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Hand-held non-electric power tools — Safety requirements —

Part 7: Grinders

Machines portatives à moteur non électrique — Exigences de sécurité —

Partie 7: Meuleuses

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11148-7 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 3, *Pneumatic tools and machines*.

ISO 11148 consists of the following parts, under the general title *Hand-held non-electric power tools — Safety requirements*:

— *Part 1: Assembly power tools for non-threaded mechanical fasteners*

— *Part 2: Cutting-off and crimping power tools*

— *Part 3: Drills and tappers*

— *Part 4. Non-rotary percussive power tools*

— *Part 5: Rotary percussive drills*

— *Part 6: Assembly power tools for threaded fasteners*

— *Part 7: Grinders*

— *Part 8: Sanders and polishers*

— *Part 9: Die grinders*

— *Part 10: Compression power tools*

— *Part 11: Nibblers and shears*

— *Part 12: Circular, oscillating and reciprocating saws*

A Part 13 dealing with fastener driving tools is under preparation.

Introduction

This document is a type-C standard as stated in ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are defined in the Scope of this part of ISO 11148.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of other standards, for machines that have been designed and built according to the requirements of this type-C standard.

ISO 11148 consists of a number of independent parts for individual types of hand-held non-electric power tools.

Certain parts of ISO 11148 cover hand-held non-electric power tools driven by internal combustion engines powered by gaseous or liquid fuel. In these parts, the safety aspects relating to internal combustion engines are found in a normative annex.

The parts are type-C standards and refer to pertinent standards of type A and B where such standards are applicable.

Hand-held non-electric power tools — Safety requirements —

Part 7: Grinders

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1 Scope

This part of ISO 11148 specifies safety requirements for hand-held non-electric power tools (hereinafter "grinders") intended for grinding and cutting-off with abrasive products, for use on all kinds of materials. The grinders can be powered by compressed air or hydraulic fluid and are intended to be used by one operator and supported by the operator's hand or hands, with or without a suspension, e.g. a balancer.

NOTE 1 At the time of publication, no grinders driven by internal combustion engines are known (other than cutting-off machines within the scope of ISO 19432). Once these are identified, it is intended to amend this part of ISO 11148 to include such power tools.

This part of ISO 11148 is applicable to grinders used with:

— abrasive products with a peripheral operating speed less than or equal to 80 m/s;

— cutting-off wheels with a peripheral operating speed less than or equal to 100 m/s;

— abrasive products with an outside nominal diameter less than or equal to 230 mm;

— cutting-off wheels with an outside nominal diameter less than or equal to 250 mm;

— wire brushes;

— diamond and reinforced (segmented) wheels with an outside nominal diameter less than or equal to 450 mm;

— flap discs and flap wheels.

NOTE 2 For examples of grinders, see Annex B.

NOTE 3 Typical abrasive products used together with hand-held grinders are listed in Annex D.

This part of ISO 11148 does not cover special requirements and modifications of grinders for the purpose of mounting them in fixtures.

This part of ISO 11148 is not applicable to:

— die grinders with collets, which are treated in ISO 11148-9;

— polishers and sanders (i.e. tools used with coated abrasives except flap discs and flap wheels), which are treated in ISO 11148-8;

— cutting-off machines which are driven by internal combustion engines and are used for cutting construction materials, which are treated in ISO 19432;

— shaft-mounted wire brushes, which are treated in ISO 11148-9.

This part of ISO 11148 deals with all significant hazards, hazardous situations or hazardous events relevant to grinders when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer, with the exception of the use of grinders in potentially explosive atmospheres.

NOTE 4 EN 13463-1 gives requirements for non-electrical equipment for potentially explosive atmospheres.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3857-3, *Compressors, pneumatic tools and machines — Vocabulary — Part 3: Pneumatic tools and machines*

ISO 5391, *Pneumatic tools and machines — Vocabulary*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13732-3, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 3: Cold surfaces*

ISO 15744, *Hand-held non-electric power tools — Noise measurement code — Engineering method (grade 2)*

ISO 17066, *Hydraulic tools — Vocabulary*

ISO 20643, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission*

ISO 28927-1:2009, *Hand-held portable power tools — Test methods for evaluation of vibration emission — Part 1: Angle and vertical grinders*

ISO 28927-4, *Hand-held portable power tools — Test method for evaluation of vibration emission — Part 4: Straight grinders*

EN 10111, *Continuously hot rolled low carbon steel sheet and strip for cold forming — Technical delivery conditions*

EN 10130, *Cold rolled low carbon steel flat products for cold forming — Technical delivery conditions*

EN 12096, *Mechanical vibration — Declaration and verification of vibration emission values*

EN 12418, *Masonry and stone cutting-off machines for job site — Safety*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3857-3, ISO 5391, ISO 12100 and ISO 17066 (for hydraulic tools) and the following apply.

3.1 General terms and definitions

3.1.1
hand-held power tool
machine operated by one or two hands and driven by rotary or linear motors powered by compressed air, hydraulic fluid, gaseous or liquid fuel, electricity or stored energy (e.g. by a spring) to do mechanical work and so designed that the motor and the mechanism form an assembly that can easily be brought to its place of operation

NOTE Hand-held power tools driven by compressed air or gas are called pneumatic tools (or air tools). Hand-held power tools driven by hydraulic liquid are called hydraulic tools.

3.1.2
inserted tool
tool inserted in the grinder to perform the intended work

3.1.3
service tool
tool intended for performing maintenance or service on the grinder

3.1.4
control device
device to start and stop the grinder or to change the direction of the rotation or to control the functional characteristics, such as speed and power

3.1.5
start-and-stop device
throttle
manually operated control on the grinder by which the energy supply to the motor can be turned on and off

3.1.6
hold-to-run start-and-stop device
constant-pressure throttle
start-and-stop device that automatically returns to the OFF position when force on the start and stop device actuator is released

3.1.7
lock-on start-and-stop device
constant pressure throttle with instant release lock
hold-to-run start-and-stop device that can be locked in the ON position and designed so that it permits the grinder to be turned off by a single motion of the same finger or fingers used to turn it on

3.1.8
lock-off start-and-stop device
lock-off throttle
start-and-stop device that automatically latches in the OFF position when the actuator is released and where two motions are required to energize the grinder

3.1.9
positive on-off start-and-stop device
positive on-off throttle
start and stop device that remains in an ON position until it is manually changed

3.1.10
maximum operating pressure
maximum pressure at which a grinder may be operated

3.1.11
whip hose
air hose connecting the main air hose with an air tool for the purpose of providing more flexibility

3.1.12
rated air pressure
air pressure, required at an air tool inlet port to ensure rated performance of the tool, also considered the maximum pressure at which the tool may be operated

3.1.13 Rated speed

3.1.13.1
rated speed
⟨pneumatic tool⟩ speed of an air tool at no load and rated air pressure at the tool inlet port

NOTE 1 The rated speed is expressed in revolutions per minute.

NOTE 2 The rated speed is also considered the maximum speed at which an abrasive tool, such as a grinder, may be operated.

3.1.13.2
rated speed
⟨hydraulic tool⟩ nominal speed of a hydraulic tool at no load and rated flow at the tool inlet port

NOTE 1 The rated speed is expressed in revolutions per minute.

NOTE 2 The rated speed is also considered the maximum speed at which an abrasive tool, such as a grinder, may be operated.

3.1.14
maximum attainable speed
maximum speed which the tool can achieve under the most adverse condition of possible maladjustment or malfunction of its speed control devices, when supplied with compressed air at the pressure marked on the grinder or when supplied with hydraulic fluid at the maximum flow rate marked on the grinder

3.1.15
suspension device
device, which is attached to the tool, whose primary purpose is to reduce the strain on the operator caused by the mass of the tool

NOTE The device can also have a secondary purpose of transmitting a reaction torque.

3.2 Terms and definitions related to grinders

3.2.1
grinder
hand-held power tool driving a rotary output spindle adapted in order to carry an abrasive wheel/product for material removal

NOTE A grinder equipped with a cutting-off wheel is often called a cutting-off machine. For examples of grinders, see Annex B.

3.2.2
machine spindle
shaft of the grinder that supports, locates and drives the abrasive product

3.2.3
flange
disc, normally of metal, mounted on the machine spindle to support and clamp the abrasive wheel/product

3.2.4
flange set
means provided to clamp an unthreaded abrasive product, on the rotating machine spindle

3.2.5
backing flange
driving flange
flange that is affixed to, or integral with, the spindle and is assembled before the abrasive wheel/product

3.2.6
front flange
outer flange
flange that is placed on the grinder's spindle after the abrasive wheel/product, which is secured by the spindle end nut

3.2.7
flange contact diameter
d_f
outside diameter of the clamping surface of a flange

3.2.8
guard
device that partly encloses the abrasive wheel/product

3.2.9
blotter
thin piece of a compressible material placed between the abrasive wheel/product and the flange of the grinder

3.2.10
tightening torque
torque for tightening the clamping device that fastens the abrasive product to the machine spindle

3.2.11
maximum operating speed of an abrasive wheel/product
maximum peripheral speed of an abrasive wheel/product, as specified by the manufacturer of the abrasive product

NOTE It is expressed in metres per second [m/s (or sfpm)].

3.2.12
abrasive product
common term for products used for abrasive material removal

EXAMPLE Grinding wheels, cutting-off wheels, diamond and reinforced wheels (superabrasives), wire brushes, flap discs and flap wheels.

3.3 Symbols

Symbol	Description	Unit
C	Radial dimension of the flange clamping surface	mm
d_f	Outside diameter of the flange clamping surface	mm
d_{f2}	Backing flange outside diameter	mm
D	Outside diameter of the abrasive wheel	mm
D_g	Guard diameter	mm
F_t	Test load	N
G	Depth of the flange recess	mm
H	Bore diameter of the abrasive wheel	mm
P	Rated power	W
n_{nom}	Rated speed	r/min

4 Safety requirements and/or protective measures

4.1 General

The machine shall comply with the following safety requirements and/or protective measures and be verified in accordance with Clause 5. In addition, the machine shall be designed in accordance with the principles of ISO 12100 for relevant, but not necessarily significant, hazards which are not dealt with by this part of ISO 11148.

The measures adopted to comply with the requirements of Clause 4 shall take account of the state of the art.

It is recognized that optimizing the design with respect to some safety measures can result in a degradation of performance against other safety requirements. In such cases, it is required to find a balance between

the various requirements in order to achieve a grinder design that satisfies each requirement, so far as is reasonably practicable, and remains fit for purpose.

4.2 Mechanical safety

4.2.1 Surfaces, edges and corners

Accessible parts of grinders, except the inserted tool, shall not have sharp edges or angles or rough or abrasive surfaces (see ISO 12100:2010, 6.2.2.1).

4.2.2 Supporting surface and stability

The grinder shall be so designed that it can be laid aside and remain in a stable position on a plane surface.

4.2.3 Hydraulic fluid ejection

Hydraulic systems of the grinder shall be enclosed so as to provide protection against high-pressure fluid ejection.

4.2.4 Speed control

The rated speed of the grinder shall not be exceeded under the conditions marked on the grinder. It shall be possible to measure rotational speed using a tachometer.

The speed control device of a grinder shall be designed to prevent incorrect assembly. The speed control device shall be manufactured from non-corrodible material.

4.2.5 Power tool construction

The grinder shall be so designed and constructed as to prevent the loosening or loss of components during expected use, including rough handling and occasional dropping, which can cause its safety functions to be compromised.

4.2.6 Attachment of abrasive product

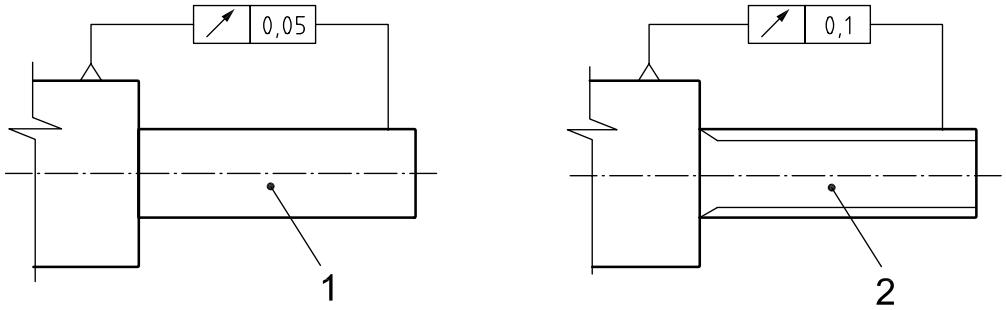
The grinder shall be designed to prevent the abrasive product from coming loose, for instance unscrewed by inertia and spun off, after the stop command has been given.

4.2.7 Spindles

Spindles shall be designed so that they locate and secure the abrasive product.

All grinders shall incorporate means to hold the spindle where a grinding wheel is being mounted or removed. For threaded spindles, the direction of the spindle threads shall be such that the clamping device, collet or wheel with threaded hole shall tend to tighten during grinding.

In order to decrease vibrations, for spindles which locate a plain bore wheel, the diameter shall have a maximum total indicator reading of 0,05 mm to the true axis of the spindle (see Figure 1).



Key

1 machine spindle

2 machine spindle with threads

Figure 1 — Maximum spindle run-out

For spindles with a threaded portion intended for locating abrasive products with threaded bores, the pitch diameter of the thread shall have a maximum total indicator reading of 0,1 mm to the true axis of the spindle.

The diameter of the part, which locates the abrasive product, shall have a tolerance of e8 or narrower (but not press fit).

Spindles shall have a suitable means of receiving a tachometer.

4.2.8 Flanges

4.2.8.1 General

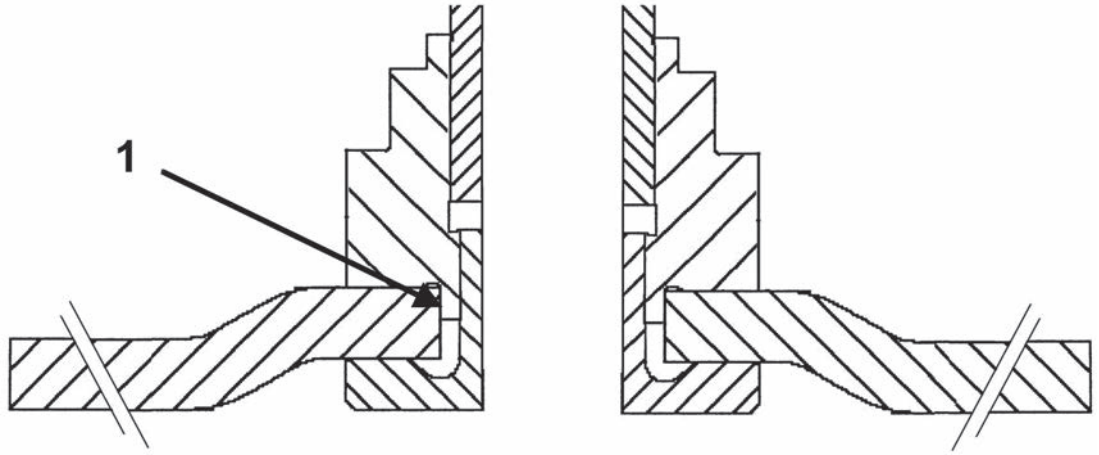
4.2.8.1.1 Flange design

Flanges shall be designed so that they provide for, or aid in, securing and driving the abrasive products, which are intended to be used with the grinder. Grinders not designed for use with certain wheels are not required to have flanges capable of mounting such wheels.

