PHANOGRAPH ENGRAVING AND PROFILING MILLER

Operating Instructions

GK12
GK21

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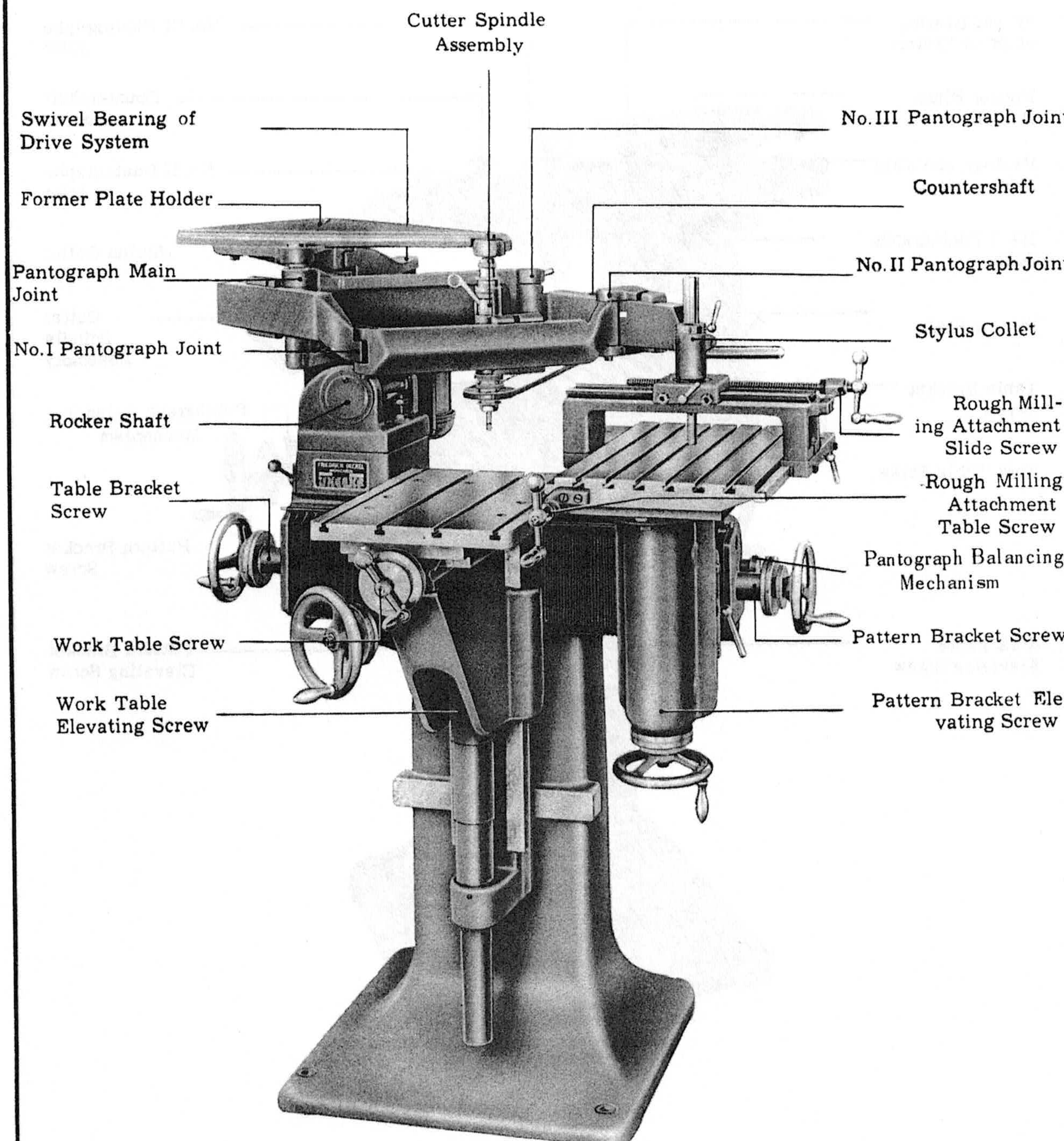
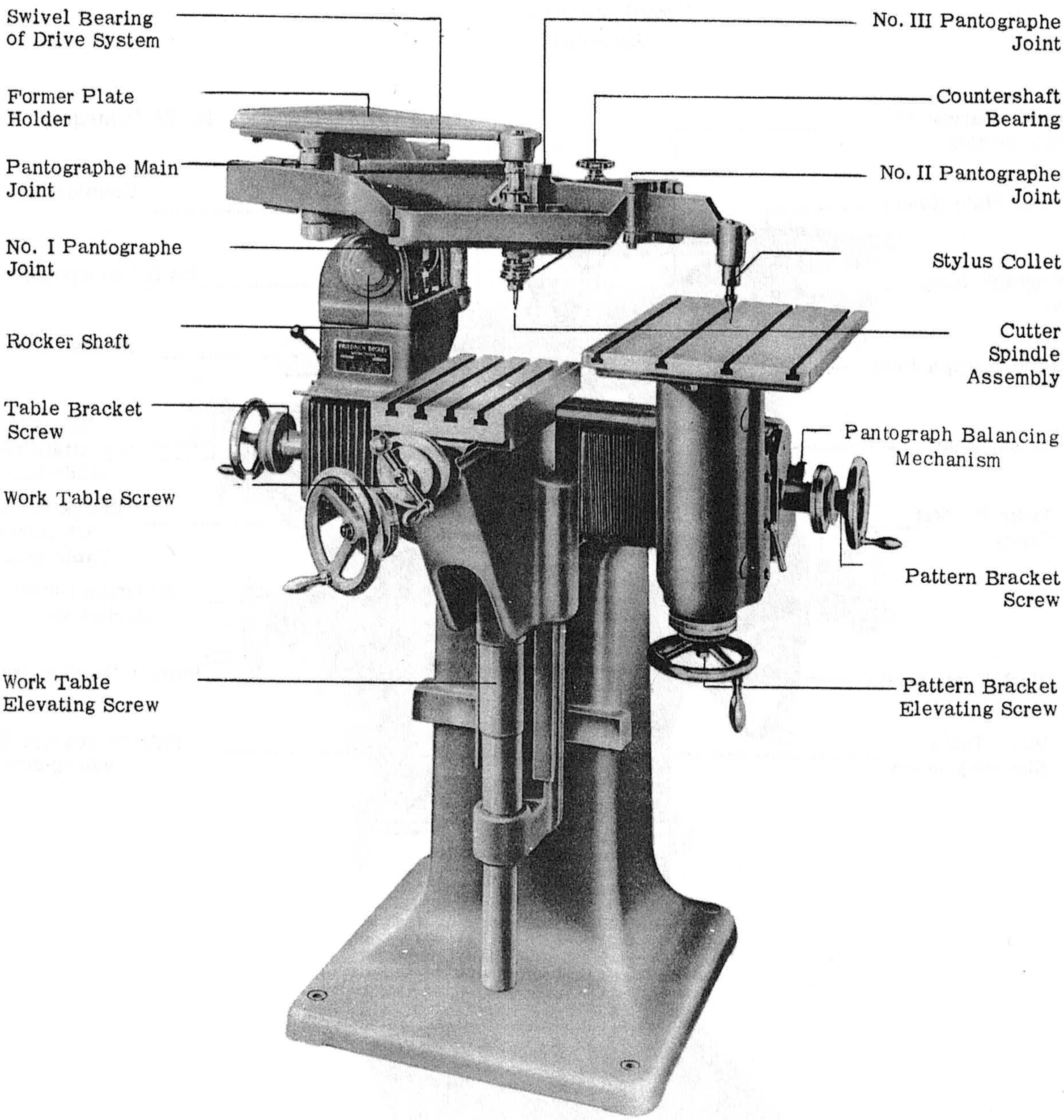
Nomenclature of Main Units

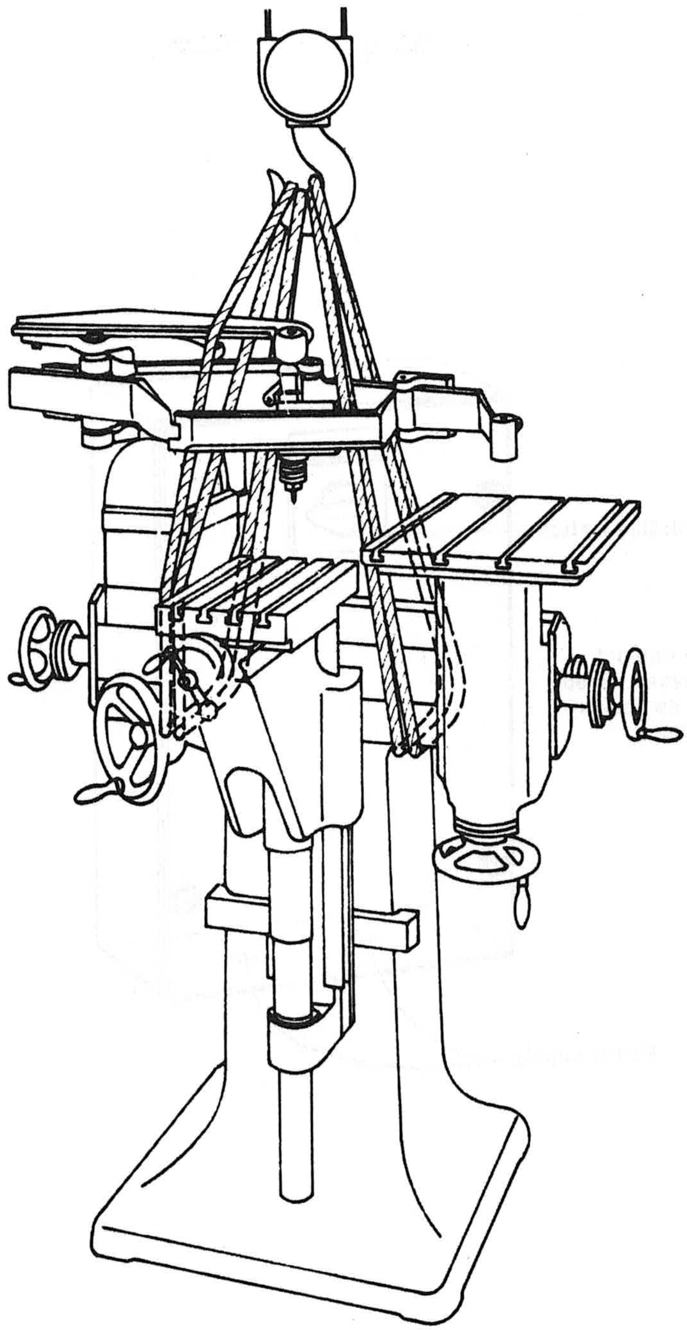


When ordering spare parts, please state serial number of machine

Nomenclature of Main Units



When ordering spare parts, please state serial number of machine

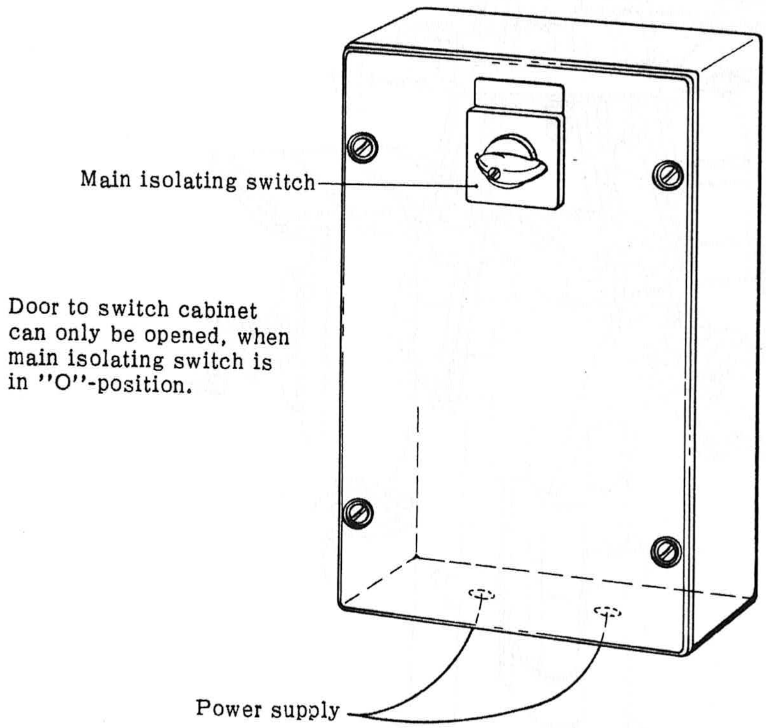


The Deckel GK Engraving Machine is a precision machine tool whose parts are machined to extremely close tolerance limits; it is, therefore, necessary to use special care in unpacking and hoisting the machine. In order to protect the accurately adjusted pantograph bearings from damage it is strongly recommended, before moving the machine, to lock the pantograph in position by means of the locking bracket shown on page **12**.

It is good practice to place the machine on round bars and to move it to the point of erection by means of crowbars which should be exclusively applied under the base of the column; the machine should not be grasped by any part other than the column. Under no circumstances must any force be applied to working parts of the machine, such as screws, handwheels, work table, pattern table, etc., as this would impair the accuracy of the machine.

When the machine is hoisted by a crane it is also necessary to protect the protruding parts. It is recommended to hoist the machine by means of a lifting sling which is placed around the machine as indicated in the above diagram. In this case, the locking bracket should not be used to lock the pantograph in position, in order to prevent detrimental pressure from being imposed on the pantograph legs. Before attaching the lifting slings, both the left-hand and the central protective bellows should be removed from the column ways (see instructions on p. **39**).

Switch Cabinet

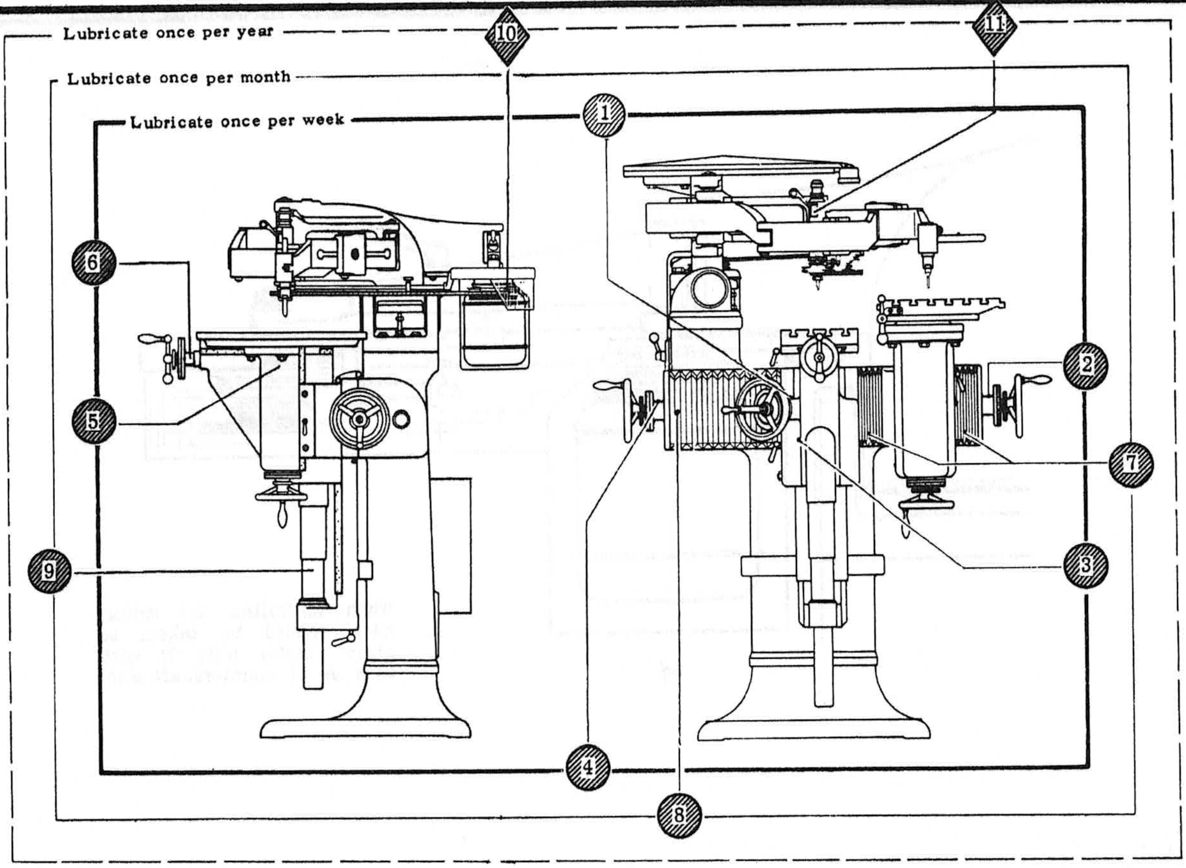


A wiring diagram will be found in the switch cabinet.

If a separate lighting current supply is not available, the voltage required for the machine lamp can in most cases be branched off the power supply line. (If in doubt, contact public utility company).

Lubricating and Servicing Chart

GK 12
GK 21



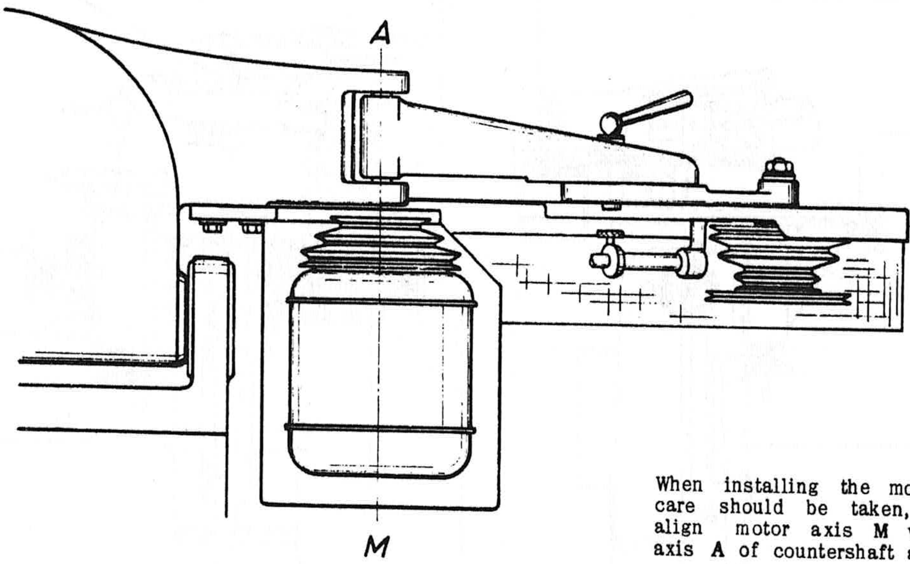
The intervals given apply for single–shift operation.

Table of lubricants		
Specification	Quality	Symbol
Bearing Oil	approx. 33.5 cSt (4.5E)/50° C approx. 44 cSt / 100° F	●
Special Grease for Spindle Bearings	ISOFLEX SUPER TEL	◆

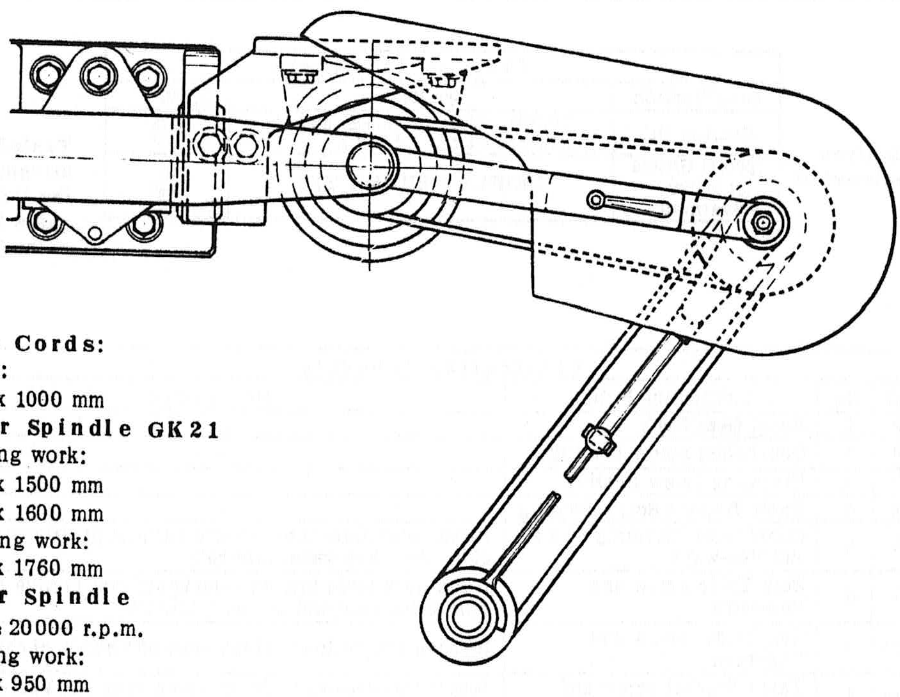
Tested grades of lubricants are listed in the "Table of Lubricants for Deckel Machine Tools".

