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STRENGTHENING THE TECHNICAL AND MANAGERIAL CAPACITIES OF THE CARPENTRY COOPERATIVES IN MUKALLA AND SEIYUN

SM/YEM/92/035

THE REPUBLIC OF YEMEN

Technical report: Review of the situation on tool maintenance*

Prepared for the Government of the Republic of Yemen
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of R. W. Moore
expert in tool maintenance

Backstopping officer: Antoine V. Bassili
Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

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* Mention of company names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). This document has not been edited.

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INTRODUCTION

The project SM/PDY/87/005 entitled "Strengthening the Technical and Managerial Capacities of the Carpentry Cooperatives in Mukalla and Seiyun" was established to support the Cooperatives' transition of manufacture of furniture and joinery from the handicraft to the industrial production methods.

The project document was signed on 10 April 1989, with the United Nations Industrial Development Organization as the executing agency. The Government agency coordinating the project is the Ministry of Industry, Mukalla Branch.

An expert in tool maintenance, R. W. Moore, was assigned for a three month mission from 6 June to 5 September 1991. His duties are given in Annex I. The list of persons he met is given in Annex II.

PROJECT BACKGROUND

The woodworking sector of the Republic of Yemen consists of a public Cooperative of carpentry in Aden Governorate and two carpentry cooperatives in Hadramout Governorate. The Mukalla Cooperative employs approximately 1000 people and its sales volume reached in 1991, nearly 1.75 million Dinar.

In general, the woodworking sector produces reasonable quality furniture (Formica finish) with lower standards of door and window frame production. Most of the low quality finish is due to poor machine finishing and an absence of sanding machines, poor tool maintenance subscribe also to the deficiency.

Lack of training in maintenance and use of servicing machines and equipment is a high contributing factor, very few machine operations have been demonstrated to the operators. Smaller units around Mukalla are increasing in size, as a rapid development in building construction is taking place. An increase in "output" is essential but training must proceed to cut down high costs of saws, tools and poor servicing.

Training schemes must be carried out by UNV or experts, not by unskilled counterparts. Lack of waste extraction systems tend to subscribe to untidy and dirty factory floors, machines and equipment.

ACTIVITIES

Aden and Mukalla

The consultant found it necessary to deviate from his terms of reference to a more practical, demonstrative training approach.

Reports and recommendations are of little value unless there is an immediate follow-up by an expert to implement the consultant's proposal and training scheme.

There was an urgent requirement of a "hands-on" action of machine repairs, relocations and their servicing operations. Some machines were not being used and some not fully utilised due to lack of training skills and generally a limited knowledge of machine operations.

It was necessary to re-design, re-fit and relocate machines and equipment in the tool room immediately, to increase production of higher standards of saws and tool servicing.

After suitable facilities had been created, courses were run at Mukalla in tool servicing and saw doctoring.

During the period at Aden, workshops were re-planned and machines located accordingly. A training course syllabus and scheme of work was produced to maintain an on-going programme of training to be carried out by counterpart and UNV staff. The syllabus is given in annex 3. The most difficult part in the training of practical skills is the un-training of bad habits prior to re-training and because of this, newly recruited younger people were selected for saw doctoring training. To back up the training scheme a manual of sketches on servicing tools was produced in English and Arabic.

A further training course for saw doctors was held in Aden in late August and the layout of the saw shop was re-designed.

Two training courses were held in Mukalla over two three day periods consisting of practical workshop instruction and class room theory. These courses were backed up by technical hand-outs on tool room servicing.

Saw doctors, counterpart staff and UNV's, amounting to some twelve people from Saiyon, Mukalla and the units attended.

ACTIVITIES

Saiyon

The consultant spent four days in Saiyon and the surrounding Co-operative units. Only one unit had a basically suitable semi-efficient shop for servicing band saws and planer knives, TCT saws and carbon steel planer knives could not be serviced.

In Saiyon, the constant servicing requirements are due to the lack of suitable saw benches and carbon steel planer knives. When sawing and planing Keruing, planer blades and saws were blunt very quickly due to working with this very abrasive timber. Narrow band saws of silver steel are not designed to rip down 100 x 75 mm planks of Keruing as is the practice. Band saws tooth shape is inconsistent with heavy ripping, therefore breakages at welding joints is constant.

A new factory has been built at Saiyon where new machines are being installed together with saw maintenance equipment.

A list of extra equipment is listed in the machine requirements under Saiyon on page 10.

The recommended tooth profile for TCT saws for ripping Keruing is given in Annex 8, under the heading Speartipt type 100 RC/T, on page 59.

OBSERVATIONS AND FINDINGS

1. The Co-operatives management in Yemen has only recently realised the priority of providing essential training of sawdoctors in the woodworking industry. The high costs of machine tooling, TCT saws and planer knives requires efficient servicing to reduce production costs to the minimum. Good workshop/tool room facilities are also necessary to obtain the required results. Remuneration for sawdoctors skills must also be recognised and a wage or salary must be paid above the rates for a wood machinist, consistent with the responsibilities of the work.

2. Very little consideration has been given to the value of the good quality tool and saw doctoring in Aden, Mukalla, Saiyon and the small units. As a result the saw shop is usually a small area tucked away in the corner of a wood machine shop with insufficient floor space, bench area and lighting. None of these areas are roofed to keep out dust from woodworking machines. The lack of dust extraction systems in all plant only accentuates the problem.

3. A number of machines have been duplicated over the years resulting in a surlpus of sharpening machines which have various parts missing or broken. These still occupy valuable space in an already limited area.

4. Maintenance of TCT saws in Aden is done by outside contract although a universal grinder to service these saws is available. At Mukalla, the universal was not used due to lack of instruction in operating these machines. The saws were being serviced freehand using a diamond wheel in a bench grinder. Freehand grinding of TCT saws leads to eventual eccentricity, resulting in reduction of efficient sawing and overloading. Ranging down teeth to retain concentric saws was not practiced.

5. Benches for cleaning saws prior to servicing were non-existent in most places, those available were fitted with grinders and band saw welding equipment and are also built at unsatisfactory working levels and built too flimsy to maintain a sound base for machines to be fitted.

6. The band saws welder and guillotine were not firmly fixed in most cases to permit efficient servicing. Saws were allowed to drag over concrete floors instead of being supported by overhead rollers, thereby eliminating damage to saw teeth. Band saw brazing was not used although available in some workshops. Accurate and equal spring setting on band saws was not fully appreciated resulting in poor sawing. Unequal dressing of grinding wheels resulting in poor quality sharpening and incorrect tooth shapes. This was due entirely to the non-existence of grinding wheel dressers or "sticks" to maintain a constant suitable section to the grinding wheels.

7. A new straight knife grinder in Mukalla was not being used, as the co-operative had changed from high speed steel to carbon steel and suitable "Boron" or diamond stones were not available for use on this machine. Using a bench type grinder with cup wheels with limited carriage, resulted in planer blades being ground to a "convex" shape.

SUMMARY OF RECOMMENDATIONS

Mukalla

1. There are sufficient servicing machines to maintain the existing saw doctoring and tooling requirements at Mukalla and, using Mukalla as a servicing base for TCT saws, servicing can also be centralized for the Shahir and Ghail Bawazir units.

2. If the work load is too heavy, Universal grinders will have to be purchased for these two units at a later date.

3. The existing "Bäuerle" horizontal plane knife grinder needs to be equipped with diamond cup wheels to enable carbon steel planer blades to be serviced. At present only HS steel knives have been maintained.

4. The use of Barnhart bench grinder for servicing carbon steel knives of lengths greater than 300 mm should cease, as it is grinding convex due to carriage limitations.

5. The existing Universal grinder has limited attachments and is not in top condition. It is however, capable of servicing TCT saws.

6. A new Universal should be purchased for Mukalla with rests and attachments to service TCT saws, tenoning knives (carbon), and HSS and carbon router cutter.s A new high speed router has been purchased.

7. The absence of suitable heavy-duty rip-saw bench has increased band saw breakages as ripping hardwood planks on narrow bands is most unsuitable. It is therefore recommended to purchase a new 600 mm diameter saw bench, with a motor of at least 12 HP.

8. A constant survey by UNV is necessary to maintain a reasonable high standard of saw sharpening and tool maintenance, training and retraining also on the servicing of woodworking machines must take priority to keep down production costs.

9. The saw doctor was not equipped with suitable machine servicing or adjustment tools, such as spanners, Alan keys, dressing wheel sticks, and Huntington type wheel dressers. This has resulted over the years in the lack of machine adjustment to various sizes and gauges of saws and constant breakages of machine parts.

10. The practice of machine operators servicing their own saws, knives and tools has caused a lack of responsible handling of machines, equipment and servicing tools.

11. Mortice chains are not being serviced on universal grinders to obtain standardization of tooth shape. These are being services freehand resulting in poor quality morticing. Only the front of the cnain link should be ground, not the top.

12. French heads on spindle moulders are used to produce ovolo moulds on traditional doors. The thickness of the cutter steel for these heads should be 5/16" or 7 mm. The practice of using 1/8" or 3 mm is very dangerous and could lead to accidents as the slot in the cutter head is 5/16" or 7 mm.

LIST OF MACHINES AND EQUIPMENT RECOMMENDED

Mukalla

Qty.	Description
1	Heavy circular saw bench to take 600 mm TCT saws. Complete with fence and guards. Motor 12 HP, 3-phase (See Annex 3). Suggested suppliers: Wadkin Group of Companies, UK[1]. Wadkin Tooling, Leicester, UK[2].
3	600 mm diameter TCT saws for ripping dense hardwoods.
12	Dressing sticks for shaping grinding wheels on band saw sharpener (see Annex 6, page 48).
3	Sets of imperial and metric Allan keys.
20	Sets of "French" head cutter steel blanks 50 x 25 x 7 mm thick.
6	Grinding wheels for Bäuerle straight knife grinder. Type AHS 8, designed for high speed steel knives, to be adapted for carbon steel. (Technical specifications must be obtained from Bäuerle.)
6	Flat belts for top motor of Bäuerle[3] grinder type AHS 8 for grinding spindle pulley.

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[1] Wadkin Group of Companies
Green Lane Road
Leicester LE5 4PF
UK
Tel.: (+44533) 769 111
Fax.: (+44533) 461 103

[2] Wadkin Tooling
331 Humberstone Lane
Leicester LE4 7LH
Tel.: (+44533) 769 111
Fax.: (+44533) 460 712

[3] Bäuerle Maschinenfabrik GmbH & Co.
Bahnhofstrasse 25
P. O. Box 40
D-W7079 Böbingen/Rems
Germany
Tel.: (+497173) 1870
Fax.: (+497173) 18746

SUMMARY OF RECOMMENDATIONS

Saiyon

1. Most of the servicing equipment in Saiyon and surrounding units is in poor condition: only one unit had equipment for welding sharpening and setting band saws in good condition.

2. As a result of the building of a new workshop in Saiyon where new woodworking machines have been installed, a new saw shop should be established to service the requirements of the surrounding units, this must be well planned, clean, and well ventilated.

3. It will be necessary, owing to the nature of the material being used in door and window construction, to change from HSS to carbon steel planer and surface planer knives.

4. This will require purchasing a new horizontal plane knife grinder with diamond wheels.

5. During the consultant's visit, 84 circular TCT saws were collected , none had ever been serviced as no machine was available. Therefore, a new Universal grinder with attachments, the same as Mukalla, must be purchased.

6. As the equipment for bandsaw servicing in Saiyon is in poor condition, a new sharpener and setting machine for narrow band saws should be purchased.

7. As in Mukalla, a heavy duty rip-saw is not availalable and timber conversion using small diameter saws, with small motors, is creating high costs. Therefore, a heavy duty saw bench of 600mm diameter with a motor of about 12HP is urgently required. TCT saws must be supplied. See annexe 3.

8. The surface finish of all joinery is of a low standard, and local demand will insist in future, on a high standard of construction and finish when the market is more affluent With this in mind budgeting for purchase of belt sanding machines should be considered.

LIST OF MACHINES AND EQUIPMENT RECOMMENDED
Saiyon

Qty.	Description
1	Heavy duty rip saw bench to take 600 mm saw with fence and guards. Motor 12HP 3-phase. Suggested supplier: Wadkin Group of Companies[4]
3	600 mm diameter TCT saws (see Annex 3) Suggested suppliers: Wadkin Tooling[5]
1	Bäuerle straight knife grinder for both HSS and carbon tipped knives. Type AHS 8 Suggested suppliers: Bäuerle[6]
1	Bandsaw filer type BNE/AM for narrow band saws complete with setting device.
30	Bandsaw files for machines. Suggested suppliers: Vollmer[7]
12	Dressing sticks for shaping grinding wheels.
2	Sets of imperial and metric Allan keys.
20	Sets of HSS blanks for "French" head on spindle moulding machine. Size 50 x 7 mm Suggested supplier: Vollmer[7]

---

[4] Wadkin Group of Companies
Green Lane Road
Leicester LE5 4PF
United Kingdom
Tel.: (+44533) 76 91 11
Fax.: (+44533) 46 11 03

[5] Wadkin Tooling
331 Humberstone Lane
Leicester LE4 7LH
Tel.: (+44533) 76 91 11
Fax.: (+44533) 46 07 12

[6] Bäuerle Maschinenfabrik G.m.b.H. & Co.
Bahnhofstrasse 25
P. O. Box 40
D-W 7079 Böbingen/Rems
Germany
Tel.: (+497173) 1870
Fax.: (+497173) 18746

[7] Vollmer Werke Maschinenfabrik G.m.b.H.
Ehringer Strasse 34
P. O. Box 1760
D-W Biberach/Riss 1
Germany
Tel.: (+497351) 5710
Fax.: (+497351) 57130

CONCLUSIONS

The expert found considerable enthusiasm for all work involving demonstration and maintenance of machines. During training sessions it was realised that inefficient servicing was frequently the result of lack of knowledge of the machine's operation and capabilities.

Unfortunately, at the time of installation of machines, demonstration was not given to the operators. Some manufacturers produce an operators manual but a lot do not. These manuals are excellent reference for operators, and assist with many setting up problems.

Inaccurate adjustment of machines is frequently due to lack of tools such as Alan keys, spanners etc.

This equipment should be kept safe in a locked box. The practice of operators servicing their own tools has been stopped. Lack of knowledge of tooth shapes, types of steel and abrasive wheels, contributes to many bad practices.

It has been seen at Mukalla that by redesigning the saw shop layout, and installing machines and equipment correctly and building benches of good design, height and strength, an increase in efficient maintenance is already evident.

An ongoing scheme of training to be carried out by the UNV's will develop the skills at operator and saw doctor levels.

Safety practices must be enforced at all times, as this has been sadly lacking.

The local building fraternity should be introduced and educated to the possible use of impregnated softwoods to the exclusion of the dense Malaysian hardwood presently used. This would eliminate many of the sharpening and servicing problems existing at present.

In Yemen, rainfall is almost non-existent and dry or wet rot have not been seen in any structure during the expert's mission.

Waste extraction of offcuts and shavings is a major problem at all machines and effects freedom of passage of palleted components.

Double handling of items is constantly leading to higher production costs. Although boxes are used as containers for offcuts, they are continually overflowing. A small forklift should be available to empty these containers at all times.

The cost of cyclones and trunking for shavings and dust extration is being looked into.

ANNEX 1

PROJECT OF THE GOVERNMENT OF THE REPUBLIC OF YEMEN

JOB DESCRIPTION

PROJECT: SM/PDY/87/005/11-04 (J-12209)

Position Title	:	Expert in Tool Maintenance
Duration	:	Three months
Date Required	:	Early 1991
Duty Station	:	Mukalla with travel to Saiyon and Aden.
Purpose of Project	:	To strengthen the technical and managerial capabilities of the carpentry co-operatives in Mukalla and Saiyon.
Duties	:	Under the guidance of the furniture and joinery production expert (CTA) the expert in tool maintenance will be expected to:

1. Review and analyze the present tool maintenance systems used by the co-operatives.

2. Assess the state of the equipment installed.

3. Assess the skills of the saw doctors and other tool and machine maintenance technicians.

4. Recommend a training programme for them to be implemented by the project's two UN volunteers

5. Draw up a list of equipment tools and auxiliary materials in order of priority for each co-operative giving detailed technical specifications, estimated costs and names and addresses of potential suppliers.

6. To the extent possible, train counterparts in the above fields.

7. Prepare a technical report outlining his findings and recommendations addressed to the management of the co-operatives, government and international organisations.