NOTE Wheel types for which grinders are designed are expected to be identified in the instructions handbook, which accompanies the grinder, or else on the exterior of the grinder.

The driving flange shall be integral with the spindle or shall be mounted on the spindle in a manner that provides sufficient rotational driving action to prevent slipping of the abrasive product.

A piloting diameter (see Figure 2) shall locate the abrasive product radially to the shaft of the tool. The flange assembly shall have the piloting diameter on either the driving or the outer flange or on the shaft itself. It is not permitted to have piloting diameters on two parts simultaneously.



Key

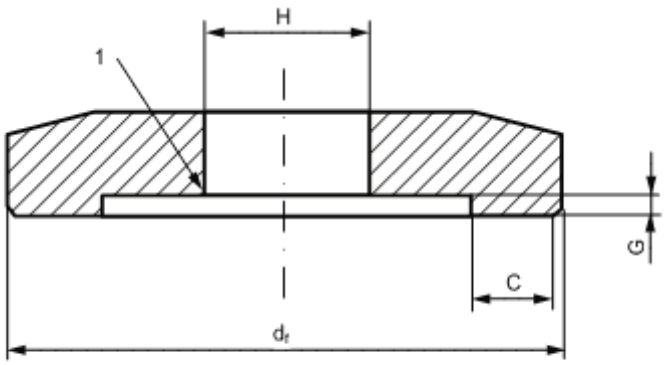
1 piloting diameter

Small indicator readings between the piloting diameter and the true axis of the spindle are essential to control the out-of-centre of the wheel and, hence, the vibrations. From this point of view, a piloting diameter on the driving flange is recommended.

Figure 2 — Flange piloting diameter

4.2.8.1.2 Chamfer and overlap

Flanges, both driving and outer, shall be designed to prevent pieces of the abrasive product from splintering due to high edge pressure arising during clamping. The most common design is with a chamfer or recess, as shown in Figure 3.



Key

1 chamfer or recess

C flange clamping surface

d_f outside diameter of the flange clamping surface

G depth of the recess

H bore diameter of the abrasive wheel

Figure 3 — Principal dimensions of flanges

The dimensions, C and G, in Figure 3, of flanges for all wheel types shall be:

$$3\,\text{mm} \leq C \leq \frac{\left(d_\text{f} - H - 2G\right)}{2} \tag{1}$$

$$G \geq 0{,}5\,\text{mm}$$

4.2.8.1.3 General tolerance of clamping surface

The clamping surface, C (see Figure 3), of the flanges shall run true with a tolerance giving a total indicator reading of maximum 0,1 % of the diameter at the position of the indicator. The indicator shall be positioned near the outside diameter.

4.2.8.1.4 General tolerance of flanges

The part of the flanges, which locates and guides the abrasive products with unthreaded holes, shall have an out-of-centre tolerance lower than 0,2 mm (see Figure 2).

4.2.8.1.5 Material of flanges

The steel in the flanges shall have a minimum tensile strength of 430 N/mm^2. Other materials may be used, in which case the flange shall be tested and fulfil the requirements of 5.4. The material should also provide necessary ductility.

4.2.8.2 Type 1 wheels

Flanges in a set shall have the same contact diameter and shall have equal contact surface.

For type 1 wheels, the flange diameter, d_f, shall be:

$$d_\text{f} \geq 0{,}33\ D \tag{2}$$

where D is the outside diameter of the abrasive wheel.

Both flanges shall be relieved to equal diameters and shall conform to the dimensions shown in Figure 3.

Exception: machines specifically designed for, and used only with, diamond and reinforced (segmented) wheels shall use flanges of not less than one fourth of the wheel diameter.

4.2.8.3 Types 6 and 11 wheels

4.2.8.3.1 Unthreaded wheels

For types 6 and 11 unthreaded wheels, the flange diameter, d_f, shall be:

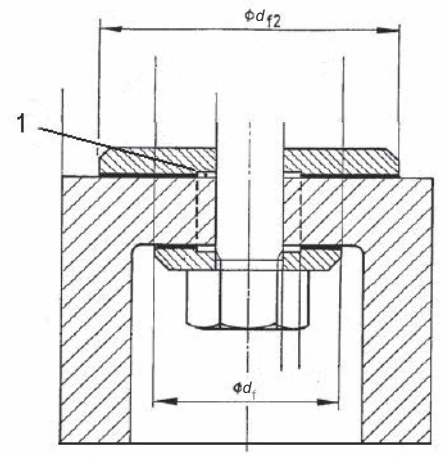
$d_\text{f} = (20 \pm 1)$ mm for 55 mm $\leq D <$ 80 mm;

$d_\text{f} = (20 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 10 mm (3/8 in UNC);

$d_\text{f} = (29 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 16 mm (5/8 in UNC);

$d_\text{f} = (41 \pm 1)$ mm for 105 mm $\leq D \leq$ 230 mm.

The backing flange (diameter $d_{\text{f}2}$) may have a larger contact surface than the outer flange, if this arrangement fulfils the requirement of absorbing the grinding forces (see Figure 4).



Key

1 recess depth, minimum 0,5 mm

d_f outside diameter of the flange clamping surface

d_{f2} backing flange outside diameter

Figure 4 — Flange for unthreaded wheels

For types 6 and 11 unthreaded wheels, the flange diameter, d_f, shall be:

$d_f = (20 \pm 1)$ mm for 55 mm $\leq D <$ 80 mm;

$d_f = (20 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 10 mm (3/8 in UNC);

$d_f = (29 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 16 mm (5/8 in UNC);

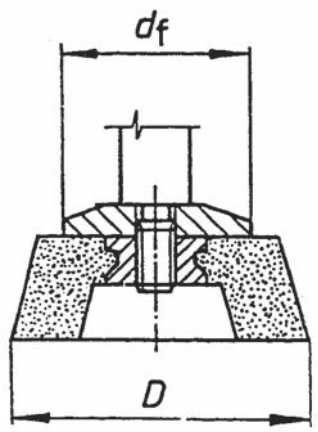
$d_f = (41 \pm 1)$ mm for 105 mm $\leq D \leq$ 230 mm.

The backing flange (diameter d_{f2}) may have a larger contact surface than the outer flange, if this arrangement fulfils the requirement of absorbing the grinding forces (see Figure 4).

4.2.8.3.2 Threaded wheels

For types 6 and 11 threaded wheels, the flange diameter shall be not less than one third of the maximum diameter of the wheel. Flanges shall not be recessed, unless the abrasive product has a riveted anchor plate (see Figures 5 and 6).

NOTE Relieved flanges are not advisable for threaded wheels because they can allow the thread to be pulled into them and break away during use. Relieved flanges are only allowed for riveted anchor plates to provide space for the rivets and allow the plate to seat against the flange.



Key

D outside diameter of the abrasive wheel

d_f outside diameter of the flange clamping surface

Figure 5 — Unrecessed flange for cups with threaded hole

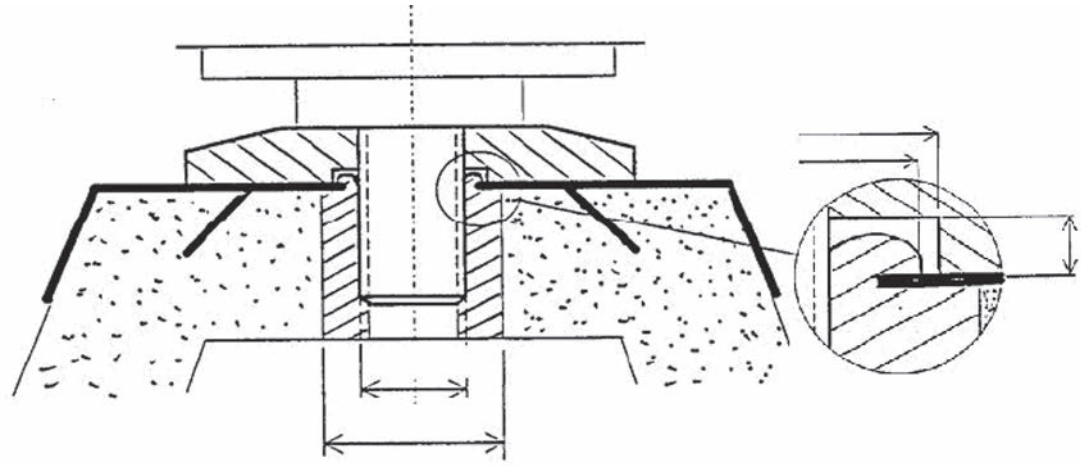


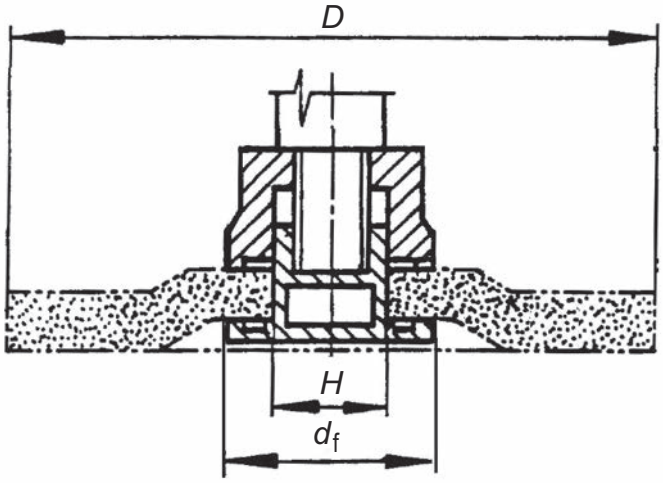
Figure 6 — Rear flange with a recess for abrasive products of types 6 and 11 with an insert riveted on an anchor plate

4.2.8.4 Types 27, 28 and 42 flap wheels and flap discs

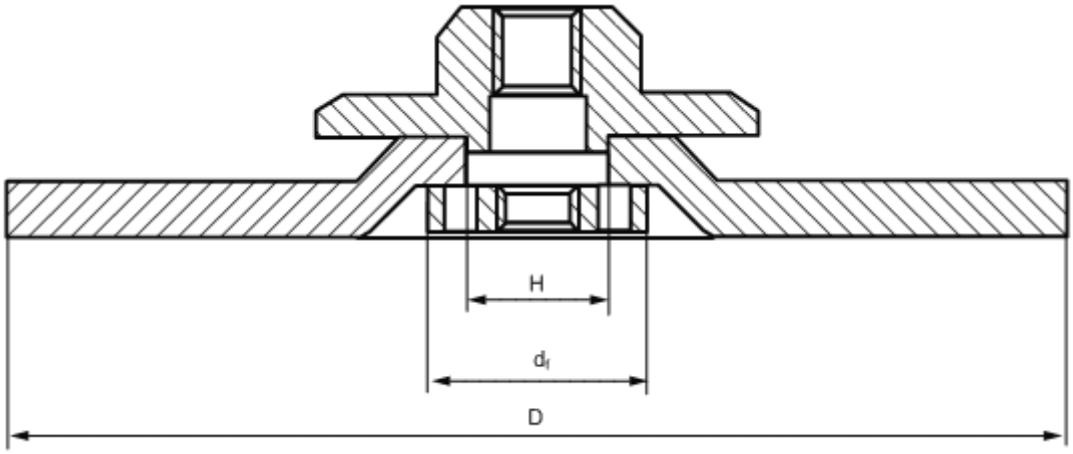
With the exception of the alternative designs of flanges described in 4.2.8.6, types 27, 28 and 42 wheels and flap discs shall be used with the flange assemblies illustrated in Figures 7 a) and 7 b).

The overlap of the backing and outer flange clamping surfaces shall be at least equal to dimension C shown in Figure 3.

Abrasive products of types 27, 28 and 42 are allowed to use a backing flange with a diameter larger than that of the outer flange [see Figure 7 b)].



a) Flange design for types 27, 28 and 42 flap wheels and flap discs — Example



Key

D outside diameter of the abrasive wheel

d_f outside diameter of the flange clamping surface

H bore diameter of the abrasive wheel

b) Flange design for types 27, 28 and 42 wheels and flap discs with a backing flange diameter larger than that of the outer flange

Figure 7 — Flange design for types 27, 28 and 42 wheels and flap discs

The flange diameter, d_f, shall be:

$d_f = (20 \pm 1)$ mm for 55 mm $\leq D <$ 80 mm;

$d_f = (20 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 10 mm (3/8 in UNC);

$d_f = (29 \pm 1)$ mm for 80 mm $\leq D <$ 105 mm for wheels with a bore diameter of 16 mm (5/8 in UNC);

$d_f = (41 \pm 1)$ mm for 105 mm $\leq D \leq$ 230 mm.

4.2.8.5 Type 41 wheels

For type 41 grinding wheels (also known as type 1 cutting-off wheels), the flanges in a set shall have the same external diameter, d_f.

$$d_f \geq 0{,}33\ D \tag{3}$$

where D is the outside diameter of the abrasive wheel.

The outer flange may have a larger recess than the backing flange (see Figure 8).

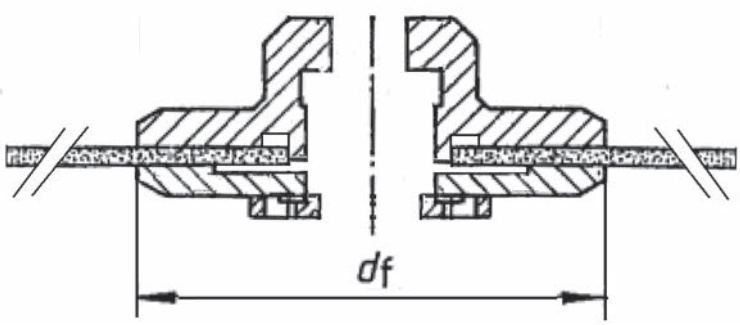


Figure 8 — Flange design for type 41 wheels

4.2.8.6 Alternative design for types 27, 28 and 42 wheels and flap discs

Alternative flanges are permitted providing they can properly locate the wheel (regardless of thickness) and transmit the necessary torque from the spindle to the abrasive wheel. Verification shall be carried out according to 4.2.8.7.

