Boneham and Turner Ltd

the precision engineers

6th Edition

Koenig Sealing Plugs

www.boneham.co.uk

System for Sealing Drilled Holes

The various types of hydraulic and pneumatic components such as controls, valves, regulators, relays, cylinders, motors, presses, pumps, etc., have one thing in common. That is that hydraulic fluid or gaseous medium under pressure flow through channels in the device. Many times these channels must be drilled from outside to connect internal passages. These drilled holes must then be sealed pressure tight to operate the device and prevent leaks. A number of other sealing methods such as plain threaded plugs, threaded plugs with lock washers, o-rings or sealants, insertion of pins, welding of holes are used. However, these are either costly due to tight tolerance requirements, extra operations or assembly requirements or are susceptible to leaking after being placed in service.

The Sealing Plug - a development by Koenig - is a safe, quick, leakproof, and low cost method for sealing cross-drilled holes. It ensures peak performance with a comfortable safety margin even in extreme applications.

MB Series

The concept of the MB Series is that of a pressure/expand principle. Each plug consists of a ball, as the expanding element, and a cup-shaped expansion sleeve. Forcing the ball into the sleeve causes the sleeve to expand outward. The serrations on the outside of the sleeve dig into the base material to provide a secure anchorage. The ball is set when it is flush with or slightly below the top of the sleeve. The top of the sleeve constricts slightly and prevents the ball from coming out.


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High Pressure Plug

This new threaded plug has a working pressure of 2500 bar. This plug must be fitted by a controlled torque (power controlled screw driver)


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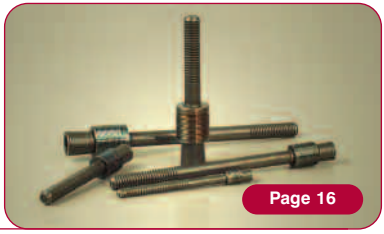
Sidex - SK Series

The Sidex SK plug works on the pull/expand principle. The plug consists of an expandable sleeve around a mandrel type expanding element. By applying an axial force to the mandrel while restraining the sleeve with a special tool, the sleeve is forced to radially expand, and the serrations on the outside of the sleeve anchor into the base material of the bore wall. Upon reaching a predetermined force, the mandrel breaks off and the plug is set.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LK Series

The LK Series works on the pull/expand principle. The plug consists of an expandable sleeve around a mandrel type expanding element. By applying an axial force to the mandrel, while restraining the sleeve with a special tool, the sleeve is forced to radially expand and the serration on the outside of the sleeve anchors in the bore of the base material due to the roughness of the hole. Upon reaching a predetermined force,the mandrel brakes off and the plug is set.


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LP Series

Press fit and anchorage concept of the LP Series are achieved by a surface hardened but still flexible cup and cone shaped insertion sleeve. During the setting process, the flexible sleeve moulds into the hole configuration and the labyrinth serration on the outside of the sleeve anchors in the bore wall due to the roughness of the hole. The insertion sleeve is forced by its self locking cone shape, to radially brace and anchor in the material.


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Setting Tools

A full range of tooling is available to cover fitting of small or large volumes of plugs.


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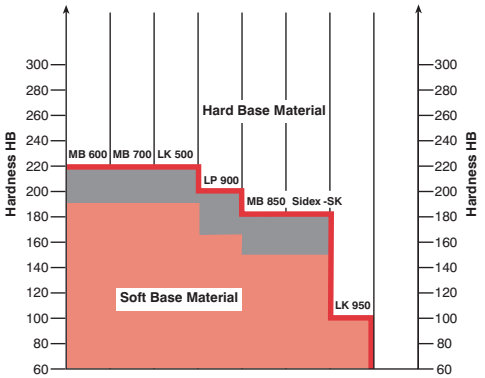
Tools for Installing Expander®

Anchorage Principle

The required bore roughness is directly related to the hardness and the mechanical characteristics of the base material. Depending on the combination of sealing plug and base material, anchorage takes place either by the groove profile of the sealing plug biting into the base material (MB & Sidex -SK Series LP) or on anchorage to the surface roughness of the bore (Sidex-SK LK & MB series in hard materials).

NOTE: When selecting a plug the bore roughness must always be adjusted according to the hardness of the base material.

Anchorage principle related to base material



To achieve the allowable working pressure, anchorage to the bore roughness of the base material is required. **Roughness Rz = 10 to 30 μm.**

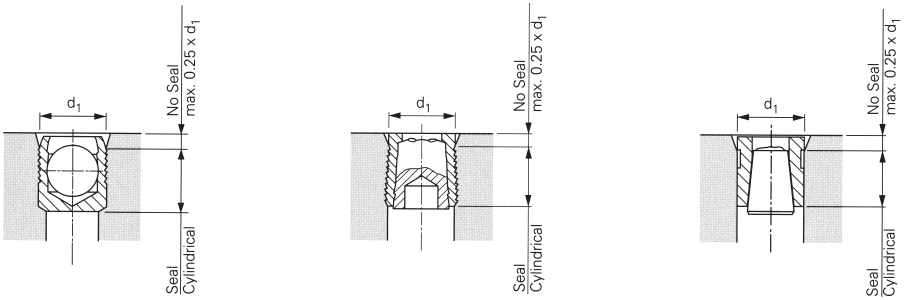
Anchorage to the bore of the base material occurs automatically due to the serrations on the sleeve of the sealing plug.

Anchorage is not possible with the HK55 and HK11 Series. Such combinations are suitable only for low pressure applications.

Transition zone: To achieve the allowable working pressure and anchorage to the bore, roughness of the base material should be 10 to 30 μm Rz.

Bore Accuracy

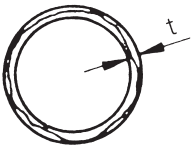
Within the **effective sealing area** of the sealing plug the bore must be a cylinder. The bore lead in can be chamfered up to a depth of 0.25 x d1 because this area has no significant effect on the sealing function.



Roundness Tolerance

To assure reliable functioning of the sealing plug with regard to pressure performance and to assure leak tight sealing, a **roundness tolerance of t=0.05mm** must be held.

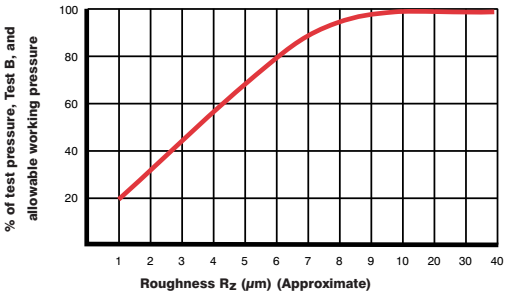
By using a double lipped twist drill, the called out hole and roundness tolerances are reached. Better tolerances, particularly for larger diameter holes, can be held by using a triple lipped twist drill.



Bore Roughness Requirements

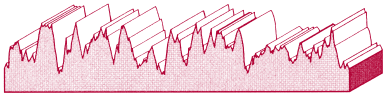
When installing Koenig Sealing Plugs in hard base material no positive anchoring is possible. So, to attain suitable working pressures and anchorage, it is necessary to have a bore roughness of R_Z = 10-30μm. At a roughness greater than R_Z 30μm leakage might occur.

Pressure performance correlation to bore roughness



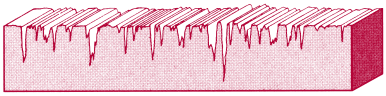
Roughness Profile

Required roughness profile



The ideal bore roughness for anchorage is attained by drilling with a twist drill or core drill.

Undesirable roughness profile

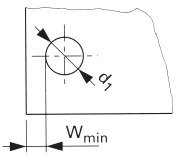


By reaming, a one-sided, smooth roughness profile is created. This is not desirable.

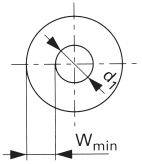
Wall thickness/distance from edge

As the radial expansion of the sleeve occurs, the base material in which it will be anchored plastically deforms. The resultant strength, as well as the hydraulic pressure and temperature service conditions depending on the plug type and characteristics of the base material, require minimum wall thickness, or distance from edge.

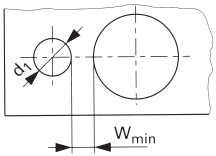
Distance to external wall



Distance to exterior wall



Wall thickness between bores



The guideline values for minimum wall thickness and distance from edge (W_{min}) express these influencing factors. At these minimum values, only slight deformation on the exterior profile of the base material of less than 20 μm is likely. This does not affect the function of the Koenig Plug. Below the guideline values (W_{min}) the possibility of overloading the base material exists, which can adversely influence the function of the plug.
In such cases tests must be conducted.