ANNEX 2

PEOPLE MET BY THE EXPERT

Name	Designation	
ADEN		
Mr Iqbal Bahader	Director of Co-operative	
Mr Omar Bazhfer	General Manager Co-op	
Mr Faadel	Deputy Manager Co-op	
Mr Qassim Hassan	General Manager Industries	
Mr Ali Mohammed Nasser	Production Manager Co-op	
MUKALLA		
Mr Omar Badofari	Director of Industries	
Mr Awadh Bin Goothe	Deputy Director of Industries	
Mr Faiz Salih Almari	General Manager Co-op	
Mr Muhfood Baswad	Deputy General Manager Co-op	
Mr Salim Jaffer	Accountant Co-op	
Mr Ahmed Salim	Production Manager	
Mr Alwi Omar	Counterpart/Engineer	
Mr Awadh Mungoosh	Manager, Shahir Unit Co-op	
Mr Ahmed Omar	Manager, Gnail Unit Co-op	
SAIYON		
Mr Awadh Khubhe	Manager of Co-operative	
UNDP STAFF		
Ms Giovanna Feraro	Programme Officer	Sana'a
Mr Mohammed Aziz	Programme Assistant	Aden
Ms Irena Koszewska	UNV Programme Assistant	Aden
Mr Fred Kesseh	UN Volunteer	Saiyon
Mr Echeng Eleng	UN Volunteer	Mukalla

ANNEX 3

THE RECOMMENDED DESIGN OF CIRCULAR SAW BENCH

Saiyon and Mukalla

Blades up to 750 mm Ø
Rim speed 50 metres per second
HP of motor 12 to 15

NOTE: The type of saw blade for ripping both hard and softwoods has the following characteristics:

Diameter:	24 inches (i.e. 610 mm)
Kerf width:	0.157 inches (i.e. 4 mm)
Plate thickness:	0.1 inches (i.e. 2.5 mm)
Number of teeth:	48
Teeth pitch:	1.5 inches (i.e. 37 mm)

Suitable sized machines can be used for deep-cutting operations, this is something that the more precision type of machine cannot cope with.

Saw benches capable of taking blades of 750 mm in diameter (approximately 30 inches) are usually fitted with motors from 12 to 15 horse power, according to the type of work on which they are to be generally used. It is also advisable that a choice of the spindle revolution speed should be available.

It is generally accepted that the rim speed (the speed at which the saw tooth is travelling should be 10,000 ft. per min, or S.I. equivalent approximately 50 metres per second.

Therefore the diameter of the saw plate has a relation to the speed of rotation of the driving spindle. The smaller diameter saws require the higher speed of rotation.

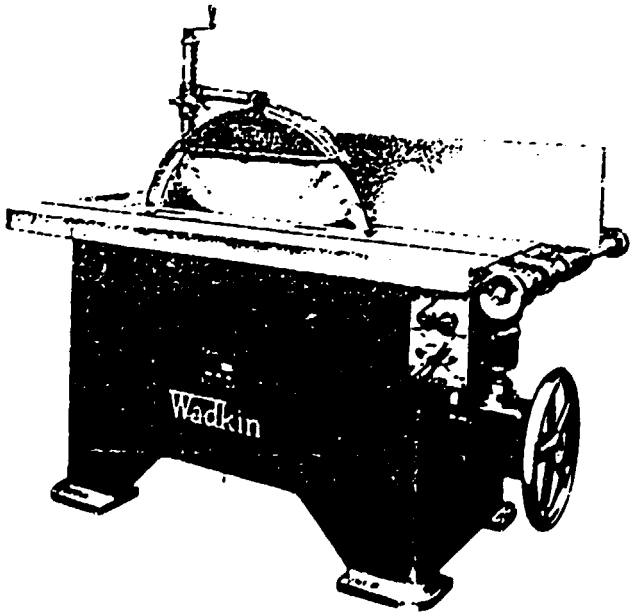


Fig. 1: Heavy duty circular saw bench of the resaw type. Points of note on this particular machine are, guard and adjustments, accessability of switch gear, screw adjustment to fence, encased raising and lowering gear to table.

ANNEX 4

MANAGEMENT RESOURCE CHART

In this annex the consultant tried to cross link the relation between machine and tool maintenance and production costs. The overall picture is given in figure 1; while the relation between figures 2 to 6 and the corresponding section in the text of the report is given in the table here under;

Figure	Section
2	B
3	A 3
	B 2
	B 3
	B 5
4	C 7
	C 9
	D 2
5	B 1
	B 5
6	C 5
	C 6
	C 7
	C 8
	C 9
	D 2
	D 3

FIGURE 1. THE ROLE OF MANAGEMENT IN CO-ORDINATING THE RESOURCES OF AN ENTERPRISE.