The flange system shall be able to accommodate types 27, 28 and 42 wheels and flap discs.

The following are the dimensional restrictions.

— The backing flange shall have a diameter that is equal to, or larger than, the diameter of the outer flange.

— The outer flange shall fit into the depressed area of types 27, 28 and 42 wheels and flap discs and clamp the abrasive wheel only at the flat bottom part of the recess; it shall not interfere with or contact the inside corner radius of the recess.

— The piloting diameter shall be located at one part only.

4.2.8.7 Testing of flanges

Flanges shall be tested for deformation under load according to 5.4.

Alternative flange designs for types 27, 28 and 42 wheels and flap discs, as described in 4.2.8.6, shall be subjected to the test described in 5.8 in order to verify their ability to maintain the correct location of the abrasive wheel during use.

4.2.9 Guards

4.2.9.1 General

Grinders shall be equipped with guards to protect against

— accidental contact with the abrasive product,

— ejection of fragments of the abrasive product, and

— sparks and debris.

Guards are mandatory for use with all types of abrasive products of diameter 50 mm and above.

NOTE 1 The reason for making burst tests mandatory is that, even if the dimensional and material specifications are fulfilled, hazards can occur where wheels burst; the guard can move or become loose, for example. Therefore, it is important to check that guards are able to prevent projectiles from entering the no-fragment area under such circumstances.

Guards are not mandatory, but are recommended, for cones, plugs and wire brushes with a diameter of less than 50 mm.

NOTE 2 For internal grinding, guards may not be needed.

The guards shall fulfil the following requirements.

a) They shall be designed so that, in case of an abrasive product burst, the guard reduces the risk of injury to the operator and remain attached to the grinder.

b) They shall be located so that the risk of accidental contact between the operator and the abrasive product during intended use is minimized.

c) The clearance between the inside of the guard and the periphery of a new abrasive product shall be:

   — maximum 8 mm and minimum 3 mm for a nominal diameter $\leq$ 125 mm,

   — maximum 10 mm and minimum 6 mm for a nominal diameter $>$ 125 mm.

NOTE 3 This provides sufficient clearance for debris to escape and prohibits the fitment of wheels which are too large to be compatible with the rated speed.

Guards shall be so constructed that wheel mounting and removal can be carried out without removing the wheel guard from the grinder.

If material other than steel plate is used, it shall be equally suitable for all working conditions.

Guards for specific wheel types shall meet the additional specifications in 4.2.9.2 to 4.2.9.8, as applicable.

The minimum thickness of the guards, for abrasive products with a maximum operating speed less than or equal to 80 m/s, are found in the Tables 2 to 9.

Types or designs (including material and thickness) of guards other than those mentioned in this subclause may be used, if they provide the same, or better, protection and if they are tested and fulfil the requirements according to 5.5.

4.2.9.2 Types 1, 4 and 5 wheels (other than cutting-off wheels)

A guard for grinders using types 1, 4 and 5 wheels shall enclose the top and both sides of the grinding wheel to at least 180° (see Figure 9). Enclosure of the spindle end, the nut, and the outer flange is not required (see Figure 10).

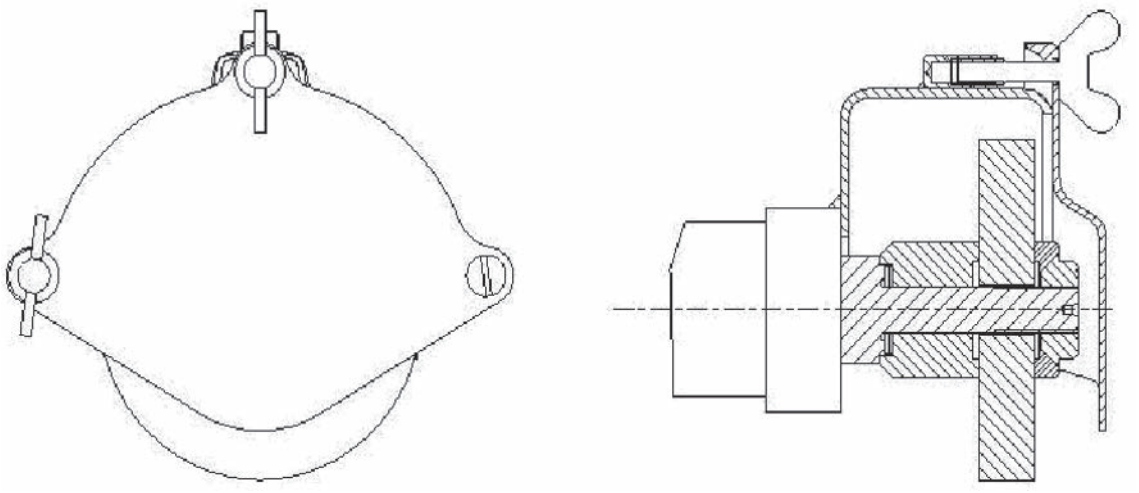
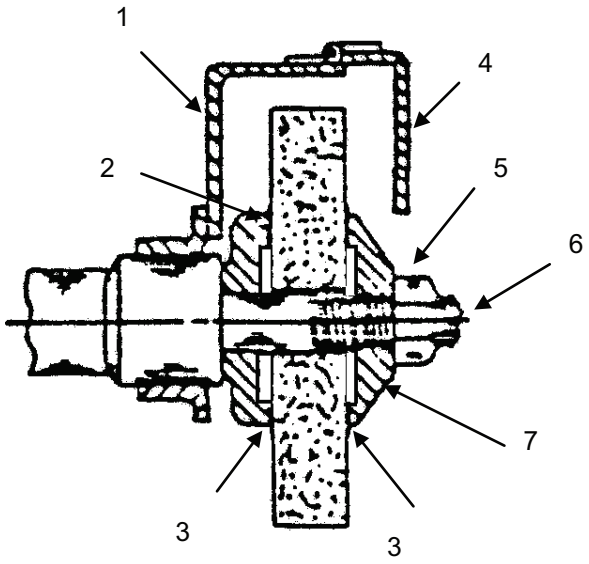


Figure 9 — Typical drawn-steel wheel guard for straight grinders used with type 1 wheels

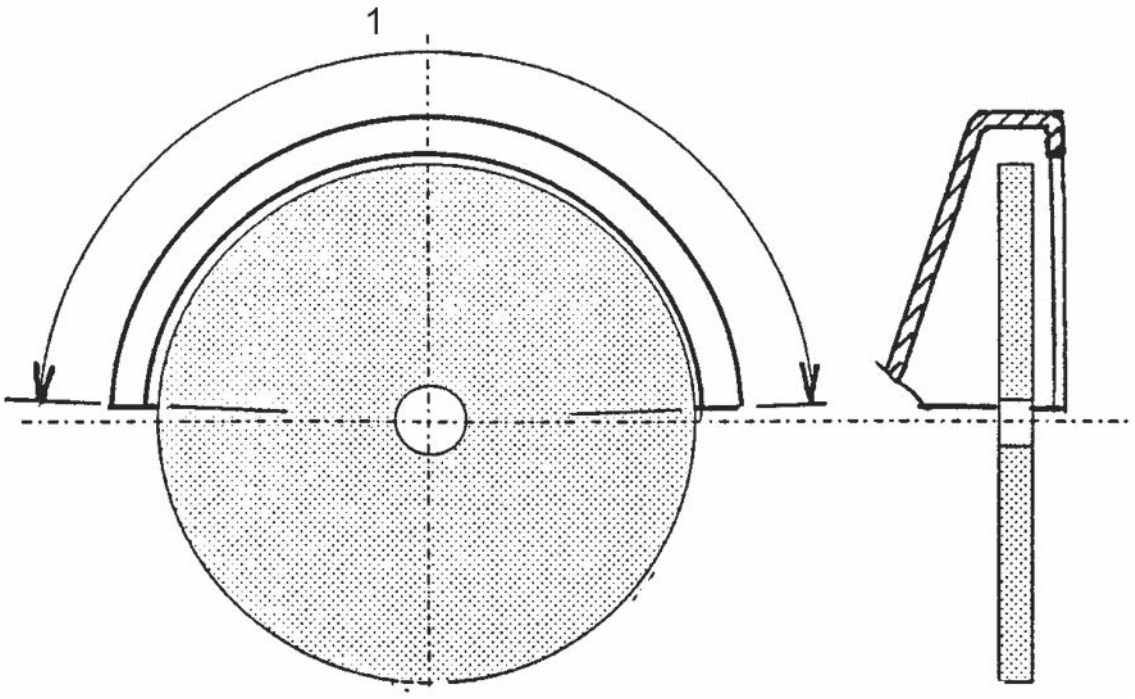


Key

1 guard
2 driving flange
3 blotter
4 cover
5 nut
6 spindle
7 outer flange

Figure 10 — Typical mounting for a type 1 wheel

Exception: small types 1, 4 and 5 wheels of 100 mm (4 in) in diameter or less do not require a guard cover. The guard shall have a lip on the outer edge, which curls inward to deflect wheel fragments and which provides the necessary strength to meet the requirements of 4.2.9.1. The lip shall extend beyond the face of the wheel all along the 180° coverage (see Figure 11).



Key

1 guard covering at least 180°

Figure 11 — Guard with front lip for small types 1, 4 and 5 wheels

Table 1 — Minimum thickness for guards with front cover

Type of abrasive product	**External diameter of abrasive product**	**Minimum thickness of the guard**
	mm	mm
Types 1, 4, 5	$D \leq 150$	1,5
	$150 \leq D \leq 200$	2

Table 2 — Minimum thickness for guards with front lip

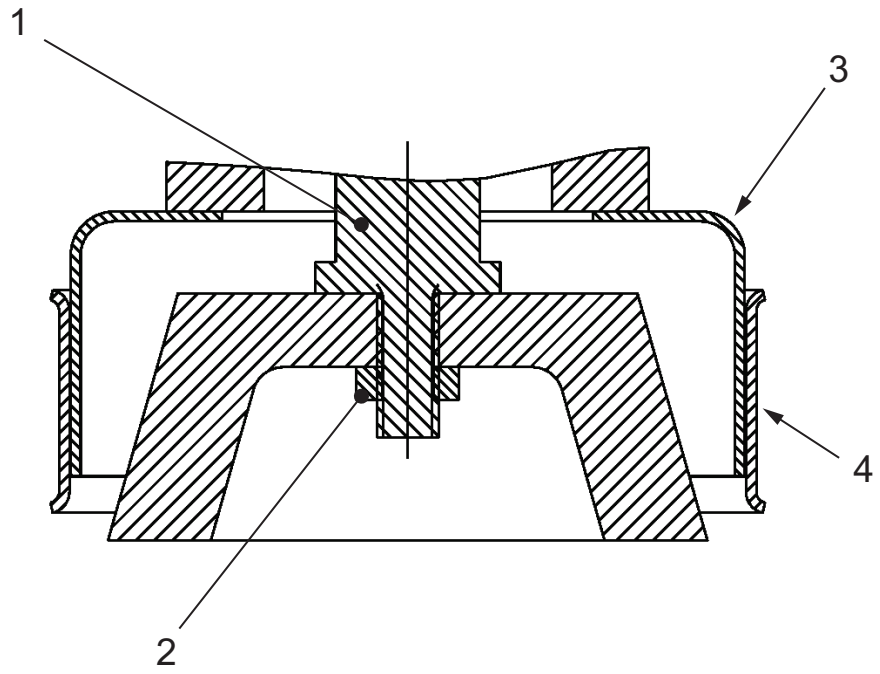
Type of abrasive product	External diameter of **abrasive product**	**Minimum thickness of the guard**
	mm	mm
Types 1, 4, 5	$D \leq 100$	2

4.2.9.3 Types 6 and 11 wheels

A guard for vertical or angle grinders using wheel types 6 and 11 shall cover the wheel's plane of rotation toward the operator for at least 180°, shall cover the side of the wheel toward the driving flange for 180°, and shall have a skirt which is adjustable to within 3 mm (1/8 inch) of the face of the wheel (see Figure 12).

Table 3 — Minimum thickness for adjustable guards

Type of abrasive product	External diameter of abrasive product	Minimum thickness of the guard
	mm	mm
Type 6	$D \leq 150$	2
Type 11	$D \leq 180$	2



Key

1 driving flange
2 wheel retainer
3 guard
4 guard skirt

NOTE Type 11 is shown.

Figure 12 — Typical mounting for a type 6 or 11 wheel

4.2.9.4 Types 16, 18, 18R and 19 abrasive products

For abrasive products of types 16, 18, 18R and 19, the guard shall cover at least the length of the abrasive product and at least 180° of the periphery (see Figure 13).

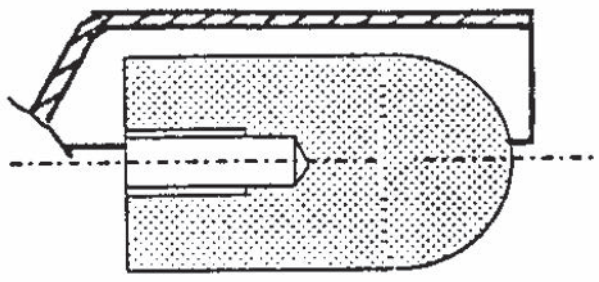


Figure 13— Guard for types 16, 18, 18R and 19 abrasive products

Table 4 — Minimum thickness for guards of types 16, 18, 18R and 19 abrasive products

Type of abrasive product	**External diameter of abrasive product** mm	**Minimum thickness of the guard** mm
Types 16, 18, 18R, 19	$D \leq 80$	1,5

4.2.9.5 Types 27, 28, 41 and 42 wheels and flap discs

The guards for grinders using wheels types 27, 28, 41 and 42 and flap discs shall

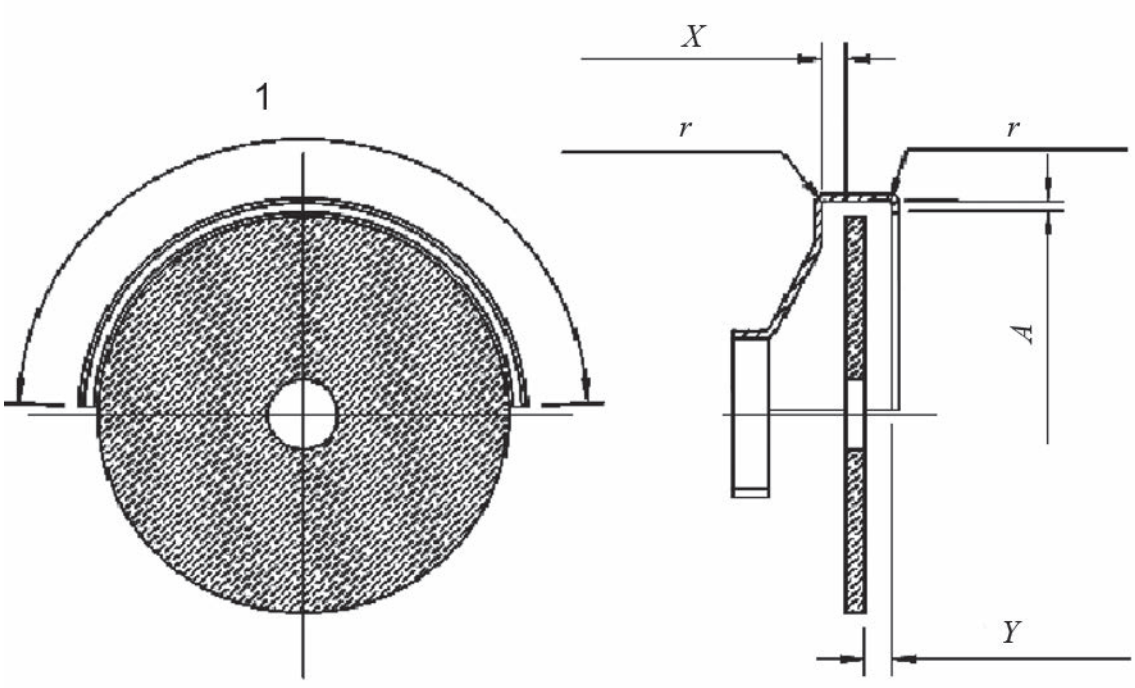
— cover the wheel's plane of rotation toward the operator for at least 180°,

— cover the side of the wheel toward the driving flange for at least 180°, and

— have a lip on the outer edge which curls inward to deflect wheel fragments and to provide necessary strength, or a curtain segment with a minimum height of a quarter of the diameter.

