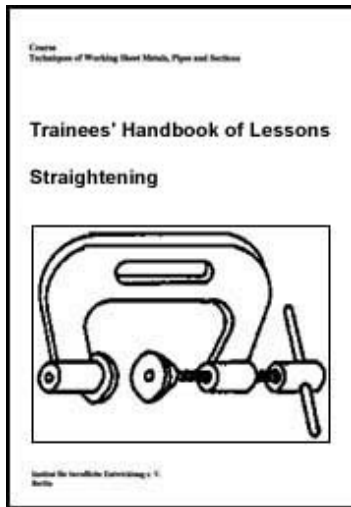


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**Institut fr berufliche Entwicklung e.V.
Berlin**

Original title:

**Arbeitsmaterial fr den Lernenden
"Richten"**

Author: B. Zierenberg

First edition © IBE

**Institut fr berufliche Entwicklung e.V.
Parkstrae 23
13187 Berlin**

Order No.: 90-35-3115/2



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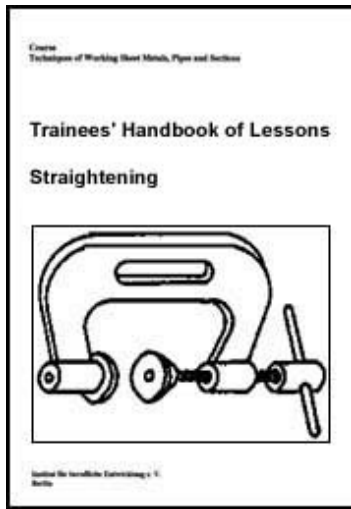
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Preliminary Remarks

This material is meant for vocational training in jobs where basic skills in the processing of metal sheets, pipes and sections are required.

The Handbook describes various techniques for straightening bendings, bucklings, distortions, dents and corrugations in metal sheets, pipes and sections.



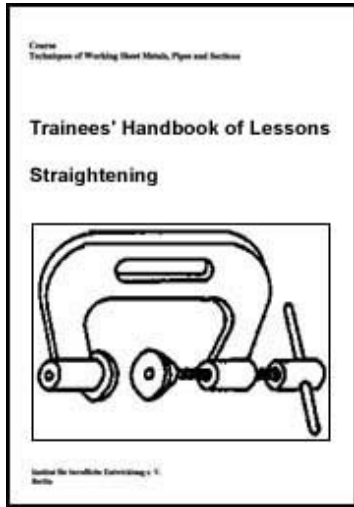
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Hints on Labour Safety

Generally, the same labour safe regulations apply to the straightening techniques as to the techniques of hammering and bending.

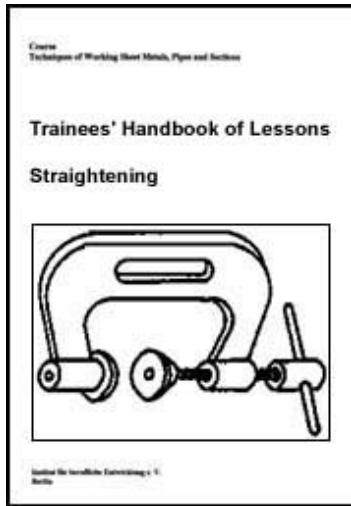
Special attention has to be paid to the following points:

- Do only use hammers that are provided with tightly fitting handles - the handle of the hammer must be firmly wedged with the hammer head.
- Choose the right support for hammering - a hard and rigid support is required.
- Workpieces that have to be clamped must be clamped firmly in the clamping devices, so that the hammer blows cannot tear them away.
- When working with presses make sure that your hands and head are protected.
- Working with welding torches is allowed only after previous instructions given by the instructor.

- Always pay attention to fire protection - place water ready for fire fighting; do not work near inflammable materials.



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1. Purpose of Straightening

Metal sheets, pipes or sections, which had been twisted, bent or deformed during transport or working may be given back their original form by means of various techniques.

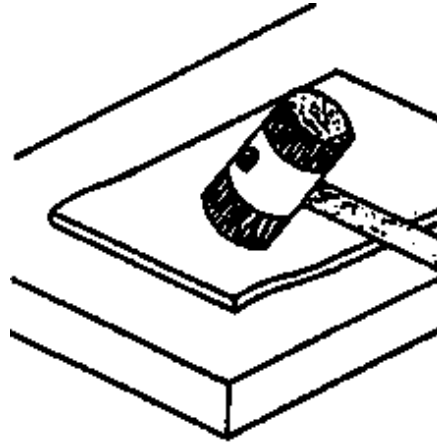
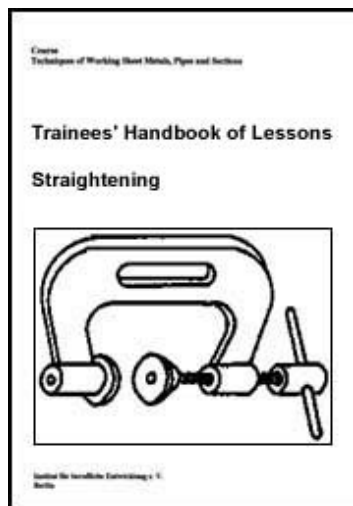


Figure 1 Straightening of metal sheets

The mainly used techniques are hammering and bending for deformation work and local heating up for eliminating tension in materials.



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2. Tools, Devices and Auxiliary Means

Small cross sections of metal sheets, pipes and sections are straightened gently by hand. For bigger and stronger materials the following tools and devices are used:

Hammers

Locksmith's hammers, straightening hammers, light metal hammers, mallets and rubber hammers are used for straightening work in a vice, on an anvil and on a straightening plate.

