



EXCELLENCE IN  
ENGINEERED ALLOYS



# TUBE BENDING & END FORMING TOOLING

Flexible Ball Mandrels  
Wiper Dies & Inserts  
End Forming Tools  
Links  
Calibration Balls

[www.ampcometal.com](http://www.ampcometal.com)



The bending tooling includes wiper dies, single and double profile wiper insert, ball mandrel, cable mandrel, end forming punches, and mandrel link set.

For tube bending of stainless steel and titanium material of exhaust pipes, AMPCO® 18, AMPCO® 21, and AMPCO® M4 are used with great product benefits for product quality and long life of the production tooling.

### AMPCO® Aluminum Bronze Advantages:

- ◆ Speed up tool manufacturing
- ◆ Improved sliding properties
- ◆ Increase in product quality
- ◆ Minimum Friction
- ◆ No seizing or scratching
- ◆ Reduced cost/bend
- ◆ Reduced production costs

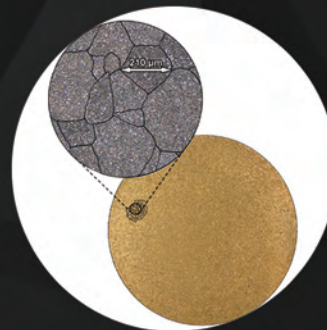


# microcast®

AMPCO METAL's patented MICROCAST® manufacturing process for continuous cast rod, rectangle and tube provide the following benefits:

- ◆ Fine and most uniform grain size available vs standard products
- ◆ Exhibit stable properties over a wide range of working temperatures, like their wrought equivalents
- ◆ High specific strength, allowing components to be fabricated in smaller dimensions, saving component weight
- ◆ High tensile and fatigue strength available in non-galling bearing and bushing material
- ◆ Outstanding wear resistance when properly lubricated

### AMPCO® Alloys



### Competitors Alloys



The above are nominal values. If specific minimum figures are required, please contact your local AMPCO METAL representative.

Alloy	Hardness Brinell (HBW) (Rockwell B/C)	Tensile Strength Mpa (KSI)	Yield Strength Mpa (ksi)	Elongation	Thermal conductivity W/mK (BTU/ft·hr F)	Coefficient of friction Unlubricated
AMPCO® 18	192 (92B)	725 (105)	365	14	63 (37)	0.18
AMPCO® 18.23	207 (95B)	758 (110)	386	16	63 (37)	0.18
AMPCO® 21	286 (29C)	758 (110)	420	1	46 (27)	0.21
AMPCO® 22	332 (35C)	724 (105)	427	0.5	42 (24)	0.25
AMPCO® 25	364 (38C)	R <sub>mc</sub> 1580	R <sub>pc</sub> 710	0.2	33 (19)	0.30
AMPCO® M4	260/300 (HBW)	1000 (145)	793 (115)	8	42 (24)	0.23

## CAPABILITIES

Our worldwide distribution network enables us to fulfill finished machined parts requirements for various applications in North America, South America, Europe, and Asia while meeting time-sensitive requirements from our customers.

Leverage our finished machined parts expertise for your applications, we provide:

- ◆ A One-Stop-Shop solution for all your finished machined needs
- ◆ Production of parts to your specification and blueprints
- ◆ From very small parts to large parts
- ◆ Expert in finishing hard bronzes

We have the knowledge, expertise, and a wide range of machining equipment for your projects, including conventional machines to 5-axis CNC machinery for high-precision parts and automatization robots for bigger lots.

## INSPECTION & QUALITY CONTROL

At AMPCO METAL, our expert engineers are committed to providing the best metal solution that performs exceptionally, exceeding our customers' requirements and improving overall quality. This is the result of quality measurement and constant improvement of production processes.

All our materials are subjected to rigorous physical testing, including tensile, yield strength, conductivity, elongations, and hardness.

All our materials are identified at all stages of the production process and are thoroughly analyzed and checked before delivery.

All material produced can be supplied with full verification in accordance to specifications, whether chemical, mechanical, or physical.



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# BEND DIE SET

Rotary draw bending is the most popular form of tube bending used in industries like aerospace, automobile, furniture etc.

Rotary draw bending can create precision bends in a repeatable process with the use of precision tooling die set.