The Guideline values W_{min} for wall thickness and distance from edge

diameters

$d_1 \geq$ 4mm: $W_{min} = F_{min} \cdot d_1$

$d_1 <$ 4mm: $W_{min} = F_{min} \cdot d_1 + 0.5$mm

Dimensions in mm

Base Material	1	2	3	4	5	6	7
Description	ETG 100	C 15 Pb	GG-25	GGG-50	AlMgSiPb	AlCuMg2	G-AlSi7Mg
Avg. tensile strength (N/mm²)	1000	560	250	500	340	480	300
Min. elongation A5 (%)	6	6	-	7	8	8	4
Avg. ultimate strength R_{P02} (N/mm²)	865	300	-	320	300	380	250
	Factor fmin						
MB 600	0.6	0.8	1.0	0.8	1.0	0.8	1.0
MB 600 Inch version	0.6	0.8	1.0	0.8	1.0	0.8	1.0
MB 700	0.6	0.8	1.0	0.8	1.0	0.8	1.0
MB 850	0.5	0.6	1.0	0.6	1.0	0.6	1.0
Sidex–SK	0.5	0.6	1.0	0.6	1.0	0.6	1.0
LP 900	0.3	0.3	0.5	0.3	0.5	0.4	0.5
LK 600	0.3	0.3	0.5	0.3	0.5	0.4	0.5
LK 950	0.3	0.3	0.5	0.3	0.5	0.4	0.5

Installation Instructions for MB Series

Drilled Hole

- The drilled hole must be within the tolerances shown on the tables.
- The counterbored hole (d_2) must be properly sized for the through hole (d_3) according to the dimension tables.
- Holes must be round within 0.05 mm.
- With hard materials the bore roughness should be from R_Z = 10 - 30 μm for best results.
- Longitudinal rifles and spiral grooves should be avoided. These influence the sealing effectiveness.
- The bore must be free of oil, grease and chips.

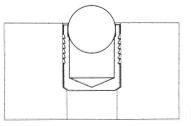


Fig. 1

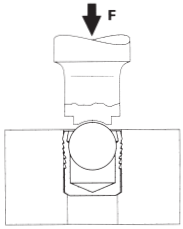


Fig. 2

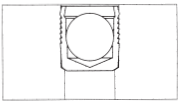


Fig. 3

Setting Procedure

- With the ball facing out the Koenig Plug is inserted in the counterbored hole. The top sleeve should not be above the surface of the base material. (Fig.1)
- With only a slight or no counterbore, the base of the sleeve must be adequately supported during installation.
- The ball can now be pressed in until the top of the ball is below the edge of the sleeve. (Fig.2 and 3) Corresponding approximate values for stroke S as well as the dimensions X are from the Table below.
- **NOTE:** Use the proper size setting tool for the sealing plug according to information.

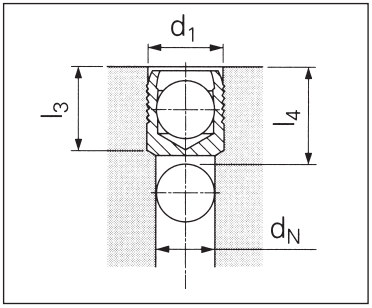
Press

Small quantities or single parts can be installed with a hammer and setting tool. Installation can also be done with an arbor press. It is preferred to limit travel when using a press because insertion force is difficult to control. Koenig Plugs are also ideal for automated installation because they are problem free.

Cleaning/degreasing of plugs before installation, only spray cleaning with air drying allowed.

Not to be dipped or vacuum dried.

Required Installation Lengths



The required installation length (l_4) min. for MB plugs is for base materials with hardness greater than HB=90.

For softer materials, deeper installation is required.

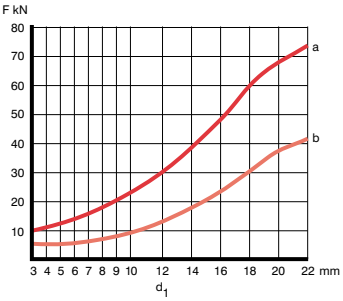
d_N	MB		
	d_1	l_3 min	l_4 min*
2.0	3.0	3.4	5.0
3.0	4.0	3.8	5.5
4.0	5.0	5.3	7.0
5.0	6.0	6.3	8.5
6.0	7.0	7.3	9.5
7.0	8.0	8.3	11.0
8.0	9.0	9.8	12.5
9.0	10.0	10.8	13.5
10.0	12.0	12.8	16.0
12.0	14.0	14.5	18.0
14.0	16.0	16.5	20.0
16.0	18.0	18.5	22.5
18.0	20.0	21.5	25.5
20.0	22.0	24.5	28.5

d_N = given nominal bore/system bore size

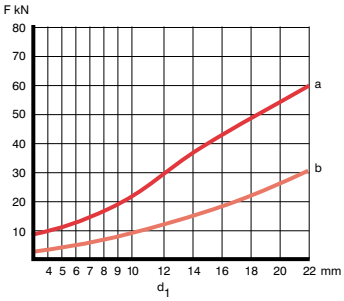
Installation Details for MB Series

Setting Force

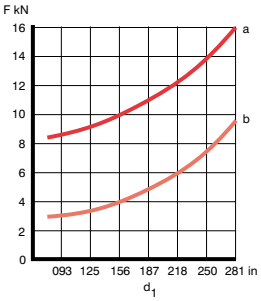
MB 600/700



MB 850



MB 600 Inch version



Measured in steel with a tensile strength of 1,000 N/mm^2. When installing in material with less strength the values are less.

a) Force with minimum bore diameter tolerance.
b) Force with maximum bore diameter tolerance.

Plug Removal

MB Series plug removal is possible. The plug can be drilled out with a carbide tipped drill or with a high speed steel drill.

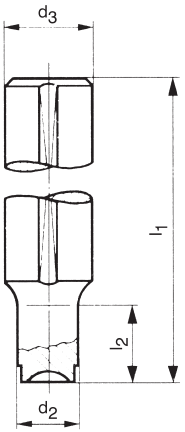
MB 600-030 to 140	Ball HB - 200	High Speed Steel Drill
MB 600-093 A	Ball HRC - 55	Carbide Tipped Drill
MB 600-125 A to 281A	Ball HB - 200	High Speed Steel Drill
MB 700-030 to 220	Ball HRC - 45	Carbide Tipped Drill
MB 850-040 to 220	Ball HRC - 45	Carbide Tipped Drill

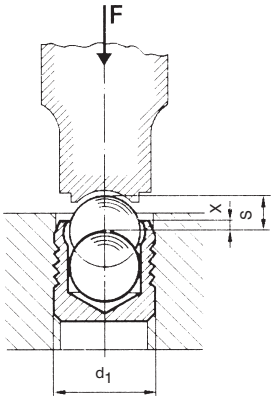
Procedure

- Plug diameter 6mm or .250 in.
  Drill out, in one process, to the next larger diameter according to the Data Sheet.
- Plug diameters over 6mm or .250 in.
  Drill out in several steps with last step to the next larger diameter according to the Data Sheet.
- Clear chips, remnants of the sleeve, oil and grease from the bore.
- Install a new Koenig Sealing plug.

  Note: After plug removal always use the next larger diameter plug.

Material: Tool Steel
Heat Treated Hardness - HRC 50





MB 600 / MB 700 / MB 850 (Dimensions in mm)							
Punch REF	**d_1**	d_3 - h_9	l_1	d_2	l_2	**x ±0.2**	s Stroke
KP 030	**3.0**	10	100	2.8	10	**0.4**	1.2
KP 040	**4.0**	10	100	3.8	10	**0.2**	1.5
KP 050	**5.0**	10	100	4.8	12	**0.4**	2.0
KP 060	**6.0**	10	100	5.8	15	**0.4**	2.5
KP 070	**7.0**	10	100	6.8	18	**0.4**	3.0
KP 080	**8.0**	10	100	7.8	20	**0.3**	3.5
KP 090	**9.0**	14	100	8.8	22	**0.4**	4.0
KP 100	**10.0**	14	100	9.8	25	**0.4**	4.5
KP 120	**12.0**	14	150	11.7	30	**0.4**	5.5
KP 140	**14.0**	20	150	13.7	35	**0.4**	6.35
KP 160	**16.0**	20	150	15.7	40	**0.6**	7.0
KP 180	**18.0**	20	150	17.7	45	**0.6**	8.0
KP 200	**20.0**	25	150	19.7	50	**0.8**	9.0
KP 220	**22.0**	25	150	21.7	55	**0.8**	10.0
	MB 600 Inch version (Dimensions in Inches)						
Punch REF	**d_1**	d_3 - h_9 0 -.002	l_1	d_2	l_2	**x 0 -.012**	s Stroke
KP 093 A	**.093 ($^3/_{32}$")**	.394	3.94	.082	.137	**.012**	0.031
KP 125 A	**.125 ($^1/_8$")**	.394	3.94	.117	.137	**.012**	0.047
KP 156 A	**.156 ($^5/_{32}$")**	.394	3.94	.148	.137	**.012**	0.059
KP 187 A	**.187 ($^3/_{16}$")**	.394	3.94	.180	.137	**.012**	0.079
KP 218 A	**.218 ($^7/_{32}$")**	.394	3.94	.211	.400	**.012**	0.094
KP 250 A	**.250 ($^1/_4$")**	.394	3.94	.242	.400	**.012**	0.109
KP 281 A	**.281 ($^9/_{32}$")**	.394	3.94	.273	.400	**.012**	0.118

