition as originally furnished.

8.5.3 SAFETY GUARDS

When operating at special high speeds, the pieces of an accidentally broken wheel will have more force than those broken at lower speeds. It is, therefore, imperative that all guards and protective devices be maintained in good condition and correctly replaced when removed. It is also important that adjacent personnel be protected by barriers, booths or segregated work areas.

8.5.4 FLANGES

A primary function of flanges is to transfer the machine power to the abrasive wheel and grinding operation. It is therefore important that flanges be maintained as defined in Section 5 page 42. Flanges which are worn, warped or sprung can contribute to wheel breakage.

8.5.5 MOUNTING

It is extremely important that all wheels, regardless of speed of operation or the type of machine involved, be inspected before mounting (see Section 6.1 page 52) and that all rules for safe mounting practices be observed.

8.5.6 GENERAL OPERATING RULES

In some instances the machine builder will provide special operating instructions and/or place warning signs on his machines. These, as well as the general operating rules listed in Section 9 page 66, should be followed to insure a safe grinding operation.

CODE REGULATIONS
Section 9
GENERAL OPERATING RULES

9.1 Users' Responsibility

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

The grinding wheel operator shall be fully instructed in the use, care and protection of grinding wheels as defined in this Code.

9.2 Investigation After Breakage

If a grinding wheel is broken, a careful investigation shall be made by the user to determine and correct the cause.

9.3 Wheel Speed

Before mounting a wheel, it shall be determined that the machine speed does not exceed the maximum safe operating speed for the wheel as established by the wheel manufacturer. Under no circumstances shall a wheel be mounted on a machine on which the RPM exceeds the maximum safe RPM recommended for the wheel.

9.4 Replacing Safety Guard

After mounting a wheel, care should be taken to see that the safety guard is properly positioned before starting the wheel.

9.5 Starting the Wheel

All grinding wheels shall be run at operating speed with safety guard in place or in a protected enclosure for at least one minute before applying work, during which time no one shall stand in front of or in line with the wheel. (See Section 4 page 27.)

9.6 Balance

Wheels should be rebalanced by the user when and as often as necessary.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 9
General Operating Rules

9.1 Users' Responsibility

More efficient grinding and a reduction of wheel breakages will result when the user insists that only personnel with mechanical aptitude and a good knowledge of the contents of this Code be assigned to the mounting, care, inspection and operation of grinding wheels and machines.

9.2 Investigation After Breakage

Should a grinding wheel be broken in service, an investigation must be made immediately by the user to be sure that any conditions at variance with the requirements contained in this code and state laws are corrected. This will help determine the cause of the breakage so that a recurrence of the trouble can be prevented. Assistance in such an investigation may be obtained from the machine maker and the wheel manufacturer.

9.3 Wheel Speed

On some variable speed machines, spindle speed is governed by an interlock with the guard or some other device that allows the RPM to be increased as wheel diameter decreases. Care must be exercised to determine that such devices are in good working order, to prevent the possibility of over-speeding and wheel breakage.

9.5 Starting the Wheel

This regulation provides for the safety of the operator and others should there have been damage to the wheel or malfunction of the machine from any cause.

9.6 Balance

Out of balance wheels set up vibrations which can result in marred work surfaces, machine damage and also cause stresses which could result in wheel failure. On most machines, the wheels can be rebalanced by truing.

9.7 Truing and Dressing

Out of truth wheels shall be trued by a competent person. Wheels out of balance which cannot be balanced by truing or dressing, shall be removed from the machine. (See Fig. No. 52.)

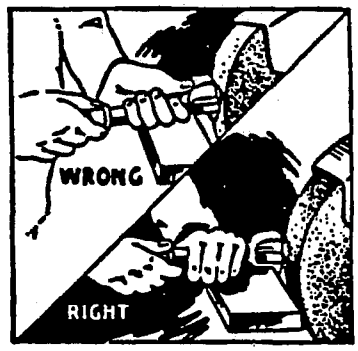


FIGURE NO. 52
The correct and incorrect method of dressing a wheel.

9.8 Wet Grinding

When shutting down a wet grinding operation, the coolant should first be shut off and the wheel allowed to rotate until coolant has been spun out.

The strength of organic bonded wheels can be affected by coolants. Therefore, the concentration and alkalinity of the coolant should be checked regularly and adjusted accordingly.

9.9 Side Grinding

Side grinding shall only be performed with wheels designed for this purpose. 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.

9.10 Lubrication

The machine spindle bearings shall be properly lubricated to prevent heating which might cause damage to the grinding wheel.

9.7 Truing and Dressing

Truing a wheel corrects any out of truth condition in the wheel.

Dressing a wheel alters its cutting action or shape.

A common method of dressing a wheel used in off-hand operations is shown in Fig. No. 52. Note that the dresser should be supported on a work rest, and that the work rest should be adjusted away from the wheel so that the heel of the dresser may hook over the work rest and be guided by it as the dresser is moved evenly across the wheel face.

9.8 Wet Grinding

Uneven accumulation of coolant can cause excessive out of balance in a wheel.

The concentration and alkalinity of coolants determines the degree to which they affect organic bonded wheels. To avoid injurious affect upon these wheels, it is important to follow the directions of the coolant manufacturer.

9.9 Side Grinding

Peripheral grinding wheels should not be used for side grinding because of insufficient support to withstand the pressures exerted. Wheels designed for side grinding such as abrasive discs are mounted with one flat side against a suitable steel machine plate to safely withstand side pressure.

9.10 Lubrication

Improperly lubricated spindle bearings will cause the mounting spindle to expand because of heat generated thus exerting a stress in the arbor hole area.

9.11 Check for Wear

All spindles, adaptors, flanges or other machine parts on which wheels fit, shall be periodically inspected and maintained to size. **(See Section 3 page 20.)**

9.12 Work Rests

On offhand grinding machines (see sec. 1.3.6, page 6) work rests shall be used to support the work. They shall be of rigid construction and designed to be adjustable to compensate for wheel wear.

Work rests shall be kept adjusted closely to the wheel with a maximum opening of ⅛" to prevent the work from being jammed between the wheel and the rest, which may cause wheel breakage. The work rest shall be securely clamped after each adjustment. The adjustment shall not be made with the wheel in motion.

9.13 Large Hole Inorganic Bonded Wheels

Large hole inorganic bonded wheels (those with hole in excess of ¼ of the wheel diameter) should not be used on snagging or other heavy duty operations.

9.12 Work Rests

ILLUSTRATION NO. 80

This floor stand grinder has a work rest which is properly adjusted. Note the provisions for work-rest adjustment.

9.13 Large Hole Inorganic Bonded Wheels

Since the strength of a grinding wheel decreases as its diameter approaches its hole size, it is not advisable to use large hole inorganic wheels for rough grinding operations since ample cross section required for strength is not maintained throughout the life of the wheel.

The fact that l a r g e hole inorganic bonded wheels cannot be manufactured with reinforcing media near the hole makes them unsuitable for rough grinding operations.

