SAFETY IN THE USE OF ABRASIVE WHEELS

Occupational Safety and Health Branch
Labour Department

safety at work

Occupational Safety & Health Council

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CONTENTS

Introduction

Abrasive wheels are extensively used in industries for various purposes. The use of abrasive wheels in an unsafe way often causes accidents leading to personal injuries and/or damage to properties. The main dangers are ——

(1) bursting of wheels as the result of:

  (i) defective wheel

  (ii) overspeeding

  (iii) faulty mounting

  (iv) misuse

(2) contact with the wheel; and

(3) injury to the eyes from flying particles.

The purpose of this guidebook is to advise readers on the precautions for the prevention of accidents in the use of abrasive wheels. It does not include technical aspects of grinding or operational techniques.

Selection of Wheels

* Consult the manufacturer for the proper type of wheels to suit a particular job. Generally, soft wheels are more suitable for hard materials and hard wheels for soft materials.

* Do not use defective wheels. Check for soundness of wheels by a 'ring test'. (Suspend the wheel vertically and tap the areas as shown in Fig. 1 with a light non-metallic tool, such as a wooden screwdriver handle. It should ring. Do not use the wheel if it sounds cracked.)

* Wheels should be kept dry and not exposed to extreme temperatures. If not in use, they should be stored properly in suitable racks as in Fig. 2.

Operating Speed

* Check that the spindle speed of a machine does not exceed the maximum permissible speed of the wheel as specified by the manufacturer. The spindle speed and the maximum permissible speed of the wheel should be marked in revolutions per minute (rpm). But in case the wheel is marked to give the peripheral speed in feet per minute (ft/min) or in metres per second (m/sec), the following formula can be used for conversion into rpm:

$$^{\Delta}\text{Speed in rpm} = \frac{\text{peripheral speed in ft/min} \times 12}{3.1416 \times \text{dia. in inches}}$$

$$\text{or} = \frac{\text{peripheral speed in m/sec} \times 1000 \times 60}{3.1416 \times \text{dia. in mm}}$$

The conversion of speed measurement for a number of specified speeds and wheel diameters can be found in the Conversion Table shown in Fig. 3.

* The speed of the wheel in rpm may, however, be increased as the diameter of the wheel is reduced through wear as follows:

$$^{\Delta}\text{increased speed in rpm} = \frac{\text{original speed in rpm} \times \text{original diameter}}{\text{reduced diameter}}$$

* If the spindle is air driven, make sure that there is a governor or other device fitted so as to control the speed of the spindle. Such device should be effectively maintained at all time. A suitable pressure reducing regulator should be fitted between the governor and the air supply outlet if the working pressure of the outlet is greater than that of the grinding machine. Where a filter is incorporated in the air supply system, it should be properly maintained to prevent clogging by dust or grits. To prevent accidents caused by snaking hoses when severed under high pressure of air, it is also recommended that an automatic hose brake valve be fitted to the hose before joining the grinder.

$^{\Delta}$ Note: The maximum permissible speed of a wheel may also change upon aging of the bonding material of the wheel after prolonged use. Consult the manufacturer or supplier in case of doubt.

Marking System for Abrasive Wheels

Abrasive wheels are marked to identify their characteristics. Persons responsible for wheel mounting should be able to recognise the specifications marked on the wheel (See Fig. 4).

Mounting

* All mountings shall only be done by competent persons appointed in writing by the proprietors. Competent persons should be well trained and have the practical experience in the mounting job. (See form in Fig. 5 for appointment of a competent person.)
* A wheel should not be mounted on a machine for which it is not intended and certainly not on any make-shift apparatus or where there is vibration of the machine.
* Check for soundness of the wheel before it is mounted.
* Do not mount a wheel on a machine the speed of which exceeds the maximum permissible speed of the wheel.
* Washers, either paper or other compressible material, should be used with all bonded abrasive wheels, except tapered wheels, threaded-hole wheels, discs, cylinder wheels, and the hub section of depressed-centre wheels. Washers should be slightly larger than the flanges and there should be no wrinkles in them.
* The bush, if any, should not project beyond the sides of the wheel.
* The wheel should fit freely but not loosely on the spindle.
* Flanges should not be less than one-third of the diameter of the wheels and their bearing surfaces should be true and free from burrs.
* With the exception of the single flange used for threaded-hole wheels, all flanges should be properly recessed or undercut.
* Flanges on both sides of the wheel should have the same outside diameter and diameter of recess.
* Clamping nuts and screws should be tightened uniformly in pattern formation (diametrical sequence) and only sufficiently to hold the wheel firmly.