See Figure 14 and Figure 15.

NOTE See 4.2.9.1 regarding the need for a guard to permit the changing of the abrasive product without being removed from the grinder.



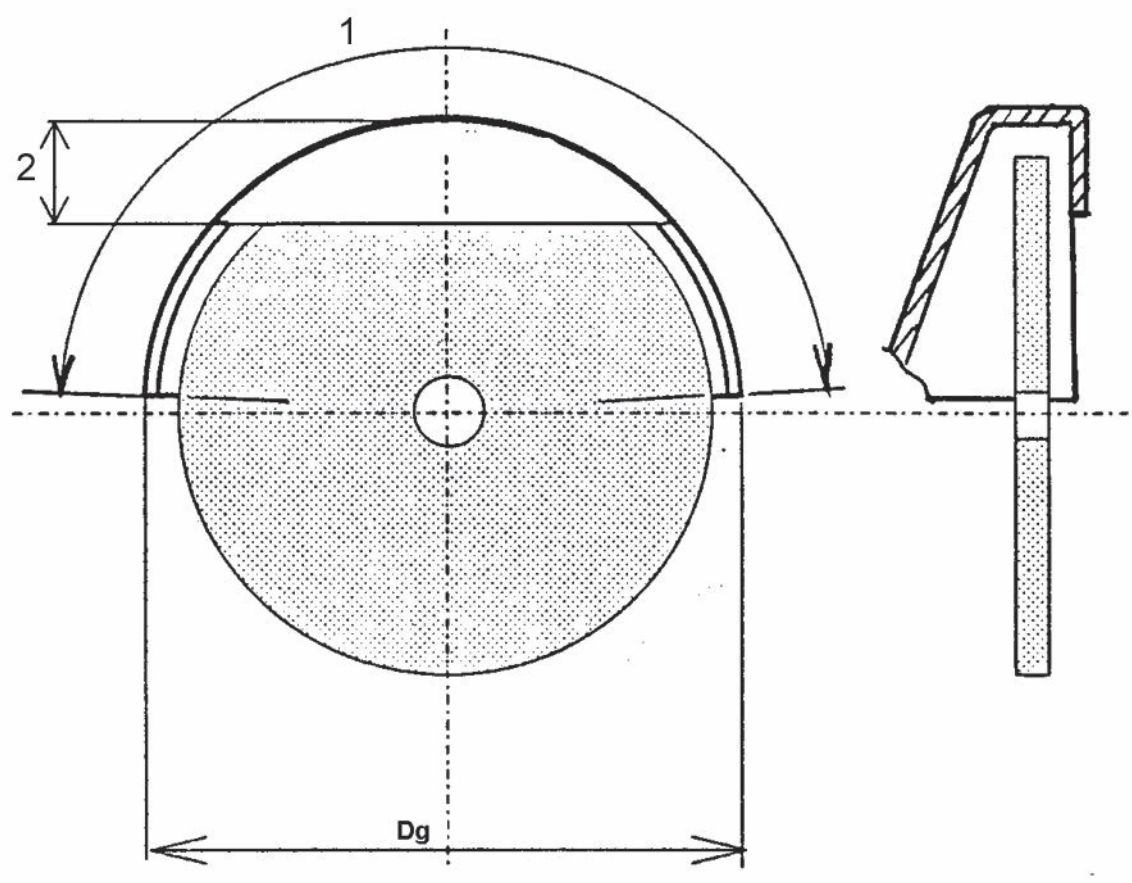
Key

1 guard covering at least 180°

r minimum radius 2 mm

Wheel diameter	**Minimum dimension** X	**Minimum dimension** Y	**Dimension** A
>130	2,0	2,0	5,0
≤130	2,0	2,0	3,0

Figure 14 — Guard design to suit abrasive wheel types 27, 28, 41 and 42 and flap discs



Key

1 guard covering at least 180°

2 at least $D/4$ (D outside diameter of the abrasive wheel)

D_g guard diameter

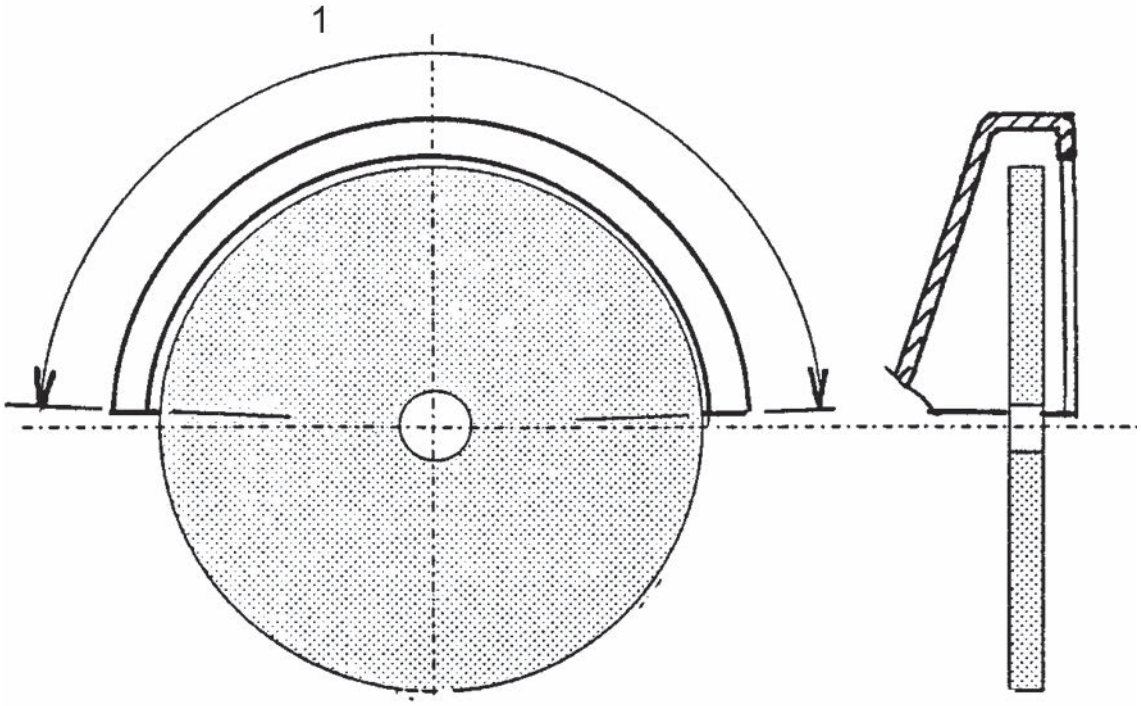
Figure 15 — Guard with curtain segment

Table 5 — Minimum thickness for guards with front lip and with curtain segment

Type of abrasive product	External diameter of abrasive product mm	Minimum thickness of the guard mm
Types 27, 28, 41, 42	$D \leq 150$	1,5
Types 27, 28, 41, 42	$150 < D \leq 230$	2
Type 41	$230 < D \leq 300$	2,5

4.2.9.6 Superabrasives wheel types D4, D5 and D6

Guards with a front lip or a curtain segment shall be used for types D4, D5 and D6 wheels (see Figures 15 and 16). Guards for type D6 wheels with a diameter larger than 150 mm shall fulfil the requirements of EN 12418.



Key

1 guard covering at least 180°

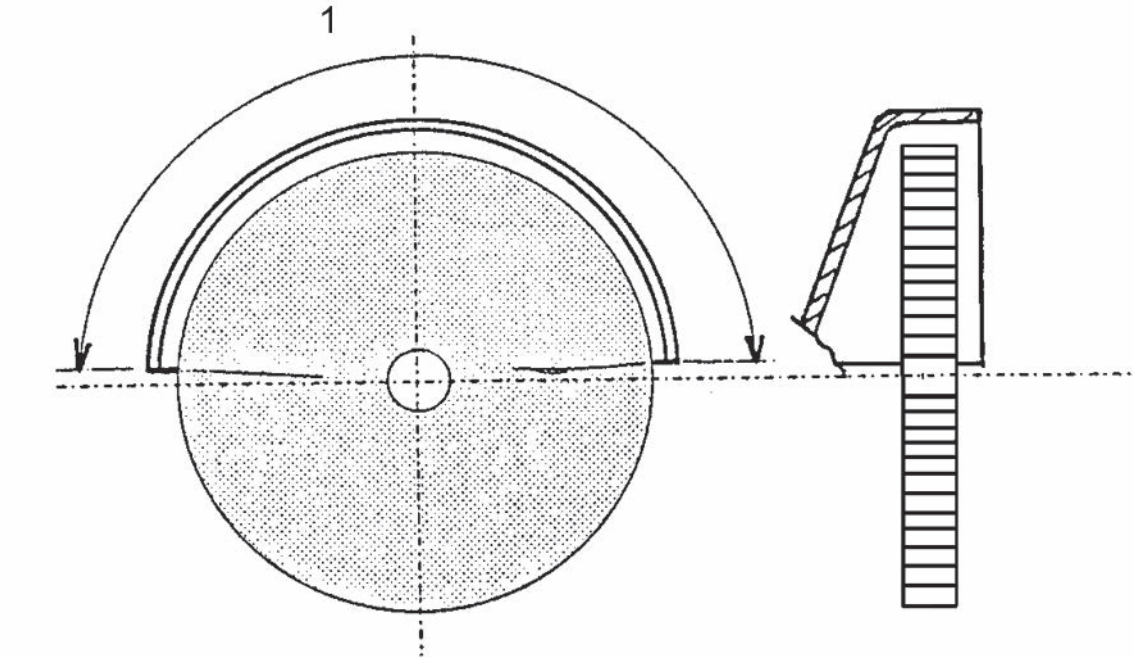
Figure 16 — Guard with front lip

Table 6 — Minimum thickness for guards with front lip and with segment curtain

Type of abrasive product	External diameter of abrasive product mm	Minimum thickness of the guard mm
Type D4, D5	$D \leq 150$	1,5
Type D4, D5	$150 < D \leq 230$	2
Type D5	$230 < D \leq 300$	2,5
Type D6	$D \leq 150$	1,5
Type D6	$150 < D \leq 450$	According to EN 12418

4.2.9.7 Flap wheels of type D2

For flap wheels, at least 180° of the abrasive wheel periphery and the side towards the grinder shall be covered by the guard (see Figure 17).



Key

1 guard covering at least 180°

Figure 17— Guard without front lip

Table 7 — Minimum thickness for guards without front lip, curtain and segment curtain

Type of abrasive product	External diameter of abrasive product mm	Minimum thickness of the guard mm
Type D2	$D \leq 150$	1,5
	$150 < D \leq 230$	2

4.2.9.8 Wire brushes

Guards shall be provided on all hand-held brushing machines. These guards shall be the same as those used on grinders for radial and cup wheels. Where these guards are not usable for certain brush shapes, suitable guards shall be devised after consultation with the brush manufacturer.

4.2.9.9 Material of guards

Guards shall be made of steel plate in accordance with EN 10111 and EN 10130, with a tensile strength of 270 N/mm^2 to 450 N/mm^2 and a minimum elongation of 28 % (gauge length 50 mm) or of other material with comparable characteristics.

4.3 Thermal safety

Surface temperatures of parts of the grinder, which are held during use or could be inadvertently touched, shall follow the provisions of ISO 13732-1 and ISO 13732-3.

Pneumatic grinders shall be designed to minimize the cooling effects of exhaust air on the handles and other gripping zones.

4.4 Noise reduction

The grinder shall be designed and constructed so that the emission of noise is reduced to the lowest level, taking account of technical progress and the availability of means for reducing noise, in particular at source. Principles for designing grinders with reduced noise emission are contained in ISO/TR 11688-1 and ISO/TR 11688-2.

The noise emission from during the use of grinders has three main sources:

— the grinder itself;

— the inserted tool;

— the workpiece.

NOTE Generally, the noise emitted due to the characteristics of the workpiece cannot be controlled directly by the manufacturer of the grinder.

Typical sources of noise emitted by the grinder itself are:

a) the motor and drive mechanism,

b) the exhaust air or gases, and

c) vibration or impact-induced noise.

Where the exhaust air or gases are the major contributor to the noise, means to reduce the noise, for example a silencer or equivalent means, shall be included in the design.

Alternatively, where practicable, the exhaust air or gases can be piped away from the operator in a hose.

Vibration-induced noise can often be reduced by vibration isolation and damping.

This list is not exhaustive; where alternative technical measures are available for reducing noise more efficiently, they should be used by the manufacturer.

4.5 Vibration

The grinder shall be designed and constructed so that the vibration is reduced to the lowest level at the handles, and at any other parts of the tool in contact with the operator's hands, taking account of technical progress and the availability of means for reducing vibration, in particular at source. Principles for designing grinders with reduced vibration emission are contained in CR 1030-1.

Typical sources of vibration emitted by a grinder are:

— unbalance of rotating parts,

— poorly designed motors and gears, and

— resonances in the structure of the machine, particularly the handles and their mounts.