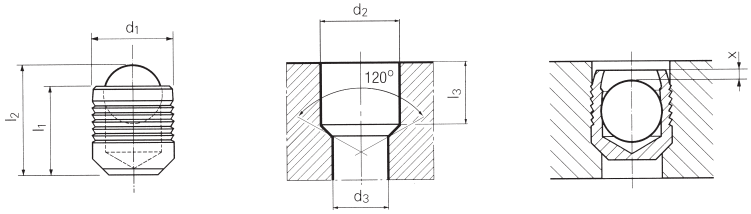
Other setting tools see page 22

MB 600 Series Sealing Plugs

Sleeve: Stainless Steel
DIN 1.4305, AISI 303
Hardness: HB = 220

Ball: Stainless Steel
DIN 1.4301, AISI 304

Sleeve and Ball clear passivated per MIL S 5002
Aerospace quality



Dimensions in mm							
Type	**d_1**	l_1	l_2 -	**d_2** + 0.1	d3 max.	l3 min.	x ±0.2
MB 600-030	**3.0**	3.6	4.6	**3.0**	2.2	3.4	0.4
MB 600-040	**4.0**	4.0	5.2	**4.0**	3.3	3.8	0.2
MB 600-050	**5.0**	5.5	7.0	**5.0**	4.3	5.3	0.4
MB 600-060	**6.0**	6.5	8.6	**6.0**	5.3	6.3	0.4
MB 600-070	**7.0**	7.5	10.1	**7.0**	6.4	7.3	0.4
MB 600-080	**8.0**	8.5	11.7	**8.0**	7.4	8.3	0.3
MB 600-090	**9.0**	10.0	13.7	**9.0**	8.4	9.8	0.4
MB 600-100	**10.0**	11.0	15.2	**10.0**	9.4	10.8	0.4
MB 600-120	**12.0**	13.0	18.0	**12.0**	10.6	12.8	0.4
MB 600-140	**14.0**	15.0	20.8	**14.0**	12.7	14.5	0.4

Pressure Performance

	Base Material / Minimum Hardness HB						
	High Strength Stl ETG-100 AISI 1144	Free Machining Case Hard Stl. C15 Pb	Cast Iron GG-25 DIN 1691	Ductile Cast Iron GGG-50 DIN 1693 DIN 1.0403	Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6
	280	180	160	170	120	90	80
d_1 mm	P Test B[1] Bar		PW[2] Bar			P Test B[1] Bar	PW[2] Bar
3-10	1400		450			1200	380
12-14	1000		350			900	280

[1] Proof Pressure Test B

[2] Maximum allowable working pressure = nominal pressure

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 μm is needed to achieve indicated working pressures.

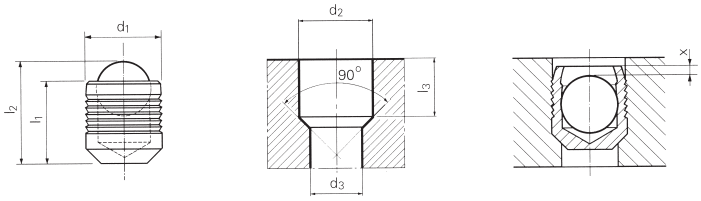
Security Range
The security range (the difference between working pressure and Test **B** pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test **A** and Test **B** pressure are reduced about 20% after this point.

MB 600 Series Inch version Sealing Plugs

Sleeve: Stainless Steel
DIN 1.4305, AISI 303
Hardness: HB = 220

Ball: Stainless Steel
DIN 1.4034, AISI 420 (.093" Dia.)
DIN 1.4301, AISI 304 (.125" to .281" Dia.)

Sleeve and ball clear passivated to MIL S 5002
Aerospace quality



Dimensions in inches

Type	d_1	l_1	l_2 -	d_2	d_3 max.	l_3 min.	x
MB 600-093 A	**.093(3/32")**	.100	.120	**$.0937^{+.002}_{0}$**	.062	.095	.0 to max. .012
MB 600-125 A	**.125(1/8")**	.138	.170	**$.1250^{+.004}_{0}$**	.093	.125	
MB 600-156 A	**.156(5/32")**	.150	.195	**$.1562^{+.004}_{0}$**	.125	.130	
MB 600-187 A	**.187(3/16")**	.193	.260	**$.1875^{+.004}_{0}$**	.156	.152	
MB 600-218 A	**.218(7/32")**	.225	.300	**$.2187^{+.004}_{0}$**	.187	.187	
MB 600-250 A	**.250(1/4")**	.260	.350	**$.2500^{+.004}_{0}$**	.218	.212	
MB 600-281 A	**.281(9/32")**	.285	.380	**$.2812^{+.004}_{0}$**	.250	.250	

Pressure Performance

	Base Material / Minimum Hardness HB						
	High Strength Stl ETG-100 ANSI 1144	Free Machining Case Hard Stl. C15 Pb	Cast Iron GG-25 DIN 1691 DIN 1.0403	Ductile Cast Iron GGG-50 DIN 1693	Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6
	280	180	160	170	120	90	80
d_1 mm	P Test B[1] Bar			PW[2] Bar		P Test B[1] Bar	PW[2] Bar
3/32 - 9/32	1400			450		1200	380

[1] Proof Pressure Test B

[2] Maximum allowable working pressure = nominal pressure

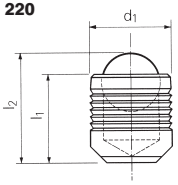
- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 μm is needed to achieve indicated working pressures.

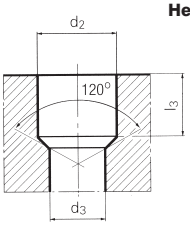
Security Range
The security range (the difference between working pressure and Test **B** pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test **A** and Test **B** pressure are reduced about 20% after this point.

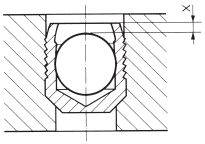
MB 700 Series Sealing Plugs

Sleeve: Stainless Steel
DIN 1.4305, AISI 303
Hardness: HB = 220

Ball: Bearing Steel
Heat treated







Dimensions in mm							
Type	**d_1**	l_1	l_2 -	**d_2** + 0.1	d_3 max.	l_3 min.	x ±0.2
MB 700-030	**3.0**	3.6	4.6	**3.0**	2.2	3.4	0.4
MB 700-040	**4.0**	4.0	5.2	**4.0**	3.3	3.8	0.2
MB 700-050	**5.0**	5.5	7.0	**5.0**	4.3	5.3	0.4
MB 700-060	**6.0**	6.5	8.6	**6.0**	5.3	6.3	0.4
MB 700-070	**7.0**	7.5	10.1	**7.0**	6.4	7.3	0.4
MB 700-080	**8.0**	8.5	11.7	**8.0**	7.4	8.3	0.3
MB 700-090	**9.0**	10.0	13.7	**9.0**	8.4	9.8	0.4
MB 700-100	**10.0**	11.0	15.2	**10.0**	9.4	10.8	0.4
MB 700-120	**12.0**	13.0	18.0	**12.0**	10.6	12.8	0.4
MB 700-140	**14.0**	15.0	20.8	**14.0**	12.7	14.5	0.4
MB 700-160	**16.0**	17.0	23.7	**16.0**	14.7	16.5	0.6
MB 700-180	**18.0**	19.0	26.3	**18.0**	16.7	18.5	0.6
MB 700-200	**20.0**	22.0	30.5	**20.0**	18.7	21.5	0.8
MB 700-220	**22.0**	25.0	34.2	**22.0**	20.7	24.5	0.8

Pressure Performance

Base Material / Minimum Hardness HB							
	High Strength St. ETG-100 AISI 1144	Free Machining Case Hard Stl. C15 Pb	Cast Iron GG-25 DIN 1691 DIN 1.0403	Ductile Cast Iron GGG-50 DIN 1693	Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6
	280	180	160	170	120	90	80
d_1 mm	P Test B[1] Bar		PW[2] Bar			P Test B[1] Bar	PW[2] Bar
3-10	1400		450			1200	380
12-22	1150		350			900	280

[1] Proof Pressure Test B

[2] Maximum allowable working pressure = nominal pressure

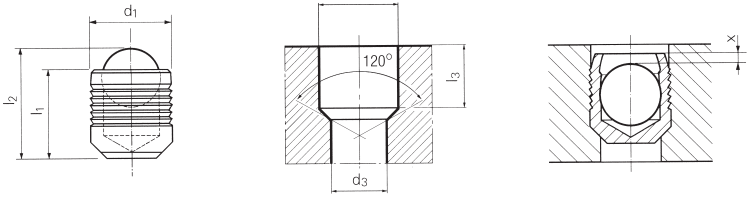
- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 μm is needed to achieve indicated working pressures.

Security Range
The security range (the difference between working pressure and Test **B** pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test **A** and Test **B** pressure are reduced about 20% after this point.

MB850 Series Sealing Plugs

Sleeve: Case Hardened Steel
Passivated coating Cr6 free coating
Hardness: HB = 180

Ball: Bearing Steel
Heat treated



Dimensions in mm							
Type	**d_1**	l_1	l_2 -	**d_2** + 0.1	d_3 max.	l_3 min.	x ±0.2
MB 850-030	**3.0**	3.6	4.6	**3.0**	2.2	3.4	0.4
MB 850-040	**4.0**	4.0	5.2	**4.0**	3.3	3.8	0.2
MB 850-050	**5.0**	5.5	7.0	**5.0**	4.3	5.3	0.4
MB 850-060	**6.0**	6.5	8.6	**6.0**	5.3	6.3	0.4
MB 850-070	**7.0**	7.5	10.1	**7.0**	6.4	7.3	0.4
MB 850-080	**8.0**	8.5	11.7	**8.0**	7.4	8.3	0.3
MB 850-090	**9.0**	10.0	13.7	**9.0**	8.4	9.8	0.4
MB 850-100	**10.0**	11.0	15.2	**10.0**	9.4	10.8	0.4
MB 850-120	**12.0**	13.0	18.0	**12.0**	10.6	12.8	0.4
MB 850-140	**14.0**	15.0	20.8	**14.0**	12.7	14.5	0.4
MB 850-160	**16.0**	17.0	23.7	**16.0**	14.7	16.5	0.6
MB 850-180	**18.0**	19.0	26.3	**18.0**	16.7	18.5	0.6
MB 850-200	**20.0**	22.0	30.5	**20.0**	18.7	21.5	0.8
MB 850-220	**22.0**	25.0	34.2	**22.0**	20.7	24.5	0.8

Pressure Performance

Base Material / Minimum Hardness HB							
	High Strength St. ETG-100 AISI 1144	Free Machining Case Hard Stl. C15 Pb	Cast Iron GG-25 DIN 1691 DIN 1.0403	Ductile Cast Iron GGG-50 DIN 1693	Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	Cast Al Alloy G-Al Si 7 Mg 3.2371 AA356-T6
	280	180	160	170	120	90	80
d_1 mm	P Test B[1] Bar			PW[2] Bar		P Test B[1] Bar	PW[2] Bar
4-10	1100			350		1000	320
12-22	900			280		800	250

[1] Proof Pressure Test B

[2] Maximum allowable working pressure = nominal pressure

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 μm is needed to achieve indicated working pressures.