* Screws for inserted nut for mounting of discs, cylinders or cones should be long enough to engage a sufficient length of thread, but not so long as to contact the abrasive material.

* When re-mounting factory-mounted wheels and points, the overhang (distance between end of support and base of wheel as illustrated in Fig. 6) for a particular diameter of mandrel, speed and size of a wheel should not be exceeded. Also there should be sufficient length of the mandrel in the collet or chuck. Consult the manufacturer for details of overhang permissible for a particular wheel.

* Protection flanges are used on tapered wheels which are not provided with safety guards. Both these flanges and the tapered wheels should be equally tapered to at least 6% and with the following dimensions:

diameter of wheel	diameter of protection flanges
below 300 mm (12 inches)	at least half the diameter of wheel
300 mm - 750 mm (12 inches - 30 inches)	at least the diameter of wheel minus 150 mm (6 inches)
above 750 mm (30 inches)	at least the diameter of wheel minus 200 mm (8 inches)

* Study carefully Fig. 7 to Fig. 11 which show the correct mounting of certain types of wheels commonly used.

Mounting of Depressed-centre Wheels

Depressed-centre wheels should only be mounted with a flange as shown in Fig. 12. Three points should be noted:

1. When the adaptor has been tightened, there should be a slight clearance between the flange and the wheel at (A). This ensures that clamping pressure is exerted only at the centre of the hub section.

2. The outer part of the face of the flange adjacent to the wheel should be tapered as shown in Fig. 12. This allows the full width of the flange to support the wheel during the grinding operation.

3. A paper washer should not be used on the hub section of a depressed-centre wheel.

Guards

* Unless the nature of the work absolutely precludes its use, a guard shall be provided and kept in position at every abrasive wheel for the following purposes:

  (1) to hold the wheel parts in the event of breakage.

  (2) to protect the wheel from accidental damage.

  (3) to prevent the operator from coming into contact with the wheel.

  (4) to prevent an oversized wheel from being fitted.

* Guards must be of rigid construction, proper dimensions and securely anchored to the machine frame. For maximum protection, the guards have to be adjusted to limit the exposure angles as in Fig. 13.

Work-rests

For bench and floor stand grinders, a work-rest has to be provided and properly adjusted as close as possible, in any case not exceeding 3.2mm (1/8 inch), to the wheel. Lack of adjustment is the cause of many serious accidents in that the workpiece was jammed between the wheel and the work-rest which forced the operator's fingers against the wheel face.

Protection of Eyes

Persons carrying out dry grinding operations and truing or dressing an abrasive wheel should wear properly fitted eye protectors or be protected by suitable transparent screens which are fitted in front of the exposed part of the wheel so as to intercept flying particles. See Fig. 14. Regulation 5 of the Factories and Industrial Undertakings (Protection of Eyes) Regulations requires that approved eye protectors, shields or fixed shields shall be provided to employees engaged in:

1. Dry grinding of metals or articles of metal applied by hand to a revolving wheel, band or disc driven by mechanical power.

2. Truing or dressing of an abrasive wheel.

Truing and Dressing

* The wheel should be dressed when necessary to remove loading or glazing at the wheel surface, both of which reduce the cutting action. Eccentric force will be created at wheels used for hand grinding rendering them out of balance if they are not trued, and if the force becomes excessive, it may damage the spindle and cause the wheel to burst.

Safety and the Operator

* Ensure that the floor in the vicinity is in good condition, free from obstruction and not slippery.
* If there is more than one speed of the machine, choose the one which does not exceed the maximum permissible speed of the wheel.
* Remember grinding on the sides of straight-sided wheels is dangerous.
* Before operating a bench or floor stand grinding wheel, ensure the proper provision and adjustment of:
    (1) the wheel guards with minimum exposure angle
    (2) the clearance between the work-rest and the wheel should be less than 3.2 mm (1/8")
    (3) the protective screen (or wear eye protectors)
* Always report any fault or unusual signs of the machine to your foreman or supervisor.
* Do not operate a grinding machine unless you have been properly trained in its safe use.
* Do not mount an abrasive wheel yourself. It is the job for a competent person appointed by the proprietor.
* Do not apply sudden pressure to the wheel.
* Do not allow the wheel to revolve unattended. Switch it off before you leave.

