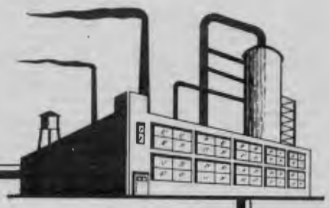
SAFETY REGULATION NO. 7



Relating to the

Use, Care and Protection

of

ABRASIVE WHEELS

EFFECTIVE MARCH 16, 1959

COPY NO. 2

BUREAU OF ENGINEERING & SAFETY
N.J. DEPARTMENT OF LABOR & INDUSTRY
Trenton, N.J.

Division of Labor.

This Safety Regulation No. 7 supersedes the following:

"Rules and Regulations for the Use, Care and Protection of Abrasive Wheels" which was filed with the Secretary of State on April 8, 1948.

EXPLANATION OF FORMAT

Many of the provisions of this Safety Regulation No. 7 are amplified by explanatory material. This explantory material is distinguished from the text of the Regulation itself being printed in italics and enclosed in parentheses. All such italized paragraphs are explanation only and do not constitute a part of the mandatory provisions of this Regulation.

CONTENTS

FOREWORD

This Regulation establishes reasonable safety standards for the use, care and protection of abrasive wheels. The text of this Regulation has been extracted virtually without change from the "American Standard Safety Code for the Use, Care and Protection of Abrasive Wheels" (B7-1-1956).

The format devised by the American Standards Association for use in its standard has likewise been employed in this Regulation. Accompanying the regulatory provisions is explanatory information and illustrative photographs and drawings which are not a part of the text itself of this Regulation.

Basic to a proper understanding of this Regulation is a thorough knowledge of the nature and characteristics of abrasive wheels, the grinding machines on which 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 where personnel contact abrasives and grinding operations are the best insurance against those unforeseen conditions or circumstances which result in an industrial accident. As the individual's knowledge at any level on any overall operation is expanded the possibility of accidental injury or damage is reduced or eliminated.

On one specific point with respect to the strength of abrasive wheels much misunderstanding exists. The following explanation will clarify this point.

The strength of an abrasive wheel is always limited by the operation it is designed to perform, for as the outer abrasive layer becomes dull from grinding the dull grains must break free, exposing new cutting edges. This action must be progressive and continuous. Wheels of greater strength than required by the stresses set up on any particular grinding operation will not grind properly for they will not release the dulled grains.

In these characteristics the abrasive wheel is unique among cutting tools. But these strength limitations are no handicap to their safe use or operation as is amply demonstrated by the excellent safety record in the field of grinding.

This Regulation outlines the best known practices, tests, and safety protection devices to use to protect all personnel and equipment from injury or damage in case of accidental wheel breakage.

As in all safety work constant education and vigilance at all levels are the best tools limiting, if not eliminating, industrial hazards.

This Regulation is promulgated by the Commissioner of Labor and Industry of the State of New Jersey under authority vested in him by law:

> R.S. 34:1-20. The commissioner may make and publish rules and regulations not inconsistent with law as he shall deem necessary to enforce the provisions of this title.

> Whenever any condition is found to exist in contravention of any provision of this title, the commissioner may by written order signed by him specifying the things to be done and the time for compliance require such conditions to be corrected.

The provisions of Title 34 which refer to the subject matter regulated are:

> 34:6-62. Machine Guards. The owner or person in charge of any factory, workshop, mill or place where the manufacture of goods is carried on where machinery is used, shall provide, in the discretion of the commissioner, friction clutches for stopping shafting, and belt shifters or other mechanical contrivances for the purpose of throwing on or off belts or pulleys. Whenever practicable, all machinery shall be provided with loose pulleys. All vats, pans, saws, planers, power presses, foot presses, cogs, gearing, belting, shafting, set screws, drums and machinery of every description shall be properly guarded. No person shall remove or make ineffective any safeguard around or attached to such machinery, vats or pans while the same are in use, unless for the purpose of immediately making repairs thereto, and all such safeguards so removed shall be promptly replaced. If the machinery, or any part thereof, or any vat, pan or vessel containing molten metal or hot liquid is in a dangerous condition or is not properly guarded, the use thereof may be prohibited by the commissioner, and a notice to that effect shall be attached thereto. Such notice shall not be removed until the machinery is made safe and the required safeguards are provided. In the meantime such unsafe or dangerous machinery, vats, pans, or vessels containing molten metal or liquid shall not be used . . . .

Prior to its promulgation, this Regulation was reviewed and approved by the New Jersey State Industrial Safety Committee.

SECTION 1 – PURPOSE, SCOPE AND DEFINITIONS

1.1 *Purpose.* The purpose of this Regulation is to establish reasonable safety standards for the use, care and protection of abrasive wheels.

1.2 *Scope.* This Regulation applies to all abrasive wheels except natural sandstones used in any factory, workshop, mill or place where the manufacture of goods is carried on.

1.3 *Exceptions.* In cases of practical difficulty or unnecessary hardship, the Commissioner may grant exceptions from this Regulation provided that a request for such exception has been made in writing. Exceptions can only be granted when it is clearly evident that a satisfactory, safe and sanitary condition is attained, but cannot be granted in any case where conflict would be created with mandatory requirements of the law.

1.4 *Compliance.* The use, care and protection of all abrasive wheels subject to this Regulation shall conform to all applicable requirements contained herein.

1.5 *Definitions.*

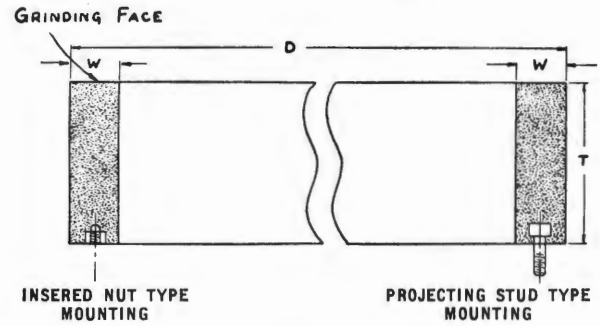
1.5.1 *Abrasive Disks.*

Abrasive discs are bonded abrasive wheels which may be of the inserted nut, inserted washer, projecting stud and tapped mounting plate type. On the mounting side of the abrasive disc, the inserted nut, inserted washer, projecting studs and tapped plate holes are located in a pattern to match the spacing of corresponding holes in the steel disc wheel (machine face plate) of grinding machines. Grinding is done on the exposed flat side. (See 1.5.9 for definition of Plate Mounted Wheel)

1.5.1.1 *Cylinder Type Abrasive Discs*

Cylinder type abrasive discs are bonded abrasive wheels similar in shape to Type 2* abrasive wheels which may be of the inserted nut type, projecting stud type or the tapped mounting plate type, the tapped holes, inserted nuts or projecting studs being located in a pattern to match the spacing of corresponding holes in the steel disc wheel or adaptor.

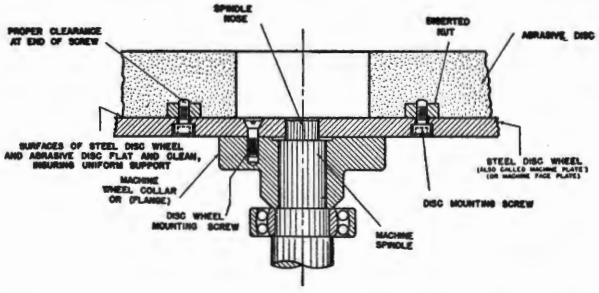
* *Recommendation R45-56.*



The above illustrates two of the popular methods of mounting cylinder type abrasive discs.

1.5.1.2 *Inserted Nut Type Abrasive Discs*

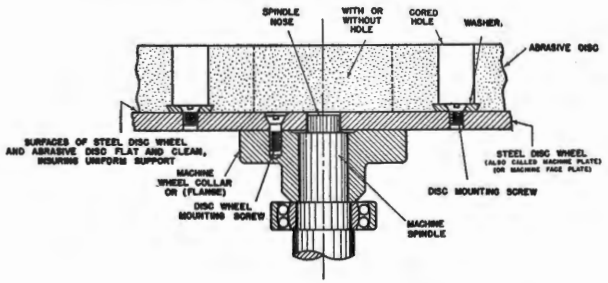
Inserted nut type abrasive discs are bonded abrasive wheels which have threaded nuts anchored in the mounting side of the wheel and are located in a pattern to match the spacing of corresponding holes in the steel disc wheel (machine face plate).



Mounting shown is referred to as the insert nut type. Note the nuts imbedded in the abrasive disc.

1.5.1.3 *Inserted Washer Type Abrasive Discs*

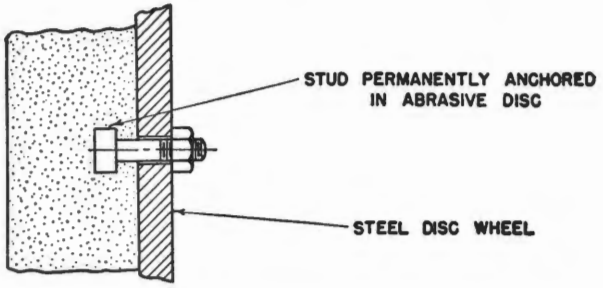
Inserted washer type abrasive discs are bonded abrasive wheels which have a special washer anchored in the mounting side of the disc and are located in a pattern to match the spacing of corresponding holes in the steel disc wheel (machine face plate).



Inserted washer type mounting. Note washer imbedded in abrasive disc.

1.5.1.4 *Projecting Stud Type Abrasive Discs*

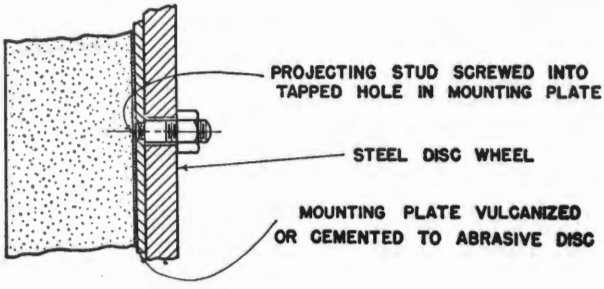
Projecting stud type abrasive discs are bonded abrasive wheels in which projecting studs are anchored in the mounting side of the disc and located in a pattern to match the spacing of corresponding holes in the steel disc wheel (machine face plate).



Projecting stud type illustrated differs from other types in that the studs or bolts are permanently anchored into the abrasive member.

1.5.1.5 *Tapped Mounting Plate Type Abrasive Discs*

Tapped mounting plate type abrasive discs are bonded abrasive wheels which have a tapped mounting plate cemented to the side of the disc, the tapped holes being located in a pattern to match the spacing of corresponding holes in the steel disc wheel (machine face plate).



Projecting studs are fastened to a tapped mounting plate which is permanently secured to the abrasive disc.

1.5.2 *Abrasive Wheel*

An abrasive wheel is a power driven wheel consisting of abrasive particles held together by artificial or natural, mineral, metal or organic bonds. Depressed center wheels, diamond wheels, and reinforced wheels are included. (See separate definitions 1.5.4, 1.5.5 and 1.5.11)

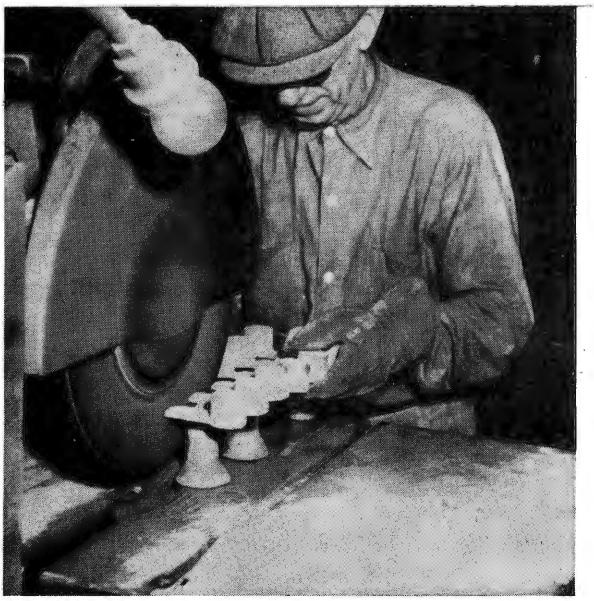
Metal, wooden, cloth or paper discs having a layer of abrasive on the surface are not included. Natural sandstones (quarried) are not included.

(*This definition excludes set-up wheels and coated abrasive products, but includes the type 27 depressed center wheel, diamond wheel and reinforced wheel.)

*Italized paragraphs are explanatory only and not a part of the mandatory provisions of this Regulation.

1.5.3 *Cutting-Off Wheels (Cut-Off)*

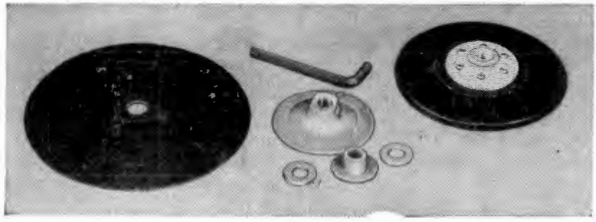
Cutting-off wheels are organic bonded wheels, the thickness of which is not more than 1/48 of their diameter for those up to and including 20" diameter, and not more than 1/60 of their diameter for those larger than 20 inches diameter and used for a multitude of operations variously known as cutting,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



Cutting-off machine used to cut-off gates and risers. Note excellent guarding.

1.5.4 *Depressed Center Wheels*

Depressed center wheels (type 27) are reinforced organic bonded wheels (see definition 1.5.11) with an offset hub to permit side grinding without interference with the mounting nut.



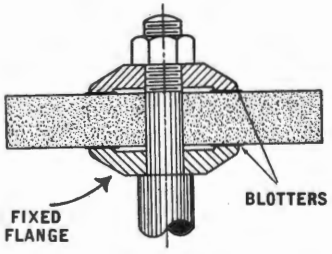
A type 27 depressed center wheel and two of the various types of components required for proper mounting.

1.5.5 *Diamond Wheels*

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

1.5.6 *Flanges (Wheel Mounts)*

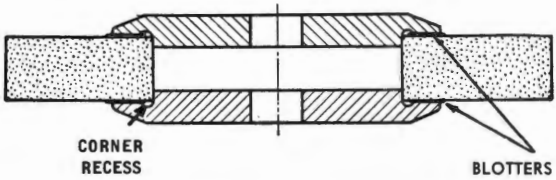
Flanges are collars, discs, or plates between which wheels are mounted. There are two main classes of flanges. One class serves only as a support and driving medium for the wheel while the other serves as an additional protection device. There is a separate definition for safety flanges. (See 1.5.12) The three types of flanges (adaptor, conventional and sleeve) which serve only as a support and driving medium are defined below.



Flanges are equal in outside diameters and relieved to produce equal and opposite bearing areas. Note blotter on bearing area between flange and wheel.

1.5.6.1 *Adaptor Type Flanges*

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



Adaptor type flanges are used with abrasive wheels having large hole diameters. Note blotter on bearing area between flange and wheel.

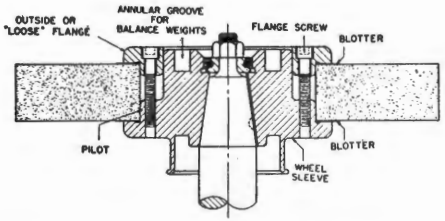
1.5.6.2 *Conventional Type Flanges*

Conventional flanges are straight flanges used with wheels which have small holes that fit directly on the machine spindle.

This drawing illustrates the straight flange which is used on the majority of abrasive wheels.

1.5.6.3 *Sleeve Type Flanges*

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



The sleeve type flange is used on precision grinding machines where wheel hole is larger than the machine arbor.

1.5.7 *Mounted Wheels*

Mounted wheels are small wheels, usually 2 inches or less in diameter and of various shapes, which are securely mounted on the end of a steel mandrel, or quill by cementing or other means. In use the mandrel or quill is adequately held or secured on the end of the grinding machine spindle.