Lubricating Schedule			
Interval	No.	Lubricating Points	Maintenance
1 week	1	Bevel Gear Shaft	–
1 week	2	Copyholder Screw Bearing	–
1 week	3	Elevating Screw Bearing	–
1 week	4	Table Bracket Screw Bearing	–
1 week	5	Copyholder Elevating Screw and Vee-ways	Bring copyholder into extreme vertical positions; remove chips from vee-ways, lubricate
1 week	6	Work Table Screw and Vee-ways	Bring work table into extreme positions; remove chips from table vees and screw, lubricate
1 month	7	Copyholder Screw and Vee-ways	Remove two bellows; clean vees and screw of chips; oil.
1 month	8	Table Bracket Screw and guide way	Remove protective bellows; clean vees and screw of chips; oil.
1 month	9	Elevating Screw	Push cover tubes up; clean and lubricate screw
1 year	10	Countershaft	Clean and lubricate as cutter spindle units
see instr.	11	Cutter Spindle Assembly	Maintenance see page 36

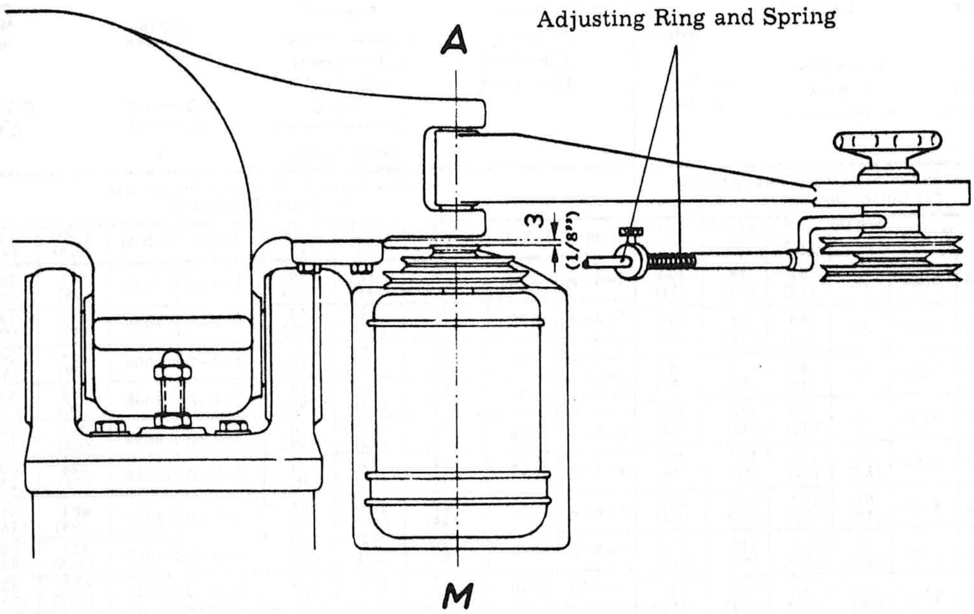
Drive System



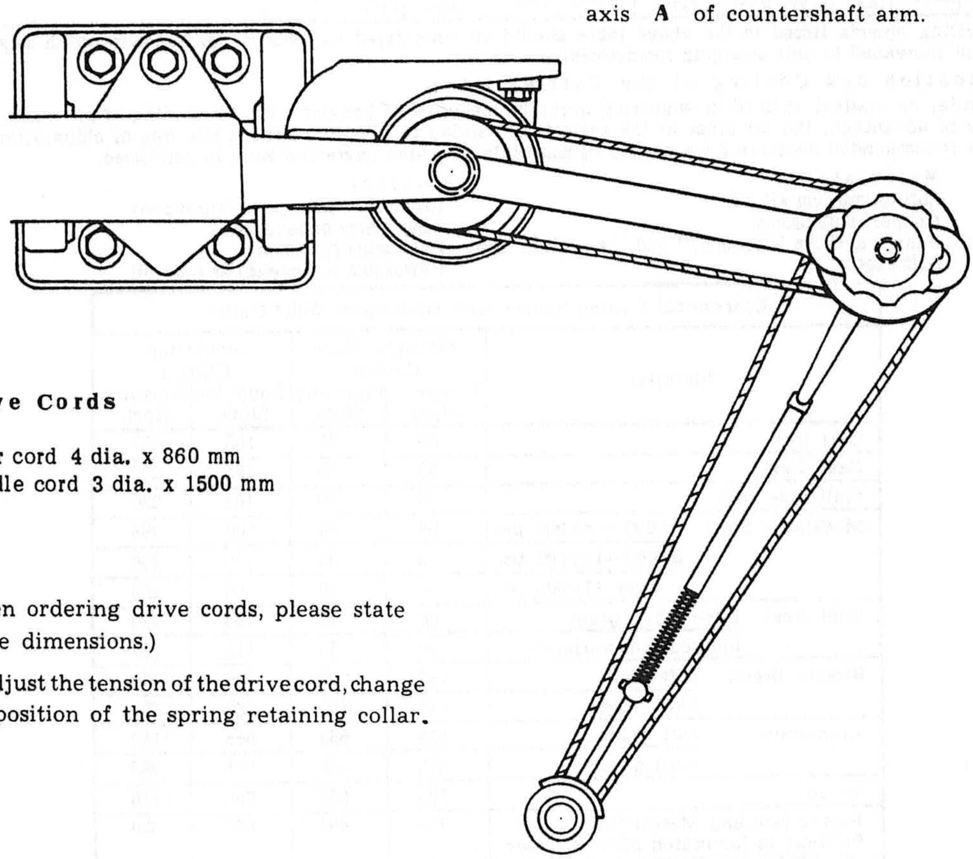
When installing the motor, care should be taken, to align motor axis M with axis A of countershaft arm.



Drive Cords:
Motor:
8 dia. x 1000 mm
Cutter Spindle GK 21
Reducing work:
8 dia. x 1500 mm
5 dia. x 1600 mm
Enlarging work:
4 dia. x 1760 mm
Cutter Spindle
$n_{max.}$ = 20000 r.p.m.
Reducing work:
6 dia. x 950 mm
5 dia. x 1600 mm
Enlarging work:
4 dia. x 1760 mm



When installing the motor, care should be taken, to align motor axis **M** with axis **A** of countershaft arm.



Drive Cords

Motor cord 4 dia. x 860 mm
Spindle cord 3 dia. x 1500 mm

(When ordering drive cords, please state above dimensions.)

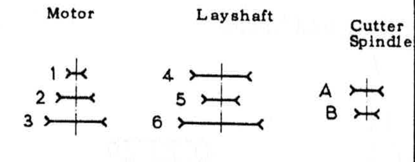
To adjust the tension of the drive cord, change the position of the spring retaining collar.

GK 12
GK 21

Spindle Speed Ranges - Cutting Speeds

GK12 — Metric dimensions are given in brackets ( ) — **GK21**

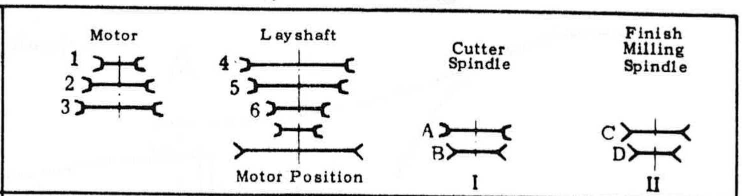
GK12



Cutter Speed in Surface Feet per min. for Cutter Diameters

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

GK21



Cutter Speed in Surface Feet per min. for Cutter Diameters

Steps	R.P.M.	3/16" (4)	1/4" (6)	5/16" (8)
1–4–A	475	24	31 (9)	39 (12)
1–5–A	600	29	39 (11)	49 (15)
2–4–A	750	37 (9)	49 (14)	61 (19)
2–5–A	950	47 (12)	62 (18)	77 (24)
3–5–A	1180	58 (15)	77 (22)	96 (30)
2–6–A	1500	74 (19)	98 (28)	122 (38)
3–6–A	1900	93 (24)	124 (36)	155 (48)
1–4–B	2350	115 (30)	154 (44)	192 (59)
1–5–B	3000	147 (38)	196 (57)	245 (75)
2–4–B	3750	184 (47)	246 (70)	306 (94)
2–5–B	4750	234 (60)	310 (90)	388 (119)
3–5–B	6000	294 (75)	392 (113)	490 (151)
2–6–B	7500	368 (94)	490 (141)	612 (188)
3–6–B	9500	467 (119)	620 (179)	770

Steps	R.P.M.	1/8" (2,5)	3/16" (4)	1/4" (6)
1–4–C	3150	103 (25)	155 (40)	206 (60)
1–5–C	4000	131 (32)	197 (50)	262 (75)
1–4–D	5000	164 (39)	246 (63)	327 (94)
1–5–D	6300	206 (50)	310 (79)	410 (119)
2–4–D	8000	262 (63)	394 (101)	520 (151)
2–5–D	10000	328 (79)	490 (126)	655 (189)
3–5–D	12500	401 (98)	610 (157)	820 (236)
2–6–D	16000	525 (126)	790 (201)	1046 (302)
3–6–D	20000	655 (157)	985 (252)	1309 (377)

Cutter spindle drive
Drive Cord 8 mm dia.
B, C, D thinner Cords

The cutting speeds listed in the above table should be considered as recommended speeds which may be reduced or increased to suit changing requirements.

Lubrication and Cooling of the Cutting Edge

As a rule, no coolant is used in engraving work; in the case of heavier cuts, air cooling of the cutting edge may be of advantage, the air blast at the same time serving to keep the cutting site free of chips. Listed below are recommended coolants for a number of materials on which engraving work is performed.

Material	Coolant
Soft aluminium alloys	Alcohol or petroleum (kerosene)
Copper, soft bronze	Soap water or rape oil
Plastics of the "Resopal" and "Astralon" type	Petroleum (kerosene)
Soft steel	Petroleum (kerosene) or rape oil

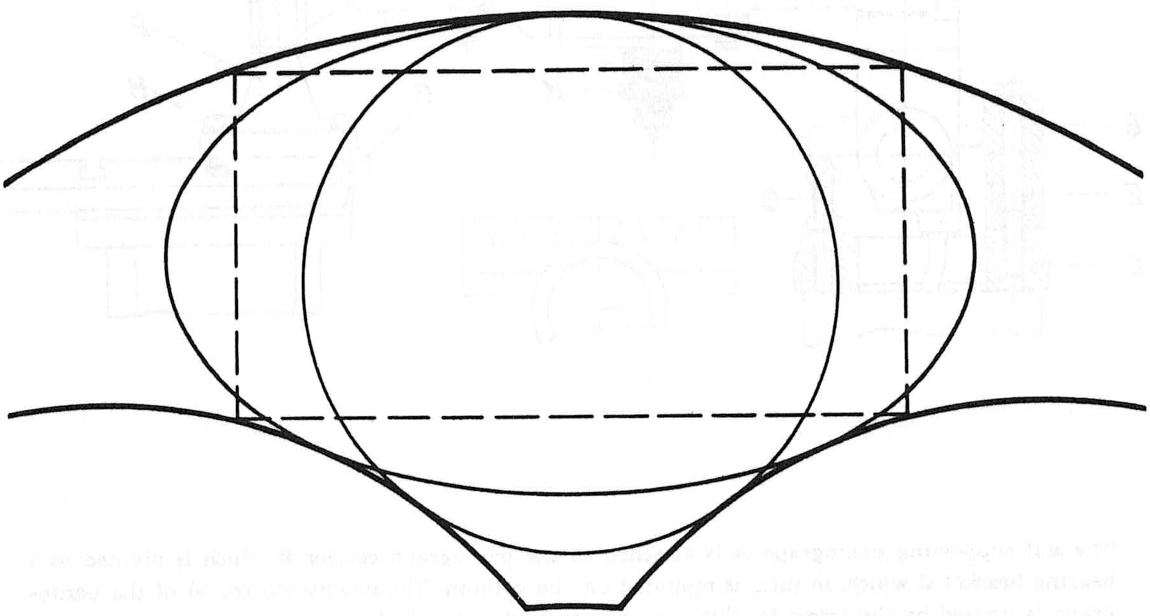
Economical Cutting Speeds with High-Speed Steel Cutters

Material		Multiple Flute Cutters Roughing Sfpm.	Multiple Flute Cutters Finishing Sfpm.	Single-Lip Cutters Roughing Sfpm.	Single-Lip Cutters Finishing Sfpm.
Cast Iron		50	65	165	230
Cast Steel		60	70	165	230
Malleable Iron		60	70	165	230
Machinery Steel	57 000— 85 000 psi.	65	80	200	295
	85 000—114 000 psi.	50	65	130	230
	over 114 000 psi.	40	50	80	150
Tool Steel	low-carbon grade	60	70	165	230
	high-carbon varieties	40	50	115	165
Bronze, Brass,	soft grade	165	200	330	490
	hard grade	130	165	260	395
Aluminium,	soft grade	525	655	985	1150
	hard grade	395	490	655	985
Wood		525	655	985	1150
Plastic Molding Materials, Pertinax (a laminated plastic), Fiber		395	490	655	820
Dekorit (a pattern casting composition)		395	490	820	985
Celluloid		395	655	655	1150

Areas Covered by the GK 12 and GK 21 Pantograph

GK 12
GK 21

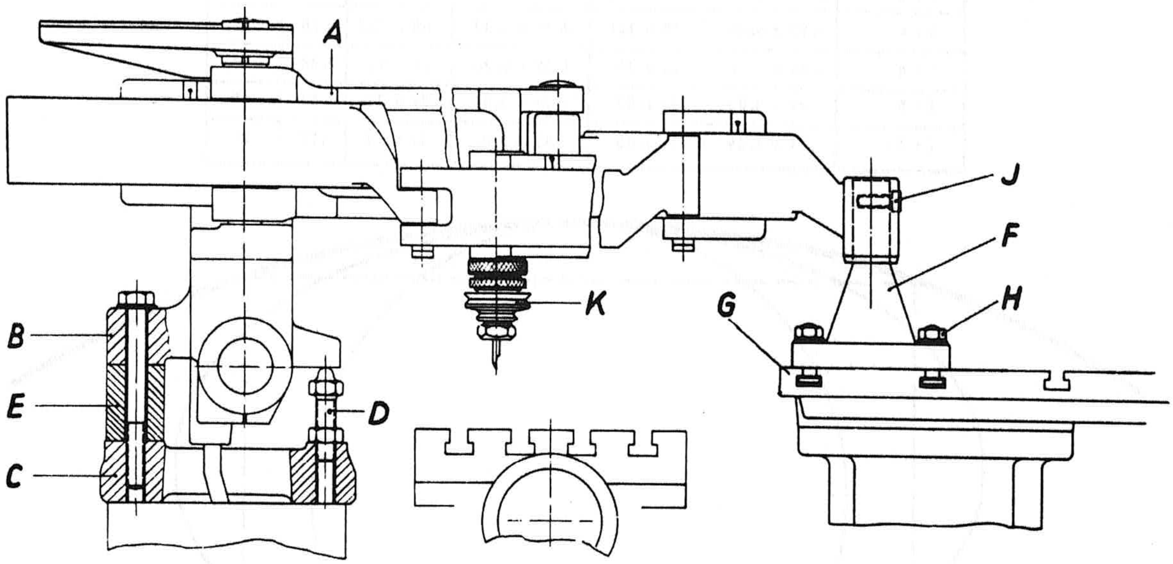
Pantograph Ratio	GK 12					
	Rectangle		Ellipse		Circle	
	inch	mm	inch	mm	in. dia.	mm Ø
1 : 1,5	5.12 x 11.42	130 x 290	5.91 x 13.78	150 x 350	5.91	150
1 : 2	3.94 x 8.27	100 x 210	5.71 x 10.24	145 x 260	6.69	170
1 : 3	2.64 x 5.51	67 x 140	3.54 x 7.28	90 x 185	4.72	120
1 : 4	1.97 x 4.13	50 x 105	2.68 x 5.31	68 x 135	2.76	70
1 : 6	1.34 x 2.76	34 x 70	1.89 x 3.74	48 x 95	2.36	60
1 : 8	.98 x 2.05	25 x 52	1.34 x 2.83	34 x 72	1.57	40
1 : 10	.71 x 1.89	18 x 48	.87 x 2.05	22 x 52	.79	20



Pantograph Ratio	GK 21					
	Rectangle		Ellipse		Circle	
	inch	mm	inch	mm	in. dia.	mm Ø
1 : 1,5	5.91 x 13.19	150 x 335	6.11 x 15.75	155 x 400	6.89	175
1 : 2	4.72 x 9.84	120 x 250	7.09 x 11.81	180 x 300	7.87	200
1 : 3	3.15 x 6.61	80 x 168	4.72 x 7.87	120 x 200	5.24	133
1 : 4	2.44 x 4.92	62 x 125	3.54 x 5.91	90 x 150	3.94	100
1 : 6	1.57 x 3.31	40 x 84	2.36 x 3.94	60 x 100	2.64	67
1 : 8	1.10 x 2.48	28 x 63	1.57 x 2.95	40 x 75	1.77	45
1 : 10	.79 x 1.97	20 x 50	1.10 x 2.36	28 x 60	.94	24

Tabulated above are the largest rectangles, ellipses and circles swept by the pantograph, it being possible, with the aid of these data, to ascertain the space available for areas which are not enclosed in the above-mentioned regular figures.

Pantograph Locking Bracket



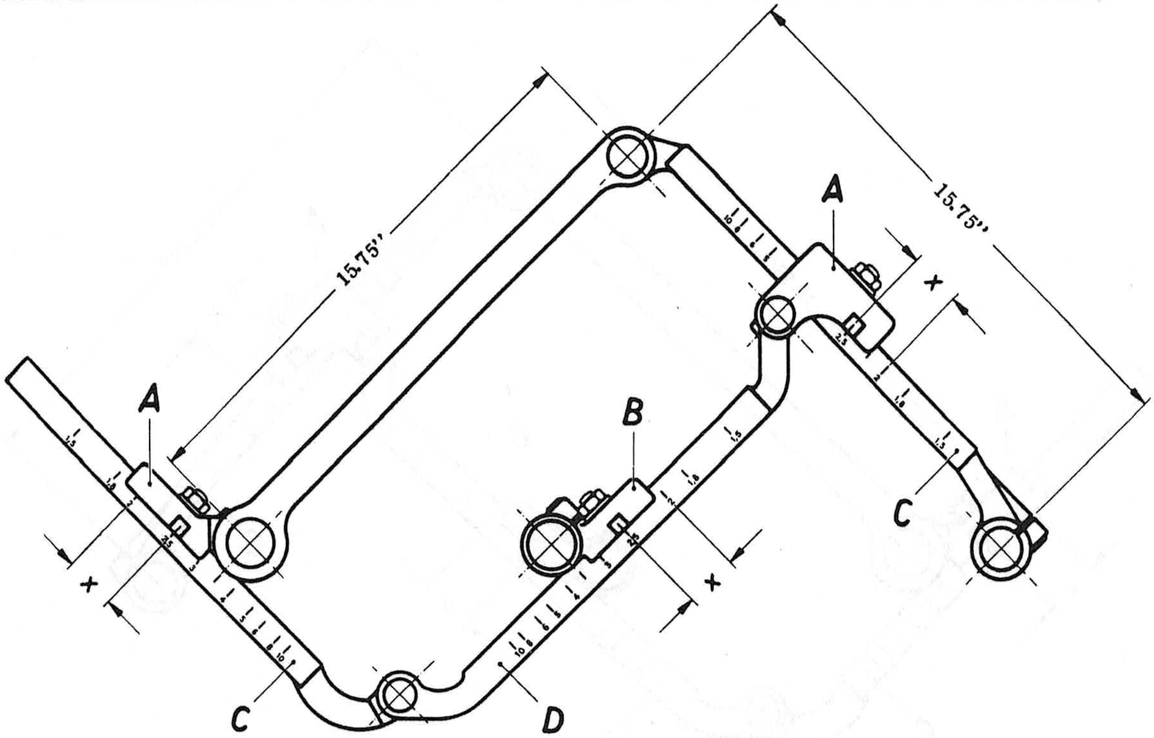
The self-supporting pantograph **A** is attached to the pantograph carrier **B** which is pivoted to a bearing bracket **C** which, in turn, is mounted on the column. The downward travel of the pantograph is limited by the screw **D** which can be adjusted and locked in the desired position.

A spacer sleeve **E** can be inserted between the pantograph carrier and the bearing bracket, in order to lock the pantograph in a horizontal plane in cases in which it is desired to cut flat designs.

For cutting operations which are to be performed by following scribed markings, no master being used, the upper portion or shank of the pantograph locking bracket **F** is inserted into the bore which normally receives the tracing stylus, the shank being clamped by means of set screw **J**. The locking bracket is placed on the pattern table **G** and clamped by T-slot bolts **H**. In this case, the pantograph carrying the cutter spindle assembly **K** is locked in position, the feed motion then being imparted to the workpiece.

