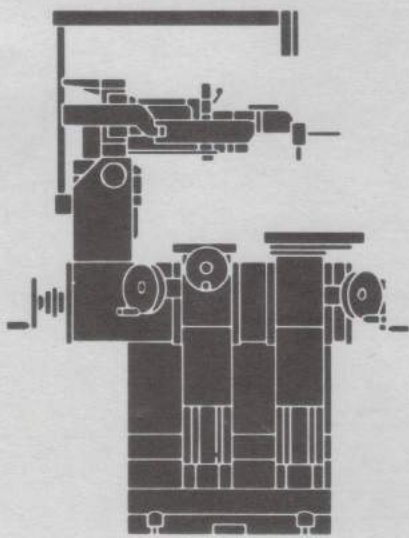


DECKEL



Operator's Manual

GK 12
GK 21

Universal
engraving and
profiling millers



This operator's manual has been issued
for GK 12/GK 21 machine No

Each machine is supplied with a spare parts catalogue to be
used as a reference for spare parts orders, complaints, etc.
Please always quote the machine serial number.

This manual contains important information on the proper
handling, operation and maintenance of the machine and
should always be at hand for the operating and servicing
personnel.

Make a point of reading the transport instructions carefully
before unpacking and transporting the machine to the place
of erection.

NOTE:

Nonmetric dimensions and weights, shown in parentheses in
this manual, are approximations.

TABLE OF CONTENTS

Transport, installation

Technical data

Lubrication, maintenance

Setting-up

Attachments

Workholding and
indexing fixtures

Practical hints

Accessories

Technical service

Identification number of this complete manual: E 417 (5.77)

Each of the sheets of this manual carries an identification number of its own on the front and back. These numbers are not consecutive page numbers.

Additional copies of individual sheets will be supplied on request if the sheet number(s), together with the model and serial number of the machine or accessory item, are specified in the order.

Please note that, due to possible engineering changes, the instructions in this manual may in some cases not be applicable to any subsequently delivered accessory items. Such items should always be handled and used as set forth in the publications specially supplied therefor.

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Transport

Whenever transporting your GK machine protect the fine-adjusted joint bearings by securing the pantograph (in a position parallel to the machine slides) by means of the spacer sleeve and adjuster screw on the pantograph main bearing, and by means of the locking bracket on the copyholder table. (Do not clamp shank of locking bracket in pantograph locating bore.)

Weight of machines:	GK12	GK21
in transport condition (as shown in illustration)	524 kg (1155 lb)	570 kg (1255 lb)
crated, depending on accessories	730 kg (1610 lb)	770 kg (1700 lb)

Transport equipment:

for uncrated machine	2 eyebolts 1 endless rope,	4 m (13 ft) long, 20 mm (7/8") dia
for crated machine	1 endless rope,	6 m (20 ft) long, 30 mm (1 1/4") dia

Sling rope around crane hook twice or secure by means of auxiliary rope.

Lower the machine carefully and avoid bumping on the floor.

Transport by crane

Clamp pantograph in position of duplicating ratio 1 : 1.5.
Rotate copyholder table top (eccentric) to the outside.
Fit two eyebolts to column.

Sling hemp (or, preferably, nylon) rope through the eyes of the eyebolts and around the crane hook as shown in the illustration. Swivel pantograph to a position where the rope exerts no pressure on the pantograph arms.

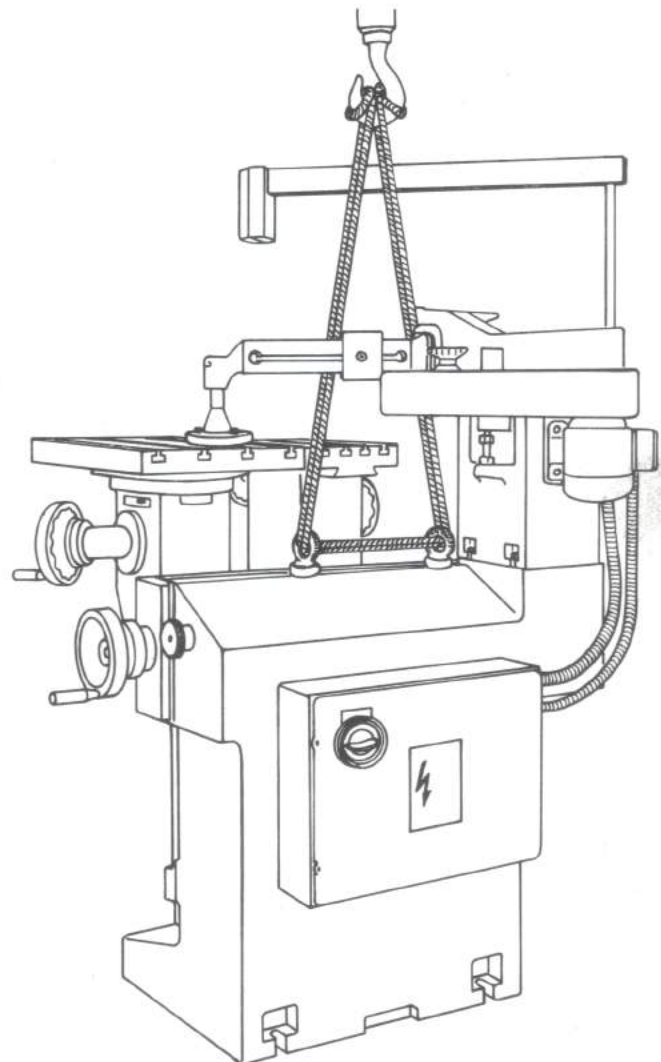
Transport on round bars

When using round bars or poles for transporting the machine to the place of installation, apply crowbars only to the recesses in the machine base and apply pushing force only to column but never to working parts such as pantograph, handwheels, levers or machine tables.

Pre-operation checks

Read this manual carefully.
Release clamps.

Remove transport eyebolts, closing the tapped holes by means of rubber plugs (standard accessory items).
Supply the machine with the prescribed lubricants in accordance with lubrication schedule and diagram.



Installing the machine

For foundation and dimension diagram see 'Technical data'. Level the machine by placing spirit level on worktable in a longitudinal and transverse direction. The machine will be in a level position when the pantograph, fixed by means of spacer sleeve 1 and adjuster screw 2 and set parallel to the table slides, remains stationary in any position without moving away by its own weight (Fig 1).

For details on placing the machine on the workshop floor, anchorage, etc, see attached special leaflet 'erection and installation of machines' (Publication 1011 E).

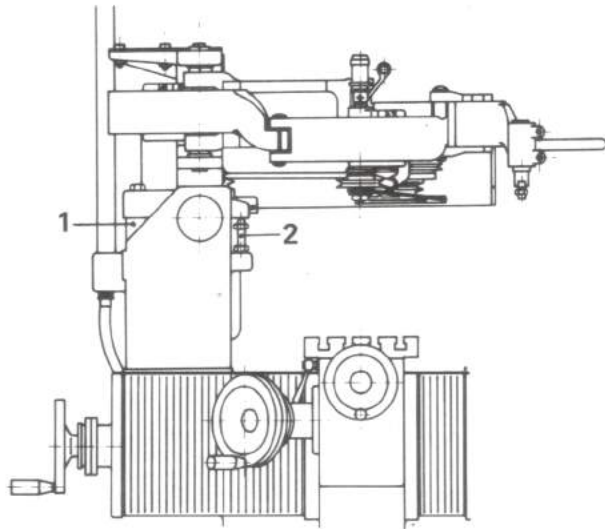


Fig 1

Electric connection

Connect the machine to power supply in accordance with the attached wiring diagram. The door of the switch cabinet cannot be opened unless the main isolating switch is in '0' position (Fig 2).

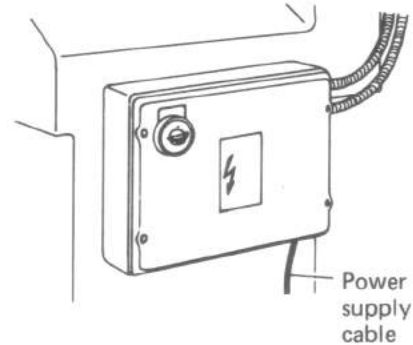


Fig 2

Mounting and connecting the machine lamp

Insert a wire from the switch cabinet through protective hose 3 (screw off if necessary), tubular support 4 and rectangular tube 5 to pull cable of articulated lamp through these parts and connect cable in accordance with wiring diagram. Rubber plate 10 can be removed to facilitate this operation. Attach lamp connecting member 6 by means of screws 7.

Use push buttons 8 and 9 for switching lamp on and off. To switch on, press button for about 2 seconds. Exchange fluorescent tubes (preferably both together) when they start flickering after approx 4000 hours. Lamp sockets will be accessible upon removal of screen 11 (Fig 3).

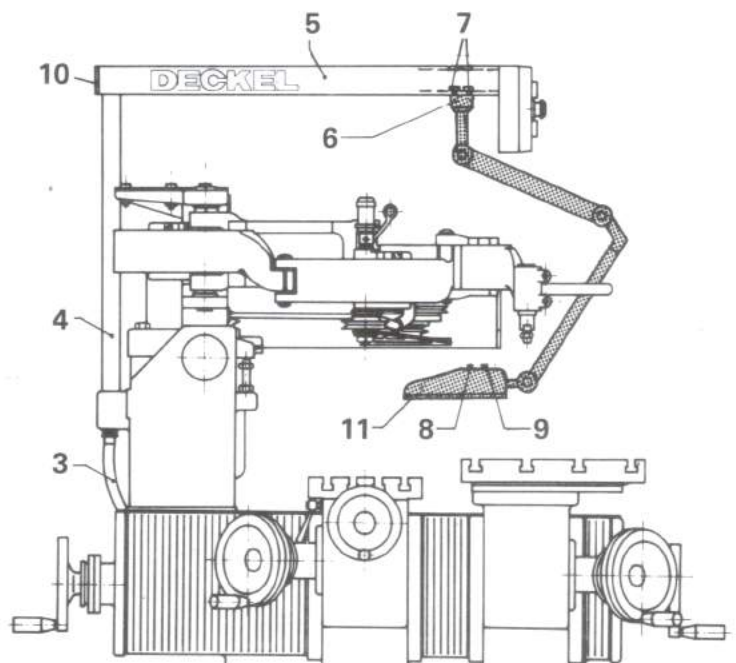
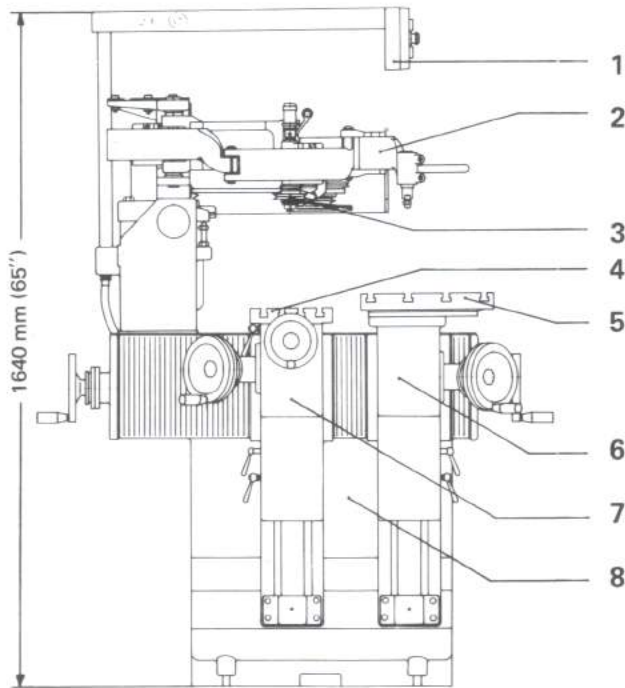


Fig 3

Main assemblies and controls

- | | |
|------------------|----------------------|
| 1 Control panel | 5 Copyholder table |
| 2 Pantograph | 6 Copyholder bracket |
| 3 Cutter spindle | 7 Worktable bracket |
| 4 Worktable | 8 Machine column |



Technical data

Drive motor

	GK12	GK21
Power	0.25 kW (0.35 hp)	0.37/0.55 kW (0.5/0.75 hp)
Standard speed (GK21: pole-changing)	2800 rpm	1400/2800 rpm

Cutter spindle

	GK12	GK21
Collet capacity	6 mm (1/4")	10 mm (3/8")
Spindle vertical adjustment		
coarse	3 mm (1/8")	6 mm (1/4")
fine	1 mm (0.04")	6 mm (1/4")
Spindle speeds	1600 ... 20000 rpm	475 ... 20000 rpm

Pantograph

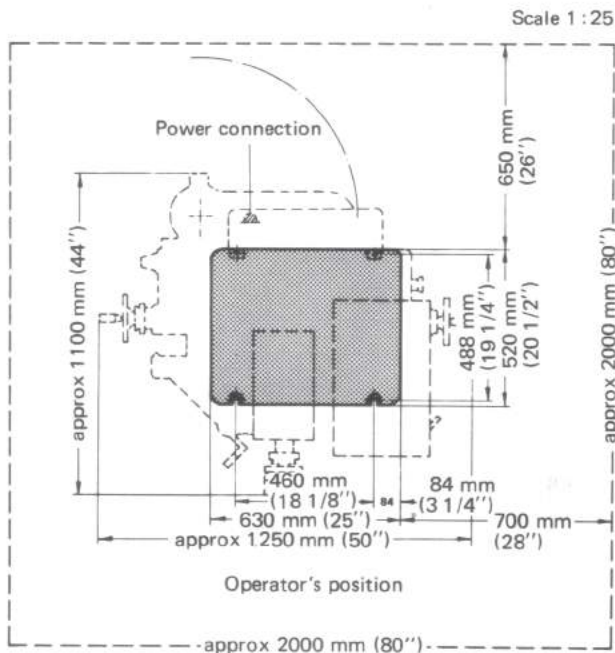
Duplicating ratios	min 1:10 max 1:1.5
adjustable by linear scales	

Worktable

Clamping area	200 × 360 mm (7 7/8" × 14 1/8")
4 T-slots, width 12 mm (15/32"), distance 45 mm (1 3/4")	
Ranges of traverse,	
longitudinal	160 mm (6 1/4")
transverse	300 mm (11 3/4")
vertical	365 mm (14 3/8")
Max distance, spindle nose from table surface	375 mm (14 3/4") 390 mm (15 3/8")
Vertical clearance between spindle and top of column	275 mm (10 3/4") 290 mm (11 3/8")

Foundation diagram

with space requirements and power connection



Copyholder table

Clamping area	300 × 520 mm (12 1/2" × 20 1/2")
4 T-slots, width 12 mm (15/32"), distance 90 mm (3 1/2")	
Ranges of traverse,	
transverse	150 mm (5 7/8")
vertical	225 mm (8 7/8")
Table swivel range (eccentric)	360°
Max distance, tracer head from table surface	290 mm (11 3/8")

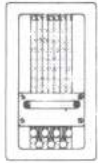
Weights

Basic machine with electrical equipment	524 kg (1155 lb)	570 kg (1255 lb)
Max weight of work, approx	250 kg (550 lb)	

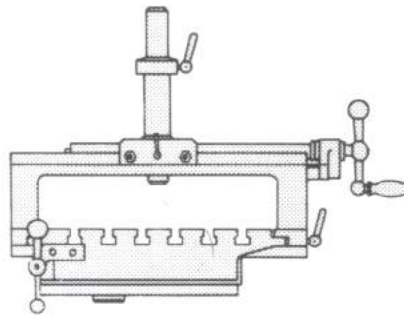
**Space requirements,
including operator**

2000 × 2000 mm (80" × 80")

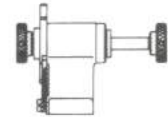
Attachments at a glance



Serial numbering holder
4017



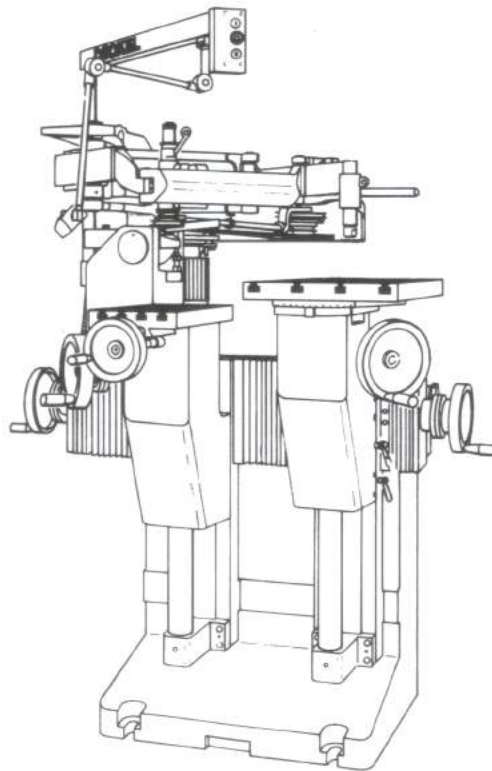
Rough milling attachment
4611



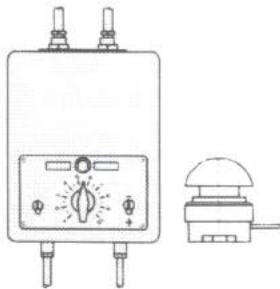
Numbering
wheel engraving device
4014



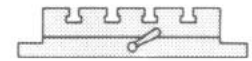
Universal copy dial
4512



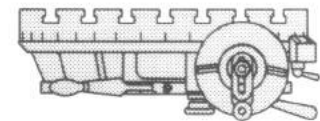
Index head
6018



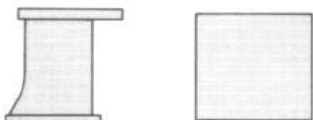
Electromarking unit
4042



Circular table
6016 - 230 mm (9") dia

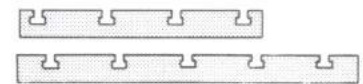


Circular table
6017 - 380 mm (15") dia



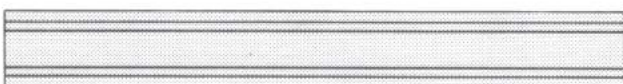
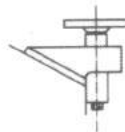
Raising blocks
6038 000013

For technical data see detailed
descriptions of the attachments.