CODE REGULATIONS
Section 10
MOUNTED WHEELS

10.1 Maximum Safe Operating Speed

The maximum safe operating speed for mounted wheels shall be determined by the following four factors:

1. **Shape and size of the mounted wheel.**
2. **Size of mandrel.**
3. **Overhang of mandrel. (See Fig. 53.)**
4. **Wheel specifications.**

Taking the first three factors noted above into consideration, look up the maximum safe operating speed in the corresponding Tables 23 through 31 page 72 through page 85. The overhangs indicated on the charts are for unthreaded mandrels. Threaded mandrels will take the same speed as the ½ inch overhang of the unthreaded mandrel.

Tables 23 through 31 page 72 through page 85 are set up for medium and high strength wheels. If the specification indicates a low strength wheel consult the wheel manufacturer for speeds. In no case shall the maximum operating speed recommended by the manufacturer be exceeded.

Exception: Under certain ideal conditions of truth and balance where the operation is fully guarded, it may be permissible to operate at a speed higher than the indicated maximum safe operating speed, provided the speed shown in section 10.2 page 70, is not exceeded.

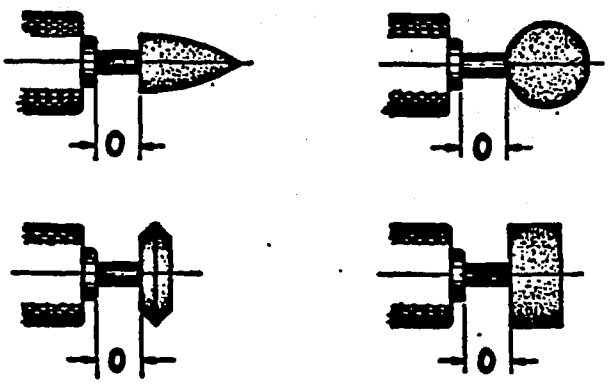


FIGURE NO. 53
Sketches defining overhang dimension "O" See Tables 23 through 31.

Explanatory Information
(NOT PART OF ANSI CODE)
Section 10
Mounted Wheels

10.1 Maximum Safe Operating Speed

Maximum safe speeds for mounted wheels are generally limited by the size and shape of the wheel, the mandrel material and diameter, and the distance from the mounting chuck to the abrasive body (overhang).

Due to the size of some mounted wheels, it is necessary to reduce the size of the mandrel where it enters the wheel. These are called tapered mandrels. It will be noted however, that the resistance to bending or whipping due to speed is dependent on the size of the mandrel at the point where it is chucked, so that the size of the mandrel for speed purposes will be the diameter of the chucked section.

As threading reduces the effective diameter of the mandrel, mounted wheels with threaded mandrels require lower operating speeds than the same size unthreaded mandrels. Because these mandrels are usually short and held closely in the chuck, the tables give only the speeds for ½ inch overhang.

Tables 23 to 31 page 72 through page 85 indicate the maximum operating speeds for various standard mounted wheels in combination with several standard mandrel sizes and various overhangs. For many common combinations, the maximum operating speeds can be read directly from the tables. For intermediate wheel and mandrel sizes and overhangs not shown the maximum operating speed can be determined by interpolation.

If it is found that the desired combination of conditions would result in operation beyond the maximum speed, a slight change in any one of the following conditions may be all that is necessary to eliminate the danger of operating over the maximum safe speed. Such corrective steps are:

1. For a given shape, reducing the size of the wheel (either diameter or thickness, or both) will raise the maximum speed.
2. Increasing the diameter of the mandrel will raise the maximum speed.
3. Reducing the overhang (pushing the mandrel back into the chuck) will raise the maximum speed.

10.2 Special Maximum Operating Speed

Table 22 shows the maximum operating speed for various diameters of mounted wheels. This speed shall not be exceeded even though higher speeds than the maximum safe operating speed are used under the exception in Section 10.1 page 69.

TABLE 22
SPECIAL MAXIMUM OPERATING SPEEDS FOR MOUNTED WHEELS
(See Exception Sec. 10.1 page 69.)

Outside Diameter of Wheel Inches	Maximum Speed (R.P.M.)
1/8	305,500
1/4	152,800
5/16	122,200
3/8	101,900
7/16	87,310
1/2	76,390
5/8	61,120
11/16	55,560
3/4	50,930
13/16	47,010
7/8	43,650
15/16	40,740
1	38,200
1 1/8	33,950
1 1/4	30,560
1 3/8	27,780
1 1/2	25,470
1 5/8	23,520
1 3/4	21,830
2	19,100

10.3 Work Pressure

Pressure between the wheel and the work shall not be so heavy that excessive springing of the mandrel will result.

10.2 Special Maximum Operating Speed

Tables 23 to 31 page 72 through page 85 are based on the several factors which affect the maximum safe operating speed, however, there is a limiting speed beyond which no mounted wheel should be run due to the inherent strength of the abrasive body itself. This is the speed set up in Table 22. No matter what factors of wheel size, shape or specification, mandrel size, overhang, or machine conditions are changed, the speeds in Table 22 shall not be exceeded.

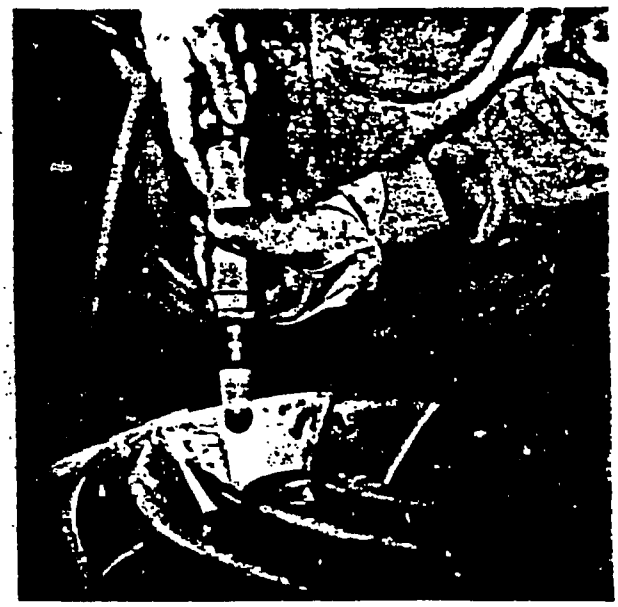


ILLUSTRATION No. 81
A mounted wheel being used to finish a die.

10.3 Work Pressure

Work pressure, if excessive, can be the cause of trouble and a source of danger, through bending or fracture of the mandrel. If there is burning of the work or excessive reduction in mandrel speed, it is quite likely that excessive pressure is being used. A freer cutting wheel specification may permit the desired rate of stock removal without excessive pressure.