Setting the GK 21 Pantograph

GK 21



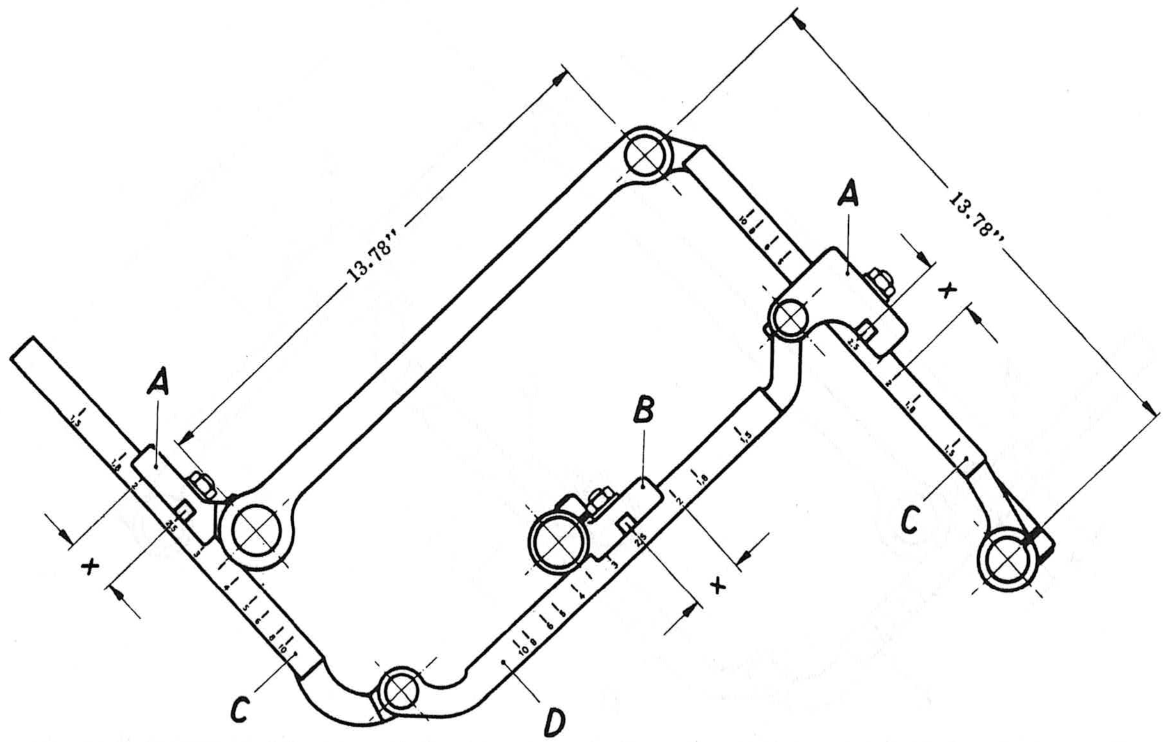
To obtain the desired transposition ratio, set the two slides **A** and the spindle carrier **B** on the pantograph legs **C** and **D** in such a manner that the index marks are exactly opposite the respective setting marks engraved on the pantograph legs. Setting marks are provided for the most commonly used transposition ratios only. Intermediate settings may be obtained with the aid of the table given at the bottom of this page. The dimension **x** is the distance of the slide index mark from the mark 2 on the pantograph leg under consideration. In cases where the transposition ratio is greater than 2:1, the length **x** will have to be laid off on the pantograph legs in an opposite direction to that shown in the above illustration.
The length **x** may be determined for any desired transposition ratio by solving the following equation:

$$x = 7.8740 - \frac{15.7480}{\text{Ratio}} \text{ (in).}$$

Red. Ratio	x	Red. Ratio	x	Red. Ratio	x	Red. Ratio	x	Red. Ratio	x
1.5	2.6246	3.2	2.9528	4.9	4.6601	6.6	5.4879	8.3	5.9767
1.6	1.9685	3.3	3.1019	5.0	4.7244	6.7	5.5236	8.4	5.9992
1.7	1.3895	3.4	3.2422	5.1	4.7862	6.8	5.5581	8.5	6.0213
1.8	0.8748	3.5	3.3746	5.2	4.8455	6.9	5.5917	8.6	6.0428
1.9	0.4144	3.6	3.4996	5.3	4.9027	7.0	5.6243	8.7	6.0639
2.0	0.0000	3.7	3.6178	5.4	4.9577	7.1	5.6560	8.8	6.0845
2.1	0.3750	3.8	3.7298	5.5	5.0106	7.2	5.6868	8.9	6.1046
2.2	0.7158	3.9	3.8361	5.6	5.0619	7.3	5.7167	9.0	6.1242
2.3	1.0270	4.0	3.9370	5.7	5.1112	7.4	5.7459	9.1	6.1435
2.4	1.3123	4.1	4.0330	5.8	5.1588	7.5	5.7743	9.2	6.1623
2.5	1.5748	4.2	4.1245	5.9	5.2048	7.6	5.8019	9.3	6.1807
2.6	1.8171	4.3	4.2117	6.0	5.2493	7.7	5.8288	9.4	6.1987
2.7	2.0414	4.4	4.2949	6.1	5.2924	7.8	5.8550	9.5	6.2163
2.8	2.2497	4.5	4.3744	6.2	5.3340	7.9	5.8806	9.6	6.2336
2.9	2.4437	4.6	4.4505	6.3	5.3743	8.0	5.9055	9.7	6.2505
3.0	2.6247	4.7	4.5234	6.4	5.4134	8.1	5.9298	9.8	6.2671
3.1	2.7940	4.8	4.5932	6.5	5.4512	8.2	5.9535	9.9	6.2833

Before setting the pantograph clean the pantograph legs from chips and apply some grease from time to time.

Setting the GK 12 Pantograph



To obtain the desired transposition ratio, set the two slides **A** and the spindle carrier **B** on the pantograph legs **C** and **D** in such a manner that the index marks are exactly opposite the respective setting marks engraved on the pantograph legs. Setting marks are provided for the most commonly used transposition ratios only. Intermediate settings may be obtained with the aid of the table given at the bottom of this page. The dimension **x** is the distance of the slide index mark from the mark 2 on the pantograph leg under consideration. In cases where the transposition ratio is greater than 2:1, the length **x** will have to be laid off on the pantograph legs in an opposite direction to that shown in the above illustration.
The length **x** may be determined for any desired transposition ratio by solving the following equation:

$$x = 6.8897 - \frac{13.7794}{\text{Ratio}} \quad \text{(in).}$$

Red. Ratio	x	Red. Ratio	x	Red. Ratio	x	Red. Ratio	x	Red. Ratio	x
1.5	2.2965	3.2	2.5836	4.9	4.0776	6.6	4.8019	8.3	5.2295
1.6	1.7224	3.3	2.7141	5.0	4.1338	6.7	4.8330	8.4	5.2493
1.7	1.2158	3.4	2.8369	5.1	4.1879	6.8	4.8633	8.5	5.2686
1.8	0.7654	3.5	2.9527	5.2	4.2398	6.9	4.8927	8.6	5.2874
1.9	0.3626	3.6	3.0621	5.3	4.2898	7.0	4.9212	8.7	5.3059
2.0	0.0000	3.7	3.1655	5.4	4.3380	7.1	4.9489	8.8	5.3239
2.1	0.3281	3.8	3.2635	5.5	4.3844	7.2	4.9759	8.9	5.3415
2.2	0.6263	3.9	3.3565	5.6	4.4291	7.3	5.0021	9.0	5.3587
2.3	0.8987	4.0	3.4449	5.7	4.4723	7.4	5.0276	9.1	5.3755
2.4	1.1483	4.1	3.5289	5.8	4.5139	7.5	5.0524	9.2	5.3919
2.5	1.3779	4.2	3.6089	5.9	4.5542	7.6	5.0766	9.3	5.4080
2.6	1.5899	4.3	3.6852	6.0	4.5931	7.7	5.1002	9.4	5.4238
2.7	1.7862	4.4	3.7580	6.1	4.6308	7.8	5.1231	9.5	5.4392
2.8	1.9685	4.5	3.8276	6.2	4.6672	7.9	5.1455	9.6	5.4543
2.9	2.1382	4.6	3.8942	6.3	4.7025	8.0	5.1673	9.7	5.4691
3.0	2.2966	4.7	3.9579	6.4	4.7367	8.1	5.1885	9.8	5.4836
3.1	2.4447	4.8	4.0190	6.5	4.7698	8.2	5.2093	9.9	5.4978

Before setting the pantograph clean the pantograph legs from chips and apply some grease frome time to time.

Cutter Spindle Assembly

with Housing and Vertical Adjustment

When ordering spare parts, please state serial number of spindle bearing and symbol of selective fit (engraved on the bearing sleeve).

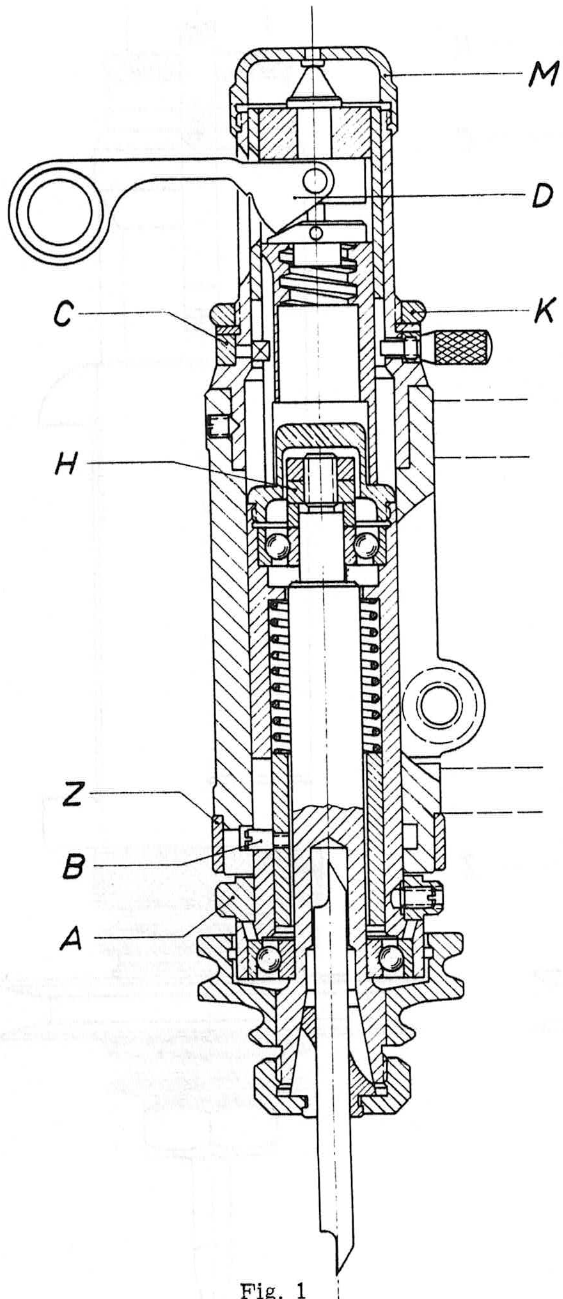


Fig. 1

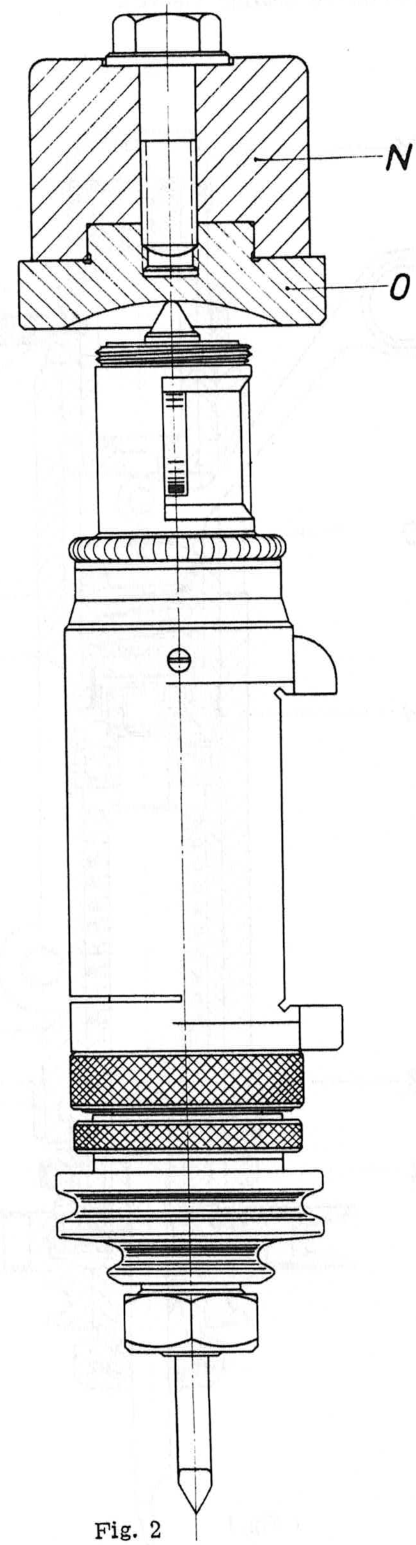


Fig. 2

Cutter Spindle Assembly
with Housing and Vertical Adjustment

When ordering spare parts, please state serial number of spindle bearing and symbol of selective fit (engraved on the bearing sleeve).

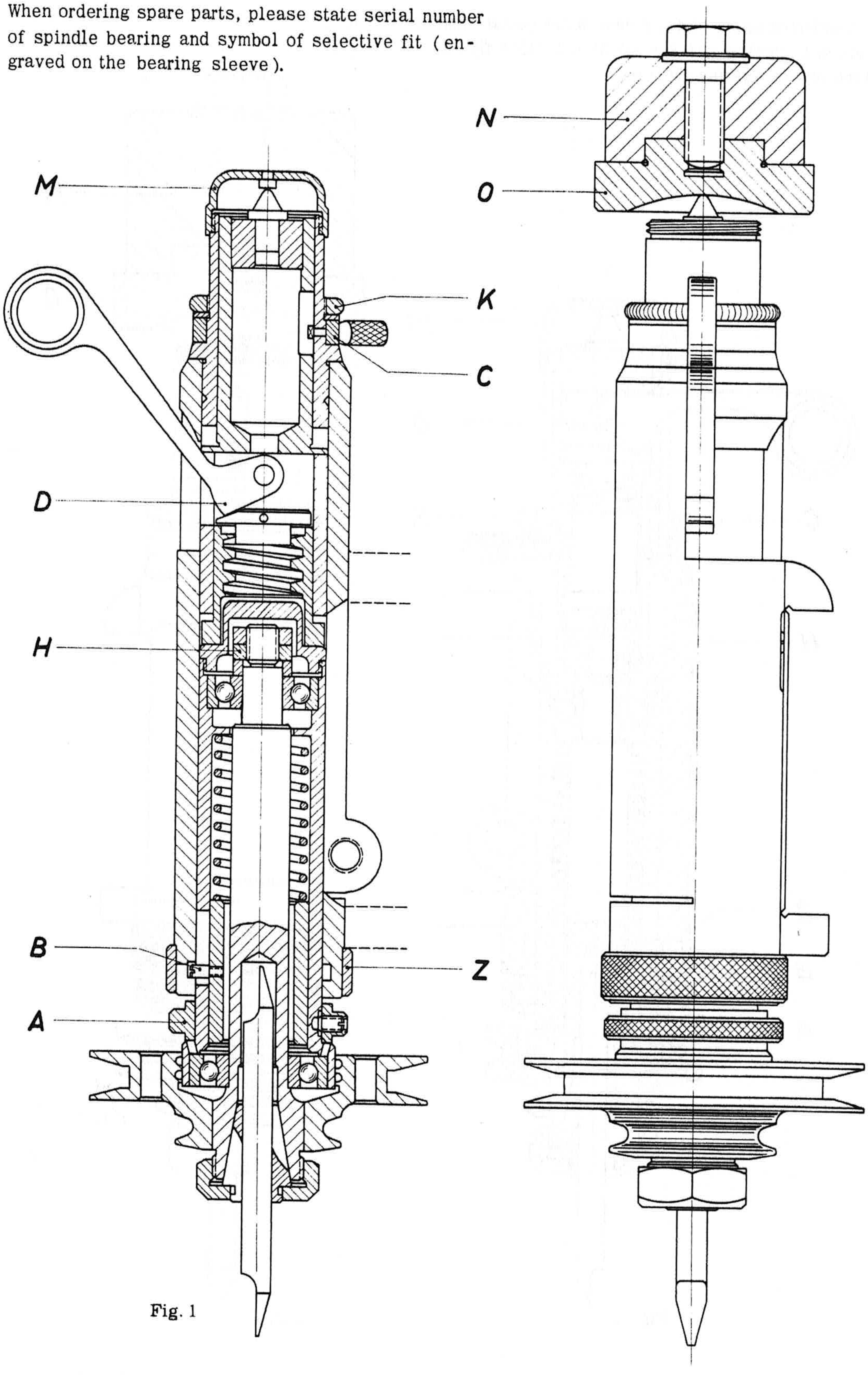


Fig. 1

1. Removal of Spindle Assembly

To remove the spindle assembly, unscrew cap M, grasp knurled ring A, push the assembly upward as far as it will go, give it a quarter turn to cause retaining screw B to register with the longitudinal groove of the housing, and pull the spindle assembly out. – To re-install the spindle assembly, reverse the above procedure.

2. Spindle Bearing Adjustment

The bearings have been factory-adjusted to exclude play while allowing for a free-running spindle. In the event some play develops in the course of time, such play should be taken up by carefully tightening the two nuts H. NOTICE: Excessive tightening of these nuts will result in bearing failure.

3. Cutter Vertical Adjustment

Depressing the lever D provides for coarse adjustment of the cutter spindle in a vertical direction towards the work. The depth of cut is controlled by rotating the lever in a horizontal plane in an anticlockwise direction. The depth of cut can be limited by means of an adjustable ring C which can be locked in the desired position by means of knurled nut K, the depth of cut being read from a scale. Upon lever D being returned to its original position, a compression spring will automatically lift the spindle away from the work surface.

Engraving Work on Convex Surfaces

1. Using a Former Plate

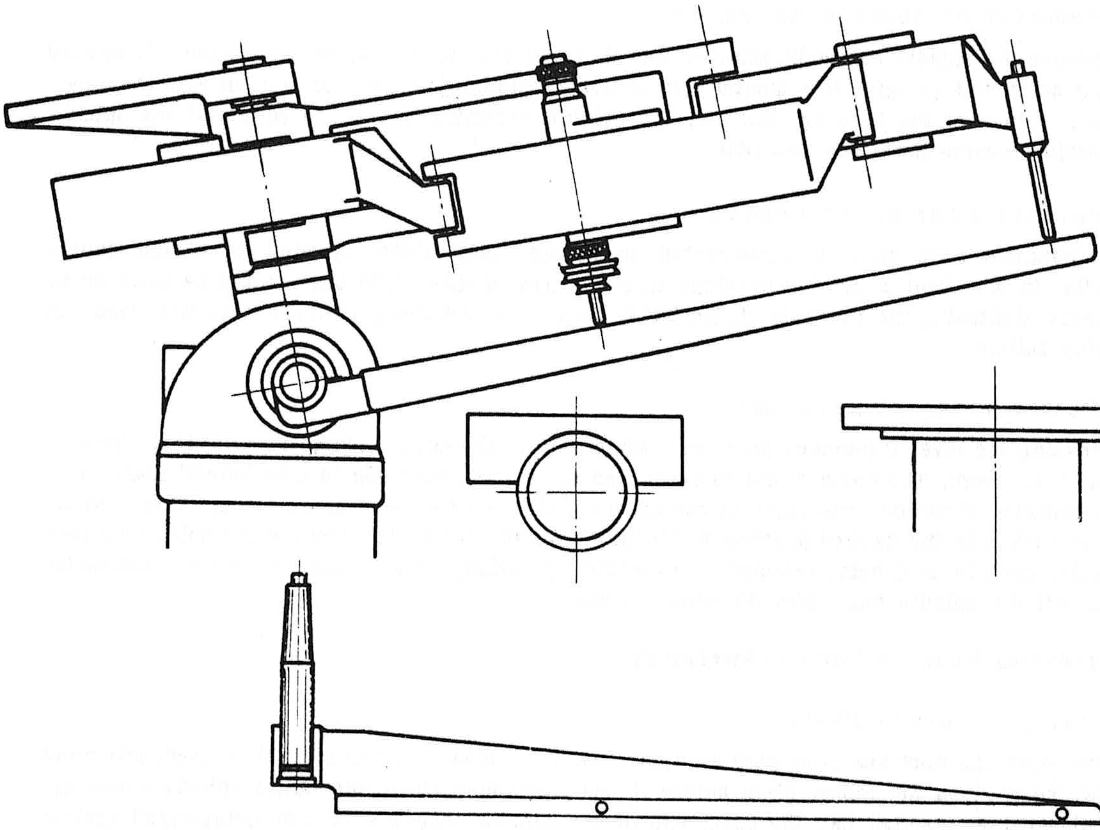
Where engraving work has to be performed on convex surfaces, a former plate O is used, this plate being mounted on the former plate holder N and positioned above the cutter spindle assembly. A guide center inserted into the upper end of the spindle assembly is then spring-urged against the former plate whose shape corresponds to that of the work surface. Any lateral movement of the cutter spindle assembly will cause the cutter to be positively moved in a vertical direction so as to maintain the proper depth of cut. When determining the correct radius of the former plate recess it is necessary to take into account the radius of the guide center point and the radius of the work surface; the surface of the recess should be positioned for parallelism with the work surface. It is recommended, if possible, to use only radiused cutters and not to allow the depth of cut to exceed the radius of the end of the cutter.

The radius of the former plate to be used can be conveniently calculated from the following equation: $Rf = Ra + Rs + rs$, where Rf = radius of former plate recess; Ra = radius of convex work surface; Rs = radius of cutting edge; rs = radius of guide center. Where pointed single-lip cutters are used to produce linear engraved work, Rs, the cutting edge radius, may be neglected in the above equation. The former plate should be used for a limited area of the recess surface only, as the cutter would cause a certain amount of distortion if moved too far away from the center of the plate. The use of an index head makes it possible, in a step-by-step manner, to engrave the entire diameter of a body of revolution. In order to keep possible distortion of the outer zone within permissible limits, it is recommended to limit deep-cut work to an area defined by a subtended angle of 30°; in other words, the cutting zone on circular word should not exceed $1/12$ of the circumference of a circle.

2. Using the Roll Engraving Attachment

After removing the protective collar Z and lifting out the cutter spindle assembly, the housing of the spindle assembly can be attached to the drive member of the roll engraving attachment as outlined on p. 32.

Aligning Cutter and Tracing Stylus by Straightedge

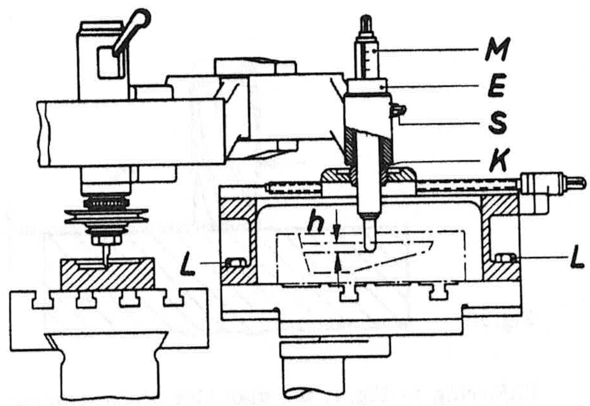


For a mathematically accurate reproduction of three-dimensional shapes it is necessary that the ends of the cutter and tracing stylus lie in a common plane which also contains the axis of the horizontal rocker shaft. To effect this alignment, insert the straightedge into the taper bore provided in the rocker shaft, clamp the cutter for the required length, and align the end of the tracing stylus accordingly.

The ratio between the diameters of the cutter and the tracing stylus should be the same as the pantograph ratio.

The straightedge should be so adjusted that, after its insertion into the taper bore, the stylus and the cutter rest simultaneously on the surface of the straightedge. If necessary, shift the straightedge in the taper bore until the correct position is obtained.

Roughing Work with the Pantograph Rigidly Connected



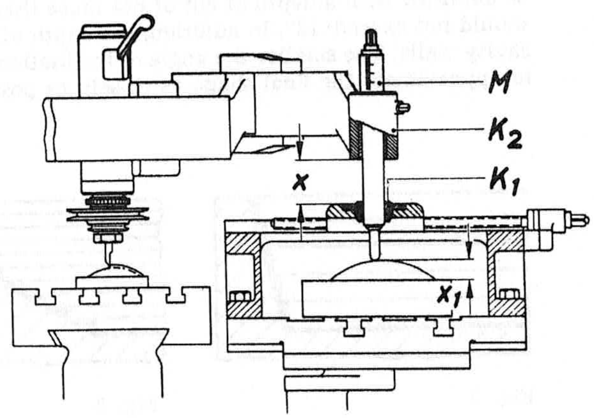
After the master has been secured in position on the copyholder, the bridge-shaped attachment ist secured to the guide rails by means of the two bolts **L**. The spherical-end sleeve **K** is inserted into the hole of the tracer pin carrier. Then, after both the tracer pin and the cutter have been set for the highest point of the master and the workpiece, respectively, the pantograph is locked in its horizontal position. Finally screw **S** is tightened, after which the insert serving to keep the pantograph in its horizontal position is removed. – Profiling work is now performed by removing stock layer by layer. To do this, the tracer pin is fed down by means of setting ring **E** and scale **M** by a suitable amount **h**, the work table being raised by a corresponding amount **h**/T.R. where T.R. is the transposition ratio.