Enquiries

If you wish to enquire about this guidebook or require advice on occupational safety and health, you can contact the Occupational Safety and Health Branch of the Labour Department through:

Telephone : 2559 2297 (auto-recording after office hours)

Fax : 2915 1410

E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our homepage at http://www.labour.gov.hk.

Information on the services offered by the Occupational Safety and Health Council can be obtained through hotline 2739 9000.

Complaints

If you have any complaints about unsafe workplaces and practices, please call the Labour Department's occupational safety and health complaint hotline at 2542 2172. All complaints will be treated in the strictest confidence.

Sketches and Tables / Forms

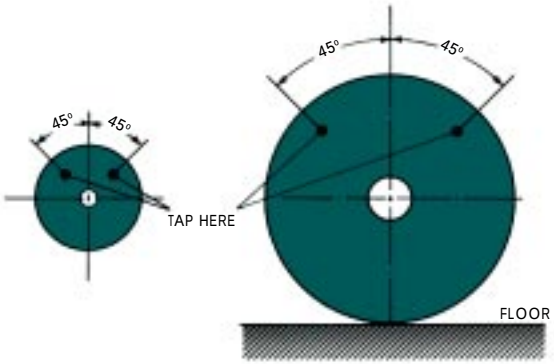

Fig. 1: Tap points for the “ring test”

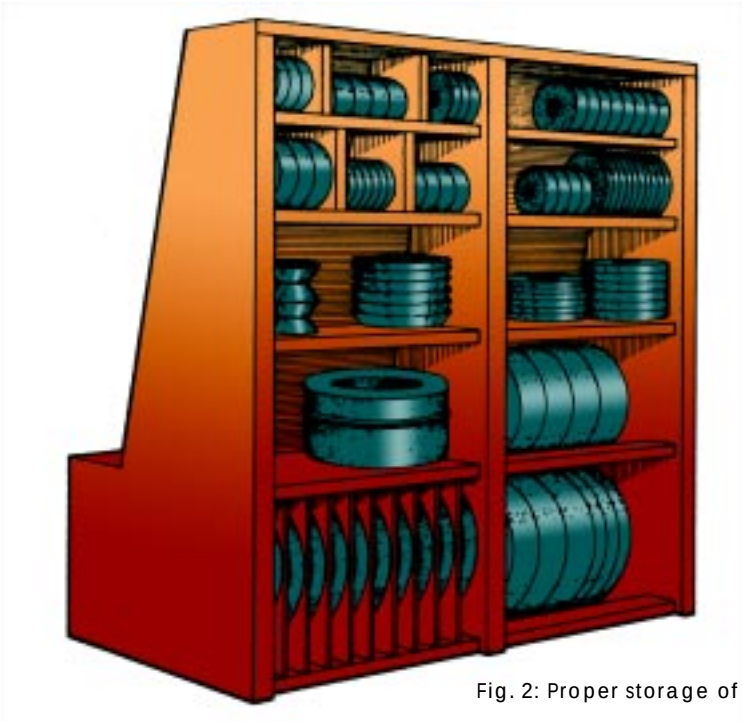

Fig. 2: Proper storage of wheels

Fig. 3: CONVERSION TABLE From peripheral speeds in feet per minute (metres per second) to wheel speed in rpm