**Bending Die** - A bending die is a tool that allows tubes to be bent around it. It defines the radius for the bend component and is generally hardened tool steel

**Clamp Die** - It is hardened tool steel used for holding the tube against the Bending Die under pressure applied by the bending machine throughout the bending. Tube grooves can be roughened by the serrations, grit blasted, or carbide impregnation. Cavity textures are good when DBB is shorter than the ideal length of the clamp die but significantly shorter than the ideal length compound cavity needed.

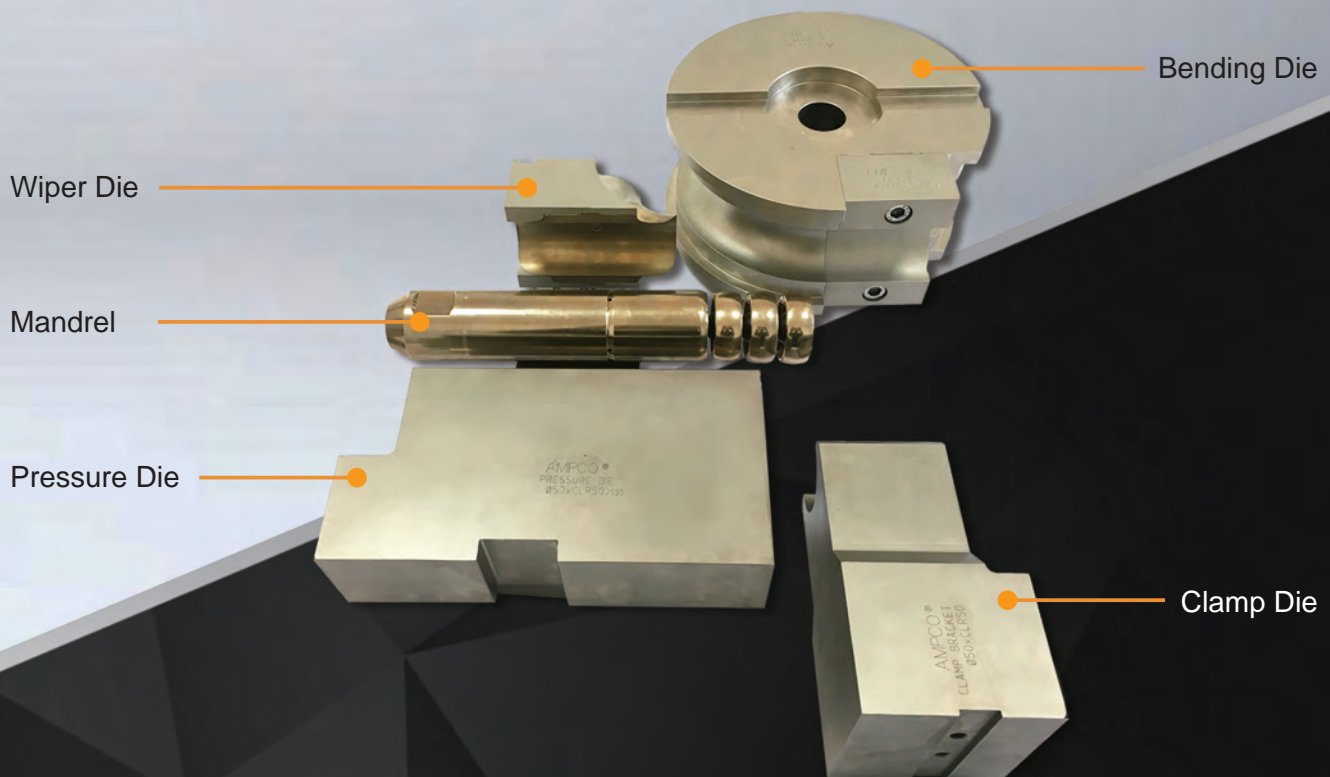
**Pressure Die** - It is hardened tool steel; the tube groove has a smooth finish to avoid drafting marks on the tube. The length of the pressure die depends on the CLR and bend angle. It holds the tube against the bend die under pressure applied by the bending machine at the tangency line.

**Wiper Die** - It is required to avoid wrinkles on the tube. It's an additional support for the tube fitted opposite to the pressure die.