This work cycle is repeated until the bottom of the work cavity is reached and all contours have been transferred. In order to conserve the master it is recommended not to allow the tracer pin to touch the inside walls of the master.

After roughing work has been completed, the bridge may be removed after removing the bolts **L**. Following this the work is finish-milled by the method customarily used with GK type machines.

Roughing Work with the Pantograph Loosely Connected

This setup in which the tracer pin is free to move endwise requires both the tracer pin and the cutter to be set with the aid of a straightedge. During milling, the tracer pin which is loaded by the deadweight of the pantograph slides over the master to be copied. The pantograph, in turn, which is locked to the tracer pin sleeve is positively guided so that the movements of the tracer pin are transferred to the milling cutter.



It should be noted that in this setup the tracer pin carrier is guided by the spherical sleeve $\mathbf{K}_1$. The tracer pin carrier is secured to the pantograph through the medium of the sleeve $\mathbf{K}_2$. The distance **x** should be selected to equal the height $\mathbf{x}_1$ of the pattern or master.

Rules for Rough Milling Work

In die sinking work it is of particular importance to perform the rough milling in a proper manner, as any excess material left for finishing would seriously reduce over-all economy. Except for very small dies and similar work, rough milling should be done with the spindle head locked in position. Where large-size workpieces are concerned, it may be possible under certain conditions to rough out the approximate shape of the die cavity in some other machine, for example, a lathe or a milling machine, while the die cavity proper is produced by means of the GK 21 machine.

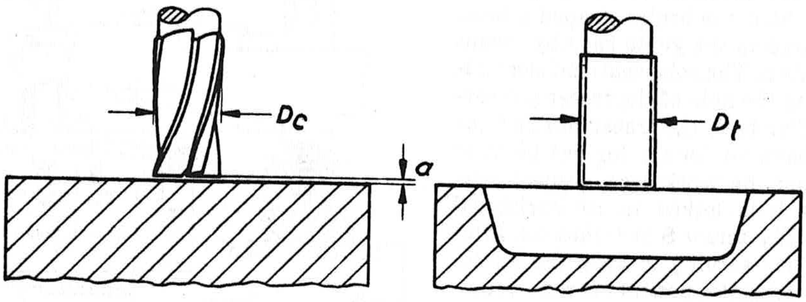


Fig. 1

Referring to Fig. 1, the diameter of the tracing stylus is determined by the cutter diameter on the one hand and by the desired finishing allowance a on the other. The tracer diameter D_t is derived from the cutter diameter D_c and the finishing allowance by solving the following equation:

Reduction:

$$D_t = (D_c + 2a) \cdot P$$

$$D_c = \frac{D_t}{P} - (2 \cdot a)$$

P = Pantograph ratio

The amount of stock left for finishing depends on the shape of the work as well as on the material to be cut. It is good practice with deep die cavities requiring a long-shank cutter, to leave a finishing allowance of .04". With dies of simple shape, this allowance may be reduced to .02". Where extremely hard and tough materials are used, care should be taken, during rough milling, to approach the final size as closely as possible in order to facilitate finishing.

It is recommended for rough milling work to use multiple fluted end mills of the largest possible diameter (maximum diameter .315"). Where steel is to be cut, it is also possible to use single-lip cutters up to .32" in diameter. Single-lip cutters, when used in rough milling work, permit using nearly double the cutting speed ordinarily recommended for multiple-fluted cutters.

During rough milling, stock is removed in successive layers. The bulk of the material is removed from the die cavity by means of multiple-flute end mills. Maximum economy has been found to be obtained with a depth of cut of not more than .16". With single-lip cutters, the depth of cut should not exceed .12". 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 should the depth of cut be in order to approximate the final shape as closely as possible (see Figs. 2 and 3).

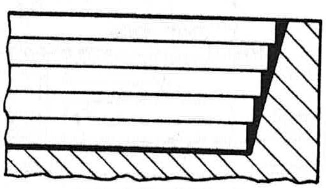


Fig. 2

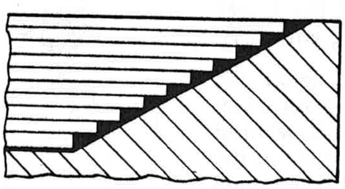


Fig. 3

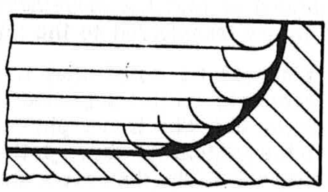
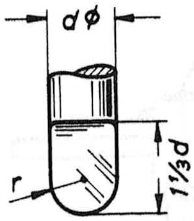


Fig. 4

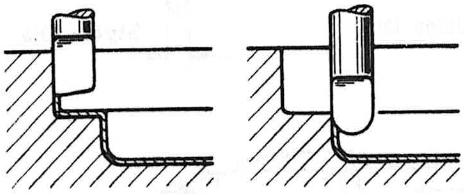
Economy in operation can be improved by adapting the cutter profile to the contour of the die cavity. As will be seen in Fig. 4, curved contours are best produced by means of rounded cutters. In this case the profile of the tracing stylus must agree with that of the cutter. The cutter and the stylus can be given identical profiles in the Model SO Cutter Grinder.

As a rule, no coolant need be used during rough milling. In special cases, when materials such as light alloys are to be cut, the cutter may be wetted with petroleum or some other coolant.

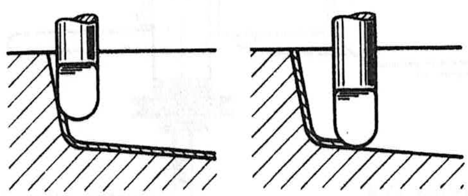
Rules for Finish Milling Work



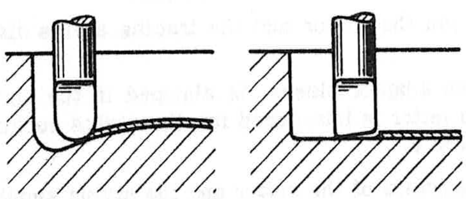
Single-lip cutters are preferably used in finishing operations, as their design greatly facilitates the meeting of special requirements regarding the cutter profile, the cutting angles, etc. The Model SO Cutter Grinder makes it possible, in minimum time, to give cutters any desired profile.



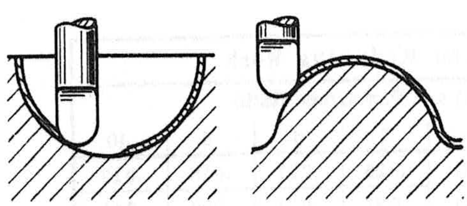
Finish milling of **steep walls** of die cavities requires the use of a cutter having an off-center radius. Only those side walls which are blended into the die bottom by a radiused corner can be milled with a fully rounded cutter.



Angular surfaces whose angle of inclination relative to a horizontal or vertical direction is 10° or more may also be finish milled with fully rounded cutters.



For the finishing of **slightly crowned surfaces,** fully rounded cutters should be used. In the case of surfaces located at right angles to the cutter axis, however, it is recommended to use a cutter having an off-center radius.



Crowned or circular surfaces, regardless whether convex or concave, are preferably finished with fully rounded cutters. Wherever possible, the cutter should be guided in a vertically upward direction, as this will ensure maximum stock removal.

Finish milling, which is required to produce accurate dimensions and high surface finish, is performed in two operations, i. e., semi-finishing and final finishing.

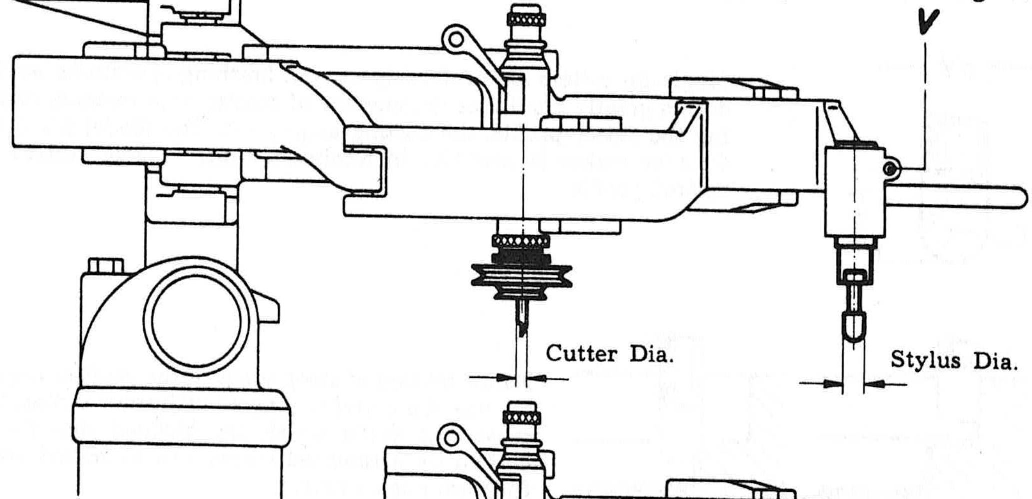
During the semi-finishing cut, the step-shaped surface irregularities produced by rough milling are removed to such an extent that a maximum final finishing allowance of .004" remains throughout the surface of the work. This step is intended to reduce the stress imposed on the single-lip cutter used for final finishing and thus to extend the useful life of the cutting edge between grinds.

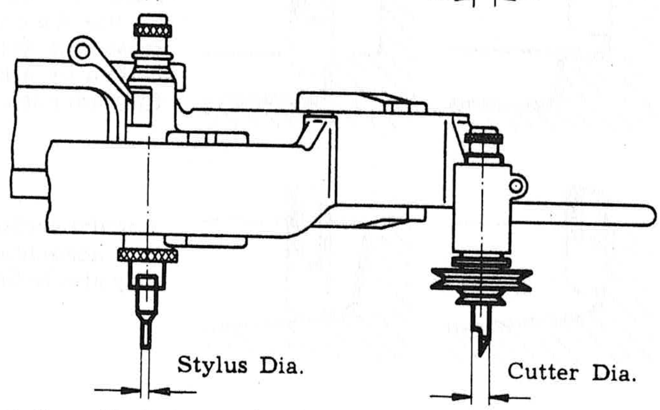
Both the surface finish and the accuracy of the work depend on the design and the nature of the pattern or master. Accuracy requirements should, therefore, be taken into account when the master is made. Maximum accuracy is obtained with masters made of steel, non-ferrous metals, and certain plastic materials, i. e., materials that permit keeping surface irregularities below the .0004" limit. Where masters are made of softer materials such as wood or porcelain cement, it will, of course, be necessary to put up with larger manufacturing tolerances.

Compliance with the rules outlined above will either eliminate the necessity of hand finishing or reduce it to a minimum.

GK 21 | Using the GK 21 Pantograph for Reducing and Enlarging Work

Positions of Cutter and Tracing Stylus for **Reducing Work**





Positions of Cutter and Tracing Stylus for **Enlarging Work**

It is necessary for reduction work that the ratio between the cutter and the tracing stylus diameters agree with the pantograph ratio.

For enlarging work, the tracing stylus, together with an adaptor sleeve, is clamped in the bore which normally receives the cutter spindle assembly; the latter is introduced into the stylus socket and clamped in position by means of hexagon-head screw V.

In the case of enlarging work, the ratio between the diameters of the cutter and the stylus should be the reciprocal of the pantograph ratio.

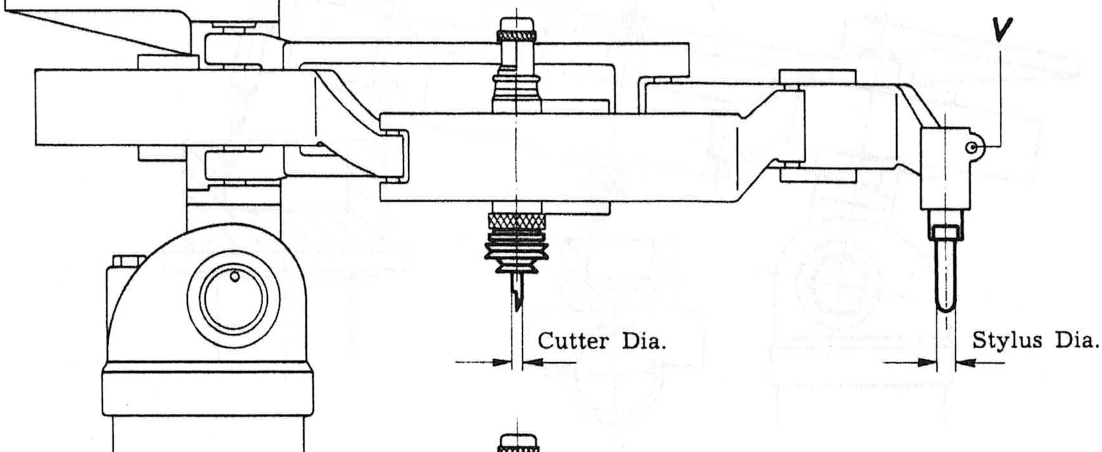
Cutter and Stylus Diameters for **Reducing Work**									
	Cutter Diameter (in inches) and Pantograph Ratio								
Stylus Dia.	1.5	2	2.5	3	4	5	6	8	10
1/8"	.083	.063	.050	.042	.031	.025	.021	.016	.013
5/32"	.104	.078	.063	.052	.039	.031	.026	.020	.016
3/16"	.125	.094	.075	.063	.047	.038	.031	.023	.019
1/4"	.167	.125	.100	.083	.063	.050	.042	.031	.025
5/16"	.208	.156	.125	.104	.078	.063	.052	.039	.031
3/8"	.250	.188	.150	.125	.094	.075	.063	.047	.038
1/2"	.333	.250	.200	.167	.125	.100	.083	.063	.050
9/16"		.281	.225	.188	.141	.113	.094	.070	.056
5/8"		.313	.250	.208	.156	.125	.104	.078	.063

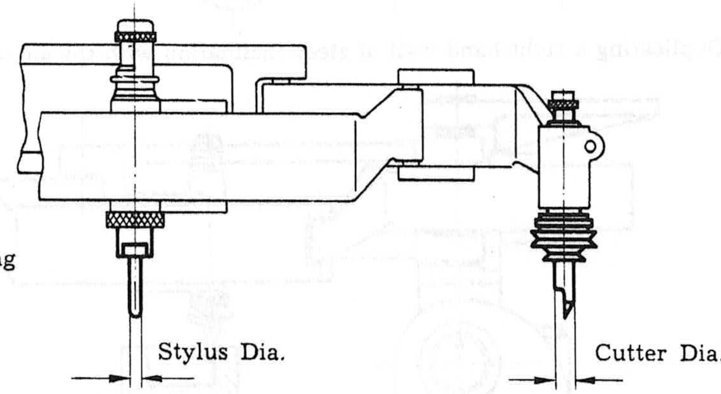
Cutter and Stylus Diameters for **Enlarging Work**									
	Stylus Diameter (in inches) and Pantograph Ratio								
Cutter Dia.	1.5	2	2.5	3	4	5	6	8	10
5/32"	.104	.078	.063	.052	.039				
1/4"	.167	.125	.100	.083	.063	.050	.042		
5/16"	.208	.156	.125	.104	.078	.063	.052	.039	.031

Using the GK 12 Pantograph for Reducing and Enlarging Work

GK 12

Positions of Cutter and Tracing Stylus for **Reducing Work**





Positions of Cutter and Tracing Stylus for **Enlarging Work**

It is necessary for reduction work that the ratio between the cutter and the tracing stylus diameters agree with the pantograph ratio.

For enlarging work, the tracing stylus, together with an adaptor sleeve, is clamped in the bore which normally receives the cutter spindle assembly; the latter is introduced into the stylus and clamped in position by means of hexagon-head screw V.

In the case of enlarging work, the ratio between the diameters of the cutter and the stylus should be the reciprocal of the pantograph ratio.

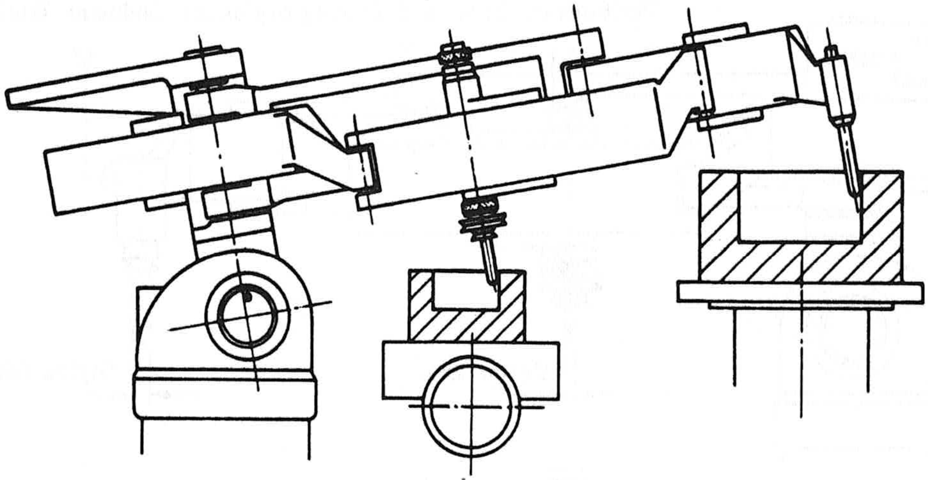
	Cutter and Stylus Diameters for **Reducing Work**								
Stylus Dia. (in.)	Cutter Diameter (in.) and Pantograph Ratio								
	1.5	2	2.5	3	4	5	6	8	10
1/8	.083	.063	.050	.042	.031	.025	.021	.016	.013
5/32	.104	.078	.063	.052	.039	.031	.026	.020	.016
3/16	.125	.094	.075	.063	.047	.038	.031	.023	.019
1/4	.167	.125	.100	.083	.063	.050	.042	.031	.025
5/16	.208	.156	.125	.104	.078	.063	.052	.039	.031
3/8		.188	.150	.125	.094	.075	.063	.047	.038
1/2		.250	.200	.167	.125	.100	.083	.063	.050
9/16			.225	.188	.141	.113	.094	.070	.056
5/8				.208	.156	.125	.104	.078	.063

	Cutter and Stylus Diameters for **Enlarging Work**								
Cutter Dia. (in.)	Stylus Diameter (in.) and Pantograph Ratio								
	1.5	2	2.5	3	4	5	6	8	10
5/32	.104	.078	.063	.052	.039	.031	.026		
1/4	.167	.125	.100	.083	.063	.050	.042	.031	.025

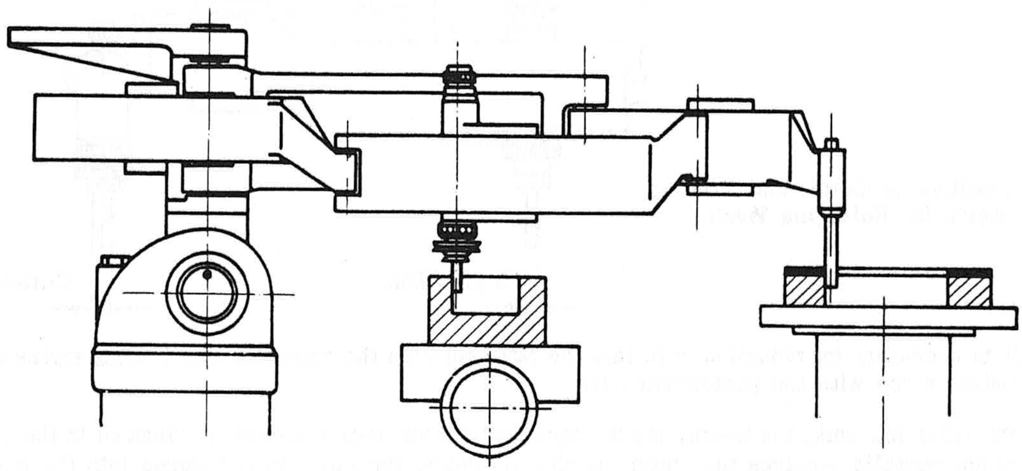
The pantograph balancing mechanism, controlled by means of the knob adjacent to the pattern racket screw, is not always fully effective if pantograph ratios between 1:7 and 1:10 are used. In such cases it will be expedient to mount the former plate holder (eccessory item) in such a way that its weight increases the weight of the pantograph. This will permit better adjustment of the balancing spring tension.

GK 12
GK 21

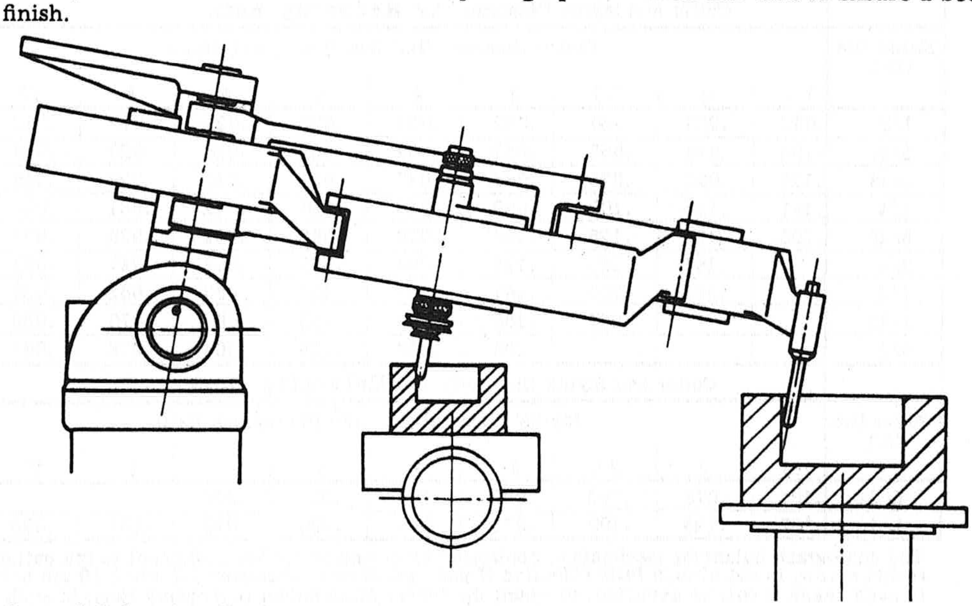
Duplication of Steeply Inclined Surfaces



Duplicating a right-hand wall of steep inclination with the aid of the freely movable pantograph.