The following design features have been found to be effective and should be considered by manufacturers where designing grinders:

a) autobalancers;

b) increasing inertia;

c) isolated casing or handles.

This list is not exhaustive; where alternative technical measures are available for reducing vibration more efficiently, they should be used by the manufacturer.

4.6 Materials and substances processed, used or exhausted

4.6.1 Exhaust air

Pneumatic grinders shall be designed in such a way that exhaust air is directed so as not to cause a hazard to the operator and so that any other effects, such as blowing dust and reflected air from the workpiece on to the operator, are minimized.

4.6.2 Dust and fumes

So far as is reasonably practicable, the grinder shall be designed to facilitate the collection and removal or suppression of airborne dust particles and fumes generated by the work process. The instructions handbook shall include sufficient information to enable adequate control of the risks from dust and fumes.

4.6.3 Lubricants

Where specifying lubricants, the manufacturer shall take environmental and occupational health aspects into account.

4.7 Ergonomics

4.7.1 Design of the handle

Gripping areas of the grinders shall be designed to provide convenient, effective means for the operator to exercise full control over the grinder.

Handles and other parts used for gripping the grinder shall be designed to ensure that the operator is able to grip the grinder correctly and to perform the expected work. Handles shall suit the functional anatomy of the hand and the dimensions of the hands of the operator population.

NOTE Further guidance on ergonomic design principles can be found in EN 614-1.

Angle and vertical grinders shall have provision for mounting a second handle, when the power output is over 0,5 kW.

Grinders having a mass greater than 2 kg (including the inserted tool) shall be capable of being supported by two hands while being lifted or operated.

The strength of a removable handle and the method used to fix it shall be appropriate to the intended principal use. Verification shall be carried out in accordance with 5.7.

4.7.2 Suspension device

Provision should be made, where appropriate, to enable the attachment to the grinder of a suspension device in order to reduce, where practicable, the physical strain placed on the operator by the mass of the grinder. The fitting of a suspension device shall not introduce an additional hazard.

4.8 Controls

4.8.1 Start-and-stop device

Grinders shall be equipped with a single control device to start and/or stop them. It shall be adapted to the handle, or to the part of the grinder being gripped, so that it can be held comfortably in the run position, and so that the operator can activate it without releasing the grip on the handles.

Start-and-stop devices shall be so designed that the inserted tool ceases to be powered when the start-and-stop device is released. Without manual effort when completely released, the device shall move to the stop position, i.e. shall be of the hold-to-run type.

Start-and-stop devices shall be in the stop position or immediately move to the stop position when the grinder is connected to the energy supply.

It shall not be possible to lock the start and stop device in the running position.

4.8.2 Unintentional start

The start-and-stop device shall be so designed, positioned or guarded that the risk of unintentional start is minimized. Verification shall be carried out in accordance with 5.6.

Lock-off start-and-stop devices are required for:

— angle grinders intended for wheels with a nominal diameter exceeding 125 mm;

— straight grinders intended for wheels with a nominal diameter exceeding 100 mm;

— vertical grinders intended for wheels with a nominal diameter exceeding 100 mm.

4.8.3 Actuating forces

For grinders that are intended to be started frequently or are intended to be used for precision work, the actuating force shall be small.

For grinders that are normally used in operations of long duration, the force required to keep the start device in the run position shall be small.

NOTE For further information on trigger forces for control devices, see EN 894-3.

5 Verification

5.1 General conditions for the tests

Tests according to this part of ISO 11148 are type tests.

5.2 Noise

The noise-emission values shall be measured and declared in accordance with ISO 15744.

Compliance with 4.4 may be verified through comparison of the noise emission values with those for other machines of the same family or with machines of similar size and performance characteristics.

5.3 Vibration

For angle and vertical grinders, the vibration total value shall be measured and reported in accordance with ISO 28927-1. For straight grinders, the vibration total value shall be measured and reported in accordance with ISO 28927-4. For grinders intended to be used with wire brushes, the vibration total value shall be measured and reported in accordance with ISO 20643.

The vibration-emission value and its uncertainty shall be declared in accordance with EN 12096.

Compliance with 4.5 may be verified through comparison of the vibration emission values with those for other machines of the same family or with machines of similar size and performance characteristics.

5.4 Test of deformation of flanges

Flanges shall be tested according to the following procedure:

— the abrasive product shall be replaced on the grinder by a steel disc having the same dimensions and shape as the abrasive product;

— the clamping nut shall be tightened with a test torque, as specified in Table 8;

— a feeler gauge of a thickness of 0,05 mm shall be used to test whether or not the flanges are in contact with the disc all around the circumference.

The flange is not accepted if the feeler gauge can be pushed underneath the flange by more than 1 mm or by more than one fifth of the rim of the clamping area, C, whichever is the smaller value. An example of C can be found in Figure 3.

Table 8 — Torque for testing of flanges

Spindle thread size		Test torque Nm
Metric threads	UN-threads	
M 8	5/16” UNF	20
M 10	3/8” – 24 UNF	25
M 12	1/2” –13 UNC	45
M 14		65
M 16	5/8” – 11 UNC	100
M 20	3/4” – UNC	200

5.5 Test of guards

5.5.1 Burst tests for guards are mandatory for all types of wheels, except for superabrasive wheels.

CAUTION This test is dangerous and shall be carried out in a properly designed and equipped test facility. The test shall be performed inside a fully protected enclosure, which can contain all of the abrasive fragments and debris.

Guards shall be tested according to the following procedure:

— the guard shall be mounted on a grinder, which shall be fixed in a stable position;

— three guards shall be tested; at each test, a new abrasive product shall be burst;

— the burst shall be caused by altering the abrasive product so that it breaks into three approximately equally sized pieces at the test speed;

— the test speed shall be in accordance with Table 9;

— the abrasive product used in the test shall have the same shape, mass and strength as the largest abrasive product which is able to be fitted to the grinder with the guard under test.

Table 9 — Test speeds for test of guards

Type of speed control	Test speed
Grinder without speed governor	Rated speed at the pressure marked on the tool
Grinder with speed governor and without overspeed shut-off device	Maximum attainable speed at the pressure marked on the tool
Grinder with speed governor and with overspeed shut-off device	Speed at which the shut-off device releases, at the pressure marked on the tool

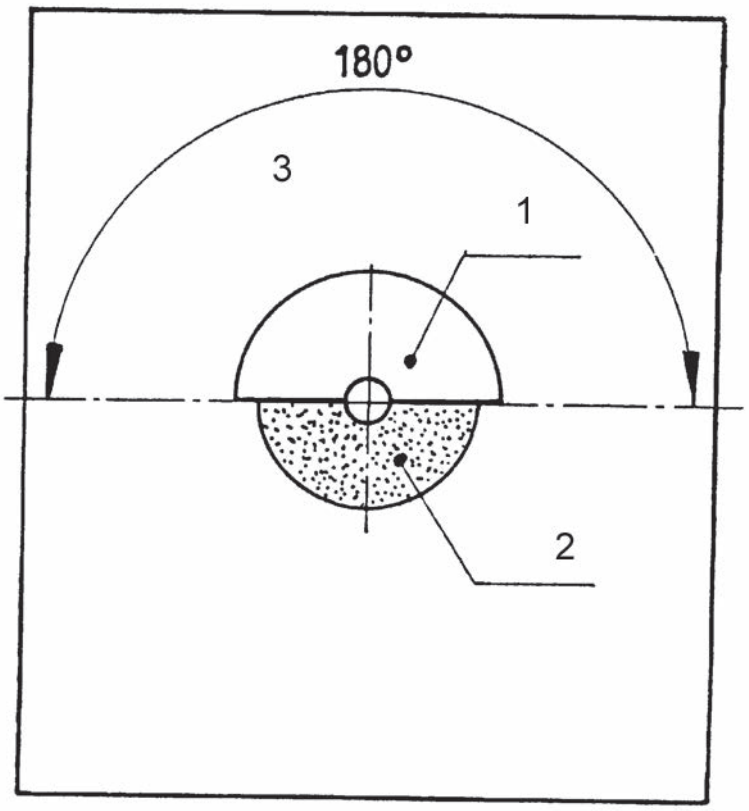
5.5.2 Acceptance criteria:

— all fragments shall be contained or deflected through an arc of 180° (small granules are not considered fragments) (see Figure 18);

— the guard shall not be separated from the grinder. No fasteners or mounting hardware may enter the no-fragment zone. Deformation of the guard and/or movement in the mounting is acceptable.

If all three guards satisfy the acceptance criteria, the design shall be considered acceptable.

If one of the three guards fails, three additional guards shall be tested. If all three of the second set satisfy the criteria, the guard design shall be considered acceptable.



1 guard
2 wheel
3 no fragments

Figure 18 — Test of guards — No-fragment area

5.6 Unintentional start

Compliance with 4.8.2 shall be established for all types of start/stop devices using the following test.

The grinder shall be connected to the energy supply and placed in any possible position and pulled over a horizontal plane by its hose.

Operation of the start-and-stop device shall (then) not occur.

Additionally, those grinders for which lock-off start-and-stop devices are required shall be checked by visual inspection to verify that the device is present and effective.

5.7 Power tool construction

Compliance with 4.2.5 shall be verified by dropping a sample grinder three times on to a concrete surface from a height of 1 m without affecting its operational and safety functions. The sample shall be positioned so as to vary the point of impact.

5.8 Test of alternative flanges

5.8.1 Test procedure

Alternative flange designs for types 27, 28 and 42 wheels and flap discs, as described in 4.2.8.6, shall be subjected to the following test, in order to verify their capability to maintain the correct location of the abrasive wheel during use:

— the grinder shall be disconnected from the power supply throughout the test;

— a type 27 depressed-centre test wheel shall be selected in accordance with ISO 28927-1:2009, 8.4.1, and mounted on the grinder using the flanges, but without blotters;

— the torque used to assemble the test wheel and flanges shall be that which is recommended for mounting an abrasive wheel for normal use of the grinder;

— the grinder shall be clamped such that the test wheel is in a vertical plane;

— the spindle shall be prevented from rotating;

— a load, F_t, shall be suspended from the unbalance hole in the test wheel, as shown in Figure 19 (for symbols, see 3.3):

$$F_t = \frac{(300\,000 \cdot P)}{(n_{nom} \cdot D)} \quad (4)$$

5.8.2 Acceptance criteria

— The test wheel shall remain clamped, without any slippage, during the application of the test load.

— The flanges shall not show any distortion upon examination after removal of the test load and test wheel.

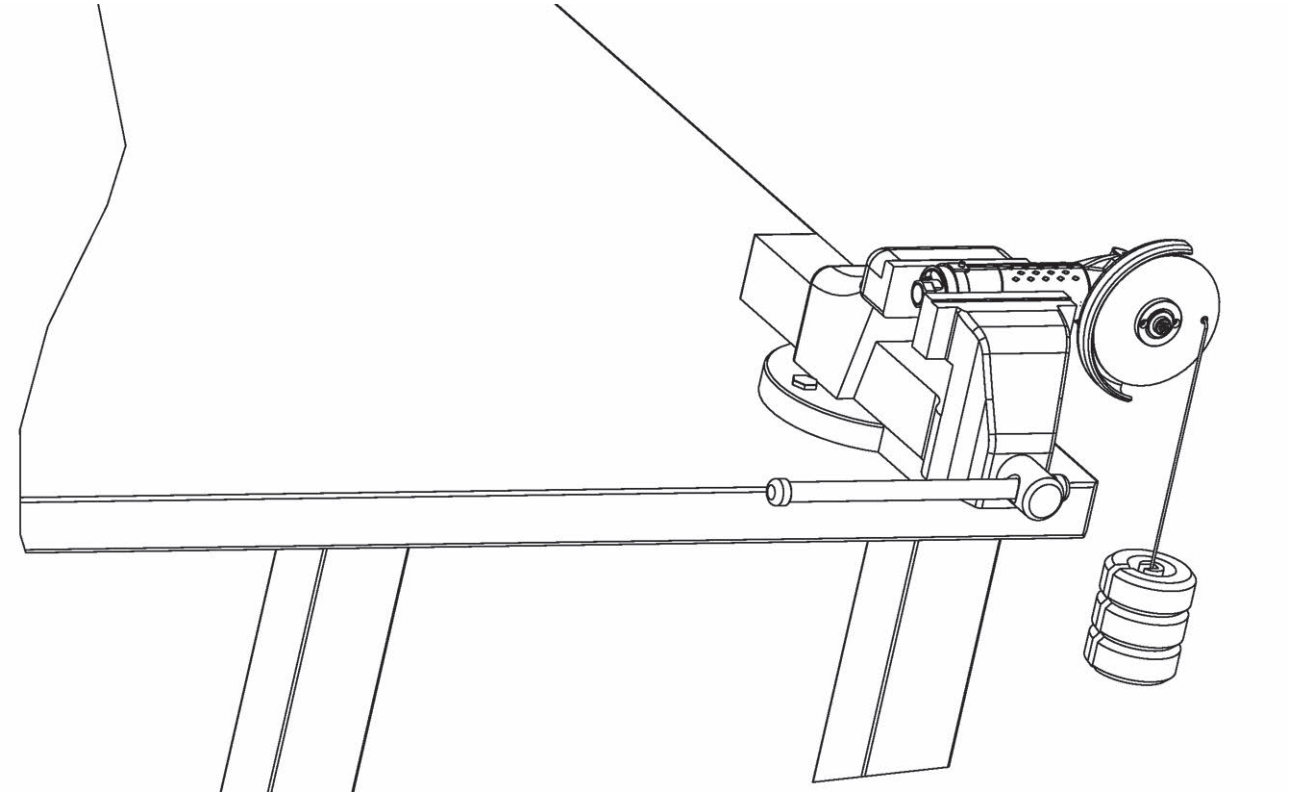


Figure 19 — Mounting arrangement for alternative flange test

5.9 Structure of verification of safety requirements

The verification shall be carried out in conformity with Table 10.