Security Range
The security range (the difference between working pressure and Test **B** pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test **A** and Test **B** pressure are reduced about 20% after this point.

New Application Plugs

MB-E TYPE
For Volume Requirements / Special Applications

Available upon approval of application

High Pressure Plugs 2,500 BAR

HP500-040/M5

TYPE 1

Sleeve:
Case hardened Steel 1.0403
Gun Metal Finish
Lubricated

Ball
Bearing Steel 1.0616
Plain Finish Lubricated

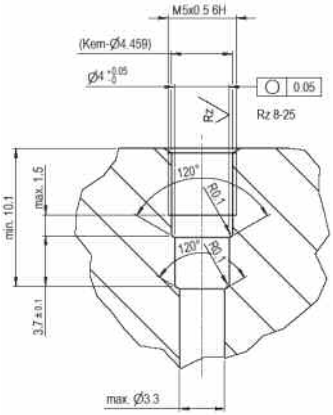
TYPE 2

Sleeve:
Case hardened Steel 1.0403
Zinc plated Clear passivated

Ball
Bearing Steel 1.0616
Plain Finish Lubricated

Sealing Diameter 4mm - Thread M5x0.5mm
Working pressure 2500 bar

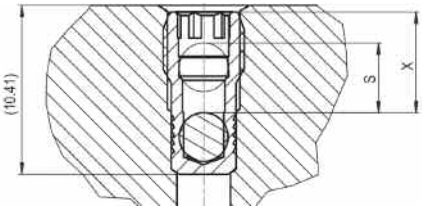
The High pressure plug must be installed by a process controlled device



Bore Machining

All the indicated dimension and tolerances are indicated as final dimensions.

Any distortion from the heat treatments has to be taken into consideration.



Assembly of HP Plug

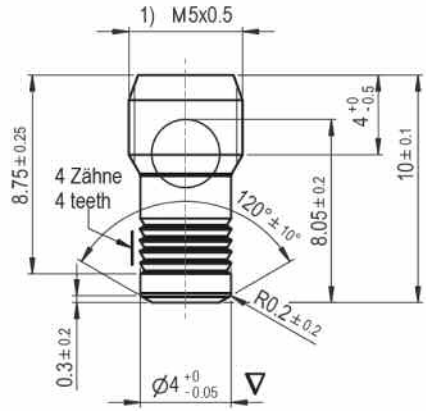
1. Screw in by controlled torque (Power controlled screwdriver)
2. Press in by controlled stroke (e.g Electro spindle press)

Assembly of the Plug

Hexagon socket 3mm max. tightening torque 1.5 Nm

Stroke S 4.3mm (reference value)

Position of top of ball x 6.1 +/-0.2mm



Thread Definition

Note m5 x 0.5mm thread non standard

1. Machined part to be inspected with gauge 6g
2. After surface treatment inspect with 8g (without ball)
3. Finished part (ball preassembled) functional test to 6H
   By applying a max. tightening torque of 0.2 Nm.

Installation Instructions for Sidex-SK / LK Series

Drilled Hole

- The drilled hole must be within the tolerances shown on tables.
- Holes must be round within 0.05 mm.
- HK Series. The bore roughness should be from R_Z = 10 - 30 μm for best results.
- Sidex-SK Series. With hard materials the bore roughness should be from R_Z = 10 - 30 μm for best results.
- Longitudinal rifles and spiral grooves should be avoided as they influence the sealing effectiveness.
- The bore must be free of oil, grease and chips.

Setting Procedure

1. Insert the plug in the tool, making sure that the sleeve is against the nosepiece. (Fig. 1)
2. After inserting the plug into the hole (making sure the tool is flush to the work surface) activate the tool to expand the plug. The mandrel will break apart when the proper tension has been reached (Fig. 2 & 3)
3. When correctly installed, the tapered portion of the mandrel will be below the sleeve surface. (Fig. 3)

Fig. 1

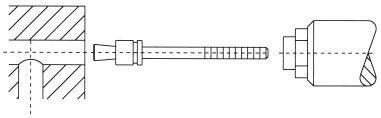


Fig. 2

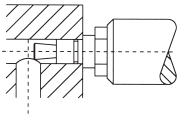
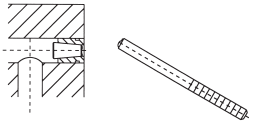


Fig. 3



NOTE:

- The assembly of Sealing Plugs should only be undertaken in a clean working area.
- The sleeve and mandrel of the plug should be clean and grease free.

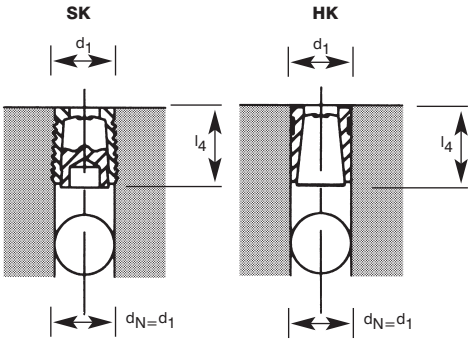
Plug Removal

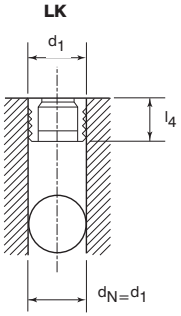
With Koenig Sealing Plugs (HK Series) plug removal is possible.

Procedure:

1. Drive the mandrel from the sleeve with a punch.
2. Drill out the sleeve and remove the mandrel.
3. Bore the hole to **the next larger plug diameter** per the data sheet.
4. Clear chips, remnants of the sleeve, oil and grease from the bore.
5. Install a new Koenig Sealing Plug.

NOTE: After plug removal always install the next larger size plug.





Required Installation Lengths

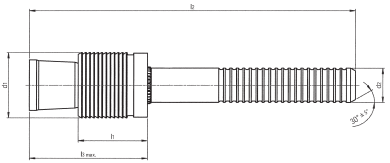
	SIDEX-SK		LP		LK	
	d1	l_4 max	d1	l_4 max	d1	l_4 max
4mm	4.0	6.5	4.40	7.0	4.0	4.0
5mm	5.0	7.5	5.40	8.0	5.0	4.8
6mm	6.0	8.0	6.40	8.5	6.0	5.3
7mm	7.0	9.0	7.40	8.5	7.0	5.8
8mm	8.0	10.5	8.45	9.5	8.0	6.8
9mm	9.0	11.0	9.60	10.0	9.0	6.8
10mm	10.0	12.5	10.65	11.0	10.0	6.8
12mm			12.75	12.0	12.0	7.8

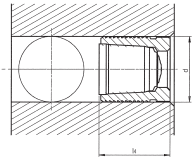
Sidex-SK Series

Sleeve: **Case Hardened Steel**
DIN 1.0403 - AISI 10L 15
Gunmetal finish
Hardness: HB = 180

Mandrel: **Heat Treated Forging Steel 1.7033**
Cold Forged

This range (Forged Steel) replaces the HK range with the exception of 3mm HK030-CK55-111-AK





Sidex-SK Series

- Working pressure to 500 Bar (7,250 psi)
- Shorter installed length
- Larger working tolerances (0/+0.12mm)
- Installs directly into drilled holes
- Clean mechanical sealing through positive anchoring
- Quick installation using rivet type tools

Dimensions in mm

Type	d_1	l_1	d_2	l_2	l_3 max.	l_4 max.	Bore Diameter d	
SK 550-F-040	**4.0**	4.5	2.50	39	9.0	6.5	**4.0**	+0.12 0
SK 550-F-050	**5.0**	5.5	3.00	41	10.0	7.5	**5.0**	
SK 550-F-060	**6.0**	6.5	3.40	43	12.0	8.0	**6.0**	
SK 550-F-070	**7.0**	7.5	4.10	43	14.0	9.0	**7.0**	
SK 550-F-080	**8.0**	8.5	4.20	40	15.0	10.5	**8.0**	
SK 550-F-090	**9.0**	9.5	4.50	43	17.0	11.0	**9.0**	
SK 550-F-100	**10.0**	10.5	4.75	45	19.0	12.5	**10.0**	

Pressure Performance

	Base Material / Minimum Hardness HB						
	High Strength St. ETG-100 AISI 1144	Free Machining Case Hard Stl. C15 Pb	Cast Iron GG-25 DIN 1691 DIN 1.0403	Ductile Cast Iron GGG-50 DIN 1693	Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	Cast Al Alloy G-Al Si 7 Mg DIN 3.2371 AA356-T6
	280	180	160	170	120	90	80
d_1 mm	P Test B[1] Bar			PW[2] Bar		P Test B[1] Bar	PW[2] Bar
4-10	1600			500		1400	450

[1] Proof Test Pressure B.