Duplicating steeply inclined surfaces with the aid of a sheet-metal template; while the pantograph is locked in a horizontal position, feed motion is imparted to the work by means of the worktable elevating screw. In the case of horizontal work it is recommended to have the stylus rest on the surface of the pattern table in order to eliminate pantograph vibration and thus to ensure a better surface finish.



Duplicating a left-hand wall of steep inclination with the aid of the freely movable pantograph.

Materials for Patterns

1. Hardwood

The preferred material for making patterns by hand is pear-tree wood which will be available in almost every pattern shop. Maple and walnut may also be used. Hardwood is primarily used in making positive patterns from which 'Monolith' composition or porcelain cement casts will then be taken. Where relatively simple shapes are concerned and where accuracy requirements are low, these patterns may be directly used as copying masters. Hardwood lends itself extremely well to being milled in the pantograph machine.

2. Monolith Composition

As has already been mentioned, Monolith is particularly suitable for the preparation of patterns by a casting process. This material is prepared for use in a way similar to that used with cement and poured in fluid form into the pattern box. While casting the pattern it is necessary constantly to stir the material in order to maintain its consistency. After between 18 and 24 hours the material will have set sufficiently to permit the use of the pattern for duplicating work. The hardening process will, however, continue for a major period of time.

Monolith patterns, while showing nearly no shrinkage, are susceptible to damage by shock or impact. They are primarily used in cases where only positive models are available, for example for the manufacture of a press die. Such positive models are obtained either by mechanical duplication of a pressed part or a sample, or the models are prepared directly in accordance with drawing specifications, wood or a similar material being used in the latter case.

3. Plastic Compositions

Commercially available plastics have proved most satisfactory for pattern making. They combine high strength and toughness. They are nearly completely free of distortion and shrinkage; they are not affected by changes in temperature or by water, and to a certain degree they are acid-resistant. They constitute no fire hazard, as even sawdust and filings will not burn but only smolder. The material permits machining by sawing, planing, drilling, milling, carving, shaving, etc. It thus lends itself to the production of enlargements which, by virtue of the high surface finish obtained, require only a small amount of hand finishing. Plastic patterns are particularly suitable for shapes showing fine details and requiring a high degree of accuracy. While permitting repeated duplication, such patterns are extremely useful for duplication in steel. They may be used for repeated duplication without showing any noticeable amount of wear.

Plastic compositions and 'Monolith' available from DECKEL factory or agencies.

GK 12
GK 21

Preparation of Patterns of Intricate Three-Dimensional Design

The GK engraver may be used to duplicate press dies, embossing dies and the like from an enlarged pattern which in most cases is obtained by using the GK machine — set up for enlarging work — in combination with suitable auxiliary templates or an actual sample. It is also possible, however, to use an actual die for a prototype in the preparation of a new enlarged pattern, taking into consideration any desired changes in design. Patterns made on an enlarged scale offer an important advantage in that all deviations from the desired shape will be reduced in proportion to the pantograph ratio used in making the final copy as a reduced replica of the pattern. Depending on the nature of the job, a pattern can be made in two different ways: —

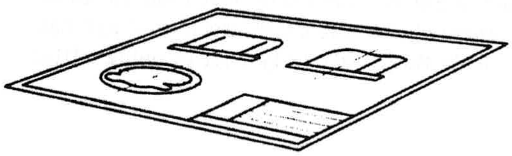


Fig. 1 Drawing

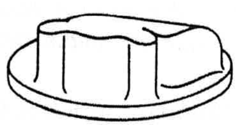


Fig. 2 Positive Pattern

1. Where intricate three-dimensional shapes are involved, it is recommended first to make a positive pattern – the so-called prototype – taking into account the expected amount of shrinkage. While larger-size patterns can be made of hardwood, plastics or other easy-to-machine materials may be used for the smaller jobs. From this pattern a Monolith cast is taken, this cast also being used as a prototype for a single duplication in a plastic material. It is more convenient, however, to take the cast from an enlarged hardwood pattern which, in turn, is used to obtain a plastic pattern. Plastic patterns offer an advantage in that they can be easily retouched. They are more wear-resistant than patterns made of a cement compound and they may be used for repeated duplication.

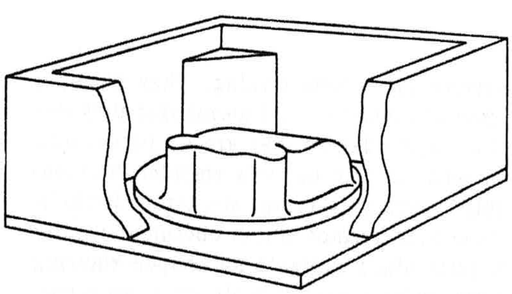


Fig. 3 Pattern Box

2. Patterns showing delicate details or requiring a high degree of surface finish and accuracy, especially such patterns which have to be copied frequently, should be made of steel (using a plastic pattern as an intermediate step), it even being possible to heat-treat or harden the finished pattern. In the case of drawing or pressing dies for hollow parts, i.e. sheet-metal embossing dies or bakelite molds, the positive pattern may also be used in making an enlarged pattern of the punch. The desired wall thicknesses can then be taken into account by using tracers of smaller diameter or cutters of larger diameter.

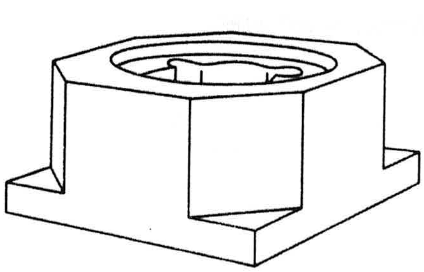


Fig. 4 Negative Pattern

Styles of Type Face Templates

The design of the standard type face template is shown in Fig. 1 the height of the characters being 20 mm (.787"); available upon request are templates having characters of a height of 40 mm (1 37/64"). The prong-type templates also shown in Fig. 1 are mounted on the universal template holder; they facilitate the engraving of lettering arranged on circular arcs. A wide variety of fonts are available in each style; special catalogue upon request.

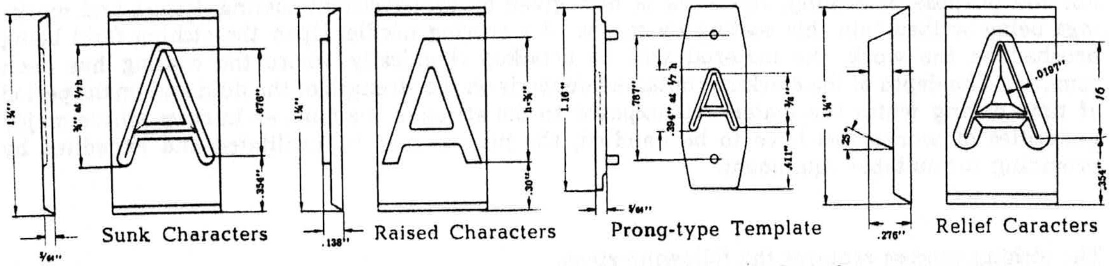


Fig. 1

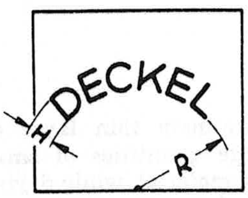


Fig. 2

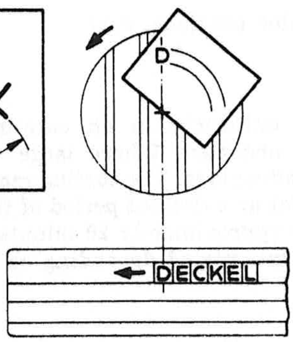


Fig. 3

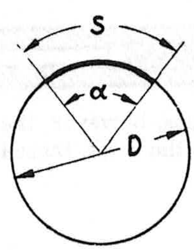


Fig. 4

Duplicating Circular Lettering

1. Mark off height **H** of characters and radius **R** on work.
2. Set pantograph in such a manner that desired height of characters can be obtained.
3. To engrave individual characters, proceed as follows:
   (a) Align centers of template and circular table.
   (b) Scribe a center line on the template holder (Fig. 3), align the first letter with the center line and cut this character. Then move the line of characters by one space to bring the next following letter in line with the scribed mark. To provide for the correct distance between letters on the work, the circular table must be rotated in each case through a corresponding angle.

Preparation of Templates for Engraving Work on Rolls

The length of arc S of the lettering to be engraved on a cylinder is given by the following equation:

$$S = \frac{D \times 3.14 \times \alpha}{360} \quad (1)$$

Where α = Subtended angle of lettering
S = Length of arcuate lettering
D = Diameter of roll

Thus, in the case of a pantograph ratio **u**, the length **L** of the lettering is given by the following equation:

$$L = \frac{u \times D \times 3.14 \times \alpha}{360} \quad (2) \text{ or}$$

$$u = \frac{L \times 360}{D \times 3.14 \times \alpha} \quad (3)$$

Most drawings specify the angular distances of individual characters from a common starting point (α_1, α_2...) as shown in Fig. 5. Using equation (2) it is then possible to calculate the distances L_1, L_2, L_3, etc. on the template. For easier calculation it is recommended to state minutes of arc in decimals.

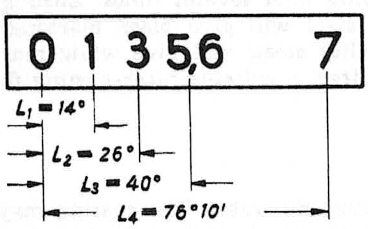


Fig. 5

Example: α_4 = 76° 10'
D = 40 mm.
u = 3 : 1

Find L_4:

$$L_4 = \frac{3 \times 40 \times 3.14 \times 76.16}{360} = 79.8 \text{ mm.}$$

For measures given in inches, follow similar procedure.

Duplicating Special-Type Templates, Brand Name Symbols, etc.

After marking the template on an enlarged scale, the pantograph is locked in position; then all lines, radii, circles, etc. are engraved in a raised or sunk manner as the case may be, 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 and similar work requiring the taking of a cast, such sharp corners are hand-finished on the cast duplicate.

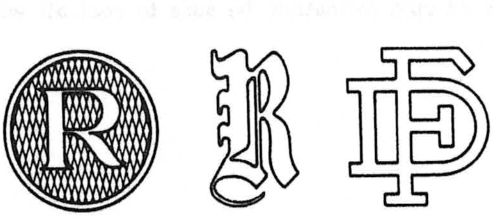


Fig. 6

The Etching Process

The etching process is used in those cases in particular where the material to be cut is so hard that conventional engraving methods tend to become uneconomical or even impracticable. This applies for the lettering or marking of hardened or natural-hard steel (tools, machine parts, etc.) as well as glass and similar materials.
For the purpose of etching, the work is first given an acid-resistant coating, letters and markings being scribed into this coating by means of a scoring needle. Upon the etching fluid being brushed on the work, the material will be attacked chemically where the coating has been removed. The depth of the markings obtained depends on the strength of the fluid and on the period of time during which the material is exposed to the action of the fluid. — In cases where major quantities of workpieces have to be handled, the process may be facilitated and expedited by providing for suitable equipment.

The etching process requires the following steps:

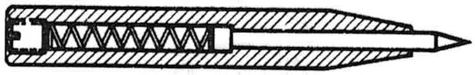
1. Remove all grease from work (use benzene, trichlor ethylene, etc.)

2. Coat Work

Use a soft camel's hair brush to apply coating uniformly in an extremely thin layer or film. Take care not to leave any exposed spots uncoated. Where large quantities of small parts are concerned, dipping may be used to good advantage. The coating material, while drying rapidly, should retain a high degree of elasticity for an extended period of time so as to prevent flaking-off during marking. While drying requires approximately 20 minutes, marking may be performed as late as 24 hours later, the length of this period depending on the composition of the coating material.

3. Marking Work in the Engraving Machine

Markings are scored into the coating by means of a spring-loaded scriber as illustrated below. In cases where curvatures or other irregularities of the work do not exceed 3/16 in. (length of travel of the scribing needle), uneven surfaces can also be marked. Delicate engraving work is performed with the aid of a pointed needle which is not required to rotate. A chisel-edged rotating scriber is used in cases where wider lines are desired. In this case, however, the work surface must be plane, as otherwise flakes from the coating may stick to the work, these flakes interfering with the etching process.



4. Etching

Using a pipette, a brush or a wooden stick wrapped with wadding, apply the etching fluid to the work which is held with the markings in a horizontal position. In the case of completely coated work, the dipping method may also be used. Where deep markings are required, the etching process may be accelerated by applying fluid several times. Etching requires between four and twelve minutes. Hardened carbon steel will give black markings, while non-hardened steel, wrought iron and certain high-quality steels will give white markings. In the case of the latter, if deep-black markings are required, a suitable black-etching fluid is applied after the fluid used first has been removed.

5. Cleaning the Work

After etching, the work is thoroughly rinsed in running water. The coating may be removed by means of benzene or hot soda solution. To prevent rust formation, be sure to coat all work with grease.

The Electric-Marking Process

Introduction

Where the electric marking method is to be used in toolrooms, for example, for the marking of gauges, jigs and fixtures, machinery components and the like, i.e. in cases in which clean and accurate lettering is required, no satisfactory results can be obtained by means of marking devices operating on the swinging armature principle; for work of the above-mentioned nature there is now being adopted a marking device having a tungsten electrode which is kept in light contact with the work. Use is made of a low-voltage alternating current of very high intensity which will immediately melt the material of the work at the point of contact, so that the proper movement of the marking head will produce the desired lettering.

The electric marking attachment, which will operate on alternating current only, is mounted for use on a pantograph-type engraving machine (see illustration). With the aid of the pantograph, the marking head which takes the place of the cutter spindle unit can be guided along lettering templates and will produce accurate deep-black markings even on glass-hard workpieces.

The attachment is very simple and easy to operate, and in view of the low voltage employed it affords completely safety. The markings and letterings produced with this attachment constitute a safeguard against confusion as well as theft, since it is possible, after an attempt has been made to erase the markings, to cause them to reappear by applying copper ammonium chloride.

Mounting the Attachment

From the top of the attachment there emerge the heavy secondary cables, one of which carries the marking head. Remove the cutter spindle unit from the pantograph of the engraving machine and insert the marking head instead. Provided on the bottom end of the marking head is a chuck with a clamping nut receiving the marking electrode. Insert the electrode in such a manner that it projects well from the head; but the free end of the electrode should not be too long either.

The free end of the other secondary cable carries a terminal which should be secured to the worktable of the engraving machine by means of a screw; tighten the screw firmly so as to provide for proper conduction of the heavy current. This will produce an electrically conductive connection forming a circuit via the marking head, the electrode point, the surface of the work, the worktable, the terminal of the return lead and back to the marking head.

The plug of the primary cable which has a built-in protective capacitor has to be connected to a source of alternating current having the voltage and cycle characteristics stated on the nameplate.

NOTICE: Connecting the attachment to a source of direct current will result in the immediate destruction of the attachment.

While the foot pedal switch connected with the attachment may be positioned for manual operation, it will be found more convenient to anchor it to the floor so that it can be easily foot-operated.

The Electric Marking Attachment comprises the following units:

(a) Electric marking head

(b) Rotary converter

(c) Pilot lamp

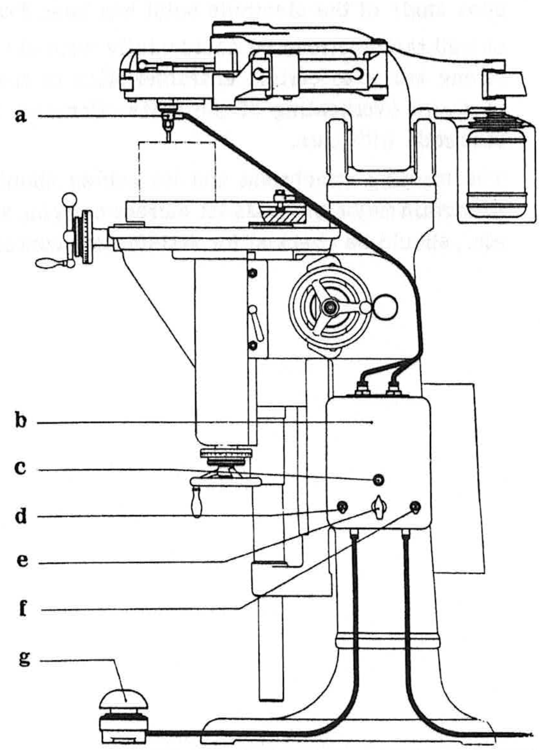
(d) Tumbler switch for foot contact

(e) Regulating knob

(f) "Strong" – "Weak" switch

(g) Foot pedal switch

Standard operating voltage 220 volts A.C.
Other voltages to special request.



Operating Instructions

First of all set the tumbler switch at the left at FUSS (Foot), thus causing the marking current to be turned on upon the foot-pedal switch being depressed. Then lower the point of the marking electrode in the marking head onto the area of the workpiece to be marked, the workpiece being of course, secured to the worktable. The pressure of the electrode should amount to between 4 and 8 ounces (100 to 200 grams). This pressure is provided for by the spring mount of the marking head. It is recommended to establish the proper intensity of the marking current by first setting the right-hand tumbler switch at SCHWACH (Weak) and then gradually turning the central regulating knob from its extreme left position in a clockwise direction until the desired current intensity is obtained. After a little practice you will remember certain appropriate settings suitable for various classes of work. Trace the lettering templates slowly and uniformly, allowing for a speed of one letter or numeral in every 4 or 5 seconds. In order to avoid the formation of craters and burned spots at the start and at the end of the lettering, do not depress the control switch until the current-carrying electrode point contacts the surface to be marked: by the same token, lift the electrode from the work surface only after releasing the foot-pedal switch.

The use of the electric marking attachment causes a relatively heavy current of low voltage (1/2 to 1 volt; 100 to 300 amps.) to be forced through a "bottleneck" between the current-carrying workpiece and the electrode point resting on the surface to be marked. The high resistance offered to the current results in the production of heat which is sufficient immediately to cause the material in the vicinity of the electrode point to be melted.

Care should be taken to see that the marking circuit is not interrupted by such insulating substances as varnish, oil or scale.

Both the width and the depth of the markings may be controlled within certain limits by selecting a more or less sharply pointed electrode and/or a stronger or weaker current. The fact should, however, be borne in mind that, as regards the width and the depth of the markings, there is a decided difference between marking and actual engraving work.

The electrodes may 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 be accidentally welded to the workpiece, which may be due to an excessively strong arc or to certain characteristics of the material being marked, turn off the current in order to avoid overheating of the parts. Unclamp the electrode and use a pair of pliers to remove the electrode with care.

The marking attachment and its cables should be protected from moisture (water, coolant, etc.). At certain major intervals all current-carrying surfaces, including the terminal, the electrode chuck, etc., should be checked for satisfactory contact and should be cleaned if necessary.

List of Roll Engraving Attachments

GK 12
GK 21

Fig. I

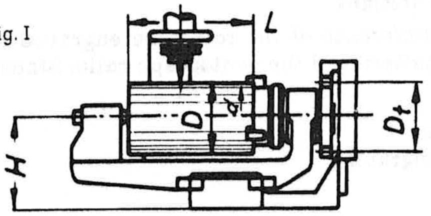
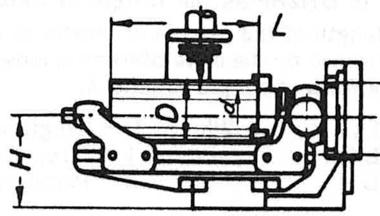


Abb. II



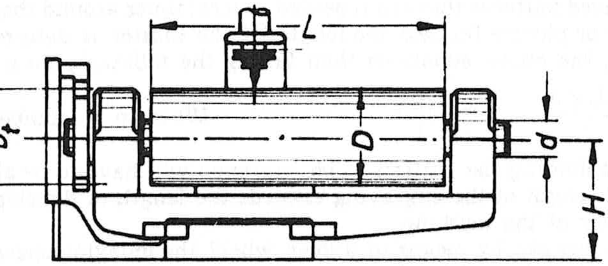


Fig. III

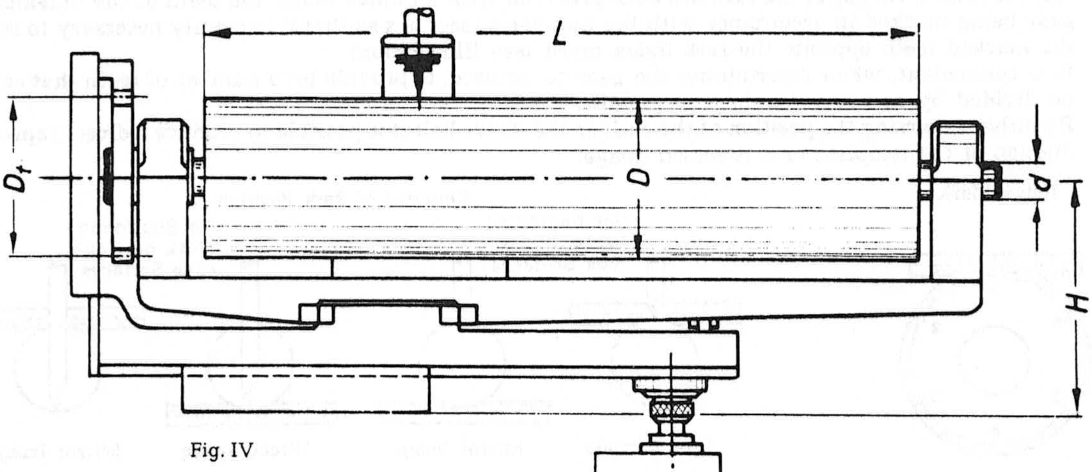


Fig. IV

Pitch Circle Diameter D_t of Gear = Diameter D of Roll

Model	Fig.	Min. Dia. of Roll D	Max. Dia. of Roll D	Length of Roll L	Max. Clamping Dia. d	Max. Length of Engraving without / with Reversal of Drive Member		Max. Length of Development	Height H	For Use with Model GK 12	For Use with Model GK 21
						without	with				
6021000000	II	.7874	3.9370	9.4488	2.7559	6.6929	8.6614	6.6142	4.0551	● ◢	● ◢
6022000000	I	1.2992	5.9055	9.8425	3.3550	7.8740	7.8740	7.8740	5.9055	□ ◢	□ ◢
6024000000	III	5.1181	11.8110	19.6850	2.7559	7.8740	19.6850	6.2992	8.4251	◒ ◢	◒ ◢
6025000000	IV	5.1181	11.8110	39.3700	2.7559	7.8740	39.3700	6.2992	13.0708	△ ◒ ◢	△ ◒ ◢

◒ – Special Equipment: Mounting bracket, 10⅝" (270 mm) high

● – Chuck swings 90° for tapered work

□ – Limited working range for reduction ratios between 1:3 and 1:1.5, especially in the case of duplicating jobs.