Table 10 — Structure of verification of safety requirements

Safety requirement	Visual check	Functional check	Measurement	Reference [to the subclause(s) of this part of ISO 11148 or other International Standard]
4.2.1 Surfaces, edges and corners	X	—	—	—
4.2.2 Supporting surface and stability	X	X	—	—
4.2.3 Hydraulic fluid ejection	X	—	—	—
4.2.4 Speed control	—	—	X	—
4.2.5 Power tool construction	—	X		5.7
4.2.6 Attachment of abrasive product	X	X	X	—
4.2.7 Spindles	—	X	—	—
4.2.8 Flanges	—	X	X	5.4, 5.8
4.2.9 Guards	X	—	—	5.5
4.3 Thermal safety	—	X	X	ISO 13732-1 ISO 13732-3

Table 10 *(continued)*

Safety requirement		Visual check	Functional check	Measurement	Reference [to the subclause(s) of this part of ISO 11148 or other International Standard]
4.4	Noise reduction	—	—	X	ISO 15744 5.2
4.5	Vibration	—	—	X	ISO 28927-1 ISO 28927-4 5.3 ISO 20643
4.6.1	Exhaust air	—	X	—	—
4.6.2	Dust and fumes	X	X	—	—
4.7.1	Design of the handle	X		—	—
4.7.2	Suspension device	X	X	—	—
4.8.1	Start-and-stop device	—	X	—	—
4.8.2	Unintentional start	X	X	—	5.6
4.8.3	Actuating forces	X	X	—	

6 Information for use

6.1 Marking, signs and written warnings

Grinders shall be marked visibly, legibly and indelibly with the following information:

— name and full address of the manufacturer and, where applicable, his/her authorized representative;

NOTE 1 The address can be simplified if there is not enough room on small machines, as long as the manufacturer (and, where applicable, his/her authorized representative) can always be identified so that mail is able to reach the company.

— designation of series or type;

NOTE 2 The designation of the tool can be achieved using a combination of letters and numbers.

— serial number or batch number;

— year of construction, that is the year in which the manufacturing process is completed;

— rated speed, expressed in revolutions per minute;

— spindle thread size (for grinders intended for use with threaded-hole wheels);

— for pneumatic grinders:

  — rated air pressure marked as (max.)

— for hydraulic grinders:

  — nominal pressure and flow;

  — maximum allowable setting for the pressure-relief valve.

Grinders shall be permanently marked with a graphical symbol in accordance with Annex C showing that the operator's instructions shall be read before work starts.

The direction of rotation shall be permanently marked in accordance with Annex C.

6.2 Instructions handbook

6.2.1 General

For the information to be provided to the user, the content of Clause 6 together with ISO 12100:2010, 6.4.5.2 and 6.4.5.3, apply.

The information provided by the manufacturer is an important, but not exclusive, basis for the safe use of the tool. It shall provide sufficient information for the end user to perform an initial risk assessment.

The hazards identified in 6.2.2.4 to 6.2.2.13 are foreseeable in the general use of hand-held grinders. The information provided with the tool shall state that the user or user's employer shall assess the specific risks that can be present as a result of each use.

The instructions handbook shall at least contain information relating to the following:

— name and address of the manufacturer or supplier or any other agent responsible for placing the grinder on the market;

— designation of the series or type;

— operating instructions; see 6.3;

— information on noise emission; see 6.4.2;

— information on vibration transmitted to the hands of the operator; see 6.4.3;

— maintenance instructions; see 6.5;

— explanations of any symbols marked on the grinder; see Annex C;

— information about residual risks and how to control them.

6.2.2 Operator's instructions

6.2.2.1 General

The instructions and warnings stated in 6.2.2 to 6.2.5 shall be given with all grinders unless the risk assessment shows that they are not relevant to a particular grinder. Words of equivalent meaning may be used.

6.2.2.2 Statement of use

The operator's instructions shall include a description of the correct use of the grinder and shall make reference to the appropriate inserted tools. The operator's instructions shall state that any other use is forbidden. Foreseeable misuse of the grinder, which experience has shown to occur, shall be warned against.

6.2.2.3 Allowance for user

The operator's instructions shall be written primarily for professional users. Where a tool may be used by non-professional users, additional information for use shall be provided.

6.2.2.4 General safety rules

— For multiple hazards, read and understand the safety instructions before installing, operating, repairing, maintaining, changing accessories on, or working near, the grinder. Failure to do so can result in serious bodily injury.

— Only qualified and trained operators should install, adjust or use the grinder.

— Do not modify this grinder. Modifications can reduce the effectiveness of safety measures and increase the risks to the operator.

— Do not discard the safety instructions; give them to the operator.

— Do not use the grinder if it has been damaged.

— Tools shall be inspected periodically to verify that the ratings and markings required by this part of ISO 11148 are legibly marked on the tool. The employer/user shall contact the manufacturer to obtain replacement marking labels when necessary.

6.2.2.5 Projectile hazards

— Be aware that the failure of the workpiece or accessories, or even of the inserted tool itself, can generate high-velocity projectiles.

— Always wear impact-resistant eye protection during the operation of the grinder. The grade of protection required should be assessed for each use.

— Ensure that the workpiece is securely fixed.

— Ensure safe clamping of the abrasive product to the grinder.

— Check that maximum operating speed of the abrasive product, converted to revolutions per minute, is equal to, or greater than, the rated speed of the spindle.

— Ensure that the guard is in place, is in good condition and is correctly mounted; ensure that the guard is regularly inspected.

NOTE It is possible for internal grinding to not require a guard, provided the workpiece encloses the abrasive product.

— Check regularly that the speed of the grinder is not higher than that marked on it. These speed checks shall be carried out without the abrasive product mounted and in accordance with the instructions given by the manufacturer.

— Check that the flanges, as specified by the manufacturer, are used and are in good condition, e.g. free from cracks and burrs, and are plane.

— Check that the spindle and spindle threads are not damaged or worn.

— Ensure that sparks and debris resulting from use do not create a hazard.

— Disconnect the grinder from the energy supply before changing abrasive product and servicing.

6.2.2.6 Entanglement hazards

Choking, scalping and/or lacerations can occur if loose clothing, personal jewellery, neck wear, hair or gloves are not kept away from the tool and accessories.

6.2.2.7 Operating hazards

— Avoid contact with the rotating spindle and mounted wheel to prevent cutting of hands and other body parts.

— Use of the tool can expose the operator's hands to hazards, including cuts, abrasions and heat. Wear suitable gloves to protect hands.

— Operators and maintenance personnel shall be physically able to handle the bulk, mass and power of the tool.

— Hold the tool correctly; be ready to counteract normal or sudden movements and have both hands available.

— Maintain a balanced body position and secure footing.

— Release the start-and-stop device in the case of an interruption of the energy supply.

— Use only lubricants recommended by the manufacturer.

— Personal protective safety glasses shall be used; suitable gloves and protective clothing are recommended.

— For overhead work, wear a safety helmet.

— The stopping time, if longer than 5 s, shall be stated, and it shall be recommended that the grinder be placed in a stable position.

— When cutting off, the workpiece shall be supported such that the slot is kept at constant or increasing width during the complete operation.

— If the abrasive product becomes jammed in a cut slot, shut off the grinder and ease the wheel free. Check that the wheel is still correctly secured and not damaged before continuing the operation.

— Grinding wheels and cutting-off wheels shall not be used for side grinding. (Exception: grinding wheels designed for side grinding.) Grinders shall not be used over the maximum peripheral speed of an abrasive product.

— The operator shall pay attention that no bystanders are in the vicinity.

— Personal protective equipment, such as suitable gloves, an apron and a helmet, shall be used.

— Grinding sparks can ignite clothing and cause severe burns. Ensure sparks do not land on clothing. Wear fire-retardant clothing and have a bucket of water nearby.

6.2.2.8 Repetitive motions hazards

— When using a grinder to perform work-related activities, the operator can experience discomfort in the hands, arms, shoulders, neck or other parts of the body.

— When using a grinder, the operator should adopt a comfortable posture while maintaining secure footing and avoiding awkward or off-balanced postures. The operator should change posture during extended tasks; this can help avoid discomfort and fatigue.

— If the operator experiences symptoms, such as persistent or recurring discomfort, pain, throbbing, aching, tingling, numbness, burning sensations or stiffness, these warning signs should not be ignored. The operator should tell the employer and consult a qualified health professional.

6.2.2.9 Accessory hazards

— Disconnect the grinder from the energy supply before fitting or changing the inserted tool or accessory.

— Only use sizes and types of accessories and consumables that are recommended by the grinder manufacturer; do not use other types or sizes of accessories or consumables.

— Ensure that the dimensions of the abrasive product are compatible with the grinder and that the abrasive product fits the spindle.

— Ensure that the thread type and size of the abrasive product exactly match the thread type and size of the spindle.

— Inspect the abrasive product before use. Do not use abrasive products which can (possibly) have been dropped or which are chipped, cracked or otherwise defective.

— Ensure that the abrasive product is correctly mounted and tightened before use and run the grinder at no-load speed for at least 1 min in a safe position; stop immediately if considerable vibration or other defects are detected and determine the cause of these defects.

— Prevent the spindle end from touching the bottom of the hole of cups, cones or plugs with threaded holes, intended to be mounted on machine spindles, by checking their dimensions and other relevant data.

— Where abrasive products are supplied or used with reducing adaptors or bushings, the user shall ensure that the adaptor or bushing does not contact the face of the flange and that the clamping force provides sufficient rotational driving action to prevent the abrasive product from slipping.

— In cases where flanges are supplied for several types or sizes of abrasive, always fit the correct flange(s) for the abrasive being used.

— Avoid direct contact with the inserted tool during and after use as it can be hot or sharp.

— Store and handle the abrasive product with care in accordance with manufacturer's instructions.

6.2.2.10 Workplace hazards

— Slips, trips and falls are major causes of workplace injury. Be aware of slippery surfaces caused by use of the tool and also of trip hazards caused by the air line or hydraulic hose.

— Proceed with care in unfamiliar surroundings. There can be hidden hazards, such as electricity or other utility lines.

— This grinder is not intended for use in potentially explosive atmospheres and is not insulated from coming into contact with electric power.

— Ensure that there are no electrical cables, gas pipes, etc., which can cause a hazard if damaged by use of the tool.

6.2.2.11 Dust and fume hazards

— Dusts and fumes generated while using grinders can cause ill health (for example cancer, birth defects, asthma and/or dermatitis); risk assessment of these hazards and implementation of appropriate controls for these hazards are essential.

— Risk assessment should include dust created by the use of the tool and the potential for disturbing existing dust.

— Operate and maintain the grinder as recommended in these instructions, to minimize dust or fume emissions.

— Direct the exhaust so as to minimize disturbance of dust in a dust-filled environment.

— Where dust or fumes are created, the priority shall be to control them at the point of emission.

— All integral features or accessories for the collection, extraction or suppression of airborne dust or fumes should be correctly used and maintained in accordance with the manufacturer's instructions.

— Select, maintain and replace the consumable/inserted tool as recommended in the instructions, to prevent an unnecessary increase in dust or fumes.

— Use respiratory protection in accordance with the employer's instructions and as required by occupational health and safety regulations.

— Working with certain materials creates emissions of dust and fumes, causing a potentially explosive environment.

6.2.2.12 Noise hazards

— Exposure to high noise levels can cause permanent, disabling hearing loss and other problems, such as tinnitus (ringing, buzzing, whistling or humming in the ears). Therefore, a risk assessment and the implementation of appropriate controls for these hazards are essential.

— Appropriate controls to reduce the risk may include actions, such as damping materials, to prevent workpieces from “ringing”.

— Use hearing protection in accordance with employer’s instructions and as required by occupational health and safety regulations.

— Operate and maintain the grinder as recommended in the instructions handbook to prevent an unnecessary increase in noise.

— If the grinder has a silencer, always ensure that it is in place and in good working order whenever the grinder is being operated.

— Select, maintain and replace the consumable/inserted tool as recommended in the instructions handbook to prevent an unnecessary increase in noise

6.2.2.13 Vibration hazards

The information for use shall draw attention to vibration hazards that have not been eliminated by design and construction and remain as a residual vibration risk. It shall enable employers to identify the circumstances in which the operator is likely to be at risk from vibration exposure. If the vibration emission value obtained using ISO 28927-1 for angle and vertical grinders, ISO 28927-4 for straight grinders or ISO 20643 does not adequately represent the vibration emission in the intended uses (and foreseeable misuses) of the machine, additional information and/or warnings shall be supplied to enable the risks arising from vibration to be assessed and managed.

— Exposure to vibration can cause disabling damage to the nerves and blood supply of the hands and arms.

— Wear warm clothing whenever working in cold conditions and keep your hands warm and dry.

— If you experience numbness, tingling, pain or whitening of the skin in your fingers or hands, stop using the grinder, tell your employer and consult a physician.

— Operate and maintain the grinder as recommended in the instructions handbook to prevent an unnecessary increase in vibration levels.

— Do not allow the inserted tool to chatter on the workpiece as this is likely to cause a substantial increase in vibration.

— Select, maintain and replace the consumable/inserted tool as recommended in the instructions handbook to prevent an unnecessary increase in vibration levels.

— Support the mass of the tool in a stand, tensioner or balancer, if possible.

— Hold the tool with a light but safe grip, taking account of the required hand reaction forces because the risk arising from vibration is generally greater where the grip force is higher.

— Use blotters where they are provided with the bonded abrasive product.

6.2.3 Additional safety instructions for pneumatic power tools

— Air under pressure can cause severe injury:

  — always shut off air supply, drain hose of air pressure and disconnect tool from air supply whenever not in use, before changing accessories or where making repairs;

— never direct air at yourself or anyone else.

— Whipping hoses can cause severe injury. Always check for damaged or loose hoses and fittings.

— Whenever universal twist couplings (claw couplings) are used, lock-pins shall be installed and whipcheck safety cables shall be used to safeguard against possible hose-to-tool and hose-to-hose connection failure.

— Do not exceed the maximum air pressure stated on the tool.

— Never carry an air tool by the hose.

6.2.4 Additional safety instructions for hydraulic power tools

— Do not exceed the maximum relief-valve setting stated on the tool.

— Carry out daily check for damaged or worn hoses or hydraulic connections and replace if necessary.

— Use only clean oil and filling equipment.

— Power units require a free flow of air for cooling purposes and should therefore be sited in a well-ventilated area free from hazardous fumes.

— Ensure that couplings are clean and correctly engaged before operation.

— Do not inspect or clean the tool while the hydraulic power source is connected. Accidental engagement of the tool can cause serious injury.

— Do not install or remove the tool while the hydraulic power source is connected. Accidental engagement of the tool can cause serious injury.

— Be sure all hose connections are tight.

— Wipe all couplers clean before connecting. Failure to do so can result in damage to the quick couplers and cause overheating.

Instructions shall be given that only hydraulic fluid recommended by the manufacturer be used.

NOTE It is advisable to enquire of the manufacturer whether or not non-flammable fluids can be used.

6.2.5 Specific safety instructions

Warnings shall be given about any specific or unusual hazards associated with the use of the grinder. Such warnings shall indicate the nature of the hazard, the risk of injury and the avoidance action to be taken.

6.3 Operating instructions

The instructions shall include, where appropriate,

— instructions for setting-up or fixing the grinder in a stable position, as appropriate for grinders, which can be mounted in a support,

— assembly instructions, including recommended guards, accessories and inserted tools,

— illustrated description of functions,

— limitations on tool use dictated by environmental conditions,

— instructions for setting and testing, and

— general instructions for use, including changing inserted tools and limits on the size and type of workpiece.