[2] Maximum allowable working pressure = nominal pressure.

- Equivalent working pressure capability can be obtained when using base materials with similar mechanical characteristics. However, the appropriate installation instructions must be followed.
- If pressure is applied to both sides of the Sidex-SK plug, allowable working pressure on the insertion side is reduced by 50%.
- Anchorage between sleeve and base material is achieved when the sleeve is a minimum of HB=30 greater than the base material. If the hardness difference is less, hole roughness of 10 to 30 μm is needed to achieve indicated working pressures.

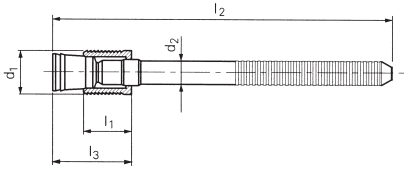
Security Range
The security range (the difference between working pressure and Test **B** pressure) allows for uncontrollable variations. For instance, dynamic loading at 1 million cycles and a frequency of 3-4Hz has shown that burst pressure Test **A** and Test **B** pressure are reduced by about 20% after this point.
Setting tools see page 20, 21 and 22.

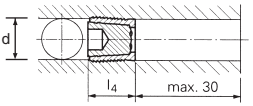
Sidex-SK Series. Long Mandrel Version

Sleeve: **Case Hardened Steel**
DIN 1.0403 - AISI 10L 15
Gunmetal finish
Hardness: HB = 180

Mandrel: **Heat Treated Steel**
- DIN 1.0728
Special oil film lubrication

One piece construction ideal for automated high production requirements. Forged long Mandrel type available upon request.



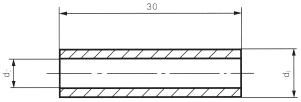


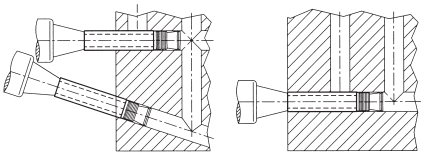
Special Type: Mandrel 30mm Longer

Dimensions in mm

Type	d_1	l_1	d_2	l_2	l_3 max.	l_4 max.	d +0.12 0
SK552-040	4.0	4.5	2.50	69	9.0	6.5	4.0
SK552-050	5.0	5.5	3.00	71	10.0	7.5	5.0
SK552-060	6.0	6.5	3.40	73	12.0	8.0	6.0
SK552-070	7.0	7.5	4.10	68	14.0	9.0	7.0
SK552-080	8.0	8.5	4.20	70	15.0	10.5	8.0
SK552-090	9.0	9.5	4.50	73	17.0	11.0	9.0
SK552-100	10.0	10.5	4.75	75	19.0	12.5	10.0

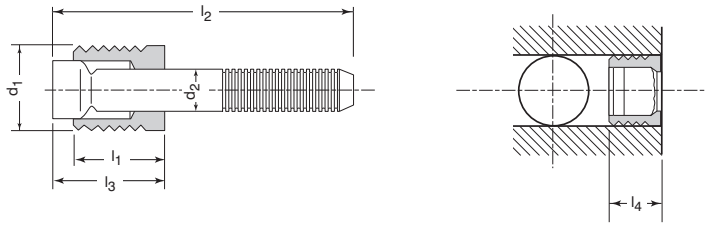
Spacers Sidex-SK





d_1	d_2	Type	Ref
4,0	2,7	4 x 30-SK	SK 552-040
5,0	3,2	5 x 30-SK	SK 552-050
6,0	3,7	6 x 30-SK	SK 552-060
7,0	4,6	7 x 30-SK	SK 552-070
8,0	4,8	8 x 30-SK	SK 552-080
9,0	5,2	9 x 30-SK	SK 552-090
10,0	5,6	10 x 30-SK	SK 552-100

LK Series. Low Pressure Applications up to 60 bar



Sleeve: Case hardened steel DIN 1.0403, soft annealed, gun finish.
Mandrel: Free cutting steel or cold forming steel, plain finish, spec. oil film lubrication.

Type	d_1	l_1	d_2	l_2	l_3 max.	l_4 max.	Bore-Diameter	
LK 950-040	4.0	3.7	2.2	36	5.5	4.0	4.0	
LK 950-050	5.0	4.5	2.95	36	6.9	4.8	5.0	
LK 950-060	6.0	5.0	3.4	36	7.4	5.3	6.0	
LK 950-070	7.0	5.5	4.2	34	8.0	5.8	7.0	+0.12
LK 950-080	8.0	6.5	4.3	34	9.8	6.8	8.0	0
LK 950-090	9.0	6.5	4.7	34	9.8	6.8	9.0	
LK 950-100	10.0	6.5	5.1	36	9.8	6.8	10.0	
LK 950-120	12.0	7.5	5.9	36	10.8	7.8	12.0	

Also available LK950-160 16mm forged mandrel or turned on low quantities

Sleeve: Stainless steel DIN 1.4305, AISI 303, plain finish, special oil film lubrication.
Mandrel: Stainless steel, plain finish. LK600 now available upon application

Type	d_1	l_1	d_2	l_2	l_3 max	l_4 max	Bore-Diameter	
LK 600-040	4.0	3.7	2.2	36	5.5	4.0	4.0	
LK 600-050	5.0	4.5	2.95	36	6.9	4.8	5.0	
LK 600-060	6.0	5.0	3.4	36	7.4	5.3	6.0	
LK 600-070	7.0	5.5	4.2	34	8.0	5.8	7.0	+0.12
LK 600-080	8.0	6.5	4.3	34	9.8	6.8	8.0	0
LK 600-090	9.0	6.5	4.7	34	9.8	6.8	9.0	
LK 600-100	10.0	6.5	5.1	36	9.8	6.8	10.0	
LK 600-120	12.0	7.5	5.9	36	10.8	7.8	12.0	

Pressure Performance

Series LK	ETG-100 AISI 1144	C15Pb 1.0403	GG-25 DIN 1691	GGG-50 DIN 1693	AlCuMg2 3.1354	AlMgSiPb 3.0615	G-AlSi7Mg 3.2371
d_1 mm	P Test (B) (1) Pressure		PB (2) Pressure			P Test (B) (1)	PB (2)
4-12	180 bar		60 bar			180 bar	60 bar

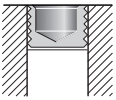
1) Proof Pressure
2) Max. allowable working pressure
*Installation See Page 15

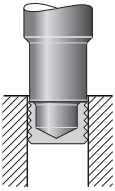
- Controlled, low stress installation
- Completely mechanical sealing
- Application for metals and plastics
- Direct installation in hydraulic through holes

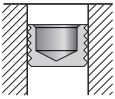
Installation instructions for LP Series

Drilled Hole

- The drilled hole must be within the tolerance shown on the dimensional sheets.
- The cone rate 1:12 must be kept as per specification sheet.
- Holes must be round within t = 0.05 mm.
- With hard materials (> 170 HB) the bore roughness should be from Rz = 10-30 um for best results.
- Longitudinal rifles and spiral grooves should be avoided. These influence the sealing effectiveness.
- The bore must be free of oil, grease and chips.







Setting Procedure

- With the setting hole facing out, the LP-Plug is inserted in the cone bore, The top sleeve should not be above the surface of the base material.
- The LP-Plug can now be pressed in with the setting tool. Corresponding approximate values for stroke S are from the table below.
- Installed LP-Plug.

Note

- Use the proper size setting tool for the sealing plug according to the Data sheet.
- Washing of the LP plugs before installation, higher Setting force might occur

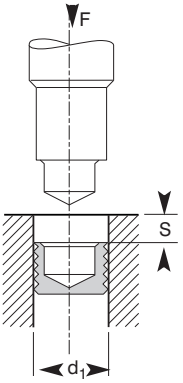
Press

- It is preferred to limit travel when using a press because insertion force is difficult to control.
- Recommended setting speed is 5 mm/sec.

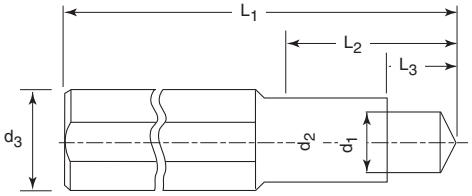
The sealing plug assuring an optimum orientation, works perfectly with automatic processing.