TABLES OF MAXIMUM OPERATING SPEEDS
FOR
MOUNTED WHEELS

TABLE 23

GROUP W — (PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 3/32" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
W 141	1/32	1/32	93,750	53,250	37,500	25,500	16,500
W 142	1/32	1/4	93,750	53,250	37,500	25,500	16,500
W 143	1/8	1/8	93,750	53,250	37,500	25,500	16,500
W 144	1/8	1/4	93,750	53,250	37,500	25,500	16,500
W 145	1/8	3/8	88,500	49,500	35,250	24,000	15,750
W 146	1/8	1/2	81,000	43,750	31,500	22,500	15,000
W 147	3/32	3/32	93,750	53,250	37,500	25,500	16,500
W 148	3/32	1/8	93,750	53,250	37,500	25,500	16,500
W 149	3/32	1/4	90,750	50,250	36,000	24,750	15,750
W 150	1/16	1/16	93,750	53,250	37,500	25,500	16,500
W 151	1/16	1/8	93,750	53,250	37,500	25,500	16,500
W 152	1/16	1/4	83,250	47,250	33,000	23,250	15,000
W 153	1/16	3/8	73,500	42,000	28,500	21,000	13,500
W 154	1/16	1/2	66,000	38,250	25,500	18,750	12,750
W 155	1/64	1/4	78,000	44,250	30,750	21,750	14,250
W 156	1/4	3/32	93,750	53,250	37,500	25,500	16,500
W 157	1/4	1/16	93,750	53,250	37,500	25,500	16,500
W 158	1/4	1/8	93,750	53,250	37,500	25,500	16,500
W 159	1/4	1/16	78,000	44,250	30,750	21,750	14,250
W 160	1/4	1/4	69,000	42,000	27,750	18,750	13,500
W 161	1/4	1/16	66,000	39,750	24,750	17,250	12,750
W 162	1/4	3/8	57,000	34,500	23,250	16,500	11,250
W 165	1/8	1/8	93,000	51,750	37,500	25,500	16,500
W 166	1/8	1/8	84,750	48,750	28,500	19,500	14,250
W 167	1/8	1/4	61,500	39,000	24,750	18,000	12,000
W 168	1/8	1/8	56,250	33,750	22,500	16,500	12,000
W 169	1/8	3/8	48,000	28,500	20,250	15,000	11,250
W 170	1/8	1/2	39,750	26,250	16,500	12,750	9,750
W 171	1/8	3/4	27,750	19,500	13,500	10,500	8,250
W 172	3/8	1/8	85,500	48,750	33,750	24,000	15,000
W 173	3/8	1/8	71,250	46,500	30,000	19,500	12,750
W 174	3/8	1/4	54,000	32,250	21,000	15,000	10,500
W 175	3/8	3/8	41,250	24,000	18,000	12,750	9,750
W 176	3/8	1/2	33,750	21,000	15,750	12,000	9,000

*See Figure 53, Page 69.

TABLE 24

GROUP W — (PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/8" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
W 143	1/8	1/8	105,000	64,500	46,650	32,400	21,370
W 144	1/8	1/4	105,000	64,500	46,650	32,400	21,370
W 145	1/8	3/8	105,000	64,500	46,650	32,400	21,370
W 146	1/8	1/2	105,000	64,500	46,650	32,400	21,370
W 151	3/16	1/8	105,000	64,500	46,650	32,400	21,370
W 152	3/16	1/4	105,000	64,500	46,650	32,400	21,370
W 153	3/16	3/8	80,850	52,500	37,500	26,250	17,620
W 154	3/16	1/2	70,500	45,600	31,500	21,970	15,220
W 157	1/4	1/16	123,000	55,625	47,770	33,150	21,750
W 158	1/4	1/8	105,000	64,500	46,650	32,400	21,370
W 159	1/4	3/16	92,400	57,370	39,370	27,900	18,900
W 160	1/4	1/4	81,370	51,000	34,120	24,000	16,870
W 161	1/4	5/16	77,250	45,970	30,900	22,500	16,120
W 162	1/4	3/8	68,400	42,370	28,870	20,850	15,000
W 163	1/4	1/2	60,000	38,020	26,250	18,750	13,870
W 164	1/4	3/4	45,900	30,000	21,750	15,900	11,850
W 165	5/16	1/16	107,400	62,470	41,250	29,250	20,250
W 166	5/16	1/8	96,970	57,000	35,620	25,120	18,000
W 167	5/16	1/4	75,000	45,750	31,120	22,500	15,750
W 168	5/16	5/16	68,400	41,770	28,650	21,000	15,000
W 169	5/16	3/8	61,650	37,720	27,000	19,870	14,250
W 170	5/16	1/2	52,500	33,000	23,020	16,650	12,600
W 171	5/16	3/4	37,120	25,500	18,750	14,620	10,020
W 172	3/8	1/16	99,370	59,250	41,020	29,250	20,250
W 173	3/8	1/8	87,600	53,250	35,250	24,750	17,250
W 174	3/8	1/4	69,000	41,250	27,750	20,400	15,000
W 175	3/8	3/8	54,000	33,000	24,150	18,000	13,500
W 176	3/8	1/2	45,370	28,500	21,000	15,900	12,150
W 177	3/8	3/4	33,750	23,250	17,620	13,650	10,350
W 178	3/8	1	26,250	18,750	14,250	10,870	8,250

*See Figure 53, Page 69.

TABLE 24 — (Continued)

GROUP W — (PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/8" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
W 181	½	1/16	76,390	55,500	36,750	25,500	17,850
W 182	½	⅛	73,500	43,650	29,100	20,770	15,450
W 183	½	¼	51,750	31,870	22,500	17,250	12,900
W 184	½	⅜	41,020	26,400	19,500	15,000	11,400
W 185	½	½	34,500	22,500	16,870	13,120	9,900
W 186	½	¾	26,250	17,400	12,750	9,750	8,020
W 187	½	1	20,620	13,870	10,120	7,870	6,370
W 190	⅝	1/16	61,120	48,000	31,500	22,650	16,870
W 191	⅝	⅛	58,870	34,500	25,120	18,900	14,250
W 192	⅝	¼	43,120	27,370	19,870	15,220	11,620
W 193	⅝	⅜	32,250	23,020	16,500	12,520	9,750
W 194	⅝	½	29,400	19,120	13,500	10,500	8,250
W 195	⅝	¾	22,120	14,250	10,120	7,650	6,150
W 196	⅝	1	17,620	11,620	8,100	6,150	5,100
W 199	¾	1/16	50,930	44,770	30,000	21,750	15,750
W 200	¾	⅛	50,930	33,520	23,850	17,850	13,350
W 201	¾	¼	38,250	24,370	17,400	13,270	9,970
W 202	¾	⅜	30,600	19,500	13,500	10,120	7,800
W 203	¾	½	25,500	15,900	10,870	8,250	6,600
W 204	¾	¾	18,900	12,000	8,400	6,220	5,250
W 210	⅞	1/16	43,650	35,250	25,720	18,900	14,320
W 211	⅞	⅛	43,650	27,900	20,400	15,820	12,220
W 212	⅞	¼	33,750	20,400	14,400	11,020	9,000
W 213	⅞	⅜	27,000	16,870	11,250	8,250	6,600
W 215	1	⅛	38,200	24,900	18,000	13,870	10,500
W 216	1	¼	30,520	18,600	12,750	9,520	7,500

*See Figure 53, Page 69.