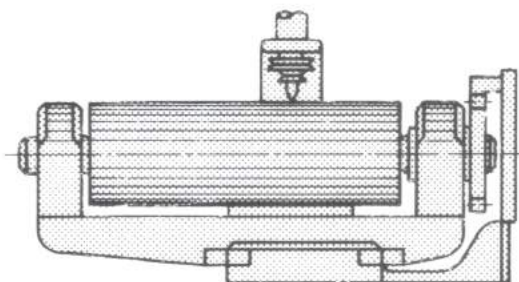


Auxiliary tables
4010/6010

Mounting bracket
6038-022
for 6025

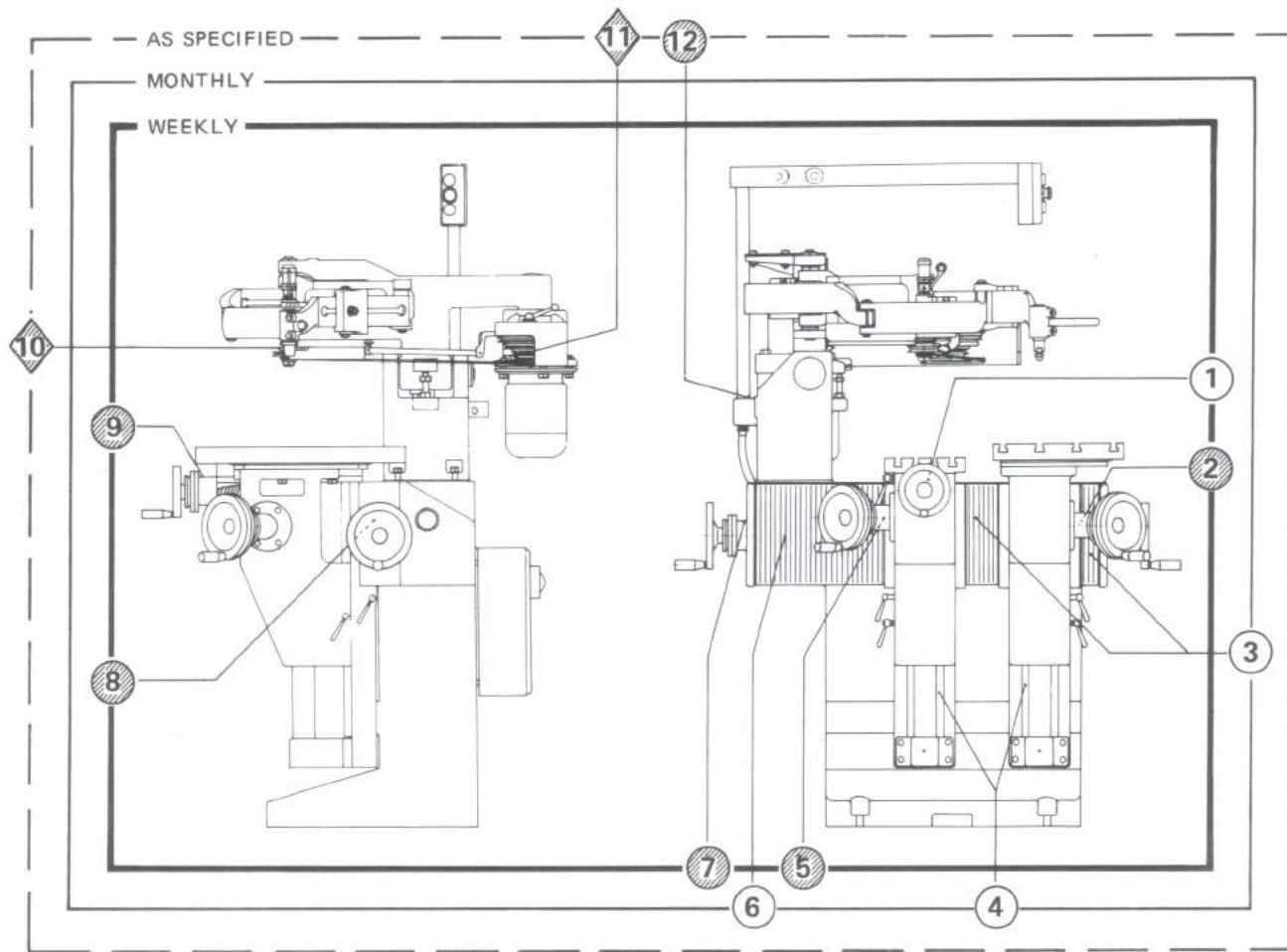


Type template holders
6015/4015



Roll engraving attachments
6021 / 6022 / 6024 / 6025

Lubrication diagram and schedule

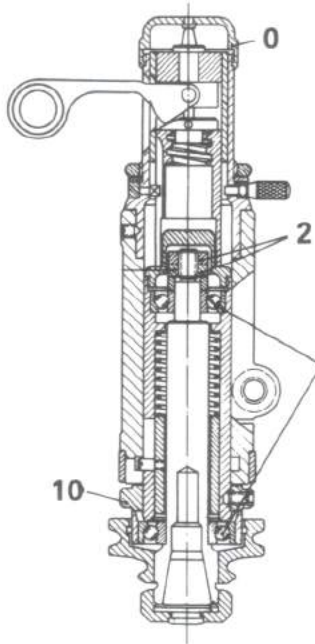


For identification of symbols see table of lubricants E 006 or 1013.

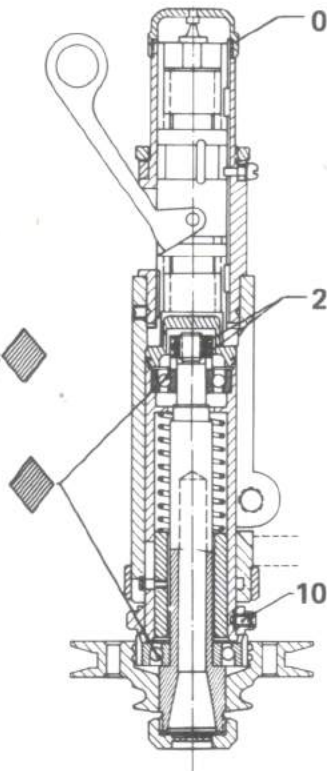
All time intervals apply to single-shift operation.

To be lubricated	No.	Item to be serviced	Quantity	Instructions and remarks
WEEKLY	1	Worktable longitudinal guide way		Clean and apply oil film.
WEEKLY	2	Bevel gear shaft and elevating screw (copyholder table)	3 ... 5 strokes	Use oil gun.
MONTHLY	3	Copyholder bracket traversing screw and V-ways		Remove bellows, clean traversing screws and guide ways apply oil film.
MONTHLY	4	Vertical ways, worktable and copyholder brackets		Clean and apply oil film.
WEEKLY	5	Bevel gear shaft and elevating screw (worktable)	3 ... 5 strokes	Use oil gun.
MONTHLY	6	Worktable bracket traversing screw and V-ways		Remove bellows, clean traversing screws and guide ways, apply oil film.
WEEKLY	7	Transverse slide screw bearing (worktable)	3 ... 5 strokes	Use oil gun.
WEEKLY	8	Transverse slide screw bearing (copyholder)	3 ... 5 strokes	Use oil gun.
WEEKLY	9	Longitudinal slide screw bearing (worktable)	3 ... 5 strokes	Use oil gun. Apply oil film to screw cover (spiral).
EVERY 5000 HRS OF OP'N	10	Cutter spindle assembly		See separate maintenance instructions.
YEARLY	11	Countershaft bearing		Dismantle, clean, grease ball bearings.
AS REQ'D	12	Control panel swivel bearing	a few drops of oil	

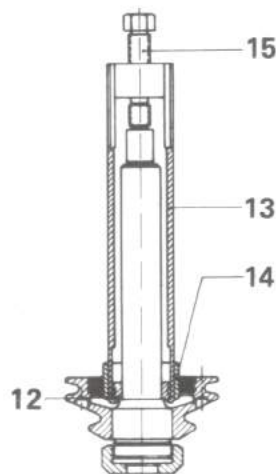
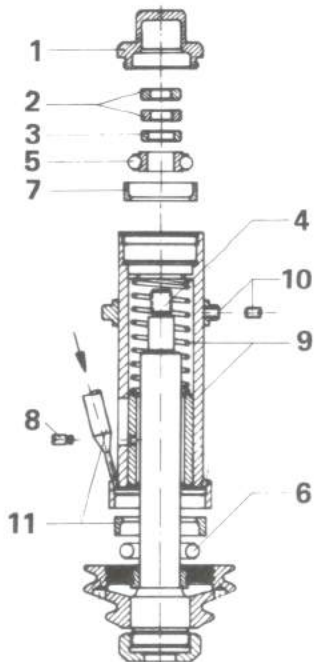
GK12



GK21

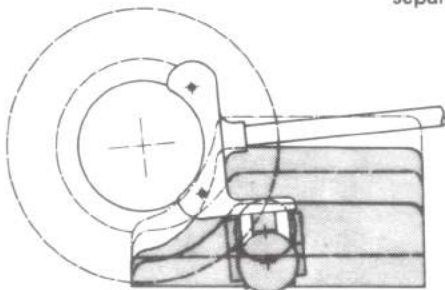


For identification of symbol see table of lubricants.



When ordering spare parts please quote spindle number (engraved on spindle quill).

Puller tool to be ordered separately.



Cutter spindle

Lubrication and maintenance

The cutter spindles are factory-greased for approx 3000 ... 5000 hours of operation. In the event of excessive soiling or other trouble dismantle spindle, clean (with pure, filtered benzine to which some ISOFLEX SUPER TEL special bearing grease has been added) and then lubricate ball bearings by applying thin coat of this special grease.

Removal of cutter spindle

Screw off cap 0. Push up spindle slightly by knurled ring 10, turn spindle 1/4 turn to the left and pull out. To re-install the spindle, reverse this procedure.

Eliminating bearing play

The bearings have been factory-adjusted to exclude play but allow for free rotary motion. In the event some play develops in the course of time, adjust by carefully tightening the two nuts 2. Excessive tightening of the nut will result in bearing failure.

Dismantling the spindle

Screw off protective cap 1.

Remove ring nuts 2.

Pull off spacer ring 3. Pull out spindle 4 with pulley and inner race 12 of lower bearing in a downward direction. Remove inner race 5 of upper bearing with ball cage, take off ball cage.

Remove ball cage 6 of lower bearing.

Push out outer race 7 of upper bearing with the aid of a suitable round rod.

Remove screw 8.

Remove sleeve 9 and compression springs.

Loosen set screw of 10 and pull off knurled ring.

Knock out outer race 11 of lower bearings by means of a drift.

The inner race 12 of the lower bearing can be pulled off by means of a special puller tool 13: push tool over bearing race, slide ring 14 downwards, force off ball race by means of screw 15. (Do not remove this ball race except when bearing has to be replaced.)








Before reassembly first lubricate bearings (see above), then reverse the above procedure. Make certain that the balls in the cage of the lower bearing are accurately seated in the groove of the inner bearing race. Adjust to eliminate bearing play (see above).

Belt guard

The belt guard can be adapted to the different pulley sizes by suitable adjustment on its two retaining pins (see illustration). Except in operations with the roll engraving attachment, the belt guard should always be left on the machine.

TABLE OF LUBRICANTS for DECKEL machine tools and NC machines

Recommended lubricants			
Preference should be given to the lubricants specified, but other brands may be used provided that their technical data are largely identical with those of the products listed below.			
Supplier	 Bearing oil approx 33.5 cSt (4.5 E)/50°C approx 44 cSt/100° F	 Spindle oil approx 21 cSt (3 E)/20° C approx 10.5 cSt/100° F	 Antifriction bearing grease normal grade
ANTAR P.A.	MISOLA BH	SPECIAL CONTINU 3 A	ROLEXA 2
ARAL	ARAL CMU Oil ARAL K Oil	ARAL CMT Oil ARAL Tu 500 Oil	ARAL HL 2 Grease
BP	BP ENERGOL HLP 100	BP ENERGOL HLP 40	BP ENERGREASE LS 2
CASTROL	CASTROL ALPHA 217	CASTROL HYPIN 40	CASTROL SPHEEROL AP 2
ESSO	ESSTIC 50 or NECTON 50	SPINESSO 34	BEACON 2 or ANDOK M 275
FUCHS	RENOLIN 2 RENOLIN MR 15	RENOLIN MR 3 RENOLIN B 3	FUCHS FETT FWA 160
HOUGHTON	COSMOLUBRIC 4	SPEEDLUBRIC 150	COSMOLUBE CA 60 W
KLÜBER LUBRICATION	LAMORA 34	LAMORA 5	CENTOPLEX 2
MOBIL OIL	MOBIL VACTRA Oil Heavy Medium	MOBIL VELOCITE Oil No 6	MOBILUX 2 MOBILPLEX 48
SHELL	SHELL VITREA Oil 31 or VOLTOL Sliding Oil II	SHELL TELLUS Oil 15	SHELL ALVANIA Grease R 2
SUNOCO	SUNVIS 827	SUNVIS 806	SUN M.D. 2 Grease
TEXACO	Cephus Oil D Wetex Oil W 2	Spintex Oil 60 Sera 1	Multifak 2 Glissando F1 20

Prescribed lubricants			
These lubricants have been thoroughly tested over many years. Do NOT use any other brands in substitution. Our customers will appreciate that testing of other lubricants involves extensive and costly experimentation.			
Supplier	 Guide way oil approx 100 cSt (13 E)/50° C	 Multiple disc clutch oil approx 29 cSt (4 E)/50° C	 Hydraulic oil SHELL TELLUS Oil 133 SHELL TELLUS Oil 933 36 cSt (4.8 E)/50° C FUCHS RENOLIN MR 15
ANTAR P.A.	MOGLIA 1300	MISOLA AH	 Special oil f.grinding head spindle sleeve 22 cSt (3.1 E)/50° C MOBIL VACTRA Oil No 1 Supplier: MOBIL OIL  Chain grease 'MOLYKOTE® MKL' Supplier: DOW CORNING GmbH Munich, F.R. Germany Distributors in all industrial countries  Special grease for spindle bearings 'ISOFLEX SUPER TEL' Supplier: KLÜBER LUBRICATION Munich, F.R. Germany and all DECKEL agents  Special oil for maintenance units KLÜBER TES 527 EP approx 21 cSt (3 E)/20° C Supplier: KLÜBER LUBRICATION
ARAL	ARAL BS - 114	ARAL HTX Oil	
BP	BP ENERGOL HP 60-C	BP ENERGOL CS 65	
CASTROL	CASTROL MAGNA CF	CASTROL HYPIN 45	
ESSO	FEBIS K 73	ESSTIC 45	
FUCHS	RENEP 5	RENOLIN MR 10	
HOUGHTON	WAYLUBRIC 12		
KLÜBER LUBRICATION	LAMORA Super Poladd 90	LAMORA Super 25	
MOBIL OIL	MOBIL VACTRA Oil No 4	MOBIL D.T.E. Oil Light	
SHELL	SHELL TONNA Oil 72	SHELL TELLUS Oil 133	
SUNOCO	WAY LUBRICANT SAE 90	SUNVIS 821	
TEXACO	Way Lubricant G	Rando Oil B	

The order in which the suppliers of lubricants are named shall in no way be deemed to constitute an order of rank or quality

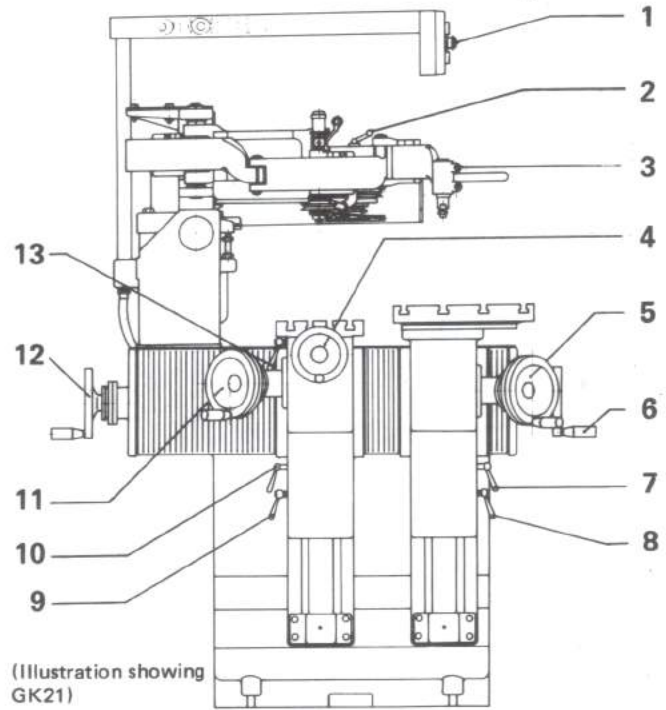
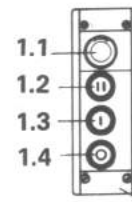


PRACTICAL HINTS for lubrication and maintenance

1. Selection of the proper grades of lubricant will essentially contribute towards maximum reliability and economy of DECKEL machine tools. Never use any other brands in substitution for the products specified under 'Prescribed lubricants', since otherwise the dependable operation of the machine might be impaired and your warranty claims might under certain circumstances become void.
2. Utmost care in handling and storing oils and greases is of predominant importance: keep all containers perfectly clean and close them tightly after use.
3. Make certain that all lubricating points on the machine are always kept clean to prevent the ingress of dirt and dust. Close filler screws etc carefully after lubricating.
4. Observe the lubrication intervals specified, making due allowance for two or three-shift operation if applicable.
5. Apply the lube gun exactly to the nipple when lubricating and make sure that an adequate quantity of lubricant is supplied to the lubricating point.
6. Use only lint-free rags (no cotton waste) for cleaning oil reservoirs. Residues and sediments can easily be removed with cleaning oil. Take care that none of the cleansing fluid is left in the reservoirs.
7. It is advisable to stick to one and the same brand of lubricant. If a change is made, flush out thoroughly before pouring in another product.
8. Milling and grinding spindle bearings for which permanent lubrication with 'ISOFLEX SUPER TEL' special grease is specified in our operator's manuals require no servicing for approx 8000 hours of operation. In the event of excessive soiling or other trouble, disassemble the spindle ball bearings, clean thoroughly, and lubricate by applying a thin coat of 'ISOFLEX SUPER TEL' merely to the ball cages.
9. Keep all guide ways free of dirt, dust and chips and clean wipers (if any) at regular intervals.
10. For breaking-in the machines at our factory we use 'MOLYCOTE' fluid grease. Possible black colouring of clean lubricants in operation is not caused by particles abraded from machine parts, but is due to residues of molybdenum sulphide.

Main controls

1. Swivel-mounted control panel with
 - 1.1 EMERGENCY STOP button
(reset in direction of arrow)
 - 1.2 START button for high motor speed II (GK21 only)
 - 1.3 START button for low motor speed I
 - 1.4 STOP button for motor speeds I and II
2. Clamp for countershaft assembly
3. Clamping screws for tracer pin sleeve
4. Handwheel for worktable longitudinal adjustment
5. Handwheel for copyholder vertical adjustment
6. Handwheel for copyholder transverse adjustment
7. Clamping lever for copyholder transverse adjustment
8. Clamping lever for copyholder vertical adjustment
9. Clamping lever for worktable vertical adjustment
10. Clamping lever for worktable transverse adjustment
11. Handwheel for worktable vertical adjustment
12. Handwheel for worktable transverse adjustment
13. Clamping lever for worktable longitudinal adjustment

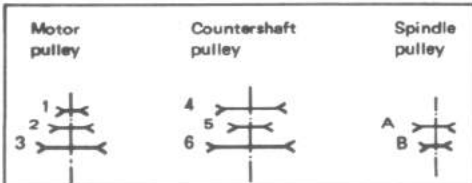


(Illustration showing GK21)

Drive system

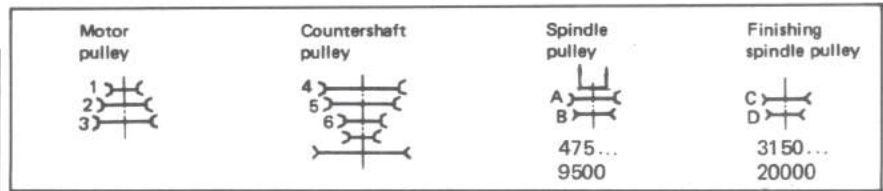
Speed ranges and cutting speeds.

The cutting speeds listed in the tables below are guiding values which may be reduced or increased to suit changing requirements.