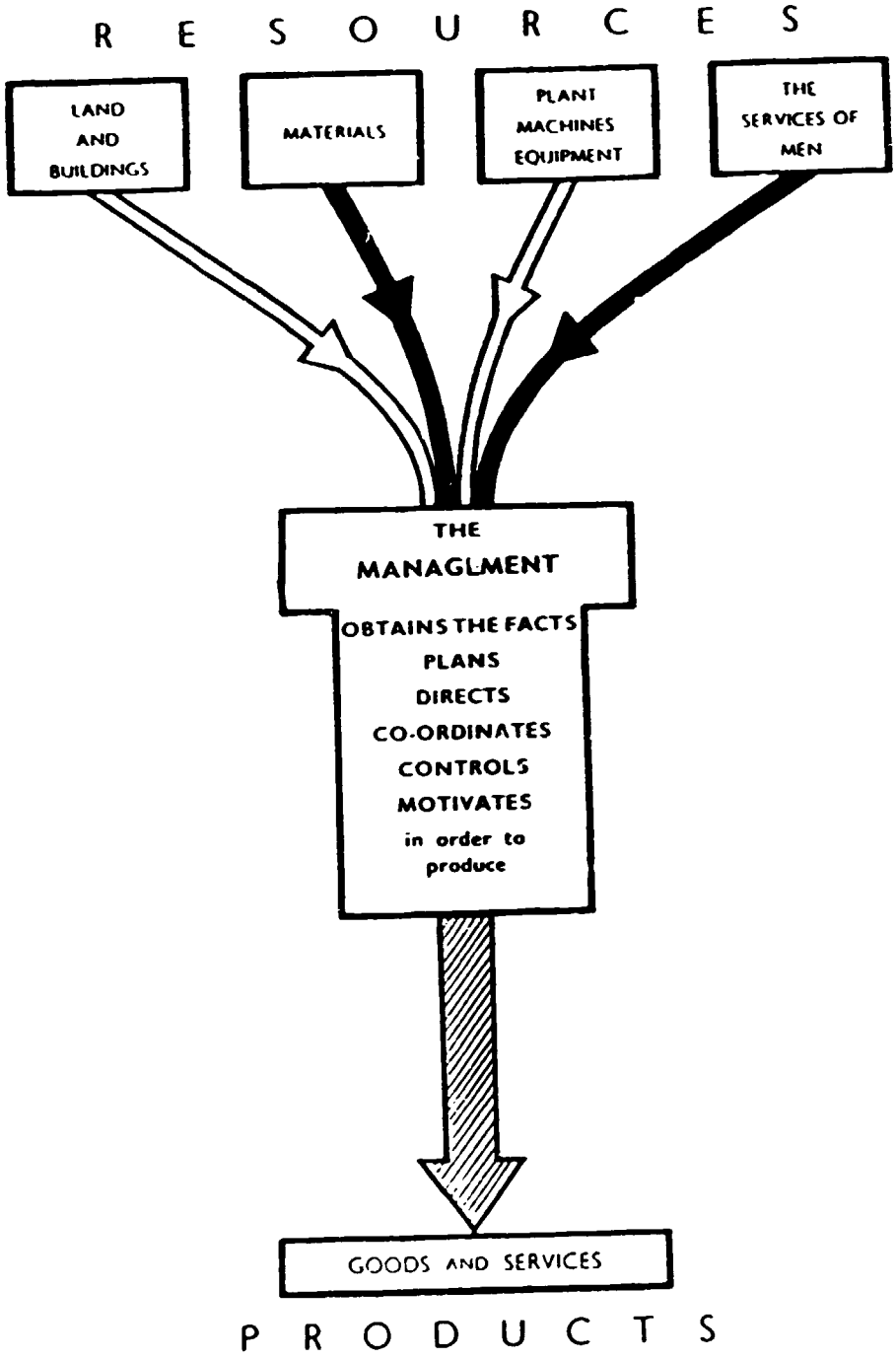


FIGURE 2. HOW MANUFACTURING TIME IS MADE UP

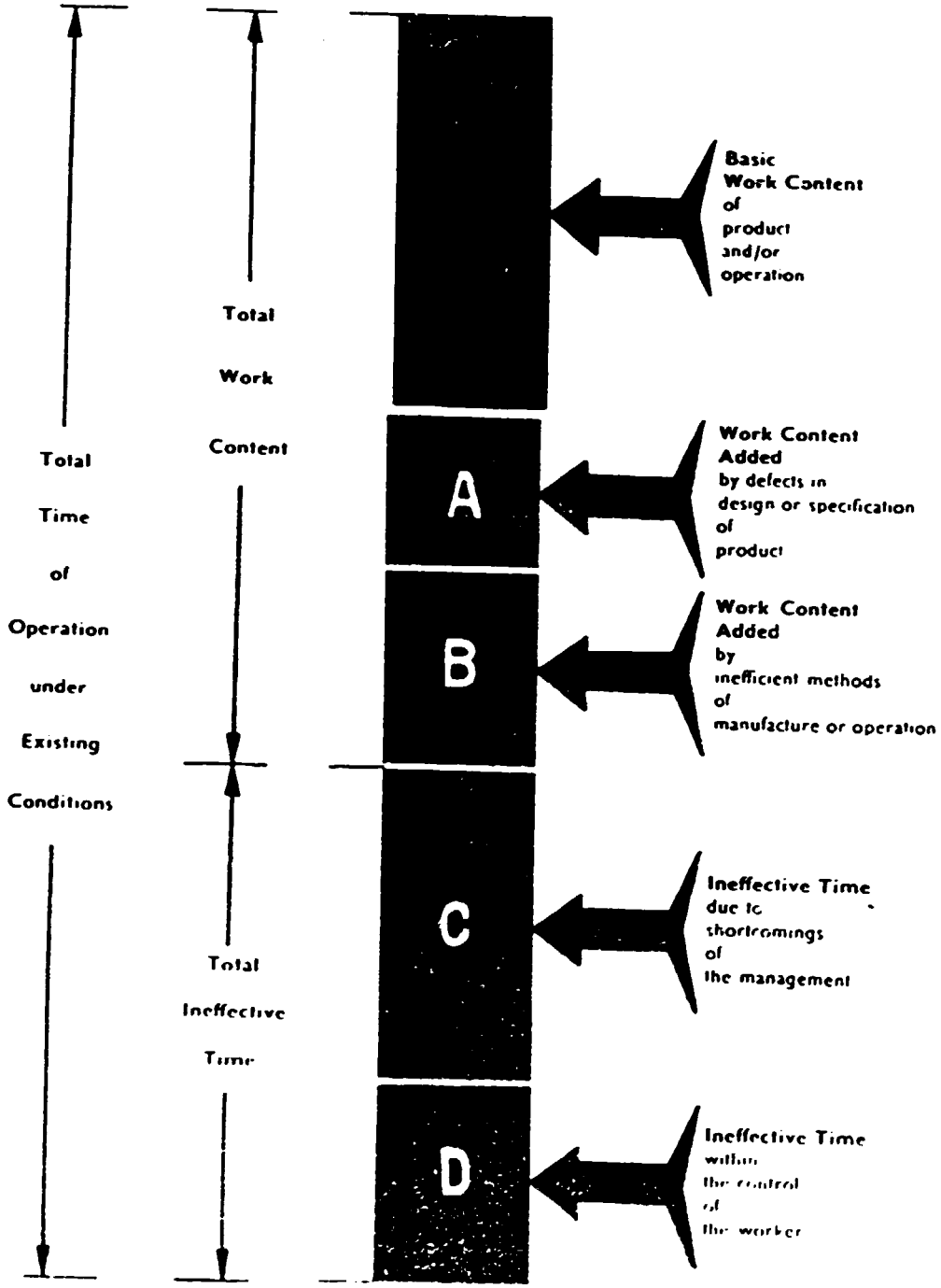


FIGURE 3. THE WORK CONTENT DUE TO THE PRODUCT AND PROCESSES

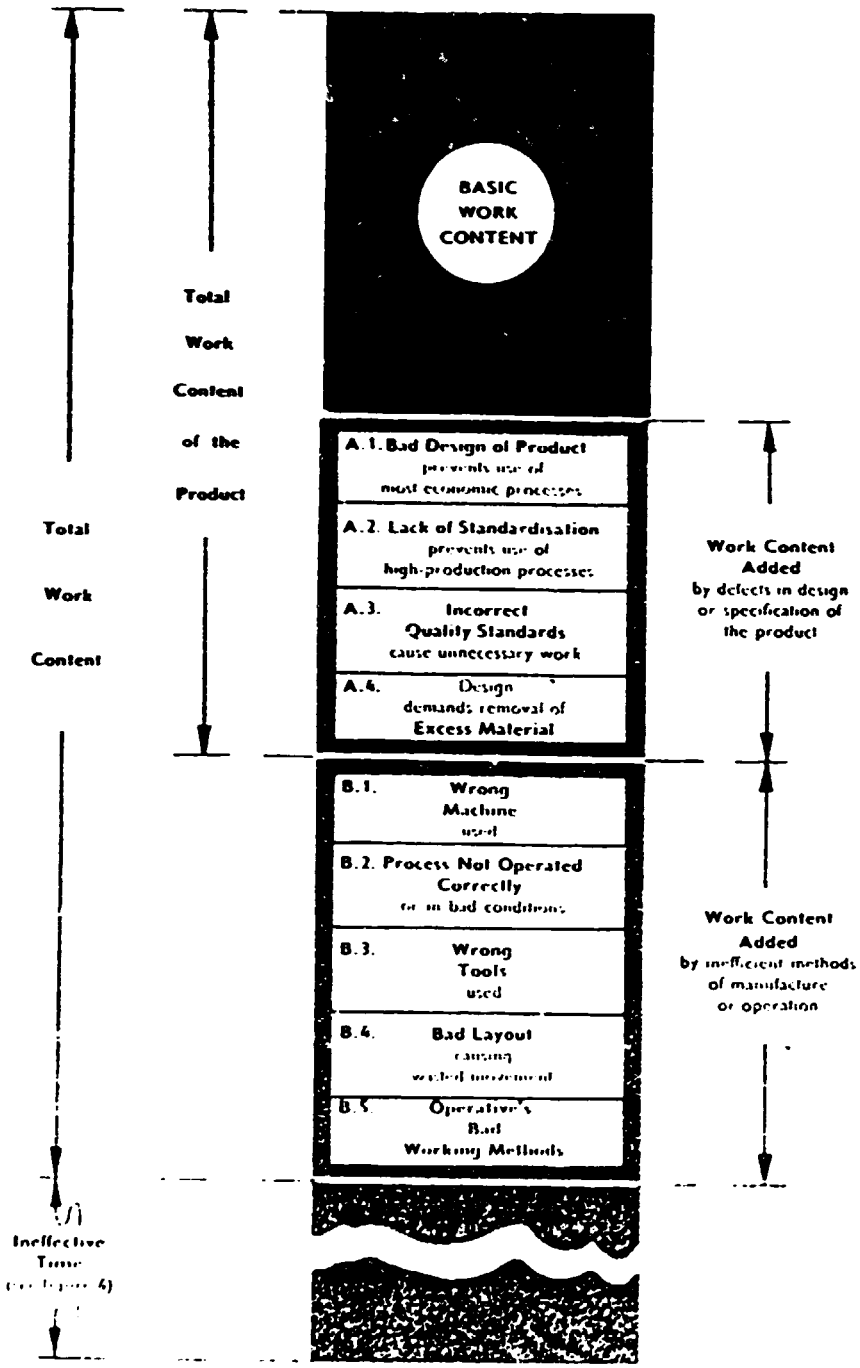


FIGURE 4. INEFFECTIVE TIME DUE TO SHORTCOMINGS ON THE PART OF MANAGEMENT AND WORKERS

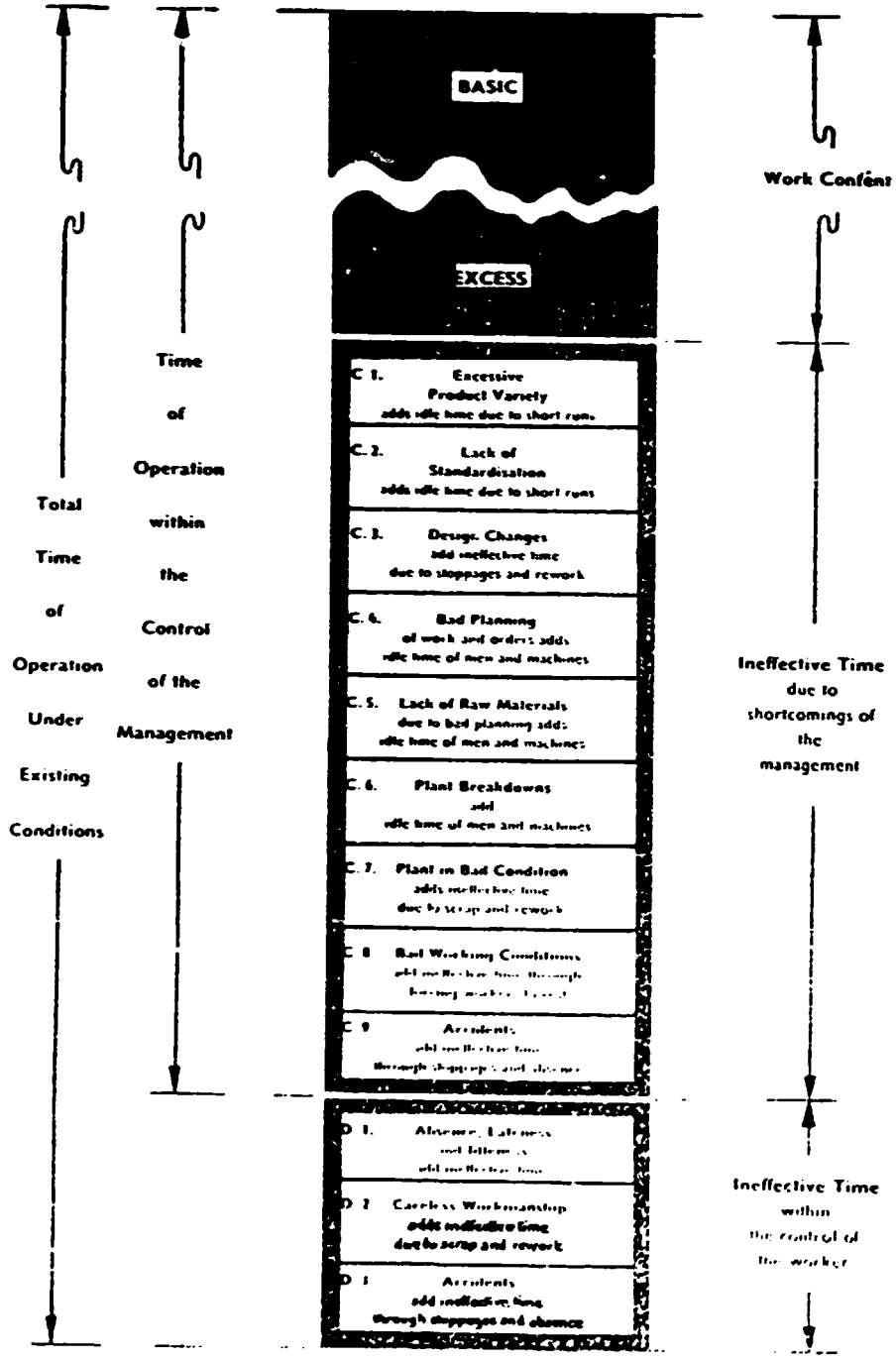


FIGURE 5. HOW MANAGEMENT TECHNIQUES CAN REDUCE EXCESS WORK CONTENT

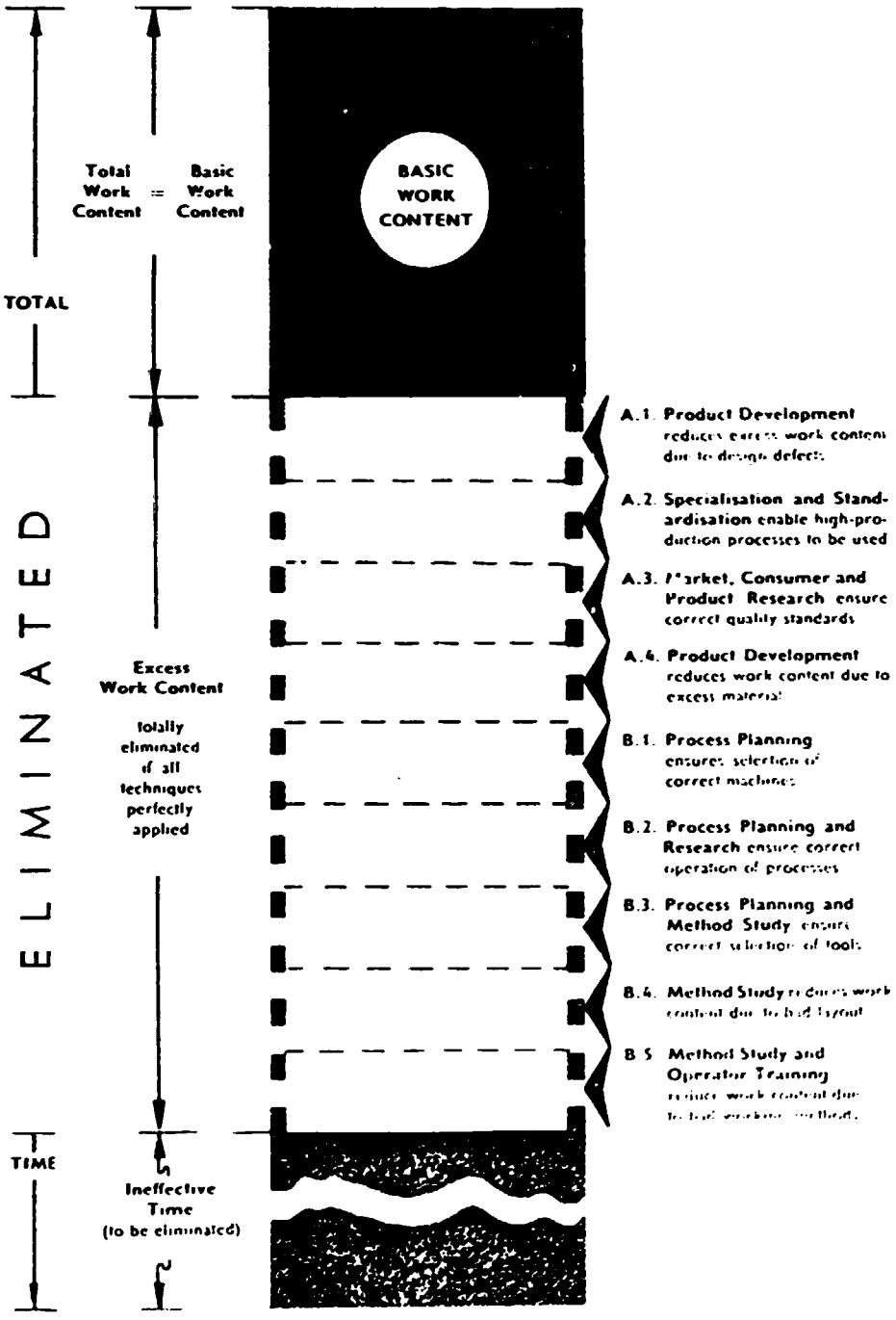
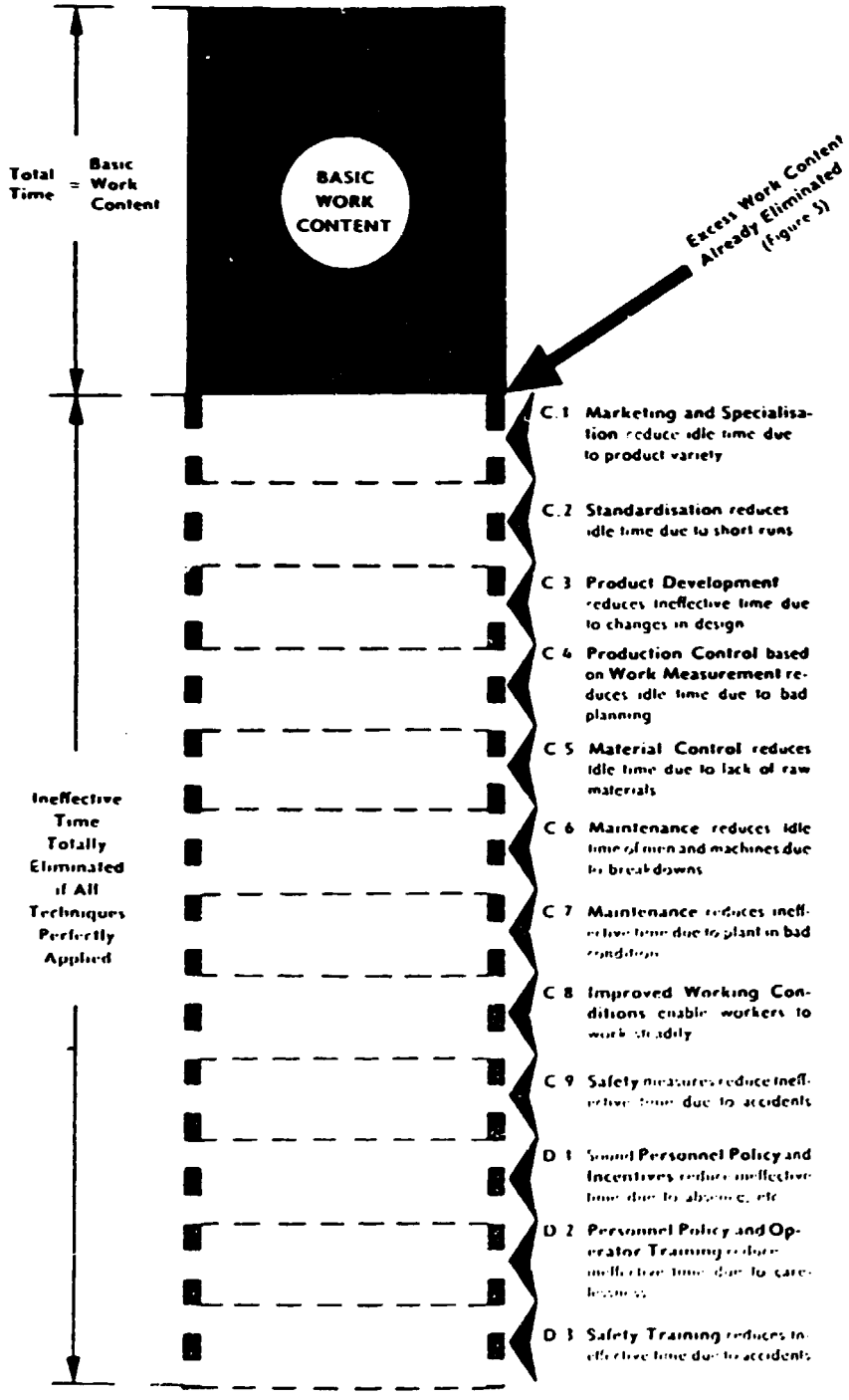


FIGURE 6. HOW MANAGEMENT TECHNIQUES CAN REDUCE INEFFECTIVE TIME



ANNEX 5

TRAINING SYLLABUS FOR TOOL ROOM WORK

No.1. TOOLROOM WORK: CHISEL MORTISER

On Completion of training, the trainee will be able to:

- Visually examine chisel, auger and state condition.
- Sharpen chisel using:
    - reamer
    - files
    - conical mounted point.
- Sharpen auger using:
    - files
- Clean and store chisel and auger
- Apply Abrasive Wheel Regulations 1970

JOB KNOWLEDGE:

- Differentiate between triangular, square and rounded fine cut files.
- Differentiate between conical points and reamers.
- State the sharpness and clearance angle for the chisel.
- Explain the reason for the auger ears/spurs projecting below the cutting edges.
- Name a suitable solvent for removing resins.
- State the purpose of the chisel having a fine taper.
- State the reason for not sharpening the outer faces of the auger wings.
- Explain the need to have the correct size pilot and reamer.
- List sharpening faults.
- Explain the procedure for sharpening mortice chisel using reamer and conical mounted point.
- Explain the procedure for sharpening auger.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS

1. Sharpness angle 35° ± 1°
2. Clearance angle 25° ± 2°
3. Length of corners equal
4. Filing smooth and even on all chisel cutting edges.
5. Easement fitted in each internal corner of chisel.
6. No breaking through of chisel corners and no file marks on outside of chisel.
7. Wings of auger filed to cut equally and to project a uniform distance below cutting edge.
8. Chisel and auger thoroughly cleaned free of resin.
9. Correct files chosen.
10. Burrs removed from end of chisel.
11. Abrasive Wheel Regulations 1970 applied correctly.

TIME

1. 20 minutes to sharpen chisel and auger.

No. 2. TOOL ROOM WORK: CHAIN MORTISER

On completion of training, the trainee will be able to:
- Visually examine chain, guide bar and state condition.
- Sharpen mortise chain using chain grinder.
- Maintain guide bar.
- Repair chain.
- Clean chain.
- Store chain, guide bar and sprocket.
- Apply Abrasive Wheels Regulations.

JOB KNOWLEDGE

- Identify and name the parts of a mortise chain grinding machine.
- State sprocket wheel sleeve adjustment to match size of chain.
- Explain the need to match the correct sprocket wheel sleeve to chain.
- Explain the need to feed chain against rotation of abrasive wheel.
- List suitable grades and sizes of abrasive wheel.
- List grinding faults.
- State the grinding angle.
- Explain what is meant by the pitch of the chain.
- State the storage and handling requirements of chains, guide bars and sprockets.
- Name suitable solvent for removing resin.
- Determine when guide bar anti-friction roller bearings need changing.
- Differentiate between first, second and marking punches/making and breaking punches.
- State the purpose of an anvil block and breaking fork.
- Explain the procedure for grinding mortice chains.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS

1. Correctly report the condition of the chain as regards:
   (a) wear
   (b) stiffness
   (c) condition of cutting edges
2. Select correct sprocket wheel sleeve for chain.
3. Chain and sprocket thoroughly cleaned free of resin.
4. Adjust chain grinder correctly.
5. Grind chain to an angle of 25° on hook ± 1°
6. Abrasive Wheel Regulations 1970 applied correctly.

TIME

1. 15 minutes to sharpen mortise chains by grinding.

No. 3. TOOL ROOM WORK: SPRING SET CIRCULAR SAW BLADES

On completion of training, the trainee will be able to:

- Range teeth:
  - in saw bench
  - on hand gulleting machine
- Set teeth by:
  - gate saw set
- Check set by:
  - dial gauge
  - metal template
- Sharpen saw by:
  - hand topping with file
  - hand operated gulleter
- Visually examine for:
  - lumps
  - tension
  - cracks
- Measure angle of hook
- Clean and store saw blade
- Apply Abrasive Wheel Regulations

JOB KNOWLEDGE

- State the need to set teeth on a saw blade.
- Explain the method of setting with a gate saw set.
- Name the type of abrasive wheel suitable for gulleting plate saws.
- Name a suitable solvent for removing resin.
- Name suitable files for hand sharpening.
- Evaluate a saw blade specifications chart for rip saws cutting hardwood and softwood.
- Describe the method to range down circular saws.
- Explain the need for a jig to hold abrasive stone when ranging in saw bench.
- Identify the clearance angle, sharpness angle, rake root, gullet, front, back, heel, point and tooth top on a circular saw blade.
- State the effect of heat generated in circular saws.
- Explain in simple terms the effects of centrifugal force and thermal stresses in circular saws.
- Describe the methods of sharpening circular saws by gulleting with a hand operated gulleter and topping with a file.
- Describe how clearance is given to circular saws by hollow grinding and applied tips.
- Outline Abrasive Wheel Regulations 1970.

STANDARDS

1. Saw blade ranged correctly.
2. Correct files used for sharpening.
3. Saw blade sharpened by hand to:
   (a) angle of hook ± 2°
   (b) clearance angle ± 1°
4. All angles and bevels filed uniformly.
5. No dubbing of points or secondary bevels.
6. All teeth of uniform shape and in the same cutting circle.
7. Each tooth set accurately to template/dial gauge ± 0.2 mm.
8. Each tooth set alternately.
9. Saw blade free form resin.
10. Abrasive Wheel Regulations 1970 applied correctly.

TIME

1. 5 minutes to clean saw blade.
2. 5 minutes to range down teeth.
3. 25 minutes to set saw blade (gauge 14-11).
4. 20 minutes to sharpen saw blade by hand (face and top).

No.4. TOOL ROOM WORK: NARROW BAND SAW

On completion of training, the trainee will be able to:

- Sharpen bandsaw blade by machine (file or abrasive wheel type)
- Set band saw blade by:
  - hand setting tool plier type.
  - hammer and block or automatic setting machine.
- Visually examine for:
  - twists
  - cracks
  - bends
  - straightness of back edge
- Clean, fold and store blades.
- Apply Abrasive Wheel Regulations 1970.

JOB KNOWLEDGE

- Differentiate between hand and automatic setting machines.
- Identify and name the parts of a hand operated setting machine.
- State the functions of the controls of a hand operated setting machine.
- Identify the rake angle, clearance angle, pitch and set of a band saw blade.
- Identify and name the parts of an automatic narrow bandsaw sharpening machine.
- State the functions of the controls of an automatic sharpening machine.
- Name a suitable file or abrasive wheel for sharpening band saw blades.
- Name a suitable solvent for removing resin.
- Describe the procedure for setting bandsaw blade using hand operated machine and sharpening bandsaw blade by machine.
- Describe the methods of jointing narrow bandsaw blades.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS

1. Fold blade correctly.
2. Saw blade correctly mounted in holder.
3. Feed pawl stroke correctly set to suit tooth pitch
4. File/abrasive wheel set to suit hook angle.
5. Correct file/abrasive wheel chosen.
6. Depth of cut correct.
7. All teeth evenly sharpened.
8. Tooth strikers correctly set.
9. Alternate teeth set.
10. Saw blade thoroughly cleaned, free of resin.

TIME

1. Cleaning saw blade: 5 minutes.
2. Setting saw blade: 15 minutes to set-up machine.
3. Sharpening saw blade: 15 minutes to set-up machine.