PERIPHERAL SPEED

ft/min		4,000	4,500	5,000	5,500	6,000	6,500	7,000	7,500	8,000	8,500	9,000	9,500	10,000	12,000	14,000	16,000
m/sec		20.3	22.8	25.4	27.9	30.5	33	35.6	38.1	40.6	43.1	45.7	48.2	50.8	60.9	71.1	81.3
Diameter of wheel		REVOLUTIONS PER MINUTE															
in	mm																
1	25	15,279	17,189	19,098	21,008	22,918	24,828	26,737	28,647	30,558	32,467	34,377	36,287	38,196	45,836	53,474	61,116
2	50	7,639	8,594	9,549	10,504	11,459	12,414	13,368	14,328	15,278	16,238	17,188	18,143	19,098	22,918	26,737	30,558
3	75	5,093	5,729	6,366	7,003	7,639	8,276	8,913	9,549	10,186	10,822	11,459	12,096	12,732	15,278	17,826	20,372
4	100	3,820	4,297	4,775	5,252	5,729	6,207	6,685	7,162	7,640	8,116	8,595	9,072	9,549	11,459	13,368	15,278
5	125	3,056	3,438	3,820	4,202	4,584	4,966	5,348	5,730	6,112	6,494	6,876	7,258	7,640	9,168	10,696	12,224
6	150	2,546	2,865	3,183	3,501	3,820	4,138	4,456	4,775	5,092	5,411	5,729	6,048	6,366	7,639	8,913	10,186
7	175	2,183	2,455	2,728	3,001	3,274	3,547	3,820	4,092	4,366	4,638	4,911	5,183	5,456	6,548	7,640	8,732
8	200	1,910	2,148	2,387	2,626	2,865	3,103	3,342	3,580	3,820	4,058	4,297	4,535	4,775	5,729	6,685	7,640
9	225	1,698	1,910	2,122	2,334	2,546	2,758	2,970	3,182	3,396	3,606	3,820	4,032	4,244	5,092	5,940	6,792
10	250	1,528	1,719	1,910	2,101	2,292	2,483	2,674	2,865	3,056	3,247	3,438	3,629	3,820	4,584	5,348	6,112
12	300	1,273	1,432	1,591	1,751	1,910	2,069	2,228	2,386	2,546	2,705	2,864	3,023	3,183	3,820	4,456	5,092
14	350	1,091	1,228	1,364	1,500	1,637	1,773	1,910	2,046	2,182	2,319	2,455	2,592	2,728	3,274	3,820	4,366
16	400	955	1,074	1,194	1,313	1,432	1,552	1,672	1,791	1,910	2,029	2,149	2,268	2,387	2,865	3,342	3,820
18	450	849	955	1,061	1,167	1,273	1,379	1,485	1,591	1,698	1,803	1,910	1,016	2,122	2,546	2,970	3,396
20	500	764	859	955	1,050	1,146	1,241	1,337	1,432	1,528	1,623	1,719	1,814	1,910	2,292	2,674	3,056
22	550	694	781	868	955	1,042	1,128	1,215	1,302	1,388	1,476	1,562	1,649	1,736	2,084	2,430	2,776
24	600	637	716	796	875	955	1,034	1,115	1,194	1,274	1,353	1,433	1,512	1,591	1,910	2,228	2,546
26	650	588	661	734	808	881	955	1,028	1,101	1,176	1,248	1,322	1,395	1,468	1,762	2,056	2,352
28	700	546	614	682	750	818	887	955	1,023	1,092	1,159	1,228	1,296	1,364	1,637	1,910	2,182
30	750	509	573	637	700	764	828	891	955	1,018	1,082	1,146	1,210	1,274	1,528	1,782	2,036
32	800	477	537	597	656	716	776	836	895	954	1,014	1,074	1,134	1,194	1,432	1,672	1,910
34	850	449	505	562	618	674	730	786	843	898	955	1,011	1,067	1,124	1,348	1,572	1,796
36	900	424	477	530	583	637	690	742	795	848	902	954	1,007	1,061	1,273	1,484	1,698
38	950	402	452	503	553	603	653	704	754	804	854	904	955	1,006	1,206	1,408	1,608
40	1,000	382	430	478	525	573	620	669	716	764	812	860	908	956	1,146	1,338	1,528
42	1,050	366	409	454	500	545	591	636	682	732	775	818	863	908	1,090	1,272	1,464
44	1,100	347	390	434	478	521	564	608	651	694	737	780	824	868	1,042	1,216	1,388
46	1,150	333	375	416	458	500	541	582	624	666	708	750	791	832	1,000	1,164	1,332
48	1,200	318	358	398	438	478	517	558	597	636	676	716	756	796	956	1,116	1,272
53	1,325	288	324	360	395	432	468	503	539	576	612	648	683	720	864	1,006	1,152
60	1,500	255	287	319	350	387	414	446	478	510	542	574	606	638	774	892	1,020
72	1,800	212	239	265	291	318	345	371	398	424	451	477	504	530	637	742	849