Belt positions, spindle speeds and cutting speeds in m/min (fpm) for different cutter diameters in mm (in)

Belt position	rpm	1 mm (3/64")	2.5 mm (1/8")	4 mm (3/16")	6 mm (1/4")
1-4-5-B	1600		13 (52)	21 (78)	31 (104)
1-4-6-A	2000		16 (65)	25 (98)	37 (131)
2-4-5-A	2500		19 (82)	32 (123)	47 (163)
1-4-6-B	3150		25 (103)	40 (155)	60 (206)
2-4-5-B	4000	13 (50)	32 (131)	50 (197)	75 (262)
2-4-6-A	5000	16 (62)	39 (164)	63 (246)	94 (327)
3-4-6-A	6300	20 (78)	50 (206)	79 (310)	119 (410)
2-4-6-B	8000	25 (100)	63 (262)	101 (394)	151 (520)
2-5-6-A	10000	31 (123)	79 (328)	126 (490)	189 (655)
3-5-6-A	12500	39 (156)	98 (401)	157 (610)	236 (820)
2-5-6-B	16000	50 (200)	126 (525)	201 (790)	302 (1046)
3-5-6-B	20000	63 (246)	157 (655)	252 (985)	377 (1309)



Belt positions, spindle speeds and cutting speeds in m/min (fpm) for different cutter diameters in mm (in)

Standard cutter spindle					Finishing spindle					
Belt position	rpm	Cutter diameter				Belt position	rpm	Cutter diameter		
		4 mm (3/16")	6 mm (1/4")	8 mm (5/16")	10 mm (3/8")			2.5 mm (1/8")	4 mm (3/16")	6 mm (1/4")
1-4-A	475		9 (31)	12 (39)	14 (46)	1-4-C	3150	25 (103)	40 (155)	60 (206)
1-5-A	600		11 (39)	15 (49)	18 (60)	1-5-C	4000	32 (131)	50 (197)	75 (262)
2-4-A	750	9 (37)	14 (49)	19 (61)	22 (72)	1-4-D	5000	39 (164)	63 (246)	94 (327)
2-5-A	950	12 (47)	18 (62)	24 (77)	28 (92)	1-5-D	6300	50 (206)	79 (310)	119 (410)
3-5-A	1180	15 (58)	22 (77)	30 (96)	34 (112)	2-4-D	8000	63 (262)	101 (394)	151 (520)
2-6-A	1500	19 (74)	28 (98)	38 (122)	47 (154)	2-5-D	10000	79 (328)	126 (490)	189 (655)
3-6-A	1900	24 (93)	36 (124)	48 (155)	56 (184)	3-5-D	12500	98 (401)	157 (610)	236 (820)
1-4-B	2350	30 (115)	44 (154)	59 (192)	71 (233)	2-6-D	16000	126 (525)	201 (790)	302 (1046)
1-5-B	3000	38 (147)	57 (196)	75 (245)	90 (295)	3-6-D	20000	157 (655)	252 (985)	377 (1309)
2-4-B	3750	47 (184)	70 (246)	94 (306)	112 (367)	Spindle drive belts: A - circular belt, 8 mm (5/16") dia B, C, D - circular belts, 5 mm (3/16") dia Enlarging work - 4 mm (5/32") dia				
2-5-B	4750	60 (234)	90 (310)	119 (388)	140 (459)					
3-5-B	6000	75 (294)	113 (392)	151 (490)	180 (590)					
2-6-B	7500	94 (368)	141 (490)	188 (612)	224 (735)					
3-6-B	9500	119 (467)	179 (620)	280 (918)						

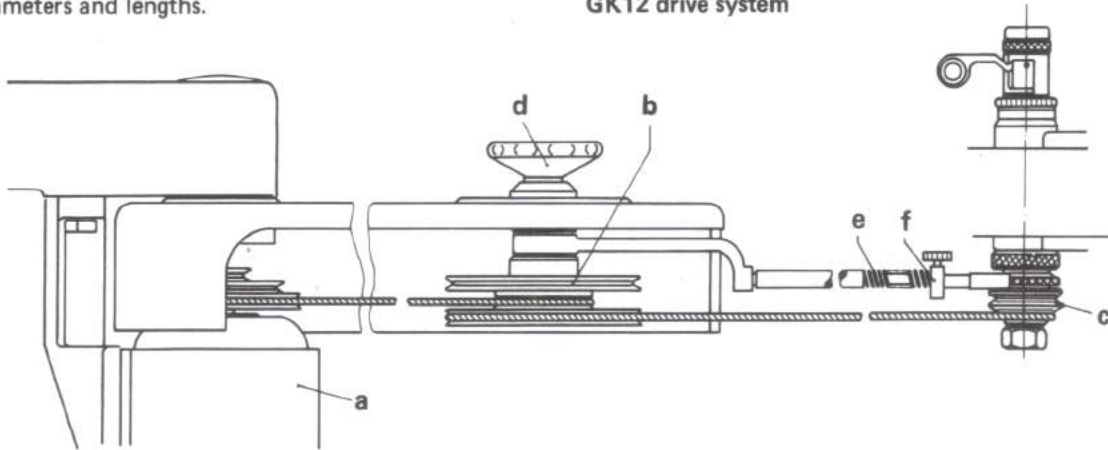
In to belt position 2-5-B the standard cutter spindle can also be used at the high motor

Drive system

Power transmission

The cutter spindle c is driven by an electric motor a via a countershaft assembly b by means of circular belts of different diameters and lengths.

GK12 drive system



To change the position of the belt between the motor and the countershaft pulleys release clamp d. Belt to be tensioned only moderately.

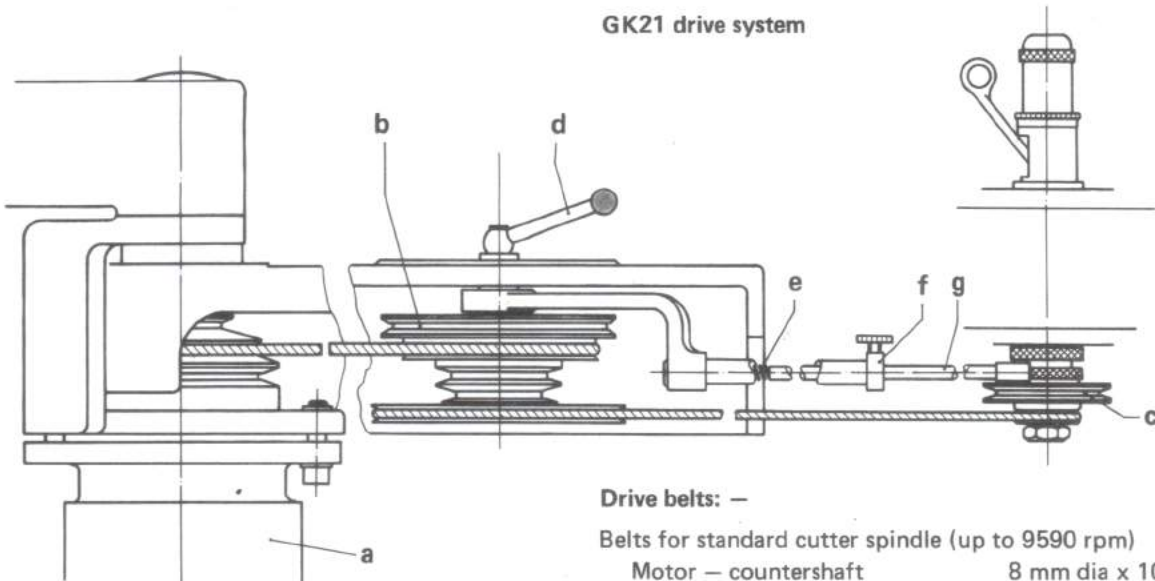
The belt between the countershaft and spindle pulleys will be tensioned by compression spring e: adjust spring retaining collar f.

Drive belts: –

Motor – countershaft	4 mm dia x 860 mm
Countershaft – spindle	
reducing	3 mm dia x 1500 mm
enlarging	3 mm dia x 1650 mm

(Always quote these dimensions when ordering replacement belts.)

GK21 drive system



Drive belts: –

Belts for standard cutter spindle (up to 9590 rpm)

Motor – countershaft	8 mm dia x 1000 mm
Countershaft spindle	
reducing (low speed range)	8 mm dia x 1500 mm
reducing (high speed range)	5 mm dia x 1600 mm
enlarging	4 mm dia x 1760 mm

Belts for finishing spindle (up to 20 000 rpm)

Motor – countershaft	6 mm dia x 950 mm
Countershaft – spindle	
reducing	5 mm dia x 1600 mm
enlarging	4 mm dia x 1760 mm

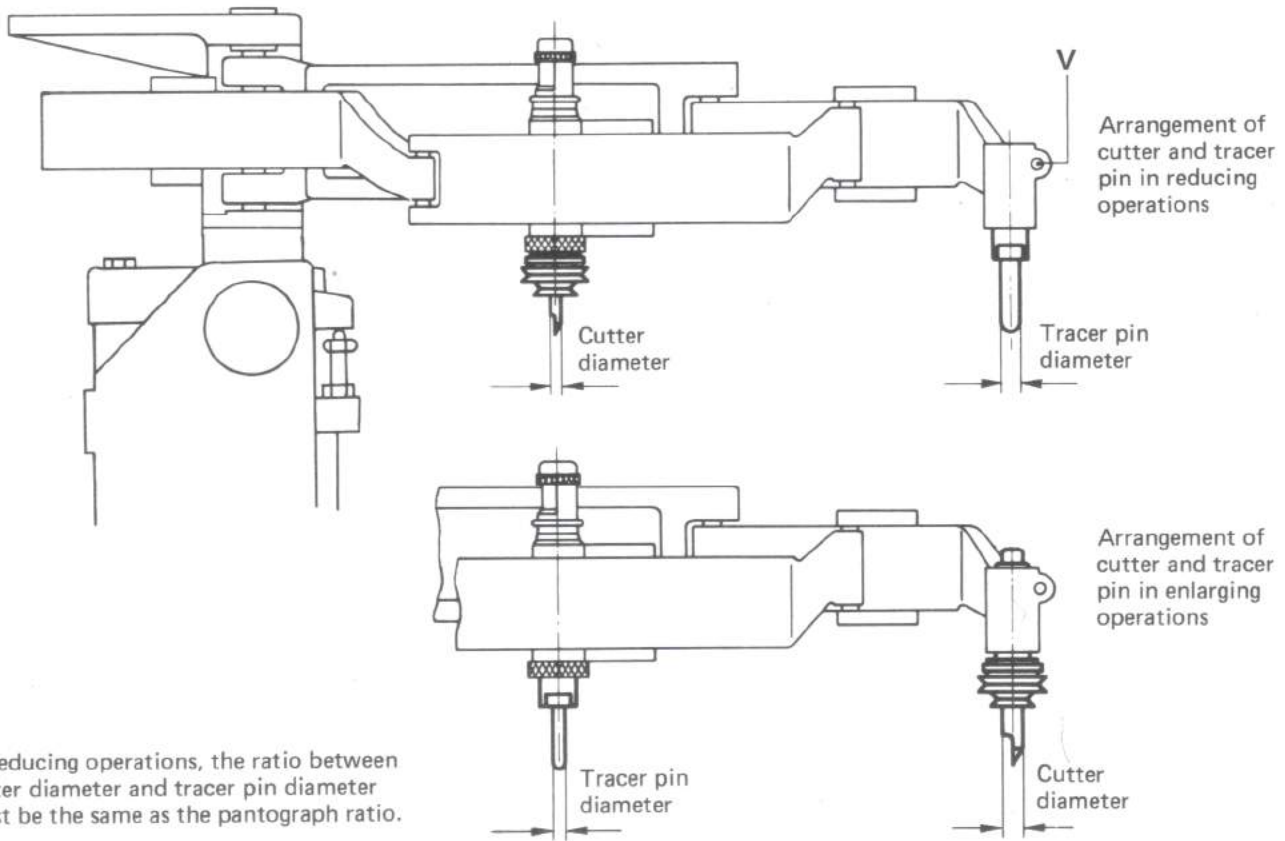
(Always quote dimensions when ordering replacement belts)

On the GK21 machine, compression spring e is provided inside a tubular support member. To change the belt position, carefully release spring retaining collar f and hold support rod g firmly grasped while lifting it off the spindle.

For belt positions see overleaf.

GK12 pantograph

Reducing and enlarging



In reducing operations, the ratio between cutter diameter and tracer pin diameter must be the same as the pantograph ratio.

For enlarging operations, interchange cutter spindle and tracer pin sleeve.

The ratio between cutter diameter and tracer pin diameter must be inversely proportional to the pantograph ratio.

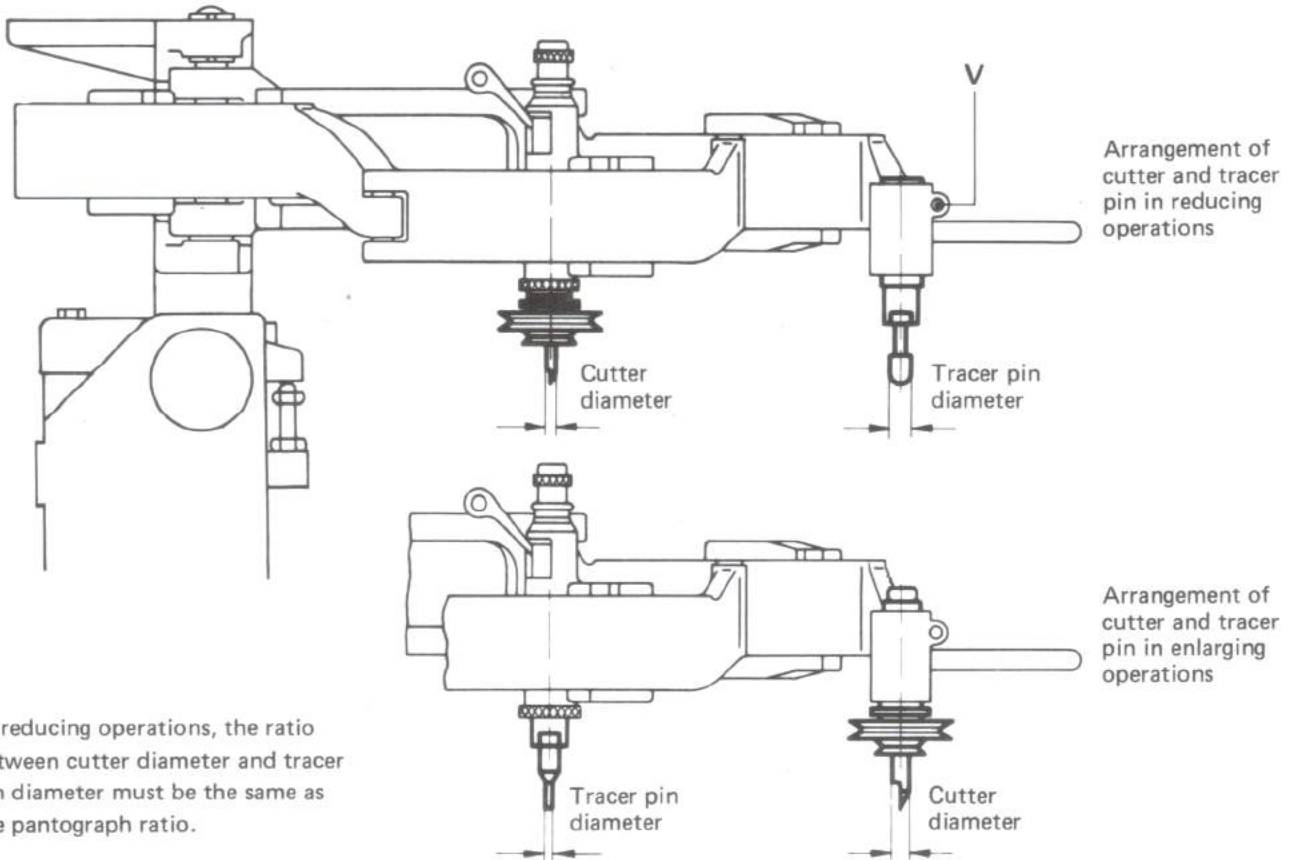
Cutter diameter and tracer pin diameter in reducing operations									
Tracer pin diameter	Cutter diameter in mm (in) for pantograph ratio setting of								
	1.5	2	2.5	3	4	5	6	8	10
3 mm (1/8")	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)	0.75 (0.031)	0.6 (0.025)	0.5 (0.021)	0.37 (0.016)	0.3 (0.013)
4 mm (5/32")	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)	0.66 (0.026)	0.5 (0.020)	0.4 (0.016)
5 mm (3/16")	3.33 (0.125)	2.5 (0.094)	2 (0.075)	1.66 (0.063)	1.25 (0.047)	1 (0.038)	0.83 (0.031)	0.62 (0.023)	0.5 (0.019)
6 mm (1/4")	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)	0.75 (0.031)	0.6 (0.025)
8 mm (5/16")	5.33 (0.208)	4 (0.156)	3.2 (0.125)	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)
10 mm (3/8")		5 (0.188)	4 (0.150)	3.33 (0.125)	2.5 (0.094)	2 (0.075)	1.66 (0.063)	1.25 (0.047)	1 (0.038)
12 mm (1/2")		6 (0.250)	4.8 (0.200)	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)
14 mm (9/16")			5.6 (0.225)	4.66 (0.188)	3.5 (0.141)	2.8 (0.113)	2.33 (0.094)	1.75 (0.070)	1.4 (0.056)
16 mm (5/8")				5.33 (0.208)	4 (0.156)	3.2 (0.125)	2.66 (0.104)	2 (0.078)	1.6 (0.063)

Cutter diameter and tracer pin diameter in enlarging operations									
Cutter diameter	Tracer pin diameter in mm (in) at pantograph ratio setting of								
	1.5	2	2.5	3	4	5	6	8	10
4 mm (5/32")	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)	0.66 (0.026)		
6 mm (1/4")	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)	0.75 (0.031)	0.6 (0.025)



GK21 pantograph

Reducing and enlarging



In reducing operations, the ratio between cutter diameter and tracer pin diameter must be the same as the pantograph ratio.

For enlarging operations, interchange cutter spindle and tracer pin sleeve.

The ratio between cutter diameter and tracer pin diameter must be inversely proportional to the pantograph ratio.

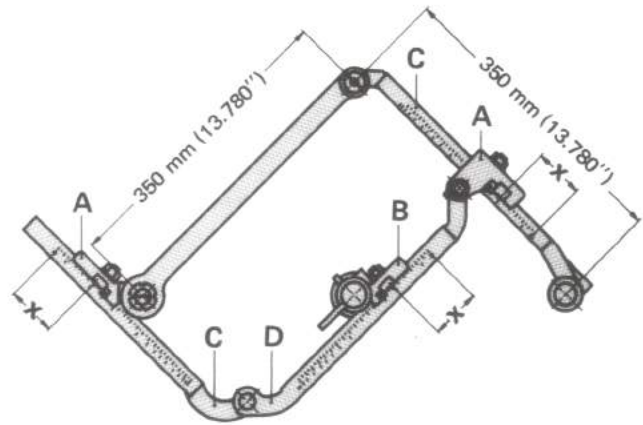
Cutter diameter and tracer pin diameter in reducing operations									
Tracer pin diameter	Cutter diameter in mm (in) for pantograph ratio setting of								
	1.5	2	2.5	3	4	5	6	8	10
3 mm (1/8")	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)	0.75 (0.031)	0.6 (0.025)	0.5 (0.021)	0.37 (0.016)	0.3 (0.013)
4 mm (5/32")	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)	0.66 (0.026)	0.5 (0.020)	0.4 (0.016)
5 mm (3/16")	3.33 (0.125)	2.5 (0.094)	2 (0.075)	1.66 (0.063)	1.25 (0.047)	1 (0.038)	0.83 (0.031)	0.62 (0.023)	0.5 (0.019)
6 mm (1/4")	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)	0.75 (0.031)	0.6 (0.025)
8 mm (5/16")	5.33 (0.208)	4 (0.156)	3.2 (0.125)	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)
10 mm (3/8")	6.66 (0.250)	5 (0.188)	4 (0.150)	3.33 (0.125)	2.5 (0.094)	2 (0.075)	1.66 (0.063)	1.25 (0.047)	1 (0.038)
12 mm (1/2")	8 (0.333)	6 (0.250)	4.8 (0.200)	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)
14 mm (9/16")	9.33 (0.375)	7 (0.281)	5.6 (0.225)	4.66 (0.188)	3.5 (0.141)	2.8 (0.113)	2.33 (0.094)	1.75 (0.070)	1.4 (0.056)
16 mm (5/8")		8 (0.313)	6.4 (0.250)	5.33 (0.208)	4 (0.156)	3.2 (0.125)	2.66 (0.104)	2 (0.078)	1.6 (0.063)

Cutter diameter and tracer pin diameter in enlarging operations									
Cutter diameter	Tracer pin diameter in mm (in) at pantograph ratio setting of								
	1.5	2	2.5	3	4	5	6	8	10
4 mm (5/32")	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)				
6 mm (1/4")	4 (0.167)	3 (0.125)	2.4 (0.100)	2 (0.083)	1.5 (0.063)	1.2 (0.050)	1 (0.042)		
8 mm (5/16")	5.33 (0.208)	4 (0.156)	3.2 (0.125)	2.66 (0.104)	2 (0.078)	1.6 (0.063)	1.33 (0.052)	1 (0.039)	0.8 (0.031)
10 mm (3/8")	6.66 (0.250)	5 (0.188)	4 (0.150)	3.33 (0.125)	2.5 (0.094)	2 (0.075)	1.66 (0.063)	1.25 (0.047)	1 (0.038)

GK12 pantograph

Setting the pantograph ratio

To obtain a desired pantograph ratio, set the two slides A and the spindle carrier B on the pantograph legs C and D in such a way that the index marks coincide with the respective setting marks engraved on the pantograph legs. For positions not marked on the pantograph legs use the setting values X shown in the tables below. The values can be set on the linear scales with the aid of the verniers.



