



**Maximum Strain**



**Deep Drawing Cup Test**

## **Universal Sheet Metal Testing Machine Model 146**



**Square Deep Drawing Cup Test**



**Software for  
Control, Adjustment,  
Documentation and Filing  
of Measuring Data**

testing equipment for quality management

**ERICHSEN**  
since 1910

### **Technical Description**

**NAKAJIMATest  
MARCINIAK-Test  
Bulge-Test High  
Speed Test  
standardized**

**Extensive  
Tools / Accessories**

**With  
electro-hydraulic Drive  
and PLC**

## Product

The special feature of **Models 146-60 and 146-100** is the increased drawing speed of the drawing punch which, in addition to the normal drawing speed range of 0 – 1200 mm/min can be adjusted, in an infinitely variable manner and independent of load, up to 3000 mm/min. This is achieved by using a separate oil circuit, fed by a pump with high volumetric displacement. Contrary to the high speed attachment based on a nitrogen accumulator, here a constant drawing speed behaviour is guaranteed over the total displacement of 150 mm. As to the technical design and the options available, including PC control and proportional valve technique, this machines are similar to Models 145.

## Application

This Sheet Metal Testing Machine is not only ideal for the effortless, quick and accurate performance of all significant known deep drawing tests for ferrous and non-ferrous metals, it is also designed for a large number of additional technological investigations:

### **ERICHSEN Cupping Test** in accordance with

DIN EN ISO 20482	JIS Z-2247
NF A 03-602	
NF A 03-652	
ASTM E 643	GOST 10510
GB 4156-07	

on sheet and strip 0.1 to 6.0 mm thick

### **ERICHSEN Deep Drawing Cup Test** in accordance with

DIN EN 1669
ISO 11 531
JIS Z 2249
GB/T 15825

### **Square Cup Test** (40 x 40 mm or 70 x 70 mm)

### **Bore Expanding Test (ISO 16630)**

### **Determination of the Forming Limit Curves (FLC)**

### **LDH Test**

### **Deep Drawing Tests with Blankholder Quick Release** (for Earing Test)

### **Deep Drawing Tests with Preselected Punch Stroke**

### **Deep Drawing Test at High Temperatures up to 550 °C / 700 °C**

### **Bulge Test** in accordance with ISO 16808

### **ERICHSEN Cupping Test for Lacquer and Paint** in accordance with DIN ISO 1520

### **Stamping Lacquer Test and Deep Drawing Cup Test on Coil Coatings**

**Special Requirements on request.**

## Description

The Testing Machine is driven electro-hydraulically. The test sequence is controlled automatically or manually as appropriate. A programme logic controller is used for the functions of the machine (optional computer controls). The drawing force and blankholder force as well as the drawing punch stroke are digitally displayed. The triple-acting hydraulic system in conjunction with the general design results in the following cost saving simplifications:

- ◆ Blanking press in the test head
- ◆ Hydraulic cup ejector
- ◆ Fully-automatic test sequence.

Further technical advantages:

- *Cylinder head with bayonet lock* permitting direct access to drawing dies, blanking rings, blank holders etc. and quick and convenient changing of the drawing and blanking tools
- *Infinitely variable drawing speed* once set it remains constant throughout the drawing movement, independent of any change of load
- *Cardanic drawing die retention* ensures the consistent, parallel clamping of the specimen, independent of variations in thickness.

### **Sheetholder Quick Release and Drawing Punch Stop (BSA-ZS)**

During the drawing sequence the constant sheet holder force acts on a continuously reducing area of sheet metal under the sheet holder. The result is increasing specific pressure as the remaining flange reduces with the result that in the final phase of the drawing process and especially in cases with severe ear forming tendency, a squashing of the ear-ends will occur. For this reason, provision is made to release the sheet holder pressure completely at a preselected depth where there is no more tendency for folds to form.

The machine is provided with an digital display of the drawing punch stroke and a selector switch for either "BSA" or "ZS". When the depth of draw selected on the digital display unit is reached the drawing punch stops completely - in case of the "ZS" mode, or the sheet holder force is released - in the case of the "BSA" mode.

### Hydraulically lifted test head

Hydraulic test head lifting function (*Fig. 1*) ensures a high rate of working safety and facilitates convenient testing due to the fact that the test head is hydraulically opened and closed.