6.4 Data

6.4.1 General

The instructions shall include the information marked on the tool as stated in 6.1 and the following:

— mass of the grinder;

— for hydraulic grinders:

  — specification of the coupling;

  — specification of hoses with regard to pressure and flow;

  — maximum inlet temperature of the inlet fluid.

6.4.2 Noise

6.4.2.1 Declaration of emission

The instructions shall include a noise-emission declaration in accordance with ISO 15744.

6.4.2.2 Additional information

If the values for noise emissions obtained using the appropriate tests defined in 5.2 do not adequately represent the emissions during the intended uses of the machine, additional information and/or warnings shall be supplied to enable the risks arising to be assessed and managed.

Information on noise emission should also be provided in the sales literature

6.4.3 Vibration

6.4.3.1 Declaration of emission

The instructions shall include the vibration-emission value and uncertainty as specified in 5.3 and the reference number of the test code, i.e. ISO 28927-1 for angle and vertical grinders, ISO 28927-4 for straight grinders or ISO 20643 for grinders intended to be used with wire brushes.

6.4.3.2 Additional information

If the values for vibration-emissions obtained using the appropriate tests defined in 5.3 do not adequately represent the emissions during the intended uses of the machine, additional information and/or warnings shall be supplied to enable the risks arising to be assessed and managed.

Information on vibration emission should also be provided in the sales literature.

6.5 Maintenance instructions

The maintenance instructions shall contain:

— instructions to keep the grinders safe by regular preventive maintenance;

— information on when the regular preventive maintenance shall be carried out, for instance after a specified time of operation, a specified number of cycles/operations or a stated number of times per year;

— instructions for disposal so as not to expose personnel and the environment to hazards;

— list of the service operations that the user should carry out;

— instructions for lubrication, if required;

— instructions to check the speed and carry out a simple check of the vibration level after each service;

— instructions to check the speed regularly;

— regular inspection of spindles, threads and clamping devices in respect of wear and tolerances for the location of abrasive products.

— specifications of the spare parts to be used where these affect the health and safety of operators.

Maintenance instructions shall also include precautions to be taken to avoid exposure to hazardous substances deposited (due to work processes) on the tool.

NOTE Skin exposure to hazardous dust can cause severe dermatitis. If dust is generated or disturbed during the maintenance procedure, it can be inhaled.

Annex A
(informative)

List of significant hazards

This annex contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this part of ISO 11148, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk. The following significant hazards can occur in the use of grinders.

Table A.1 — List of significant hazards

Hazard type	Reference to safety requirement	
	By design or guarding	Information for use
1 Mechanical hazards		
— cutting	4.2.1, 4.8.1, 4.8.2	6.2.2.7, 6.2.2.9
— drawing in or trapping (caused by hair, clothing, etc. getting entangled in a rotating grinder)	4.2.5, 4.8.1, 4.8.2	6.2.2.6, 6.2.2.9
— friction or abrasion hazard	4.2.1, 4.8.1, 4.8.2	6.2.2.7, 6.2.2.9
— loss of stability	4.2.2	
— whipping hose		6.2.3
— ejection from high-pressure hydraulic systems	4.2.3	
— ejection of parts due to		
— cracked abrasive product		6.2.2.5
— incorrect mounting of the abrasive product		6.2.2.9
— misuse of grinder		
— overspeed of grinder	4.2.4	6.2.2.5
— use of incorrect flanges	4.2.8	6.2.2.5
— use of wrong abrasive product		6.2.2.5, 6.2.2.9
— hose and hose coupling specifications		6.2.3
— due to loosening or loss of tool components during use	4.2.5, 4.7.1	
— due to the abrasive product coming loose	4.2.6, 4.2.7	6.2.2.5, 6.2.2.7, 6.2.2.9
2 Electrical hazards		6.2.2.10
3 Thermal hazards	4.3	
— explosions		6.2.2.4, 6.2.2.10, 6.2.2.11
— health damage due to hot or cold surfaces	4.3	
4 Hazards caused by noise	4.4	6.2.2.12
5 Hazards generated by vibration	4.5	6.2.2.13, 6.2.2.9

Table A.1 *(continued)*

Hazard type	Reference to safety requirement	
	By design or guarding	Information for use
6 Hazards generated by materials and substances processed, used or exhausted		
— inhalation of harmful dust and fumes	4.6.2	6.2.2.11
— formation of explosive dust and fumes		6.2.2.11
— sparks		6.2.2.5, 6.2.2.7
— exhaust air	4.6.1	6.2.2.11
— lubricants	4.6.3	6.2.2.7, 6.2.2.11
— hydraulic fluid		6.2.4
7 Hazards caused by neglecting ergonomic principles		
— repetitive strain injuries	4.7.1, 4.7.2	6.2.2.8
— unsuitable postures		6.2.2.8
— inadequate grip design and tool balance	4.7.1	6.2.2.7
— neglected use of personal protective equipment		6.2.2.7, 6.2.2.11
8 Hazards caused by the energy supply		
— unexpected return of energy supply after a breakdown		6.2.3
— discharge of high-pressure air or hydraulic fluid		6.2.3, 6.2.4
— incorrect hydraulic fluid flow and outlet pressure		6.2.4

Annex B
(informative)

Examples of grinders covered by this part of ISO 11148

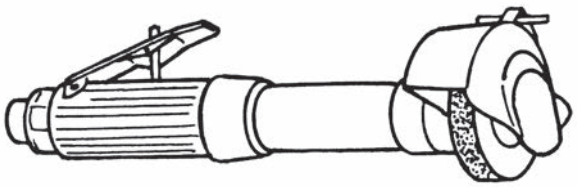


Figure B.1 — Grinder — Straight

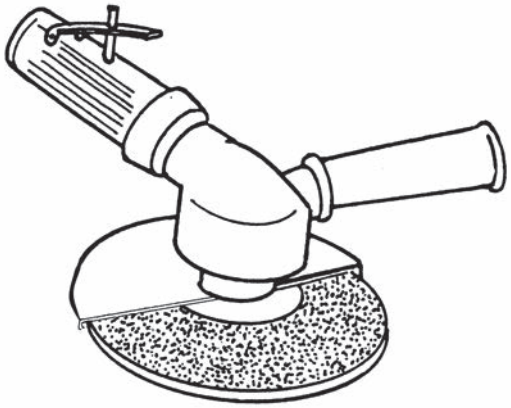


Figure B.2 — Grinder — Angle

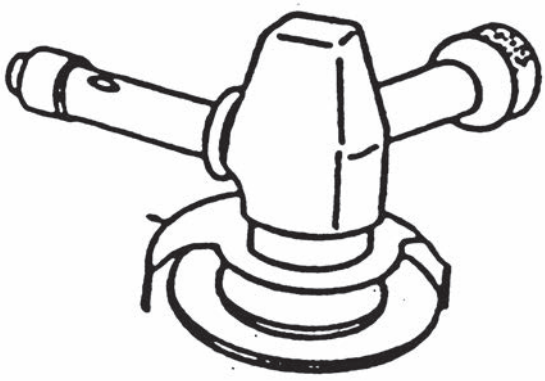


Figure B.3 — Grinder — Vertical

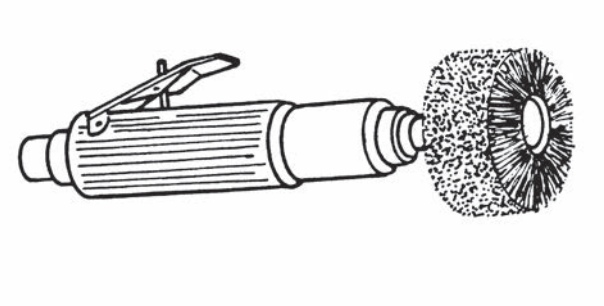
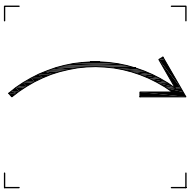


Figure B.4 — Wire brush

Annex C
(normative)

Symbols for labels and signs

Table C.1 — Symbols for labels and signs

No.	Symbol	Significance	Colours	Symbol registration number or source
C.1.1		Warning See instruction handbook. Minimum requirement. This symbol is normative. Additional symbols and/or text are informative.	Background in the circle: blue Symbol: white Background for warning: orange	ISO 3864-2 ISO 7010–M002
C.1.2		Direction of rotation	Background: optional Symbol: black	Application of ISO 7000–0004

Annex D
(informative)

Examples of abrasive products for hand-held grinders

D.1 General

Three types of abrasive products are included in this annex, bonded, coated and super, of which the latter is coated with diamonds or cubic boron nitride.

— B = resinoid bond

— BF = fibre-reinforced resinoid bond

— M = metal bond

Table D.1 — Bonded abrasive products

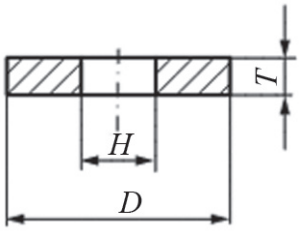
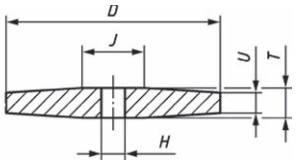
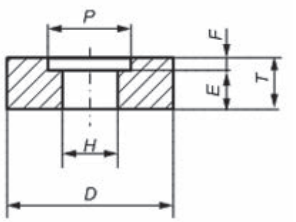
Type according to ISO 525	Description, shape and designation	Type of bonding	Maximum operating speed m/s	Dimension limits mm	Guard according to Figure	Applicable International Standard
Type 1	Straight grinding wheel 	B	≤ 50	$D \leq 200$	9 10 11	ISO 603-12
		BF	≤ 80		11	
Type 4	Wheel, tapered on both sides 	B	≤ 50	$D \leq 200$	9 10 11	ISO 603-12
		BF	≤ 80		11	
Type 5	Wheel, recessed on one side 	B	≤ 50	$D \leq 200$	9 10 11	ISO 603-12
		BF	≤ 80		11	
For other dimensions and tolerances of the diameters, see ISO 603-12, ISO 603-13, ISO 603-14 and ISO 603-16, and ISO 525.						

Table D.1 *(continued)*

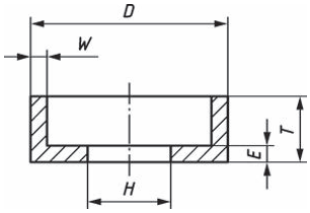
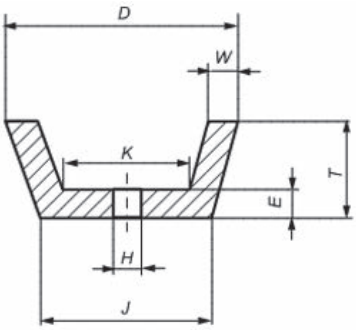
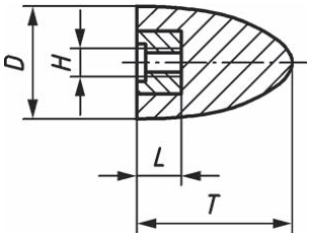
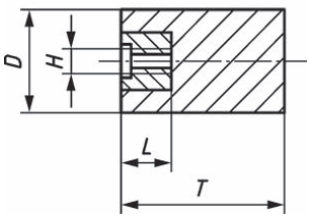
Type according to ISO 525	Description, shape and designation	Type of bonding	Maximum operating speed m/s	Dimension limits mm	Guard according to Figure	Applicable International Standard
Type 6	Straight cup 	B	≤ 50	$D \leq 150$	13	ISO 603-13 ISO 603-14
Type 11	Flaring cup 	B	≤ 50	$D \leq 180$	13	ISO 603-14
Type 16	Abrasive with threaded insert, tapered 	B	≤ 50	$D \leq 80$	14	ISO 603-12
Type 18	Abrasive with threaded insert, cylindrical 	B	≤ 50	$D \leq 80$	14	ISO 603-12
For other dimensions and tolerances of the diameters, see ISO 603-12, ISO 603-13, ISO 603-14 and ISO 603-16, and ISO 525.						

Table D.1 *(continued)*

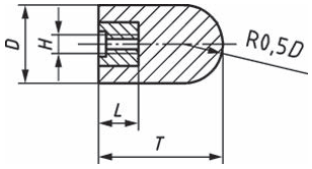
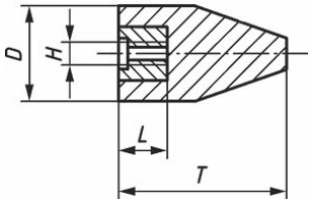
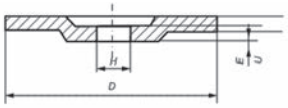
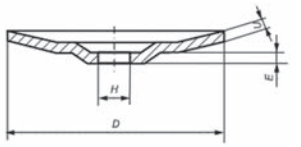
Type according to ISO 525	Description, shape and designation	Type of bonding	Maximum operating speed m/s	Dimension limits mm	Guard according to Figure	Applicable International Standard
Type 18 R	Abrasive with threaded insert, cylindrical and rounded 	B	≤ 50	$D \leq 80$	14	ISO 603-12
Type 19	Abrasive with threaded insert, cylindrical and tapered 	B	≤ 50	$D \leq 80$	14	ISO 603-12
Type 27	Depressed centre grinding wheel 	BF	≤ 80	$D \leq 230$	15 16	ISO 603-14
Type 28	Depressed-centre grinding wheel, saucer shaped 	B	≤ 80	$D \leq 230$	15 16	ISO 603-14
For other dimensions and tolerances of the diameters, see ISO 603-12, ISO 603-13, ISO 603-14 and ISO 603-16, and ISO 525.						

Table D.1 *(continued)*

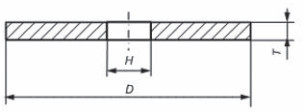
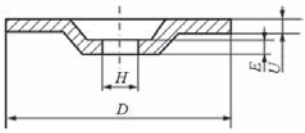
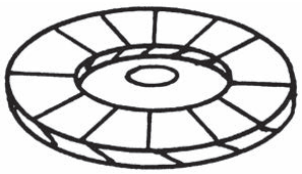
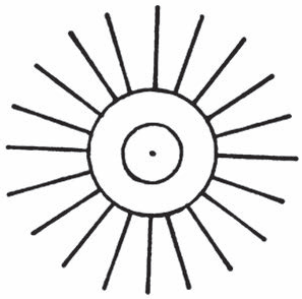
Type according to ISO 525	Description, shape and designation	Type of bonding	Maximum operating speed m/s	Dimension limits mm	Guard according to Figure	Applicable International Standard
Type 41	Straight cutting-off wheel 	BF Body: metal, textile BF	≤ 80	$D \leq 300$	15 16	ISO 603-16
Type 42	Depressed-centre cutting-off wheel 	BF	≤ 80	$D \leq 230$	15 16	ISO 603-16
For other dimensions and tolerances of the diameters, see ISO 603-12, ISO 603-13, ISO 603-14 and ISO 603-16, and ISO 525.						