To compute value X use the following formula –

$$\text{METRIC: } X = 233.33 - \frac{350}{z} \quad \text{INCH: } X = 9.185 - \frac{13.780}{z}$$

where z is the reducing factor of the pantograph ratio.

The table below shows the values obtainable by applying the above formula, but rounded up to one decimal.

Before setting the pantograph clean the pantograph legs and apply thin grease film from time to time.

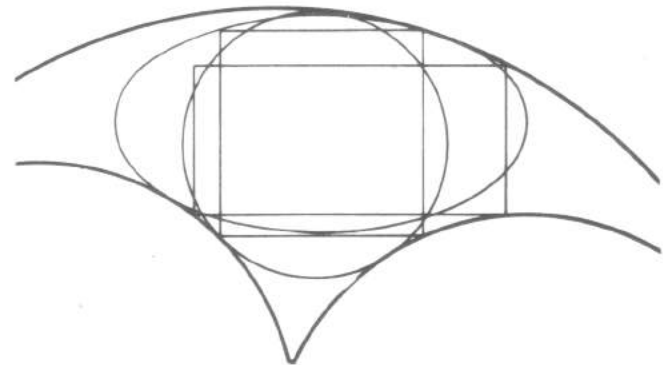
Z	X		Z	X		Z	X		Z	X		Z	X	
	mm	in		mm	in		mm	in		mm	in		mm	in
1.5	0	0	3.2	124.0	4.882	4.9	161.9	6.374	6.6	180.3	7.098	8.3	191.2	7.528
1.6	14.6	0.575	3.3	127.3	5.012	5.0	163.3	6.429	6.7	181.1	7.130	8.4	191.7	7.547
1.7	27.4	1.079	3.4	130.4	5.134	5.1	164.7	6.484	6.8	181.9	7.161	8.5	192.1	7.565
1.8	38.9	1.531	3.5	133.3	5.248	5.2	166.0	6.535	6.9	182.6	7.189	8.6	192.6	7.583
1.9	49.1	1.933	3.6	136.1	5.358	5.3	167.3	6.587	7.0	183.3	7.217	8.7	193.1	7.602
2.0	58.3	2.295	3.7	138.7	5.461	5.4	168.5	6.634	7.1	184.0	7.244	8.8	193.6	7.622
2.1	66.7	2.626	3.8	141.1	5.559	5.5	169.7	6.681	7.2	184.7	7.272	8.9	194.0	7.638
2.2	74.2	2.921	3.9	143.6	5.654	5.6	170.8	6.724	7.3	185.4	7.299	9.0	194.4	7.654
2.3	81.2	3.197	4.0	145.8	5.740	5.7	171.9	6.768	7.4	186.0	7.323	9.1	194.9	7.673
2.4	87.5	3.445	4.1	148.0	5.827	5.8	173.0	6.811	7.5	186.7	7.350	9.2	195.3	7.689
2.5	93.3	3.673	4.2	150.0	5.906	5.9	174.0	6.850	7.6	187.3	7.374	9.3	195.7	7.705
2.6	98.7	3.886	4.3	151.9	5.980	6.0	175.0	6.890	7.7	187.9	7.398	9.4	196.1	7.720
2.7	103.7	4.083	4.4	153.8	6.055	6.1	175.9	6.925	7.8	188.5	7.421	9.5	196.5	7.736
2.8	108.3	4.264	4.5	155.5	6.122	6.2	176.9	6.965	7.9	189.0	7.441	9.6	196.9	7.752
2.9	112.6	4.433	4.6	157.2	6.189	6.3	177.8	7.000	8.0	189.6	7.465	9.7	197.2	7.766
3.0	116.7	4.594	4.7	158.9	6.256	6.4	178.6	7.031	8.1	190.1	7.484	9.8	197.6	7.780
3.1	120.4	4.740	4.8	160.4	6.315	6.5	179.5	7.067	8.2	190.6	7.504	9.9	198.0	7.795

Areas covered by GK12 pantograph

The areas shown in the table below apply to reducing operations; for enlarging work multiply the dimensions by the pantograph ratio.

The direction of the rectangle, square and ellipse is parallel to the main axes of the machine.

The fringe areas shown in the drawing are limited by the drive system in enlarging operations.



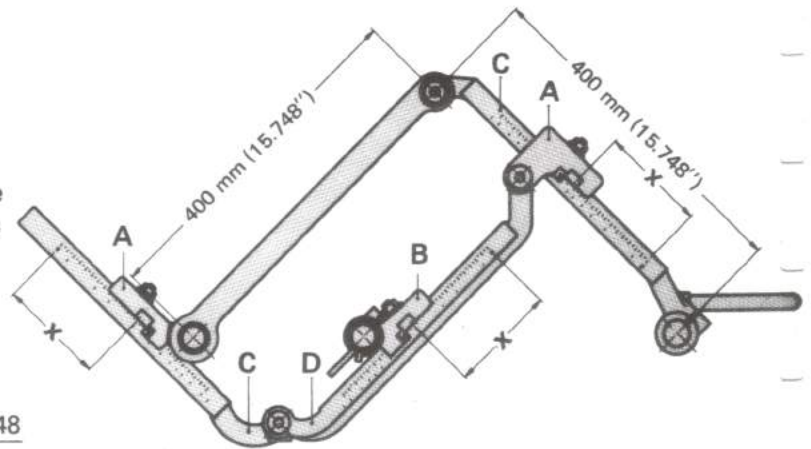
Pantograph ratio	Rectangle		Square		Circle		Ellipse	
	mm	in	mm	in	mm	in	mm	in
1:1.5	145 x 320	5 3/4 x 12 1/2	153	6	155	6 1/8	155 x 400	6 1/8 x 15 3/4
1:2	112 x 255	4 3/8 x 10	148	5 3/4	174	6 7/8	155 x 310	6 1/8 x 12 1/4
1:3	75 x 150	3 x 5 7/8	98	3 7/8	126	5	106 x 210	4 1/8 x 8 1/4
1:4	55 x 115	2 1/8 x 4 1/2	73	2 7/8	94	3 3/4	80 x 160	3 1/8 x 6 1/4
1:6	36 x 75	1 3/8 x 3	48	1 7/8	61	2 3/8	52 x 105	2 x 4 1/8
1:8	26 x 52	1 x 2	34	1 3/8	43	1 5/8	36 x 75	1 3/8 x 3
1:10	18 x 44	3/4 x 1 3/4	22	7/8	23	7/8	23 x 55	7/8 x 2 1/8



GK21 pantograph

Setting the pantograph ratio

To obtain a desired pantograph ratio, set the two slides A and the spindle carrier B on the pantograph legs C and D in such a way that the index marks coincide with the respective setting marks engraved on the pantograph legs. For positions not marked on the pantograph legs use the setting values X shown in the tables below. The values can be set on the linear scales with the aid of the verniers.



To compute value X use the following formula –

$$\text{METRIC: } X = 266.66 - \frac{400}{z} \quad \text{INCH: } X = 10.498 - \frac{15.748}{z}$$

where z is the reducing factor of the pantograph ratio.

The table below shows the values obtainable by applying the above formula, but rounded up to one decimal.

Before setting the pantograph clean the pantograph legs and apply thin grease film from time to time.

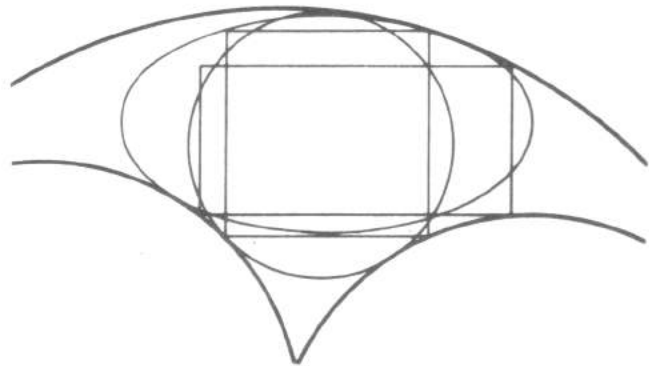
Z	X		Z	X		Z	X		Z	X		Z	X	
	mm	in		mm	in		mm	in		mm	in		mm	in
1.5	0	0	3.2	141.7	5.579	4.9	185.0	7.283	6.6	206.1	8.114	8.3	218.5	8.602
1.6	16.7	0.657	3.3	145.5	5.728	5.0	186.7	7.350	6.7	207.0	8.150	8.4	219.0	8.622
1.7	31.4	1.236	3.4	149.0	5.866	5.1	188.2	7.409	6.8	207.8	8.181	8.5	219.6	8.646
1.8	44.4	1.748	3.5	152.4	6.000	5.2	189.7	7.469	6.9	208.7	8.216	8.6	220.2	8.669
1.9	56.1	2.209	3.6	155.6	6.126	5.3	191.2	7.528	7.0	209.5	8.248	8.7	220.7	8.689
2.0	66.7	2.626	3.7	158.6	6.244	5.4	192.6	7.583	7.1	210.3	8.279	8.8	221.2	8.709
2.1	76.2	3.000	3.8	161.4	6.354	5.5	193.9	7.634	7.2	211.1	8.311	8.9	221.7	8.728
2.2	84.8	3.339	3.9	164.1	6.461	5.6	195.2	7.685	7.3	211.9	8.342	9.0	222.2	8.748
2.3	92.8	3.653	4.0	166.7	6.563	5.7	196.5	7.736	7.4	212.6	8.370	9.1	222.7	8.768
2.4	100.0	3.937	4.1	169.1	6.657	5.8	197.7	7.783	7.5	213.3	8.398	9.2	223.2	8.787
2.5	106.7	4.201	4.2	171.4	6.748	5.9	198.9	7.831	7.6	214.0	8.425	9.3	223.7	8.807
2.6	112.8	4.441	4.3	173.6	6.835	6.0	200.0	7.874	7.7	214.7	8.453	9.4	224.1	8.825
2.7	118.5	4.665	4.4	175.8	6.921	6.1	201.1	7.917	7.8	215.4	8.480	9.5	224.6	8.843
2.8	123.8	4.874	4.5	177.8	7.000	6.2	202.1	7.957	7.9	216.0	8.504	9.6	225.0	8.858
2.9	128.7	5.067	4.6	179.7	7.075	6.3	203.2	8.000	8.0	216.7	8.532	9.7	225.4	8.874
3.0	133.3	5.248	4.7	181.6	7.150	6.4	204.2	8.039	8.1	217.3	8.555	9.8	225.8	8.890
3.1	137.6	5.417	4.8	183.3	7.217	6.5	205.1	8.075	8.2	217.9	8.579	9.9	226.5	8.910

Areas covered by GK21 pantograph

The areas shown in the table below apply to reducing operations; for enlarging work multiply the dimensions by the pantograph ratio.

The direction of the rectangle, square and ellipse is parallel to the main axes of the machine.

The fringe areas shown in the drawing are limited by the range of movement of the drive system in enlarging operations.



Pantograph ratio	Rectangle		Square		Circle		Ellipse	
	mm	in	mm	in	mm	in	mm	in
1:1.5	165 x 335	6 1/2 x 13 1/4	174	6 7/8	176	6 7/8	176 x 450	6 7/8 x 17 3/4
1:2	122 x 255	4 3/4 x 10	162	6 3/8	200	7 7/8	120 x 320	4 3/4 x 12 5/8
1:3	80 x 173	3 1/8 x 6 3/4	107	4 1/4	138	5 3/8	115 x 230	4 1/2 x 9
1:4	62 x 125	2 3/4 x 4 7/8	81	3 1/8	104	4 1/8	92 x 155	3 5/8 x 6 1/8
1:6	37 x 87	1 1/2 x 3 3/8	52	2	67	2 5/8	57 x 110	2 1/4 x 4 3/8
1:8	26 x 63	1 x 2 1/2	37	1 1/2	47	1 7/8	42 x 76	1 5/8 x 3
1:10	15 x 50	5/8 x 2	24	1	25	1	25 x 65	1 x 2 1/2

Pantograph

Pantograph locking bracket

The self-supporting pantograph 1 is attached to pantograph carrier 2 which is pivoted to a bearing bracket 3 mounted on the column. The downward travel of the pantograph is limited by a screw 4 which can be adjusted to and locked in the desired position.

For machining flat surfaces the pantograph can be locked in a horizontal plane by means of a spacer sleeve 5 fitted between the pantograph carrier and the bearing bracket.

To perform cutting operations by scribed lines, i.e. without the use of templates, mount pantograph locking bracket 6 on copyholder table 7 by means of T-slot bolts 8 and lock the pantograph by inserting the shank of locking bracket 6 into the bore of the tracer pin holder. Clamp by means of screw 9.

The instructions in the last paragraph above apply to GK21A machines used without automatic scanning unit.

Bracket for spacer sleeve and straightedge

Spacer sleeve 5 and straightedge 10 can be fitted to bracket 11 on the rear side of the bearing bracket for storage during periods of non-use.

Connecting the compressed-air line

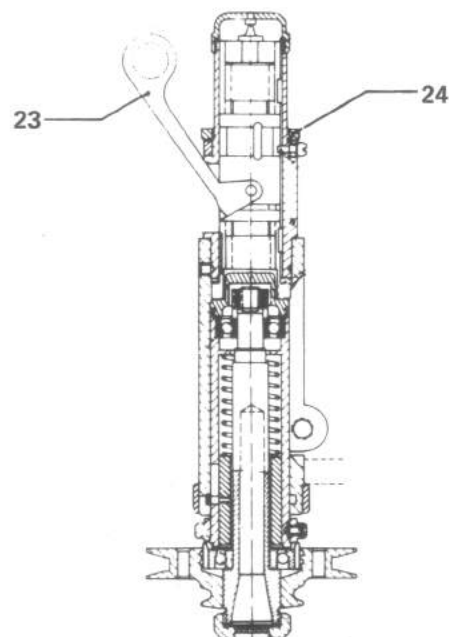
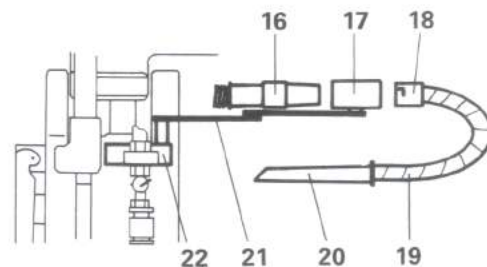
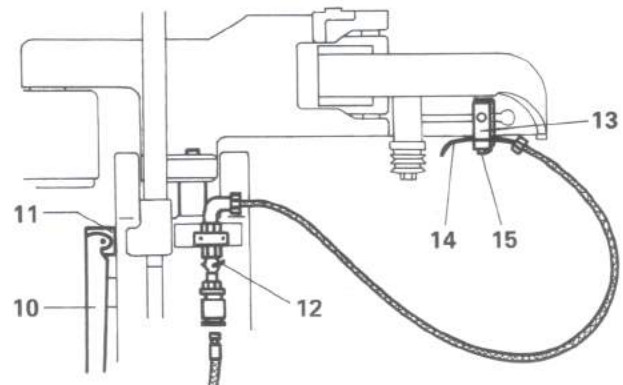
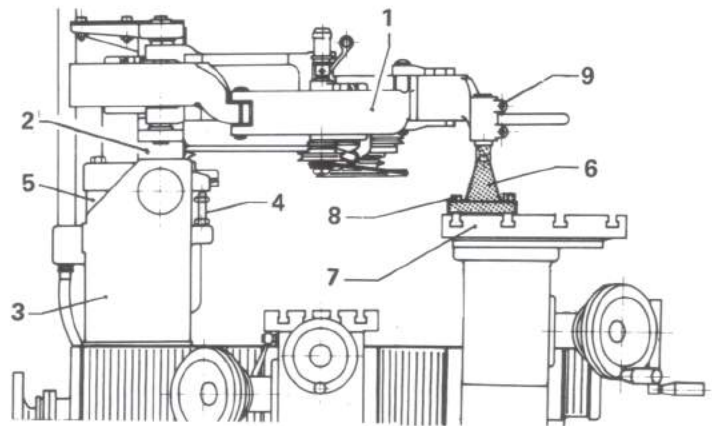
If the air line is supplied separately, first screw two-way valve 12 with pipe clip and coupler nipple to bracket 22. Pipe holder 13 can be attached to pantograph arms as required. Clamp nozzle 14 by means of screw 15.

Mounting the dust exhaust hose line

Fit pivot pin of holder 21 to bracket 22. Insert end piece 16 and connecting line 19 with coupler sleeve 18 (bayonet mount) into tubular holder 17. Attach rubber mouthpiece 20 if required.

Spindle vertical adjustment

Coarse vertical adjustment of the cutter spindle is obtained by depressing lever 23, fine adjustment (depth of cut) cut rotating the lever anticlockwise. The depth of cut (to be read off from a scale) can be limited by an adjustable ring locked in any desired position by means of knurled nut 24. When lever 23 is returned, the spindle will be moved back to starting position by spring pressure.



Pantograph

The setup and machining instructions on this page apply to GK21A machines used without automatic scanning unit.

Alignment of cutter and tracer pin

The accurate duplication of three-dimensional shapes at a reduced or enlarged scale requires the exact alignment of the tips of cutter and tracer pin with the axis of the horizontal rocker shaft.

Insert the straightedge into the taper hole provided in the rocker shaft, clamp the cutter for the required length and align the tracer pin accordingly (Fig 1).

Make certain that the ratio between the diameters of cutter and tracer pin is the same as the pantograph ratio.

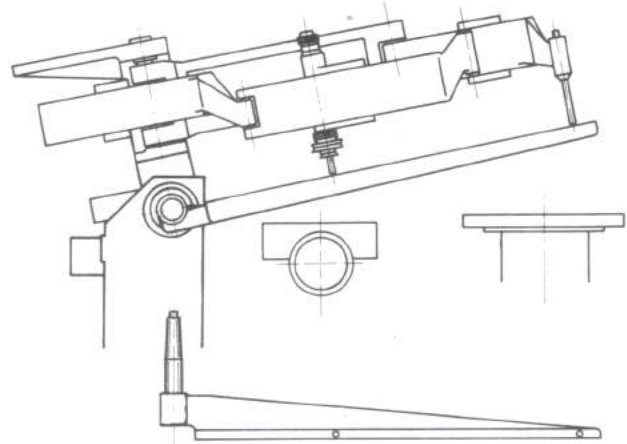


Fig 1

Setup for machining steep or vertical surfaces

Machining of right-hand surface with the aid of freely movable pantograph (Fig 2).