1.5.8 *Overhung Wheels*

An overhung wheel is any wheel which is not supported between bearings.

(Grinding wheels generally are "overhung", since the supporting bearing or bearings are on one side of the wheel only, allowing change of wheel without dismantling the spindle bearings.)

1.5.9 *Plate Mounted Wheels*

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

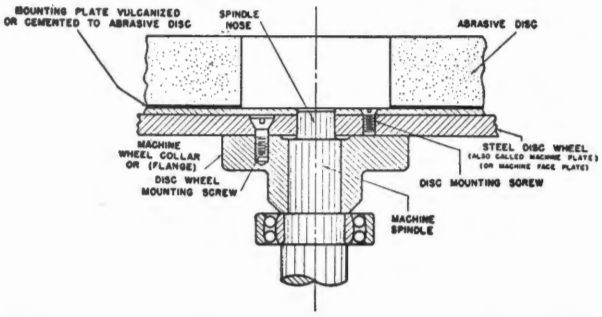


Plate mounted wheels are designed for grinding on the flat side of the wheel. The steel disc wheel imparts rigidity to the abrasive wheel section.

1.5.10 *Precision Grinding*

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

(Common examples of precision grinding include cylindrical, tool and cutter, and surface grinding.)

1.5.11 *Reinforced Wheels*

The term "Reinforced" as applied to grinding wheels shall define a class of wheels which utilize some type of mechanical addition as an integral part of the wheel to increase its strength. (See Fig. 1)

(The term "reinforced" does not cover wheels using steel safety rings as in resinoid snagging or cup wheels. It is applied to organic wheels which contain a layer or layers, of strengthening material. This is especially true in relatively thin wheels in order to increase the resistance to breakage from side or cross bending strain. Typical examples are cutting-off wheels, Type 27 depressed center wheels, portable saw wheels, and small diameter thin wheels used on portable grinders.)

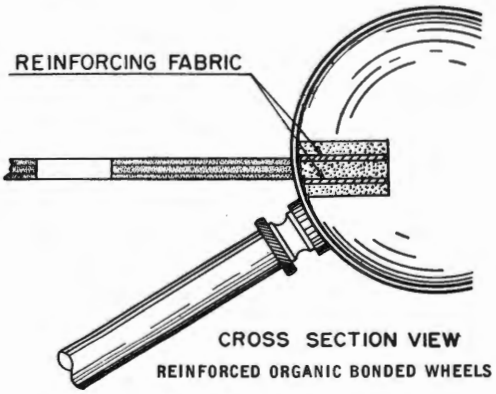


FIGURE NO. 1

1.5.12 *Safety Flanges*

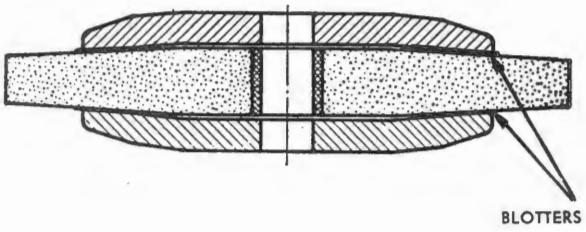
Safety Flanges or Safety Collars are flanges used with abrasive wheels of special shape, so designed that in addition to the usual function of clamping the wheel to the spindle they will also serve to retain effectively the pieces of the wheel if broken in operation.

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

"Tapered Flanges," sometimes called safety or beveled flanges or collars, which are used with wheels having sides with corresponding taper.

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

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

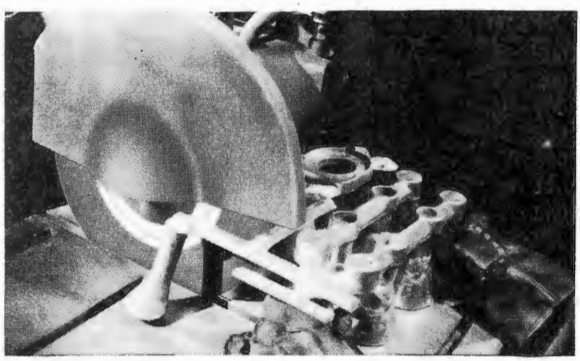


The most important feature of safety flanges is the uniform taper between the flange and the abrasive wheel which imparts a "wedging" effect on the abrasive wheel, in case of accidental breakage.

1.5.13 *Safety Guards (Protection Hoods)*

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

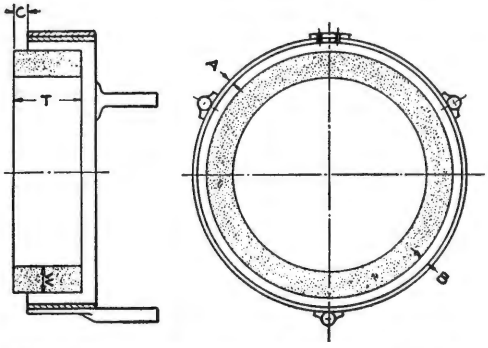
Band Type Guard
Cast Guard
Drawn Steel Guard
Fabricated Guard
Revolving Cup Type Guard



The safety guard affords operator protection in case of accidental breakage.

1.5.13.1 *Band Type Safety Guard*

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



The band type safety guard is employed on vertical spindle disc grinding machines where the diameter of the wheel remains constant.

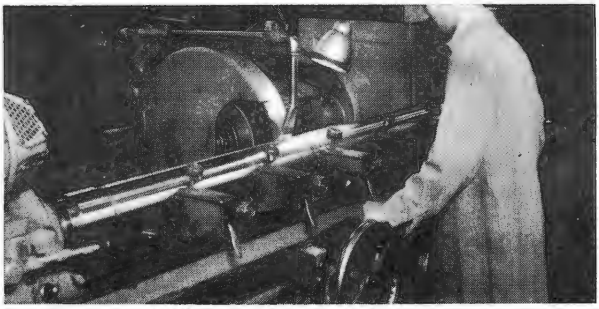
1.5.13.2 *Cast Safety Guard*

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

A typical example of the cast type safety guard. Note that the side member is hinged for easy access to wheel.

1.5.13.3 *Drawn Steel Safety Guard*

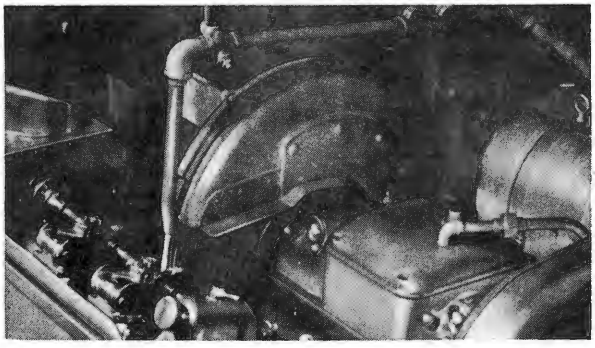
A drawn steel guard is a safety guard where the peripheral member and the fixed side member are formed from a single plate or sheet of steel. A cover, consisting of a side plate and a relatively narrow peripheral member, is similarly formed from a single plate or sheet of steel. The peripheral member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



A typical application of the drawn steel safety guard.

1.5.13.4 *Fabricated Safety Guard*

A fabricated guard is a safety guard which is built up or constructed by bolting, pinning, riveting, or welding the peripheral protecting member to the side members, and may be made of structural steel plate, in combination with iron or steel castings, or a material possessing an equivalent tensile strength.



The fabricated safety guard is easily identifiable by the rivets, bolts or welds used in its assembly.

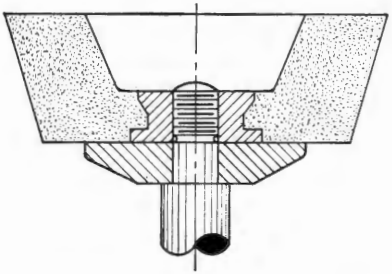
1.5.13.5 *Revolving Cup Safety Guard*

A revolving cup guard is a safety guard which is used with cup type wheels on portable grinders. It is made with adequate strength of steel or other material and provides a complete closure of the back and has a peripheral member outward from the back for 1/3 of the wheel thickness. The guard is mounted behind the wheel on the spindle and revolves with the wheel.

The revolving cup guard is used on either the straight or flaring type cup wheels for off-hand grinding.

1.5.14 *Threaded Hole Wheels*

Threaded hole wheels have one central threaded metal bushing securely anchored in place by cementing, casting or molding. The machines using this type of wheel have relatively short threaded arbors and the wheels are mounted by being screwed on to the threaded arbor. No outside flange is required.



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

**Type numbers refer to classifications listed in Department of Commerce Simplified Practice Recommendation R45-56.*

SECTION 2 – HANDLING, STORAGE AND INSPECTION

2.1 *Handling*

A ll grinding wheels are breakable and some are very fragile (See Fig. No. 2). Great care shall be exercised in handlingand 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 suitable conveyors which will provide proper support for all transportation of wheels which cannot be carried by hand.

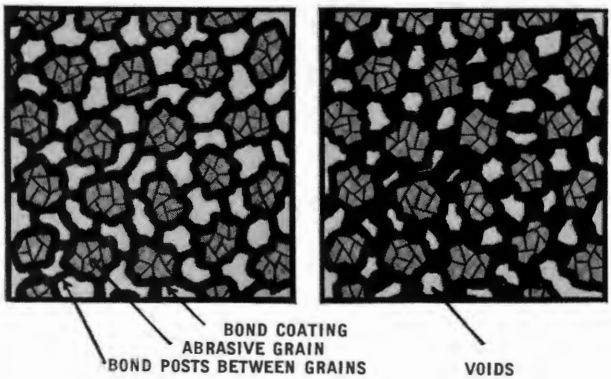


FIGURE NO. 2

Soft Grade (Weaker) Wheels **Hard Grade (Stronger) Wheels**

STRENG TH OF GRINDING W HEELS

(It should be realized that grinding wheels are necessarily of limited strength to grind properly (See foreword). Care must be used in handling. Some wheels are more fragile than others. The factors influencing this are: 1. Bond, 2. Grain size, 3. Grade, and 4. Dimensions.

1. Bond – In general, inorganic bonds (vitrified, silicate and magnesite) are more brittle than organic bonds (resinoid, shellac and rubber). Hence, inorganic bonded wheels can be broken more readily by handling, shock or impact.

2. Grain Size – Generally the finer wheels in any grade and bond are stronger than the coarser wheels in the same grade and bond.

3. Grade – Harder grade wheels are stronger than softer wheels in the same grain and bond.

4. Dimensions – Wheel strength is reduced as the hole diameter is increased in any wheel thickness.)

2.2 *Storage*

Suitable racks, bins or drawers shall be provided to store the various types of wheels used. (See Figs. 3, 4, 5 and 6)

FIGURE NO. 3
A well-designed grinding wheel storage area used by a large industrial plant.

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

(Grinding wheels must be protected while awaiting use. Wheel storage should be arranged to allow wheel selection and removal without disturbing or damaging other wheels. Such suitable storage should be available for partly used wheels as well as new wheels.

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

Rack Construction

The racks, bins or drawers should be constructed to accommodate each of the various types of wheels stored in an orderly and safe manner. (See Fig. 4) Wheel Selection should be possible with a minimum of handling.

The size and type of the wheels to be stored should determine the design of the rack. Generally, the following suggestions should be observed:

1. *Thin organic bonded wheels (cutting-off) should be laid flat on a perfectly flat horizontal surface away from excessive heat to prevent warpage. A heavy, flat steel plate makes a good foundation for stacking. Not even blotters should be allowed between stacked thin wheels.*

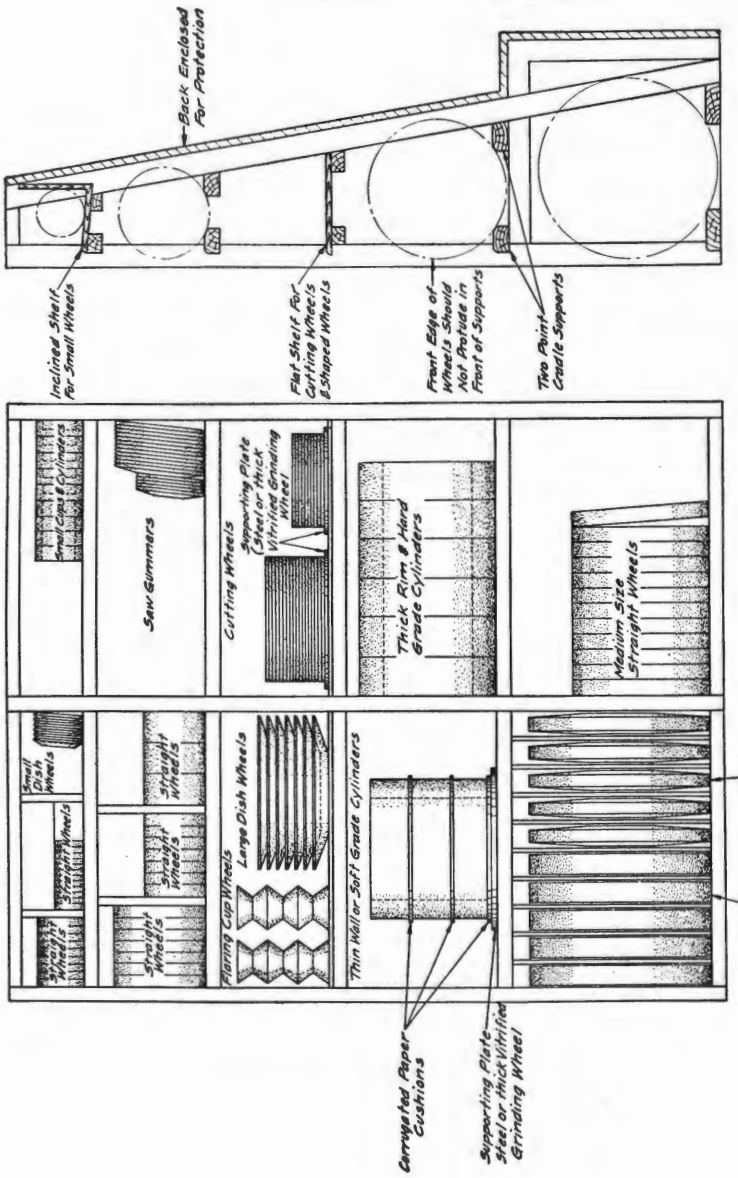


FIGURE NO. 4

This drawing illustrates a rack designed which is suitable for handling a wide variety of grinding wheels.

2. Most straight or tapered wheels of appreciable thickness are best supported on edge in racks. Such racks should preferably be made to provide two-point cradle support to prevent rolling, and with frequent partitions to allow wheel selection without handling or tipping wheels.

Certain strong wheels like the larger organic snagging type are sometimes stacked in orderly piles on a clean, dry, flat floor. Such stacks should be limited to approximately 3 feet high and each stack should contain only one type and specification to minimize handling.

FIGURE NO. 5

The various sizes and shapes of wheels are located in the racks so that they are easily accessible and protected from damage.

3. *Cylinder wheels and large straight cup wheels may be stacked on flat sides with corrugated paper or other cushioning material between them; or they may be stored on edge in racks similar to those used for large straight wheels.*

4. *Small cups and other shapes, as well as small internal wheels, may be stored in boxes, bins or drawers.)*

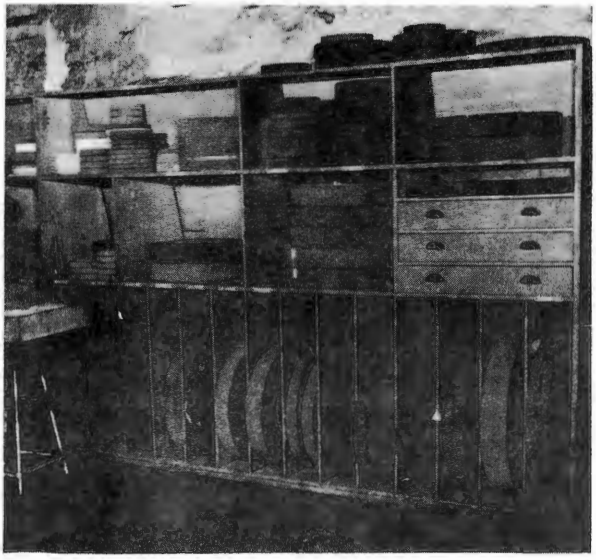


FIGURE NO. 6

A storage rack used to handle a small inventory of grinding wheels.