No. 5 TOOL ROOM WORK: STRAIGHT PLANER KNIVES

On completion of training, the trainee will be able to:

- Grind cutters, hollow and flat.
- Form:
    - back bevels
    - front bevels
- Measure cutting angles
- Use balancing scales to balance cutters/knives, bolts, nuts and washers
- Use balancing stand to:
    - balance block
    - set cutters
- Joint, hone, clean and store cutters.
- Apply Abrasive Wheel Regulations 1970

JOB KNOWLEDGE

- Differentiate between hollow and flat grinding.
- Differentiate between front bevels, back bevels clearance, sharpness and cutting angles.
- State the purpose and effect of jointing cutters.
- Identify defects in cutter blocks and holding devices and state how they affect safe working.
- Describe what is meant by static and dynamic balance and method of balancing knives/cutters.
- Name a suitable solvent for removing resin.
- Describe the procedure to set-up and grind straight knives (hollow and flat).
- Describe the effects of forces involved in rotating cutter blocks and the effect on balance and safety.
- Describe the effect rotary cutters have on surface finish.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS

1. Cutters hollow ground to grinding angle ± 1°
2. Cutters flat ground to grinding angle ± 1°
3. Cutters weight ± 5 gms
4. Cutter width ± 0.5 mm
5. Cutter honed at correct angle to remove burr
6. Jointing of cutters accurate.
7. Cutter block accurately balanced.
8. Cutters correctly set.
9. Abrasive Wheel Regulations 1970 applied correctly.

TIME

1. Cleaning knives: 2 minutes per knife.
2. Grinding flat: 10 minutes per knife (automatically)
   20 minutes per knife (manually)
3. Grinding hollow: 12 minutes per knife (automatically)
   22 minutes per knife (manually)
4. Balancing knives: 5 minutes.
5. Setting knives (foursider): 5 minutes per knife.
6. Form back bevel: 5 minutes per knife (four sider/panel planer)
7. Form front bevel: 5 minutes per knife (four sider/panel planer)
8. Knife jointing: 5 minutes per block (panel planer)
9. Honing: 2 minutes per knife.

No.6. TOOL ROOM WORK: MOULDING CUTTERS

On completion of training, the trainee will be able to:

- Prepare grinding and setting templates for:
  - circular moulding block,
  - slotted collars,
  - tenon cutters,
  - square blocks.
- Grind cutters free hand.
- Measure cutting angles on circular and solid profile blocks.
- Use balancing scales to balance cutters, bolts, nuts and washers.
- Use balancing stand to:
  - balance block
  - set cutters.
- Hone, clean and store cutters.
- Apply Abrasive Wheel Regulations.

JOB KNOWLEDGE

- Differentiate between clearance, sharpness and cutting angles.
- Identify defects in cutter blocks and holding devices and state how they affect safe working.
- Describe what is meant by static and dynamic balance and method of balancing cutters.
- State the use of datums for dimensioning and specification of tolerances.
- List materials suitable for grinding and setting templates.
- Name drawing instruments suitable to prepare grinding and setting templates.
- Name a suitable solvent for removing resin.
- Describe the procedure for free hand grinding shaped moulding cutters.
- Describe the effects of forces involved in rotating cutter blocks and the effect on balance and safety.
- Describe the effect rotary cutters have on surface finish.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS

1. Prepare grinding/setting template for mouldings accurately.
2. Grind cutter accurately to grinding template profile.
3. Grind cutting angle accurately to ± 1°
4. Relief angle ground accurately to ± 1°
5. No secondary bevels formed.
6. Cutters free from burn marks.
7. Cutter 'honed' accurately.
8. Set cutters correctly to setting template.
9. Cutters weight equal to within ± 1 division on scales.
10. Cutter block accurately balanced.
11. Abrasive Wheel Regulations 1970 applied correctly.

TIME

1. Preparation of grinding templates:
   30 minutes for steel template on modern profile grinder.
2. Preparation of projection scales for square block:
   45 minutes (including drawing)
3. Free hand grinding:
   Two cutters: 15 minutes per cutter (circular moulding block type)
4. Balancing cutters for square block:
   5 minutes (including nuts, bolts and washers)
5. Set cutters using balancing stand: 15 minutes per pair.
6. Honing cutters: 2 minutes per cutter.

No. 7. TOOL ROOM WORK: HIGH SPEED STEEL ROUTER CUTTERS

On completion of training, the trainee will be able to:
- Use grinding attachment for universal grinder or router.
- Grind single and double flute cutters.
- Select appropriate abrasive wheels.
- Hone, clean and store router cutters.
- Apply Abrasive Wheel Regulations 1970.

JOB KNOWLEDGE
- Differentiate between single and double flute cutters.
- State composition of abrasive wheels suitable to grind HSS cutters.
- Describe the procedure and need to hone HSS cutters after grinding.
- Determine the correct grinding angles.
- Differentiate between blunt and sharp cutters.
- State grades/types of stone suitable for honing.
- State a suitable lubricant for honing.
- Name a suitable solvent for removing resin.
- Outline Abrasive Wheel Regulations 1970 for safe use.

STANDARDS
1. Correct abrasive wheel chosen.
2. Grinding attachment fitted correctly to table for flute end grinding.
3. Cutters set in correct position in relation to wheel face.
4. Table stops correctly set for length of flute.
5. Cutters free of burn marks.
6. Cutters evenly and accurately ground.
7. Cutters correctly honed after grinding.
8. End of cutter ground evenly to give correct clearance angle.
9. Abrasive Wheel Regulations 1970 applied correctly.

TIME
1. Set up cutter holding device on universal grinder using cranked block: 20 minutes.
2. Set-up cutter holding device on high speed router: 15 minutes.
3. Grinding double and single flute high speed steel cutters: 10 minutes.
4. Honing cutters: 5 minutes.

No. 8. TOOL ROOM WORK: SIMPLE REPAIRS AND MAINTENANCE

On completion of training, the trainee will be able to:
- Use extractors for removing high tensile and mild steel sheared bolts.
- Use taps and dies.
- Make simple clamping devices for jigs.

JOB KNOWLEDGE
- State the difference between high tensile and mild steel bolts.
- Differentiate between high tensile and mild steel bolts.
- State the methods of removing sheared high tensile and mild steel bolts.
- Explain the advantages and disadvantages of collet and wedge type stud removers.
- State the purpose of taper-bit screw extractors.
- Differentiate between taps and dies.
- Explain the need for accurate drilling of pilot holes.
- Determine the direction of thread on bolt.
- State suitable materials for jig clamping devices.
- Determine drawings of (make) or design of clamping devices.
- List suitable tools for making clamping devices.

STANDARDS
- Removing sheared bolts:
1. Correct extractor used.
2. Pilot hole drilled accurately.
3. Bolt/stud removed without damage to thread
- Jig clamping devices:
1. Made accurately to drawing.
2. Correct tools chosen for construction.
3. Moving parts operating smoothly.

No. 9. TOOL ROOM WORK: USE OF ABRASIVE WHEELS

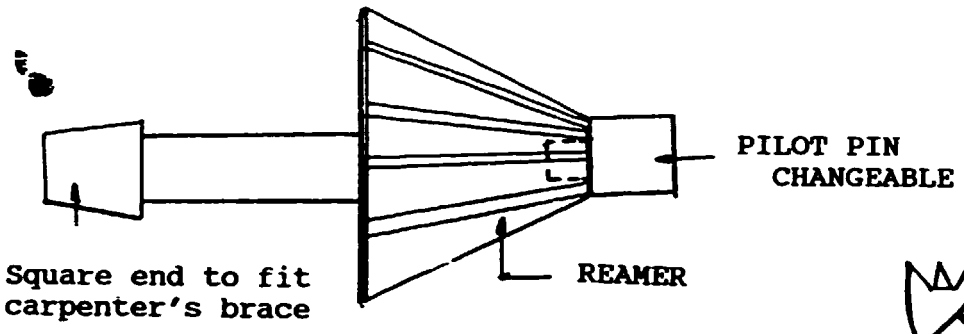
On completion of training, the trainee will be able to:
- Safely grind using wet and dry methods.
- Apply Abrasive Wheels Regulations 1970 as per the schedule.

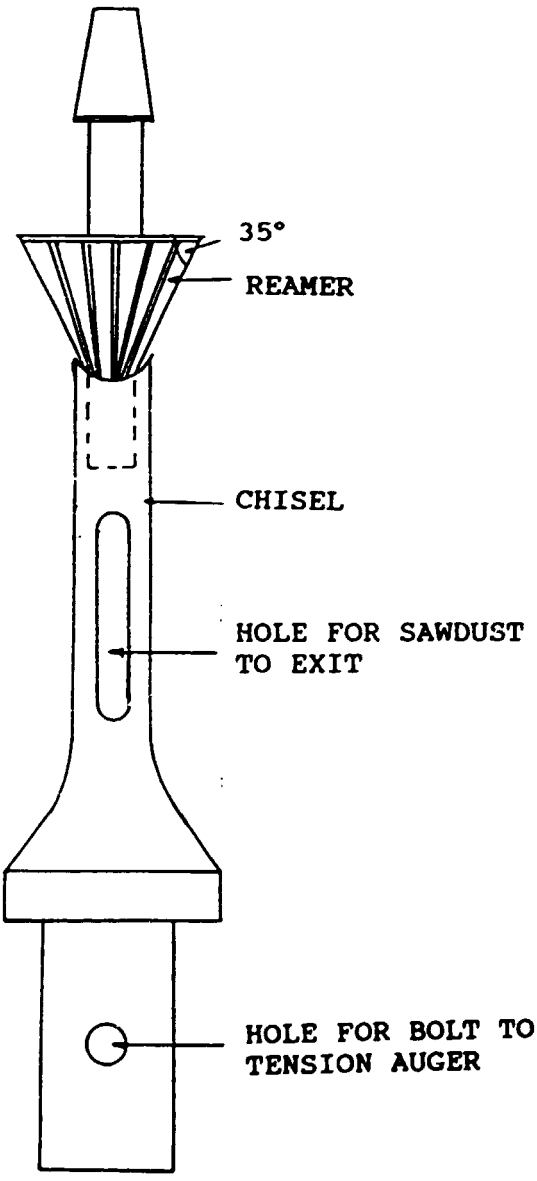
JOB KNOWLEDGE
- Outline the Abrasive Wheels Regulations 1970
- State suitable wheels for grinding tungsten-carbide tool tips, HSS cutters and carbon steel tools.

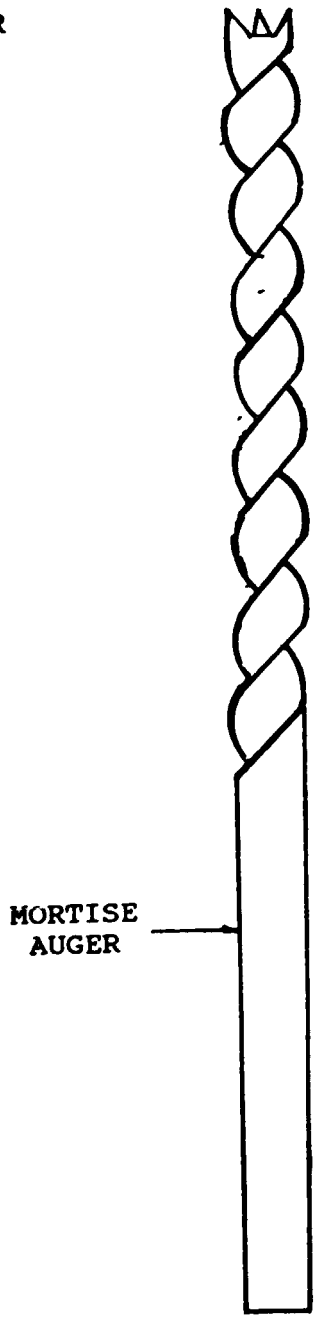
STANDARDS
1. Apply the Abrasive Wheels Regulations 1970 schedule correctly.

ANNEX 6

TOOL ROOM WORK: MORTISE MACHINE
MORTISE CHISEL REAMER

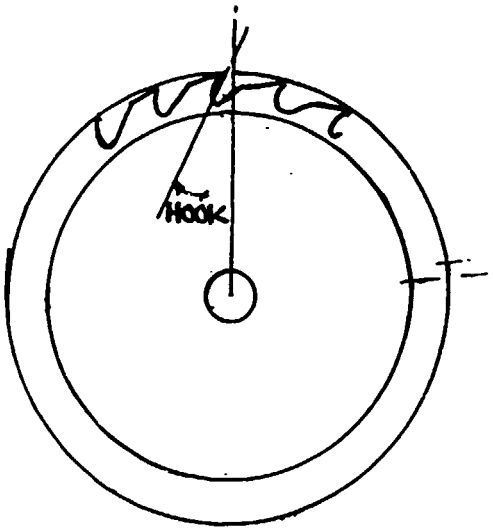




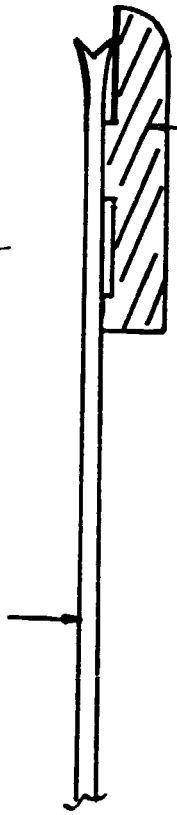


MORTISE
CHISEL AUGER

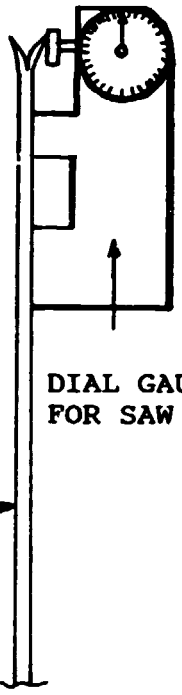
TOOL ROOM WORK:
SPRING SET AND TCT SAWS



THE ANGLE
OF HOOK



HAND MADE SAW
SET GAUGE 1/8th STEEL



DIAL GAUGE
FOR SAW SETTING

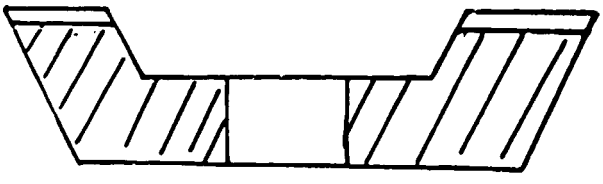
SAW BODY →

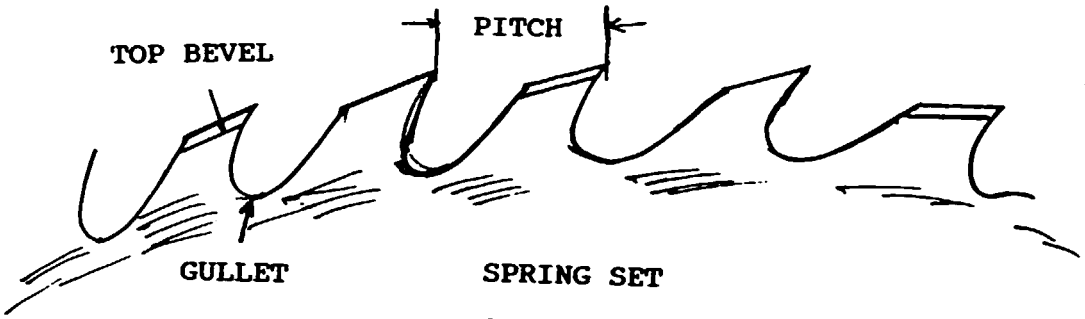
FILES FOR TOPPING

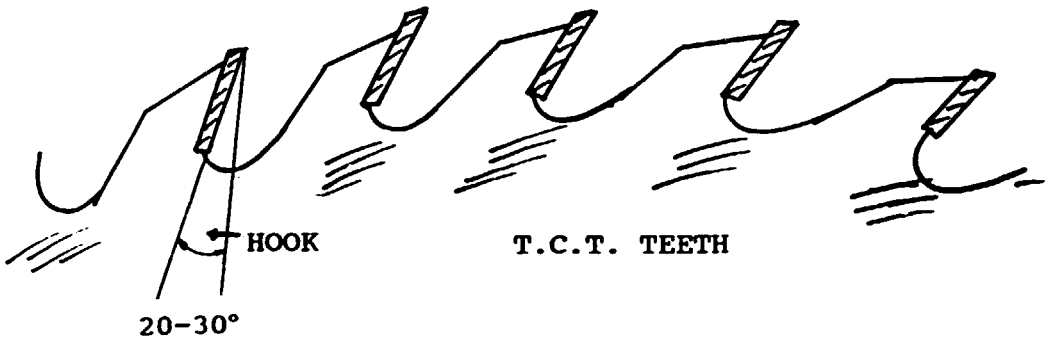
1. 10inches mill saw flat file
   10inches second cut flat file

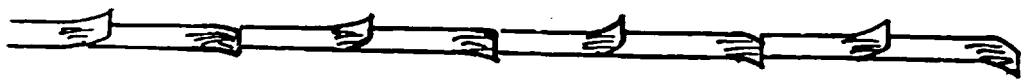
2. Stones for gulleting silver steel
   Bauxite 8inches x 3/8inches medium

3. <u>For grinding TCT</u>
   <u>Abrasiflex Diamond Cup shape</u>









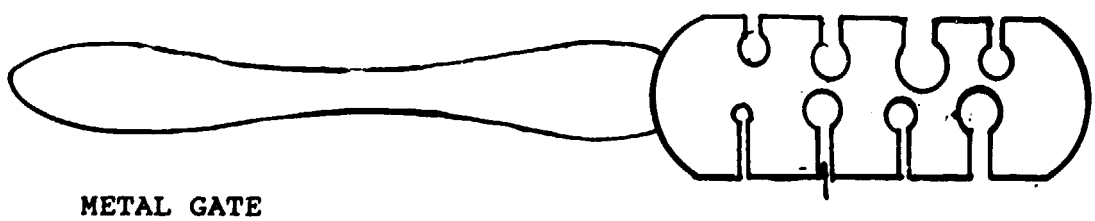
SPRING SET (PLAN VIEW)

TCT TEETH

NOTE:

(a) Spring set teeth are bent left and right alternatively to obtain clearance to the body of the saw.