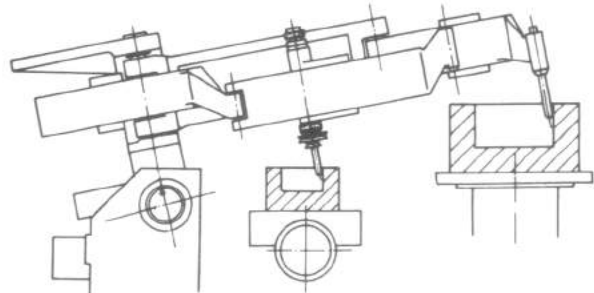


Fig 2

Machining of left-hand surface with the aid of freely movable pantograph (Fig 3).

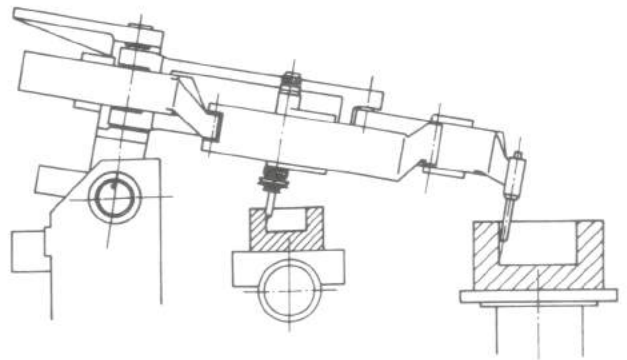


Fig 3

To duplicate steep surfaces by using a sheet-metal template, lock pantograph in a horizontal position by means of the spacer sleeve and impart feed motion to workpiece by means of worktable elevating screw. In the case of horizontal work it is advisable to have the tracer pin rest on a plane surface (use auxiliary template if necessary) to eliminate vertical pantograph movements and thus ensure a better surface finish (Fig 4).

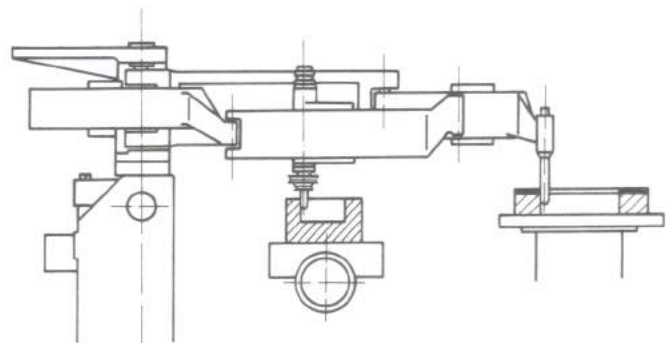


Fig 4

Pantograph weight balancer

The weight of the pantograph in all its positions can be balanced for effortless guidance by means of a balancing spring provided inside the column. Use knurled knob R, which is easily accessible from the operator's position, for adjusting the spring tension (Fig 5).

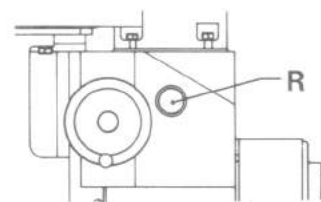


Fig 5

Rough milling attachment (GK21 only)

Rough milling with rigidly connected pantograph

Mount the pattern or master on the copyholder table, then fit bridge slide B to the guide rails by means of the two hex bolts L and insert ball-end sleeve K into the tracer pin bore of the pantograph. Move pantograph into horizontal position with the aid of the spacer sleeve, set tracer pin and cutter for the highest point of the master and workpiece, and clamp by means of screw S. Remove spacer sleeve after clamping.

Rough milling is now performed by removing the stock layer by layer. Proceed as follows: upon removal of first layer, feed tracer pin down by means of setting ring E and scale M by a suitable amount (h) and raise worktable with workpiece by an amount of h divided by the pantograph ratio.

Repeat this procedure until the bottom of the work cavity is reached and all contours have been duplicated. To protect the master, the tracer pin should not be allowed to contact the inside walls of the master.

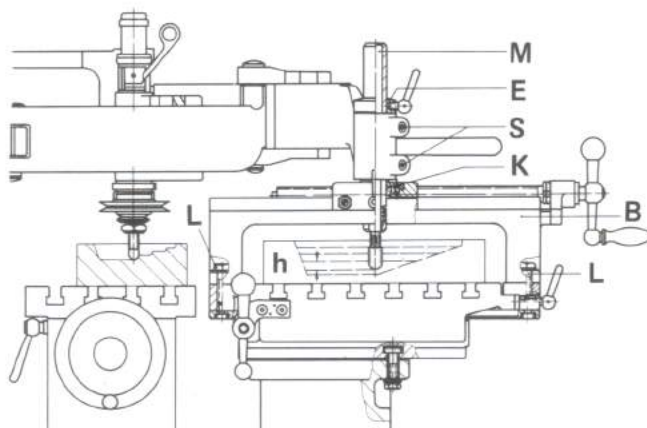
Upon completion of rough milling work in the manner described above, remove the steps produced on the workpiece by a further rough milling process with loosely connected pantograph. This will greatly facilitate the subsequent finishing operation.

Rough milling with loosely connected pantograph

This operation requires accurate alignment of tracer pin and cutter by means of the straightedge. In milling, the tracer pin (loaded by the weight of the pantograph) slides along the contours of the master which are thus transferred to the workpiece by means of the pantograph attached to the tracer pin sleeve.

When this method is used, ball-end sleeve K is replaced by ball sleeve K_1 while the tracer pin is held in the pantograph by tracer pin sleeve K_2 . Select distance X slightly larger than the height X_1 of the pattern or master contour.

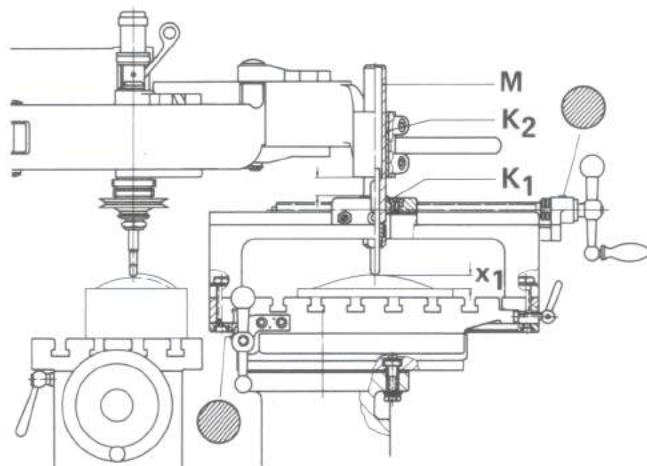
Finish milling of the workpiece will then be performed as usual on the GK.



The raising blocks (with long mounting screws) supplied as standard equipment of the rough milling attachment can be used for raising the bridge slide B 60 mm (2 3/8") to permit tracing of higher masters or contours.

Maintenance: supply rough milling spindle bearings with bearing oil (through nipple) as required. Lubricate daily if rough milling spindle is in constant use.

Keep feed screws and slide ways free of chips.



For identification of lubricant symbol see table of lubricants.

Rough milling

General information

Proper rough milling is of particular importance in die sinking work, since any excess material left for finishing would seriously reduce overall economy. In the case of large components it may be expedient to rough out the approximate shape of the die cavity on some other machine, for example a lathe or milling machine and leave only the genuine duplicating or contouring operation to the GK machine.

The amount of stock left for finishing (finishing allowance) is dependent on the shape of the component and the material to be cut. It is good practice to leave a finishing allowance of 1 mm (0.04") in deep die cavities requiring a long-shank cutter, and 0.5 mm (0.02") in the case of simple contours. When hard and tough materials are machined, the final size should be approached as closely as possible to facilitate the subsequent finishing operation.

Stock removal in rough milling with single-lip or multi-flute cutters will always be layer by layer, the bulk of the material being removed from the die cavity by means of multi-flute cutters for which a depth of cut of no more than 4 mm (5/32") has proved most economical. When single-lip cutters are used, the depth of cut should never exceed 3 mm (1/8"). In addition, the depth of cut is governed by the angle of inclination of the cavity walls: the smaller the angle of inclination, the smaller the depth of cut should be (Fig 3 and 4).

Economy in operation can be improved by adapting the cutter profile to the contour of the die cavity. Curved contours, for example, should be produced by means of rounded cutters. Obviously, the profile of the tracer pin must correspond to that of the cutter. For profiling cutters and tracer pins we recommend our SO single-lip cutter grinder.

The tracer pin diameter D_t is determined by the cutter diameter D_c plus the finishing allowance a .

Use the following formulas: —

Fig 1

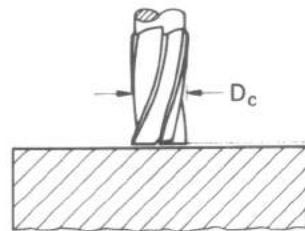
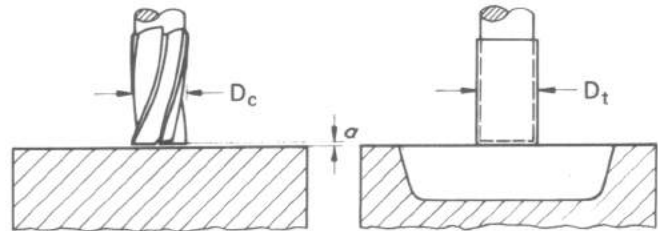


Fig 2



Reducing operations:

$$D_t = (D_c + 2a) \times P \quad D_c = \frac{D_t}{P} - 2a$$

where P = pantograph ratio

Always use the largest possible cutter for rough milling work, preferably multi-fluted end mills up to 10 mm (3/8") diameter. Single-lip cutters up to 10 mm (3/8") diameter can be used for machining steel components. Single-lip cutters, when used in rough milling, permit about three times the cutting speed ordinarily recommended for multi-flute cutters.



Fig 3

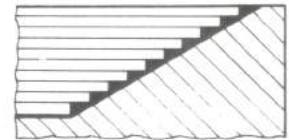


Fig 4



Fig 5

As a rule, coolant is not required for rough milling operations. In special cases, when cooling appears advisable, e.g. in machining light alloys, the cutter may be wetted with paraffin oil (kerosene) or the like.

Finish milling work

General information

Single-lip cutters should be given preference in finish milling because this type of tool provides optimum conditions for meeting the varying requirements with respect to profile, cutting angle, etc. We recommend the S0 single-lip cutter grinder for rapid and convenient profiling (see 'Grinding of single-lip cutters').

Vertical or near-vertical side walls of a die cavity require a cutter with off-centre radius. Only side walls blended into the die bottom by a radiused corner will be machined with a fully rounded cutter (Fig 1 and 2).

Angular surfaces with an angle of inclination of 10° or more from the horizontal or vertical plane will be machined with a fully rounded cutter (Fig 3 and 4).

Slightly crowned or plane surfaces require a fully rounded cutter, however, if a surface is at **right angles** to the cutter axis, a cutter with off-centre radius will be more economical (Fig 5 and 6).

Curved internal or external surfaces should be finish-milled by means of fully rounded cutters. Always work from the bottom to the top, if possible, because this ensures a higher rate of stock removal (Fig 7 and 8).

Sharp internal corners, V-type grooves, etc. are first machined by means of a tapered cutter with rounded end and finally with a pointed cutter for finishing the corners. In the latter operation, the profile angle of the cutter should never be larger, but may be slightly smaller, than the inclination of the angular surfaces (Fig 9 and 10).

Compliance with these general rules will in most cases make subsequent hand finishing superfluous or at least reduce it to a minimum.

Finish milling, which is required to produce accurate dimensions and a high degree of surface finish, is performed in two operations — semi-finishing and final finishing.

The initial semi-finishing cut is used to remove the steps and surface irregularities produced by rough milling. The final finishing allowance to be left throughout the surface of the work should not exceed 0.1 mm (0.05"). This semi-finishing operation serves to reduce the cutter load and extend the cutter life between regrinds in final finishing.

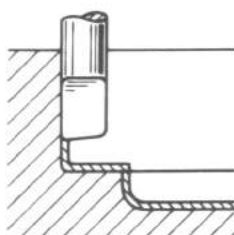


Fig 1

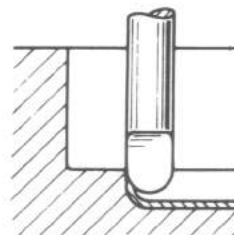


Fig 2

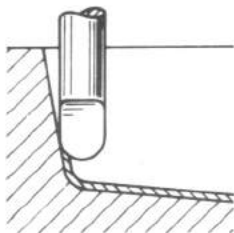


Fig 3

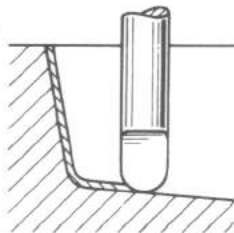


Fig 4

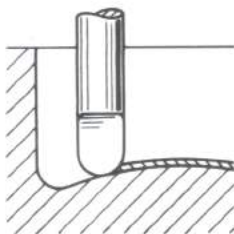


Fig 5

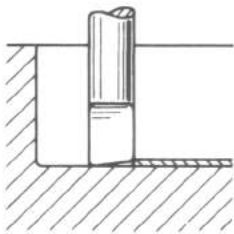


Fig 6

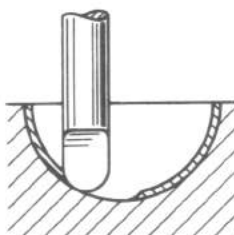


Fig 7

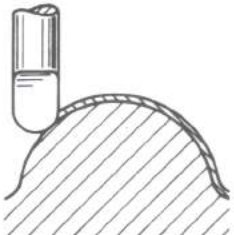


Fig 8

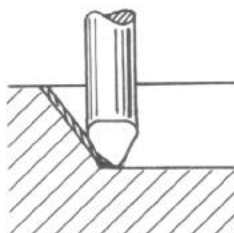


Fig 9

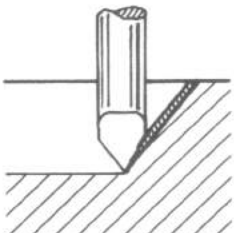


Fig 10

Both the surface finish and the accuracy of the work are largely dependent on the type and design of the pattern or master. Accuracy requirements should, therefore, be taken into due account in pattern making. Maximum accuracy will be obtained with masters made of steel, non-ferrous metals and certain plastics, i.e. materials that permit keeping surface irregularities within 10 microns (0.0005").

Masters made of soft materials such as wood or porcelain cement will result in larger manufacturing tolerances.

Forming attachment (standard equipment)

The forming attachment comprises a forming guide holder 1 with forming guide locating fixture and clamping screw and the cutter spindle fine adjustment 2. The attachment permits engraving of components with crowned or inclined surfaces (up to 15°).

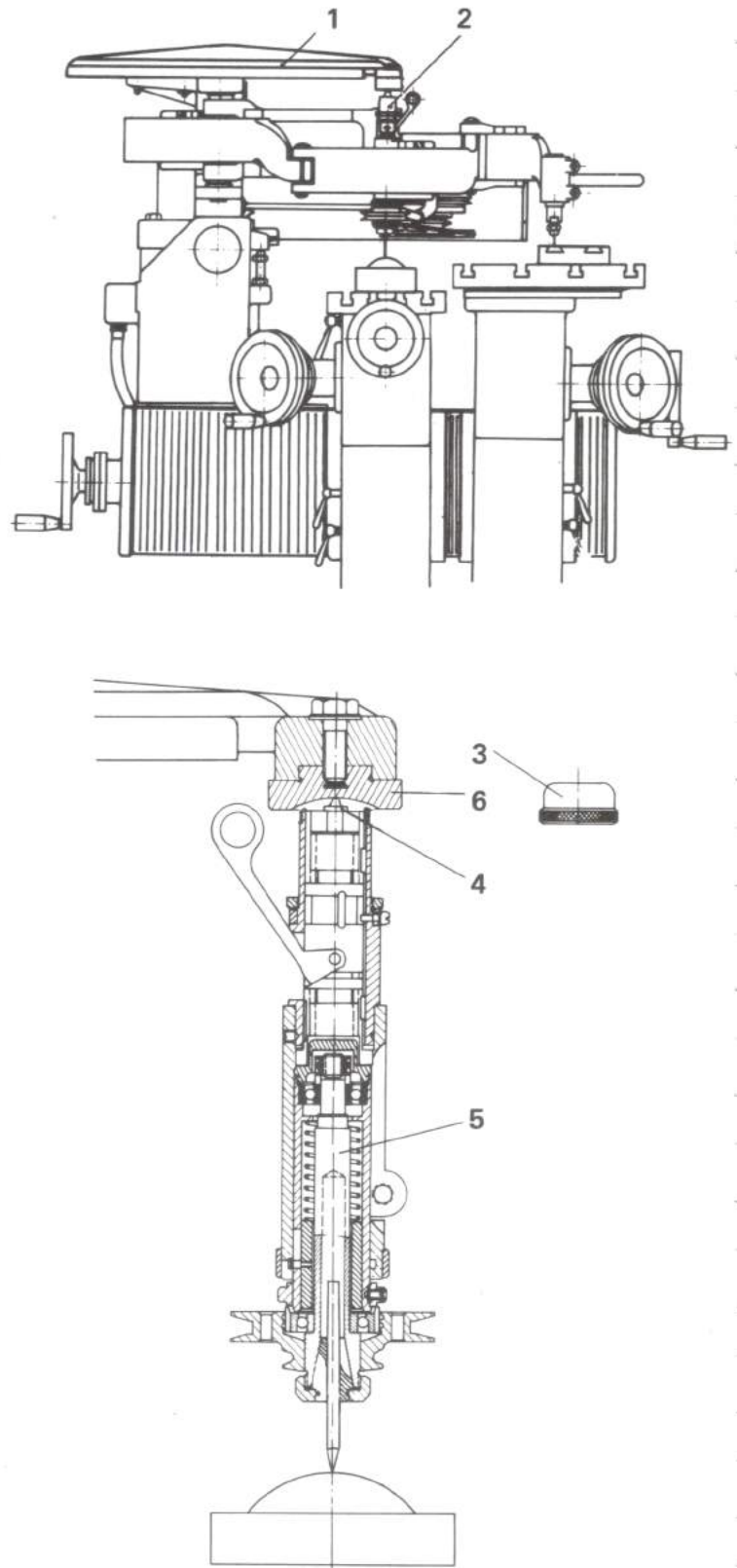
Operation

Upon removal of cap 3, the spring-loaded cutter spindle 5 urges the guide centre 4 at the end of the spindle fine adjustment in an upward direction against the forming guide 6 corresponding to the crowned or inclined surface of the workpiece.

Any lateral movement of the cutter spindle will thus result in a positively controlled cutter movement perpendicular to the the clamping surface. The crowned shape of the forming guide is governed by the crowned shape of the workpiece (with a due allowance for the radius of the guide centre) and must be accurately aligned with the work.

Use only radiused cutters and make certain that the engraving depth does not exceed the radius of the cutter tip.

To compute the radius of the forming guide use the following formula: $R_f = R_w + R_c + r_c$, where R_f = radius of crown in forming guide, R_w = radius of crown on workpiece, R_c = radius of cutter, r_c = radius of guide centre point (1 mm or 0.04" radius). When pointed single-lip cutters are used for linear engraving, the cutter radius R_c can be neglected. The forming guide should preferably be used for only a limited area of the crowned surface because the cutter point will cause a certain amount of distortion if moved too far away from the centre. To engrave the entire diameter of a body of revolution use an index head and proceed step by step. To keep possible distortion in the outer zone within acceptable limits it will be expedient to restrict deep-cut engraving work to an area defined by a central angle of 30°, i.e. the cutting range on circular work should not exceed 1/12 of the circumference of a circle.