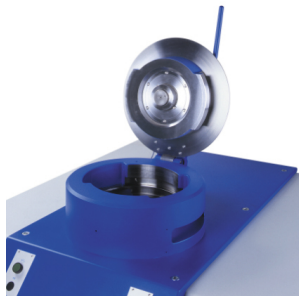


Fig. 1

### Accessories (Options)

#### Hot Drawing Equipment up to 550 °C

A further valuable addition to the possibilities offered by Model 146 is provided by the additional hot drawing equipment (*Fig.2*). In this, the blankholder and drawing die are heated in an insulated container and special provision is made to enable these then to be set up without difficulty on the machine. An electronic temperature measuring device is incorporated, and on this the preset intended temperature and the current measure temperature are displayed. The preset temperature can be set up to 550 °C, and in the test, the temperature remains constant within  $\pm 1$  °C.

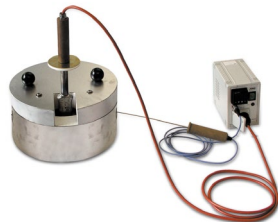


Fig. 2

#### Hot Drawing Equipment up to 700 °C

To determine also Forming Limited Diagrams at higher temperatures, the temperature accessory for Mod. 146 is the appropriate solution.

Tests according Nakajima- and Marciniak can be performed in order to evaluate FLC / FLD. This accessory will be assembled directly into the test cylinder. Hereby, the complete tool is heated to the desired temperature together with the test specimen, and then the deformation will be performed.

By using a cooling connection the jacket of the device can be cooled, thus the thermal load on the environment is minimized. The corresponding electronic control units are placed in a separate cabinet. The opening in the test head of the hot-drawing device is manufactured, that optical 3D measurement systems can document and evaluate the deforming process.



Fig. 3  
Hot Drawing Equipment

#### HEXRASCAN I / II

Camera with traversing bar and lighting, for rupture detection according to ISO 16630 'hole expansion test' (HEXRASCAN I) or for strain measurement on flat sheet metal specimen (e.g. PV 1054) (HEXRASCAN II).

An appropriate recording and analysis software is included.

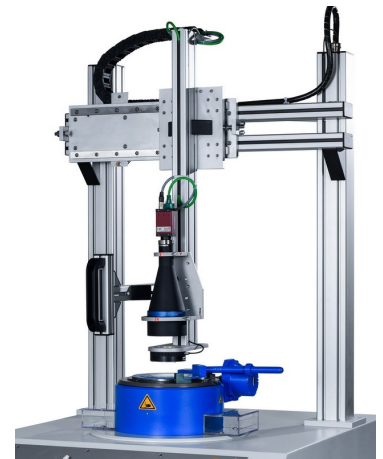


Fig. 4 – HEXRASCAN I

#### Special Applications

This Sheet Metal Testing Machine can be customized and extended to accommodate special requirements (*Fig. 5*), e.g. determination of forming limit curves (FLC) using a 3D.

Generally the sheet metal testing machine will be equipped with proportional technology and difference pressure measuring. As option it is possible to select a PC controls/regulation with software.



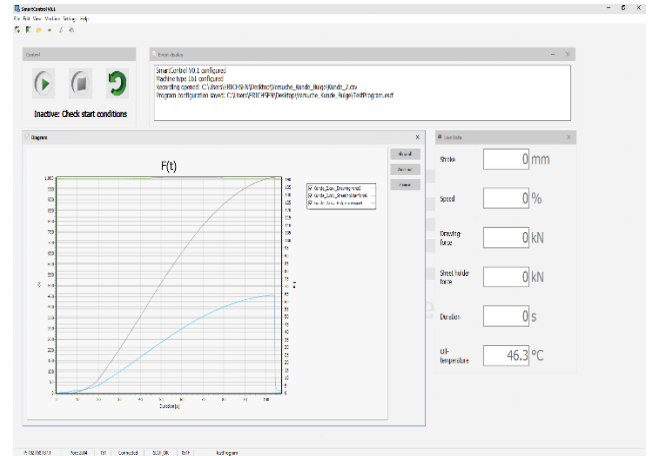
Fig. 5

## Universal User Software SmartControl with PC

The software enables the control, adjustment, documentation and filing of measuring data of the testing machine. Software for recording of force-displacement diagrams such as drawing force and blank holder force, stroke. Creation of scripts (test sequences); presetting of freely selectable parameters such as drawing and blank holder force as well as drawing speed. Via SPS drawing force, blank holder force and stroke are acquired. The connection is made by an Ethernet connection. This programme enables to create and evaluate test sequences for tests e.g. Erichsen deep-drawing cup test, bore expanding test, bulge test, Erichsen deep drawing test (only in connection with the proportional valve technique).