△ – Special Equipment: Supporting bracket (Fig. IV)

◢ – For use with machine models indicated

Models I and II are supplemented by three-jaw chuck and outboard center.

Note: The use of roll engraving attachments on GK machines at reduction ratios exceeding 1:6 will reduce the working range of the machine.

Roll Engraving Attachment - Instructions for Use

How to Determine the Length of Patterns and Engraved Designs

The length of the pattern or master in relation to the circumference of the roll to be engraved is determined by the circumferential length of the engraved pattern and the pantograph ratio. Stated in the form of simple equations,

$L = l \times u$ Where L = Length of template or master
$l = L / u$ l = Circumferential length of engraving
$u = L / l$ u = Pantograph ratio.

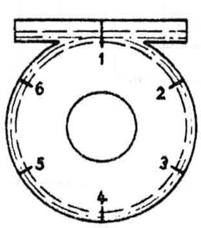
In the case of engraved patterns that are repeated several times around the circumference (e.g. with rolls for wall paper or picture frames), the length of the master is determined by the number of repetitive portions, the above equations then taking the following form:

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

Where n = number of portions or sections

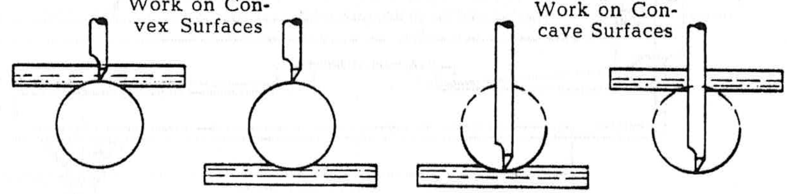
This method of subdividing the pattern to be engraved will have to be adopted in cases in which the circumferential length of the engraving exceeds the length of development of the attachment or the work capacity of the machine.
Where the work is indexed by means of a gear wheel, the indexing operation is facilitated by the fact that one tooth gap of the rack has been provided with an index mark, the teeth of the indexing gear being marked in accordance with the number of sections so that it is merely necessary to set the marked teeth opposite the rack index mark (see illustration).
It is convenient, when determining the gear to be used, to provide for a number of teeth that can be divided by as many numbers as possible.
By either reversing the position of the rack or the drive belt it is possible to produce a direct reproduction of the template or a reversed image.

Index Marks



Reversal of Rack Position

For Engraving Work on Convex Surfaces — For Engraving Work on Concave Surfaces



Direct Image — Mirror Image — Direct Image — Mirror Image

How to Determine the Indexing Gear or the Indexing Disc

The nature of the engraved work is determined by the ratio between pitch circle diameter of the indexing gear or the indexing disc diameter and the roll diameter. Any major difference between the above-mentioned diameters will change the appearance of the characters, i. e. the characters will become either 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 sum of the pitch diameter (or disc diameter) and the drive belt (where used) equals the outside diameter of the roll. In most cases slight deviations in either direction are permissible. This relation between the two diameters can be stated as follows:

$D_t = D_a$ $D_a = D_t$ (Transmission by gear)
or $W = D_a - s$ $D_a = W + s$ (Transmission by disc)

Where D_t = Pitch diameter of gear
D_a = Outside diameter of roll to be engraved
W = Disc diameter
s = Thickness of drive belt

This relation is changed in the case of relief-type engraving work: The greater depth of the engraving has to be taken into account as follows:

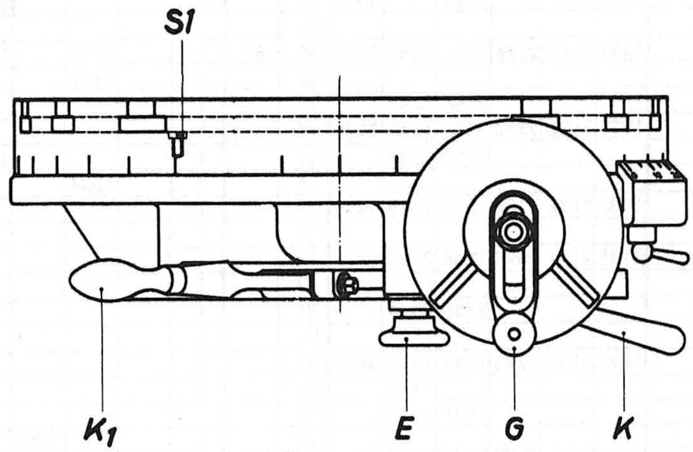
$D_t = D_a - h$ or $D_a = D_t + h$ (Transmission by gear)
$W = D_a - s - h$ or $D_a = W + s + h$ (Transmission by disc)

Where h = Height of engraved pattern.

The height **h** is given as the height **H** of the reliefmaster, divided by the pantograph ratio: $h = H/u$. Thus, it is recommended, in the case of relief work, first to determine the pitch or disc diameter, then the outside diameter.
The module of the rack is 1; thus the number of gear teeth is computed as follows: Pitch diameter of gear, divided by the module. Assuming whole numbers, the number of teeth always equals the pitch diameter, since the module is 1.

Operation of the Circular Table 15 in. dia.

GK 12
GK 21



The Circular Table has been designed for plain and compound indexing and for indexing any desired angle in degrees. Compound and plain indexing accuracy is ± 90 sec.

Compound Indexing

When indexing by the compound system the circular table setting is accomplished by manipulating crank handle **G** operating a worm gear arrangement. In so doing, first bring the worm in mesh with the worm wheel, whereby after having loosened locking handle **K** index plate and crank handle are moved counter-clockwise until contacting the stop pin.

Apply utmost care when engaging the worm, to prevent the precision worm gear from being spoiled, since this would result in indexing errors. It is of prime importance also, that the worm is completely brought in mesh until contacting the stop pin in order to maintain the indexing accuracy as long as possible and to avoid a damage of the worm gear arrangement. A marking on the eccentric sleeve rear of the index plate serves for checking the aforementioned movement. Bear in mind that locking handle **K** is again to be securely clamped before starting milling.

For readjusting the eccentric sleeve and for mating the worm wheel more closely so as to eliminate any possible backlash provision has been made for a hexagon socket screw fitted at the locking handle **K.**

For this purpose, remove the screw, grind off a few ten-thousandths of an inch from its crowned end, replace the screw, and check the backlash of the readjusted worm by rotating the circular table.

Plain Indexing

Indexing operations by the direct method are performed by first disengaging and clamping the worm. Divisions can then be made either by means of an index plate with 24 holes through index pin **E** or by the aid of a graduation to 360 degrees provided on periphery of table. The accuracy of the index settings can be greatly improved by means of an adjustable vernier. The scale of the vernier has 60 divisions covering 59 degrees thus enabling a setting of minimum 1 minute.

Take care that before starting the milling work the table top is clamped into position by moving locking handle **K 1** in order to relieve worm and index pin from the thrust of the cutter.

Lubrication

Worm and worm wheel run in oil. The ways supporting the table can be supplied with oil through hole **S1.**

GK 12 GK 21	**Index Table** for Use with the Circular Table 15 in. dia.

Number of Div.	Divisions Spaced in deg.	Number of Turns of Index Crank									
		Full Turns	Fractional Turns								
2	180°	45									
	175°	43							27/36		30/40
	160°	40									
	150°	37		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	140°	35									
	135°	33							27/36	30/40	
	130°	32		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	125°	31							9/36	10/40	
3	120°	30									
	110°	27		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	100°	25									
4	90°	22		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	80°	20									
	75°	18							27/36	30/40	
5	72°	18									
	70°	17		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	67°30'	16								35/40	
	65°	16							9/36	10/40	
6	60°	15									
	55°	13							27/36	30/40	
7	–	12									36/42
	50°	12		17/34		19/38	21/42	23/46	18/36	20/40	29/58
8	45°	11							9/36	10/40	
9	40°	10									
10	36°	9									
	35°	8							27/36	30/40	
11	–	8				6/33					
12	30°	7		17/34		19/38	21/42	23/46	18/36	20/40	29/58
13		6					36/39				
14		6					18/42				
	25°	6							9/36	10/40	
15	24°	6									
16		5								25/40	
17		5		10/34							
18	20°	5									
19		4				28/38					
20	18°	4		17/34		19/38	21/42	23/46	18/36	20/40	29/58
	16°	4									
21		4					12/42				
22		4				3/33					
23		3						42/46			
24	15°	3							27/36	30/40	
25		3								24/40	
26		3					18/39				
27		3	9/27			11/33	13/39	14/42	12/36		
28		3						9/42			
29		3									6/58
30	12°	3									
31		2		28/31							
		2									
33		2				24/33					
34		2		22/34							
35		2						24/42			
36	10°	2		17/34		19/38	21/42	23/46	18/36	20/40	29/58
37		2								16/37	
38		2				14/38					
39		2					12/39				
40	9°	2							9/36	10/40	
41		2			8/41						
42		2					6/42				
43		2			4/43						
45	8°	2									
46		1						44/46			
48		1								35/40	
50		1								32/40	
51		1		26/34							
	7°	1							27/36	30/40	
54		1		18/27		22/33	26/39	28/42	24/36		

Number of Div.	Divisions Spaced in deg.	Number of Turns of Index Crank									
		Full Turns	Fractional Turns								
55		1				21/33					
57		1				22/38					
58		1									32/58
60	6°	1		17/34		19/38	21/42	23/46	18/36	20/40	29/58
62		1		14/31							
63		1					18/42				
65		1					15/39				
66		1				12/33					
68		1		11/34							
69		1						14/46			
70		1					12/42				
72	5°	1							9/36	10/40	
74		1							8/37		
75		1								8/40	
76		1					7/38				
78		1					6/39				
80		1								5/40	
81		1							4/36		
82		1			4/41						
84		1					3/42				
85		1		2/34							
86		1			2/43						
87		1									2/58
90	4°	1									
92		–						45/46			
93		–		30/31							
95		–						36/38			
	3°30'	–								35/40	
99		–				30/33					
100		–								36/40	
102		–		30/34							
108		–					35/42		30/36		
111		–								30/37	
114		–				30/38					
116		–									45/58
117		–					30/39				
120	3°	–							27/36	30/40	
123		–			30/41						
126		–					30/42				
129		–			30/43						
135		–	18/27			22/33			24/36		
138		–						30/46			
140		–					27/42				
144		–								25/40	
150		–								24/40	
153		–		20/34							
155		–		18/31							
162		–	15/27						20/36		
165		–				18/33					
170		–		18/34							
171		–				20/38					
174		–									30/58
180	2°	–		17/34		19/38	21/42	23/46	18/36	20/40	29/58
185		–								18/37	
186		–		15/31							
189		–					20/42				
190		–				18/38					
195		–					18/39				
198		–				15/33					
200		–								18/40	
204		–		15/34							
205		–			18/41						
207		–						20/46			
210		–					18/42				
215		–			18/43						
216		–							15/36		
222		–								15/37	
225		–								16/40	

Index Table

for Use with the Circular Table 15 in. dia.

GK 12
GK 21

Number of Divisions	Divisions Spaced in deg.	Number of Turns of Index Crank				Number of Divisions	Divisions Spaced in deg.	Number of Turns of Index Crank				Number of Divisions	Divisions Spaced in deg.	Number of Turns of Index Crank			
		Full Turns	Fractional Turns					Full Turns	Fractional Turns					Full Turns	Fractional Turns		
228		–		15/38		400		–			9/40	1020		–	3/34		
230		–		18/46		405		–	6/27		8/36	1035		–		4/46	
234		–		15/39		410		–	9/41			1044		–			5/58
240		–			15/40	414		–		10/46		1080		–			3/36
243		–	10/27			420		–		9/42		1110		–			3/37
246		–	15/41			430		–	9/43			1140		–		3/38	
252		–		15/42		435		–			12/58	1170		–		3/39	
255		–	12/34			450		–			8/40	1200		–			3/40
258		–	15/43			460		–		9/46		1215		–	2/27		
261		–			20/58	465		–	6/31			1230		–	3/41		
270		–	9/27	11/33	12/36	486		–	5/27			1260		–		3/42	
276		–		15/46		495		–		6/33		1290		–	3/43		
279		–	10/31			510		–	6/34			1305		–			4/58
285		–		12/38		522		–			10/58	1380		–		3/46	
290		–			18/58	540		–		7/42	6/36	1395		–	2/31		
297		–		10/33		555		–			6/37	1485		–		2/33	
300		–			12/40	558		–	5/31			1530		–	2/34		
306		–	10/34			570		–		6/38		1620		–			2/36
310		–	9/31			580		–			9/58	1665		–			2/37
315		–		12/42		585		–		6/39		1710		–		2/38	
324		–			10/36	594		–		5/33		1740		–			3/58
330		–		9/33		600		–			6/40	1755		–		2/39	
333		–			10/37	612		–	5/34			1800		–			2/40
340		–	9/34			615		–	6/41			1845		–	2/41		
342		–		10/38		630		–		6/42		1890		–		2/42	
345		–		12/46		645		–	6/43			1935		–	2/43		
348		–			15/58	648		–			5/36	2070		–		2/46	
351		–		10/39		666		–			5/37	2430		–	1/27		
360	1°	–		9/36	10/40	684		–		5/38		2610		–			2/58
	54′	–			9/40	690		–		6/46		2790		–	1/31		
	48′	–			8/40	702		–		5/39		2970		–		1/33	
	42′	–			7/40	720		–			5/40	3060		–	1/34		
	36′	–			6/40	738		–	5/41			3240		–			1/36
	30′	–			5/40	756		–		5/42		3330		–			1/37
	24′	–			4/40	765		–	4/34			3420		–		1/38	
	18′	–			3/40	774		–	5/43			3510		–		1/39	
	12′	–			2/40	810		–	3/27			3600		–			1/40
	6′	–			1/40	828		–		5/46		3690		–	1/41		
369		–	10/41			855		–		4/38		3780		–		1/42	
370		–			9/37	870		–			6/58	3870		–	1/43		
378		–		10/42		900		–			4/40	4140		–		1/46	
380		–		9/38		930		–	3/31			5220		–			1/58
387		–	10/43			945		–		4/42							
390		–		9/39		990		–		3/33							

Available Hole Circles: 27, 31, 34, 41, 43 / 33, 38, 39, 42, 46 / 36, 37, 40, 58

The denominators of the fractions indicate the hole circle: Example: $^{6}/_{27}$ = Number of Holes/Hole Circle

The index table includes settings for simple indexing of 2 - 5220 divisions and for indexing angles from 6' - 180° when applying the compound indexing method.

Suppose we wish to obtain a production part spaced in 20 divisions or indexed for an angle of 18 degrees. The table indicates for this indexing $4\,^{17}/_{34}$ or $4\,^{19}/_{38}$ turns of the crank. The index pin of the crank handle is now set for hole circle 34 or 38 and the crank rotated four full revolutions and 17 or 19 holes, as the case may be, either clockwise or counter-clockwise.

To avoid indexing errors the index plate is provided with a quadrant which should be so adjusted that one arm always contacts the inner face of the index pin, whereas the second arm covers a number of free holes in either right or left-hand direction to an amount being equivalent to the index crank movement. Prior to each successive division the quadrant is to be repositioned by turning same round until contacting the index pin.

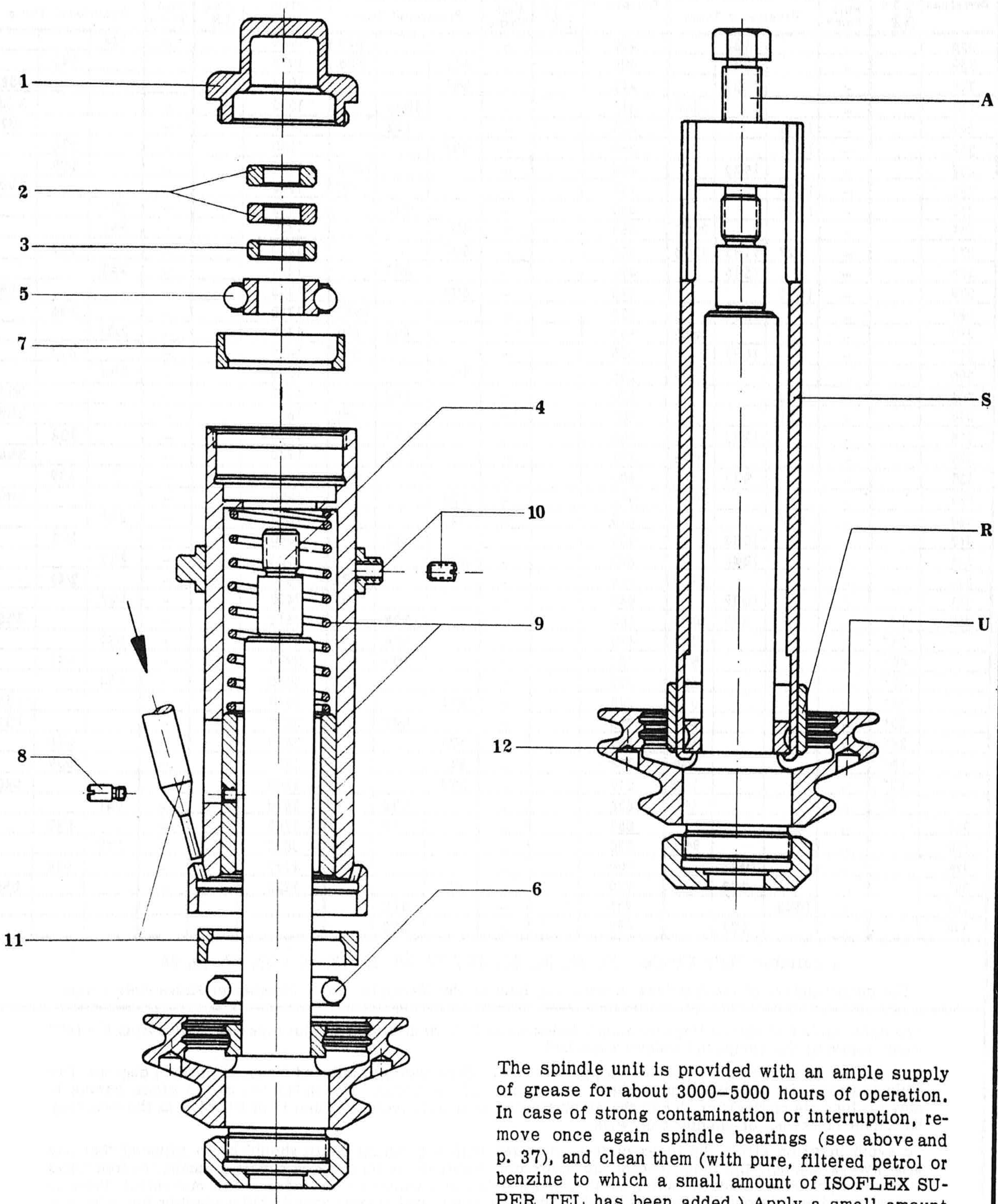
The index worm can be disengaged by releasing the locking handle and revolving the index plate counter-clockwise.

Within the range of between 1 and 100 divisions, the following numbers of divisions which cannot be obtained by means of the circular table can be obtained with the aid of Model Dividing Head:
32; 44; 52; 56; 64; 88; 96.

Neither the circular table nor the dividing head will enable the following numbers of divisions to be obtained:
47; 49; 53; 59; 61; 67; 71; 73; 77; 79; 83; 89; 91; 94; 97; 98.
In these cases, special-type index plates will have to be used.

GK 12
GK 21

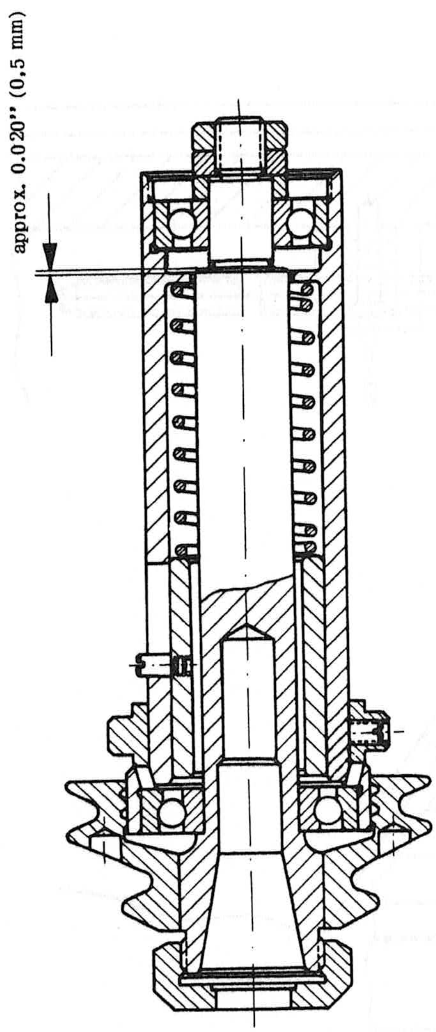
Lubricating, Instructions for Disassembly for Cutter Spindle Units



The spindle unit is provided with an ample supply of grease for about 3000–5000 hours of operation. In case of strong contamination or interruption, remove once again spindle bearings (see above and p. 37), and clean them (with pure, filtered petrol or benzine to which a small amount of ISOFLEX SUPER TEL has been added.) Apply a small amount of this special grease to smear the cages. (See lubricating and maintenance instructions, p. 7).