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. 7 and 8)

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

"Tap" wheels about 45 degrees either side of the vertical center line and and about 1 or 2 inches from the periphery as indicated by the spots in Fig. 7 and Fig. 8.

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".

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.

"Ring Test"

If the wheel is not too heavy it may be suspended from the hole on a small pin or the finger. Heavier wheels may be allowed to rest in a vertical position on a clean hard floor.

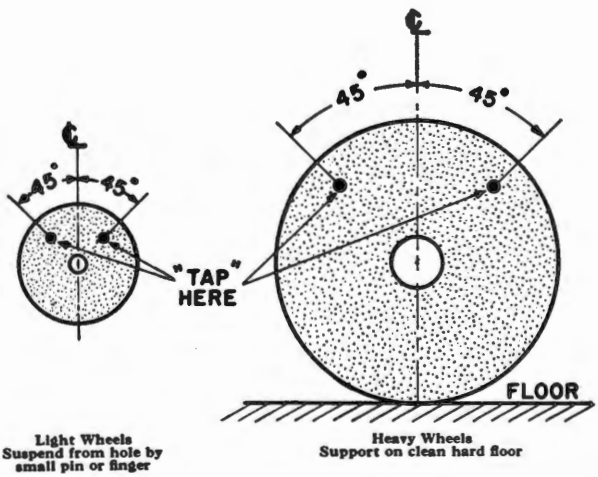


FIGURE NO. 7 **FIGURE NO. 8**

"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. 7 and 8)

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. 8) 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 for further testing before use.)

SECTION 3 – GENERAL MACHINE REQUIREMENTS

3.1 *Rigidity, Supports*

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

(Only machines designed for the required spindle speed with suitable bearings to take the pressure and thrust of the grinding operation are recommended. Sturdy supports for safety guards and workrest on the machine frame are essential.)

3.2 *Safety Guards*

All grinding machines shall be equipped with safety guards. (See Sections 4 and 5)

(Safety guards must be used on all grinding machines to insure operator protection in case of an accidental wheel breakage.)

3.3 *Power*

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

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.

(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 *Diameter of Spindle*

Tables 1 and 2 show the minimum diameters of spindles for wheels of various sizes. Table 1 applies to machines where wheels are overhung. Table 2 applies to large wheels which are mounted between bearings. In general, the use of heavier spindles than those listed in this table is recommended.

(Standard machine design generally conforms to the minimum spindle diameter requirements in Table 1. Investigation often shows that requests for undersize holes result from the use of larger diameter wheels than originally intended for the machine. Other factors including adequate flange diameter, excessive speed and suitable safety guards should be investigated before considering approval of wheels with holes smaller than Table 1 figures.)

3.5 *Work Rests*

On floor stands, bench grinders or disc grinders where work rests or plain tables are used either to support the work or to guide the dresser, they shall be of rigid construction and rigidly supported. They shall be readily adjustable to compensate for wheel wear. (See 9.14)

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

(Work rests should be kept adjusted close to the wheel with a maximum opening of 1/8" to prevent the work from being drawn 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.)

TABLE 1

MINIMUM DIAMETERS OF MACHINE SPINDLES AT POINT OF MOUNTING FOR OVERHUNG WHEELS OF VARIOUS DIAMETERS AND THICKNESSES OPERATING AT SPEEDS UP TO 9,500 PERIPHERAL FEET PER MINUTE

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

Note: For speeds exceeding 9,500 peripheral feet per minute and for wheels with heavy mountings, (such as bolted-on abrasive discs) the spindle sizes shown in the above table are usually not adequate. Inasmuch as the proper spindle size is dependent upon many factors, such as general design of the machine, type of bearings, quality of materials and workmanship, a simple table is not practicable. Wheels larger than specified by the machine manufacturer should not be used on any given machine.

TABLE 2

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

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

3.6 *Limit Stop*

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

(*Where variable speeds are available to increase the spindle speed of a worn wheel to maintain its original peripheral speed, a positive mechanical or manual regulation check should be maintained to avoid overspeeding.*)

3.7 *Direction of Machine Spindle Thread*

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

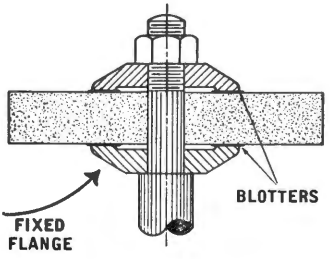
> "To remove the nut it must be turned in the direction that the spindle revolves when the wheel is in operation."

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

(*Threads on both the machine spindle and the mounting nut (or threaded bushing in grinding wheel) should be maintained at a close (Class No. 2 fit to avoid unscrewing or "spinning off" if the machine spindle stops quickly when power is shut off.*)

3.8 *Length of Machine Spindle Thread*

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



The spindle is of sufficient length to accomodate the wheel and flanges.

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.

3.9 *Size of Arbor or Mount*

A controlled clearance in the wheel hole around the machine arbor (or wheel sleeves or adapters is essential to avoid rupturing pressure from mounting. Grinding wheels shall fit freely (but not loosely) on the arbor and remain free under all grinding conditions.

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

(*The greatest stress from centrifugal force in a rotating wheel occurs in the zone around the central hole. Additional stresses must not be superimposed at this critical hole zone.*

To avoid additional rupturing pressure in the wheel hole, the diameter of the arbor 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, including possible expansion of the wheel mount from the heat of operation.)

3.10 *Threaded Hole Wheels*

Machines on which threaded hole wheels are mounted shall be provided with arbors which are so threaded or relieved as to allow the wheel to be screwed firmly against the back plate (flange). (See Figs. 9 and 10) The back plate (flange) shall be flat and unrelieved as it is important, with this type of mounting, that the end of the bushing bear against the back plate (flange) to prevent the tendency to pull it out of the wheel.

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.

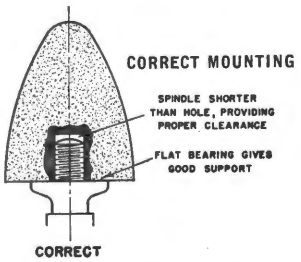


FIGURE NO. 9

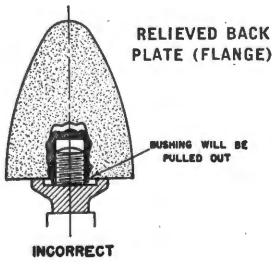


FIGURE NO. 10

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

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

(When threaded hole wheels are necessary, as in cups, cones and plugs, types No. 16, 17, 18, 18R, and 19, the size and mass of threaded hole wheels shall be kept within limits which have been found safe by experience for this mounting procedure.

In wheels whose mass is too great under the conditions mentioned above it is preferable to use unthreaded hole wheels mounted on spindles with suitable recessed flanges. This avoids the mounting and driving stresses in the critical zone around the wheel hole.

This is a type of mounting where a relief of the back plate (flange) is undesirable. If made with a relief, it is quite possible to pull the bushing out of the wheel as shown in Fig. 10.

The back plate (flange) should be perfectly flat and heavy enough to prevent "springing". If the back plate (flange) is "sprung" so that the bearing is concentrated close to the hole, trouble will likely occur.)

3.11 *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 proper necessary support. Minimum steel disc wheel (machine face plate) thicknesses for single spindle hand operated disc grinders are shown in Table 3.

TABLE 3

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

Note: These thicknesses are not adequate for heavy duty disc grinders. For this class of service thickness must be specified by the grinder manufacturer.

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. 11) shall be uniform for all holes so that screws can be used interchangeably.

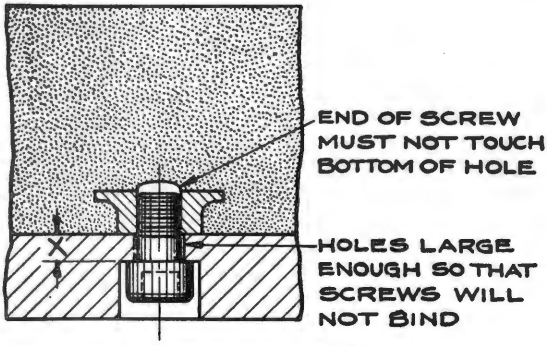


FIGURE NO. 11

Screws shall be of sufficient length to properly engage the threads in the inserted nuts, yet not so long that there will be any possibility of the ends touching bottom. They should have square ends and should be threaded clear to the end. (See Figs. 12 and 13)

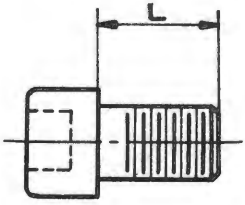


FIGURE NO. 12

CORRECT

***L** = Length under head to end of screw*

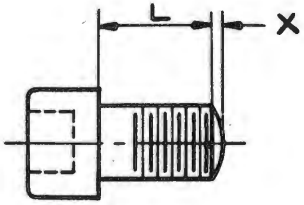


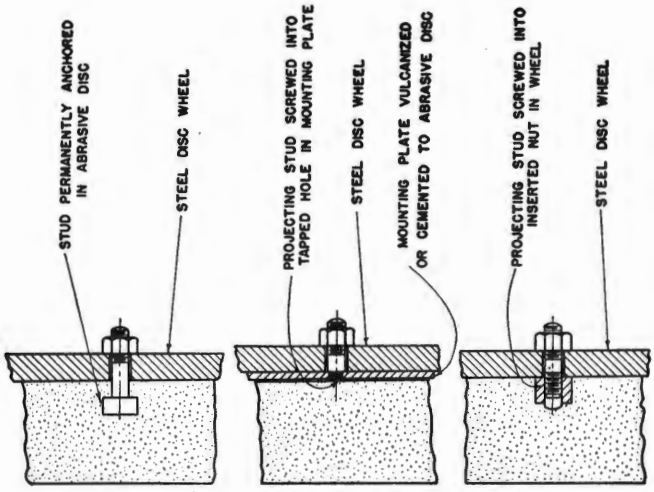
FIGURE NO. 13

INCORRECT

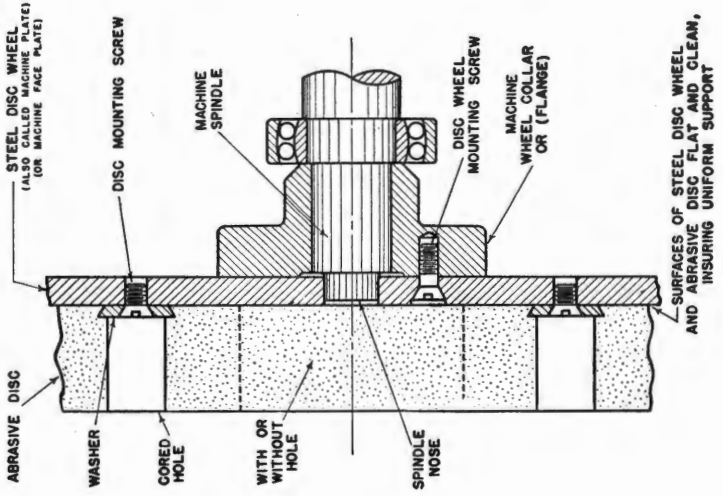
***L** = Does not represent total length of screw. Projection X will cause trouble*

Steel disc wheels (machine face plates) shall be maintained true and flat so as to provide even support over entire contact area between wheel and plate.

(The following illustrations 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.)



Various methods of mounting projecting stud or stud mounted type abrasive discs.



Inserted washer type abrasive disc.

3.12 *Mounting of Plate Mounted Type Wheels*

Plate mounted wheels generally are made with plates of insufficient thickness to provide adequate self-support.

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

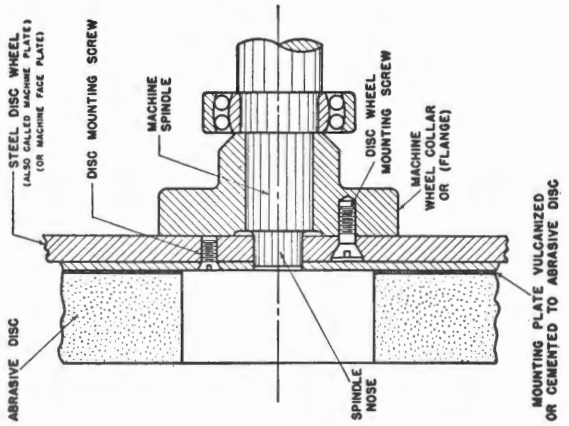
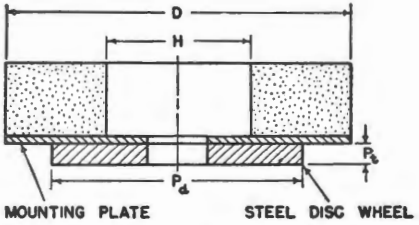


Plate mounted type wheels.

If the plates attached to the wheel are thinner than shown in Table 3 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 4 for single spindle hand operated disc grinders.

TABLE 4

MINIMUM THICKNESS OF STEEL DISC WHEELS FOR PLATE MOUNTED DISCS 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 P_t (Inches)
12 and smaller.....	3/8
14 to 16 inclusive.....	1/2
17 to 18 inclusive.....	5/8
19 to 26 inclusive.....	3/4
27 to 36 inclusive.....	7/8

Note: These thicknesses are not adequate for heavy duty disc grinders. For this class of service thicknesses must be specified by the grinder manufacturer.

A typical method of mounting a plate mounted type wheel is shown. 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 4 to allow for remachining to correct for wear.

SECTION 4 – TYPES OF PROTECTION DEVICES

4.1 *General Requirements*

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

(a) Safety Guards (Protection Hoods) (See 5.1)

(b) Safety Flanges (Protection Flanges) (See 6.1)

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 (see definition Sec. 1.5.7) 2 inches and smaller in diameter.

(3) Threaded hole pot balls, cones or plugs having a blind threaded hole, operating at normal speed where work offers protection. (See classification No. 1, Table 18)

NOTE: See 5.12.2 for additional protection for solid Cutting Wheels.

There are two distinct problems in grinding wheel safety.

1. *Care in handling, mounting and operating the wheels to prevent wheel breakage.*

2. *Guarding of the operating wheels to prevent injury to the operator if a wheel is accidentally broken.*

Only by strictly observing recommended safety regulations for both the operation of the wheels and for adequate wheel-guarding can the operator and others be protected from injury.

Safety guards (protection hoods) should be used if possible even in operations listed under "Exceptions".

Threaded hole pot balls, cones or plugs having a blind threaded hole should be limited to a mass of not greater than 3" diameter and 3" wide (thick) if used without guards to limit the potential hazard.

4.2 *Peripheral Grinding Wheels*

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

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

(b) Safety Flanges (Protection Flanges) as specified in 6.9.

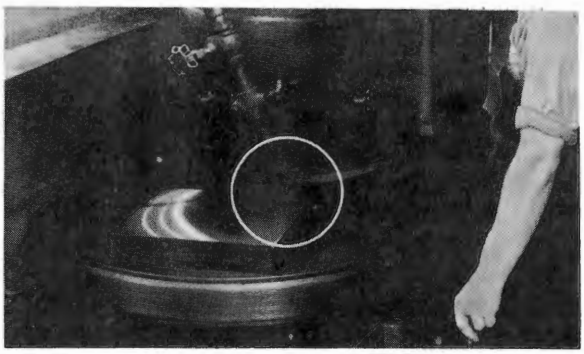
(Safety Guards (Protection Hoods) are the preferred and generally used type of protection. They are recommended even though Safety Flanges (Protection Flanges) may be used.)