There are 2 types of wipers

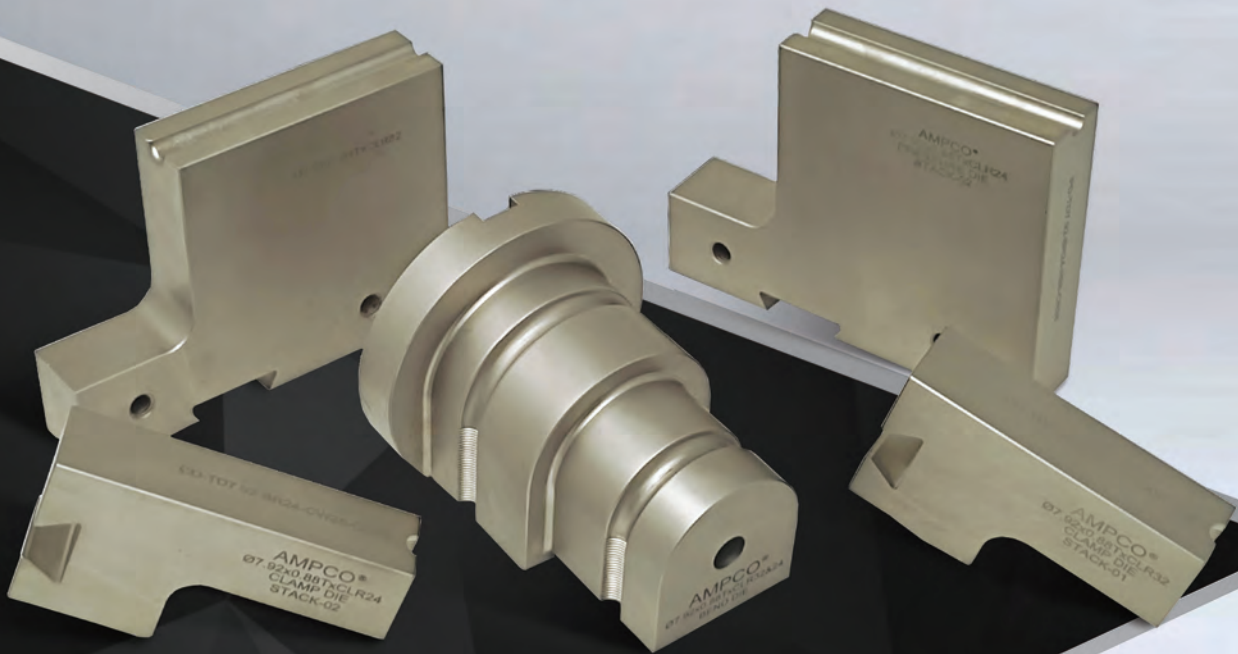
- ◆ Square back
- ◆ Insert type

**Mandrel** - The Mandrel is the tool used in the rotary draw tube bending process which supports the tube from the inside while the bending operations as it forms and works to prevent drastically reducing flattening, deformation, and wrinkling in the tube while the bending process.





## OVAL BEND TOOL SET



## MULTI STACK BEND TOOL SET

For tube bending of stainless steel and titanium exhaust pipes, AMPCO® 18, AMPCO® 18.23, and AMPCO® M4 are used with great benefits for product quality and long-life of the production tooling.

### Advantages of AMPCO® 18 mandrels

- ◆ Perfect product finish for exhaust pipes made from Aluminized steel
- ◆ Extended life of the tooling
- ◆ Cost savings due to minimal downtime for maintenance

### Advantages of AMPCO® M4 mandrels

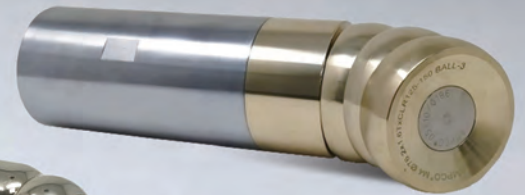
- ◆ Extended life, lasts up to 20 times longer
- ◆ Perfect Stainless-steel tube
- ◆ No hardening or expensive coatings required