Lubricating, Instructions for Disassembly for Cutter Spindle Units

GK 12
GK 21



Text belongs to fig. page 36

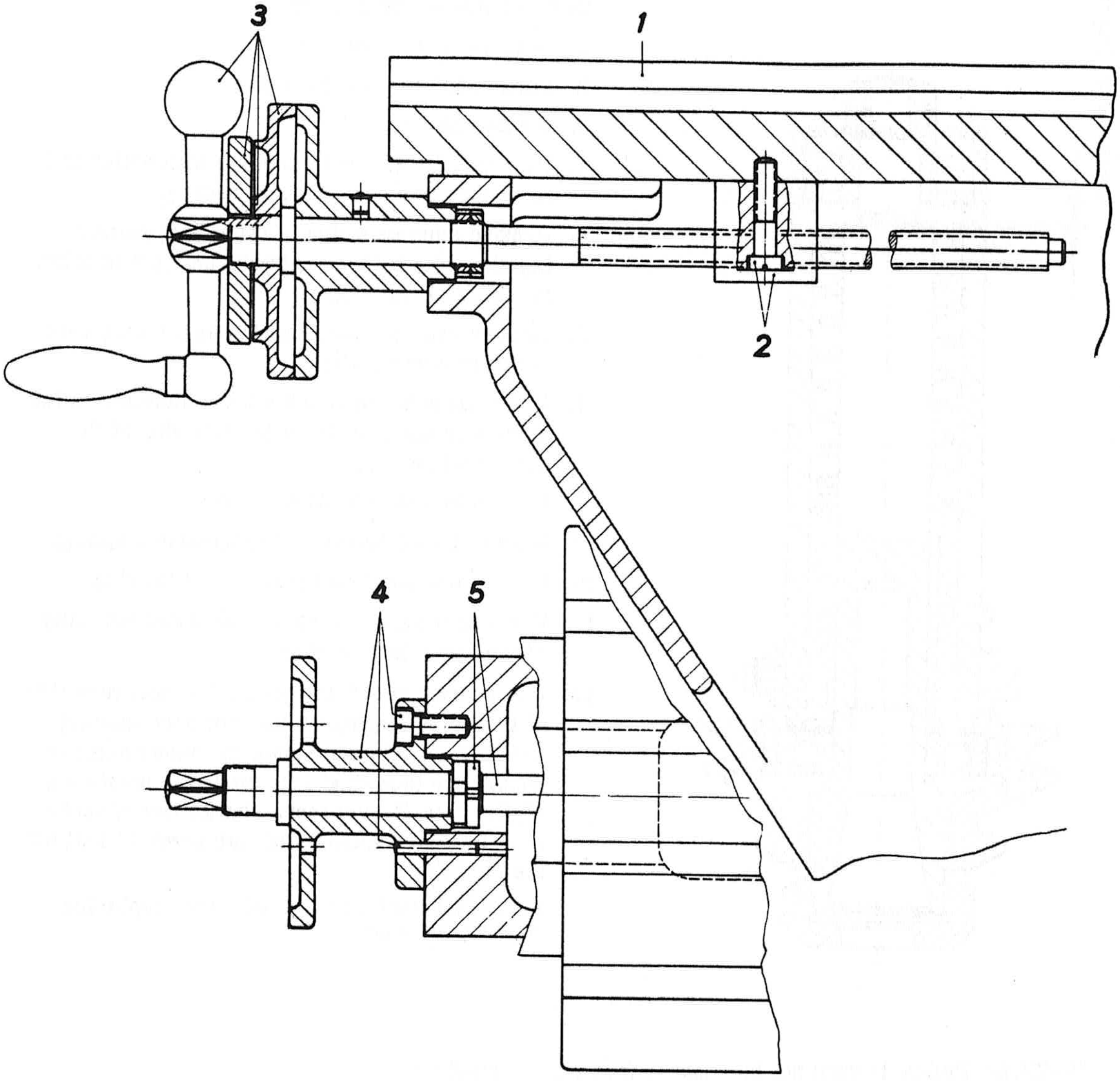
1. Unscrew protective cap;
2. Loosen and remove ring nuts;
3. Remove spacer;
4. Pull out cutter spindle together with pulley and inner race ring of lower ball bearing;
5. Remove inner race ring of upper ball bearing together with ball cage, taking care not to allow the balls to drop out;
6. Remove cage of lower ball bearing, taking care not to lose any balls;
7. Use a round bar having the same diameter as the spindle to push out the outer race ring of the upper ball bearing ;
8. Loosen and remove pilot screw;
9. Remove thrust sleeve and compression spring;
10. Loosen set screw and pull off knurled ring;
11. Use a drift punch to tap out the outer race ring of the lower ball bearing;
12. Use special tool **S** to remove the inner race ring of the lower bearing: Slide tool over spindle; exerting sufficient pressure to cause prongs to engage the race ring; lock prongs in position by sliding ring **R** over them; engage end of screw **A** in center of spindle and turn screw to pull off the race ring.
    (This paragraph is valid only when replacing the ball bearing)

NOTICE: Pulley **U** must not be removed from cutter spindle.

In the case of repairs, the pulley has to be press-fitted onto the cutter spindle, the pulley then being finish-turned; it is recommended, therefore, when ordering a pulley, to send in the complete spindle unit for necessary repairs.

To re-assemble the spindle unit, reverse the above procedure, taking care to replace the cup springs in the correct position. Special care must be exercised to see that during re-assembly the balls in the cage of the lower ball bearing are accurately positioned in the race of the inner ring to ensure true rotation of the spindle. This may be checked by observing the cutter spindle which should project about 0.020" (0,5 mm) above the internal flange of the ball bearing mounting sleeve. (see fig. ahead)
During re-assembly, follow lubricating instructions.

Removal of Work Table Screw



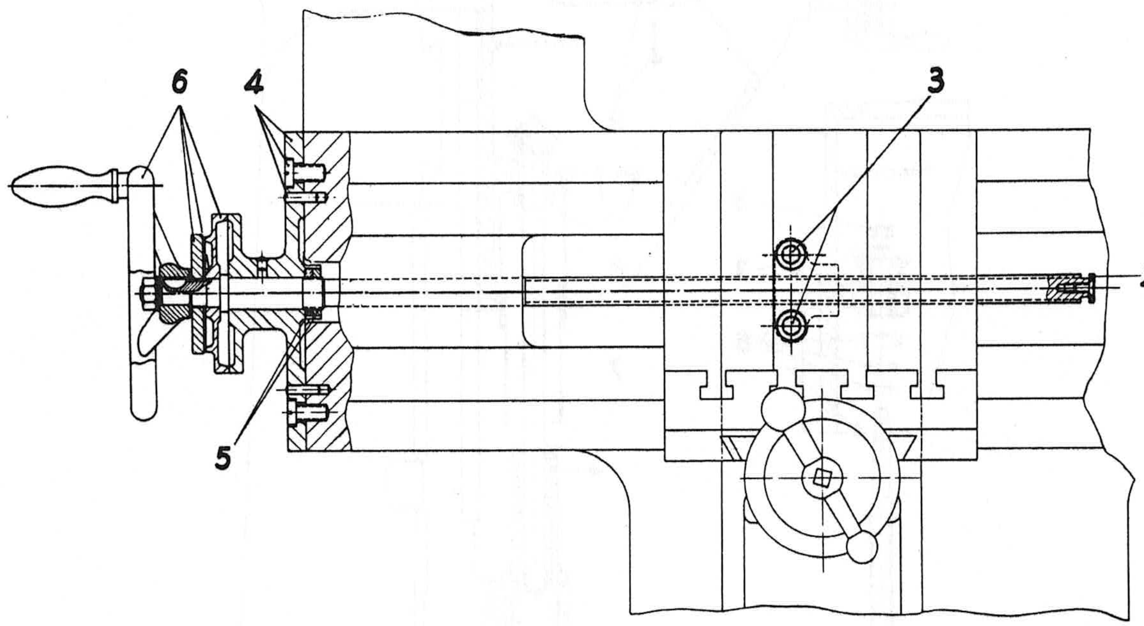
To remove work table screw, proceed as follows:

1. Move work table to central position on bracket.
2. Detach table screw nut from work table by removing two cap screws.
3. Remove ball handle, knurled ring, tab washer and scale drum.
4. Remove two cap screws and cylindrical pins, then remove screw bearing and table screw. Using the ball handle, remove screw from nut.
5. Loosen ring nuts, then remove screw from bearing.

To re-install work table screw, reverse above procedure.

Removal of Table Bracket Screw
Protective Bellows

GK 12
GK 21



To remove table bracket screw, proceed as follows:

1. Before removing the screw, remove the left-hand and central protective bellows.
2. Loosen the countersunk-head screw, then remove the stop plate.
3. Lower the bracket together with the work table to give access to the two securing screws in order to make loosening of the nut possible.
4. Remove two securing screws and taper pins from screw bearing; then remove screw bearing and remove nut from screw.
5. Loosen ring nuts and remove screw from bearing.
6. Remove handwheel, knurled ring, tab washer and scale drum.

To re-install table bracket screw, reverse above procedure.

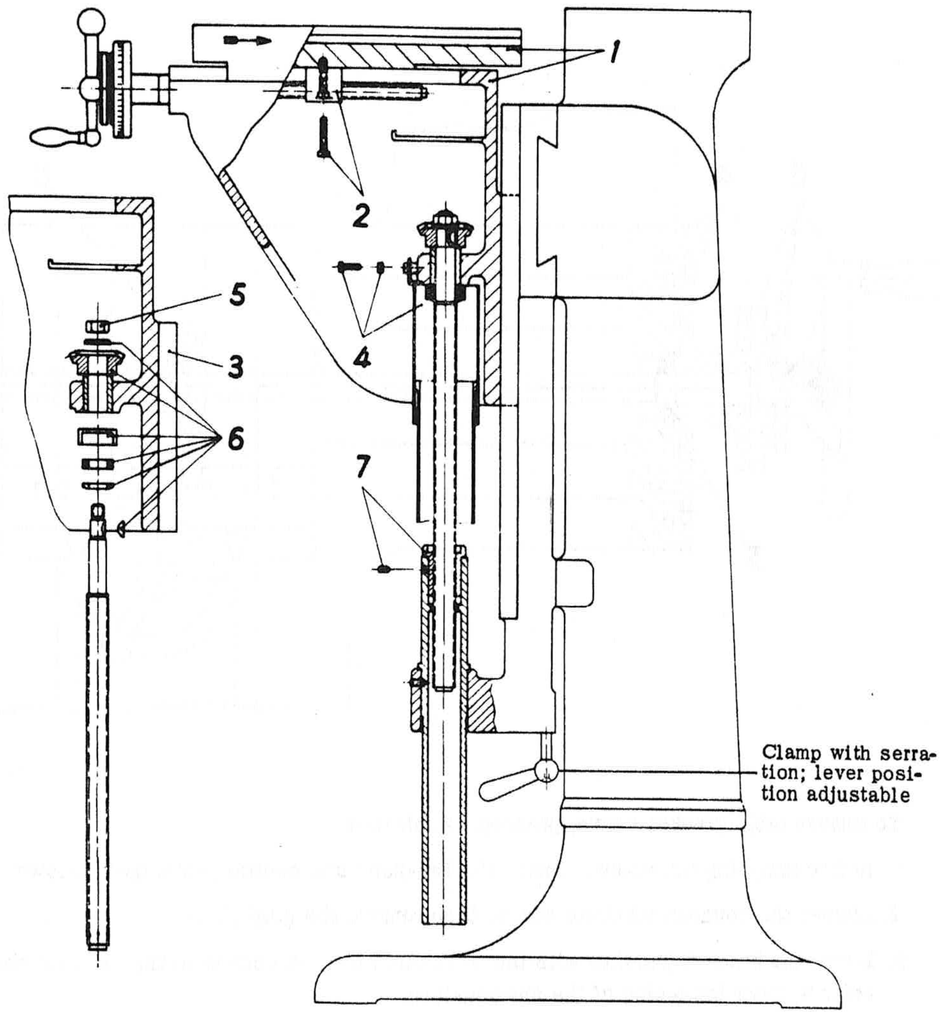
It may be necessary, before re-installing the screw, to give the new nut the proper height.

Protective Bellows

The three bellows attached to the machine serve to protect the guide ways from chips and dirt. For regular lubrication of the guide ways it is necessary to remove the bellows. For this purpose, the end faces of the bellows each are provided with three patent fasteners which are engaged with corresponding pegs on the table rests and screw bearings, respectively.

It is recommended to use a screwdriver to pry the bellows off the above-mentioned pegs.

Removal of Bracket Elevating Screw
Readjustment of Table Bracket Clamp



To remove bracket elevating screw, proceed as follows:

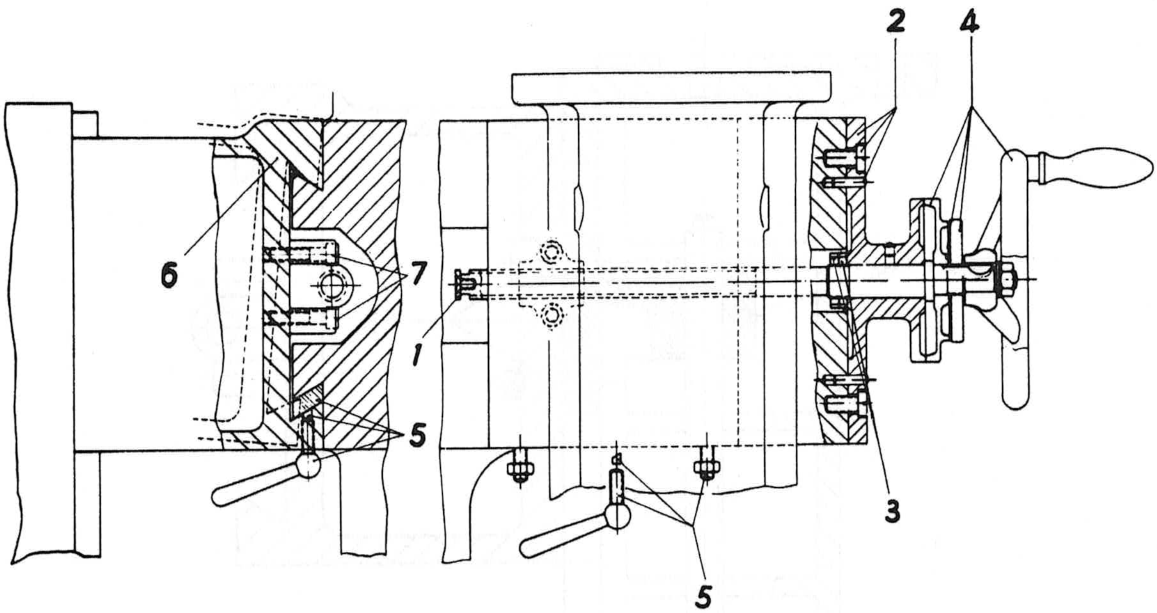
1. Elevate bracket until screw is disengaged from nut.
   To observe the screw, raise telescoping protective tubes.
2. Remove two securing screws from work table, then remove table from bracket in direction of arrow.
3. Lift bracket and screw off machine.
4. Loosen two cap screws and spacers of protective tubes, then remove tubes.
5. Loosen hexagon nut, remove spindle in vertical direction.
6. Remove washer, bevel gear, protective cover, thrust bearing and Woodruff key.
7. Remove set screw and pull nut out of sleeve.

To re-install bracket elevating screw, reverse above procedure.

Care should be taken, when re-inserting the screw, to protect the screw threads of the nut from damage.

Removal of Pattern Bracket Screw

GK 12
GK 21



Before removing the pattern bracket screw, remove the pattern table and both the central and the right-hand protective bellows.

To remove pattern bracket screw, then proceed as follows:

1. Loosen countersunk-head screw and remove stop plate.

2. Remove two securing screws from screw bearing and remove bearing; then remove screw from nut.

3. Loosen ring nuts and remove screw from bearing.

4. Remove handwheel, knurled ring, tab washer and scale drum.

5. Remove set screws and clamping screws; remove jib to the left.

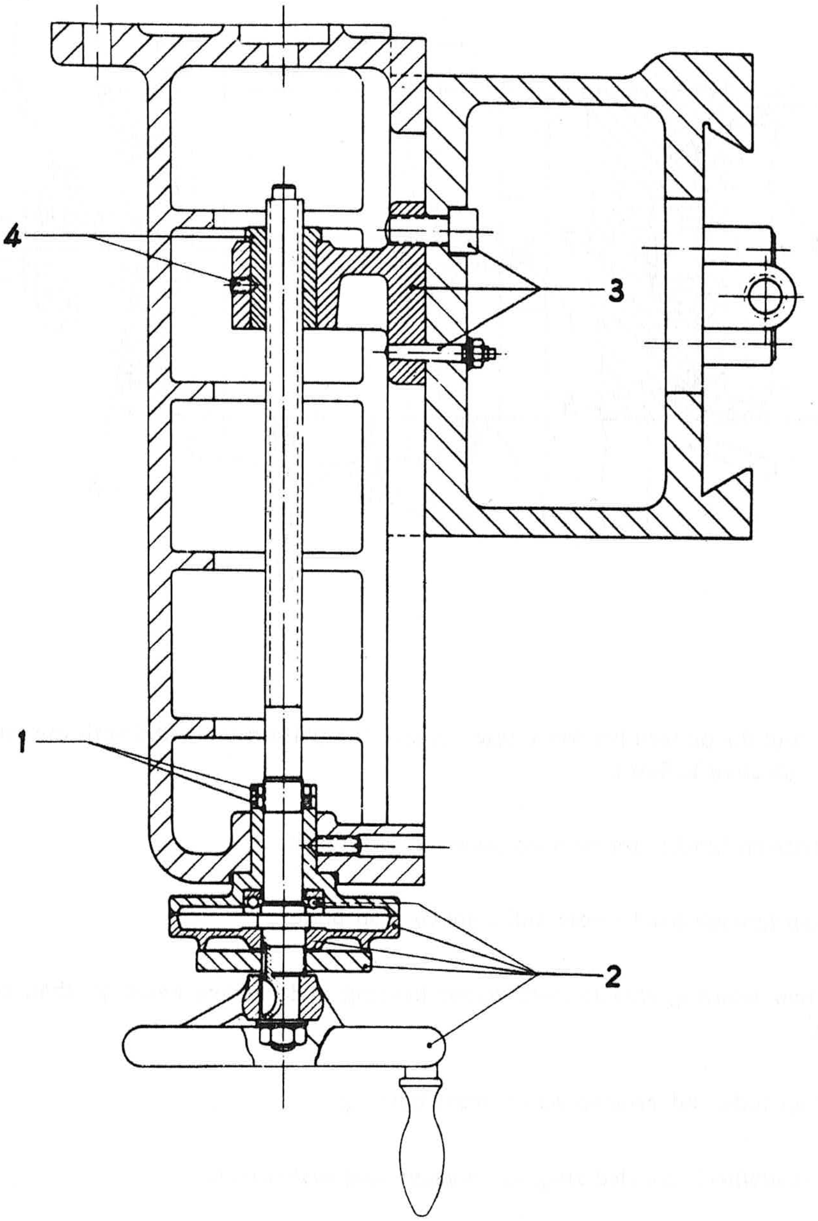
6. Remove pattern bracket and bracket rest (pattern bracket is indicated by broken lines in above illustration).

7. Loosen two securing screws of nut, then remove pattern bracket screw.

To re-install pattern bracket screw, reverse above procedure.

It may be necessary, before re-installing the screw, to give the new nut the proper height.

Removal of Pattern Bracket Elevating Screw



To permit removal of pattern bracket elevating screw, it is necessary first to perform steps 1, 2, 5 and 6 of procedure given for removal of pattern bracket screw (see p. 41), the pattern table being also removed.

To remove pattern bracket elevating screw, then proceed as follows:

1. Remove ring nuts, then rotate screw anti-clockwise to remove it from nut.
2. Remove handwheel, knurled ring, tab washer, scale drum and thrust bearing.
3. Remove two securing screws and taper pins from screw bearing, then remove bearing together with screw nut.
4. Loosen set screw and remove screw from bearing.

To re-install pattern bracket elevating screw, reverse above procedure.

Removal of Pantograph Balancing Mechanism

Fig. 1

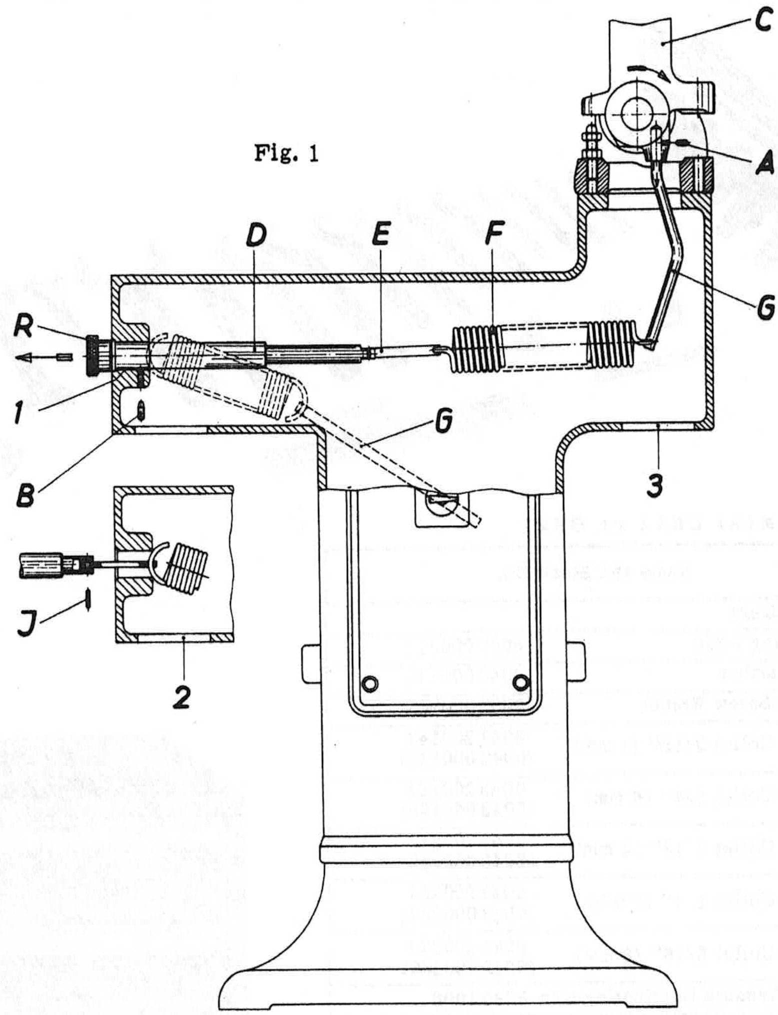


Fig. 2

The weight of the pantograph and its associated parts is balanced regardless of the pantograph position by a spring accommodated within the column, this arrangement greatly facilitating accurate guiding of the pantograph. The tension of the balancing spring can be conveniently adjusted from the operator's position by means of knurled knob **R**.