4.3 *Abrasive Discs, Cylinders and Plate Mounted Wheels*

Disc wheels and cylinder wheels where grinding is done on the exposed flat side of same shall be protected by

(a) Safety Guards (Protection Hoods) as specified in 5.1 to 5.18 inclusive.

(b) Band Type Guards as specified in 5.19 and 5.20.



Application of a cylinder wheel. Note the band type safety guard enclosing the periphery of the wheel.

4.4 *Cup Wheels*

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

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

(b) Band Type Guards as specified in 5.19 and 5.20 or

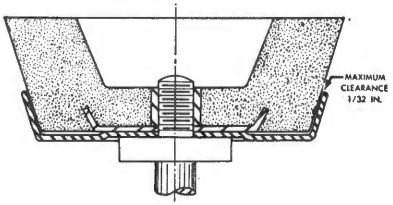
(c) Special "Revolving Cup Guards" for cup wheels used on portable grinders which mount behind the wheel on the spindle and turn with it. They shall be made with adequate strength of steel or other material and provide a peripheral member outward from the back for 1/3 of the wheel thickness. The mounting features shall conform with all requirements.

A plain hole wheel is held in place by an outer flange or adaptor. Threaded hole wheels shall have threaded inserts of suitable design or additional reinforcement to retain adequately the wheel pieces within the guard in case of accidental breakage.

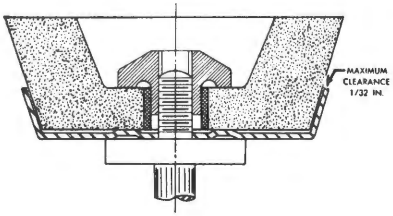
In using the Revolving Cup Guard, the clearance between wheel and guard shall not exceed 1/32 in. to insure optimum protection.

(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).

(Cup wheels are available with either a threaded or unthreaded hole. The following two illustrations show the typical types available. Each is shown mounted in conjunction with the revolving cup guard.)



Resinoid bonded flaring cup wheel showing threaded prong-anchor bushing molded into back, and revolving cup guard.



An unthreaded hole cup wheel and revolving cup guard assembly.

SECTION 5 – SAFETY GUARDS (PROTECTION HOODS)

5.1 *General Requirements (Same as Sec. 4.1)*

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

(a) Safety Guards (Protection Hoods)

(b) Safety Flanges (Protection Flanges)

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 (See 1.5.7) 2 inches and smaller in diameter.

(3) Threaded hole pot balls, cones or plugs having a blind threaded hole, operating at normal speed where work offers protection. (See Classification No. 1 Table 18)

NOTE: See 5.12.2 for additional protection for solid Cutting Wheels.

(Direction of wheel rotation and position of the operator in the various grinding operations were primarily considered in establishing regulations for safety guards. Since the line of flight of broken wheel pieces will be tangential in the direction of rotation of the wheel, the maximum exposure angles must be strictly observed for operator protection.)

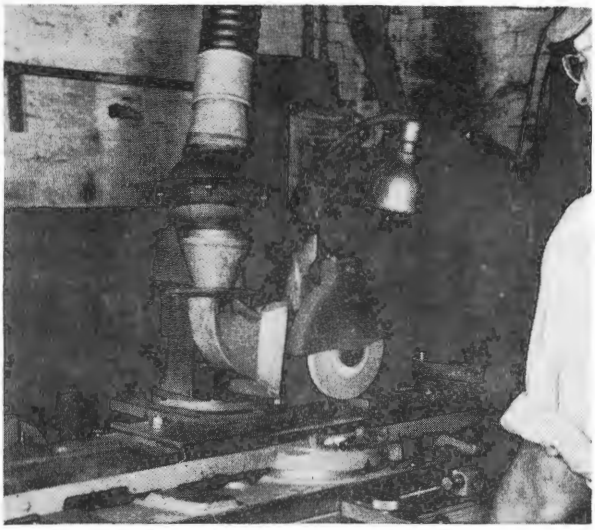
5.2 *Mounting and Fastenings*

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

(Fastenings must be strong enough to hold the safety guard in place at all times and under all conditions.)

5.3 *Dust Exhaust Provision*

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



Note the excellent provisions employed to exhaust grinding dust.

5.4 *Exposure – Bench and Floor Stands*

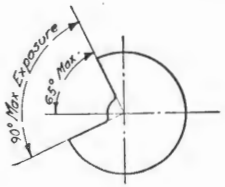


FIGURE NO. 14

The maximum 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 Fig. 14)

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

FIGURE NO. 15

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125 degrees. This exposure shall begin at a point not more than 65 degrees above and extend to a point not more than 60 degrees below the horizontal plane of the wheel spindle. (See Fig. 15)

5.5 *Exposure – Cylindrical Grinders*

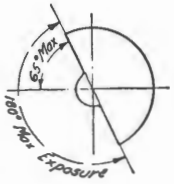
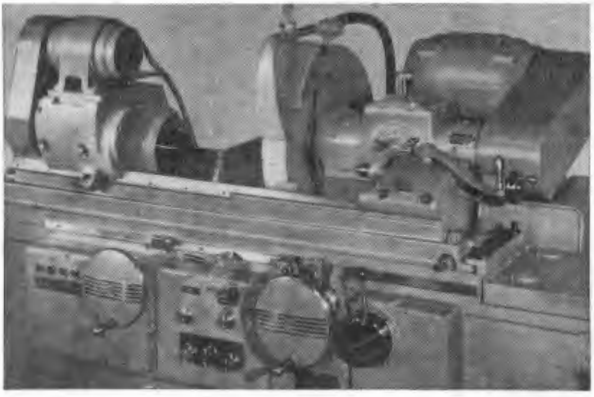


FIGURE NO. 16

The maximum angular exposure of the grinding wheel periphery and sides for safety guards usedon cylindrical grinding machines shall not exceed 180 degrees. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. (See Fig. 16)

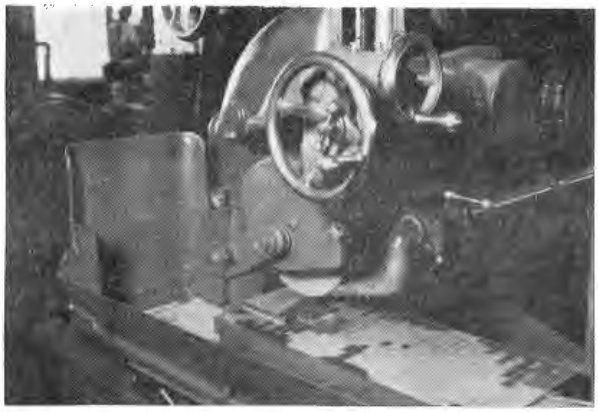


A cylindrical grinding machine employing a well-designed guard.

5.6 *Exposure – Surface Grinders and Cutting-Off Machines*

FIGURE NO. 17

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 Fig. 17)



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.

5.7 *Exposure – Swing Frame and Portable Grinders*

FIGURE NO. 18

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

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

5.8 *Exposure – Top Grinding*

In operations where the work is ground on the top of the wheel, the exposure of the grinding wheel periphery shall be as small as practicable, with a maximum exposure of 60 degrees. (See Fig. 19)

FIGURE NO. 19

5.9 *Exposure Adjustment*

Safety Guards of the types described in 5.4 and 5.5 where the operator stands in front of the opening, shall be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in 5.4 and 5.5 shall never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top shall never exceed 1/4 inch. (See Figs. 20, 21 and 22)

(Figures 20 and 21 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. Figure 22 shows a condition that does not comply with the requirements.)

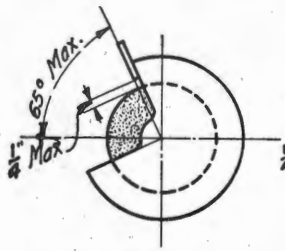


FIGURE NO. 20
CORRECT
Showing adjustable tongue giving required angular protection for all sizes of wheels used

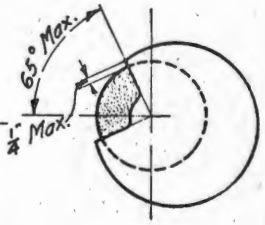


FIGURE NO. 21
CORRECT
Showing movable hood with opening small enough to give required protection for smallest size wheel used

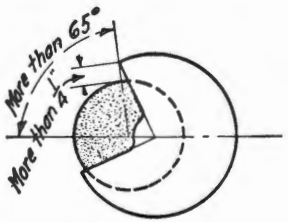


FIGURE NO. 22
INCORRECT
Showing movable hood with size of opening correct for full size wheel, but too large for smaller wheels

5.10 *Exposure – High Speeds*

The maximum exposure allowances specified in 5.4 to 5.8 are designed to provide satisfactory protection when peripheral speeds do not exceed 9500 fpm. If wheels are broken when running at higher speeds there is a tendency for them to break into smaller pieces. Smaller openings would therefore be required to provide the same degree of protection. No data are available from which specifications can be compiled, but this feature shall be taken into consideration in any special cases where safety guards are being designed for use with wheels operating at higher peripheral speeds than 9500 fpm. This is especially important in connection with safety guards of the types where operator stands in front of the opening.

5.11 *Fixed Members*

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

This cutting-off machine employs a guard which is designed to allow removal of side member for access to wheel.

5.12 *Enclosure Requirements*

5.12.1 *Safety Guard*

The safety guard shall enclose the spindle end, nut and flange projections, if any.

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

5.12.2 *Additional Enclosure*

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

This auxiliary enclosure shall be in addition to the safety guard. The enclosure may consist of a set of heavy screen panels suspended from above and extending from a level approximately 8 feet above the floor, downward to a level at or below that of the table on which the work is placed. The screen for such panels should be of 1/2 inch mesh or smaller and the wire 1/8 inch diameter or more. The framework for the panels should be of 1 x 1/4 inch or heavier structural steel angles or channels. Other forms affording equal or greater protection are also acceptable.

5.13 *Material Requirements and Minimum Dimensions*

Figure 23 and Table 5 specify minimum basic thicknesses of peripheral and side members for various types of safety guards and classes of service.

5.13.1 *For Speeds Up To 10,000 S. F. P. M.*

Steel casting safety guards, structural steel or drawn steel safety guards as specified in table 5 shall be used where operating speed of wheels is faster than 7000 peripheral feet per minute up to a maximum of 10,000 peripheral feet per minute.

5.13.2 *For Speed Up To 7,000 S. F. P. M.*

If operating speed does not exceed 7,000 peripheral feet per minute cast iron safety guards, malleable iron guards or other guards as described in 5.13.1 shall be used.

5.13.3 *Optional Materials*

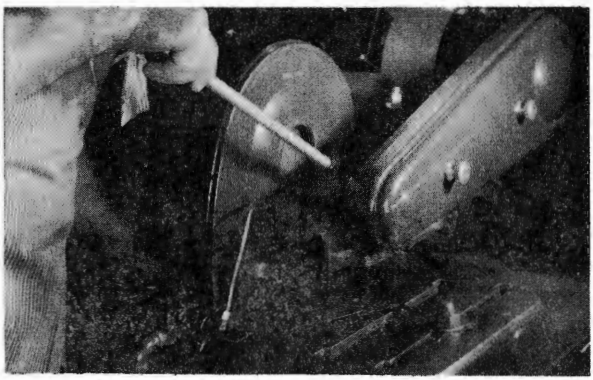
If materials other than those listed in table 5 are used, the thickness of the peripheral and side members shall be such that the resultant safety guard will be as strong or stronger.

5.13.4 *Exceptions:*

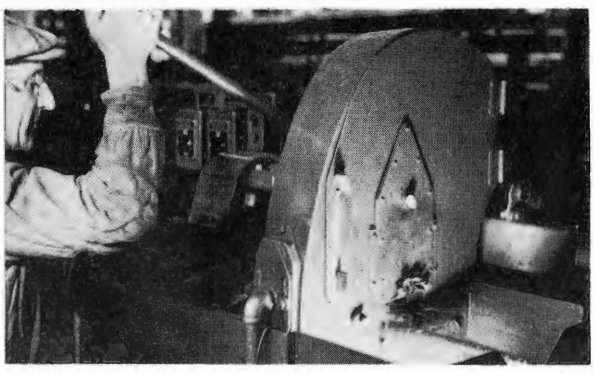
(1) For cutting-off wheels 16 inches diameter and smaller and where speed does not exceed 16,000 peripheral feet per minute, cast iron or malleable iron safety guards as specified in Table 5 or other safety guards providing equal or better protection shall be used.

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



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



This cutting-off machine has a wheel larger than 16 inches diameter but is not operating in excess of 14,000 peripheral feet per minute. Note complete enclosure of wheel by the fabricated safety guard.

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		7 to 12 Inches		13 to 16 Inches		17 to 20 Inches		21 to 24 Inches		25 to 30 Inches		31 to 48 Inches	
			A	B	A	B	A	B	A	B	A	B	A	B	A	B
Materials satisfactory for speeds up to 7,000 ft. per min.	Cast Iron	Inches	Inches		Inches		Inches		Inches		Inches		Inches		Inches	
		2	1/4	1/4	3/8	5/16	1/2	3/8	5/8	1/2	7/8	5/8	1	3/4	1 1/4	1
		4	5/16	5/16	3/8	5/16	1/2	3/8	3/4	5/8	1	5/8	1 1/8	3/4	1 3/8	1
		6	3/8	5/16	1/2	7/16	5/8	1/2	1	5/8	1 1/8	3/4	1 1/4	7/8	1 1/2	1 1/8
	Malleable Iron	2	1/4	1/4	3/8	5/16	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1	7/8
		4	5/16	5/16	3/8	5/16	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1 1/8	7/8
		6	3/8	5/16	3/8	5/16	5/8	1/2	3/4	5/8	7/8	5/8	1	3/4	1 1/4	7/8
Materials satisfactory for speeds up to 16,000 ft. per min.*	Steel Castings	2	1/4	1/4	1/4	1/4	3/8	3/8	1/2	7/16	5/8	1/2	3/4	5/8	7/8	3/4
		4	1/4	1/4	1/4	1/4	3/8	3/8	1/2	7/16	5/8	1/2	3/4	5/8	1	3/4
		6	3/8	1/4	3/8	1/4	1/2	3/8	5/8	1/2	3/4	5/8	7/8	3/4	1 1/8	3/4
	Structural Steel	2	1/8	1/16	3/16	1/8	3/16	3/16	1/4	1/4	5/16	1/4	3/8	5/16	1/2	3/8
		4	1/8	1/16	3/16	1/8	3/16	3/16	1/4	1/4	5/16	1/4	3/8	5/16	1/2	3/8
		6	3/16	1/16	1/4	1/8	1/4	3/16	3/8	1/4	3/8	1/4	7/16	5/16	5/8	3/8

* Includes cutting-off wheels 16 in. Dia. and smaller at speeds not exceeding 16,000 SFPM.