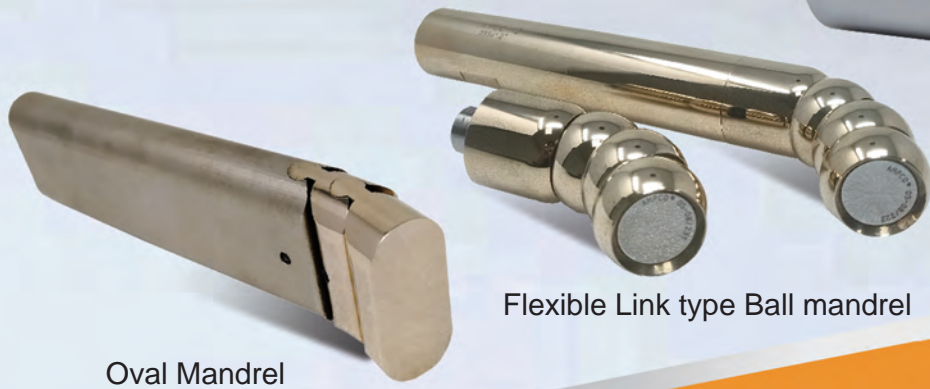
Rectangular Mandrel - Pin Type



Square Mandrel - Link & Pin type



Ball mandrel - Link Type



Flexible Link type Ball mandrel

Oval Mandrel



## WIPER DIES AND INSERTS

For tube bending of stainless steel and titanium exhaust pipes, AMPCO® 18, AMPCO® 18.23, and AMPCO® M4 are used with great benefits for product quality and the long life of the production tools.

### Advantages of wiper dies made of AMPCO® alloys

- ◆ Perfect exhaust pipes of out aluminized steel
- ◆ Extended life of the tools
- ◆ Cost savings with minimal maintenance downtime
- ◆ Extended life, lasts up to 20 times longer
- ◆ Perfect finish for stainless steel tubes
- ◆ No galling, no scratching, and no corrosion starting point



# END FORMING & CALIBRATION BALLS



This type of end forming tooling supports material forming from both sides to deliver tighter roundness tolerances for joining or welding.



Without AMPCO®



With AMPCO®

End-forming tools are used for flaring, beading, large expansions, or reductions using multi ram tooling to gradually move the material to prevent stresses that could crack or break material.

- ◆ Provides a high-quality surface finish
- ◆ Form symmetrical and non-symmetrical shapes
- ◆ Provides better roundness
- ◆ Specifically designed for angle requirements

## LINKS

The whole family of link sizes has a uniform pitch length. A uniform pitch length ensures the strength and integrity of the link design which remains proportional to tube size.

The material is a high-quality tool steel that boasts a higher tensile and yield strength.

Tips:

To minimize ovality loss, add a link  
To reduce slippage, take a link out



### Product overview - Flexible mandrel

#### Connectors for Flexible mandrel

No.	Tube	Mandrel Link	Screw head M	Split Link	End Link
4	15.8 - 18.9		4		
5	19.0 - 23.9		5		
6	24.0 - 28.4		8		
7	28.5 - 37.5		8		
8	38.0 - 43.5		10		
9	44.0 - 53.0		10		
10	53.5 - 66.0		12		
11	6.5 - 85.0		12		
12	85.5 - 117.0		16		