TABLE 25

GROUP W — (PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 3/16" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
W 158	¼	1/8	121,500	66,750	48,000	36,000	26,250
W 159	¼	3/16	112,500	63,000	47,250	34,650	25,120
W 160	¼	¼	103,500	60,000	44,250	33,000	24,000
W 161	¼	5/16	93,750	58,120	42,750	31,870	22,500
W 162	¼	⅜	89,250	56,250	41,250	30,000	21,750
W 163	¼	½	78,750	52,500	39,000	28,870	20,620
W 164	¼	¾	62,250	39,750	30,000	23,250	16,500
W 166	5/16	1/8	118,500	65,250	47,250	35,250	25,500
W 167	5/16	¼	100,500	58,500	43,500	32,620	23,250
W 168	5/16	5/16	93,000	57,000	42,000	30,750	22,120
W 169	5/16	⅜	87,370	55,350	40,870	28,880	21,000
W 170	5/16	½	76,500	47,250	34,500	25,500	18,750
W 171	5/16	¾	57,000	37,500	27,750	21,750	15,750
W 173	⅜	1/8	101,900	65,250	46,500	34,500	24,750
W 174	⅜	¼	98,850	57,750	42,750	32,250	23,250
W 175	⅜	⅜	81,750	50,620	36,750	27,750	20,250
W 176	⅜	½	66,750	43,120	31,350	23,620	17,400
W 177	⅜	¾	54,000	36,000	26,250	20,250	15,000
W 178	⅜	1	42,000	29,250	22,500	17,250	12,900
W 182	½	1/8	76,390	56,250	39,870	29,250	21,750
W 183	½	¼	75,000	47,400	33,370	24,900	18,750
W 184	½	⅜	57,750	39,750	29,250	21,750	15,750
W 185	½	½	49,870	33,750	25,500	19,500	14,620
W 186	½	¾	39,000	28,120	21,370	15,750	12,000
W 187	½	1	32,250	23,250	18,370	13,500	10,500
W 188	½	1½	22,870	17,620	13,870	11,250	.....
W 189	½	2	17,250	13,500	10,500	8,620	.....
W 191	⅝	1/8	61,120	51,370	36,370	27,000	20,250
W 192	⅝	¼	61,120	43,500	30,750	23,400	18,000
W 193	⅝	⅜	52,500	34,870	25,500	18,750	15,000
W 194	⅝	½	44,400	31,120	23,400	18,000	13,500

*See Figure 53, Page 69.

TABLE 25 — (Continued)

GROUP W — (PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 3/16" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
W 195	⅝	¾	34,500	24,000	18,370	14,250	10,500
W 196	⅝	1	25,870	18,900	15,000	11,620	9,370
W 197	⅝	2	14,770	11,770	8,700	7,270	.....
W 200	¾	⅛	50,930	48,750	33,750	25,500	19,500
W 201	¾	¼	50,930	37,500	27,900	21,370	16,500
W 202	¾	⅜	45,750	31,500	24,370	18,000	13,870
W 203	¾	½	39,750	27,370	20,620	15,900	12,000
W 204	¾	¾	29,250	20,250	15,000	12,000	9,370
W 205	¾	1	24,750	17,250	12,750	10,500	8,620
W 206	¾	1¼	19,500	14,250	11,620	9,000	6,750
W 207	¾	1½	16,500	12,370	9,750	7,870	.....
W 208	¾	2	12,750	9,370	7,500	6,000	.....
W 211	⅞	⅛	43,650	43,650	31,870	24,000	18,370
W 212	⅞	¼	43,650	34,500	25,870	19,870	14,620
W 213	⅞	⅜	42,370	28,120	21,370	16,500	12,370
W 215	1	⅛	38,200	38,200	31,120	23,620	18,000
W 216	1	¼	38,200	33,750	24,750	19,120	14,250
W 217	1	⅜	38,200	27,000	19,870	15,750	12,000
W 218	1	½	32,700	22,120	16,870	12,900	10,350
W 219	1	¾	25,120	17,620	12,900	9,900	8,400
W 220	1	1	19,500	14,250	11,250	8,620	7,120
W 221	1	1½	13,120	9,370	7,120	6,000	.....
W 222	1	2	9,000	7,120	5,620	4,870	.....
W 225	1¼	¼	30,560	28,870	21,220	16,270	12,300
W 226	1¼	⅜	30,560	22,120	16,350	12,750	10,270
W 227	1¼	½	27,750	19,120	13,950	10,650	8,700
W 228	1¼	¾	20,620	14,620	11,020	8,770	7,120
W 229	1¼	1	16,500	12,000	8,620	6,900	5,770
W 230	1¼	1¼	13,270	9,150	6,970	5,700	.....
W 231	1¼	1½	10,270	7,270	6,000	5,100	.....
W 232	1¼	2	7,500	6,000	4,870	4,500	.....
W 235	1½	¼	25,470	24,900	18,900	15,150	11,770
W 236	1½	½	25,470	18,750	13,870	10,500	8,620
W 237	1½	1	15,750	11,250	7,870	6,370	5,620
W 238	1½	1½	9,900	6,970	5,470	4,870	

*See Figure 53, Page 69.

TABLE 26

GROUP W—(PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR ¼" MANDRELS

Shape No.	Wheel Diameter Inches	Wheel Thickness Inches	⅛" Overhang & Thd. Mdls.	Overhang — Dimension O*						
				1"	1½"	2"	2½"	3"	4"	5"
W 176	⅝	½	81,000	54,379	42,000	33,000	25,500	20,400	13,260	9,550
W 177	⅝	¾	66,000	46,500	32,250	27,370	21,000	16,800	10,920	7,860
W 178	⅝	1	55,200	40,500	30,000	23,250	17,250	13,800	8,970	6,460
W 179	⅝	1¼	45,750	33,750	25,720	19,720	15,300	12,240	7,960	5,730
W 182	½	⅛	76,390	62,400	45,750	35,400	27,520	22,020	14,310	10,300
W 183	½	¼	76,390	54,750	40,500	31,120	24,000	19,200	12,480	8,990
W 184	½	⅜	71,250	47,620	35,020	27,000	20,850	16,680	10,840	7,800
W 185	½	½	61,500	42,000	31,500	24,000	18,370	14,700	9,560	6,880
W 186	½	¾	51,000	36,370	27,750	21,220	16,120	12,900	8,390	6,040
W 187	½	1	40,500	30,000	24,000	18,750	14,250	11,400	7,410	5,340
W 188	½	1½	30,370	24,000	18,900	15,000	12,000	9,600	6,240	4,490
W 189	½	2	24,000	18,750	15,000	12,150	9,900	7,920	5,150	3,710
W 190	⅝	⅛	61,120	61,120	48,000	31,500	29,020	23,220	15,090	10,800
W 191	⅝	⅛	61,120	60,000	44,250	34,500	27,000	21,600	14,040	10,110
W 192	⅝	¼	61,120	51,750	38,400	29,770	23,250	18,680	12,140	8,740
W 193	⅝	⅜	61,120	45,000	33,370	25,870	20,100	16,080	10,450	7,520
W 194	⅝	½	56,400	39,750	29,400	22,720	17,400	13,920	9,050	6,520
W 195	⅝	¾	46,500	32,400	24,900	19,720	15,370	12,300	8,000	5,760
W 196	⅝	1	35,250	27,000	21,300	16,870	13,120	10,500	6,830	4,920
W 197	⅝	2	21,000	16,500	12,900	10,870	8,700	6,960	4,520	3,250
W 198	⅝	2½	16,500	12,900	10,870	8,700	7,000	5,600	3,640	2,620
W 201	¾	¼	50,930	50,930	38,100	29,020	22,500	18,000	11,700	8,420
W 202	¾	⅜	50,930	44,100	32,400	25,120	19,350	15,480	10,060	7,240
W 203	¾	½	50,930	36,370	27,750	21,750	16,870	13,500	8,780	6,320
W 204	¾	¾	42,750	30,750	23,250	18,000	14,020	11,220	7,290	5,250
W 205	¾	1	34,500	25,870	19,500	15,000	12,000	9,600	6,240	4,490
W 206	¾	1¼	28,720	21,520	17,020	13,500	10,800	8,640	5,620	4,050
W 207	¾	1½	24,000	18,520	14,620	12,000	9,900	7,920	5,150	3,710
W 208	¾	2	18,750	15,370	12,000	9,900	8,000	6,400	4,160	3,000
W 209	¾	2½	15,000	12,150	10,500	8,400	6,800	5,440	3,540	2,550
W 211	⅞	⅛	43,650	43,650	42,900	33,000	26,250	21,000	13,650	9,820