The software included in the scope of supply runs under WIN 10.

The scope of supply includes PC and VDU.



The Universal Sheet Metal Testing Machines, Models 146, together with the wide range of accessories can be comprehensively adapted to individual requirements. Since due to the tremendous number of different applications our price lists cannot take all conceivable tools and accessories into account, please contact us if you have any special requirements. This will enable us to draw up a quotation according to your specific needs.

## Technical Data

Drawing force	146-60	600 kN
	146-100	1000 kN
Blanking force	146-60	700 kN
	146-100	1000 kN
Blankholder force, max.	146-60	2 up to 100 kN and 10 up to 600 kN
	146-100	5 up to 250 kN and 20 up to 1000 kN
Drawing punch stroke		approx. 150 mm
Blankholder stroke		approx. 38 mm
Ejector stroke		approx. 150 mm
Drawing punch dia.		up to 100 mm
Blank dia.		up to 220 mm
FLC test (drawing punch dia.)		up to 100 mm
Bulge test (bulge dia.)		up to 100 mm
Drawing speed		up to 3000 mm/min
<u>Digital indicators:</u>		<u>Resolution:</u>
Drawing punch stroke		0.1 mm (on request 0.01 mm)
Drawing force		0.1 kN
Blankholder force		0.1 kN
Mains supply		400 V / 3~, 50/60 Hz (Other voltages upon request)
Power required	146-60	55 kW
	146-100	80 kW
Dimensions (W x D x H) / Weight (net)	146-60	approx. 2400 x 1540 x 1500 mm / approx. 3100 kg
	146-100	approx. 3000 x 1500 x 1880 mm / approx.. 7000 kg

**Selection table for drawing dies B1/C2  
(#01370132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)  
Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,076	28	0,85
2	0,100	29	0,90
3	0,127	30	0,95
4	0,13	31	1,00
5	0,14	32	1,10
6	0,15	33	1,15
7	0,18	34	1,20
8	0,20	35	1,25
9	0,21	36	1,30
10	0,23	37	1,40
11	0,24	38	1,50
12	0,25	39	1,60
13	0,26	40	1,70
14	0,27	41	1,80
15	0,28	42	1,90
16	0,30	43	2,00
17	0,32	44	2,10
18	0,35	45	2,20
19	0,40	46	2,30
20	0,45	47	2,40
21	0,50	48	2,50
22	0,55	49	2,60
23	0,60	50	2,65
24	0,65	51	2,70
25	0,70	52	2,8
26	0,75	53	2,9
27	0,80	54	3,0

**Selection table for drawing dies B1/C2  
(#01370132)**

valid for **aluminium and aluminium alloy**  
Norm: DIN EN 1669

valid for Clearance ratio <b>1,15 bis 1,52</b>		valid for Clearance ratio <b>1,34 bis 1,76</b>	
1	0,095 < s ≤ 0,120	1	0,080 < s ≤ 0,100
2	0,121 < s ≤ 0,150	2	0,101 < s ≤ 0,125
3	0,151 < s ≤ 0,185	3	0,126 < s ≤ 0,157
4	0,186 < s ≤ 0,235	4	0,158 < s ≤ 0,195
5	0,236 < s ≤ 0,280	5	0,196 < s ≤ 0,240
6	0,281 < s ≤ 0,345	6	0,241 < s ≤ 0,290
7	0,346 < s ≤ 0,435	7	0,291 < s ≤ 0,360
8	0,436 < s ≤ 0,535	8	0,361 < s ≤ 0,450
9	0,536 < s ≤ 0,665	9	0,451 < s ≤ 0,555
10	0,666 < s ≤ 0,800	10	0,556 < s ≤ 0,670
11	0,801 < s ≤ 0,940	11	0,671 < s ≤ 0,800
12	0,941 < s ≤ 1,130	12	0,801 < s ≤ 0,965
13	1,131 < s ≤ 1,450	13	0,966 < s ≤ 1,250
14	1,451 < s ≤ 1,900	14	1,251 < s ≤ 1,600
15	1,901 < s ≤ 2,350	15	1,601 < s ≤ 2,000
16	2,351 < s ≤ 2,900	16	2,001 < s ≤ 2,400
17	2,901 < s ≤ 3,500	17	2,401 < s ≤ 3,000

**Selection table for drawing dies B1/C2  
(#01370132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)  
Norm: ISO 11531