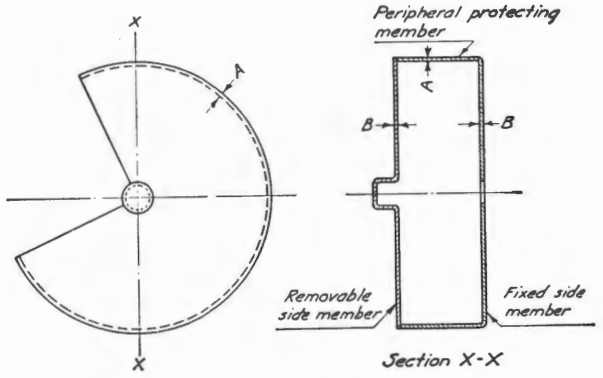


FIGURE NO. 23

TABLE 6
MINIMUM BASIC THICKNESSES FOR PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS USED WITH CUTTING-OFF WHEELS LARGER THAN 16" DIAMETER AT SPEED NOT EXCEEDING 14,000 SFPM

Material Used in Construction of Guard		Maximum Thickness of Cutting-off Wheel	Cutting-Off Wheel Diameters											
			12 to 16 Inches		17 to 20 Inches		21 to 24 Inches		25 to 30 Inches		32 to 36 Inches			
			A	B	A	B	A	B	A	B	A	B		
Cutting-off Wheels 14,000 ft. per min.	Structural Steel	Inches ½ and less	Inches ⅛	⅛	Inches ⅛	⅛	Inches $\frac{3}{16}$	⅛	Inches $\frac{3}{16}$	⅛	Inches ¼	$\frac{3}{16}$		

5.14 *Material Specifications*

The minimum thickness specifications shown in T ables 5 and 6 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

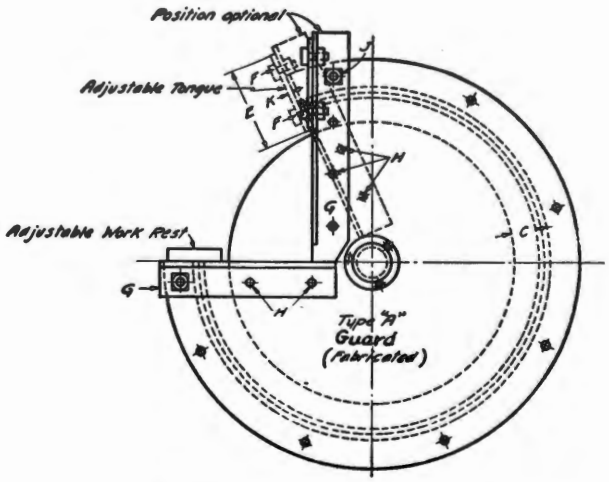
(d) Structural Steel Plate – A 7-53T (excluding specifications for rivet steel)

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

5.15 *Construction Guide for Fabricated Guards*

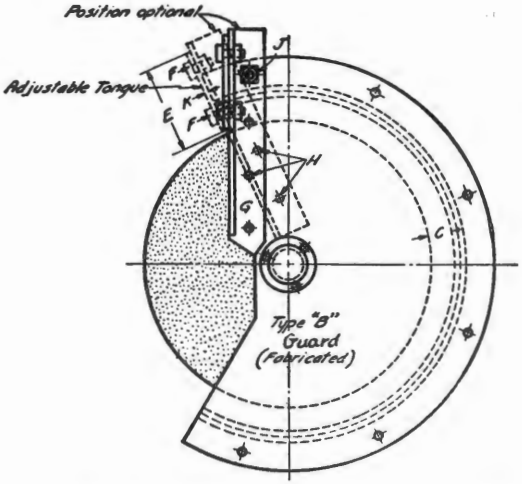
As a guide for the construction of fabricated guards of structural steel. Figures 24 to 27 inclusive and Table 7 have been prepared. Other designs affording equal or better protection are also acceptable.

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



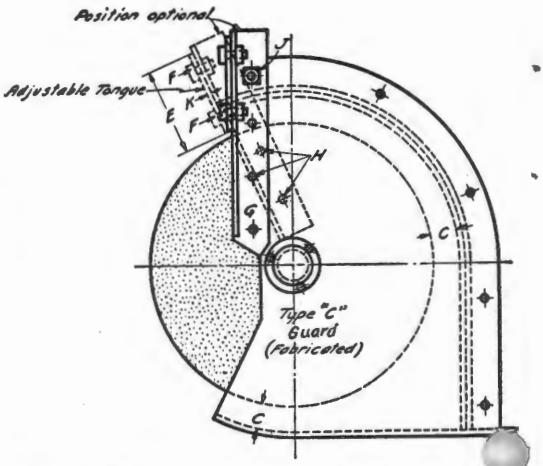
See Rule 5.3 for Dust Exhaust Provision

FIGURE NO. 24



See Rule 5.3 for Dust Exhaust Provision

FIGURE NO. 25



See Rule 5.3 for Dust Exhaust Provision

FIGURE NO. 26

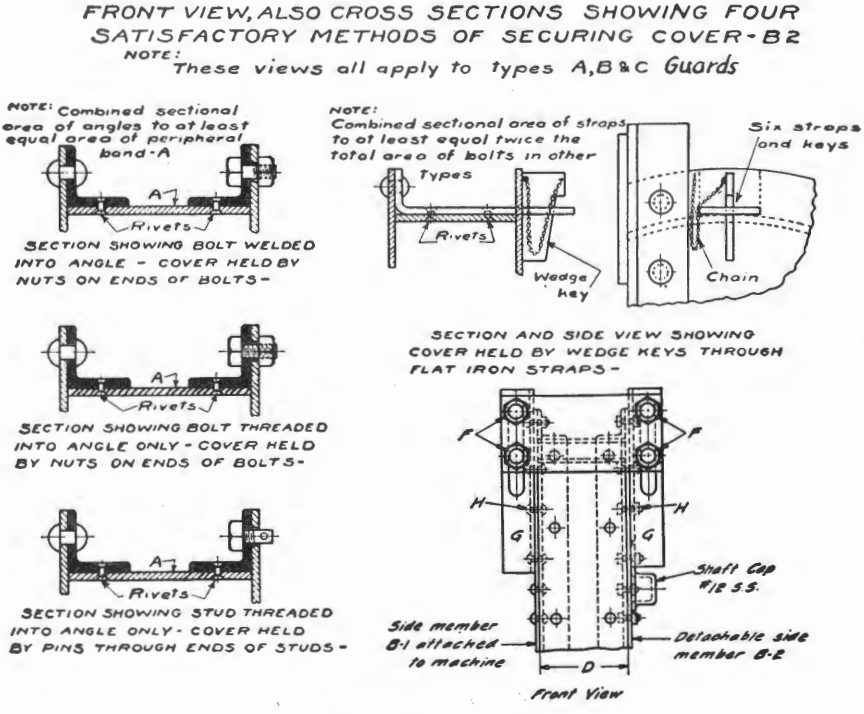


FIGURE NO. 27

TABLE 7

DIMENSIONAL REQUIREMENTS FOR CONSTRUCTION OF FABRICATED GUARDS

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

5.16 *Strength of Connections*

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

5.17 *Specifications for Rivets, Bolts and Studs for Fabricated Guards*

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

TABLE 8

MINIMUM SIZES AND SPACING OF RIVERS, 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	3½	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	3½	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

5.18 *Construction Guide for Drawn Steel Guards*

As a guide for the construction of drawn steel guards for wheels 8 inches diameter and smaller, Figure 28, Table 9 have been prepared. Other designs affording equal or better protection are also acceptable.

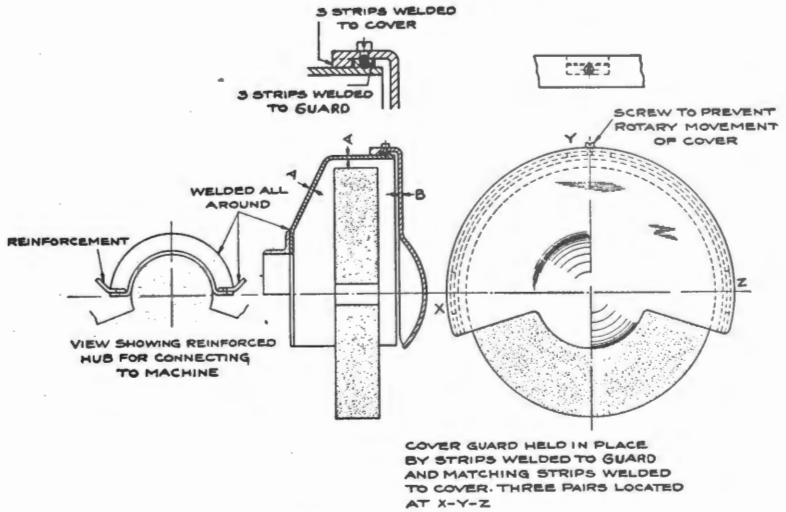


FIGURE NO. 28

TABLE 9

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

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

Special design drawn steel guards for use with only very thin abrasive wheels on portable machines have been tested and approved. (See Fig. 29 and Table 10) An essential feature of design is the lip on the outer edge which curls inward to retain pieces if a wheel is broken in the 180° arc next to the operator and to provide necessary strength with light sheet steel.

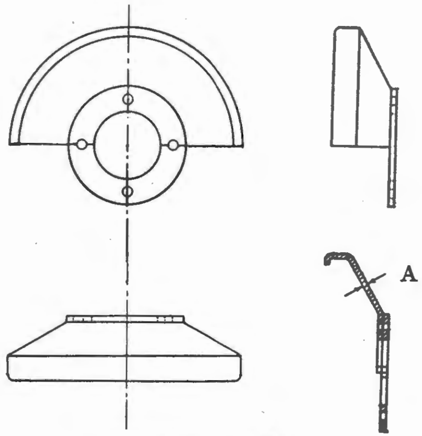
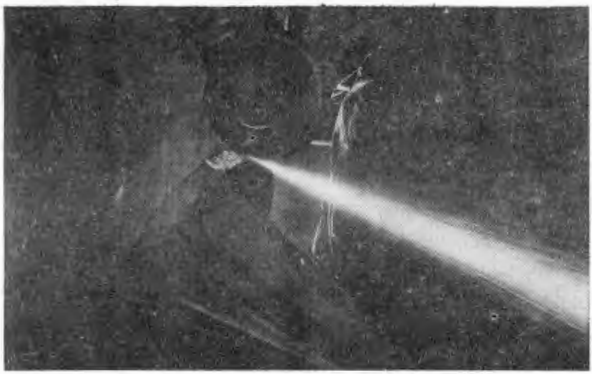


FIGURE NO. 29

TABLE 10

DRAWN STEEL GUARD FOR PORTABLE GRINDERS

Material Used in Construction of Guard		Maximum Thickness of Wheel	Wheel Diameter 2 to 9 Inches A
Material satisfactory for speeds up to 14,200 SFPM	Hot Rolled Steel SAE 1008	$\frac{3}{8}$ Inches	$\frac{1}{16}$ Inches



This drawn steel guard affords proper operator protection. Notice that wheel exposure is less than the maximum 180° and the top half of the wheel is fully enclosed.

.19 ***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 11; nor the wall thickness (W) whichever of these is the lesser.

TABLE 11

Exposer 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

(See Fig. 30.)

5.20 *Construction Guide for Band Type Guards*

As a guide for the construction of band type guards. Figure 30 and Table 12 have been prepared. Other designs affording equal or better protection are also acceptable.

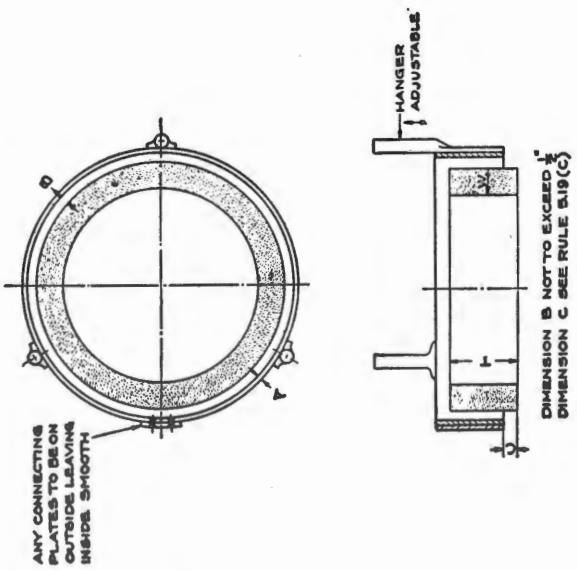


FIGURE NO. 30

TABLE 12

Guide for Construction of Band Type Guards

Diameter of Wheel	Minimum Thickness of Band A	Minimum Diameter of Rivets	Maximum Distance between Centers of Rivets
Inches Under 8	Inches $\frac{1}{8}$	Inches $\frac{3}{8}$	Inches ¾
8 to 24	⅛	¼	1
25 to 30	¼	⅜	1¼

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

SECTION 6 – FLANGES

6.1 *General Requirements*

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

Exceptions:

Mounted Wheels
Threaded Wheels (Plugs and Cones)
Abrasive Discs (Inserted Nut, Inserted Washer and Projecting Stud Type)
Plate Mounted Wheels
Cylinder, Cup or Segmental Wheels that are mounted in chucks.

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

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

(2) Safety flanges shall be used where no other standard form of protection is employed. They shall be used only with wheels designed to fit the flanges. Safety flanges are usually of the tapered type described in 6.9, but may be of any other type affording equal or better protection.

(*There are two major stresses in grinding wheels. These stresses are caused from wheel rotation and from the heat of grinding. Since they combine at the hole they cause this to be the area with the greatest stress.*

It is, therefore, important that other stresses developed through mounting (compressive stress) and driving (torque stress) be applied to the wheel as far from the hole as practical.

This is best accomplished by using flanges at least as large as those listed in Table 13.

Flanges must be at least minimum diameters specified, identical in diameter and radial bearing surface to avoid crossbending pressures and stresses in the wheel structure. Blotters (Compressible washers) shall always be used between metal flanges and abrasive wheel surfaces for uniform distribution of flange pressure.

Flanges should be checked periodically for flatness, burrs or wear.)

6.2 *Material*

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

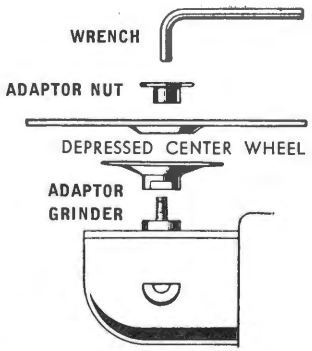
6.3 *Finish and Balance*

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

6.4 *Uniformity of Diameter*

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

EXCEPTION: Depressed center wheels (Type 27) are designed and reinforced for use with a special large-back flange and a smaller outer flange nut.

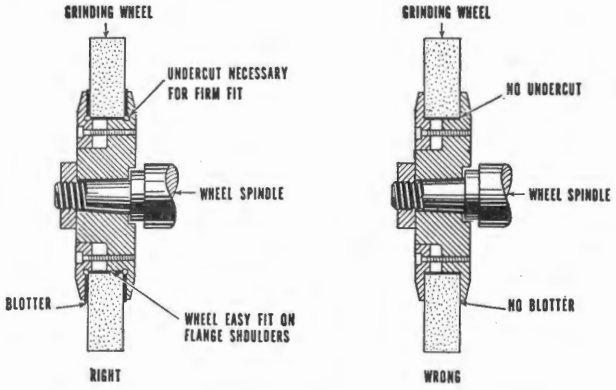


Typical assembly of the Type 27 wheel exclusive of guard.

6.5 *Recess*

Straight flanges made according to Fig. 31 and tapered flanges made according to Fig. 34 shall be recessed at least one sixteenth of an inch (1/16") on the side next to the wheel for a distance as specified in the respective tables of dimensions for straight and tapered flanges.

Straight flanges of the adaptor and sleeve types (Figs. 32 and 33) shall be recessed so that there will be no bearing on the sides of the wheel within 1/8 inch of the wheel hole.

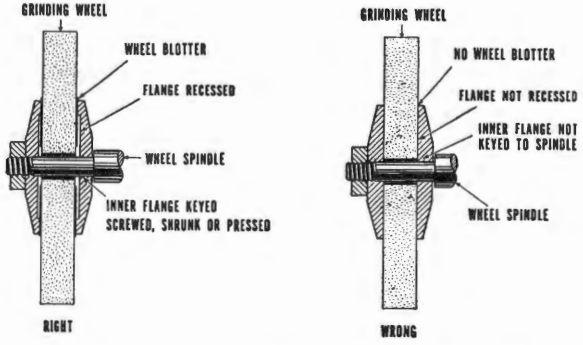


Proper and improper methods of mounting wheels having large holes.

6.6 *Contact*

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

(Flanges must be at least minimum diameters specified, identical in diameter and radial bearing surface to avoid crossbending pressures and stresses in the wheel structure. Blotters (Compressible washers) shall always be used between metal flanges and abrasive wheel surfaces for uniform distribution of flange pressure.)