*See Figure 53, Page 69.

TABLE 26 — (Continued)

GROUP W—(PLAIN WHEELS)

MAX. OPER. SPEED (RPM) FOR ¼" MANDRELS

Shape No.	Wheel Diameter Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*						
				1"	1½"	2"	2½"	3"	4"	5"
W 212	⅞	¼	43,650	43,650	35,100	27,600	21,370	17,100	11,120	8,010
W 213	⅞	⅜	43,650	40,870	29,400	23,400	18,370	14,700	9,560	6,880
W 215	1	⅛	38,200	38,200	38,200	33,750	25,500	20,400	13,260	9,550
W 216	1	¼	38,200	38,200	33,750	26,250	20,250	16,200	10,530	7,580
W 217	1	⅜	38,200	38,200	28,500	22,500	17,400	13,920	9,050	6,520
W 218	1	½	38,200	32,770	24,900	19,500	14,850	11,880	7,720	5,560
W 219	1	¾	35,100	24,520	18,750	15,000	12,000	9,600	6,240	4,490
W 220	1	1	25,500	19,120	15,750	12,370	10,500	8,400	5,460	3,930
W 221	1	1½	19,120	14,620	12,000	10,500	8,400	6,720	4,370	3,150
W 222	1	2	15,900	12,370	9,750	8,620	6,900	5,520	3,590	2,580
W 223	1	2½	12,370	9,900	8,620	6,900	5,500	4,400	2,860	2,060
W 225	1¼	¼	30,560	30,560	30,560	24,000	18,750	15,000	9,750	7,020
W 226	1¼	⅜	30,560	30,560	26,250	20,100	15,750	12,600	8,190	5,900
W 227	1¼	½	30,560	29,620	22,650	18,000	14,100	11,280	7,330	5,280
W 228	1¼	¾	30,520	22,500	17,850	14,250	11,400	9,120	5,930	4,270
W 229	1¼	1	24,000	18,750	15,370	12,000	9,900	7,920	5,150	3,710
W 230	1¼	1¼	20,400	15,900	12,750	10,500	8,400	6,720	4,370	3,150
W 231	1¼	1½	17,620	13,500	10,650	9,000	7,200	5,760	3,740	2,690
W 232	1¼	2	14,250	10,650	9,000	7,500	6,000	4,800	3,120	2,250
W 235	1½	¼	25,470	25,470	25,470	22,720	17,620	14,100	9,170	6,600
W 236	1½	½	25,470	25,470	21,750	17,250	13,650	10,920	7,100	5,110
W 237	1½	1	22,500	17,620	13,270	10,870	9,520	7,620	4,950	3,560
W 238	1½	1½	15,600	12,000	9,750	8,250	6,600	5,280	3,430	2,470
W 239	1½	2	12,750	9,900	8,000	6,400	5,100	4,080	2,650	1,910
W 240	1½	2½	10,500	8,400	6,800	5,500	4,400	3,520	2,290	1,650
W 241	1½	3	9,000	7,250	6,000	4,800	3,900	3,120	2,030	1,460
W 242	2	1	19,100	15,950	11,750	10,000	8,800	7,040	4,580	3,300
W 243	2	1½	14,500	12,750	9,800	7,800	6,300	5,040	3,280	2,360
W 244	2	2	11,750	10,500	7,500	6,200	5,030	4,000	2,600	1,870
W 245	2	2½	9,600	7,250	6,400	5,300	4,250	3,400	2,210	1,590
W 246	2	3	8,250	6,750	5,600	4,600	3,700	2,960	1,920	1,380

*See Figure 53, Page 69.

TABLE 27

GROUP W—(PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR ⅛" MANDRELS

Shape No.	Wheel Diameter Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	1"	Overhang — Dimension O*					
					1½"	2"	2½"	3"	4"	5"
W 185	½	½	76,390	76,390	63,000	48,000	36,740	29,400	19,120	13,760
W 186	½	¾	76,390	72,740	55,500	42,440	32,240	25,800	16,780	12,080
W 187	½	1	76,390	60,000	48,000	37,500	28,500	22,800	14,820	10,680
W 188	½	1½	60,740	48,000	37,800	30,000	24,000	19,200	12,480	8,980
W 189	½	2	48,000	37,500	30,000	24,300	19,800	15,840	10,300	7,420
W 194	⅝	½	61,120	61,120	58,800	45,440	34,800	27,840	18,100	13,040
W 195	⅝	¾	61,120	61,120	49,800	39,440	30,740	24,600	16,000	11,520
W 196	⅝	1	61,120	54,000	42,600	33,740	26,240	21,000	13,660	9,840
W 197	⅝	2	42,000	33,000	25,800	21,740	17,400	13,970	9,040	6,500
W 198	⅝	2½	33,000	25,800	21,740	17,400	14,000	11,200	7,280	5,240
W 203	¾	½	50,930	50,930	50,930	43,500	33,740	27,000	17,560	12,640
W 204	¾	¾	50,930	50,930	46,500	36,000	28,040	22,440	14,580	10,500
W 205	¾	1	50,930	50,930	39,000	30,000	24,000	19,200	12,480	8,980
W 206	¾	1¼	50,930	43,040	34,040	27,000	21,600	17,280	11,240	8,100
W 207	¾	1½	48,000	37,040	29,240	24,000	19,800	15,840	10,300	7,420
W 208	¾	2	37,500	30,740	24,000	19,800	16,000	12,800	8,320	6,000
W 209	¾	2½	30,000	24,300	21,000	16,800	13,600	10,880	7,080	5,100
W 218	1	½	38,200	38,200	38,200	38,200	29,700	23,760	15,440	11,120
W 219	1	¾	38,200	38,200	37,500	30,000	24,000	19,200	12,480	8,980
W 220	1	1	38,200	38,200	31,500	24,740	21,000	16,800	10,920	7,860
W 221	1	1½	38,200	29,240	24,000	21,000	16,800	13,440	8,740	6,300
W 222	1	2	31,800	24,740	19,500	17,240	13,800	11,040	7,180	5,160
W 223	1	2½	24,740	19,800	17,240	13,800	11,000	8,800	5,720	4,120
W 227	1¼	½	30,560	30,560	30,560	30,560	28,200	22,560	14,660	10,560
W 228	1¼	¾	30,560	30,560	30,560	28,500	22,800	18,240	11,860	8,540
W 229	1¼	1	30,560	30,560	30,560	24,000	19,800	15,840	10,300	7,420
W 230	1¼	1¼	30,560	30,560	25,500	21,000	16,800	13,440	8,740	6,300
W 231	1¼	1½	30,560	27,000	21,300	18,000	14,400	11,520	7,480	5,380
W 232	1¼	2	28,500	21,300	18,000	15,000	12,000	9,600	6,240	4,500

*See Figure 53, Page 69.