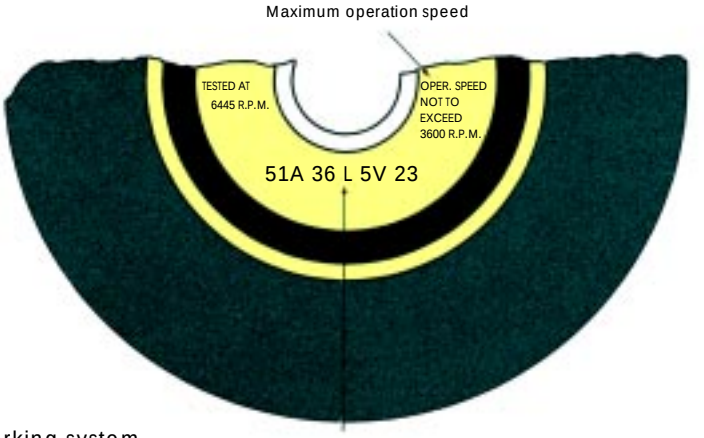

Fig. 4: Marking system

sequence of symbols

	0	1	2	3	4	5	6
Order of marking	Type of abrasive*	Nature of abrasive	Grain size	Grade	Structure*	Nature of bond	Type of bond etc*
Example	51	A	36	L	5	V	23

Aluminium abrasives	A
Silicon carbides	C

coarse	medium	fine	very fine
8	30	70	220
10	36	80	240
12	46	90	280
14	54	100	320
16	60	120	400
20		150	500
24		180	600

Spacing from the closest to the most open	
0	8
1	9
2	10
3	11
4	12
5	13
6	14
7	etc.

V	vitrified
S	silicate
R	rubber
B	resinoid (synthetic resins)
BF	resinoid (synthetic resins) reinforced
E	shellac
Mg	magnesia

Soft											Medium											Hard
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

* Optional symbols – The symbols 0 and 6 are the manufacturer's own setting

Fig. 5: Form*

(Regulation 7(2))

Factories and Industrial Undertakings (Abrasive Wheels) Regulations

Name of Industrial Undertaking_____

Address of Industrial Undertaking_____

Appointment of Competent Persons to mount abrasive wheels

Date of Appointment	Name of competent persons appointed	Identity card number	Address of competent person	Signature of proprietor	Signature of competent person

* This is not a prescribed form because the law does not require one. This form is merely offered for the convenience of proprietors for the purpose of appointing a competent person.

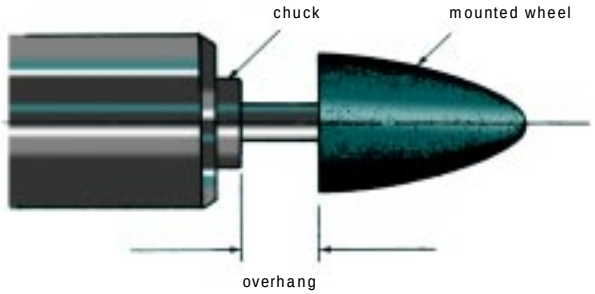

Fig. 6: Sketch defining “overhang”