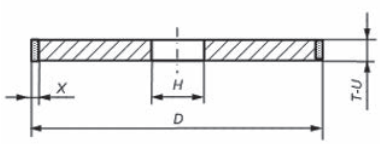
Table D.2 — Coated abrasive products

Type[a]	Description, shape and designation	Type of bonding	Maximum operating speed[b] m/s	Dimension limits mm	Guard according to Figure	Applicable International Standard
Type D1	Flap disc 	Coated Body: metal, textile	≤ 80	$D \leq 230$	15	
Type D2	Flap wheel 	Coated	≤ 40	$D \leq 230$	19	
Type D3	Vulcan disc 	Coated	≤ 80	$D \leq 230$	No guard	

[a] Type numbers do not refer to any International Standard at the time of publication.

[b] According to FEPA (Federation of European Producers of Abrasives).

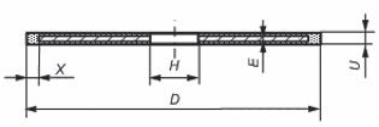
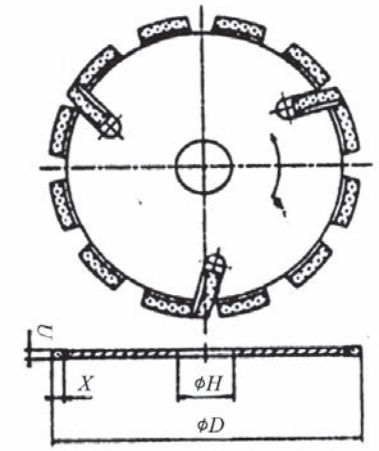
Table D.3 — Superabrasive products

Type[a]	Description, shape and designation	Type of bonding	Maximum operating speed[b] m/s	Dimension limits mm	Guards according to Figure	Applicable International Standard
Type D4	Straight grinding wheel 	M	≤ 80	$D \leq 230$	16 17	

[a] Type numbers do not refer to any International Standard at the time of publication.

[b] According to FEPA (Federation of European Producers of Abrasives).

Table D.3 *(continued)*

Type[a]	Description, shape and designation	Type of bonding	Maximum operating speed[b] m/s	Dimension limits mm	Guards according to Figure	Applicable International Standard
Type D5	Cutting-off wheel 	M	≤ 100	$D \leq 300$	16 17	
Type D6	Cutting-off wheel with segments 	M	≤ 80	$D \leq 450$	16 17	

[a] Type numbers do not refer to any International Standard at the time of publication.

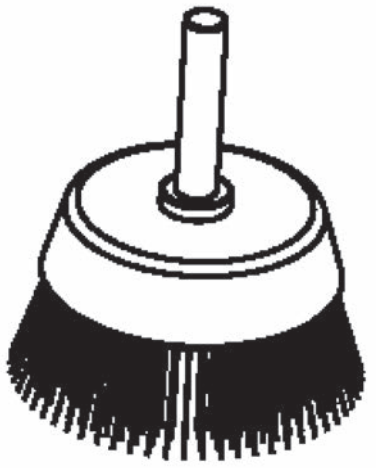
[b] According to FEPA (Federation of European Producers of Abrasives).

D.2 Wire brush

A wire brush is a brush, constructed of crimped, knotted or encapsulated wire bristles, designed and intended for use on portable wire brush machines.

Table D.4 shows the two main types of wire brushes used with grinders. EN 1083-1 gives a detailed description of variants.

Table D.4 — Wire brushes

Type[a]	Description, shape and designation	Applicable International Standard
Type X1	Radial wire brush 	EN 1083-1 EN 1083-2
Type X2	Cup brush 	EN 1083-1 EN 1083-2

[a] At the time of publication, there are no known International Standards for wire brushes.

Annex E
(informative)

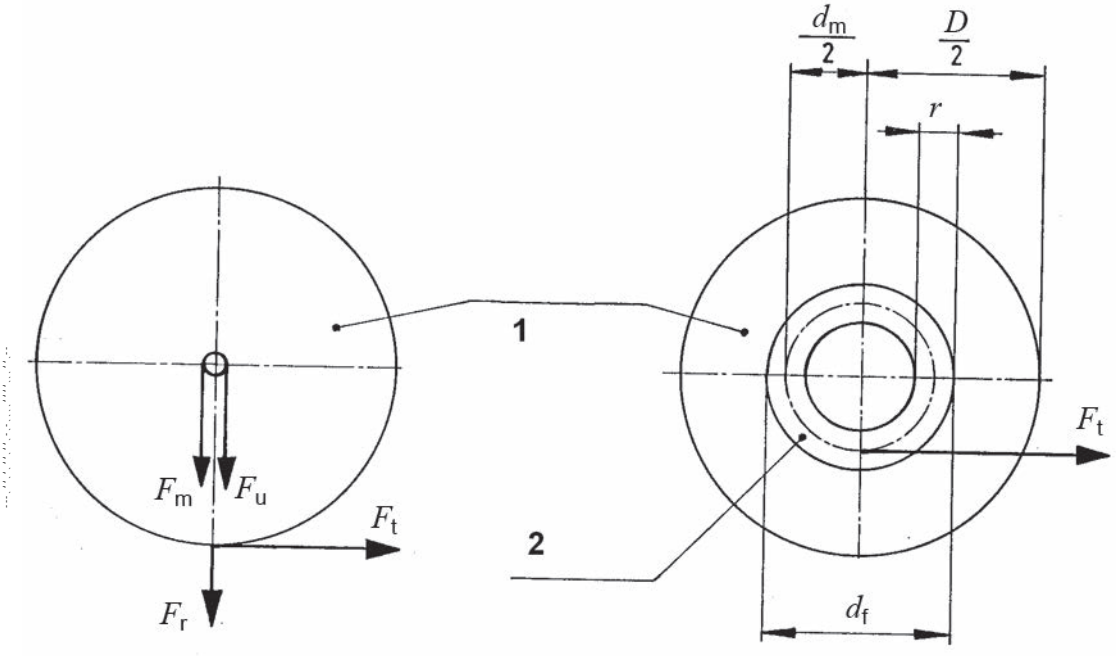
Example of calculating procedure of clamping force

E.1 Calculation of maximum total force and required clamping force

E.1.1 General

The calculation procedure in this annex is based on the same principles as for stationary grinding machines.

For the calculation of the clamping forces and tightening torque of screws for clamping, the forces which affect the clamping device shall be considered (see Figure E.1).



Key
1 grinding wheel
2 flange gripping rim

Figure E.1 — Forces of an abrasive product when grinding

For calculation, the following symbols are required:

d_f is the outside diameters of the flanges, in metres (m);

D is the outside diameter of the abrasive product, in metres (m);

H is the bore diameter, in metres (m);

r is the width of the rim of the clamping area, in metres (m);

T is the thickness of the grinding wheel, in metres (m);

v is the maximum operating speed of the grinding wheel, in metres per second (m/s);

P is the power of the grinding machine spindle drive, in watts (W);

ζ_m is the density of the grinding wheel, in kilograms per cubic metre (kg/m^3).

E.1.2 Total force, F_{tot}

The largest total force, F_{tot}, occurs where the four forces are acting in the same direction:

$$F_{tot} = F_m + F_u + F_T + F_r \quad \text{(E.1)}$$

where

F_m is the force due to the mass of the abrasive product, in newton (N);

F_u is the force due to the unbalance of the grinding wheel, in newton (N);

F_T is the shearing force, in newton (N);

F_r is the perpendicular force from the grinding operation, in newton (N);

E.1.3 Forces due to the grinding operation, F_r, F_t

$$F_t = \frac{P}{v} \cdot k_1 \quad \text{(E.2)}$$

$$F_r = k \cdot F_t \quad \text{(E.3)}$$

where

F_r is the perpendicular force from the grinding operation, in newton (N);

F_t is the tangential force from the grinding operation, in newton (N);

k is the factor by experience for rough grinding (normally between 3 and 5);

k_1 is the safety factor (normally 2,5);

P is the power of the grinder at the machine spindle, in watts (W);

v is the operating speed of the grinding wheel, in metres per second (m/s).

E.1.4 Shearing force, F_T

The tangential force, F_t, transformed to the mean radius of the clamping area, d_m, where it generates the shearing force, F_T:

$$F_T \cdot 0{,}5 d_m = F_t \cdot 0{,}5 D \quad \text{(E.4)}$$

E.1.5 Force due to the mass of the abrasive product, F_m

$$F_m = M \cdot g = V \cdot \zeta_m \cdot g \quad \text{(E.5)}$$

$$M = V \cdot \zeta_{\mathrm{m}} \tag{E.6}$$

where

g is the gravity, i.e. 9,81, in metres per square second (m/s^2);

M is the mass of the grinding wheel, in kilograms (kg);

V is the volume of the grinding wheel, in cubic metres (m^3);

ζ_{m} is the density of the grinding wheel, in kilograms per cubic metres (kg/m^3).

E.1.6 Force due to the unbalance of the grinding wheel, F_{u}

This force, F_{u}, is due to the unevenness of mass distribution in the grinding wheel and is directed towards the centre of the wheel deduced from movements of particles in a bent orbit. The force due to the unbalance of the grinding wheel, F_{u}, is as given by Formula (E.7):

$$F_{\mathrm{u}} = c \cdot m_{\mathrm{u}} \cdot \frac{v^2}{R} = c \cdot m_{\mathrm{u}} \cdot \frac{2v^2}{D} \tag{E.7}$$

where

c is 10^{-3} according to ISO 6103;

D is the outside diameter of the abrasive product, in metres (m);

m_{u} is the “unbalance mass”, in gram metres (gm);

R is the constant radius orbit;

v is the operational speed, in metres per second (m/s).

The unbalance mass is $m_{\mathrm{u}} = k\sqrt{M}$ according to ISO 6103, where M is in grams and k is a value obtained from the to abrasive product type and operating speed.

E.2 Required clamping force between the flanges, F_{req}

The required clamping force between the flanges, with only one flange driven, is as given by Formula (E.8):

$$F_{\mathrm{req}} = F_{\mathrm{tot}} \cdot \frac{S}{\mu_{\mathrm{c}}} \tag{E.8}$$

where

F_{req} is the required force, in newton (N);

S is the safety factor against slipping;

μ_{c} is the coefficient of friction between the surface of the flanges, the blotter and the grinding wheel:

$\mu_{\mathrm{c}} = 0{,}2$ for blotter made of paper against steel;

$\mu_{\mathrm{c}} \geq 0{,}2$ without steel bushing;

$\mu_{\mathrm{c}} < 0{,}15$ for steel against steel.

S is the safety factor against slipping and is dependent on the clamping conditions, for which the designer of the grinder shall consider, for instance, the following facts:

— one or two flanges driving;

— flange geometry;

— flange and roughness of clamping area;

— tightening methods;

— vibrations;

— impacts.

E.3 Clamping area and surface pressure between the flanges and the grinding wheel, P_a

$$P_a = \frac{F_{req}}{A_c} \tag{E.9}$$

$$A_c = \frac{\pi}{4} \cdot \left(d_0^2 - d_i^2 \right) \tag{E.10}$$

where

P_a is the surface pressure, in newtons per square metre (N/m^2);

F_{req} is the required clamping force, in newton (N);

A_c is the clamping area, in square metres (m^2);

d_o is the outside diameter of the flange, in metres (m);

d_i is the inside diameter of the flange, in metres (m).

The maximum permissible P_a shall be specified by the manufacturer of the abrasive product.

Ensure that $P_a \cdot A_c > F_{req}$ after having calculated and chosen the dimensions that define the clamping area.

Bibliography

NOTE The documents listed are not referred to as normative in the text of this part of ISO 11148; however, they have a bearing on the specifications and are listed for information. This is not an exhaustive list.

[1] ISO 525, *Bonded abrasive products — General requirements*

[2] ISO 603-12, *Bonded abrasive products — Dimensions — Part 12: Grinding wheels for deburring and fettling on a straight grinder*

[3] ISO 603-13, *Bonded abrasive products — Dimensions — Part 13: Grinding wheels for deburring and fettling on a vertical grinder*

[4] ISO 603-14, *Bonded abrasive products — Dimensions — Part 14: Grinding wheels for deburring and fettling/snagging on an angle grinder*

[5] ISO 603-16, *Bonded abrasive products — Dimensions — Part 16: Grinding wheels for cutting-off on hand held power tools*

[6] ISO 2787, *Rotary and percussive pneumatic tools — Performance tests*

[7] ISO 3857-1, *Compressors, pneumatic tools and machines — Vocabulary — Part 1: General*

[8] ISO 3864-2, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

[9] ISO 3864-4, *Graphical symbols — Safety colours and safety signs — Part 4: Colorimetric and photometric properties of safety sign materials*

[10] ISO 6103, *Bonded abrasive products — Permissible unbalances of grinding wheels as delivered — Static testing*

[11] ISO 7000, *Graphical symbols for use on equipment — Registered symbols*[1)]

[12] ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*[1)]

[13] ISO/TR 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

[14] ISO/TR 11688-2, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 2: Introduction to the physics of low-noise design*

[15] ISO 14163, *Acoustics — Guidelines for noise control by silencers*

[16] ISO 19432, *Building construction machinery and equipment — Portable, hand-held, internal combustion engine driven cut-off machines — Safety requirements*

[17] EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

[18] EN 626 (all parts), *Safety of machinery — Reduction of risks to health from hazardous substances emitted by machinery*

[19] EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

[20] EN 982, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*

[21] EN 983, *Safety of machinery — Safety requirements for fluid power systems and components — Pneumatics*

1) The graphical symbol collections of ISO 7000, ISO 7001 and ISO 7010 are also available online from the ISO web store. For more information, consult http://www.iso.org/iso/fr/publications_and_e-products/databases.htm.

[22] EN 1070, *Safety of machinery — Terminology*

[23] EN 1083-1, *Power-driven brushes — Part 1: Definitions and nomenclature*

[24] EN 1083-2, *Power-driven brushes — Part 2: Safety requirements*

[25] EN 13463-1, *Non-electrical equipment for use in potentially explosive atmospheres — Part 1: Basic method and requirements*

[26] IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

[27] IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

[28] CR 1030-1, *Hand-arm vibration — Guidelines for vibration hazards reduction — Part 1: Engineering methods by design of machinery*

[29] FEPA, *Safety code for the use of coated abrasive products*[2)]

2) Federation of European Producers of Abrasives (FEPA) publications can be obtained from: FEPA, 20 Avenue Reille, F– 75014, Paris, France.

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