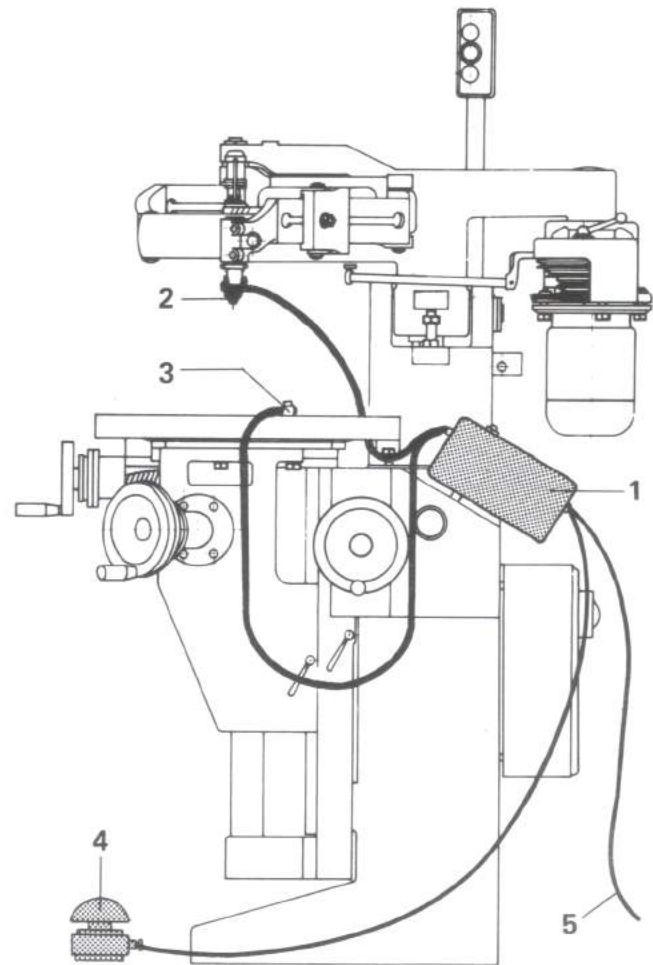
Electromarking unit

The electromarking unit used in conjunction with engraving and copy milling machines has primarily been designed for lettering and marking of hardened steel components. The appearance of such lettering will be between brown and deep black, depending on the hardness of the material.

The electromarking unit is simple to operate and, in view of the low voltage employed, completely safe. It is only available for 220 V AC power supply.

Main components

1. Converter
2. Marking head
3. Earth (ground) terminal
4. Foot switch
5. Power supply cable



Mounting and connecting the unit

Mount converter cabinet 1, preferably by fitting the rail on the underside of the housing to a mounting strap to be attached to the machine column.

Remove cutter spindle and insert marking head 3 in its place (do NOT clamp). Use an adapter sleeve on GK21 machines.

Attach earth (ground) terminal 3 close to component to be marked, ensuring good electric conductivity. Place foot switch 4 in convenient location (may also be operated by hand).

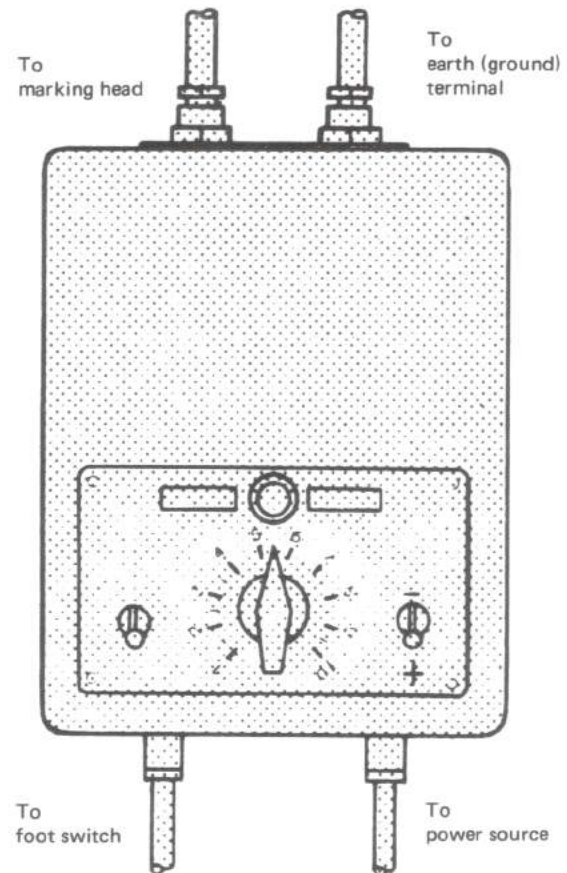
Connect power supply cable 5 to 220 V AC power source, observing local regulations.

CAUTION: the connection to a DC power source will immediately destroy the attachment.

Electromarking unit

Operation

Set toggle switch on the left to 'foot' position: the marking current will not flow until the foot switch is operated. Then place the tip of the electrode in the marking head at the point to be marked on the component mounted on the engraving machine. The pressure on the electrode, which is exerted by the spring-loaded mount of the marking head, should be approx 100 ... 200 g (4 ... 7 oz). It is advisable first to establish the intensity of the marking current by setting the toggle switch on the right to 'weak' and turning the regulating control in the middle, from its extreme left position in a clockwise direction until the desired current intensity is obtained. In the course of time you will be familiar with the attachment and know the appropriate settings for different classes of work by experience. Trace the letter templates slowly and at a uniform rate, allowing a time of 4 to 5 seconds for each letter or numeral. To avoid burned spots or craters at the start and end of a letter, do not operate the foot switch until the electrode is in contact with the surface to be marked and, in the same way, do not lift off the electrode until after the switch has been released.



The use of the electromarking unit causes a relatively heavy volume of low-voltage current (0.5 ... 1 V, 100 ... 300 A) to flow through the 'bottle-neck' between the current-carrying workpiece and the electrode tip. The high resistance at this point results in the generation of heat causing the instantaneous melting and burning of the material in the vicinity of the electrode point.

Make certain that the marking circuit is not interrupted by any insulating substances such as paint, oil or scale.

Both the width and the depth of the markings can be controlled within certain limits by selecting a more or less sharply pointed electrode and/or by varying the current. It should be borne in mind, however, that a process such as electromarking is not meant to compete with the versatility of mechanical engraving.

The electrodes can be resharpened with cemented carbide grinding wheels. The most suitable apex angle of the electrode point has been found to be 30°.

Should the electrode accidentally be welded to the workpiece, which may be due to an excessively strong arc or to certain characteristics of the material being marked, switch off the current to avoid overheating of the parts. Unclamp the electrode and cautiously remove its point from the work using a pair of small pliers or tweezers.

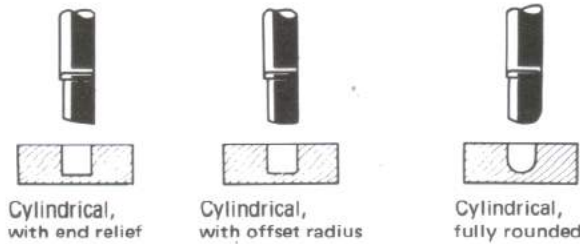
The electromarking unit and its cables should be protected from moisture (water, coolant). Check all current-carrying surfaces such as terminal, electrode chuck, etc. for satisfactory contact from time to time and clean if necessary.

Single-lip cutters

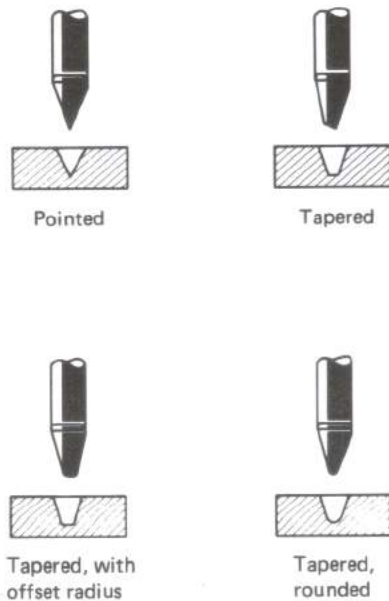
Cutting profiles

The following seven basic profiles are chiefly used in cutting operations on GK machines.

Cylindrical profiles



Tapered profiles



Lubrication and cooling of cutting point

Engraving is usually a dry cutting process. Air cooling of the cutting edge may be advisable for high stock removal rates: the air current will at the same time keep the cutting point free of chips. The use of a lubricoolant is recommended only for certain 'difficult' materials.

Material

Soft aluminium alloy
Copper or soft bronze
Plastics such as Resopal or Astralon
Soft steels
Sheet steel

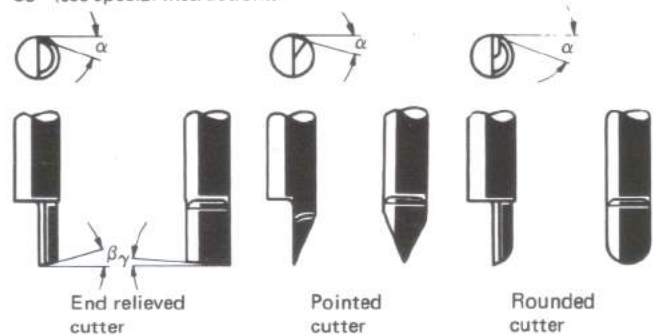
Lubricant

White spirit or paraffin oil
Water-soluble cutting oils
Paraffin oil (kerosene)
Paraffin oil or cooling oil
Special cutting oils

Cutting angles

Single-lip cutters as, in fact, all cutting tools require a certain amount of relief behind the cutting edges to achieve maximum cutting capacity and obtain a good surface finish. Three cutting angles are of importance, which apply to all profiles (see illustration below).

Cutting angle β is applicable only to cutters with end relief. Cutters having an angle α below 20° should be back-relieved approx 25° to 30° (see special instructions).



Cutting speed

The cutting speed of single-lip cutters should be about three times the value ordinarily used for multi-flute cutters. The speeds shown in the table below are merely guiding values because such factors as the machine drive system, obtainable speeds of rotation, etc, have to be taken into account as well. It should be noted that, on rounded cutters, the cutting speed at the front face cutting edge decreases towards the cutter axis and it will thus be good practice to cut only with the outer portion of the cutting edge wherever possible. For this reason, angular surfaces should not be machined in a downward but rather in an upward direction.

Cutting angles and economical cutting speeds for single-lip cutters

Material	Cutting angles			Cutting speed mm/min (fpm)	
	α	β	γ	Roughing	Finishing
Cast iron, cast steel				60 (195)	80 (260)
Structural steel 40 - 60 kg/mm ² 60 - 80 kg/mm ² over 80 kg/mm ²	25°	15°	5°	70 (230)	90 (295)
				60 (195)	70 (230)
				40 (130)	50 (165)
Tool steel soft hard	25°	15°	5°	60 (195)	80 (260)
				50 (165)	70 (230)
Brass 58/42 soft hard	30°	15°	5°	200 (655)	250 (820)
				250 (820)	350 (1150)
Brass 63/37 soft hard	30°	15°	5°	120 (390)	150 (490)
				150 (490)	180 (590)
Bronze soft hard	30°	15°	5°	160 (525)	200 (655)
				200 (655)	230 (755)
Aluminium soft hard	35°			200 (655)	300 (985)
				250 (820)	350 (1150)
Wood				300 (985)	350 (1150)
Plastics: Trolon (pattern casting composition) Pertinax (laminated plastics), fibre Pollopas, Resopal Astralon, plexiglass, celluloid	25°	15°	5°	250 (820)	300 (985)
				200 (655)	250 (820)
	45°	25°	20°	200 (655)	300 (985)
				200 (655)	350 (1150)

Etching

Etching is primarily used where the material is so hard that conventional engraving is either uneconomical or even impracticable. This applies in particular to lettering and marking of hardened or very hard steel components (tools, machine parts, etc) as well as glass or similar materials. The workpiece surface is first coated with some acid-resistant material into which the desired lettering or marking is scribed by means of a scoring needle. The etching depth depends on the type of acid used and the time of exposure to the acid. In the case of large production lots, the process can be facilitated and expedited considerably by using suitable equipment.



Sequence of operations

1. Degreasing the component

Use benzene, benzine, trichloroethylene or the like.

2. Applying the acid-resistant coat

Use a fine camel-hair brush and apply very thin and uniform coating. Take care not to leave any exposed spots uncoated. Small mass-production parts should preferably be dip-coated. The coating material should dry rapidly but retain a high degree of elasticity for an extended period of time to prevent flaking-off during marking. Drying will take approx 20 minutes, while marking should be possible for a period of 24 hours, depending on the composition of the coating material.

3. Marking the component

Markings are scored into the coating by means of a spring-loaded etching needle (see illustration). Such a needle can also be used for slightly curved or irregular surfaces, provided the length of travel of the spring-loaded needle insert (approx 5 mm or 0.2") is not exceeded. Delicate engraving work is performed by means of a pointed needle while the cutter spindle is standing still. Wider lines can be obtained with the aid of a chisel-edged scriber rotating in the cutter spindle. Etching tools of this kind can only be used on plane surfaces, otherwise the coating might not be fully removed and this would yield unsatisfactory etching results.

4. Etching the components

The acid is applied by means of a pipette, a brush or a wooden stick wrapped with cotton wool. Dip-coated components can also be dip-etched. For deep markings the acid may be applied several times to accelerate the process. Etching time approx 2 ... 12 minutes. Hardened carbon steel will give black markings, while unhardened steel, wrought iron and certain high-grade steels will give white markings. In the latter case, if deep-black markings are required, a suitable black mordant is applied after the acid has been removed.

5. Cleaning the workpiece

After etching, rinse the work thoroughly in running water. Remove the coating by means of benzene or hot soda solution. To prevent rusting, grease the components immediately with good petroleum jelly.

Roll engraving attachments

The roll engraving attachments permit the use of ordinary templates, type templates or relief patterns for engraving characters, linear patterns and designs or 3-dimensional shapes on the entire circumference (dependent on diameter) of cylindrical or tapered components without resetting the work.

For technical data see the table below.

Roll engraving attachments 6021 and 6022 are equipped with a three-jaw chuck and a tail centre. The use of roll engraving attachments at reduction ratios exceeding 1 : 6 will reduce the working range of the machine.

Attachments 6024 and 6025 require raising blocks of 190 mm (7 1/2") for the pantograph carrier and the copyholder table.

Fig 1

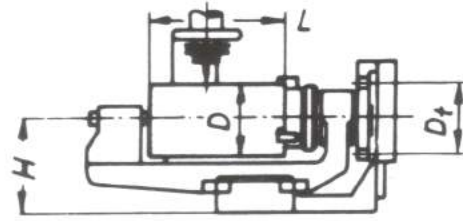


Fig 2

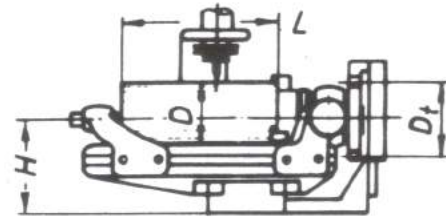


Fig 3

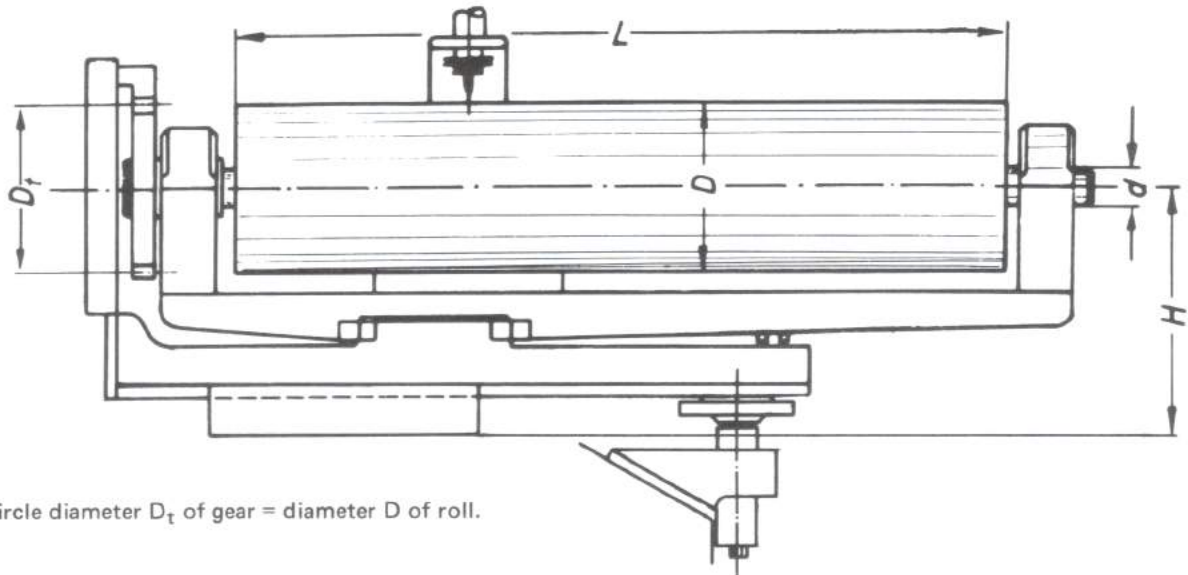
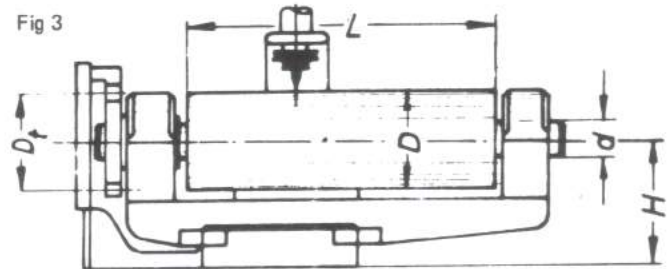


Fig 4

Pitch circle diameter D_t of gear = diameter D of roll.

Stock No	Fig	Min roll dia D	Max roll dia D	Roll length L	Max clamping dia d	Max engraving length		Max length of development	Overall height H	Range of use on		Weight
						with reversal of drive member	without reversal of drive member			GK12	GK21	
		mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)			kg (lb)
6021 000000	2	20 (0.8)	100 (3.9)	240 (9.4)	70 (2.7)	170 (6.7)	220 (8.7)	168 (6.6)	103 (4.1)	● ▲	● ▲	27 (60)
6022 000000	1	33 (1.3)	150 (5.9)	250 (9.8)	85 (3.3)	200 (7.9)	200 (7.9)	200 (7.9)	150 (5.9)	□ ▲	□ ▲	41 (90)
6024 000000	3	130 (5.1)	300 (11.8)	500 (19.7)	70 (2.7)	200 (7.9)	500 (19.7)	160 (6.3)	214 (8.4)	● ▲	● ▲	88 (195)
6025 000000	4	130 (5.1)	300 (11.8)	1000 (39.4)	70 (2.7)	200 (7.9)	1000 (39.4)	160 (6.3)	332 (13.1)	△ ▲	△ ▲	186 (410)

- - Special equipment: raising blocks 190 mm (7 1/2"); usable only for pantograph ratios of 1 : 2.5 to 1 : 1.8; reduced working range at ratios of 1 : 3 and 1 : 1.5.
- - Chuck swings 90° for tapered work.

- △ - Special equipment: mounting bracket (Fig 4).
- ▲ - Suitable for use on machines indicated.
- - Limited working range at ratios of 1 : 3 and 1 : 1.5, especially in duplicating work.

Roll engraving attachments

Operating instructions

Determining the length of patterns and engraved designs

The length of the pattern or master in relation to the roll circumference is determined by the circumferential length of the engraved pattern and the pantograph ratio.

In simple terms: —

$$L = l \times u$$

$$l = L/u$$

$$u = L/l$$

where —

L = length of template or master
l = circumferential length of engraved pattern
u = pantograph ratio

In the case of engraved patterns repeated several times around the circumference (e.g. rolls for wall paper or picture frames), the length of the master is determined by the number of repetitive portions and governed by the following formula: —

$$L = \frac{l \times u}{n} \quad l = \frac{L \times n}{u} \quad u = \frac{L \times n}{l}$$

where n = number of repetitive portions or sections.