(b) With TCT teeth the hardened tooth is wider than the body thereby obtaining clearance.

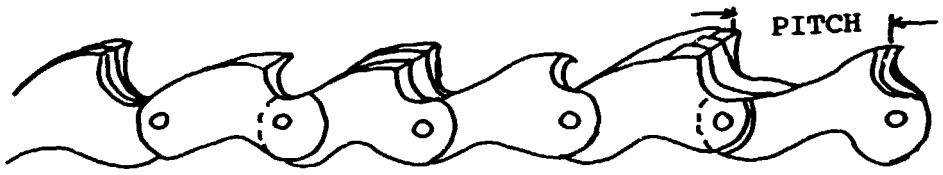


METAL GATE SAW SET

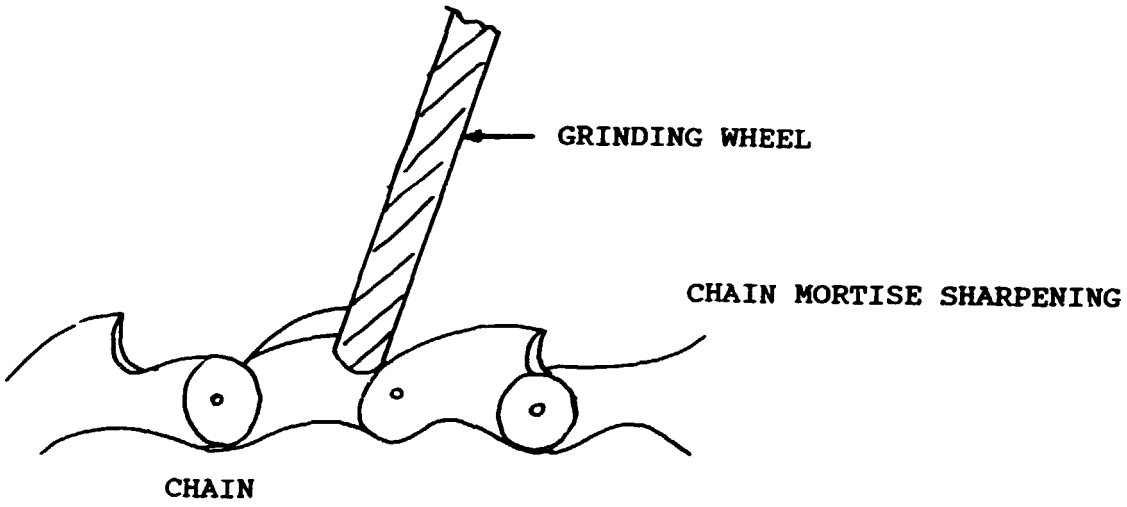
SAW GAUGES BWG*

* BWG Birmingham wire gauge

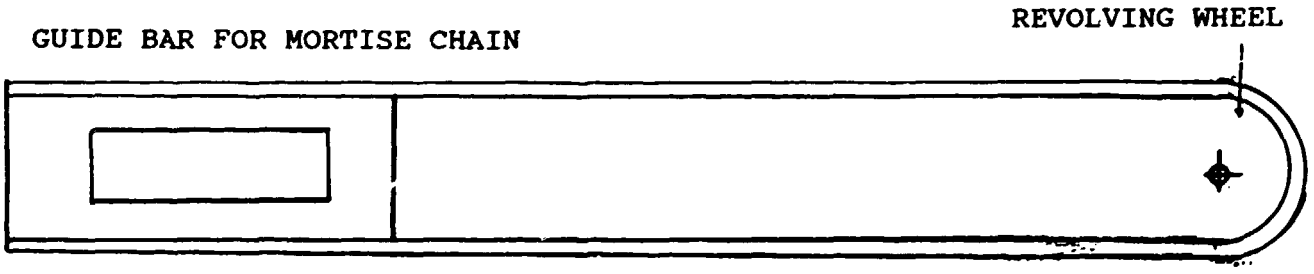
TOOL ROOM WORK:
CHAIN MORTISER



NOTE: The chain links vary from 3 to 5 links wide depending on the size of the mortise required.



NOTE: Normally, the chains are sharpened on a special grinding attachment fitted to the chain mortise machine.

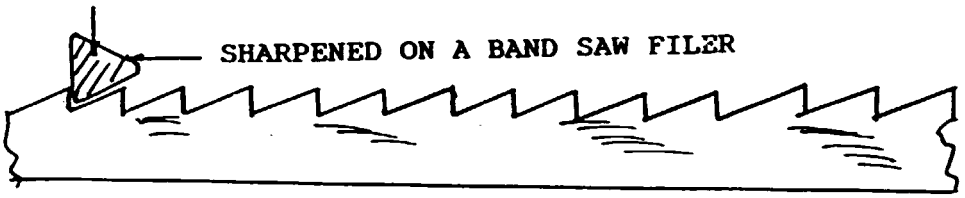


NOTE: This guide bar will vary in both width and thickness according to the size and length of the mortise.

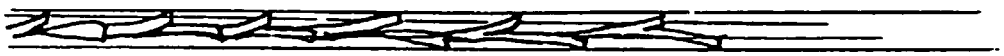
Chains should be stored in an oil bath.

TOOL ROOM WORK:
NARROW BAND SAW

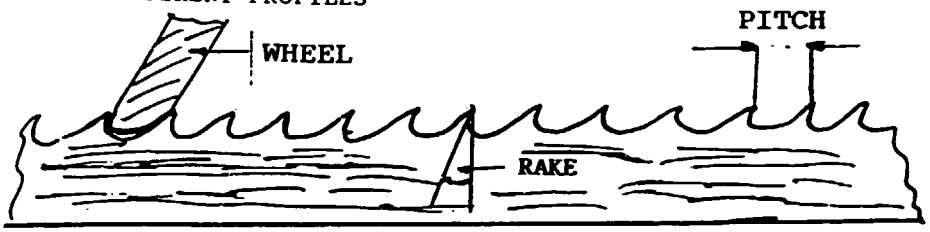
FILE



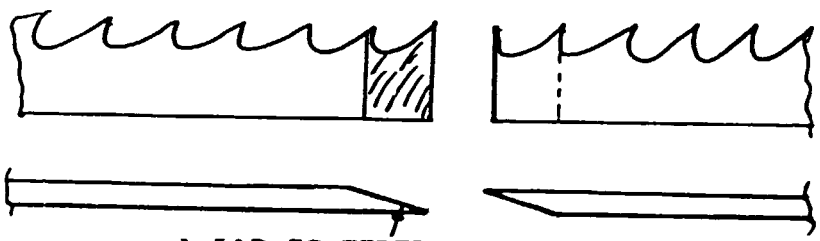
ALL NARROW BAND SAWS HAVE SPRING SET TEETH LEFT AND RIGHT ALTERNATIVELY.



SHARPENED WITH GRINDING WHEELS HAVING DIFFERENT PROFILES

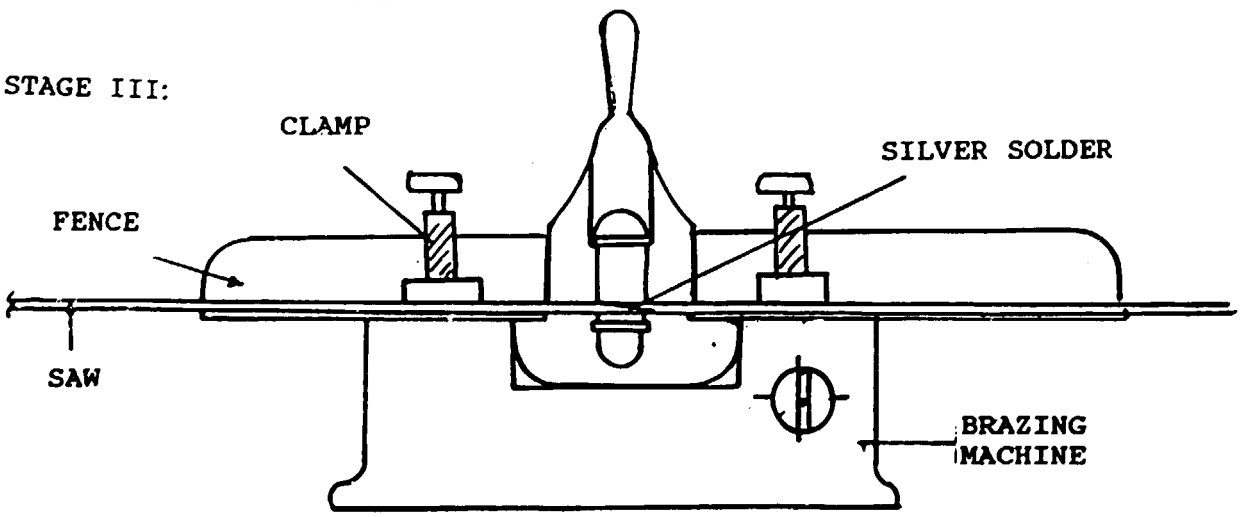


STAGE I: BRAZING



STAGE II: THE SAW CRAMPED IN THE BANDSAW BRAZING MACHINE, A PIECE OF SILVER SOLDER IS PLACED BETWEEN LAPS AND SOLDER FLUX.

STAGE III:



STAGE IV:

NOTE: WHEN THE BANDSAW IS CLAMPED TO THE BRAZING MACHINE, THE SILVER SOLDER IS PLACED IN THE LAP. ENSURE THERE IS AN OVERHANG OF SOLDER BEYOND THE SPAN OF THE LAP.

SAW SILVER SOLDER

STAGE V:

THE SAW IS HEATED ON NO. 1, WHEN IT TURNS BLUE, SWITCH TO NO. 2. AS THE SOLDER MELTS, SWITCH OFF AND CLAMP SAW AT THE SAME TIME. THE SAW AFTER COOLING WILL BE HARD, BECAUSE OF THE HEATING AND WILL BREAK EASILY ON REMOVAL.

IMPORTANT NOTE:

THEREFORE THE SAW MUST BE REHEATED AFTER COOLING TO A DULL BLUE, THIS PUTS "TEMPER" BACK IN THE SAW AND MAKES IT PLIABLE.

STAGE VI:

THE LAP CAN BE FILED AFTER BRAZING TO OBTAIN A FLAT SURFACE TO THE SAW, ALSO THE BACK EDGE OF THE SAW MUST BE LEVEL.

BANDSAW WELDING

THE BAND SAW WELDING PROCESS IS A MUCH SIMPLER PROCESS:

(A) THE ENDS OF THE BAND SAW ARE SQUARED OFF ON THE GUILLOTINE.

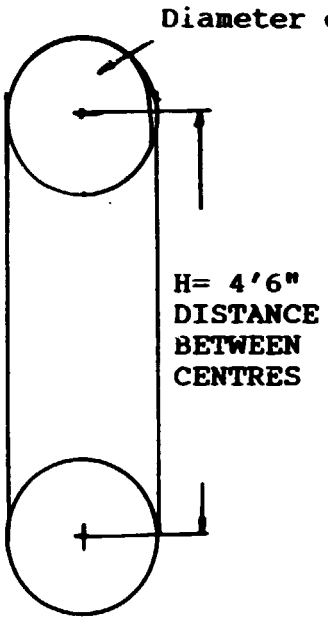
(B) THESE ENDS ARE CLAMPED INTO THE WELDER SLIGHTLY APART.

(C) WHEN THE WELDER IS SWITCHED ON AND HEATING OCCURS AND THE GAP CLOSES AND WELDS.

(D) SOMETIMES IT WILL BE NECESSARY TO GRIND THE LAP AS THE WELD OFTEN HARDENS.

CALCULATION FOR LENGTH OF BAND SAWS

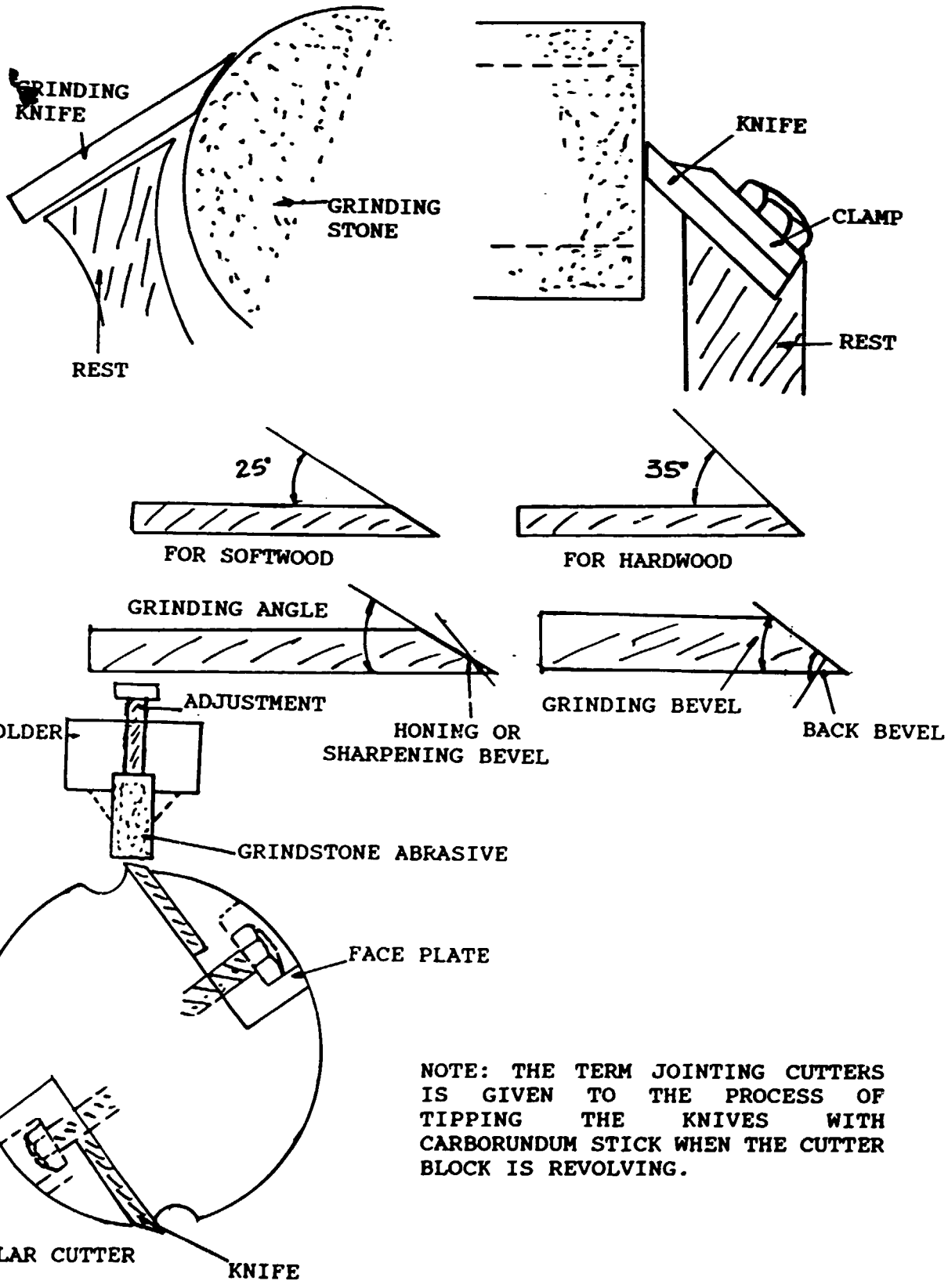
NOTE: DIFFERENT MAKES OF BAND SAWS NEED DIFFERENT LENGTHS DUE TO WEIGHT AND DIAMETER OF WHEELS. THE FORMULA FOR OBTAINING THIS LENGTH IS AS FOLLOWS:



FORMULA:
CIRCUMFERENCE OF ONE WHEEL
+
TWICE DISTANCE BETWEEN CENTRE

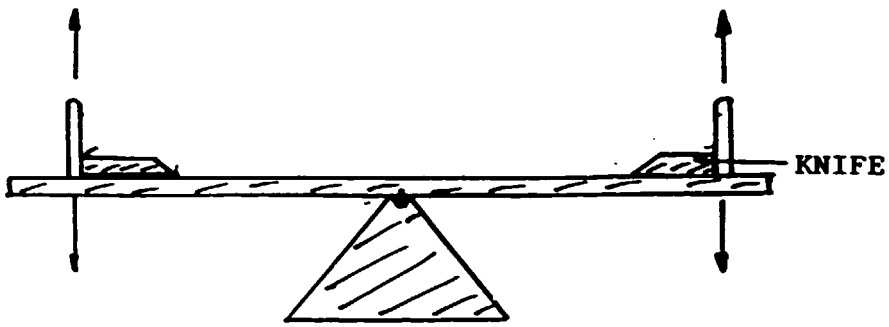
EXAMPLE: π X D + 2H
3.14 X 30" + 2 X 4' 6"
7' 10.5" + 9'
LENGTH= 16' 10.5"

TOOL ROOM WORK:
STRAIGHT KNIFE GRINDER



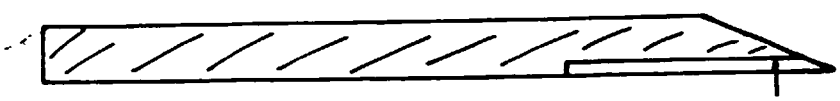
NOTE: THE TERM JOINTING CUTTERS IS GIVEN TO THE PROCESS OF TIPPING THE KNIVES WITH CARBORUNDUM STICK WHEN THE CUTTER BLOCK IS REVOLVING.