Proper and improper methods of mounting wheels having small holes.

6.7 *Fit*

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

6.8 *Dimensions*

6.8.1 *Straight Flanges (See Fig. 31)*

Table 13 shows minimum dimensions for straight flanges for use with wheels with small holes that fit directly on the machine spindle. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made considerably thicker to allow for truing when they become worn through use.

6.8.2 *Straight Adaptor Flanges*

Table 14 shows minimum dimensions for straight adaptor flanges for use with wheels having holes larger than the machine arbor. Dimensions of such adaptor flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new adaptor flanges be made considerably thicker to allow for truing when they become worn through use. (See Fig. 32)

Note: Adaptor flanges are designed especially for use with organic bonded wheels. Large hole vitrified wheels are not recommended for snagging or any rough heavy grinding.

(*When the hole diameter of a wheel is specified beyond 1/8th of the wheel diameter, the unit stress at the hole increases quite rapidly. Consequently, the factor of safety decreases as the hole diameter approaches one-half of the wheel diameter. For this reason, it is desirable to use small-hole grinding wheels where possible.*

This is especially true in the case of vitrified snagging wheels. The structure of these wheels is rigid and non-yielding and, therefore, cannot withstand the heavy and sudden pressure or shock encountered in the snagging operation.

The fact that larger hole vitrified wheels cannot be manufactured to incorporate additional reinforcing at stub size makes them unsuitable for rough grinding applications.)

6.8.3 *Sleeve Flanges (See Fig. 33)*

Table 15 shows minimum dimensions for straight flanges that are an integral part of wheel sleeves such as are frequently used on precision grinding machines. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made thicker to allow for truing when they become worn through use.

(In mounting large hole wheels, it is more important than ever to be sure that equipment and mounting procedures are satisfactory to avoid springing 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.)

6.9 *Tapered Safety Flanges*

6.9.1 *Degree of Taper*

Tapered wheels used with tapered safety flanges should be tapered at least 3/4 inch per foot on each side.

Tapered flanges or collars made according to Fig. 34 and Fig. 35 shall have the same degree of taper as the wheels.

Tapered flanges or collars made according to Fig. 36 and Fig. 37 shall be tapered 1/32 inch per foot more than the taper of the wheel.

(Use of tapered sided wheels with tapered safety flanges has two advantages:

1. Stronger (Safer) Wheels

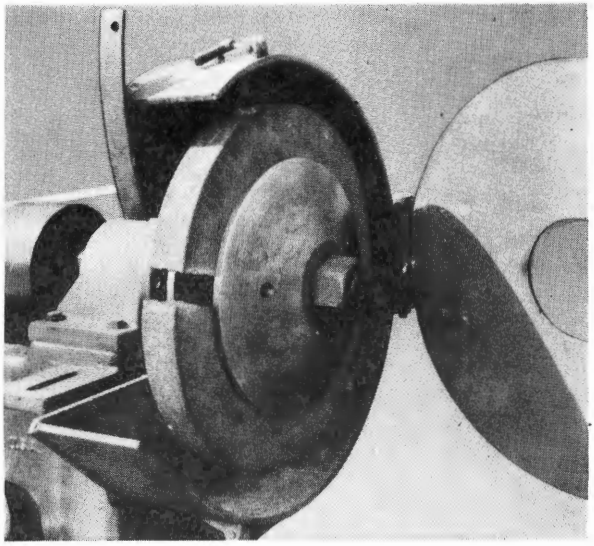
The increased wheel section at the hole provides additional strength and safety where operational stresses are highest. This increase in thickness of the critical zone at the hole increases substantially the strength and safety of these wheels.

2. Protection Flanges

Properly designed tapered flanges, used with wheels having a taper on both sides of at least 3/4 inches per foot, will retain the wheel pieces at safe speeds in case of accidental breakage. Blotters (Compressible washers) should always be used.

6.9.2 *Dimensions for Slow Speed*

Fig. 34 and Fig. 36 illustrate two satisfactory styles of tapered safety flanges for use where wheel speed does not exceed 6500 peripheral feet per minute. Minimum dimensions covering both styles are shown in Table 16. Dimensions of such flanges shall never be less than indicated and should be greater where practical. It is especially recommended that new flanges be made thicker to allow for truing when flanges become worn through use.



These tapered safety flanges effectively retained the wheel when it was broken. Notice, however, that even though safety flanges were used the machine employs a safety guard of proper design.

6.9.3 *Dimensions for High Speed*

Fig. 38 illustrates a style of tapered safety flanges for use where wheel speed exceeds 6500 but does not exceed 9500 peripheral feet per minute. Minimum dimensions are shown in Table 17. Dimensions of flanges used for this class of service shall not be less than indicated.

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

6.10 *Repairs and Maintenance*

All flanges whether straight or tapered 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 is maintained as specified in 6.5 and 6.6 and they shall be replaced when they do not conform to 6.5 and 6.6 and Tables 13-14-15-16-17. This is especially important in connection with flanges of the adaptor and wheel-sleeve types or excessive flange pressure around the edge of the hole of the wheel is apt to result.

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

TABLE 13

MINIMUM DIMENSIONS FOR STRAIGHT FLANGES
(THESE ARE NOT SAFETY FLANGES)

A	B	C		D	E
Diameter of Wheel	Minimum Outside Diameter of Flanges	Radial Width of Bearing Surface		Minimum Thickness of Flange at Bore	Minimum Thickness of Flange at Edge of Recess
		Minimum	Maximum		
Inches	Inches	Inches	Inches	Inches	Inches
1	3/8	1/16	1/8	1/16	1/16
2	3/4	1/8	3/16	1/8	3/32
3	1	1/8	1/4	3/16	3/32
4	1 1/4	3/16	3/8	3/16	1/8
5	1 1/2	3/16	3/8	1/4	1/8
6	2	1/4	1/2	3/8	3/16
7	2 1/2	1/4	1/2	3/8	3/16
8	3	1/4	1/2	3/8	3/16
10	3 1/2	5/16	5/8	3/8	1/4
12	4	5/16	5/8	1/2	5/16
14	4 1/2	3/8	3/4	1/2	5/16
16	5 1/2	1/2	1	1/2	5/16
18	6	1/2	1	5/8	3/8
20	7	5/8	1 1/4	5/8	3/8
22	7 1/2	5/8	1 1/4	5/8	7/16
24	8	3/4	1 1/4	5/8	7/16
26	8 1/2	3/4	1 1/4	5/8	1/2
28	10	7/8	1 1/2	3/4	1/2
30	10	7/8	1 1/2	3/4	5/8
36	12	1	2	7/8	3/4
42	14	1	2	7/8	3/4
48	16	1 1/4	2	1 1/8	1
60	20	1 1/4	2	1 1/4	1 1/8

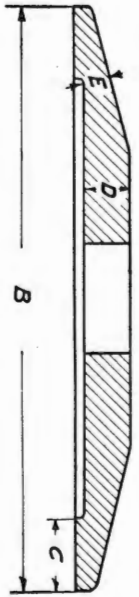


FIGURE NO. 31

Driving flange secured to spindle. See Rule 6.7

TABLE 14

MINIMUM DIMENSIONS FOR STRAIGHT ADAPTOR FLANGE FOR HEAVY DUTY GRINDING

(These are not safety flanges)

Wheel Diameter	Hole Diameter	B Minimum Flange Diameter	D Minimum Thickness of Flange at Bore	E Minimum Thickness of Flange at Edge of Recess
Inches	Inches	Inches	Inches	Inches
12	4	6	5/8	3/8
to	5	7	5/8	3/8
14	6	8	5/8	3/8
Larger than	4	6	5/8	3/8
14	5	7	5/8	3/8
to	6	8	5/8	3/8
18	7	9	5/8	3/8
	8	10	5/8	3/8
Larger than	6	8	3/4	1/2
18	7	9	3/4	1/2
to	8	10	3/4	1/2
24	10	12	3/4	1/2
	12	14	3/4	1/2
Larger than 24 to 36	12	15	3/4	1/2
	16	20	1 1/8	7/8
	20	24	1 1/4	1
Larger than 36 to 48	12	16	1	3/4
	16	20	1 1/8	7/8
	20	24	1 1/4	1
Larger than 48 to 60	16	20	1 1/8	7/8
	20	24	1 1/4	1
	24	29	1 1/4	1

Note: These adaptors may be clamped together by means of a central nut, or by a series of bolts or some other equivalent means of fastening. For hole sizes smalller than shown in this table, use table 13.

TABLE 15

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

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 13.

(These are not safety flanges)

Wheel Diameter	Wheel Hole	B Minimum Outside Diameter of Flange	D Minimum Thickness of Flange of Bore	E Minimum Thickness of Flange at Edge of Recess
Inches	Inches	Inches	Inches	Inches
12 to 14	5	7	½	7/16
Larger than 14 to 20	5	7	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

TABLE 16

MINIMUM DIMENSIONS FOR TAPERED SAFETY FLANGES FOR SPEEDS LESS THAN 6500 SFPM

A Diameter of Wheel	B Minimum Outside Diameter of Flanges	C Radial Width of Bearing Surface Fig 35 Only		D Minimum Thickness of Flange at Bore	E Minimum at Edge of Recess Fig. 35 Only	E_1 Minimum Thickness at Bevel Fig. 37 Only	F Maximum Flat Spot at Center of Flange Inside	F_1 Diameter of Flat Area Outside Fig. 37 Only	G Maximum Diameter of Flat Spot or Hub of Wheel
		Minimum	Maximum						
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
6	3	1/4	1/2	3/8	3/16	..	0	..	1
8	4	5/16	5/8	3/8	1/4	..	0	..	1
10	5	1/2	1	1/2	1/4	..	0	..	2
12	6	1/2	1	5/8	5/16	1/2	4	5	4 1/2
14	8	5/8	1 1/4	5/8	3/8	1/2	4	5	4 1/2
16	10	3/4	1 1/2	5/8	3/8	1/2	4	6	6
18	12	1	2	3/4	1/2	5/8	4	6	6
20	14	1 1/4	2 1/2	3/4	1/2	5/8	4	7	6
22	16	1 3/8	2 3/4	3/4	9/16	5/8	4	7	6
24	18	1 1/2	3	3/4	9/16	5/8	4	8	6
26	20	1 1/2	3 1/4	3/4	5/8	5/8	4	8	6
28	22	1 3/4	3 3/4	7/8	5/8	5/8	4	8	6
30	24	2	4	7/8	3/4	3/4	4	8	6
36	28	2	4	1	7/8	..	4	..	6

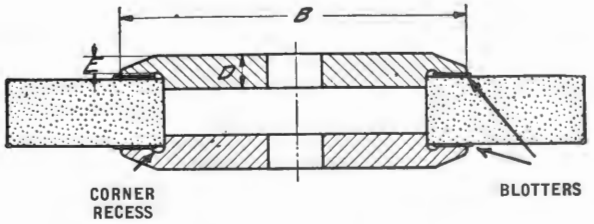


FIGURE NO. 32

Driving flange secured to spindle. See Rule 6.7

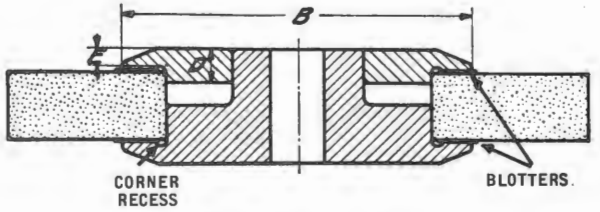


FIGURE NO. 33

Driving flange secured to spindle. See Rule 6.7

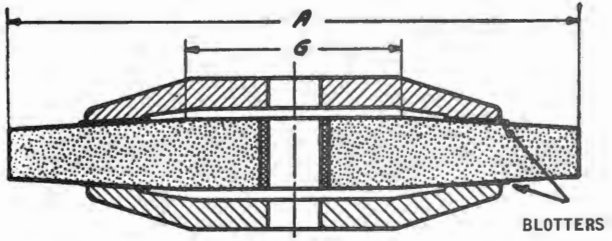


FIGURE NO. 34

Driving flange secured to spindle. See Rule 6.7

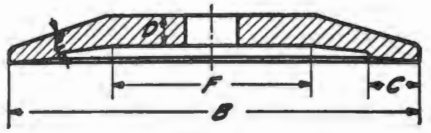


FIGURE NO. 35

For degree of taper see Rule 6.9.1

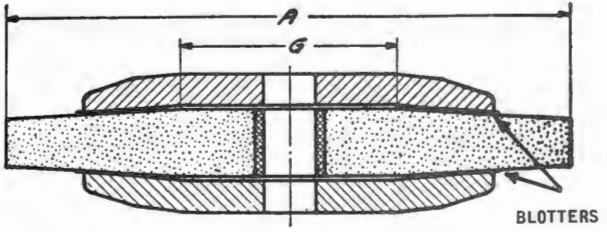


FIGURE NO. 36

Driving flange secured to spindle. See Rule 6.7

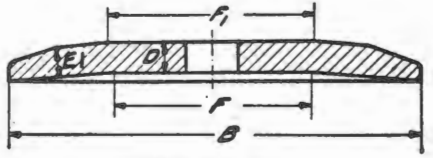


FIGURE NO. 37

For degree of taper see Rule 6.9.1

TABLE 17

MINIMUM DIMENSIONS FOR TAPERED SAFETY FLANGES FOR SPEEDS GREATER THAN 6500 SFPM BUT LESS THAN 9500 SFPM

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

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

For degree of taper see Rule 6.9.1

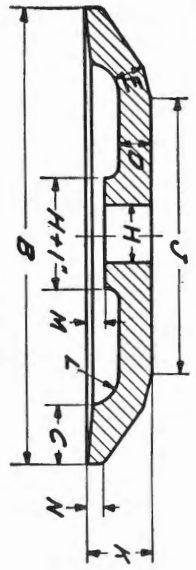


FIGURE NO. 38

Driving flange secured to spindle. See Rule 6.7

SECTION 7 – MOUNTING

7.1 *Inspection*

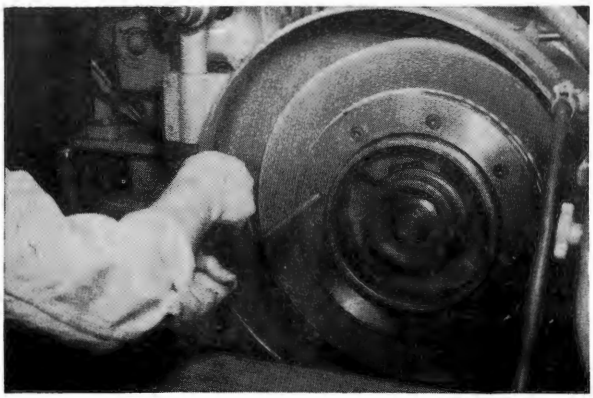
Before mounting, all wheels shall again be closely inspected and sounded (ring test – see 2.3) to make sure that they have not been injured in transit, storage or otherwise.

(Major stresses from rotation and grinding heat cause high stresses around the central hole. Great care must be used to observe safety regulations on size and design of mounting flanges and mounting techniques. This will assure that the driving torque is applied to the wheel well outside the hole area.)

7.2 *Fit*

Grinding wheels shall fit freely on the spindles; they should not be forced on, nor should they be too loose. (See 3.9)

(The hole in the wheel must be suitably oversize so that the wheel fits freely but not loosely under all operating conditions, including possible expansion of the wheel mount from the heat of operation.)



Note the washer (blotter) between the abrasive wheel and the flange.

7.3 *Surface Condition*

All surfaces of wheels, blotters (washers) and flanges in contact with each other shall be free from foreign material.