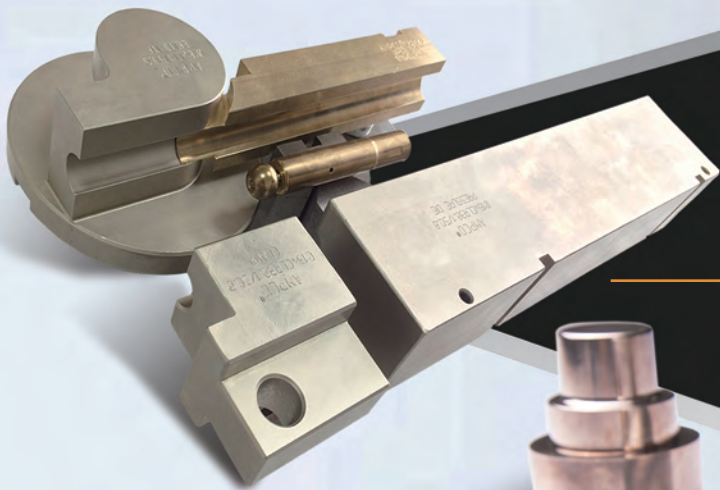
# Design System Flexible Mandrel

## TECHNICAL SPECIFICATIONS

D of Bend = Center Line Radius / Tube Outside Diameter

D of Bend Wall Factor	1 D	1.25 D	1.5 D	1.75 D	2 D	2.25 D	2.5 D	2.75 D	3 D	3.5 D	4 D
	10										
15	1W	1W	1W	1W	1	1	1	1			
20	2W	2W	1W	1W	1W	1	1	1	1	1	1
25	3W	3W	2W	2W	2W	2W	1W	1W	1W	1W	1W
30	3W	3W	3W	3W	2W	2W	2W	2W	2W	2W	2W
35	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W	3W
40	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W	3W
45	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W	3W
50	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W	3W
55	4W	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W
60	4W	4W	3W	3W	3W	3W	3W	3W	3W	3W	3W
65	5W	5W	5W	5W	5W	3W	3W	3W	3W	3W	3W
70	5W	5W	5W	5W	5W	5W	5W	3W	3W	3W	3W
80	5W	5W	5W	5W	5W	5W	5W	3W	3W	3W	3W
90	5W	5W	5W	5W	5W	5W	5W	5W	5W	5W	5W
100	5W	5W	5W	5W	5W	5W	5W	5W	5W	5W	5W
125	6W	6W	6W	6W	6W	6W	5W	5W	5W	5W	5W
150	6W	6W	6W	6W	6W	6W	5W	5W	5W	5W	5W
175	8W	8W	8W	8W	7W	7W	7W	7W	6W	6W	6W
200	10W	10W	10W	10W	10W	10W	9W	9W	9W	9W	9W
225		10W	10W	10W	10W	10W	10W	10W	10W	10W	10W

Plug Mandrel    Regular Pitch    Close Pitch    Ultra Close Pitch    W = Wiper Dies Needed



## BEND DIE SET



## CALIBRATION BALLS



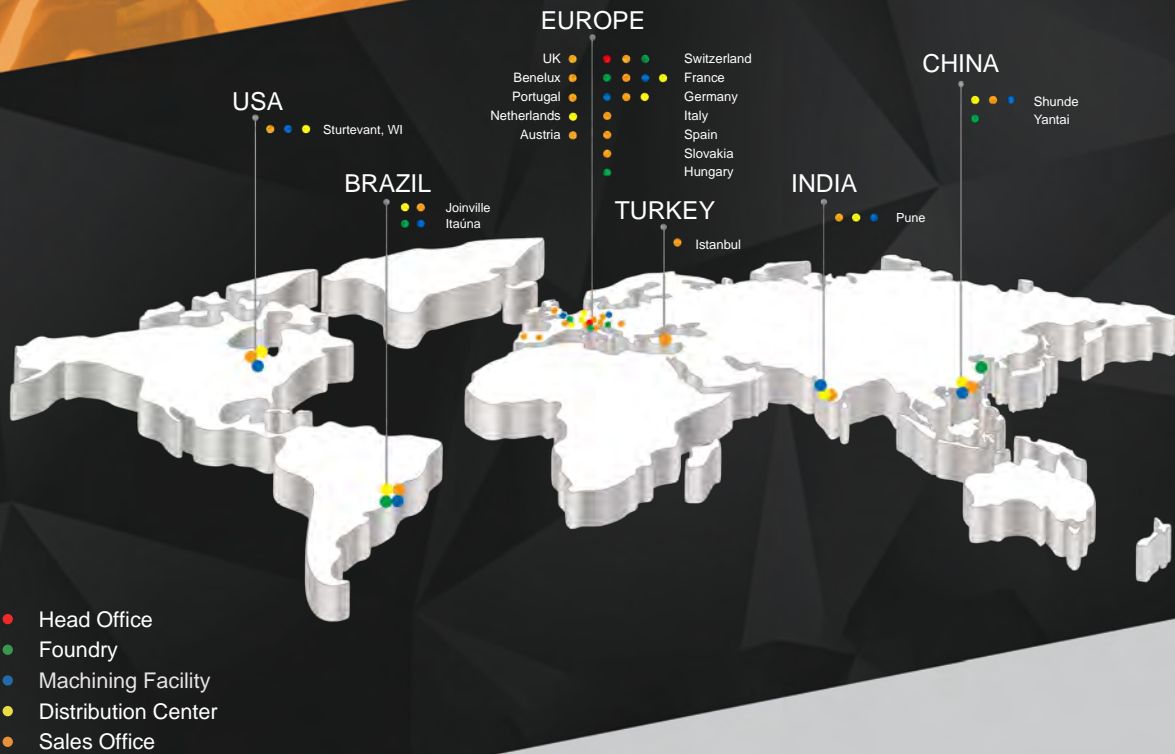
## WIPER DIES

## MANDRELS





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