BALANCING



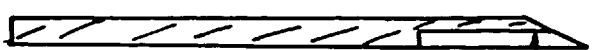
NOTE: THE OBJECTIVE IN ENSURING THAT CUTTERS ARE EVENLY BALANCED AFTER GRINDING IS TO STOP AN UNEQUAL WEIGHT IN A ROTATING CUTTER BLOCK. UNEQUAL WEIGHT WILL CAUSE WEAR ON BEARINGS AND COULD ALSO SET UP VIBRATIONS.

THE FORCE IN A ROTATING CUTTER BLOCK IS CALLED *CENTRIFUGAL FORCE*.



9mm - MILD STEEL

HIGH SPEED STEEL INSERT

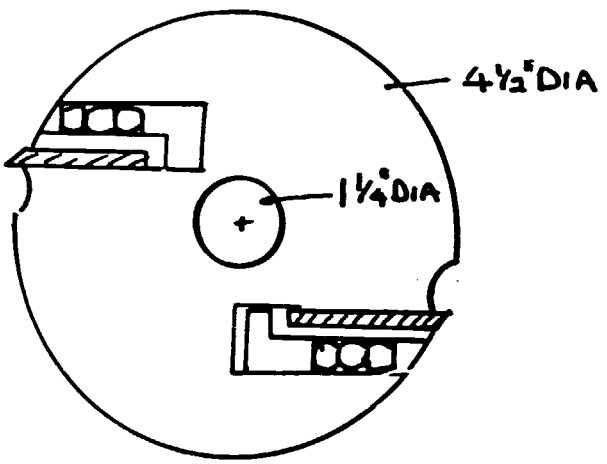


3mm - SILVER STEEL

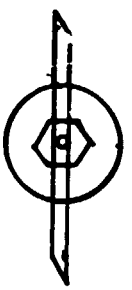
CARBON STEEL INSERT

TOOL ROOM WORK:
MOULDING CUTTERS

CUTTER BLOCKS



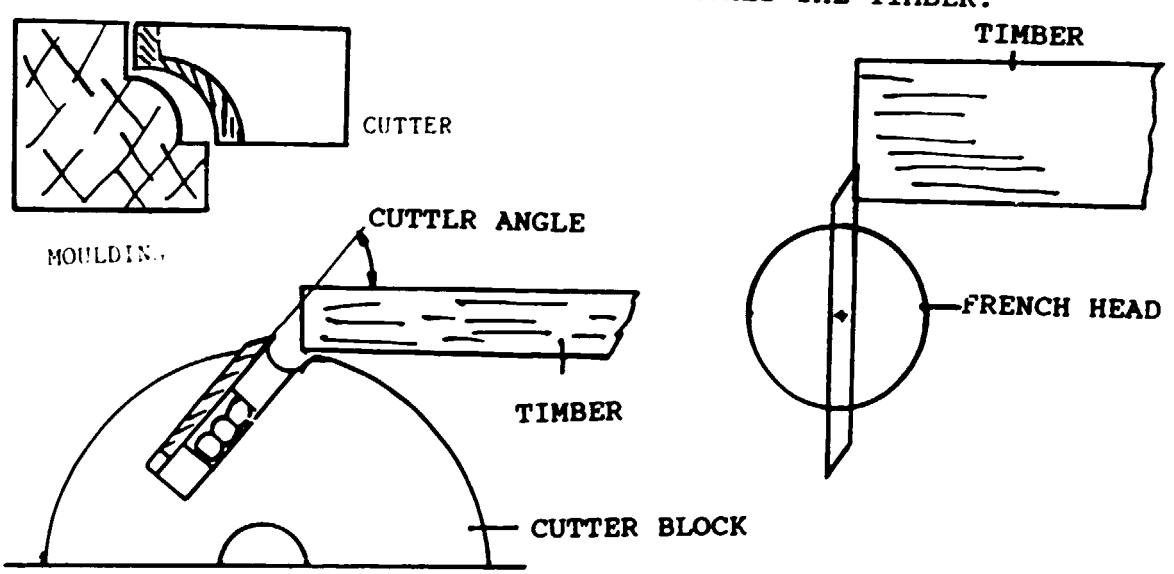
CIRCULAR WHITE HILL
TYPE CUTTERBLOCK



FRENCH HEAD
CUTTER BLOCK

PROFILE GRINDING OF CUTTERS FOR CIRCULAR CUTTER BLOCK

NOTE: TO PRODUCE THE MOULDING AS SHOWN. THE CUTTER HAS TO BE GROUND TO THE SHAPE AS SHOWN. THIS IS BECAUSE OF THE ANGLE AT WHICH IT APPROACHES THE TIMBER.

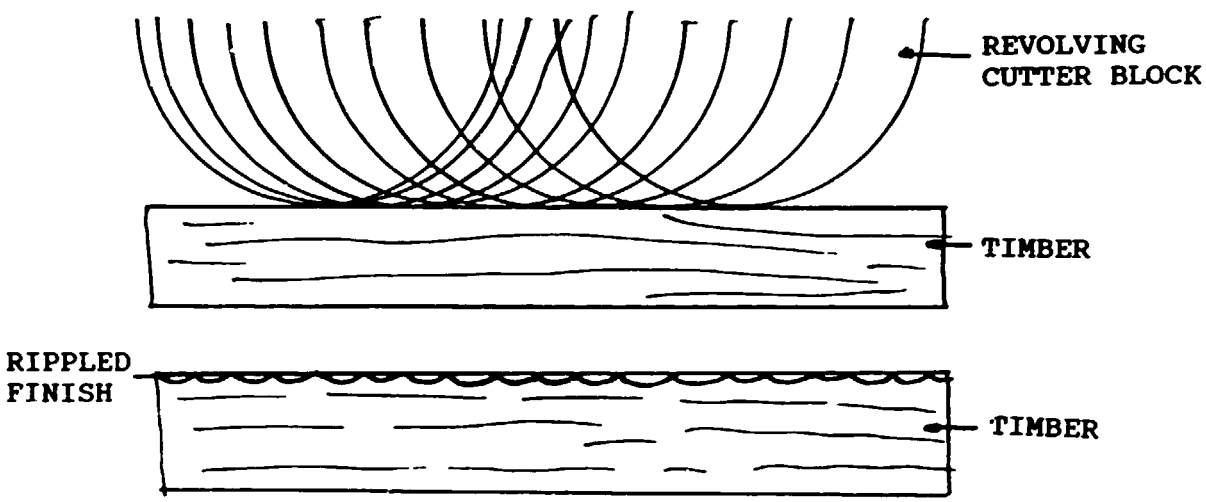


NOTE: OWING TO THE APPROACH ANGLE BEING 90° TO THE TIMBER, THE CUTTER REPRODUCES ITS EXACT SHAPE ON THE FRENCH HEAD.

TOOL ROOM WORK:
MOULDING CUTTERS

FINISHES: ALL ROTARY CUTTER BLOCKS PRODUCE A RIPPLED OR RIDGING FINISH. SOMETIMES IT IS MORE PRONOUNCED ON SOME MACHINES THAN ON OTHERS.

THIS IS DUE TO:
1. NUMBER OF KNIVES.
2. RPM OF CUTTER BLOCK.
3. FEED SPEED.



ACCEPTABLE FINISH STANDARDS

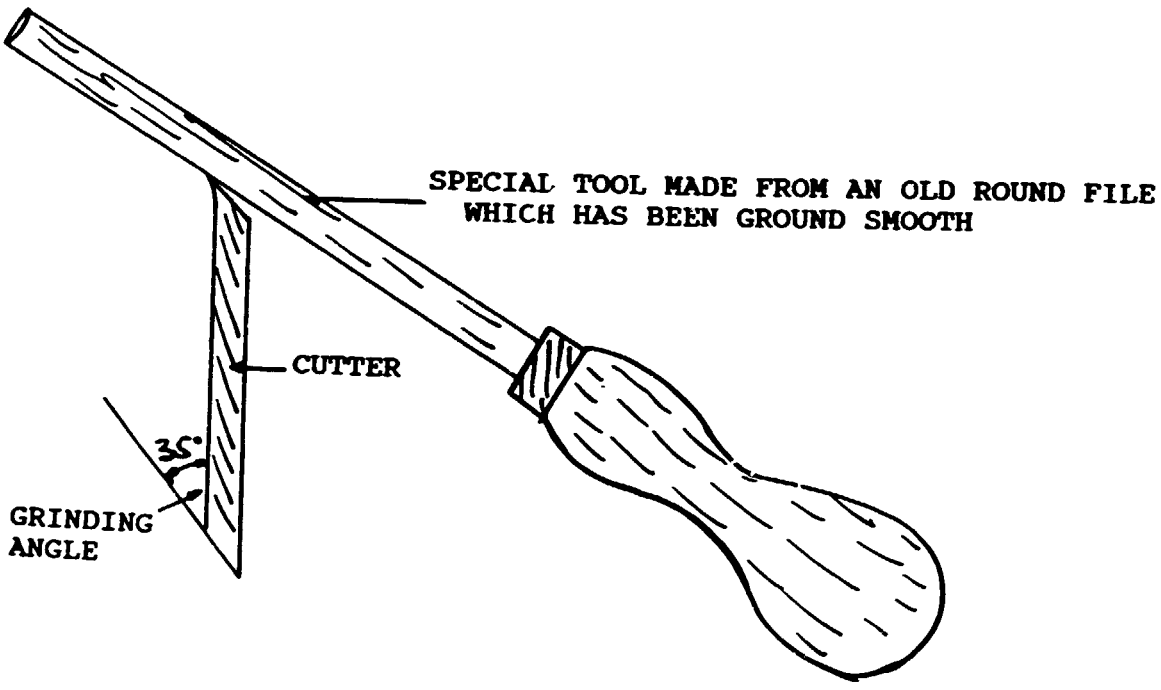
EXTERNAL JOINERY = 8-10 CMPI
INTERNAL JOINERY = 12-14 CMPI
FURNITURE = 18-24 CMPI

FORMULA: $\frac{\text{RPM OF CUTTER BLOCK}}{\text{FEED SPEED}} \times \frac{\text{NO. OF KNIVES}}{\text{INCHES IN A FOOT}}$

$$\frac{4500}{50} \times \frac{2}{12} = \frac{60}{4} = 15 \text{ CMPI}$$

15 CMPI IS A SATISFACTORY FINISH, WE CANNOT THEREFORE INCREASE THE FEED SPEED.

GRINDING AND SHARPENING FRENCH HEAD CUTTERS

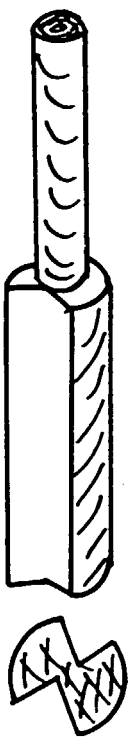


THE FRENCH HEAD ON THE SPINDLE MOULDER DOES NOT HAVE A CUTTER ANGLE BUT APPROACHES TIMBER AT RIGHT ANGLE. THIS IN EFFECT GIVES A SCRAPING ACTION. RATHER MOST CUTTER BLOCKS WHICH PRODUCE A CUTTING ACTION, THEREFORE IN ORDER TO PRODUCE A CUTTING ANGLE WE BURR OVER THE CUTTING EDGE AS SHOWN TO OBTAIN A CUTTING ANGLE.

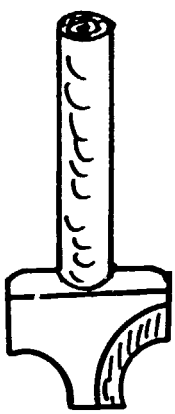
TOOL ROOM WORK:
HIGH SPEED ROUTER CUTTERS

ROUTER CUTTERS: MAIN TYPES

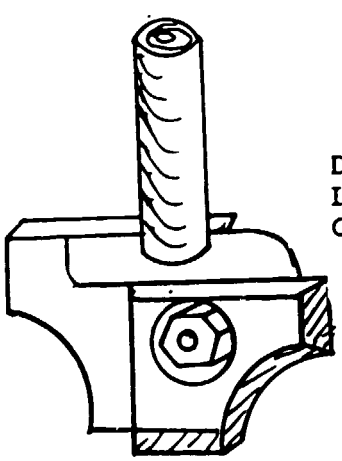
SPOON BITS



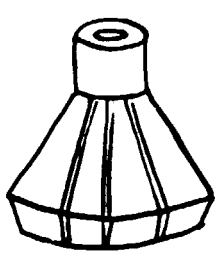
DOUBLE EDGE
PANEL CUTTER



MOULDING
CUTTER



DOUBLE EDGE
LOOSE MOULDING
CUTTERS



COLLET FOR
ROUTER CUTTERS

NOTE: MOULDING CUTTER CAN BE FIXED TO THIS CUTTER HEAD TO PRODUCE ANY SHAPE.

TOOL ROOM WORK:
AERASIVE WHEEL REGULATIONS

SAFETY:

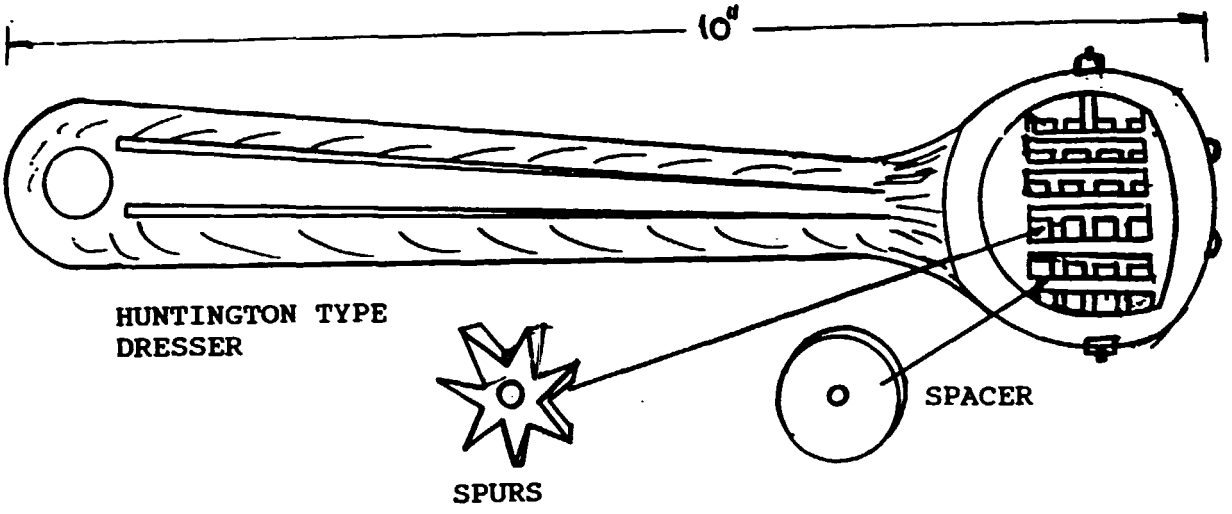
(1) ALL GRINDING WHEELS SHOULD BE FITTED WITH A PERSPEX OR PLASTIC VISOR AND GUARD WITH THE EXCEPTION OF THOSE WHICH ARE PROTECTED WITH MACHINE MOUNTINGS IN ADDITION TO GLASS VISORS. OPERATORS MUST WEAR AT ALL TIMES SOME FORM OF PROTECTION FOR THEIR EYES AND IF NECESSARY FOR THEIR HANDS.

(2) ALL GRINDING WHEELS BEFORE FITTING SHOULD BE TESTED FOR CRACKS, BY LIGHTLY TAPPING THE STONE WITH A PIECE OF WOOD/METAL.

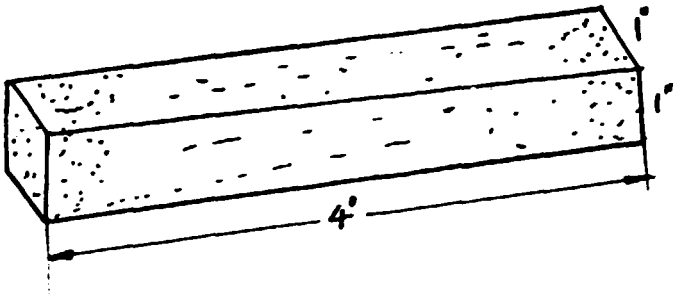
(3) BEFORE MOUNTING A STONE ON BENCH GRINDERS THE STONE SHOULD BE CHECKED TO SEE IF THE RPM WRITTEN ON THE STONE IS EQUAL OR LESS THAN THE MACHINE SPEED, I.E. STONES WHICH ARE RUN AT HIGHER SPEED THAN THAT SPECIFIED BY MANUFACTURERS CAN DISINTEGRATE.

(4) ENSURE THAT WHEN MOUNTING NEW WHEELS A MARK IS MADE ON ONE FACE OF THE WHEEL SO THAT IF THE STONE IS TAKEN OFF AND REMOUNTED THE FACE IS ALWAYS FITTED THE SAME WAY.