7.4 *Bushing*

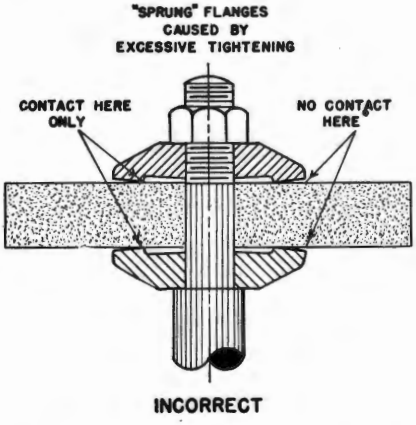
The wheel bushing shall not extend beyond the sides of the wheel.

7.5 *Washers (Blotters, etc.)*

Washers (blotters) or flange facings of compressible material shall be fitted between the wheel and its flanges. If blotting paper is used, it should not be thicker than 0.025 inch. If other compressible material is used, it should not be thicker than 1/8 inch. The diameter of the washers shall not be smaller than the diameter of the flanges.

7.6 *Tightening of Nut*

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



The above clearly illustrates the results encountered when the spindle end nut is excessively tightened.

SECTION 8 – SPEED

8.1 *Operating Speeds*

8.1.1 *Standard Maximum Speeds*

The maximum operating speed of each wheel must be established at the time of manufacture to assure proper manufacturer's approval and suitable test. The manufacturer's established maximum operating speed shall never be exceeded.

Table 18 indicates maximum peripheral operating speeds (SFPM) which are standard for various classes of wheels.

Higher speeds than indicated in Table 18 may be used if conditions (A), (B), (C) and (D) listed under 8.1.2 are met.

TABLE 18
STANDARD MAXIMUM SPEEDS

Classification Number	Types of Wheels	Vitrified and Silicate Bonds			Organic Bonds		
		Low Strength	Medium Strength	High Strength	Low Strength	Medium Strength	High Strength
		SFPM	SFPM	SFPM	SFPM	SFPM	SFPM
1	*Type 1—Straight Wheels (Except classification No. 7 Below) *Type 4—Taper Wheels *Types 5 and 7—Recessed Wheels *Type 12—Dish Wheels *Type 13—Saucer Wheels	5,500	6,000	6,500	6,500	8,000	9,500
2	*Type 2—Cylinder Wheels	4,500	5,500	6,000	5,000	6,000	7,000
3	**Dovetail Wheels *Type 11—Flaring Cups	4,500	5,500	6,000	6,000	8,000	9,500
4	*Type 6—Cup Wheels	4,500	5,000	5,500	6,000	8,000	9,500
5	Abrasive Discs—#Plate mounted Inserted nut, & Projecting Stud	5,500	6,000	6,500	5,500	7,000	8,500
6	Cylinder Type Abrasives Discs #-Plate Mounted, Inserted Nut, & Projecting Stud.	4,500	5,500	6,000	5,000	6,000	7,000
7	Type 1 - Reinforced 10" dia. & Smaller - ½" Thick and under except Cutting-off Wheels				9,500	12,000	14,200
8	Type 27 - Depressed Center Reinforced Wheels				9,500	12,000	14,200
9	Diamond Wheels — Cutting Wheels (a) Metal bonded with Steel center						14,000
	(b) Metal bonded with Metallic compound center						7,500
	(c) Resin bonded with Resin or Metallic compound center						7,500
	All other types						6,500

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

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

* Standard Shapes. ** Non-Standard Shapes. # See Definition. Sec 1.2.2

Note: The number of revolutions per minute may be increased as the diameter of a wheel is reduced through wear provided the original peripheral speed is never exceeded.

(The maximum safe speeds established in Table 18 have proven satisfactory and ample for most grinding operations over past decades. Maintaining the excellent safety record in the use of grinding wheels depends on not exceeding these maximum safe speeds.

Under no condition should a wheel be operated any faster than the safe maximum speed established by the wheel manufacturer.

The maximum safe speed should not be confused as indicating the best grinding speed for the operation which may be considerably lower.)

8.1.2 *Special Maximum Speeds*

Special high speeds as listed in Table 19 for specially designed and fully protected machines have been established for cutting-off wheels, thread grinding, crank grinding and cam grinding. These special applications and others not listed in Table 19 are subject to ALL CONDITIONS (a), (b), (c) and (d) below and arenot approved except on adequate, fully protected machines.

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

CONDITION (b) The wheels shall be of adequate strength and shall have been tested by the wheel manufacturer at a suitable overspeed (See 8.2), and shall bear the wheel manufacturer's approval of the higher speed.

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

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

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

(Table 19 recognizes that specially designed and adequately protected grinding machines have been made available for the safe use of abrasive wheels on these special operations. These special high speeds should be used only when machine design and protection has been approved in accordance with conditions (a), (c) and (d) and the wheel has been tested and approved for the higher speed by the manufacturer.

TABLE
SPECIAL MAXIMUM SPEEDS

Classification Number	Types of Wheels	Vitrified and Silicate Bonds			Organic Bonds		
		Low Strength	Medium Strength	High Strength	Low Strength	Medium Strength	High Strength
		SFPM	SFPM	SFPM	SFPM	SFPM	SFPM
11	‡‡Cutting-off Wheels Larger than 16" diameter including reinforced organic.	xxxx	xxxx	xxxx	xxxx	xxxx	7,500 to 14,000‡
12	‡‡Cutting-off Wheels 16" and smaller including reinforced organic.	xxxx	xxxx	xxxx	xxxx	xxxx	10,000 to 16,000‡
13	Thread Grinding Wheels	5,500 to 8,000‡	6,000 to 10,000‡	6,500 to 12,000‡	xxxx	xxxx	9,500 to 12,000‡
14	Automotive and Aircraft Crank Grinding	5,500	6,000 to 7,300‡	6,500 to 8,500‡	xxxx	xxxx	xxxx
15	Automotive and Aircraft Cam Grinding	5,500	6,000 to 8,000‡	6,500 to 8,500‡	xxxx	xxxx	xxxx

Certain other grinding applications where high special speeds may be proven desirable are permissible if machine condition, protection and operating details meet conditions (a), (c) and (d), and the wheel involved can be tested and approved for the higher speed (condition (b)).

Such special high speed approvals are generally treated as individual specific applications and should be confined to the equipment and operation investigated.

TABLE 20
WHEEL MANUFACTURERS TESTING SPEEDS

Class of Wheel	Peripheral Operating Speed Feet per Minute	Minimum Test Factor*
Cutting-off Wheels	Up to 16,000	1.2
Resinoid Rubber and Shellac (Except Cutting-off Wheels)	Up to 5,000	1.25
	Faster than 5,000	1.5
Vitrified and Silicate Wheels	Up to 5,000	1.25
	Faster than 5,000	1.5

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

Under these special speed conditions, it is extremely important that having arrived at the satisfactory machine operating conditions for safe usage, the user maintain the established safe conditions.

Special attention must be given to maintenance of machine spindle and bearings to control vibration—flanges to control mounting stresses and all guards and safety devices for continuing safety.

Power delivered to the wheel must be delivered uniformly and adequately. Loss of speed is an added source of stress through generation of heat.

Whereas all of the points discussed above are of great importance on any grinding operation, they take on added significance as wheel speeds are increased.)

8.1.3 *Speed Limitations*

The peripheral speed approved by the wheel manufacturer shall not be exceeded, even though it is lower than the speed listed in tables 18 and 19.

8.2 *Manufacturers Test*

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

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

(a) Wheels less than 6 inches diameter.

(b) Diamond Wheels.

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

(It is customary for all wheel makers to test all wheels larger than a certain minimum size at a speed higher than the known or the safe maximum operating speed. This test establishes a satisfactory factor of safety.

It is wrong to assume that this overspeed test justifies operation of the wheel higher than the established safe maximum speed. On the contrary, the recommended safe speed should never be exceeded because the additional tested strength is intended to cover the other normal grinding stresses and is adequate for safe use of the wheel if all regulations are observed.)

8.3 *Speed Check*

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

(Portable air operated hand grinders should also be periodically checked to be sure that air pressure is maintained and that governor is functioning properly.)

8.4 *Speed Adjustment Control*

If speed of wheel spindle is adjustable to compensate for wheel wear or for other reasons, the speed adjustment shall be in control of authorized persons only.

(On machine which have adjustable speeds, special care must be exercised when mounting new wheels to be sure that the present operating speed of the machine conforms to that established for the new wheel.)

SECTION 9 – GENERAL OPERATING RULES

9.1 *Responsibility*

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

(Basic suggestions here listed to assure the efficient and safe use of grinding wheels are regularly practiced in all modern plants. It is as important for the smaller grinding rooms to observe these and other necessary regulations as for the larger plants.)

9.2 *Inspection After Breakage*

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

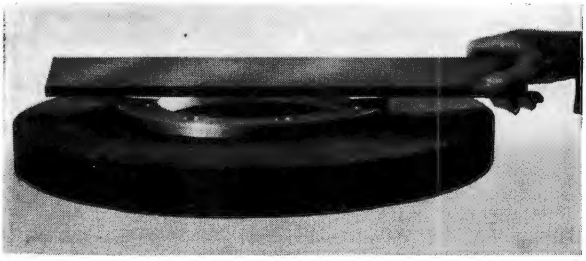


FIGURE NO. 39

Operator inspecting flange to be sure that the flange is not bent or sprung.

(Should a grinding wheel be broken in service, the cause of breakage should be immediately investigated and established. Such procedure will correct the condition and prevent a recurrence.

The more important factors to be investigated at the time of a wheel breakage are:

1. *Grinding Wheel*
   a. *Proper wheel selection*
   b. *Wheel inspection*

2. *Machine Equipment*
   a. *Spindle speed*
   b. *Mounting equipment*
      Flange design and size
      Flange condition (if worn or sprung)
   c. *Guards adequate*

3. *Wheel Mounting Procedure*
   a. *Free fit on spindle*
   b. *Clean blotters used*
   c. *Flanges carefully tightened*

4. *Evidence of Accidental Abuse*
   a. *Dropped wheel or equipment*
   b. *Damage from external sources*
   c. *Abusive pressure or other practice by operator*

A thorough investigation at the time of a breakage will prevent future trouble.)

9.3 *Replacing Safety Guard*

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

9.4 *Starting New Wheels*

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

(During the first one minute of operation the machine and wheel assembly rise in temperature. This temperature rise if coupled with improper mounting procedures may cause the wheel to break.)

9.5 *Applying Work*

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

(The temperature differential caused by too rapid work application on a cold wheel is a common cause of wheel failure and must be avoided.)

9.6 *Balance*

Wheels should be rebalanced if necessary.

9.7 *Truing and Dressing*

Wheels worn out of round 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. 40)

(Truing a wheel corrects out-of-round conditions so that the wheel will produce perfectly round (or flat) and smooth work surfaces, or alters the cutting face for grinding special contours.

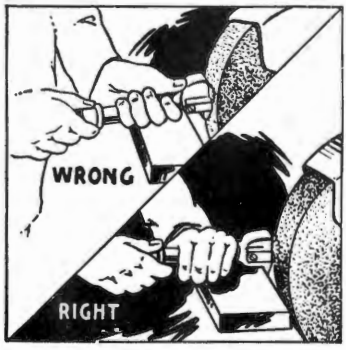


FIGURE NO. 40
The correct and incorrect methods of dressing a wheel.

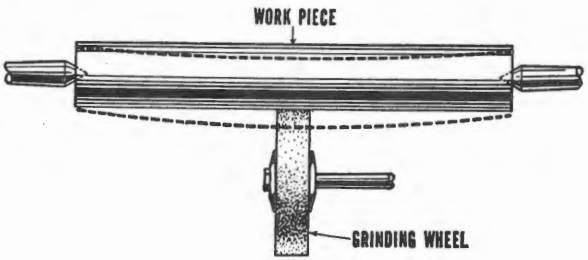
Dressing a wheel is intended to improve or alter its cutting action. It removes the outer layer of dulled, loaded or glazed abrasive grains and presents new and sharp grains to the work surface. To accomplish both purposes, the dresser should be supported on a work rest. The work rest should be adjusted 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. (See Fig. No. 40))

9.8 *Wet Grinding*

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

When shutting down a wet grinding operation, the coolant should first be shut off and the wheel allowed to run free until all coolant has been removed.

(For satisfactory operation, adherence to the recommended practices of coolant manufacture is very important.)



The dotttd lines show how the work is distorted when heat is localized in the area of contact between wheel and work. Proper application of coolant will help minimize this condition.

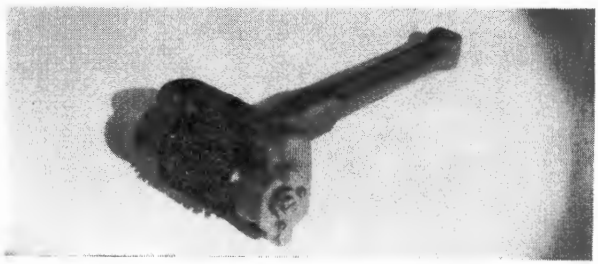
9.9 *Side Grinding*

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

Special abrasive disc wheels shall be used when it is necessary to grind on the flat side of straight wheels. These discs are designed to be mounted with one flat side against a suitable steel machine plate to safely withstand the side pressure.

9.10 *Dresser Guards*

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



A star type dresser properly guarded for operator protection.

9.11 *Grinding Machine Area*

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

9.12 *Lubrication*

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

(Improperly lubricated spindle bearings will cause the mounting spindle to expand because of heat generated thus exerting a stress on the critical wheel hole area.)

9.13 *Check for Wear*

All arbors, adaptors, or other machine parts on which wheels fit, should be periodically inspected and maintained to size. (See 3.9)

9.14 *Work Rests*

Work rests (or plain tables) shall be kept adjusted close to the wheel with a maximum distance of 1/8 inch to prevent the work from being caught between the wheel and the rest. The work rest shall be securely clamped after each adjustment. The adjustment shall not be made while the wheel is in motion.

SECTION 10 – MOUNTED WHEELS

10.1 *Maximum Safe Operating Speed*

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

1. Shape and size of the mounted wheel.
2. Size of mandrel.
3. Overhang of mandrel. (See Fig. 41)

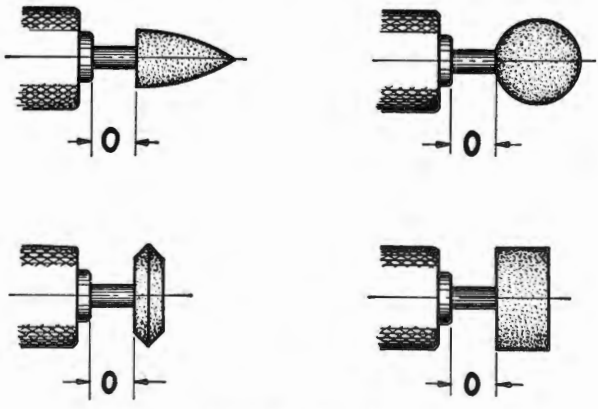


FIGURE NO. 41

Sketches defining overhang dimension "O"
See tables 22 through 29.

Taking the three factors noted above into consideration, look up the maximum safe operating speed in the corresponding Tables 22 through 29. The overhangs indicated on the charts are for unthreaded mandrels. Threaded mandrels will take the same speed as the 1/2 inch overhand unthreaded mandrel.

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

(Maximum safe speeds for mounted wheels are generally limited by the steel mandrel diameter and the distance from the mounting chuck to the abrasive body rather than the strength of the abrasive body itself.

Operating speed Tables 22 to 29 for various standard mounted wheels combined with common mandrel diameters and various overhangs are determined by multiplying the theoretical critical speed (speed at which vibration due to deflection or whip tends to become excessive) by a factor of 75%. Where this result is higher than the speeds listed in Table 21, the lower figure is used. These speeds apply to unthreaded mandrels for vitrified, resinoid and rubber bonds.

Mounted wheels with threaded mandrels require lower operating speeds than the same size unthreaded mandrels. Special sections of the operating speed tables cover 1/8, 3/16, and 1/4 inch diameter threaded mandrel items. Because these mandrels are usually short and held closely in the chuck, the tables relate to 1/2 inch overhangs only.)