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,1 < s ≤ 0,2	4	0,8 < s ≤ 1,6
2	0,2 < s ≤ 0,4	5	1,6 < s ≤ 3,0
3	0,4 < s ≤ 0,8		

**Selection table for drawing dies B2/C3  
(#01430132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)

Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,076	43	2,00
2	0,100	44	2,10
3	0,127	45	2,20
4	0,13	46	2,30
5	0,14	47	2,40
6	0,15	48	2,50
7	0,18	49	2,60
8	0,20	50	2,65
9	0,21	51	2,70
10	0,23	52	2,8
11	0,24	53	2,9
12	0,25	54	3,0
13	0,26	55	3,1
14	0,27	56	3,2
15	0,28	57	3,3
16	0,30	58	3,4
17	0,32	59	3,5
18	0,35	60	3,6
19	0,40	61	3,7
20	0,45	62	3,8
21	0,50	63	3,9
22	0,55	64	4,0
23	0,60	65	4,1
24	0,65	66	4,2
25	0,70	67	4,3
26	0,75	68	4,4
27	0,80	69	4,5
28	0,85	70	4,6
29	0,90	71	4,7
30	0,95	72	4,8
31	1,00	73	4,9
32	1,10	74	5,0
33	1,15	75	5,1
34	1,20	76	5,2
35	1,25	77	5,3
36	1,30	78	5,4
37	1,40	79	5,5
38	1,50	80	5,6
39	1,60	81	5,7
40	1,70	82	5,8
41	1,80	83	5,9
42	1,90	84	6,0

**Selection table for drawing dies B2/C3  
(#01430132)**

valid for **aluminium and aluminium alloy**  
Norm: DIN EN 1669

gültig für Clearance ratio <b>1,15 bis 1,52</b>		gültig für Clearance ratio <b>1,34 bis 1,76</b>	
1	3,501 < s ≤ 4,100	1	3,001 < s ≤ 3,500
2	4,101 < s ≤ 5,000	2	3,501 < s ≤ 4,400
3	5,001 < s ≤ 6,000	3	4,401 < s ≤ 5,300

**Selection table for drawing dies B2/C3  
(##01430132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)

Norm: ISO 11531

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,1 < s ≤ 0,2	4	0,8 < s ≤ 1,6
2	0,2 < s ≤ 0,4	5	1,6 < s ≤ 3,0
3	0,4 < s ≤ 0,8		

**Selection table for drawing dies B3/C4  
(#01480132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)  
Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,076	31	1,00
2	0,100	32	1,10
3	0,127	33	1,15
4	0,13	34	1,20
5	0,14	35	1,25
6	0,15	36	1,30
7	0,18	37	1,40
8	0,20	38	1,50
9	0,21	39	1,60
10	0,23	40	1,70
11	0,24	41	1,80
12	0,25	42	1,90
13	0,26	43	2,00
14	0,27	44	2,10
15	0,28	45	2,20
16	0,30	46	2,30
17	0,32	47	2,40
18	0,35	48	2,50
19	0,40	49	2,60
20	0,45	50	2,65
21	0,50	51	2,70
22	0,55	52	2,8
23	0,60	53	2,9
24	0,65	54	3,0
25	0,70	55	3,1
26	0,75	56	3,2
27	0,80	57	3,3
28	0,85	58	3,4
29	0,90	59	3,5
30	0,95		

**Selection table for drawing dies B4  
(#03980132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)  
Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,20	16	1,70
2	0,30	17	1,80
3	0,40	18	1,90
4	0,50	19	2,00
5	0,60	20	2,10
6	0,70	21	2,20
7	0,80	22	2,30
8	0,90	23	2,40
9	1,00	24	2,50
10	1,10	25	2,60
11	1,20	26	2,70
12	1,30	27	2,80
13	1,40	28	2,90
14	1,50	29	3,00
15	1,60		