TABLE 27 — (Continued)

GROUP W—(PLAIN WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR ⅛" MANDRELS

Shape No.	Wheel Diameter Inches	Wheel Thickness Inches	⅛" Overhang & Thd. Mdls.	Overhang — Dimension O*						
				1"	1½"	2"	2½"	3"	4"	5"
W 236	1½	½	25,470	25,470	25,470	25,470	25,470	21,840	14,200	10,220
W 237	1½	1	25,470	25,470	25,470	21,740	19,040	15,240	9,900	7,120
W 238	1½	1½	25,470	24,000	19,500	16,500	13,200	10,560	6,860	4,940
W 239	1½	2	25,470	19,800	16,000	12,800	10,200	8,160	5,300	3,820
W 240	1½	2½	21,000	16,800	13,600	11,000	8,800	7,040	4,580	3,300
W 241	1½	3	18,000	14,500	12,000	9,600	7,800	6,240	4,060	2,920
W 242	2	1	19,100	19,100	19,100	19,100	17,600	14,080	9,160	6,600
W 243	2	1½	19,100	19,100	19,100	15,600	12,600	10,080	6,560	4,720
W 244	2	2	19,100	19,100	15,000	12,400	10,000	8,000	5,200	3,740
W 245	2	2½	19,100	14,500	12,800	10,600	8,500	6,800	4,420	3,180
W 246	2	3	16,500	13,500	11,200	9,200	7,400	5,920	3,840	2,760

*See Figure 53, Page 69.

TABLE 28

GROUP B — (SHAPED WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 3/32" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
B 43	¼	1/16	67,500	41,250	27,000	18,750	12,750
B 44	3/32	⅜	57,000	34,500	22,500	16,500	11,250
B 45	1/16	1/16	86,250	50,250	35,250	24,000	15,000
B 46	⅛	1/16	87,000	52,500	36,750	24,750	16,500
B 47	⅛	3/32	87,000	52,500	36,750	24,750	16,500
B 53	¼	⅝	49,500	30,750	20,250	14,250	10,500
B 55	⅛	¼	87,000	52,500	36,750	24,750	16,500
B 63	¼	1/16	76,500	46,500	30,750	21,750	14,250
B 64	¼	1/16	87,000	52,500	36,750	24,750	16,500
B 65	⅛	⅛	87,000	52,500	36,750	24,750	16,500
B 70	¾	⅛	50,930	33,750	21,750	15,750	11,250
B 71	⅝	⅛	61,120	39,000	24,750	17,250	12,750
B 72	½	⅛	60,750	35,250	23,250	16,500	12,000
B 73	½	⅛	60,750	35,250	23,250	16,500	12,000
B 74	3/32	3/32	87,000	52,500	36,750	24,750	16,500
B 81	¾	1/16	50,930	33,750	21,750	15,750	11,250
B 82	½	¼	67,500	41,250	27,000	18,750	12,750
B 83	⅜	1/16	72,750	43,500	27,750	19,500	12,750
B 84	1/16	1/16	87,000	52,500	36,750	24,750	16,500
B 92	¼	¼	67,500	41,250	27,000	18,750	12,750
B 93	1/16	1/16	87,000	52,500	36,750	24,750	16,500
B 94	1/64	3/32	87,000	52,500	36,750	24,750	16,500
B 95	⅛	1/16	87,000	52,500	36,750	24,750	16,500
B 96	⅛	¼	87,000	52,500	36,750	24,750	16,500
B 97	⅛	⅜	87,000	52,500	36,750	24,750	16,500
B 98	3/32	¼	87,000	52,500	36,750	24,750	16,500
B 104	1/16	⅜	57,000	34,500	22,500	16,500	11,250
B 105	¼	¼	86,250	50,250	35,250	24,000	15,000
B 106	⅛	1/64	87,000	52,500	36,750	24,750	16,500
B 112	⅜	½	37,500	23,250	16,500	12,750	9,000
B 113	¼	¼	67,500	41,250	27,000	18,750	12,750
B 114	3/32	⅜	57,000	34,500	22,500	16,500	11,250
B 115	3/32	⅛	87,000	52,500	36,750	24,750	16,500
B 122	⅜	⅜	51,000	30,750	21,000	15,000	10,500
B 123	1/16	1/16	86,250	50,250	35,250	24,000	15,000
B 124	⅛	⅛	87,000	52,500	36,750	24,750	16,500

*See Figure 53, Page 69.

TABLE 29

GROUP B— (SHAPED WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/8" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
B 41	5/16	5/16	33,750	23,250	17,620	13,650	10,350
B 42	½	3/4	33,750	23,250	17,620	13,650	10,350
B 43	¼	1/16	81,370	51,000	34,120	24,000	16,870
B 44	3/32	3/8	68,400	42,370	28,870	20,850	15,000
B 45	1/16	1/16	104,250	61,870	44,620	30,900	20,250
B 46	1/8	1/16	105,000	64,500	46,650	32,400	21,370
B 47	1/8	3/32	105,000	64,500	46,650	32,400	21,370
B 51	1/16	3/4	45,370	28,500	21,000	15,900	12,150
B 52	3/8	3/4	45,370	28,500	21,000	15,900	12,150
B 53	¼	5/8	60,000	38,020	26,250	18,750	13,870
B 54	¼	½	60,000	38,020	26,250	18,750	13,870
B 55	1/8	¼	105,000	64,500	46,650	32,400	21,370
B 61	3/4	1/16	38,250	24,370	17,400	13,270	9,970
B 62	½	3/8	41,020	26,400	19,500	15,000	11,400
B 63	¼	1/16	92,400	57,370	39,370	27,900	18,900
B 64	¼	1/16	105,000	64,500	46,650	32,400	21,370
B 65	1/8	1/8	105,000	64,500	46,650	32,400	21,370
B 70	3/4	1/8	50,930	41,250	27,750	20,400	15,000
B 71	5/8	1/8	61,120	48,000	31,500	22,650	16,870
B 72	½	1/8	73,500	43,650	29,100	20,770	15,450
B 73	½	1/8	73,500	43,650	29,100	20,700	15,450
B 74	3/32	3/32	105,000	64,500	46,650	32,400	21,370
B 81	3/4	1/16	50,930	41,250	27,750	20,400	15,000
B 82	½	¼	76,390	51,000	34,120	24,000	16,870
B 83	3/8	1/16	87,600	53,250	35,250	24,750	17,250
B 84	1/16	1/16	105,000	64,500	46,650	32,400	21,370
B 91	½	5/8	34,500	22,500	16,870	13,120	9,900
B 92	¼	¼	81,370	51,000	34,120	24,000	16,870
B 93	1/16	1/16	105,000	64,500	46,650	32,400	21,370
B 94	11/64	3/32	105,000	64,500	46,650	32,400	21,370
B 95	1/8	1/16	105,000	64,500	46,650	32,400	21,370
B 96	1/8	¼	105,000	64,500	46,650	32,400	21,370
B 97	1/8	3/8	105,000	64,500	46,650	32,400	21,370

*See Figure 53, Page 69.