(5) WHEN FITTING A NEW GRINDING WHEEL, IT SHOULD BE DRESSED TO SHAPE AND TO ENSURE ITS CONCENTRICITY. TWO TYPES OF DRESSERS ARE NORMALLY USED, THE HUNTINGTON TYPE AND THE CARBORUNDUM DRESSING STICK.



NOTE: THESE SPURS AND SPACERS CAN BE REPLACED WHEN THEY BECOME WORN.



CARBORUNDUM GRINDING STICK FOR CLEANING AND SHAPING GRINDSTONES.

NOTE: THESE DRESSERS ARE FOR STANDARD GRINDING WHEELS AND NOT FOR DIAMOND STONES.

(6) ALL GRINDING WHEELS SHOULD BE DRESSED OCCASIONALLY TO CLEAN THE WHEELS OF STEEL PARTICLES WHICH CAN BE EMBEDDED IN THE WHEEL FROM CONSTANT GRINDING.

IF THIS IS NOT DONE REGULARLY, THE STEEL WILL OVERHEAT AND TURN BLUE AND SOFTEN, OR THE WHEEL, WHEN CLOGGED, IS LIABLE TO DISINTEGRATE UNDER PRESSURE.

ANNEX 7

SELECTION AND ORDERING GRINDING WHEELS.

Which wheel do I need?

Before this question can be answered it is necessary to know the following details. (Numbers 1 to 4 are constant factors and 5 to 8 variable factors).

1. Materials to be ground.
2. Amount of stock to be removed, accuracy and finish required.
3. Area of contact.
4. Type of grinding machine.
5. Wheel speed.
6. Work speed.
7. Condition of grinding machine.
8. Skill of workman.

1. The following factors are controlled by material to be ground.
   A. Abrasives.
   i) Aluminium Oxide for materials having high tensile strength, i.e. saws, cutters etc.
   ii) Silicon Carbide for materials having low tensile strength, i.e. cemented carbides.

   B. Grain size fine for hard and brittle materials, coarse for soft ductile materials.

   C. Grade hard for soft materials, i.e. cast steel saws, French head cutters, soft for hard materials, i.e. HSS cutters, profile cutters etc.

   D. Structure close grain spacing for hard and brittle materials, wide grain spacing for soft ductile materials.

2. Amount of stock removed controls the following factors.
   Note: Accuracy and finish required controls the amount of stock removed at each pass.

   A. Grain size usually coarse grain for fast cutting, fine grain for fine finish although if the wheel is properly dressed it is possible to produce a fine finish with a course wheel.

   B. Structure wide spacing for rapid stock removal, close spacing for fine finish.

3. Area of contact.

A. Grain size fine for small area, coarse for large area.

B. Grade small areas of contact require a hard wheel. In most changes in specification made to compensate for area of contact are made by grade variations.

C. Structure close for small contact area, wide for large contact area.

4. Type of grinding machine.

Grade softer wheels can be used on the heavy, rigidly constructed machines.

5. Wheel Speed.

A. Grade the higher the wheel speed in relation to work speed the softer the wheel should be.

B. **Bond up to 1976 surface metres per minute (s.m.p.m.) Vitrified, Rubber, Shellac, or Resinoid for speeds over 1976 s.m.p.m.**

6. Work Speed.
Grade high work speeds with relation to wheel speed requires a harder wheel.

7. Condition of Grinding Machine.
Grade Machines in poor condition or on insecure foundations require harder wheels than would be used on well maintained machines.

8. Skill of the Workman.
This factor depends on the type of work being done and refers mainly to free hand grinding.

Making changes in wheels used.
The foregoing may seem rather confusing at first but when considered the practical application will be apparent When selection of a wheel is considered the starting point is either from the wheel at present in use or from study of the constant and variable factors.

If the grinding wheel is not giving satisfactory results, consideration of the factors will usually highlight the cause of the trouble and either a change of wheel type or condition of work or machine should produce the desired effect. It is important when making a change in wheel specification to only change one characteristic at a time.

Diamond Wheel Marking System.
This is in many ways similar to the standardised system used for grinding wheel, the main difference being:

1). In place of optional marking for structure the concentration of diamond (expressed on a definite weight of diamond per cubic inch of abrasive volume) is used. The method of showing this concentration varies from manufacturer to manufacturer. Norton define 25% by volume of diamond 100 while Carborundum use 8.

2). An extra marking for depth of diamond section; here again manufacturers differ with their marking. Norton use 1/16, 1/8, 1/4, while Carborundum use a number system which indicates the depth of sixty-fourths of an inch, i.e. 1 = 1/64"(0.397mm) 4 = 4/64" or 1/16"(1.588mm) and 16 = 1/4"(6.35mm).

3). An optional marking to indicate a variation from standard bond. This symbol is placed between the bond and depth of diamond symbols.

The markings used on similar diamond wheels from Norton and Carborundum are compared below:

1. Norton D.240-L50B 1/16
2. Carborundum D.240-L4-B4

Key
D = Diamond
240 = Grit size
L = Grade(J.L.N.P. used by Norton: L.M.N.O.P by Carborunum).

these markings cannot be compared with those used for other bonded wheels.

Diamond wheel grades are considerably harder;
50 or 4 = Medium concentrate
B = Resinoid Bond
1/16 = depth of diamond section.

Useful Notes

1. Grit Size this can be from as large as 24 to as fine as 800, however these extremes are not used in the maintenance of woodworking tools, common size being 100 for roughing and 200 or 240 for final lapping.

2. Concentration this controls the amount of stock removed and also the price, the higher concentrations use more diamond for a given wheel size. It has been found by experience that medium concentration is the most suitable for woodworking tools

3. Bond resinoid bond gives long life with good freedom of cut and can be used dry or with a minimum of coolant. Finer finishes can be obtained than those possible with other bonds due mainly to the cushioning effect of the diamond grit by the resinoid bond.

4. Depth of diamond section this also has a bearing on price and life of the wheel although price is not proportionate to depth, i.e. a 1/8th (3.175mm) depth of diamond will not cost twice a 1/16" depth (1.588mm) therefore some saving can be gained by the purchase of the greater amount of diamond, however until the tool room staff are fully conversant with diamond wheels this saving may be completely lost through not taking the precaution of ensuring that the tool will clear the face of the wheel on the first pass.

HOW TO ORDER

When ordering Abrasiflex superabrasive wheels it is important to provide as much information as possible so the correct wheel can be specified for the job — a prerequisite for getting the best performance.

To assist in this regard you can use the order form below. Just photocopy from this page.

Abrasiflex Superabrasive Order Form

Please quote on/supply the following:

- Number of wheels required .....
- Wheel Shape .....
- Dimensions .....
  - — Diameter .....
  - — Thickness .....
  - — Superabrasive section .....
  - — Bore size .....
  - — Other dimensions as appropriate to key letters on diagrams
- Specifications (complete if known)
  - — Superabrasive type .....
  - — Superabrasive concentration .....
  - — Bond type .....
  - — Grit size .....
  - — Wheel core material .....
  - — Bond hardness .....
  - — Other .....

- Operating Conditions
  - — Machine type(s) .....
  - — Machine condition(s) .....
  - — Wet or dry grinding .....
  - — Finish required .....
  - — Stock removal rate(s) .....
  - — Machine speed(s) .....
  - — Material(s) and shape(s) to be ground
  - — Other .....

To be delivered by .....

Delivery address

.....

.....

.....

Company .....

Contact Name .....

Phone .....

Order number .....

Do you require

- Technical advice before ordering

Yes	No

- Our technical staff to assist you in the use of superabrasives (e.g. machine set-up, training)

Yes	No

Please let us know at any time if you do need advice — we are only a phone call away.

STANDARD WHEEL TYPES

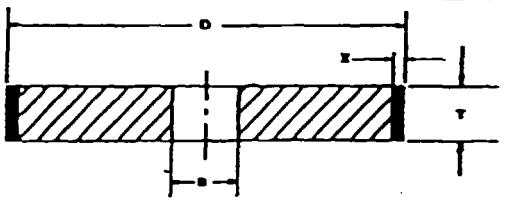
The key parameters to be specified are listed below:

D = Wheel diameter
T = Wheel thickness
X = Depth of Superabrasive segment
H = Bore size
E = Depth of preform base
W = Width of Superabrasive segment
J = Diameter of wheel base

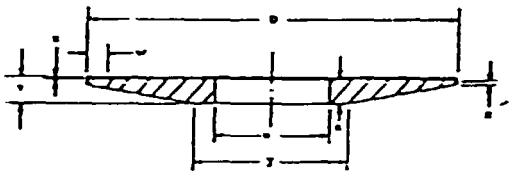
Superabrasive concentration (50, 75, 100)

For some shapes further parameters are required.

1a1



4A2



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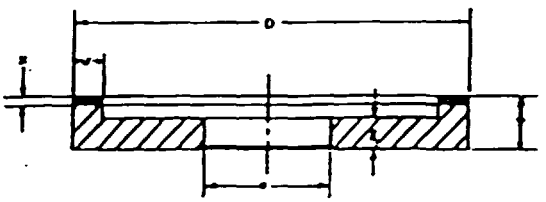

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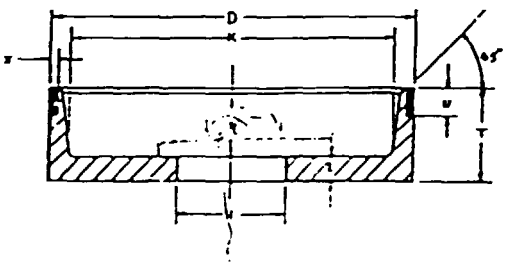

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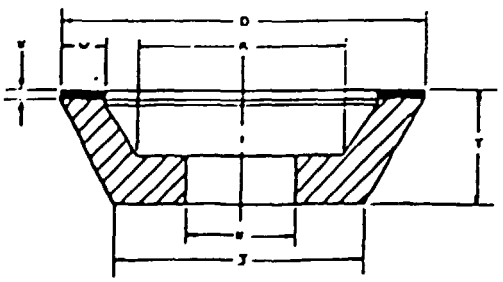
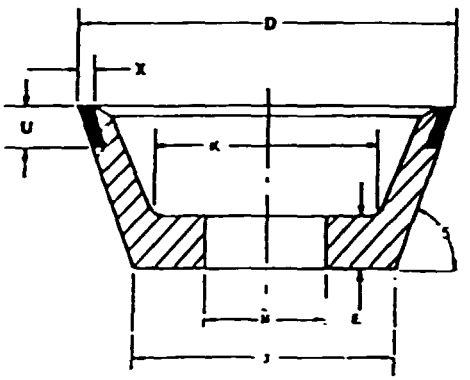
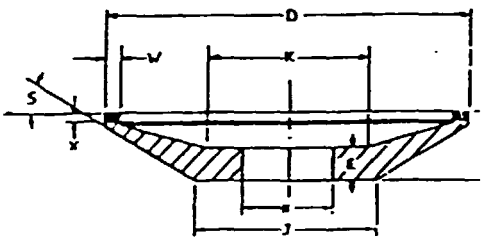


K = internal base diameter

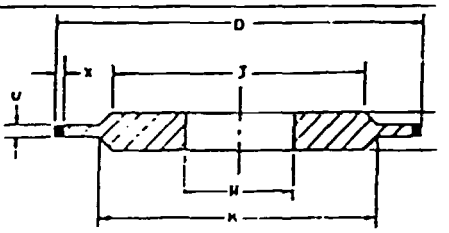
11V9



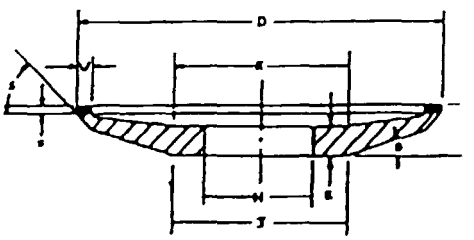
12A2



14A1



15A2



OTHER SHAPES AVAILABLE FOR SPECIAL REQUIREMENTS FROM OUR OWN AND OVERSEAS SOURCES

ANNEX 8

Hints on the care and maintenance of "speartipt" tungsten carbide tipped saws[1]

1. Tungsten carbide tipped saw blades are valuable precision tools, and must be cared for accordingly. They must be in perfect working order to perform their task efficiently and to give the best finish.

2. Always store the blade when not in use in its original pack. Every "Speartipt" tungsten carbide tipped saw up to 18inches diameter inclusive is supplied in a new pack made from high density polythene. This pack is lightweight yet extremely strong and tough, with "rib" supports and a ridged centre portion secured with a nut and bolt. It is designed to protect the blade during transit for servicing etc., and to prevent damage and rust when the blade is not in use.

Never place the tips directly on hard surfaces such as the saw bench top, saw doctor's anvil or on concrete as they may become fractured or chipped.

3. Keep the blade clean. Resin and other foreign matter sticking to the saw will cause over-heating which results in blistering and cracking.

4. Use a suitable solvent to dissolve resin and then wipe the blade clean. Never scrape clean with a hard instrument such as a file, as this will scratch the blade and create greater adhesion problems.

5. It is uneconomical to use tungsten carbide tipped blades when the saw is dull. This causes fracture and loss of tips.

6. To ensure maximum performance from "Speartipt" saws the following points must be observed:

(a) To avoid play the machine spindle must fit the bore exactly. "Speartipt" blades have a centre hole tolerance of:
+0.002 to Nil up to 1,24 inch diameter.
+0.003 inches to Nil over 1.25 inches diameter.

(b) The saw collars must be true and clean. The maximum "out of true" allowed on saw collars is 0.001 to 4 inches diameter, 0.0015 inches over 4 inches diameter.

(c) The machine bearings should be free from defects and vibration. Vibration causes rapid blade wear and gives uneven cuts. Maximum "out of true" on spindle 0.002.

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[1] Source: Spear & Jackson Limited
Aetna Works - Savile Street - Sheffield S4 7UR Telephone 20202 (STD Code 0742)

(d) The machine should be of rigid construction and free from vibration.

(e) The material being cut should be clamped or held firmly in position during sawing.

(f) The workpiece should be fed into the machine evenly and care must be taken to ensure that the fence is parallel to the saw. Feeding at an angle can cause over-heating.

Grinding the "Speartipt" blade

Do not wait until the blade becomes excessively dull before regrinding. The correct time to resharpen is when the flat wear is about 0.008 inches (see Fig. 4). Check wear by means of a tool room microscope or an X10 hand lens. Always regrind the carbide tips with a diamond impregnated grinding wheel. It is necessary to grind both face and top, starting with the face (see Fig. 5). But remember that the grinding allowance on the top of the tip is bigger than on the face.

FIG.4

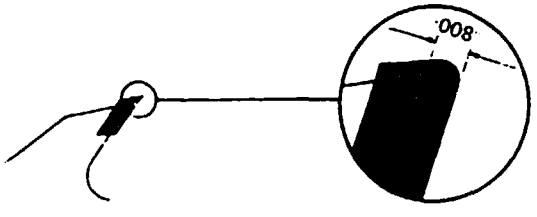
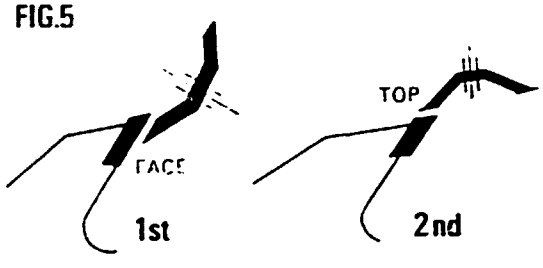


FIG.5



It has been proved in practice that a much keener edge can be obtained by a secondary grinding operation called polishing. This keener edge is given to new "Speartipt" blades to provide longer life and greater production between sharpening.

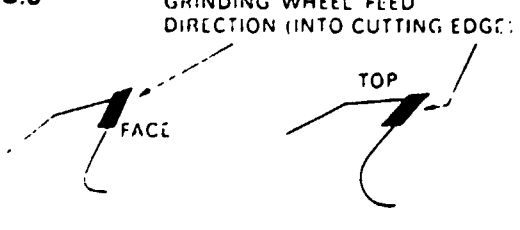
This polished finish, known as "mirror finish", is achieved by the same method as for normal grinding, but using a finer 400 to 600 grit lapping wheel. It is recommended to first polish the face, then the top. For the top, set the clearance angle to 2° as it is not absolutely necessary to polish all the top area.

Recommended grits

Green grit: 60 grit.
General grinding or lapping: 220 grit.
Polish grinding: 400 to 600 grit.

The wheel should be fed into the cutting edge and not away from it (see Fig. 6). This also applies when lapping tungsten carbide tipped cutters.

FIG.6



Use of coolants

Grinding

A continuous flow of coolant is recommended, but if this is not obtainable dry grinding should be carried out very carefully, taking the lightest possible cuts, to avoid any local heating.

N.B. Intermittent coolant flow tends to cause greater local heat at the tip.

Lapping

When using Resinoid Bonded Diamond Wheels it is recommended to use a "spray" coolant or a soaked felt pad applied to the face of the wheel. This will keep the face free and prevent glazing, and helps to hold down rising carbide dust. A continuous flow of coolant can also be used with this type of Diamond Wheel.
It is very important that the diamond Wheel should not be allowed to touch the steel backing of the saw, otherwise the wheel will quickly become loaded and create excessive heat, causing the carbide tips to crack.