**Selection table for drawing dies C1  
(#01410132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)

Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,076	43	2,00
2	0,100	44	2,10
3	0,127	45	2,20
4	0,13	46	2,30
5	0,14	47	2,40
6	0,15	48	2,50
7	0,18	49	2,60
8	0,20	50	2,65
9	0,21	51	2,70
10	0,23	52	2,8
11	0,24	53	2,9
12	0,25	54	3,0
13	0,26	55	3,1
14	0,27	56	3,2
15	0,28	57	3,3
16	0,30	58	3,4
17	0,32	59	3,5
18	0,35	60	3,6
19	0,40	61	3,7
20	0,45	62	3,8
21	0,50	63	3,9
22	0,55	64	4,0
23	0,60	65	4,1
24	0,65	66	4,2
25	0,70	67	4,3
26	0,75	68	4,4
27	0,80	69	4,5
28	0,85	70	4,6
29	0,90	71	4,7
30	0,95	72	4,8
31	1,00	73	4,9
32	1,10	74	5,0
33	1,15	75	5,1
34	1,20	76	5,2
35	1,25	77	5,3
36	1,30	78	5,4
37	1,40	79	5,5
38	1,50	80	5,6
39	1,60	81	5,7
40	1,70	82	5,8
41	1,80	83	5,9
42	1,90	84	6,0

**Selection table for blanking die ring  
(#08690132)**

valid for **ferrous and non-ferrous** material  
Norm: ISO 16630

Var.	Thickness s / mm	Var.	Thickness s / mm
1	$1,2 \leq s < 1,5$	7	$3,6 \leq s < 4,0$
2	$1,5 \leq s < 1,9$	8	$4,0 \leq s < 4,4$
3	$1,9 \leq s < 2,3$	9	$4,4 \leq s < 4,8$
4	$2,3 \leq s < 2,7$	10	$4,8 \leq s < 5,2$
5	$2,7 \leq s < 3,1$	11	$5,2 \leq s < 5,7$
6	$3,1 \leq s < 3,6$	12	$5,7 \leq s < 6,0$

**Selection table for drawing dies for square  
cups 40x40 (#01530132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)

Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,10	20	0,85
2	0,15	21	0,90
3	0,20	22	0,95
4	0,22	23	1,00
5	0,23	24	1,10
6	0,24	25	1,20
7	0,25	26	1,25
8	0,26	27	1,30
9	0,30	28	1,40
10	0,35	29	1,50
11	0,40	30	1,60
12	0,45	31	1,70
13	0,50	32	1,80
14	0,55	33	1,90
15	0,60	34	2,00
16	0,65	35	2,30
17	0,70	36	2,50
18	0,75	37	2,60
19	0,80	38	3,00

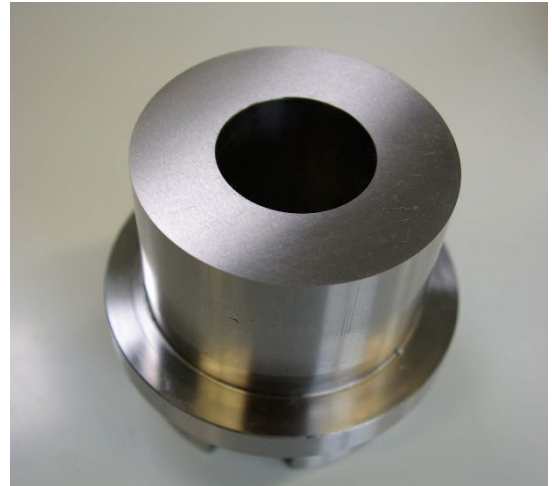


**Selection table for square cups 70x70  
(#03880132)**

valid for **ferrous and non-ferrous** material  
(material type necessary for order)  
Norm: ERICHSEN

Var.	Thickness s / mm	Var.	Thickness s / mm
1	0,10	23	1,00
2	0,15	24	1,10
3	0,20	25	1,20
4	0,22	26	1,25
5	0,23	27	1,30
6	0,24	28	1,40
7	0,25	29	1,50
8	0,26	30	1,60
9	0,30	31	1,70
10	0,35	32	1,80
11	0,40	33	1,90
12	0,45	34	2,00
13	0,50	35	2,30
14	0,55	36	2,50
15	0,60	37	2,60
16	0,65	38	3,00
17	0,70	39	3,50
18	0,75	40	4,00
19	0,80	41	4,50
20	0,85	42	5,00
21	0,90	43	5,50
22	0,95	44	6,00

## Selection table for blanking tools



### **Blanking tool for deep-drawing cups blank cut with punch dia 33 mm (B1):**

- consists of blanking die ring (# 01380132) and blanking punch (01390132)

for ferrous material:

- 55 – 80 mm
- 64 mm recommended
- ISO 11531 approx. 60 mm

for non-ferrous material:

- DIN EN 1669 / 60 or 64 mm

Punching areas for sheet thicknesses of ferrous materials:

- 0,2 – 1,0 mm
- 1,1 – 2,5 mm

Punching areas for sheet thicknesses of non-ferrous materials:

- 0,1 – 0,59 mm
- 0,6 – 1,69 mm
- 1,7 – 3,0 mm

### **Blanking tool for deep-drawing cups blank cut with punch dia 50 mm (B2):**

- consists of blanking die ring (# 01440132) and blanking punch (01450132)

for ferrous material:

- 81 - 120 mm
- 90 mm recommended
- Square cups 40 x 40 approx. 85 mm (blanking punch # 04190132)

Punching areas for sheet thicknesses of ferrous materials:

- 0,2 – 1,0 mm
- 1,1 – 2,0 mm
- 2,1 – 4,0 mm
- 4,1 – 6,0 mm

Punching areas for sheet thicknesses of non-ferrous materials:

- 0,1 – 0,59 mm
- 0,6 – 1,69 mm
- 1,7 – 3,0 mm

### **Blanking tool for deep-drawing cups blank cut with punch dia 75 mm (B3):**

- consists of blanking die ring (# 01490132) and blanking punch (01500132)

for ferrous material:

- 121 - 170 mm
- 90 mm recommended
- Square cups 40 x 40 approx. 85 mm (blanking punch # 04190132)

Punching areas for sheet thicknesses of ferrous materials:

- 0,2 – 1,0 mm
- 1,1 – 2,0 mm
- 2,1 – 4,0 mm
- 4,1 – 6,0 mm

Punching areas for sheet thicknesses of non-ferrous materials:

- 0,1 – 0,59 mm
- 0,6 – 1,69 mm
- 1,7 – 3,0 mm

### **Blanking tool for deep-drawing cups blank cut with punch dia 100 mm (B4):**

- consists of blanking die ring (# 01490132) and blanking punch (01500132)

for ferrous material:

- 175 - 220 mm
- 180 mm recommended
- Square cups 70 x 70 approx. 130 mm (blanking punch # 04200132)

Punching areas for sheet thicknesses of ferrous materials:

- 0,2 – 1,0 mm
- 1,1 – 2,0 mm
- 2,1 – 4,0 mm
- 4,1 – 6,0 mm

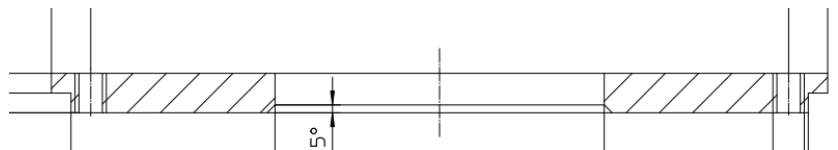
Punching areas for sheet thicknesses of non-ferrous materials:

- 0,1 – 0,59 mm
- 0,6 – 1,69 mm
- 1,7 – 3,0 mm

### **Wiper rings**

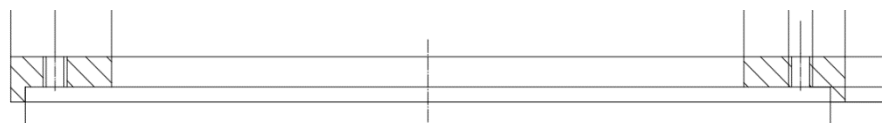
**Wiper ring (# 30730032)** for a specific punching area:

- Ø 55-67mm
- Ø 67-80mm
- Ø 80-100mm
- Ø 100-120mm
- Ø 120-130mm
- Ø 130-140mm
- Ø 140-150mm
- Ø 150-160mm
- Ø 160-170mm



**Wiper ring (# 30740032)** for a specific punching area:

- Ø 171-180mm
- Ø 181-190mm
- Ø 191-200mm
- Ø 201-210mm



***Further Universal Sheet Metal Testing Machines supplied by ERICHSEN:***

**Electro-hydraulically driven Sheet Metal Testing Machine with Automatic Controls – Model 134**  
(drawing force 120 kN)



**Universal Sheet Metal Testing Machine with Automatic Test Sequence - Model 142-Basic**  
(drawing force 200 kN or 400 kN) – *compact design*



**Universal Sheet Metal Testing Machine with Automatic Test Sequence - Model 142**  
(drawing force 200 kN or 400 kN)



**Universal Sheet Metal Testing Machine with Automatic Test Sequence - Model 145-60-Basic**  
(drawing force 600 kN) – *compact design*



**Universal Sheet Metal Testing Machine for Research and Development - Model 146**  
(drawing force 600 kN or 1000 kN)