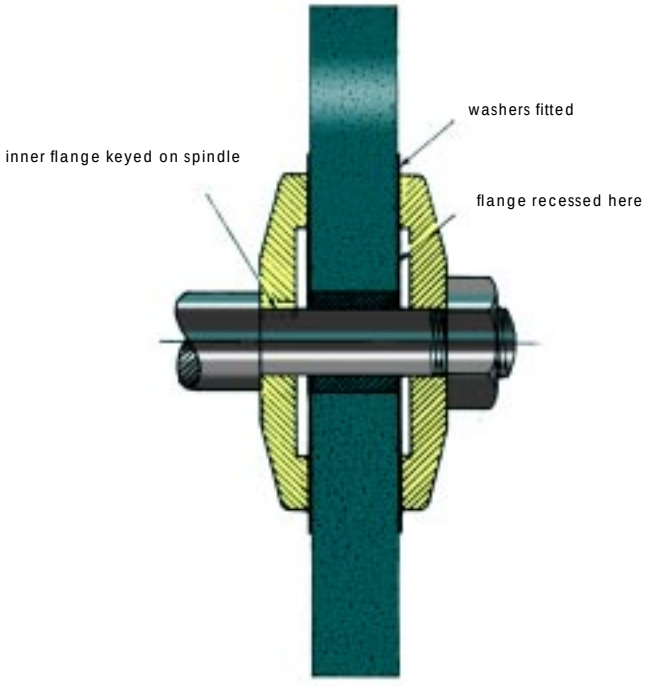

Fig. 7: A straight-wheel with a small bore

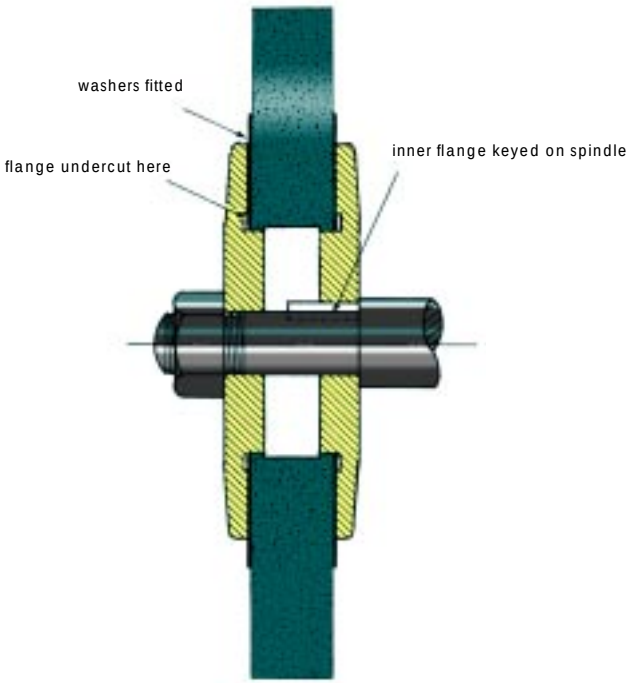

Fig. 8: A straight-wheel with a large bore

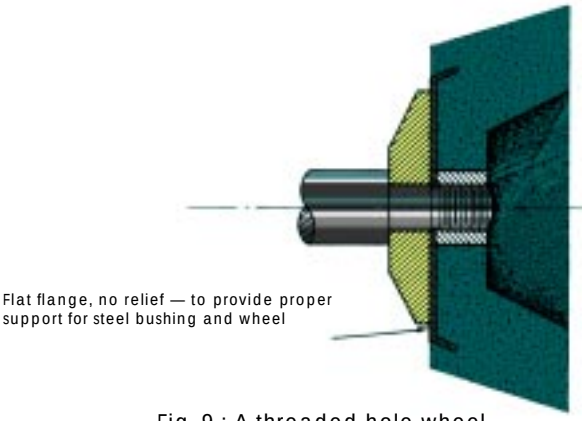

Fig. 9 : A threaded-hole wheel

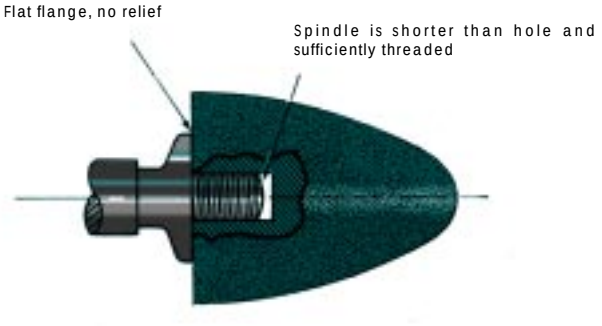

Fig. 10: A cone wheel

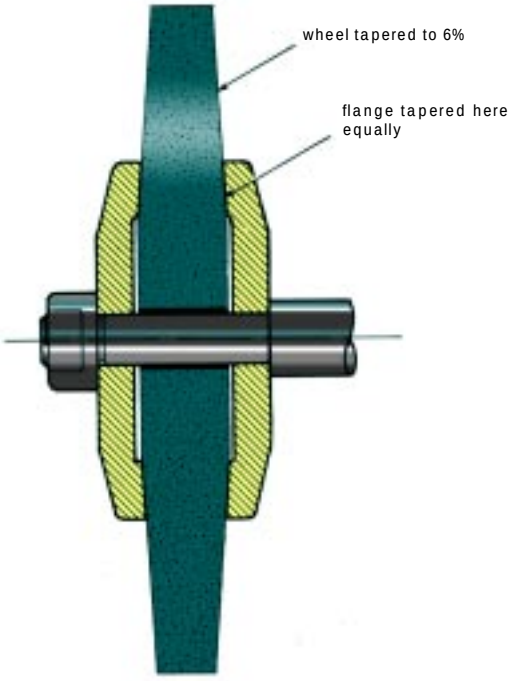

Fig. 11: A tapered wheel

Fig. 12 : Flange assembly for a depressed-centre wheel. The outer part of the flange adjacent to the wheel should be tapered as shown and there should be a slight clearance at A.