TABLE 29 — (Continued)

GROUP B — (SHAPED WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/8" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
B 98	3/32	1/4	105,000	64,500	46,650	32,400	21,370
B 101	5/8	1/16	33,750	23,250	17,620	13,650	10,350
B 102	5/8	1/2	45,370	28,500	21,000	15,900	12,150
B 103	5/8	3/16	61,120	41,250	27,750	20,400	15,000
B 104	5/16	3/8	68,400	42,370	28,870	20,850	15,000
B 105	1/4	1/4	104,250	61,870	44,620	30,900	20,250
B 106	1/8	1/8	105,000	64,500	46,650	32,400	21,370
B 111	1/16	1/16	33,750	23,250	17,620	13,650	10,350
B 112	3/8	1/2	45,370	28,500	21,000	15,900	12,150
B 113	1/4	1/4	81,370	51,000	34,120	24,000	16,870
B 114	3/32	3/8	68,400	42,370	28,870	20,850	15,000
B 115	3/32	1/8	105,000	64,500	46,650	32,400	21,370
B 121	1/2	1/2	45,370	28,500	21,000	15,900	12,150
B 122	3/8	3/8	61,650	37,720	27,000	19,870	14,250
B 123	1/16	1/16	104,250	61,820	44,620	30,900	20,250
B 124	1/8	1/8	105,000	64,500	46,650	32,400	21,370
B 131	1/2	1/2	34,500	22,500	16,870	13,120	9,900
B 132	3/8	1/2	45,370	28,500	21,000	15,900	12,150
B 133	3/8	3/8	54,000	33,000	24,150	18,000	13,500
B 134	1/16	3/8	61,650	37,720	27,000	19,870	14,250
B 135	1/4	1/2	60,000	38,020	26,250	18,750	13,870
B 136	1/4	1/16	77,250	45,920	30,900	22,500	16,120

*See Figure 53, Page 69.

TABLE 30

GROUP B — (SHAPED WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/4" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O*			
				1"	1½"	2"	2½"
B 41	5/8	5/8	61,120	46,500	35,250	27,370	21,000
B 42	1/2	3/4	61,120	46,500	35,250	27,370	21,000
B 51	7/16	3/4	81,000	54,370	42,000	33,000	25,500
B 52	3/8	3/4	81,000	54,370	42,000	33,000	25,500
B 61	3/4	7/16	50,930	50,930	38,100	29,020	22,500
B 62	1/2	3/8	71,250	47,620	35,020	27,000	20,850
B 71	5/8	1/8	61,120	61,120	48,000	37,500	29,020
B 72	1/2	1/8	76,390	62,400	45,750	35,400	27,520
B 73	1/2	1/8	76,390	62,400	45,750	35,400	27,520
B 91	1/2	5/8	61,500	42,000	31,500	24,000	18,370
B 101	5/8	11/16	61,120	46,500	35,250	27,370	21,000
B 102	5/8	1/2	61,120	54,370	42,000	33,000	25,500
B 111	7/16	11/16	66,000	46,500	35,250	27,370	21,000
B 112	3/8	1/2	81,000	54,370	42,000	33,000	25,500
B 121	1/2	1/2	76,390	54,370	42,000	33,000	25,500
B 131	1/2	1/2	61,500	42,000	31,500	24,000	18,370
B 132	3/8	1/2	81,000	54,370	42,000	33,000	25,500

*See Figure 53, Page 69.

TABLE 31

GROUP A — (SHAPED WHEELS)

MAXIMUM OPERATING SPEEDS (RPM) FOR 1/4" MANDRELS

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	½" Overhang & Thd. Mdls.	Overhang — Dimension O°				
				1"	1½"	2"	2½"*	3"
A 1	¾	2½	19,800	16,500	13,120	10,650	9,000	6,750
A 2	1	1¼	38,200	32,620	25,500	20,620	16,870	13,500
A 3	1	2¾	16,100	13,080	10,730	8,720	6,710	4,700
A 4	1¼	1¼	30,560	24,750	20,250	16,120	13,120	10,500
A 5	¾	1⅛	45,000	33,750	27,000	21,000	16,500	13,500
A 6	¾	1⅛	39,000	29,700	24,000	18,970	15,000	12,000
A 11	⅞	2	19,860	15,100	12,000	9,810	8,220	7,020
A 12	1⅛	1¼	48,000	35,250	27,370	21,750	17,250	13,500
A 13	1⅛	1⅛	33,950	32,250	25,500	20,620	16,500	12,750
A 14	1⅛	⅞	55,560	40,500	30,750	24,370	19,500	15,000
A 15	¼	1 1/16	72,750	47,620	34,500	26,250	19,870	13,870
A 21	1	1	34,500	26,250	21,000	17,250	13,870	10,870
A 22	¾	⅝	50,930	40,500	30,750	24,370	19,500	15,000
A 23	¾	1	39,370	30,370	24,370	19,500	15,000	12,000
A 24	¼	¾	76,500	49,500	36,370	27,000	20,250	15,370
A 25	1	1	35,620	27,370	22,120	18,000	14,250	11,250
A 26	⅝	⅝	61,120	46,500	35,250	27,750	21,370	15,750
A 31	1⅜	1	27,780	26,250	21,000	17,250	13,500	10,870
A 32	1	⅝	38,200	38,200	30,000	24,000	18,900	15,000
A 33	1	½	38,200	38,200	30,000	24,000	18,900	15,000
A 34	1½	⅜	25,470	25,470	25,470	21,970	18,000	13,870
A 35	1	⅜	38,200	38,200	31,500	25,500	20,250	15,900
A 36	1⅝	⅜	23,520	23,520	23,520	21,750	17,620	13,870
A 37	1¼	¼	30,560	30,560	30,560	28,100	22,500	18,000
A 38	1	1	34,500	26,250	21,000	17,020	13,500	10,650
A 39	¾	¾	47,250	35,250	27,750	22,120	17,250	13,120

*See Figure 53, Page 69.