Installation Chart

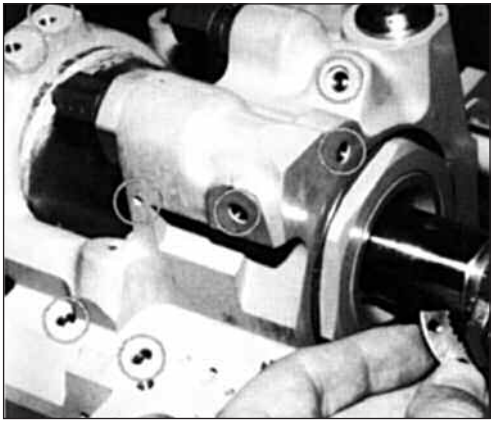
Series LP 900									
d1 (mm)4		5	6	7	8	9	10	12	
S(mm) ± 0.25	Stroke (average Value)	1.0	1.3	1.3	1.5	1.8	1.8	2.0	2.0
in steel, grey cast, nodulized cast iron in aluminium wrought alloy, aluminium-cast material									



Material Tool Steel Heat Treated Hardness HRC50



Type	Series LP 900					
	d_1 +0.1 0	d_2 +0.15 0	d_3 h9	L_1	L_2	L_3 +0.1 0
LP 040	2.5	3.7	10	100	10	3.80
LP 050	3.1	4.7	10	100	15	4.76
LP 060	3.8	5.7	10	100	15	4.79
LP 070	4.6	6.7	10	100	15	4,74
LP 080	5.3	7.7	10	100	20	5.77
LP 090	6.5	8.7	14	100	20	6.23
LP 100	7.4	9.7	14	100	25	6.96
LP 120	9.1	11.7	14	100	25	7.94

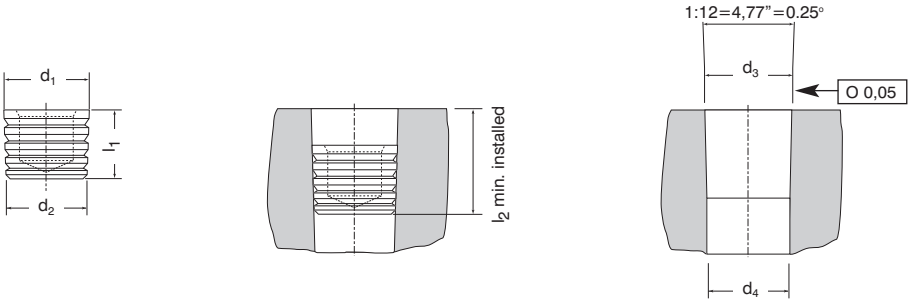


Hydraulic Actuator (fitted on Airbus A310, Swissair.)
MB 600 Series plugs fitted to hydraulic actuators and sequence valves (trim/control and others). The sealing plug replaced Lee plugs and threaded plugs for hole tolerance criteria - overall performance - economical aspect.

Hydraulic Actuator.

LP Series. Sealing Plug

Material Free Cutting Steel
DIN 1.0718, nitrocarburized



Type	d_1	d_2	l_1	d_3 min.	d_4 +0.1 -0.3	l_2 min.
LP 900-040	4.4	3.7	5	4.55	4	7
LP 900-050	5.4	4.7	6	5.55	5	8.0
LP 900-060	6.4	5.7	6	6.55	6	8.5
LP 900-070	7.4	6.7	6	7.55	7	8.5
LP 900-080	8.45	7.7	7	8.6	8	9.5
LP 900-090	9.6	9.0	7.5	9.75	9	10.0
LP 900-100	10.65	10.0	8.5	10.8	10	11.0
LP 900-120	12.75	12.0	9.5	12.9	12	12.0

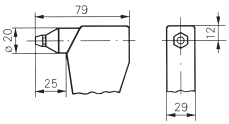
Pressure Performance

Series LP	ETG-100 AISI 1144	C15Pb 1.0403	GG-25 DIN 1691	GGG-50 DIN 1693	AlCuMg2 3.1354	AlMgSiPb 3.0615	G-AlSi7Mg 3.2371
d_1 mm	P Test (B) [1] Pressure			PB [2] Pressure		P Test (B) [1]	PB [2]
4-12	180 bar			60 bar		180 bar	60 bar

1) Proof Pressure
2) Max. allowable working pressure

- Press fit, grooved, labyrinth sealing surface
- Direct installation in hydraulic through holes
- Ideal for automated installation
- Applicable for metals and plastics

Type KW-002
Hand Plier

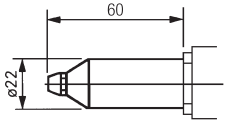


Dimensions in mm

d_1	Nosepiece Series HK 55 Type	Jaws Series HK 55 Type
3.0	HKW-002103•	15068•
4.0/4.3	HKW-002104•	

•Standard set-ups

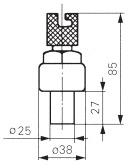
Type KW-007
Hand Lever Tool



ø Plug	Series SK Type	Nosepiece Series LK Type	Series HK-55 Type
3	-	-	HKW-55-103
4	SKW-104	LKW-104	HKW-55-104
5	SKW-105	LKW-105	HKW-55-105
6	SKW-106	LKW-106	HKW-55-106

Jaws PRG 540-46E

Type KW-003/KW-004
Handsetting Tool (without ratchet)



Ratchet Spanner Wrench
HKW-003908

Dimensions in mm

d_1	Series	Type
8.0/8.3/9.0 9.3/10.0/10.3	HK55	KW-003

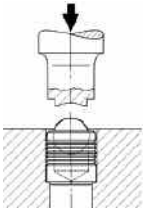
Setting Tool

Process Controlled Press (30 and 50kN)

Express 3000 and Exprss 5000

Programming via connected PC wih Winscope software or on the control unit of the press

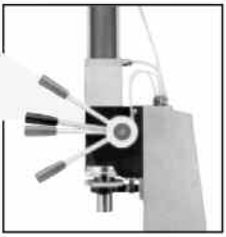
Statistical Data recording with Winscope software saves up to 16 processes

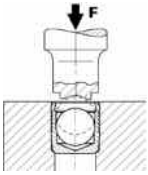


STEP 1

Approach Stroke

1 The lever operates the down stroke of the piston rod through a rack-and-pinion device.
It allows the approach of the tool to workpiece.

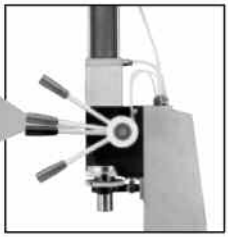




STEP 2 / 3

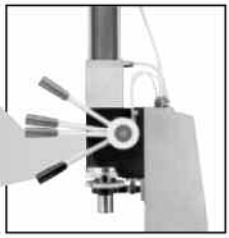
Slip clutch stroke of intensifier

2 The continuing movement of the lever, engages the intensifier. It operates with a friction clutch system.



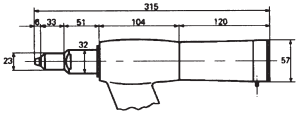
Working stroke with hydropneumatic force

3 During further down stroke of the lever, the hydropneumatic intensifier carries out the working stroke, always with friction engaged. The release of the lever causes the return to starting position



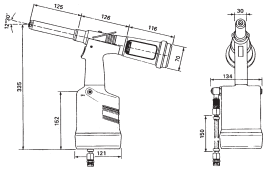
Settings Tool KW-010-MCS

Hydraulic/Pneumatic Tool
Tool with mandrel collecting system
Air Pressure 6-5 bar
Weight 2.1 kg



Setting Tool KW-020-B

Hydraulic/Pneumatic Tool
Tool with mandrel collecting system
Air Pressure 7 bar
Weight 2.22 kg



Available with process control units

Settings Tools Sidex-SK Series

d_1	Tool head	Nose piece	Jaw Case	Jaws	Jaw pusher	Tool	
	Type	Type	Type	Type	Type	Type	
4.0	SKW-040	SKW-104	PRG-740-11AE	PRG-540-46E	PRG-14	KW010	
5.0	SKW-040	SKW-105	PRG-740-11AE	PRG-540-46E	PRG-14	KW010	
6.0	SKW-060	SKW-106	PRG-740-11AE	PRG-540-46E	PRG-740-7A	KW010	
7.0	SKW-070	SKW-107	HK-010308	HK-014208	HK-010508	KW010	KW020-B
8.0	SKW-080	SKW-108	HK-010308	HK-014208	HK-010508	-	KW020-B
9.0	SKW-080	SKW-109	HK-010308	HK-014208	HK-010508	-	KW020-B
10.0	SKW-080	SKW-110	HK-010308	HK-014208	HK-010508	-	KW020-B

* Tool KW-010-MCS needs to be switched off when using plugs 7mm

Settings Tools for LK Series

d_1	Tool head	Nose piece	Jaw case	Jaws	Pusher	Tool
	Type	Type	Type	Type	Type	Type
4	LKW-040	LKW-104	PRG 740-11AE	PRG 540-46E	PRG-14	KW-010-1
5		LKW-105				
6	LKW-060	LKW-106			PRG-740-7A	
7	LKW-070	LKW-107	HKW-010308	HKW-014208	HKW-010508	KW-020-B
8	LKW-080	LKW-108				
9		LKW-109				
10		LKW-110				
12	LKW-120	LKW-112		HKW-014210	10x30	

KW-010-1 mcs covers 4mm - 10mm
KW-020-B covers 7mm - 12mm

The mandrel collection system must not be switched off when fitting LK 600 and LK 950 10mm and 12mm.
If using KW-010-1 tool switch the mandrel collection system off for 9mm and 10mm sizes. (12mm not possible)

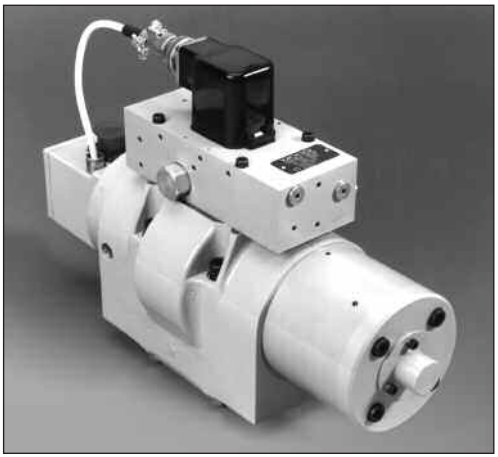
Setting Tools

REF DAH

Air operated hammer for fitting MB type plugs. 3mm to 10mm

Air pressure required 6 Bar

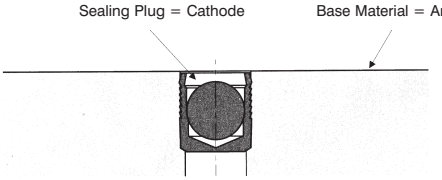
Typical Application



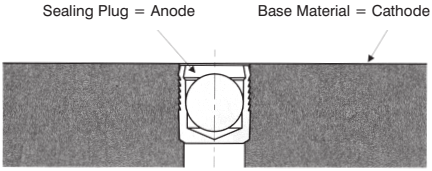
Moog Controls
E790 Series servo valve used for flight simulators
fitted with MB700-040
MB 700-050
MB 700-080
MB 700-160
Fluid medium: mineral oil
Working pressure 2,000 psi

Galvanic Corrosion

In choosing a sealing plug you must consider that the material of the sealing plug and the material of the production piece can show different electrical potentials. In the presence of an electrolyte (e.g. 5% Water-NaCl solution), this potential difference causes electrochemical attack on the least noble of the metals in contact - galvanic corrosion. In this case, either the base material or the surface protection of the plug (MB 800) will become the anode and will be transferred to the pure metal of the cathode. The corrosion speed or the current density will be determined by the relative surface area or volume of the anode and cathode as illustrated below.