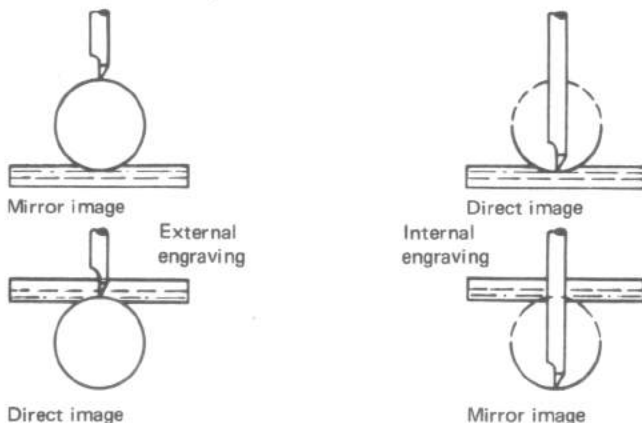
This method of subdividing the pattern to be engraved will also be applied if the circumferential length of the engraving exceeds the length of development of the roll engraving attachment or the working range of the machine.

When the roll is driven by a rack and gear, indexing is facilitated by an index mark on the rack to be set in line with corresponding marks on the gear in accordance with the number of repetitive portions to be engraved (see illustration).

Preferably use a gear with a number of teeth that can be divided by as many numbers as possible.

By reversing the position of the rack (or generating band), the same template can be used for obtaining either a direct image or a mirror image of the pattern.

Reversing the rack position



Drive gears and discs

The nature of the engraved work is determined by the ratio between the pitch circle diameter of the drive gear (or the disc diameter when a generating band is used) and the roll diameter. Any major difference between these diameters will change the appearance of the characters or patterns, i.e. they will be narrower or wider depending on whether a larger or smaller gear (disc) is selected. In the case of shallow engraved work, a true reproduction of the template will only be obtained if the pitch diameter (or the disc diameter plus generating band) equals the outside diameter of the roll. Slight deviations in either direction are in most cases permissible. The relationship between the two diameters is governed by the following formulas: —

Rack and drive gear:

$$D_t = D_a \quad D_a = D_t$$

Generating band:

$$W = D_a - s \quad D_a = W + s$$

where —

D_t = pitch circle of drive gear
 D_a = outside diameter of roll to be engraved
W = disc diameter
s = thickness of generating band

The relationship will be different in the case of relief-type engraving work because an allowance has to be made for the depth of the engraved patterns: —

Rack and drive gear:

$$D_t = D_a - h \quad D_a = D_t + h$$

Generating band:

$$W = D_a - s - h \quad D_a = W + s + h$$

where h = height (or depth) of engraved pattern.

To determine value h, divide the height H of the relief master by the pantograph ratio: $h = H/u$.

In such type of work it will thus be expedient first to determine the pitch circle or disc diameter and then the outside diameter of the roll.

The pitch of the rack is module 1 (25 DP). To determine the number of teeth of the gear, divide the pitch circle diameter in mm by the module (or multiply the pitch circle diameter in inches by the diametral pitch). In the case of metric gears, the number of teeth always equals the pitch diameter in mm.

More detailed information on the operation and maintenance of roll engraving attachments will be found in the operating instructions supplied with each attachment.

Preparation of patterns and masters

The duplication (copy milling) of dies and moulds on the GK machine requires an enlarged pattern or master which, in turn, is usually produced on the GK machine itself (set for enlarging work) in conjunction with suitable auxiliary templates or a hand-made sample. Alternatively, a finished die or mould can be used for preparing a new, enlarged pattern or master, in which case possible design changes or modifications would have to be incorporated. Patterns made on an enlarged scale have the advantage that possible deviations from the desired shape will be reduced in proportion to the pantograph ratio by the copying operation. Depending on the job on hand, patterns or masters can be made in two different ways:

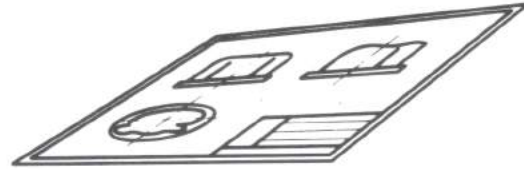


Fig 1 Drawing

1. In the case of intricate three-dimensional shapes with irregular contours it is good practice first to prepare a positive pattern, called prototype, making due allowance for the expected amount of shrinkage. Large patterns will be made of hardwood, small patterns of synthetic resin or some other easy-to-machine material. From this prototype pattern a Monolith cast is taken, which is then used as a basis for a single enlarged-scale duplication in a synthetic resin material. A more convenient procedure would be taking the cast from an enlarged hardwood pattern and use this for duplication. Patterns made of plastics can be easily retouched, are more resistant to wear than patterns made of a cement compound, and can thus be used for repeated duplication.



Fig 2 Positive pattern

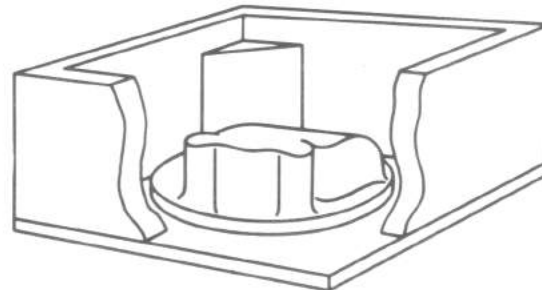


Fig 3 Pattern box

2. Patterns showing delicate details or requiring a high degree of surface finish and accuracy, especially if required for repeated copying operations, should be made of steel (using a plastic pattern as an intermediate step) and can even be heat-treated or hardened if required. In the case of drawing or pressing dies for hollow parts, e.g. sheet-metal embossing dies or bakelite moulds, the positive pattern can also be used for machining an enlarged pattern of the punch. Allowance for the desired wall thickness can be made by using a different tracer pin or cutter diameter.

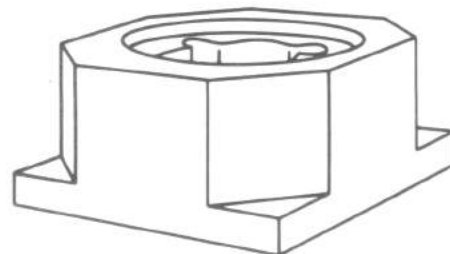


Fig 4 Negative pattern



Pattern making

Materials

1. Hardwood

The preferred material for hand-made patterns is pear-tree wood which will be available in almost every pattern shop. Maple and walnut can also be used. Hardwood is primarily employed in making positive patterns which are then used for making Monolith (rock powder) or porcelain cement casts. Where relatively simple shapes are concerned and accuracy requirements are not very stringent, these positive patterns can be directly used as copying masters. Hardwood is very easily machinable on the GK engraving and copy milling machine.

2. Monolith rock powder

Monolith is a rock powder composition which is particularly suitable for pattern casting. The material is prepared for use in much the same way as cement and poured in fluid form into the pattern box. While casting is in progress, the compound should be stirred continuously in order to maintain its consistency. Setting takes approximately 18 to 24 hours, then the cast can be used for duplicating work, although the hardening process still continues for a substantial period of time.

Monolith patterns show hardly any shrinkage but are susceptible to damage by shock or impact. They are chiefly used in cases where only positive patterns are available, for example for the manufacture of press dies. Such positive patterns are either obtained by mechanical duplication of a pressed part or sample or cut directly in wood or a similar material in accordance with drawing specifications.

3. Plastics

Synthetic resins have proved most satisfactory for pattern making. They combine high strength with toughness, are practically free of distortion and shrinkage, not affected by changes in temperature or by water, and to a certain extent they are acid-resistant. They constitute no fire hazard, since even sawdust and filings of the material will not burn but only smoulder. Pattern-making plastics are easily machinable by sawing, planing, drilling, milling, carving, shaving, etc, and can thus be used for enlarging work. The obtainable surface finish is such that only a minimum of hand finishing is required. Patterns made of plastics are particularly suitable for shapes showing fine details and requiring a high degree of accuracy. They are extremely useful for duplication in steel and can be used for repeated copy milling operations.

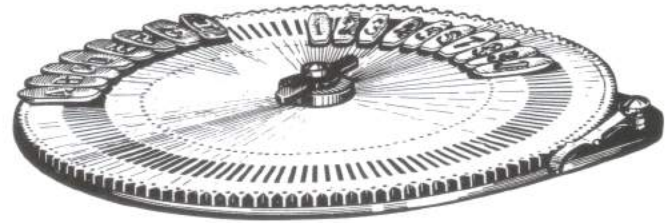
Suitable plastics and monolith rock powder are available from the DECKEL factory or from DECKEL agents.

Engraving accessories

Universal copy dial

The use of the copy dial in conjunction with the circular table greatly facilitates the engraving of letters arranged on arcuate lines. The copy dial comprises a base plate mounted on the copyholder table by means of clamps, and a rotatable top provided with holes and slots for prong-type templates. The top plate is locked by means of a pawl engaging peripheral teeth.

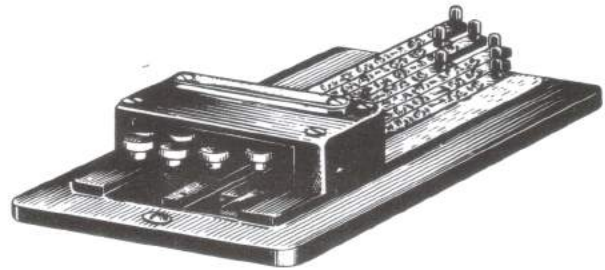
Outside diameter 200 mm (7 7/8")
 Diameter of circle formed by characters
 (middle of templates) . . . 139 mm (5 1/2") or 179 mm (7")



Serial numbering holder

For engraving consecutive or frequently changing numbers or identifications. The serial numbering holder consists of a base plate holding seven adjustable copy strips (figures and/or characters) which are held in position by means of detent pins and can be rapidly positioned to give the desired combination.

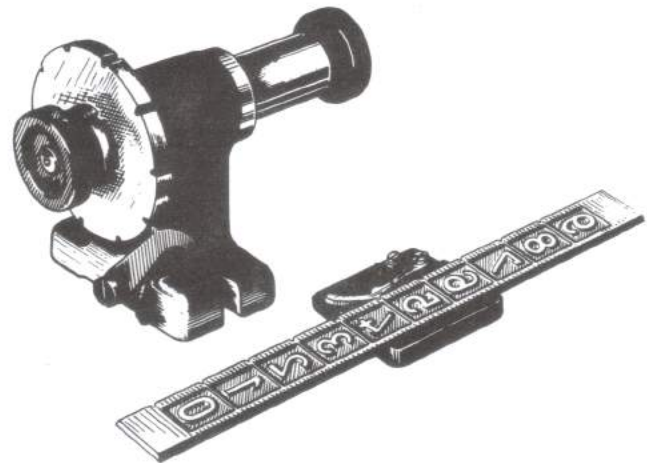
Overall dimensions 100 x 200 mm (4" x 7 7/8")



Numbering wheel engraving device

This attachment includes a template holder and is used for the engraving of numbering wheels, date wheels and similar parts. A cast base member carries a quill with a 10-register index plate and a work locating arbor. Both the index plate and the master copy strip are arrested in position by detent pawls. Several components can be clamped at a time: max capacity 50 mm (2").

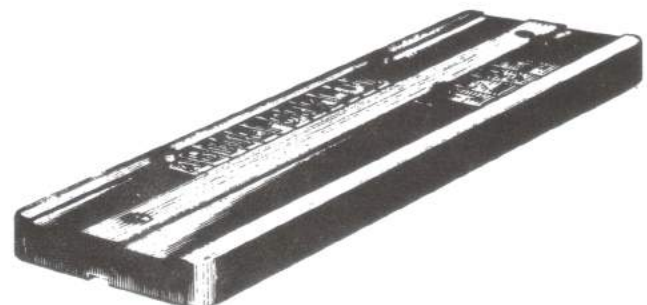
Optional: master copy strip with raised reflected numerals, as shown. Special strips available on request.



Type template holders

The two-groove model (metric and inch) receives type templates with 20 mm or 3/4" height of letters; the single-groove model (metric only) holds type templates with 40 mm height of letters. Mounted on the copyholder table by means of T-slot bolts.

	2-groove holder		1-groove holder	
Dimensions	120x440 mm (4 3/4"x 17 3/8")	500x100 mm (19 5/8"x 4")	800x100 mm (31 1/2"x 4")	

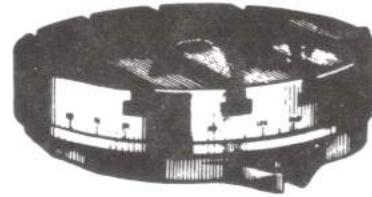


Work holding and indexing fixtures

Circular table

The circular table has a 360° graduation permitting angular positioning of the work with the aid of a zero reference line. The table top can be clamped in position.

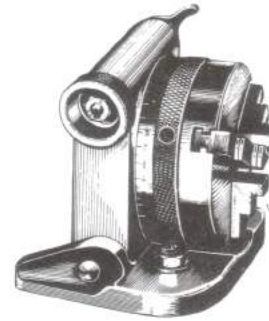
Diameter of table top 230 mm (9 1/8")
Overall height 60 mm (2 3/8")



Index head, tilting range 90°

The three-jaw chuck of this clamping and indexing fixture is fitted with external and internal jaws, can be tilted 90°, rotated 360° and locked in any desired position. The indexing accuracy is ± 2.5 minutes of arc. Rotary adjustment either by means of a worm drive (fine adjustment to graduated scale) or by hand with the worm disengaged.

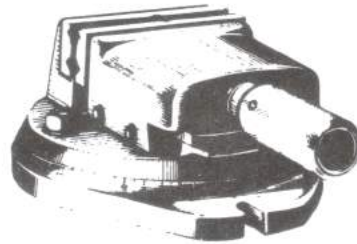
Height, chuck axis horizontal 138 mm (5 1/2")
Max work diameter
with chuck axis horizontal 95 mm (3 3/4")
with chuck axis vertical 110 mm (4 3/8")



Machine vice

The vice is fitted with grooved clamping jaws for holding different work shapes and has a swivel base for rotary adjustment with the aid of a 360° graduation.

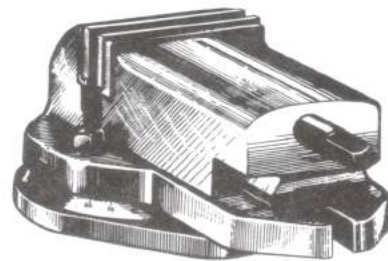
Clamping capacity 55 mm (2 1/8")
Width of jaws
with base 85 mm (3 3/8")
without base 65 mm (2 5/8")



Machine vice

Provided with plain clamping jaws and a swivel base for 360° rotary adjustment to scale. Pull-down clamping action for firm holding of component.

Clamping capacity 80 mm (3 1/8")
Width of jaws 110 mm (4 3/8")
Overall height
with base 115 mm (4 1/2")
without base 90 mm (3 1/2")

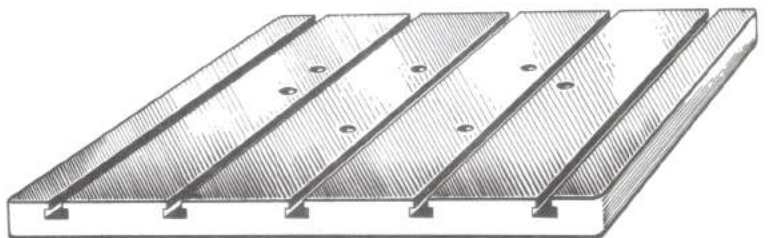


Accessories: 2 V-blocks.

Auxiliary tables

The two auxiliary tables are used for increasing the clamping area.

Sizes 320 x 425 mm (12 5/8" x 16 3/4")
and 450 x 600 mm (17 3/4" x 23 5/8")



Circular table 6017—380 mm (15") diameter

Technical data

Clamping surface diameter	380 mm (15")
Overall height	110 mm (4 3/8")
7 T-slots, width	12 mm (15/32")
distance	50 mm (2")
Worm gear ratio	90 : 1
Centre bore diameter	40 mm (1.575")
Direct indexing by graduation, 1 division	1°
with vernier, smallest value	1 min of arc
Direct indexing by index plate, number of registers	24
Indirect indexing, number of index plates	3
	27, 31, 34, 41, 43 / 33, 38, 39, 42, 46 / 36, 37, 40, 58
Indexing accuracy	± 1' 30"
Weight approx	55 kg (121 lb)

Special equipment: supplementary indexing device.

Aligning table axis with vertical spindle axis

See 'Setting-up'.

Engaging and disengaging the worm

Release clamp 1. Cautiously swivel index plate and crank handle 3 to the left (engagement) or right (disengagement) up to stop, observing the mark behind the index plate. Move crank slightly back and forth to facilitate engagement. Retighten clamp 1.

Direct indexing

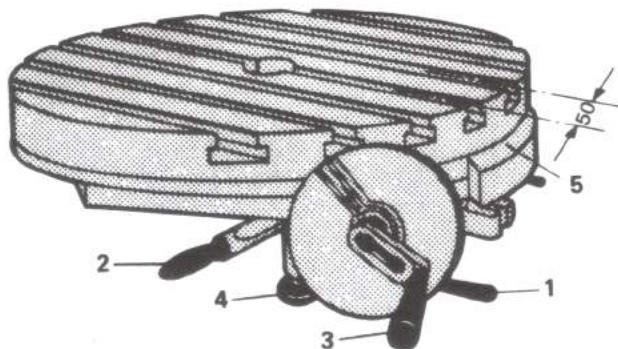
When using 24-register index plate, pull out index pin 4 downwards and turn into locked position. Rotate table top either by means of crank handle 3 or, upon disengagement of the worm, by hand to the desired register position. Then turn index pin back to unlocked position and allow to snap into the register.

An alternative method is indexing by the 360° graduation with adjustable vernier 5. The latter has 60 divisions covering 59° and thus permits readings to an accuracy of 1 min of arc.

Indirect indexing by means of index plates

Mount the index plate with the required index circle, proceeding as follows: remove nut, washer, crank handle and sector arms. Exchange index plates, refit the parts removed and set the crank for the index circle required.

Indexing operation: loosen clamping screw and adjust sector in such a way that one arm rests against the index pin and the required number of holes (NOT counting the hole engaged by the pin) is between the two arms. First rotate the crank through the required number of full turns, then through the angle enclosed by the sector. Allow pin to snap into hole and advance sectors. For table of indexing values see overleaf.

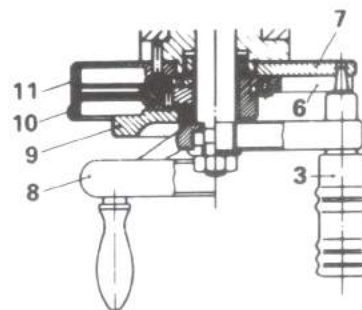


Clamp table top by means of clamping lever 2 during milling and boring operations, if possible.

A hoisting chain is available for transporting the table.

Indirect indexing with supplementary indexing device

To mount the supplementary indexing device, remove crank handle 3, sector arms 6 and index plate 7, then fit parts 8, 9, 10 and 11 as shown in the illustration. Engage indexing worm.

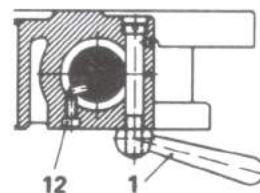


Indexing operation: align table (with or without workpiece) with milling or boring spindle or with X and Y axes of machine and clamp by means of 2. Release locking nut 9, set graduated disc 10 to 0 or other desired starting value and (if required) set vernier 5 to 0. Clamp 10 by means of 9 and continue indexing by means of graduated scale.

- 1 revolution of graduated disc = 4°
- 1 division of graduated disc = 1 sec of arc

Eliminating play between worm and worm gear

Should play develop, remove hex socket screw 12 grind off a few thousandths of an inch from the point or insert shims, and refit. This will result in a slightly deeper engagement of the worm. To check for play, rotate the table top with the worm engaged.