CONVERSION TABLE—WHEEL SPEEDS
REVOLUTIONS PER MINUTE FOR VARIOUS DIAMETERS OF GRINDING WHEELS TO GIVE SURFACE SPEED IN FEET PER MINUTE AS INDICATED

Diameter of Wheel in Inches	Surface 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	12,500	14,200	16,000	16,500	17,000	
	Revolutions per Minute				Revolutions per Minute			Revolutions per Minute				Revolutions per Minute			Revolutions 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	47,745	54,240	61,116	63,025	64,935	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	23,875	27,120	30,558	31,510	32,465	2
3	5,093	5,729	6,366	7,003	7,639	8,276	8,913	9,549	10,186	10,822	11,459	12,096	12,732	15,278	15,915	18,080	20,372	21,010	21,645	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	11,940	13,560	15,278	15,755	16,235	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	9,550	10,850	12,224	12,605	12,985	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	7,960	9,040	10,186	10,505	10,820	6
7	2,183	2,455	2,728	3,001	3,274	3,547	3,820	4,092	4,366	4,638	4,911	5,183	5,456	6,548	6,820	7,750	8,732	9,005	9,275	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	5,970	6,780	7,640	7,880	8,115	8
9	1,698	1,910	2,122	2,334	2,546	2,758	2,970	3,182	3,396	3,606	3,820	4,032	4,244	5,092	5,305	6,030	6,792	7,000	7,215	9
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	4,775	5,425	6,112	6,300	6,495	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	3,980	4,520	5,092	5,250	5,410	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	3,410	3,875	4,366	4,500	4,640	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	2,985	3,390	3,820	3,940	4,060	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	2,655	3,015	3,396	3,500	3,605	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	2,390	2,715	3,056	3,150	3,245	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	2,170	2,465	2,776	2,865	2,950	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	1,990	2,260	2,546	2,625	2,705	24
26	588	661	734	808	881	955	1,028	1,101	1,176	1,248	1,322	1,395	1,468	1,762	1,840	2,090	2,352	2,425	2,495	26
28	546	614	682	750	818	887	955	1,023	1,092	1,159	1,228	1,296	1,364	1,637	1,705	1,940	2,182	2,250	2,320	28
30	509	573	637	700	764	828	891	955	1,018	1,082	1,146	1,210	1,274	1,528	1,595	1,810	2,056	2,100	2,165	30
32	477	537	597	656	716	776	836	895	954	1,014	1,074	1,134	1,194	1,432	1,495	1,695	1,910	1,970	2,030	32
34	449	505	562	618	674	730	786	843	898	955	1,011	1,067	1,124	1,348	1,405	1,595	1,796	1,855	1,910	34
36	424	477	530	583	637	690	742	795	848	902	954	1,007	1,061	1,273	1,330	1,510	1,698	1,750	1,805	36
38	402	452	503	553	603	653	704	754	804	854	904	955	1,006	1,206	1,260	1,430	1,608	1,660	1,710	38
40	382	430	478	525	573	620	669	716	764	812	860	908	956	1,146	1,195	1,355	1,528	1,575	1,625	40
42	366	409	454	500	545	591	636	682	732	775	818	863	908	1,090	1,140	1,295	1,464	1,500	1,545	42
44	347	390	434	478	521	564	608	651	694	737	780	824	868	1,042	1,085	1,235	1,388	1,432	1,475	44
46	333	375	416	458	500	541	582	624	666	708	750	791	832	1,000	1,040	1,180	1,332	1,370	1,410	46
48	318	358	398	438	478	517	558	597	636	676	716	756	796	956	995	1,130	1,272	1,315	1,350	48
53	288	324	360	395	432	468	503	539	576	612	648	683	720	864	900	1,025	1,152	1,189	1,225	53
60	255	287	319	350	387	414	446	478	510	542	574	606	638	774	795	905	1,020	1,050	1,080	60
72	212	239	265	291	318	345	371	398	424	451	477	504	530	637	665	755	849	875	905	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 A
(Not Part of ANSI Safety Code B7.1-1970)

Introduction

While not part of this Code, the following relates a number of factors which contribute to the safe operation of grinding wheels. Safety is everyone's business.

General Requirements

Abrasive wheels should be used with operator safety in mind and in conjunction with the type of protective devices most effective for each application.

Classes of Protection Devices

There are two main classes of protection devices: those that protect the operator (A.3.1), and those that provide protection to others in the work area (A.3.2).

Operator Protection Devices

Safety Guards

The most positive way to protect the operator as well as others in the immediate area is by guarding the wheel effectively. Section 4 (Safety Guards) page 27 explains the provisions necessary for adequate guarding. A guard protects the operator either by containing or deflecting the pieces of an accidentally broken wheel. Guards also control sparks and swarf.

Safety Goggles and Face Shields

Because the grinding operation produces sparks and swarf, eye protection is of utmost importance. Safety goggles or face shields shall be worn at all times in the grinding area. Dust masks may be required as well.

Protective Clothing

Safety aprons, gloves, safety shoes, and other protective clothing should be worn as required by the nature of the grinding operation. Well designed protective clothing will allow the operator to work more efficiently and safely.

Dust Protection

Dust masks may be required in an extremely dusty or contaminated environment.

Work Area Protection

Barriers

In some operations, partitions, walls, or separate grinding booths will provide protection to other people nearby.

Exhaust Systems

Adequate ventilation and swarf removal should be provided in the grinding area.

Types of Wheel Reinforcing Devices

Cup Back Bushing

The cup wheel back bushing is a metallic cup with a mounting bushing which encases the back and extends from the back partially down the side of the wheel and is an integral part thereof. This device, while not providing the same protection as a stationary guard, does reinforce the wheel while in use.

Steel Rings

Steel rings are generally used in large hole organic bonded snagging wheels. They are molded into the wheel and serve to reinforce the wheel as it approaches discard size.

Fiberglass and Filament Reinforcing

Fiberglass and filament reinforcing is molded on or into organic bonded wheels. This type of reinforcing increases the ability of wheels to withstand operational forces when cracked.

Wire or Tape Winding

Certain types of wheels are wrapped with bands of wire or tape. Such wrapping acts as a reinforcement of the wheel and can also serve to protect the wheel during handling, shipping, and storage.

INDEX

This index is not part of the American National Standard Safety Code for The Use, Care, and Protection of Abrasive Wheels, B7.1. Its object is to aid the reader in finding references to key words and subjects.

American National Standards

The standard in this booklet is one of nearly 4,000 standards approved to date by the American National Standards Institute, formerly the USA Standards Institute.

The Standards Institute provides the machinery for creating voluntary standards. It serves to eliminate duplication of standards activities and to weld conflicting standards into single, nationally accepted standards under the designation "American National Standards."

Each standard represents general agreement among maker, seller, and user groups as to the best current practice with regard to some specific problem. Thus the completed standards cut across the whole fabric of production, distribution, and consumption of goods and services. American National Standards, by reason of Institute procedures, reflect a national consensus of manufacturers, consumers, and scientific, technical, and professional organizations, and governmental agencies. The completed standards are used widely by industry and commerce and often by municipal, state, and federal governments.

The Standards Institute, under whose auspices this work is being done, is the United States clearing house and coordinating body for standards activity on the national level. It is a federation of trade associations, technical societies, professional groups, and consumer organizations. Some 1,000 companies are affiliated with the Institute as company members.

The American National Standards Institute is the United States member of the International Organization for Standardization (ISO), the International Electro-technical Commission (IEC), and the Pan American Standards Commission (COPANT). Through these channels American industry makes its position felt on the international level. American National Standards are on file in the libraries of the national standards bodies of more than 50 countries.

For a free list of all American National Standards, write:

American National Standards Institute
1430 Broadway New York, N.Y. 10018