'SPEARTIPT'
TUNGSTEN CARBIDE TIPPED SAWS

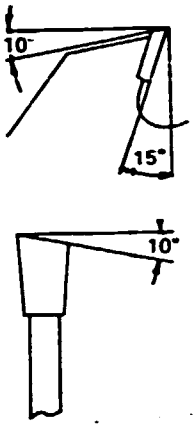
SPEARTIPT TYPE 100 RC/N

RIPPING SAW

For cutting softwoods and hardwoods including waney edged boards. Also suitable for cutting hardboard, plaster-board and chipboard where finish is not of prime importance.

GOOD FINISH

Feed rate: 25 to 100 f.p.m.
Peripheral Speed: 10,000 to 12,000 f.p.m.



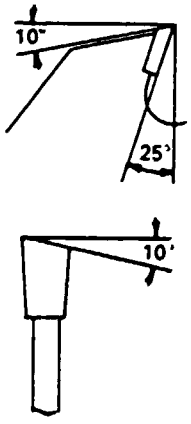
Code	Diameter		Kerf width		Plate thickness		No. of	Pitch	
	in.	mm	in.	mm	in.	mm	teeth	in.	mm
06-002									
0125	6	150	0.094	2.4	0.062	1.5	16	1.25	30
0130	8	205	0.098	2.5	0.065	1.625	20	1.25	30
0135	10	255	0.110	2.8	0.073	1.828	24	1.25	30
0140	12	305	0.118	3	0.080	2.032	30	1.25	30
0145	14	355	0.126	3.2	0.085	2.1	36	1.25	30
0150	16	405	0.138	3.5	0.092	2.336	40	1.25	30
0155	18	455	0.150	3.8	0.100	2.5	44	1.25	30
0160	20	510	0.157	4	0.100	2.5	48	1.25	30
0165	22	560	0.165	4.2	0.109	2.7	52	1.25	30
0170	24	610	0.169	4.3	0.109	2.7	60	1.25	30

SPEARTIPT TYPE 100 RC/T

RIPPING SAW

Suitable for ripping hard and semi-hard woods, preferably knot-free, and for cutting acoustic board and soft plastics where light resistance is met.

GOOD FINISH
Feed rate: 25 to 100 f.p.m.
Peripheral Speed: 12,000 f.p.m.

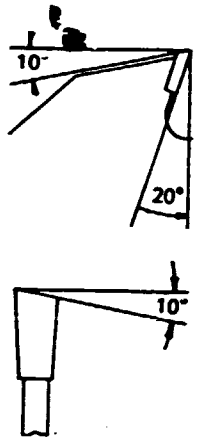


Code	Diameter		Kerf width		Plate thickness		No. of	Pitch	
	in.	mm	in.	mm	in.	mm	teeth	in.	mm
6-002									
0080	6	150	0.079	2	0.056	1.442	16	1.25	30
0085	8	205	0.083	2.1	0.056	1.442	20	1.25	30
0090	10	255	0.087	2.2	0.056	1.442	24	1.25	30
0095	12	305	0.091	2.3	0.062	1.5	30	1.25	30
0100	14	355	0.098	2.5	0.065	1.625	36	1.25	30
0105	16	405	0.106	2.7	0.073	1.828	40	1.25	30
0110	18	455	0.114	2.9	0.080	2.032	44	1.25	30
0115	20	510	0.118	3	0.080	2.032	48	1.25	30

SPEARTIPT TYPE 100 R/A

RIPPING SAW
For general ripping of softwoods and hardwoods, green or seasoned timber. Specially designed for power-fed machined, eg. circular re-saws.

GOOD FINISH:
Feed rate: 25 to 150 + f.p.m.
Peripheral Speed: 10,000 to 12,000 r.p.m.



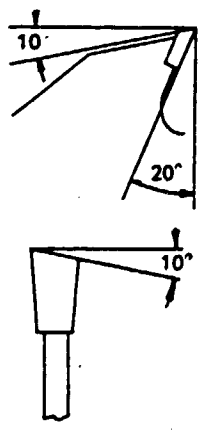
Code	Diameter		Kerf width		Plate thickness		No. of	Pitch	
	in.	mm	in.	mm.	in.	mm	teeth	in.	mm
06-002									
0060	26	660	0.157	4	0.100	2.5	42	2	50
0065	30	760	0.165	4.2	0.109	2.7	48	2	50
0070	36	915	0.177	4.5	0.120	3	54	2	50

NB. The above saws are also obtainable at 25° hook angle.

SPEARTIPT TYPE 100 R/B

RIPPING SAW
For general ripping of softwoods and hardwoods, green or seasoned timber. For use in hand-fed or power-fed machines. For faster feed speeds 25 hook should be used.

GOOD FINISH
Feed rate: 25 to 100 f.p.m.
Peripheral Speed: 12,000 f.p.m.



Code	Diameter		Kerf width		Plate thickness		No. of	Pitch	
	in.	mm	in.	mm	in.	mm	teeth	in.	mm
06-002									
0005	6	150	0.087	2.2	0.056	1.442	12	1.5	37
0010	8	205	0.091	2.3	0.062	1.5	16	1.5	37
0015	10	255	0.098	2.5	0.065	1.625	20	1.5	37
0020	12	305	0.106	2.7	0.073	1.828	24	1.5	37
0025	14	355	0.110	2.8	0.073	1.828	28	1.5	37
0030	16	405	0.118	3	0.080	2.032	32	1.5	37
0035	18	455	0.130	3.3	0.085	2.1	36	1.5	37
0040	20	510	0.138	3.5	0.085	2.1	40	1.5	37
0045	22	560	0.150	3.8	0.092	2.336	44	1.5	37
0050	24	610	0.157	4	0.100	2.5	48	1.5	37
0055	26	660	0.157	4	0.100	2.5	54	1.5	37

ANNEX 9

Tungsten Carbide Tipped Saws and Knives.

Being next in hardness to diamond, Tungsten Carbide can only be ground by using wheels manufactured or impregnated with this material.

The grinding of Tungsten Carbide is a long and tedious job requiring a high degree of skill and above all patience. Care is needed in mounting the wheels and in the case of diamond wheels they must be checked for concentricity and truth before final tightening of the nut. Allowance for small corrections of eccentricity are made by making the centre hole slightly oversize.

The truth of the periphery should be checked by means of a dial gauge and any necessary correction made by lightly tapping the wheel at the high point with a light hammer cushioned with a small piece of timber. Accuracy of 0.015 mm is satisfactory.

Cup type wheels are produced, with their face absolutley parallel to the back and therefore providing the machine back plate is accurate the faces should run true. If the face is found to be out of truth, correction should be made by truing the back plate and not the wheel face. Any heavy dressing of the face will greatly reduce the working life of the wheel (the average thickness of diamond facing being only 1.58 mm). If it is necessary to remove the diamond wheel frequently it is recommended that it be mounted onto a self centering collet.

Where practicable a coolant should be used when grinding or lapping with a diamond wheel. A flood of coolant is not essential however, it is necessary to ensure that the wheel is kept wet. A practical method is the fitting of a small tank above the wheel and applying the coolant by means of a wick held in light contact with the face of the wheel by a spring. Another method is the supply of coolant in the form of an oil mist spray applied to the wheel face through a 1.5 mm diameter hole. This oil mist needs to be of a greater velocity than the peripheral speed of the grinding wheel. The coolant used being 25% lubricating oil to 75% paraffin. With the latter method a good exhaust system is required to remove the vapour. Other suitable coolants are light lubricating oils or most proprietary brands of coolant providing they are not excessively alkaline. Where a number of small tools are to be ground and it is felt that the above devices would not be used extensively some success may be achieved by means of intermittent dabs with a small paint brush, loaded with coolant. It is however essential to keep the wheel damp and no lubrication (and reduced stock removal) is better than intermittent lubrication which could lead to overheating of the tips.

On no account should the tip be cooled by the application of coolant after overheating.

Speed of Diamond Wheels.

For optimum conditions a peripheral speed of between 1520 and 1824 surface metres per minute is recommended.

ANNEX 10

THE ABRASIVE WHEELS REGULATIONS - 1970

BASIC GRINDING INFORMATION

A grinding machine may be defined as any type of machine tool which utilises an abrasive grinding wheel as its cutting agent.

Grinding wheels are basically composed of a combination of abrasive grains and bonding material or "bond".

The abrasive grain does the cutting and the bond holds the abrasive grain in place. The measure of the strength of the bonding material to hold the abrasive grains and its measure of resistance to grinding stresses is known as "grade".

All grinding wheels are porous to some degree and this porous quality, known as structure, is built into the wheel and carefully controlled. The structure is necessary to provide chip clearance during cutting.

The two main types of abrasives are:-

(a) Silicon Carbide.
(b) Aluminium Oxide.

Both are manufactured abrasives, products of the electric furnace.

Silicon Carbide

This was the first manufactured abrasive, it is the result of the chemical interaction of Silica and Carbon at very high temperatures in an electric furnace, 2400°C approximately, this abrasive is hard and is used on low tensile and non-ferrous materials.

Aluminium Oxide

Aluminium oxide is made in electric arc type furnaces by the fusion of Bauxite. Bauxite which is the purest form of aluminium oxide, is mixed with ground coke and iron borings. The mixture is then fed into a circular arc type furnace. Electrodes are inserted vertically into the charge and a temperature of approximately 2000°C is reached after about 36 hours. This results after solidification in an abrasive tougher than silicon carbide, aluminium oxide is used for grinding metals of high tensile strength.

Grit Size

The abrasive is crushed, processed and screened until it reaches grain form. The abrasive particles are sifted through screens of various known sizes, e.g. 24 grit size is 1/24",grit sizes range from 6 (very coarse) to 800 (very fine).

Grade

The grade of a grinding wheel is considered to be the measure of the strength with which the bond hold the abrasive grits in place within the wheel. Its a measure of the bond post and abrasive grain particles to the grinding stresses which tend to wear away the wheel.

Grade (Cont)

The amount of bond is increased then the bond post linking the particles together is enlarged. The measure of grade strength is indicated by the wheel grade symbols which range from 'A' Soft, through 'L' Medium to 'Z' Hard.

The selection of the correct wheel grade is critical and is determined by the requirement of the operation.

Structure

The structure can be manufactured either dense or open in varying degrees of density or openness.

The structure provides the chip clearance, it prevents the chips from clogging or "loading" the wheel face and thus creating a dull cutting surface which reduces the cutting efficiency of the grinding wheel.

The structures range from 2, which is very dense to 25, which is extremely open.

Bond

There are four types of bonds:

(a) Vitrified, (b) Resinoid, (c) Rubber, (d) Shellac.

(a) Vitrified abrasive wheels, which are made in either glass type or porcelain type bonds are the most widely used. They are made by mixing the abrasive grains with the ceramic materials such as flint, feldspar or clay, moulded into shape and fired in a kiln at 1270°C for about 7 days to vitrify the bond.

This type of bonded wheels are used for most metal grinding and finishing operations, general purpose grinding.

(b) Resinoid abrasive wheels have a high degree of toughness and are for high speed operations in fettling and cutting off.

(c) Rubber bonds are used in the production of very thin slitting wheels. They have a very cool cutting-off operations where it is essential.

(d) Shellac bonded wheels, are, in the main used for slitting operations and where high surface finishes are required.

Truing, dressing, loading, glazing

Truing is necessary when a wheel wears out or becomes "out of true" it needs to be made concentric with its spindle again.

If the wheel requires dressing due to the wheel face being loaded or glazed. The wheel face must be changed with the aid of a star type dresser or abrasive stick.

Loading: This is when small metal chips become embedded in the face of the wheel, this causes the cutting rate of the grains to be decreased, a condition referred to as a loaded wheel. This condition may be caused by using a wheel unsuitable for the material being ground.

Glazing: This is when the abrasive grains have become dull and are worn down to the bond holding them in the wheel face. The wheel face has a shiny or glazed appearance and ceases to cut efficiently, rubbing the work rather than cutting. This condition may be caused by using a wheel too hard or too fine grit size, or by unsatisfactory truing or dressing.

Order of marking	0	1	2	3	4	5	6
	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

British Standard system for marking abrasive wheels (BS 4481 : Part 1 : 1969)

SUMMARY OF MOUNTING PRECAUTIONS

1. Wheel mounting should be carried out only by competent and appointed persons.

2. A wheel should be mounted only on the machine for which it was intended. Before mounting, all wheels should be closely inspected to ensure that they have not been damaged in storage or transit.

3. The speed marked on the machine should not exceed the speed marked on the wheel, washer or tag.

4. The bush, if any, should not project beyond the sides of the wheel.

5. The wheel should fit freely but not loosely on the spindle.

6. Flanges should be not less than one-third the diameter of the wheel, and their bearing surfaces should be true and free from burrs.

7. With the exception of the single flange used with threaded-hole wheels, all flanges should be properly recessed or undercut.

8. Flanges should be of equal diameter and have equal bearing surfaces.

9. Protection flanges, should have the same degree of taper as the wheel.

10. Paper washers, slightly larger than the flanges, should be used with all bonded abrasive wheels, except tapered wheels, threaded-hole wheels, discs, cylinder wheels and on the hub section of depressed-centre wheels. Wrinkles in washers should be avoided.

11. Wheels, washers and flanges should be free from foreign matter.

12. Clamping nuts should be tightened only sufficiently to hold the wheel firmly. When the flanges are clamped by a series of screws they should be tightened uniformly in pattern formation (diametrical sequence).

13. Screws for inserted nut mounting of discs, cylinder and cones should be long enough to engage a sufficient length of thread, but not so long that they contact the abrasive.

14. When mounting mounted wheels and points, the overhang appropriate to the speed, diameter of mandrel and size of wheel should not be exceeded, and there should be sufficient length of mandrel in the collet or chuck.

15. Guards should be properly secured and adjusted and work rests set as close as possible to the wheel. New wheels should be run free for a short period before they are used; everyone should stand clear.

SUMMARY OF OPERATING PRECAUTIONS

Given an abrasive wheel of good manufacture, mounted on a well-designed machine, safe operation depends largely on proper maintenance and on the treatment to which the wheel is subjected when in use. The following are among the main operating precautions to consider, some of which are discussed in greater detail elsewhere in this publication.

Training of operators: Operators should be properly trained in the safe use of grinding machines.

Floors: The floor immediately surrounding fixed grinding machines should be maintained in good condition, and free from obstruction. Splash guards should be used when appropriate to prevent the floor from becoming slippery.

Mounting: Mounting of abrasive wheels should only be done by competent and trained persons appointed by management for this task.

Speeds: The maximum operating speed marked on the wheel should under no circumstances be exceeded.

Guarding: The wheel guard should always be in position and properly adjusted before a wheel is run.

Work rests: Work rests should be kept adjusted as close as possible to the wheel. Lack of compensation for wheel wear is the chief reason for bad work rest adjustment; all work rests should therefore be inspected and adjusted at frequent intervals.

Side grinding: Grinding on the sides of straight-sided wheels is dangerous, particularly when they are appreciably worn or when sudden pressure is applie

Truing and dressing: Wheels used for off-hand grinding should be frequently trued to eliminate out-of-balance conditions and to enable the work rest to b adjusted close to the wheel surface.

Lubrication: Spindles should not be allowed to become overheated because of lack of lubrication.

Starting new wheels: New wheels should be run free at normal operating speed for a short period; operators and others should stand clear during the trial run.

Stopping wheels: Wheels should not be brought to rest by applying pressure to the periphery or face.

Wet grinding: Prolonged immersion of a stationary wheel in coolant can throw the wheel out of balance when the machine is started. The coolant should be drained off and the wheel run free until it is dry.

Centreless grinding: Components in the tray should be carefully inspected before grinding, as an oversize piece may damage the wheel or may be projected back causing injury to the operator.

Cutting-off wheels: The correct wheel for the job, as recommended by the wheel maker, should be used. Cutting-off wheels should be inspected before mounting for possible warping or other defects. A warped wheel may cause excessive vibration at high speeds, side pressure, or heating and possible wheel breakage

Cutting-off wheels (Cont): Cutting-off wheels should be mounted only on machines designed for their use. Power should be adequate, otherwise stresses may build up and the wheel may stall and break. Pressure should be applied evenly. Care should be taken to avoid twisting or exerting pressure on the side of the wheel. The workpiece should be rigidly supported and firmly clamped. Lack of rigidity either in the wheel or the workpiece can lead to wheel breakage.

Cylinder wheels: Wire or tape bound cylinder wheels should be worn down to the first tape or group of wires before any are removed. Care should be taken not to damage the wheel when removing the binding.

Mounted wheels and points: The overhang should not exceed that appropriate to the speed, size of point and diameter of mandrel.

Eye protection: Eye protectors should be worn in all dry grinding operations or, alternatively, transparent screens should be fitted to the machine to intercept sparks and particles.

Loose clothing: Loose clothing, such as ties or coat sleeves are easily drawn in between the wheel and the workpiece. Rags and waste should not be used near a revolving wheel.

Supervision: Frequent checks should be made by management to ensure that the foregoing safety precautions are being observed.

ANNEX 11

BACKSTOPPING OFFICER'S COMMENTS

The consultant has carried out a successful assignment, and provided more assistance than originally foreseen by the project, since he was also asked by the UNDP office in Aden to provide assistance to the Carpentry Workshop in Aden.

The diagnostic of the tool maintenance facilities of both Cooperatives (in Mukalla and Saiyon) conform to those made by the CTA, and he furthermore identified the additional equipment needed, giving full technical specifications.

Training was provided to the staff of the Mukalla Cooperative.

The training material he has prepared is clear and to the point, bearing in mind the level of education of the trainees.