To remove the balancing spring, proceed as follows:

Removal:
1. Disconnect power supply to machine.
2. Rotate knurled knob **R** to relieve spring tension.
3. Loosen set screws **A** and **B** and slightly swivel pantograph carrier **C** in direction of arrow. Pull bar **G** out of pantograph carrier **C** (accessible through opening 3), then remove complete balancing mechanism **D-E-F-G** in direction of arrow (opening 1) and position it as shown in Fig. 2.
4. Drive out cylindrical pin **J** and remove the members **E-F-G** through opening 2.
5. Replace spring **F**.

Reassembly:
1. Insert parts **E-F-G** through opening 2, position them as shown in Fig. 2 and connect to part **D** by means of cylindrical pin **J**.
2. Grip bar **G** through opening 3 (supporting and pulling part **D** into the machine through opening 2) and move bar **G** over opening 3.
3. Pull part **D** fully into its seat and secure by set screw **B**.
4. Swivel pantograph carrier **C** slightly in direction of arrow and, through opening 3, insert bar **G** into pantograph carrier **C** (as shown above). Secure by means of set screw **A**.
   Caution: Watch for proper position of bar **G** relative to spring **F**— the spring must not apply any moment to the bar (adjust member **E** if necessary).
5. Rotate knurled knob **R** to tension the spring.

GK 12 GK 21	Standard Equipment and Tool Cabinet

Standard Equipment GK12 or GK21

Quantity GK12	Quantity GK21	Name and Stock-No.	
1	1	Set of Keys	
8	8	Clamping Strap	6047 000213
1	1	Stop Member	4040 000121
1	1	Socket Screw Wrench	6052 004702
1	–	Spring Collet 3/16" (4 mm)	6043 200148 (6043 000140)
1	–	Spring Collet 1/4" (6 mm)	6043 200164 (6043 000160)
–	1	Spring Collet 3/16" (4 mm)	6043 200248 (6043 000240)
–	1	Spring Collet 1/4" (6 mm)	6043 200364 (6043 000260)
–	1	Spring Collet 5/16" (8 mm)	6043 200279 (6043 000280)
1	1	High-Pressure Lubricating Gun	6980 1006
1	–	Drive Cord 4 x 860 mm (set)	6096 010255
1	–	Drive Cord 3 x 1500 mm (set)	6096 010220
–	1	Drive Cord 5 x 1600 mm	6096 000232
–	1	Drive Cord 4 x 1760 mm	6096 000230
–	1	Drive Cord 8 x 1000 mm	6096 000241
–	1	Drive Cord 8 x 1500 mm	6096 000254

Further accessories include:

1	1	Forming Attachment with rough-turned forming plate GK–431	
1	1	Pantograph Locking Bracket	
1	1	Straightedge Attachment	4003 000345
1	1	Intermediate Member	
		Tracer Head consisting of:	
1	1	Clamping Sleeve	
1	1	Tightening Nut	
		Adapter Sleeve consisting of:	
1	1	Clamping Sleeve	
1	1	Hexagon Nut	
1	1	Tracing Stylus	4001 200324 (4001 000324)

Tool Cabinet GK12/21

Dimensions:
500 x 750 x 945 mm (19¾" x 29½" x 37¼")
Net Weight: 187 lbs. (85 kg)
Stock No. 6057 000000

For details see special catalogue.

Tracing Styluses - Clamping and Cutting Tools

GK 12
GK 21

*for GK21 only   **Metric dimensions are given in brackets ( )**

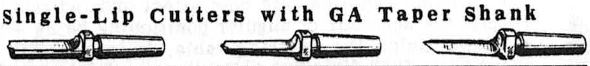
Single-Lip Cutters, Cylindrical High-Speed HSS2, HSS3 or HSS5

Stock No. Cylindrical high-speed Steel			Cutter Dia.	Overall Length
HSS2	HSS3	HSS5		
6071 202003 (6071 002003)			1/8" (2.5)	2 3/8" (40)
	6071 203004 (6071 003004)	6071 205004 (6071 005004)	3/16" (4)	2 3/4" (63)
	6071 203006 (6071 003006)	6071 205006 (6071 005006)	1/4" (6)	3 1/8" (80)
	*6071 203008 (6071 003008)	*6071 205008 (6071 005008)	5/16" (8)	3 1/2" (90)
	*(6071 003080)	*(6071 005080)	(8)	(125)

Single-Lip Cutters, Cylindrical or Tapered, All - carbide - tools C3 or C4

Stock No.		Cutter Dia.	Overall Length
Cylindrical			
	6071 244103/C4	1/8"	2 3/8"
(6071 033104/C3)	6071 244104/C4 (6071 044104/C4)	3/16" (4)	2 3/4" (63)
6071 233106/C3 (6071 033106/C3)	6071 244106/C4 (6071 044106/C4)	1/4" (6)	3 1/8" (80)
*6071 233108/C3 (6071 033108/C3)	*6071 244108/C4 (6071 044108/C4)	5/16" (8)	3 1/2" (90)
*(6071 033180/C3)	*(6071 044180/C4)	(8)	(125)
Tapered			
6071 233504/C3 (6071 033604/C3)	6071 244604/C4 (6071 044604/C4)	3/16" (4)	2 3/4" (63)
6071 233506/C3 (6071 033606/C3)	6071 244606/C4 (6071 044606/C4)	1/4" (6)	3 1/8" (80)
* (6071 033608/C3)	*(6071 044608/C4)	(8)	(90)

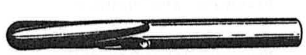
Single-Lip Cutters with GA Taper Shank



Stock No.	Cutter Dia.	Length of Cut	Overall Length
(4071 001314)	5/32" (4)	7/8" (22)	1 3/4" (45)
(4071 001324)	5/32" (4)	7/8" (22)	1 3/4" (45)
(4071 001336)	1/4" (6)	7/8" (22)	1 3/4" (45)

Material: High Speed Steel HSS

Radius End Mills



Stock No.	Cutter Dia.	Length of Cut	Overall Length
6070 208003 (6070 008003)	1/4" (6)	1" (25)	3" (75)
*6070 208004 (6070 008004)	5/16" (8)	1 3/8" (35)	3 5/8" (90)

Material: High Speed Steel HSS

End Mill, Straight-Fluted

Stock No.	Cutter Dia.	Length of Cut	Shank Dia.	Overall Length
*6070 220008 (6070 020008)	5/16" (8)	1" (25)	5/16" (8)	2 3/4" (70)

Material: High Speed Steel HSS

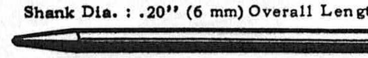
Guide Pins

Shank Dia. 20" (6 mm)
Overall Length: 4" (100)

Stock No.	End Dia.
4073 200101 (4073 000101)	.020 / .025" (0.5 / 0.6)
4073 200102 (4073 000102)	.030 / .035" (0.8 / 1.0)
4073 200103 (4073 000103)	.040 / .045" (1.2 / 1.4)
4073 200104 (4073 000104)	.050 / .055" (1.6 / 1.8)
4073 200105 (4073 000105)	.060 / .070" (2.0 / 2.5)
4073 200106 (4073 000106)	.080 / .090" (3.0 / 3.5)
4073 200107 (4073 000107)	.100 / .125" (4.0 / 4.5)
4073 200108 (4073 000108)	.150 / .175" (5.0 / 6.0)
4073 200109	.200 / .200"

Tracer Pin

Shank Dia. : .20" (6 mm) Overall Length: 4" (100 mm)



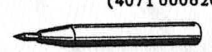
Stock No.
4001 200324
(4001 000324)

Tracing Styluses Shank Dia. : 1/2" (12 mm)

Stock No.	End Dia.	Ground Length	Overall Length
4073 202103 (4073 002103)	1/8" (3)	3/8" (20)	5 7/8" (150)
4073 202104 (4073 002104)	5/32" (4)	1 1/2" (40)	5 7/8" (150)
4073 202105 (4073 002105)	3/16" (5)	2" (50)	5 7/8" (150)
4073 202106 (4073 002106)	1/4" (6)	2 1/4" (60)	7 1/8" (180)
4073 202108 (4073 002108)	5/16" (8)	2 3/4" (70)	7 7/8" (200)
4073 202110 (4073 002110)	3/8" (10)	3 1/2" (90)	8 5/8" (220)
4073 202112 (4073 002112)	1/2" (12)	– –	9" (230)
4073 202114 (4073 002114)	9/16" (14)	2 1/4" (55)	9" (230)
4073 202116 (4073 002116)	5/8" (16)	2 1/4" (55)	9 1/2" (240)

Etching Needle

Shank Dia.: 1/4" (6)
Overall Length: 2" (51)
Stock No. 4071 200620 (4071 000620)



Spring Collets

Stock No.	Hole Dia.
6043 200132/GK12 (6043 000125/GK12)	1/8" (2.5)
6043 200148/GK12 (6043 000140/GK12)	3/16" (4)
6043 200164/GK12 (6043 000160/GK12)	1/4" (6)
6043 200232/GK 21 (6043 000225/GK 21)	1/8" (2.5)
6043 200248/GK 21 (6043 000240/GK 21)	3/16" (4)
6043 200264/GK 21 (6043 000260/GK21)	1/4" (6)
6043 200279/GK21 (6043000280/GK21)	5/16" (8)

Taper Adapters

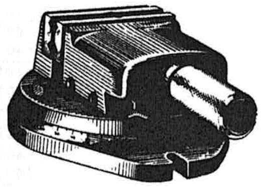
Stock No.	Hole
(6043 000356/GK12)	GA Taper
(6043 000456/GK21)	GA Taper

GK 12
GK 12

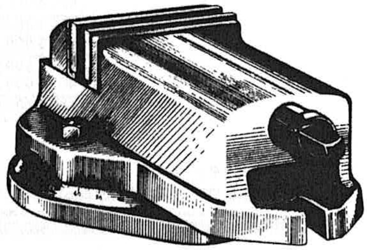
Machine Lamp - Work Holding and Indexing Fixtures

Machine Lamp
The Machine Lamp, which is furnished complete with plug and wiring, has swivel joints and permits swivelling movements when attached to the column of the machine. Swivel joints on holding arm and shade permit universal illumination of the work.
Stock No. 4550 002200

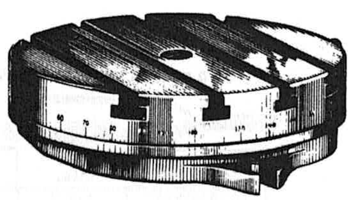
To switch on:
Depress switch button for approx. 2 seconds.
To replace fluorescent tubes:
When fluorescent tubes start flickering (after approx. 4000 hours, as compared to 1000 hours for incandescent lamps), they should be replaced, preferably both at the same time.
Square section tube:
Caution: Never drill into this tube, as it contains the ballast for the lamps.



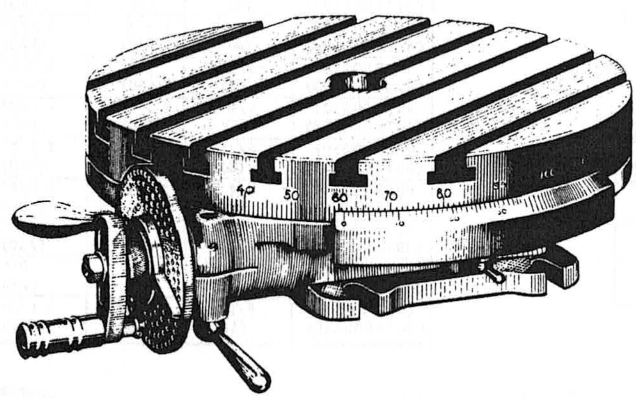
Machine Vise
The jaws of Vise are of special shape in order to facilitate the clamping of a wide variety of work. The vise has a swivel base permitting any angular position to be obtained with the aid of a 360° graduation.
Maximum gap . . . . 2 3/16" (54 mm)
Width of jaws . . . . 3 3/8" (85 mm)
Heigth without / with
swivel base . . . . 2 1/2" / 3 3/8" (65/85mm)
Stock No.: 6013 000000



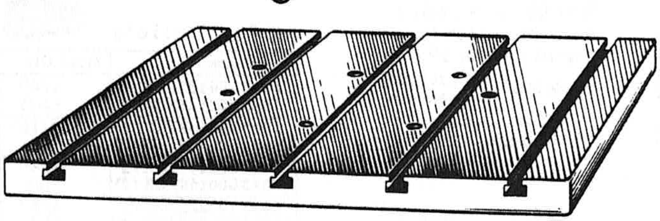
Machine Vise
The vise has plain jaws and a swivel base with 360° graduation. Safe clamping by underslung screw mechanism.
Max. gap. . . . . 3 1/8" (80 mm)
Width of jaws . . . . 4 3/8" (110 mm)
Heigth with / without
swivel base . . . . 4 1/2" / 3 1/2" (115/90 mm)
Stock No. 6012 000012
Accessories: 2 V-type jaw inserts permitting small-width workpieces to be clamped close to spindle.
Stock No. 6012 000013



Circular Table
The Circular Table has a 360° graduation permitting angular positioning of work from a zero reference line, the swivel plate being clamped in position.
Diameter of swivel plate . . . . 9 1/8" (230 mm)
Height . . . . 2 3/8" (60 mm)
Stock No. 6016 000000



Circular Table
The Circular Table permits both direct and indirect indexing, the accuracy of angular positioning being ± 90 seconds. Using the indexing table, it is possible to space up to 5220 divisions along the circumference of a circle. Direct indexing is performed by means of a 24-notch index plate. The circumference of the table is graduated in degrees, a vernier scale permitting to read ± 1 minute. A clamping lever enables the table to be immobilized in any desired position.
Diameter of swivel plate . . . . .15" (380 mm)
Overall height . . . . .4.4" (110 mm)
Number of index plates 3
Stock No. 6017 000000



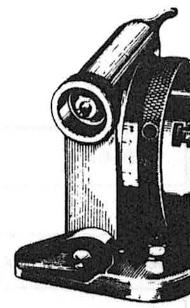
Auxiliary Tables
The Auxiliary Tables can be placed on the work-table in order to provide for a larger clamping surface.

Work clamping Surface	12 5/8" x 16 3/4" (320 x 425 mm)	17 3/4" x 23 5/8" (450 x 600 mm)
Stock No.	4010 000101	6010 000000

Automatic Tracing Unit
This tracing unit permits the automated production of primarily round moulds and dies, embossing tools, etc.
Diameter of copyholder . . . . .220 mm (8 - 5/8")
Max. height of master . . . . .50 mm (2")
Max. diameter of master . . . . 200 mm (7 - 7/8")
Max. pantograph ratio 1:2
Min. distance between tracing lines
in finishing operations . . . . .08 mm (.003")
Stock No. 6030 000000

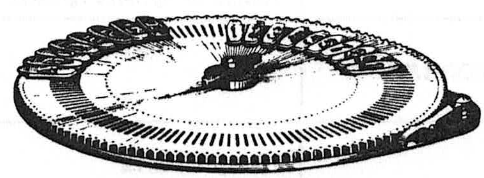
Indexing Work Holder - Copyholders

Indexing Work Holder (can be tilted by 90°)



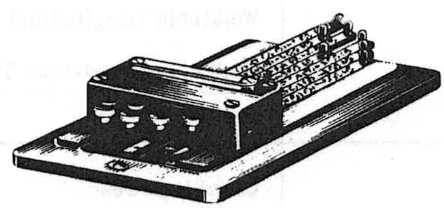
The Indexing Work Holder is equipped with one set of jaws each for external and internal gripping of work. The index head can be tilted 90° and rotated 360°, a graduation permitting the head to be set at any desired angle. Scale readings are accurate within ± 2.5 mins. Accurate angular positioning by worm and wheel drive, coarse settings manually with the worm disengaged.
Height with chuck axis horizontal 5 1/4" (138 mm)
Maximum work diameter:
with chuck axis horizontal . . . . 3 3/4" (95 mm)
with chuck axis vertical . . . . . 4 3/8" (110 mm)
Stock No. 6018 000000

Universal Copy Dial



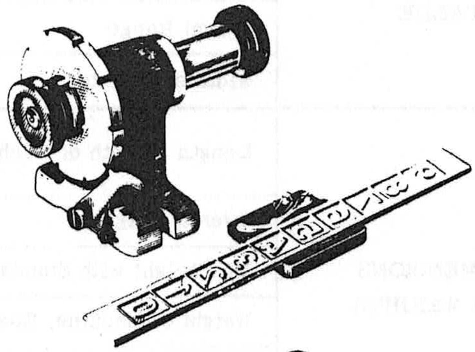
The use of the Copy Dial in combination with the circular table greatly facilitates the engraving of letters arranged on arcuate lines. A screw clamp permits quick clamping of the copy dial to the copyholder table. The rotatable plate is provided with small holes and slots receiving corresponding projections of the letter templets. An indexing pawl engages peripheral notches of the rotatable plate in order to hold it in the desired positions.
Diameter of the attachment . . . 7 7/8" (200 mm)
Diameter of circle formed by characters . . . . 5 ½" or 7 1/16" (139 or 179 mm)
Stock No. 4512 000000

Serial Numbering Holder



The Serial Numbering Holder proves extremely useful in cases where it is intended to identify parts by engraving frequently changed serial numbers and type designations. This templet has a baseplate on which seven movable copy strips can be rapidly positioned to give the desired designation, the individual strips being locked by detent plungers.
Overall dimensions . . 4 x 7 7/8" (100 x 200 mm)
Stock No. 4017 000000

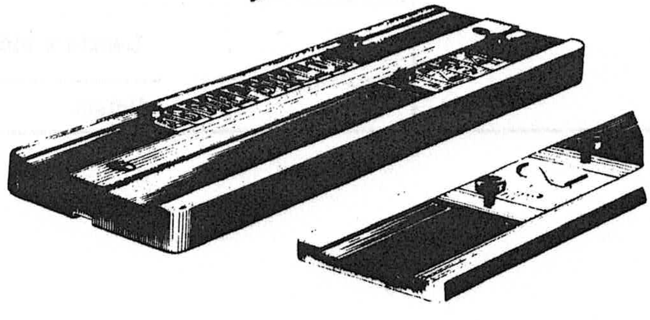
Numbering Wheel Engraving Device



This device, which includes copyholder, serves to facilitate the engraving of numbering and date wheels and the like. A cast base member carries a quill with locking device, the quill receiving an index plate having 10 indexing notches and the wheel to be engraved. Both the index plate and the number strip are arrested in position by detent pawls. A number of workpieces can be clamped at a time (max. clamping capacity 2" 50 mm).
Stock No. 4014 000000 (4014 200000)

As a supplement to the numbering wheel engraving device a Number Strip DIN 1451 (raised reflected characters) can be furnished (see fig.) (Special types upon request)

Copyholders



The two-groove Copyholder is used for holding copy strips with characters. 79" (20 mm) high. It is clamped to the copyholder table by bolts inserted in the table T-slots.
For copy strips the characters of which are 1.57" (40 mm) high, the single-groove Copyholder is available.

	twin grooved	single grooved	
Sizes	4 3/4 x 17 3/8 (120 x 440 mm)	19 3/4" x 4" (500 x 100 mm)	31 ½" x 4" (800 x 100 mm)
Stock No.	6015 000000 (6015 200000)	4015 000101	4015 000102

Specifications

			GK 12	GK 21
SPINDLE MOTOR	Capacity		0,25 kW	0,34/0,4 kW
	Speed		2800 R.P.M.	1400 / 2800 R.P.M.
CUTTER SPINDLE	Max. Collet Capacity		15/64" (6 mm)	5/16" (8 mm)
	Spindle Vertical Adjustment	Fine	3/64" (1 mm)	5/64" (2 mm)
		Coarse	1/8" (3 mm)	1/4" (6 mm)
	Range of Spindle Speeds		1600–20000 R.P.M.	475–20 000 R.P.M.
PANTOGRAPH	Ratio	min.	1 : 10	1 : 10
		max.	1 : 1,5	1 : 1,5
WORKTABLE	Clamping Area		7 7/8" x 13 3/4" (200 x 350 mm)	7 7/8" x 13 3/4" (200 x 350 mm)
	Max. Distance, spindle nose to table surface		13 3/4" (350 mm)	13 3/4" (350 mm)
	Worktable Longitudinal Travel		5 7/8" (150 mm)	5 7/8" (150 mm)
	Worktable Transverse Travel		11 3/4" (300 mm)	11 3/4" (300 mm)
	Width of T-slots		1/2" (12 mm)	1/2" (12 mm)
COPYHOLDER TABLE	Clamping Area		12 5/8" x 17 3/4" (320 x 450 mm)	12 5/8" x 17 3/4" (320 x 450 mm)
	Max. Distance, pantograph arm to copyholder surface		9 1/16" (230 mm)	9 7/16" (240 mm)
	Swivel Range		360 °	360 °
	Width of T-slots		1/2" (12 mm)	1/2" (12 mm)
DIMENSIONS AND WEIGHTS	Length x Width of Machine		46 1/2" x 38 5/8" (1180 x 980 mm)	49 1/4" x 41" (1250 x 1040 mm)
	Overall Height		57" (1450 mm)	59" (1500 mm)
	Net Weight with Standard Equipment		925 lbs. (420 kgs)	970 lbs. (440 kgs)
	Weight of Machine, Boxed		1808 lbs. (820 kgs)	2116 lbs. (960 kgs)
	Box Dimensions	Length x Width	51" x 43 1/4" (1300 x 1100 mm)	55" x 43 1/4" (1400 x 1100 mm)
		Height	63" (1600 mm)	63" (1600 mm)