TABLE 21
SPECIAL MAXIMUM OPERATING SPEEDS FOR MOUNTED WHEELS
(See Exception Sec. 10.1)

Outside Diameter of Wheel Inches	Maximum Speed (R.P.M.)
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

10.2 *Maximum Speed (Strength of Wheel)*

Table 21 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 10.1.

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

(The maximum safe speeds in Table 21 are established for vitrified and resinoid bonded wheels 60 grit size and finer in grades providing high strength. Coarser or softer (weaker) wheel specifications may be assigned lower safe speeds by the manufacturer.

Tables 22 to 29 indicate the maximum operating speeds for various standard mounted wheels in combination with several standard mandrel sizes and various overhangs. These are for unthreaded mandrels. 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. *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.)*

10.3 *Work Pressure*

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

(Work pressure, if excessive, can be the cause of trouble and a source of danger, through bending or fracture of the mandrel. If the wheel causes 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.)

TABLE 22

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	3/32	5/32	93,750	53,250	37,500	25,500	16,500
W 142	3/32	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	5/32	1/32	93,750	53,250	37,500	25,500	16,500
W 148	5/32	1/16	93,750	53,250	37,500	25,500	16,500
W 149	5/32	1/4	90,750	50,250	36,000	24,750	15,750
W 150	3/16	1/16	93,750	53,250	37,500	25,500	16,500
W 151	3/16	1/8	93,750	53,250	37,500	25,500	16,500
W 152	3/16	1/4	83,250	47,250	33,000	23,250	15,000
W 153	3/16	3/8	73,500	42,000	28,500	21,000	13,500
W 154	3/16	1/2	66,000	38,250	25,500	18,750	12,750
W 155	13/64	1/4	78,000	44,250	30,750	21,750	14,250
W 156	1/4	1/32	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	3/16	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	5/16	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	5/16	1/16	93,000	51,750	37,500	25,500	16,500
W 166	5/16	1/8	84,750	48,750	28,500	19,500	14,250
W 167	5/16	1/4	61,500	39,000	24,750	18,000	12,000
W 168	5/16	5/16	56,250	33,750	22,500	16,500	12,000
W 169	5/16	3/8	48,000	28,500	20,250	15,000	11,250
W 170	5/16	1/2	39,750	26,250	16,500	12,750	9,750
W 171	5/16	3/4	27,750	19,500	13,500	10,500	8,250
W 172	3/8	1/16	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

TABLE 23

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	65,625	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

TABLE 23—(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

TABLE 24

GROUP W — (PLAIN WHEELS)

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

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	⅛″ Overhang & Thd. Mdls.	Overhang — Dimension O			
				1″	1⅛″	2″	2⅛″
W 158	¼	⅛	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	⅛	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	⅛	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	⅛	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	⅛	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

TABLE 24—(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	.....

TABLE 25

GROUP W — (PLAIN 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"
W 176	⅜	½	81,000	54,379	42,000	33,000	25,500
W 177	⅜	¾	66,000	46,500	32,250	27,370	21,000
W 178	⅜	1	55,200	40,500	30,000	23,250	17,250
W 179	⅜	1¼	45,750	33,750	25,720	19,720	----------
W 182	½	⅛	76,390	62,400	45,750	35,400	27,520
W 183	½	¼	76,390	54,750	40,500	31,120	24,000
W 184	½	⅜	71,250	47,620	35,020	27,000	20,850
W 185	½	½	61,500	42,000	31,500	24,000	18,370
W 186	½	¾	51,000	36,370	27,750	21,220	16,120
W 187	½	1	40,500	30,000	24,000	18,750	14,250
W 188	½	1½	30,370	24,000	18,900	15,000	----------
W 189	½	2	24,000	18,750	15,000	12,150	----------
W 190	⅝	1/16	61,120	61,120	48,000	37,500	29,020
W 191	⅝	⅛	61,120	60,000	44,250	34,500	27,000
W 192	⅝	¼	61,120	51,750	38,400	29,770	23,250
W 193	⅝	⅜	61,120	45,000	33,370	25,870	20,100
W 194	⅝	½	56,400	39,750	29,400	22,720	17,400
W 195	⅝	¾	46,500	32,400	24,900	19,720	15,370
W 196	⅝	1	35,250	27,000	21,300	16,870	13,120
W 197	⅝	2	21,000	16,500	12,900	10,870	----------
W 198	⅝	2½	16,500	12,900	10,870	----------	----------
W 201	¾	¼	50,930	50,930	38,100	29,020	22,500
W 202	¾	⅜	50,930	44,100	32,400	25,120	19,350
W 203	¾	½	50,930	36,370	27,750	21,750	16,870
W 204	¾	¾	42,750	30,750	23,250	18,000	14,020
W 205	¾	1	34,500	25,870	19,500	15,000	12,000
W 206	¾	1¼	28,720	21,520	17,020	13,500	----------
W 207	¾	1½	24,000	18,520	14,620	12,000	----------
W 208	¾	2	18,750	15,370	12,000	9,900	----------
W 209	¾	2½	15,000	12,150	10,500	----------	----------
W 211	⅞	⅛	43,650	43,650	42,900	33,000	26,250
W 212	⅞	¼	43,650	43,650	35,100	27,600	21,370
W 213	⅞	⅜	43,650	40,870	29,400	23,400	18,370

TABLE 25—(Continued)

GROUP W — (PLAIN 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"
W 215	1	⅛	38,200	38,200	38,200	33,750	25,500
W 216	1	¼	38,200	38,200	33,750	26,250	20,250
W 217	1	⅜	38,200	38,200	28,500	22,500	17,400
W 218	1	½	38,200	32,770	24,900	19,500	14,850
W 219	1	¾	35,100	24,520	18,750	15,000	12,000
W 220	1	1	25,500	19,120	15,750	12,370	10,500
W 221	1	1½	19,120	14,620	12,000	10,500	.....
W 222	1	2	15,900	12,370	9,750	8,620	.....
W 223	1	2½	12,370	9,900	8,620	.....	.....
W 225	1¼	¼	30,560	30,560	30,560	24,000	18,750
W 226	1¼	⅜	30,560	30,560	26,250	20,100	15,750
W 227	1¼	½	30,560	29,620	22,650	18,000	14,100
W 228	1¼	¾	30,520	22,500	17,850	14,250	11,400
W 229	1¼	1	24,000	18,750	15,370	12,000	9,900
W 230	1¼	1¼	20,400	15,900	12,750	10,500	.....
W 231	1¼	1½	17,620	13,500	10,650	9,000	.....
W 232	1¼	2	14,250	10,650	9,000	7,500	.....
W 235	1½	¼	25,470	25,470	25,470	22,720	17,620
W 236	1½	½	25,470	25,470	21,750	17,250	13,650
W 237	1½	1	22,500	17,620	13,270	10,870	9,520
W 238	1½	1½	15,600	12,000	9,750	8,250	.....

TABLE 26

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	7/32	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	5/32	87,000	52,500	36,750	24,750	16,500
B 53	1/16	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	3/16	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	7/32	5/32	87,000	52,500	36,750	24,750	16,500
B 81	¾	3/16	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	3/16	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	5/32	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	7/64	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	7/32	⅜	57,000	34,500	22,500	16,500	11,250
B 115	5/32	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	3/16	86,250	50,250	35,250	24,000	15,000
B 124	⅛	⅛	87,000	52,500	36,750	24,750	16,500

TABLE 27

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	5/8	5/8	33,750	23,250	17,620	13,650	10,350
B 42	1/2	3/4	33,750	23,250	17,620	13,650	10,350
B 43	1/4	5/16	81,370	51,000	34,120	24,000	16,870
B 44	7/32	3/8	68,400	42,370	28,870	20,850	15,000
B 45	3/16	5/16	104,250	61,870	44,620	30,900	20,250
B 46	1/8	5/16	105,000	64,500	46,650	32,400	21,370
B 47	1/8	5/32	105,000	64,500	46,650	32,400	21,370
B 51	7/16	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	5/16	5/8	60,000	38,020	26,250	18,750	13,870
B 54	1/4	1/2	60,000	38,020	26,250	18,750	13,870
B 55	1/8	1/4	105,000	64,500	46,650	32,400	21,370
B 61	3/4	5/16	38,250	24,370	17,400	13,270	9,970
B 62	1/2	3/8	41,020	26,400	19,500	15,000	11,400
B 63	1/4	3/16	92,400	57,370	39,370	27,900	18,900
B 64	1/4	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	1/2	1/8	73,500	43,650	29,100	20,770	15,450
B 73	1/2	1/8	73,500	43,650	29,100	20,700	15,450
B 74	7/32	3/32	105,000	64,500	46,650	32,400	21,370
B 81	3/4	3/16	50,930	41,250	27,750	20,400	15,000
B 82	1/2	1/4	76,390	51,000	34,120	24,000	16,870
B 83	3/8	3/16	87,600	53,250	35,250	24,750	17,250
B 84	5/16	3/16	105,000	64,500	46,650	32,400	21,370
B 91	1/2	5/8	34,500	22,500	16,870	13,120	9,900
B 92	1/4	1/4	81,370	51,000	34,120	24,000	16,870
B 93	3/16	3/16	105,000	64,500	46,650	32,400	21,370
B 94	1/64	3/32	105,000	64,500	46,650	32,400	21,370
B 95	1/8	3/16	105,000	64,500	46,650	32,400	21,370
B 96	1/8	1/4	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

TABLE 27—(Continued)

GROUP B — (SHAPED WHEELS)

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

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	⅛" Overhang & Thd. Mdls.	Overhang — Dimension O			
				1"	1⅛"	2"	2⅛"
B 98	3/32	¼	105,000	64,500	46,650	32,400	21,370
B 101	⅝	1/16	33,750	23,250	17,620	13,650	10,350
B 102	⅝	½	45,370	28,500	21,000	15,900	12,150
B 103	⅝	3/16	61,120	41,250	27,750	20,400	15,000
B 104	5/16	⅜	68,400	42,370	28,870	20,850	15,000
B 105	¼	¼	104,250	61,870	44,620	30,900	20,250
B 106	⅛	7/64	105,000	64,500	46,650	32,400	21,370
B 111	7/16	1/16	33,750	23,250	17,620	13,650	10,350
B 112	⅜	½	45,370	28,500	21,000	15,900	12,150
B 113	¼	¼	81,370	51,000	34,120	24,000	16,870
B 114	7/32	⅜	68,400	42,370	28,870	20,850	15,000
B 115	3/32	⅛	105,000	64,500	46,650	32,400	21,370
B 121	½	½	45,370	28,500	21,000	15,900	12,150
B 122	⅜	⅜	61,650	37,720	27,000	19,870	14,250
B 123	3/16	5/16	104,250	61,820	44,620	30,900	20,250
B 124	⅛	⅛	105,000	64,500	46,650	32,400	21,370
B 131	½	½	34,500	22,500	16,870	13,120	9,900
B 132	⅜	½	45,370	28,500	21,000	15,900	12,150
B 133	⅜	⅜	54,000	33,000	24,150	18,000	13,500
B 134	5/16	⅜	61,650	37,720	27,000	19,870	14,250
B 135	¼	½	60,000	38,020	26,250	18,750	13,870
B 136	¼	5/16	77,250	45,920	30,900	22,500	16,120

TABLE 28

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	5/16	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	1/16	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	1/16	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

TABLE 29

GROUP A — (SHAPED WHEELS)

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

Shape No.	Wheel Diam. Inches	Wheel Thickness Inches	⅛" 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	⅞	2¾	18,000	14,620	12,000	9,750	7,500	5,250
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	1⅛	1¾	27,520	21,900	18,000	14,620	12,000	9,370
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	13,370
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

CONVERSION TABLE—WHEEL SPEEDS

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

Diameter of Wheel in Inches	Peripheral Speed in Feet per Minute																Diameter of Wheel in Inches
	4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500	10,000	12,000	14,000	16,000	
	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	53,474	61,116	1
2	7,639	8,594	9,549	10,504	11,459	12,414	13,368	14,328	15,278	16,238	17,188	18,143	19,098	22,918	26,737	30,558	2
3	5,093	5,729	6,366	7,003	7,639	8,276	8,913	9,549	10,186	10,822	11,459	12,096	12,732	15,278	17,826	20,372	3
4	3,820	4,297	4,775	5,252	5,729	6,207	6,685	7,162	7,640	8,116	8,595	9,072	9,549	11,459	13,368	15,278	4
5	3,056	3,438	3,820	4,202	4,584	4,966	5,348	5,730	6,112	6,494	6,876	7,258	7,640	9,168	10,696	12,224	5
6	2,546	2,865	3,183	3,501	3,820	4,138	4,456	4,775	5,092	5,411	5,729	6,048	6,366	7,639	8,913	10,186	6
7	2,183	2,455	2,728	3,001	3,274	3,547	3,820	4,092	4,366	4,638	4,911	5,183	5,456	6,548	7,640	8,732	7
8	1,910	2,148	2,387	2,626	2,865	3,103	3,342	3,580	3,820	4,058	4,297	4,535	4,775	5,729	6,685	7,640	8
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	5,940	6,792	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	5,348	6,112	10
12	1,273	1,432	1,591	1,751	1,910	2,069	2,228	2,386	2,546	2,705	2,864	3,023	3,183	3,820	4,456	5,092	12
14	1,091	1,228	1,364	1,500	1,637	1,773	1,910	2,046	2,182	2,319	2,455	2,592	2,728	3,274	3,820	4,366	14
16	955	1,074	1,194	1,313	1,432	1,552	1,672	1,791	1,910	2,029	2,149	2,268	2,387	2,865	3,342	3,820	16
18	849	955	1,061	1,167	1,273	1,379	1,485	1,591	1,698	1,803	1,910	2,016	2,122	2,546	2,970	3,396	18
20	764	859	955	1,050	1,146	1,241	1,337	1,432	1,528	1,623	1,719	1,814	1,910	2,292	2,674	3,056	20
22	694	781	868	955	1,042	1,128	1,215	1,302	1,388	1,476	1,562	1,649	1,736	2,084	2,430	2,776	22
24	637	716	796	875	955	1,034	1,115	1,194	1,274	1,353	1,433	1,512	1,591	1,910	2,228	2,546	24
26	588	661	734	808	881	955	1,028	1,101	1,176	1,248	1,322	1,395	1,468	1,762	2,056	2,352	26
28	546	614	682	750	818	887	955	1,023	1,092	1,159	1,228	1,296	1,364	1,637	1,910	2,182	28
30	509	573	637	700	764	828	891	955	1,018	1,082	1,146	1,210	1,274	1,528	1,782	2,036	30
32	477	537	597	656	716	776	836	895	954	1,014	1,074	1,134	1,194	1,432	1,672	1,910	32
34	449	505	562	618	674	730	786	843	898	955	1,011	1,067	1,124	1,348	1,572	1,796	34
36	424	477	530	583	637	690	742	795	848	902	954	1,007	1,061	1,273	1,484	1,698	36
38	402	452	503	553	603	653	704	754	804	854	904	955	1,006	1,206	1,408	1,608	38
40	382	430	478	525	573	620	669	716	764	812	860	908	956	1,146	1,338	1,528	40
42	366	409	454	500	545	591	636	682	732	775	818	863	908	1,090	1,272	1,464	42
44	347	390	434	478	521	564	608	651	694	737	780	824	868	1,042	1,216	1,388	44
46	333	375	416	458	500	541	582	624	666	708	750	791	832	1,000	1,164	1,332	46
48	318	358	398	438	478	517	558	597	636	676	716	756	796	956	1,116	1,272	48
53	288	324	360	395	432	468	503	539	576	612	648	683	720	864	1,006	1,152	53
60	255	287	319	350	387	414	446	478	510	542	574	606	638	774	892	1,020	60
72	212	239	265	291	318	345	371	398	424	451	477	504	530	637	742	849	72

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