Large Anode area ' Low current density at the Anode ' **Slow corrosion**



Small Anode area ' High current density at the Anode ' **Fast corrosion**

Effect of Galvanic Corrosion

The following table shows the expected galvanic corrosion behaviour of Koenig Plugs in common base materials allowing for the relative surface areas of both metals, which influences the speed of corrosion.

Base Material	KOENIG Expander Series				
	MB 600	MB 700	MB 800	Sidex-SK	HK 55
Steel, carbon/low alloy, plain	2	2	2	2	2
Steel, carbon/low alloy, Zn plated chromate	2	2	1	2	2
Steel, carbon/low alloy, phosphatized	2	2	2	2	2
Nitrided or case hardened steel	Behaviour depends on method used				
Stainless steel, DIN 1.4305, AISI 303	1	1	3	3	3
Stainless steel, DIN 1.4005, AISI 416	1	1	3	3	3
Cast iron, GG, DIN 1691, plain	2	2	2	2	2
Cast iron, GG, DIN 1691, Zn plated, chromate	2	2	1	2	2
Cast iron, GG DIN 1691, phosphatized	2	2	2	2	2
Ductile cast iron, GGG, DIN 1693, plain	2	2	2	2	2
Ductile cast iron, GGG DIN 1693, Zn plated, chromate	2	2	1	2	2
Ductile cast iron, GGG DIN 1693 phosphatized	2	2	2	2	2
Aluminium alloy, Ws-Nr. 3.3211, AA 6061	2	2	2	2	2
Aluminium alloy, Ws-Nr. 3.0615, AA 6262	2	2	2	2	2
Aluminium alloy, Ws-Nr. 3.1354, AA 2024	2	2	2	2	2
Aluminium alloy, Ws-Nr. 3.4365, AA 7075	2	2	2	2	2
Cast aluminium alloy, Ws-Nr. 3.2371, AA 356-T6	2	2	2	2	2
Cast aluminium alloy, Ws-Nr 3.2371	2	2	2	2	2
Cast aluminium alloy, Ws-Nr. 3.2371	2	2	2	2	2

New range of plugs LK950-LP900 have similar characteristics as HK55/SK55. LK 600 as MB 600 but breaking surface of mandrel is not corrosion resistant.

Key to the galvanic corrosion behaviour of Koenig Plugs in the presence of an electrolytic medium installed in base materials per the above table: **1** Very good **2** Good **3** Usable **4** Not recommended

Suggestions to prevent galvanic corrosion

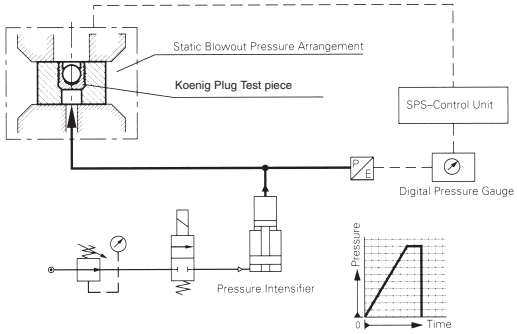
- Chose materials with no or low potential difference
- Use corrosion reducing designs, i.e. if possible prevent the accumulation of fluids on the outer surface of the workpiece
- By using suitable surface coatings, corrosion attack can be considerably reduced.

Salts spray testing per DIN 50021 can be done in lab.

Pressure Performance Tests - Koenig Sealing Plugs

Test Ⓐ Pressure Test to Failure

In Test Ⓐ the Koenig Plug is subject to increasing static pressure until plug blowout occurs. These tests are done by KVT for functional testing during manufacturing runs. Each production lot (Batch No.) undergoes these tests.



Test Ⓑ Temperature/Pressure Cycling

In Test Ⓑ the Koenig Plug is subject to a long term test simulating practical conditions. This determines the pressure which can be applied (lower limit) without plug blowout, with intermittent pressure and varying temperature.

Conditions

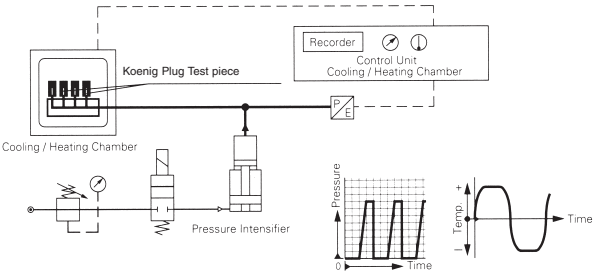
Temperature : 2 hours at 100˚C, 2 hours at -40˚C
temperature change: between 30 and 45 minutes

Pressure : intermittent
2 minutes at 0 bar, 3 minutes at test pressure

Duration : 170 h (Long term test)

Drill Hole : Tolerances, roundness, and roughness per data sheets, plain surface

Distance from edge per data sheets



Base Material Of the Installation	Tensile Strength (avg.) (N/mm^2)	Elongation (min.) (%)	Ultimate Strength (avg.) Rp 0.2 (N/mm^2)	Hardness (min.) HB
High Strength St ETG-100 AISI 1144	1000	6	865	280
Free Machining Case Hard. Stl. C15 Pb DIN 1.0403	560	6	300	180
Cast Iron GG-25 DIN 1691	250	-	-	160
Ductile Cast Iron GGG-50 DIN 1693	500	7	320	170
Aluminium Alloy Al Mg Si Pb DIN 3.0615 AA6262	340	8	300	90
Aluminium Alloy Al Cu Mg 2 DIN 3.1354 AA2024	480	8	380	120
Cast Al Alloy G-Al Si 7 Mg DIN 3.2371 AA356-T6	300	4	250	80

All technical information in this catalogue for test results is based on the material to the left:

Hardness Conversion Table for Hardenable Carbon and Low Alloy Steel

Taken from DIN 50150 (Issued 12/76)

Tensile Strength 2	Vickers Hardness	Brinell Hardness 1	Rockwell Hardness		
N/mm^2	(F≥ 98 n)	$(0.102 \cdot F/D^2 = 30 N/mm^2)$	HRB	HRC	HRA
255	80	76			
270	85	80.7	41		
285	90	85.5	48		
305	95	90.2	52		
320	100	95	56.2		
335	105	99.8			
350	110	105	62.3		
370	115	109			
385	120	114	66.7		
400	125	119			
415	130	124	71.2		
430	135	128			
450	140	133	75		
465	145	138			
480	150	143	78.7		
495	155	147			
510	160	152	81.7		
530	165	156			
545	170	162	85		
560	175	166			
575	180	171	87.1		
595	185	176			
610	190	181	89.5		
625	195	185			
640	200	190	91.5		
660	205	195	92.5		
675	210	199	93.5		
690	215	204	94		
705	220	209	95		
720	225	214	96		
740	230	219	96.7		
755	235	223			
770	240	228	98.1	20.3	60.7
785	245	233		21.3	61.2
800	250	238	99.5	22.2	61.6
820	255	242		23.1	62
835	260	247	(101)	24	62.4
850	265	252		24.8	62.7
865	270	257	(102)	25.6	63.1
880	275	261		26.4	63.5
900	280	268	(104)	27.1	63.8
915	285	271		27.8	64.2
930	290	276	(105)	28.5	64.5
950	295	280		29.2	64.8
965	300	285		29.8	65.2
995	310	295		31	65.8
1030	320	304		32.2	66.4
1060	330	314		33.3	67
1095	340	323		34.3	67.6
1125	350	333		35.5	68.1

Tensile Strength 2	Vickers Hardness	Brinell Hardness 1	Rockwell Hardness		
N/mm^2	(F≥ 98 n)	$(0.102 \cdot F/D^2 = 30 N/mm^2)$	HRB	HRC	HRA
1155	360	342		36.6	68.7
1190	370	352		37.7	69.2
1220	380	361		38.8	69.8
1255	390	371		39.8	70.3
1290	400	380		40.8	70.8
1320	410	390		41.8	71.4
1350	420	399		42.7	71.8
1385	430	409		43.6	72.3
1420	440	418		44.5	72.8
1455	450	428		45.3	73.3
1485	460	437		46.1	73.6
1520	470	447		46.9	74.1
1555	480	(456)		47.7	74.5
1595	490	(466)		48.4	74.9
1630	500	(475)		49.1	75.3
1665	510	(485)		49.8	75.7
1700	520	(494)		50.5	76.1
1740	530	(504)		51.1	76.4
1775	540	(513)		51.7	76.7
1810	550	(532)		52.3	77
1845	560	(532)		53	77.4
1880	570	(542)		53.6	77.8
1920	580	(551)		54.1	78
1955	590	(561)		54.7	78.4
1995	600	(570)		55.2	78.6
2030	610	(580)		55.7	78.9
2070	620	(589)		56.3	79.2
2105	630	(599)		56.8	79.5
2145	640	(608)		57.3	79.8
2180	650	(618)		57.8	80
	660			58.3	80.3
	670			58.8	80.6
	680			59.2	80.8
	690			59.7	81.1
	700			60.1	81.3
	720			61	81.8
	740			61.8	82.2
	760			62.5	82.6
	780			63.3	83
	800			64	83.4
	820			64.7	83.8
	840			65.3	84.1
	860			65.9	84.4
	880			66.4	84.7
	900			67	85
	920			67.5	85.3
	940			68	85.6

Numbers in brackets indicate hardness values, which are outside the definition area of the standard hardness test, but are actually often used as approximate values. The Brinell values (in brackets) are only used when measured with a hard metal ball.