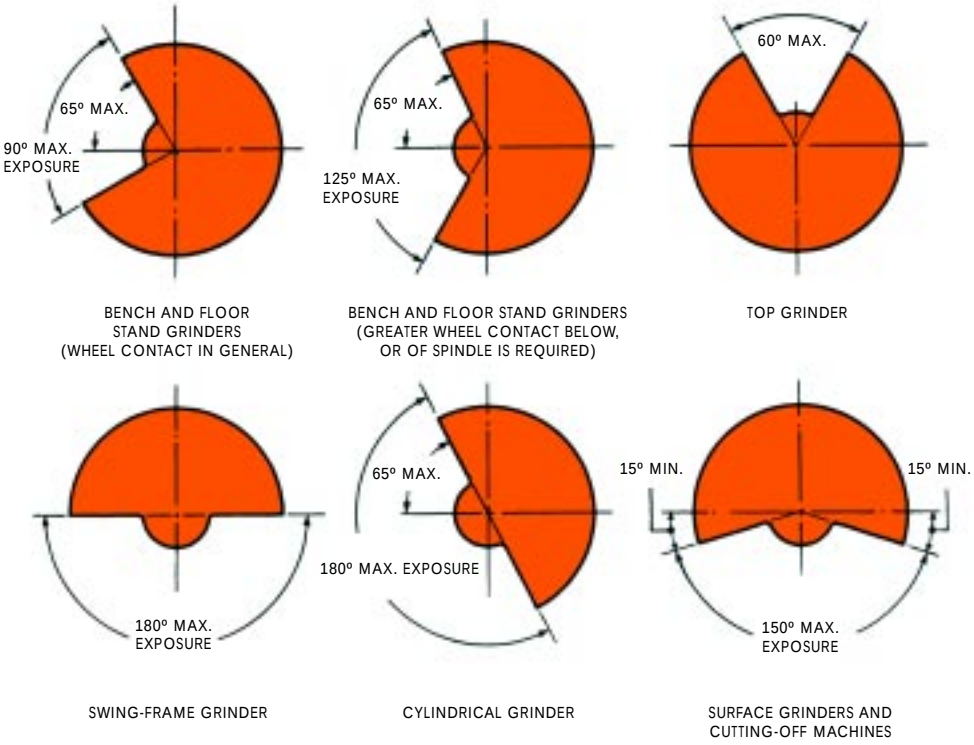

Fig. 13: Maximum exposure angles for various grinding applications

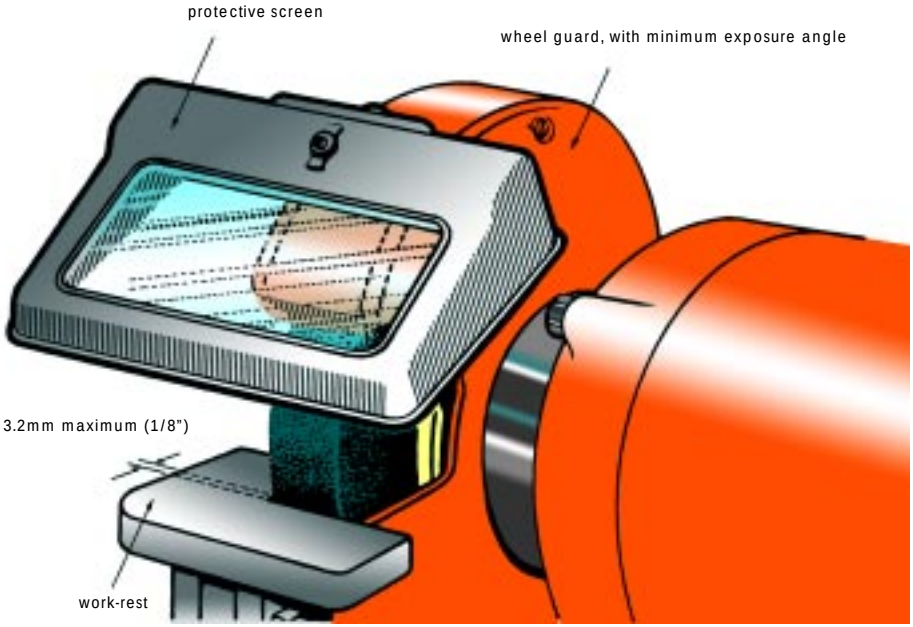

Fig. 14 : A grinding wheel fitted with wheel guard, work-rest and protective screen.

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