FP1
FP2 E2
FP3 E3
KF
G
GK



Circular table 6017 - 380 mm (15") diameter

Number of divisions	Value in degrees	Number of crank turns		Number of division	Value in degrees	Number of crank turns		Number of divisions	Value in degrees	Number of crank turns		Number of divisions	Value in degrees	Number of crank turns		Number of divisions	Value in degrees	Number of crank turns	
		full	fractional			full	fractional			full	fractional			full	fractional			full	fractional
2	180°	45	—	20	18°	4	17/34	68	—	1	11/34	180	2°	29/58	—	24'	4/40	900	4/40
—	175°	43	30/40	"	"	"	23/46	69	—	1	14/46	185	"	18/37	—	18'	3/40	930	3/31
—	160°	40	—	"	"	"	29/58	70	—	1	12/42	186	—	15/31	—	12'	2/40	945	4/42
—	150°	37	17/34	—	16°	4	—	72	5°	1	10/40	189	—	20/42	—	6'	1/40	990	3/33
—	"	"	23/46	21	—	4	12/42	74	—	1	8/37	190	—	18/38	369	—	10/41	1020	3/34
—	"	"	29/58	22	—	4	3/33	75	—	1	8/40	195	—	18/39	370	—	9/37	1035	4/46
—	140°	35	—	23	—	3	42/46	76	—	1	7/38	198	—	15/33	378	—	10/42	1044	5/38
—	135°	33	30/40	24	15°	3	30/40	78	—	1	6/39	200	—	18/40	380	—	9/38	1080	3/36
—	130°	32	17/34	25	—	3	24/40	80	—	1	5/40	204	—	15/34	387	—	10/43	1110	3/37
—	"	"	23/46	26	—	3	18/39	81	—	1	4/36	205	—	18/41	390	—	9/39	1140	3/38
—	"	"	29/58	27	—	3	9/27	82	—	1	4/41	207	—	20/46	400	—	9/40	1170	3/39
—	125°	31	10/40	"	—	"	14/42	84	—	1	3/42	210	—	18/42	405	—	8/36	1200	3/40
3	120°	30	—	"	—	"	12/36	85	—	1	2/34	215	—	18/43	410	—	9/41	1215	2/27
—	110°	27	17/34	28	—	3	9/42	86	—	1	2/43	216	—	15/36	414	—	10/46	1230	3/41
—	"	"	23/46	29	—	3	6/58	87	—	1	2/58	222	—	15/37	420	—	9/42	1260	3/42
—	"	"	29/58	30	12°	3	—	90	4°	1	—	225	—	16/40	430	—	9/43	1290	3/43
—	100°	25	—	31	—	2	28/31	92	—	—	45/46	228	—	15/38	435	—	12/58	1305	4/58
4	90°	22	17/34	—	11°	2	30/40	93	—	—	30/31	230	—	18/46	450	—	8/40	1380	3/46
"	"	"	23/46	33	—	2	24/33	95	—	—	36/38	234	—	15/39	460	—	9/46	1395	2/31
"	"	"	29/58	34	—	2	22/34	—	3 1/2°	—	35/40	240	—	15/40	465	—	6/31	1485	2/33
"	80°	20	—	35	—	2	24/42	99	—	—	30/33	243	—	10/27	486	—	5/27	1530	2/34
"	75°	18	30/40	36	10°	2	17/34	100	—	—	36/40	246	—	15/41	495	—	6/33	1620	2/36
5	72°	18	—	"	"	"	23/46	102	—	—	30/34	252	—	15/42	510	—	6/34	1665	2/37
—	70°	17	17/34	"	"	"	29/58	108	—	—	35/42	255	—	12/34	522	—	10/58	1710	2/38
—	"	"	23/46	37	—	2	16/37	"	—	—	30/36	258	—	15/43	540	—	6/36	1740	3/58
—	"	"	29/58	38	—	2	14/38	111	—	—	30/37	261	—	20/58	555	—	6/37	1755	2/39
—	67 1/2°	16	35/40	39	—	2	12/39	114	—	—	30/38	270	—	12/36	558	—	5/31	1800	2/40
—	65°	16	10/40	40	9°	2	10/40	116	—	—	45/58	276	—	15/46	570	—	6/38	1845	2/41
6	60°	15	—	41	—	2	8/41	117	—	—	30/39	279	—	10/31	580	—	9/58	1890	2/42
—	55°	13	30/40	42	—	2	6/42	120	3°	—	30/40	285	—	12/38	585	—	6/39	1935	2/43
7	—	12	36/42	43	—	2	4/43	123	—	—	30/41	290	—	18/58	594	—	5/33	2070	2/46
—	50°	12	17/34	45	8°	2	—	126	—	—	30/42	297	—	10/33	600	—	6/40	2430	1/27
—	"	"	23/46	46	—	1	44/46	129	—	—	30/43	300	—	12/40	612	—	5/34	2610	2/58
—	"	"	29/58	48	—	1	35/40	135	—	—	18/27	306	—	10/34	615	—	6/41	2790	1/31
8	45°	11	10/40	50	—	1	32/40	"	—	—	22/33	310	—	9/31	630	—	6/42	2970	1/33
9	40°	10	—	51	—	1	26/34	"	—	—	24/36	315	—	12/42	645	—	6/43	3060	1/34
10	36°	9	—	—	7°	1	30/40	138	—	—	30/46	324	—	10/36	648	—	5/36	3240	1/36
—	35°	8	30/40	54	—	1	18/27	140	—	—	27/42	330	—	9/33	666	—	5/37	3330	1/37
11	—	8	6/33	"	"	"	28/42	144	—	—	25/40	333	—	10/37	684	—	5/38	3420	1/38
12	30°	7	17/34	"	"	"	24/36	150	—	—	24/40	340	—	9/34	690	—	6/46	3510	1/39
"	"	"	23/46	55	—	1	21/33	153	—	—	20/34	342	—	10/38	702	—	5/39	3600	1/40
"	"	"	29/58	57	—	1	22/38	155	—	—	18/31	345	—	12/46	720	—	5/40	3690	1/41
13	—	6	36/39	58	—	1	32/58	162	—	—	15/27	348	—	15/58	738	—	5/41	3780	1/42
14	—	6	18/42	60	6°	1	17/34	"	—	—	20/36	351	—	10/39	756	—	5/42	3870	1/43
—	25°	6	10/40	"	"	"	23/46	165	—	—	18/33	360	1°	10/40	765	—	4/34	4140	1/46
15	24°	6	—	"	"	"	29/58	170	—	—	18/34	—	54'	9/40	774	—	5/43	5220	1/58
16	—	5	25/40	62	—	1	14/31	171	—	—	20/38	—	48'	8/40	810	—	3/27	—	—
17	—	5	10/34	63	—	1	18/42	174	—	—	30/58	—	42'	7/40	828	—	5/46	—	—
18	20°	5	—	65	—	1	15/39	180	2°	—	17/34	—	36'	6/40	855	—	4/38	—	—
19	—	4	28/33	66	—	1	12/33	"	"	—	23/46	—	30'	5/40	870	—	6/58	—	—

The numerators in the above fractional values indicate the number of holes through which to advance the crank. The denominators indicate the index circle.

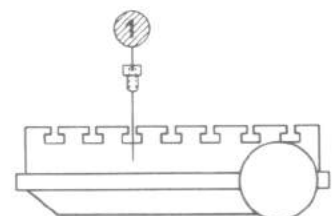
Example: 68 divisions — 1 full turn of crank and 11 holes on index circle 34.

The following divisions between 2 and 100 cannot be obtained on the circular table but are available when using the index head: 32, 44, 52, 56, 64, 88, 96.

The following divisions require the use of special index plates: 47, 49, 53, 59, 61, 67, 71, 73, 77, 79, 83, 89, 91, 94, 97, 98.

Lubrication and maintenance

Remove screw (bearing of table top) and lubricate with bearing oil. Lubricate table daily while in use.



For identification of symbol see table of lubricants.

Type templates and special templates

Styles of type templates

The design of the standard dovetail type templates, 20 mm (3/4") height of letters, is shown in Fig 1. Type templates with 40 mm height of letters (metric only) are available on request. The prong-type templates shown Fig 1 have been designed for use in conjunction with the universal copy dial to facilitate engraving of letters arranged on arcuate lines. All type templates are available in different styles and fonts (special catalogue on request).

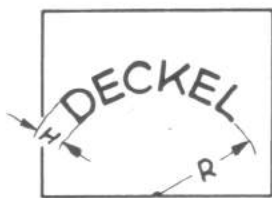


Fig 2

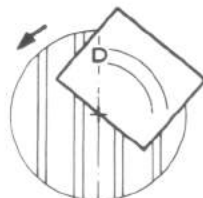


Fig 3

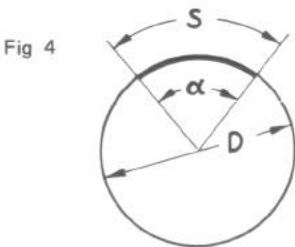
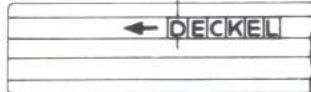


Fig 4



Engraving of special templates, symbols, etc

Upon marking out the template on an enlarged scale, lock the pantograph and engrave all lines, radii, circles, etc (raised or sunk) by moving the machine table with the aid of the screws or by rotating the circular table. Sharp inside corners should be hand-finished with suitable tools. In the case of stamps, marking dies and blocks or similar work requiring the taking of a cast, such sharp corners should be hand-finished on the cast duplicate.

Template

Fig 5

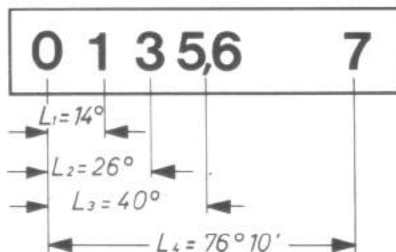
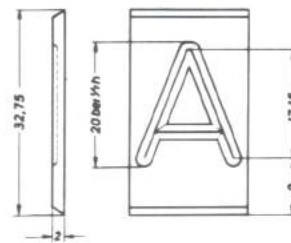


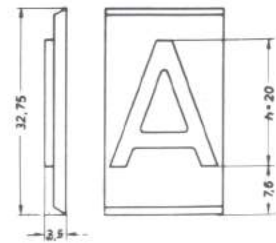
Fig 6



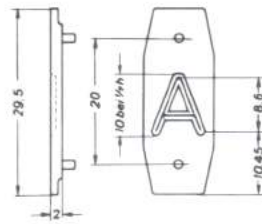
Fig 1



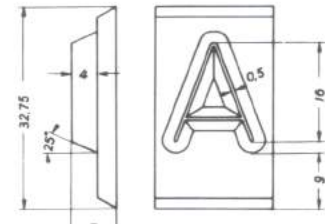
Sunk characters



Raised characters



Prong-type template



Bevel template

Engraving of circular lettering

1. Mark off height H and radius R on work.
2. Set pantograph in such a way that desired height of characters can be obtained.
3. To engrave the individual characters, proceed as follows: —
 - (a) Align centres of template and circular table.
 - (b) Mark a line on the type template holder (Fig 3), align the middle of the first letter with this reference line and engrave this letter. Then advance type templates until the middle of the next letter coincides with the mark and rotate the circular table accordingly to provide for the correct distance between letters on the work.

Templates for roll engraving

The length of arc S (Fig 4) of the lettering to be engraved on a cylinder is —

$$S = \frac{D \times \pi \times \alpha}{360} \quad (1)$$

where —

α = subtended angle of lettering
 S = length of arc of lettering
 D = roll diameter

For a pantograph ratio u, the length L of the lettering will then be —

$$L = \frac{u \times D \times \pi \times \alpha}{360} \quad (2)$$

or

$$u = \frac{L \times 360}{D \times \pi \times \alpha} \quad (3)$$

Most drawings specify the angular distances of individual characters from a common starting point ($\alpha_1, \alpha_2, \dots$), as shown in Fig. 4. Use formula (2) to determine the distances L_1, L_2, \dots on the template. For easier calculation express minutes of arc in decimals.

Example: $\alpha_4 = 76^\circ 10'$ Find: L_4 .
 $D = 40 \text{ mm}$
 $u = 3:1$
 $L_4 = \frac{3 \times 40 \times \pi \times 76.16}{360} = 79.8 \text{ mm}$

Cutting tools

Single-lip cutters



2 HSS grades, cylindrical;
3 carbide grades, cylindrical and tapered;
2.5...10 mm (1/8"...3/8").

Single-lip cutters



with 'GA' taper shank;
90° and half-round;
4 and 6 mm (5/32" and 1/4").

End mills, spiral-fluted



with cylindrical shank;
8 and 10 mm (5/16" and 3/8") dia;
for GK21 only.

End mills, ball-nosed



with cylindrical shank;
6...10 mm (1/4"...3/8") dia;
for GK21 only.

Tracer and guide pins

Tracer pins



12 mm (1/2") shank dia;
3...16 mm (1/8"...5/8") dia.

Guide pins



for tracing vertical-edge templates;
0.5...6 mm (0.02"...0.2") end dia.

Template tracer pin



6 mm (1/4") shank dia.

Etching needle



6 mm (1/4") shank dia.

Marking electrodes



for electromarking unit.

Clamping equipment

Spring collets



GK12: 2.5...6 mm (1/8"...3/8") ID;
GK21: 2.5...10 mm (1/8"...3/8") ID.

Taper adapters



with 'GA' internal taper for single-lip cutters.

Type clamps



for lateral clamping of master copy types in type template holders.

Clamping straps and dogs



for workpieces, templates, patterns and the like.
Clamping range up to 140 mm (5 1/2").

Helix clamps



with T-slot bolts; adaptable units for rapid adaptation to different workpiece heights up to 255 mm (10").

Other accessories

Plastic cover

for covering up the machine while not in use.

Machine lamp



including two fluorescent tubes.

Tool cabinet



for attachments and accessories —

dimensions
500 x 750 x 945 mm
(20" x 30" x 37").

For further details please request special catalogue.

With the purchase of a DECKEL machine each customer acquires a right to take advantage of our various Technical Services:

Training courses

At our factory in Munich, Germany, we have established a special training shop where the prospective operators of new DECKEL-machines have the opportunity to acquaint themselves with the efficient operation and the manifold applications of their machine.

After mutual agreement as to dates, instruction will be imparted by one of the members of our experienced demonstration shop staff. Each trainee will go through a full instruction programme specially worked out for each of our machines. We will try, of course, to adapt the training to the individual requirements, e.g. by taking into account the trainee's proficiency and/or the customer's special field of production, provided this fits into the general framework of our systematic programme. The duration of a course is one week, as a general rule. On request we will do our best to assist in finding suitable accommodation for participants.

Advisory service

A staff of qualified experts with thorough practical knowledge of our machines and all their applications are available for the discussion of specific production problems, whether brought to us on the occasion of a visit to our factory or submitted to us in writing. Drawing on a wealth of practical experience, these advisers will always do their utmost to assist in finding an optimum solution for any type of work to be performed on a DECKEL machine. It goes without saying that, in so doing, we will comply with all requests that may be made by our customers, including, in particular, the keeping of manufacturing secrets.

Our "Technical Bulletin" series of service information leaflets keep our customers informed on interesting aspects of the work with DECKEL machines. The information includes both design details and reports on practical experience. The "Technical Bulletins" are supplied free of charge. Several copies are available on request. If collected, they will constitute a valuable and handy reference manual, especially for the foremen and for the operators of the machine.

Personal visits

Please contact your DECKEL agent if and when you wish any visit.

If you wish, one of the DECKEL specialists will call on you, in order to give you advice and practical assistance in solving technical questions related to the use of our machines. Moreover, he will advise you on the application of the machines for certain jobs and demonstrate the operation concerned if required.

Repair service

In the case of a defect in a machine we will, of course, do our best to help our customer as rapidly as possible. However, to ensure speedy service, the following important points should be observed: in the case of trouble we recommend first of all that the operator's manual be consulted in order to find out whether the trouble might not be due to an error in operation or maintenance of the machine (e.g. wrong settings or erroneous switch operation, selection of wrong lubricant, wrong quantity of lubricant, etc).

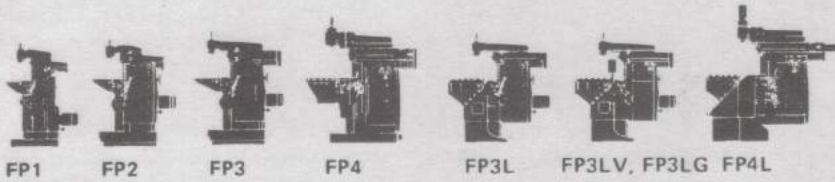
Should repair be necessary, please contact your competent DECKEL agent, giving him the following information: type, model and serial number of the machine and, if applicable, of the attachment; description of the defect and its cause in as much detail as possible.

The machine will first be inspected by us, if necessary, and then it will be decided by mutual agreement whether the machine is to be repaired in your workshop or at our factory.

Spare parts service

Please specify the type, model and serial number of the machine and, if applicable, of the attachment whenever a spare parts order is placed. In addition, we require the Stock No of the spare part, which will be found in the "Notes on Disassembly & Reassembly". Please indicate the operating voltage in all orders for electrical parts, and the number of the circuit diagram for switch cabinet spares.

DECKEL



FP1 FP2 FP3 FP4 FP3L FP3LV, FP3LG FP4L

FP1, FP2, FP3

Universal tool milling and boring machines

FP4 Universal milling and boring machine

FP3L, FP3LV

Universal milling and boring machines

FP3LG High-precision boring machine

FP4L Universal milling and boring machine



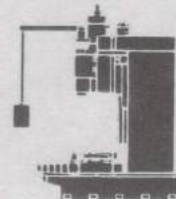
E3 E3L, E3LV C3 C3L, C3LV

E3, E3L, E3LV

NC milling and boring machines with push-button straight-line control system

C3, C3L, C3LV

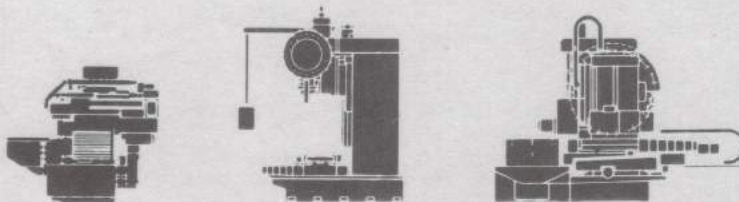
NC milling and boring machines with continuous-path control system



V410

V410

NC milling and boring machine with continuous-path control system



FP5C

V400

S500

FP5C

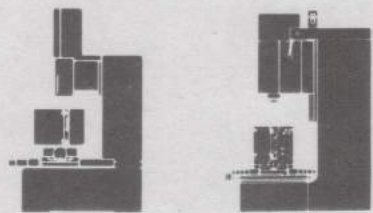
Universal machining centre

V400

NC machining centre

S500

NC machining centre



DE30

DE40

DE 30, DE 40

Spark erosion machines



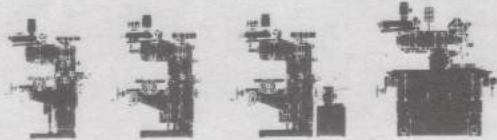
G1L, G1F GK12, GK21 GK21A

G1L Universal letter engraving machine

G1F Universal engraving miller

GK12, GK21, GK21A

Universal engraving and copy milling machines



KF1

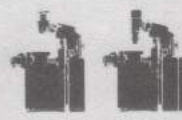
KF2

KF2S

KF3S

KF1, KF2 Universal copy milling machines

KF2S, KF3S Servo-controlled universal copy milling machines



LKB

LKS

LKB

Optical coordinate boring machine

LKS

Optical coordinate grinding machine

SO Single-lip cutter grinder

SOE

Single-lip cutter grinder