1) Calculated as: HB = 0.95 HV.

2) The tensile strength values shown in the table are only to be used as approximate values. To get the exact tensile strength values a tensile test must be performed.

General Conditions of Sale

1 General

(a) Save as otherwise agreed in writing by Boneham & Turner Limited ('The Company'), these conditions shall govern the contract to the entire exclusion of any other express or implied conditions.

(b) Descriptions, illustrations and particulars of goods contained in the Company's price lists, catalogues or other advertising material shall not form part of the contract unless specifically included.

(c) If the goods are required for any special use not reasonably to be inferred by the Company, the customer shall disclose such use before the Contract is entered into.

2 Performance

(a) The Company warrants that the goods shall at the time of delivery correspond with the specifications agreed (subject to any specified tolerance limits) and be free from defects in workmanship and materials. If any goods do not conform to this warranty the Company will at its option:

(i) replace the goods found not to to the warranty or

(ii) take such steps as the Company deems necessary to bring the goods into conformity with the agreed specifications (subject as aforesaid) and into a state where they are free from such defects; or

(iii) take back the goods found not to conform to the warranty and refund the appropriate part of the purchase price.

Provided that the liability of the Company shall in no event exceed the purchase price of the goods, and performance of any of the above options shall constitute an entire discharge of the Company's liability under this warranty.

(b) The foregoing warranty is conditional upon:

(i) the customer giving notice to the Company of the alleged defect or failure to correspond with specification immediately the customer discovers or ought to have discovered the same;

(ii) the customer affording the Company a reasonable opportunity to inspect the goods; and

(iii) the customer making no further use of the goods that are alleged to be defective or which do not correspond with specification after the time agreed the customer discovers or ought to have discovered the same.

(c) Save as provided in paragraph (a) of this Condition:

(i) all conditions and warranties, express or implied, as to the quality or fitness for any purpose of the goods are hereby expressly excluded; and

(ii) the Company shall be under no liability for any loss or damage (whether direct, indirect or consequential) howsoever arising which may be suffered by the customer.

(d) in the event that, notwithstanding the foregoing provisions of this Condition, the Company is found liable for any loss or damage suffered by the customer, the liability shall in no event exceed the purchase price of the goods.

(e) The foregoing provisions of this Condition shall not apply to sales which are made to persons who deal as consumers (as the expression is defined in Section 12 of the Unfair Contract Terms Act 1977).

3 Price

(a) The price payable for each consignment of goods exstock will be the Company's price on the date on which that consignment is delivered to the customer.

(b) In the case of goods which are not exstock the Company reserves the right to increase the contract price at any time after the date of the contract by such additional sums as may from time to time be necessary to cover increased costs due to:

(i) alteration of the customer's requirements;

(ii) suspension of work due to the lack of or on the customer's instructions;

(iii) any variation in costs of materials, labour, overheads or transport, or in conforming to any Act of Parliament or Order, Regulation or Bye-Laws made by any competent National or Local Authority arising after the date of the contract. Further in the case of specials the Company shall be entitled to deliver up to 110% of the quantity ordered and to increase the contract price accordingly.

(c) The contract price is exclusive of Value Added Tax or any similar taxes, levies or duties, which will be added to or charged on invoices at the appropriate rate.

(d) There is no minimum order value, but credit sales of goods having a total net value (exclusive of VAT, carriage, packing or postage) will be subject to an administration charge to cover the relatively high cost of processing such orders.

4 Payment

Unless otherwise agreed in writing, the customer shall pay for the goods by cash on delivery. Where an order is designated as a credit order, payment shall be made on or before the tenth day of the month following the month of the invoice date. If the customer fails to make any payment in accordance with the agreed terms, the Company shall be entitled to charge interest at the rate of 3% per annum over the base rate of National Westminster Bank Limited on a day to day basis for the time being on all overdue payments.

5 Delivery

(a) A date or period of delivery agreed by the Company shall be an estimate only. Every effort will be made to adhere to delivery dates, but the Company accepts no liability for any direct or any consequential loss or damage arising from delay in delivery or despatch, in particular where such delay is caused by lack of instructions from the customer, strikes, lock-outs, other industrial action, failure of the Company's suppliers to fulfil their obligations, or any other cause beyond the Company's reasonable control.

(b) Unless otherwise stated, the price quoted is for the supply of the goods exworks and unpacked. All packing, postage or other costs of delivery, and costs of storage following any failure by the customer to take delivery, will be subject to an extra charge.

(c) If the customer being a company shall pass a resolution or suffer an order of a court to be made for its winding-up, or if a receiver shall be appointed, or being an individual or partnership shall suspend payment or propose or enter into any competition with creditors or suffer a receiving order in bankruptcy, then the Company may without prejudice to any other right rescind the contract, or suspend or cancel delivery or recover the possession of any goods for which full payments has not been received.

6 Risk and Property

(a) The risk in the goods shall pass to the customer upon delivery of the goods to him or any carrier acting on his behalf.

(b) The property in the goods shall not pass to the customer until the price of the goods and of any other goods delivered by the Company to the customer is paid.

In the event of the customer failing to pay for the goods, then all such goods of the Company not paid for shall be handed over to the Company on demand and the Company is hereby granted a licence to enter into the customer's premises for the purpose of recovering such property.

Without prejudice to the generality of the foregoing, if the said goods are sold by the customer then the Company's beneficial interest shall attach to any proceeds of such sale and the customer shall forthwith hand over to the Company any proceeds of such sale and the Company shall be entitled to call upon the customer to assign all claims that the customer may have in respect of such sale.

7 Copyright etc.

All designs, drawings, plans or models prepared by the Company for the customer's information remain the Company's property and copyright, and neither they nor any copies thereof must be made use of by any person without the Company's written consent. In respect of any goods supplied to the customer the design or specification whereof shall have been supplied by the customer, the customer accepts responsibility for any claims which may arise in respect of the making, supplying or using for the purposes of the contract of any patented invention or process or registered design, and the customer agrees to indemnify the company against any action, claim or proceeding for infringement or alleged infringement in respect thereof.

8 Cancellation

Contracts are not subject to cancellation without the Company's written consent. Where cancellation is accepted, the Company shall in addition to any express terms of acceptance of cancellation be entitled to reimbursement of any costs incurred by the Company in connection with the contract.

9 Force Majeure

The Company shall have the right to cancel or to reduce the volume of the goods delivered if it is prevented from or hindered in delivering the goods through any circumstances beyond its control including (but not limited to) industrial action, war, fire, or prohibition or enactment of any kind, without incurring any liability for any loss or damage whatsoever resulting therefrom.

10 Arbitration

At the option of either party in writing, any question, dispute or difference arising between the Company and the customer in relation to the contract shall be referred to the arbitration in England of a person to be mutually agreed upon, or failing arrangement of some person appointed by the London Chamber of Commerce and Industry and the City Corporation in accordance with, and subject to, the provisions of the Arbitration Act 1934 or any statutory modifications or re-enactment thereof.

11 Loss or damage in transit

Where the price includes delivery other than at our works we will repair or at our option replace free of charge within a reasonable time all goods lost or damaged in transit, provided we are given written notice of such loss or damage within such time as will enable us to comply with the carrier's conditions of carriage or where delivery is made by our own transport within seven days (exclusive of Public Holidays) after receipt of the Advice **Note**. If so requested by you prior to the despatch of goods we will notify you of the name, and address of the carrier (if any) and any time limit laid down by such carrier's conditions of carriage.

12 Governing Law

The contracts shall be governed by English Law.

Note:

The Company's prices are calculated on the basis that the above Conditions will apply. Customers requiring prices to be quoted on a different basis should inform the Company. Information regarding any of our components that bears reference to the Health and Safety at Work Act 1974 will be available upon request.

Aerospace
Control Gear
Landing Gear
Flight Simulators

Automotive
Brake Systems
Power Transmissions
Engine Transmissions
Power Steering Systems
Fuel Injection Systems

Hydraulics and Pneumatics
Control and Drive Units
Valves
Pumps
Jacks
Lifts
Cylinders

"World Class Precision"

Boneham and Turner Ltd

New Premises

Oddicroft Industrial Estate, Oddicroft Lane, Sutton In Ashfield,
Nottinghamshire NG17 5FS
Telephone: +44 (0)1623 445 450 Fax: +44 (0)1623 445 451
www.boneham.co.uk sales@boneham.co.uk

FM25000
ISO 9001