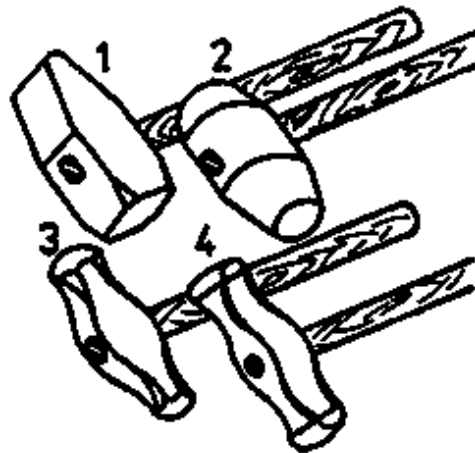


Figure 2 Hammers 1 locksmith's hammer, 2 straightening hammer, 3 light metal hammer, 4 mallet

Moving iron and tap wrench

Various moving irons and tap wrenches are used for straightening twisted flat sections, square and angle sections in the vice.

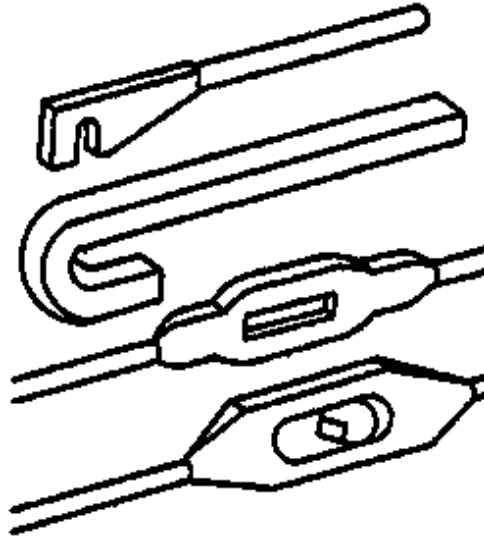


Figure 3 Moving iron and tap wrench

Tongs

Round tongs and flat tongs are used for straightening small bent metal sheets and small sections in the vice or freely by hand.

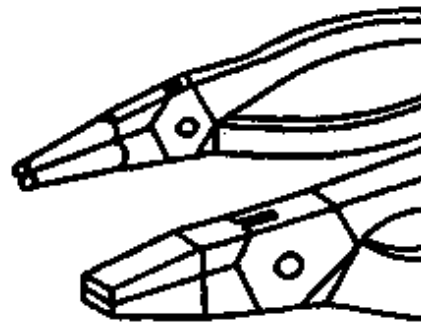


Figure 4 Round tongs and fiat tongs

Clamps

Clamps of various kinds and sizes are used for clamping and twisting distorted metal

sheets and sections.

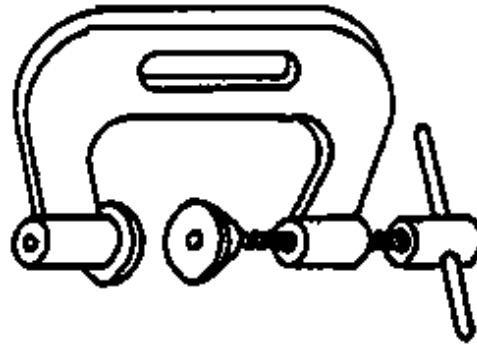


Figure 5 Clamp

Welding torches

Oxy-acetylene welding torches or blacksmith's fire and annealing furnaces are used for the local heating up of bent profiles and dented metal sheets.



Figure 6 Welding torch

Screw presses

Hand screw presses and hydraulic presses with various inserts and supports are used for straightening bent sections and smaller dented metal sheets.

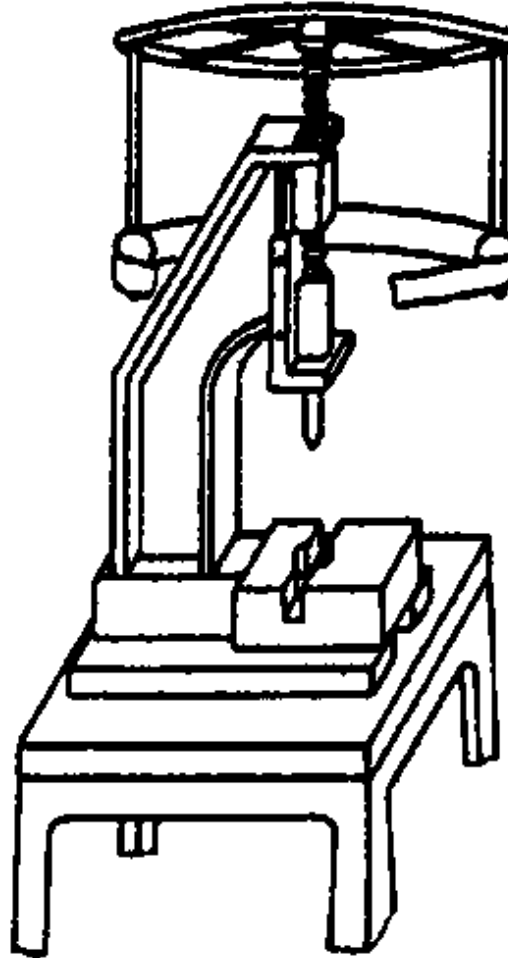


Figure 7 Screw press

Straightening machines

Used are mainly roller straightening machines, on which bent metal sheets, flat materials, pipes and wires are led over a system of rollers, so that they become plane or straight

In addition to the above mentioned tools and devices, the following clamping devices and supports are required.

Vice

Used is mainly the parallel vice for straightening work with hammers, moving irons and tap wrenches or tongs as well as for straightening work without tools.

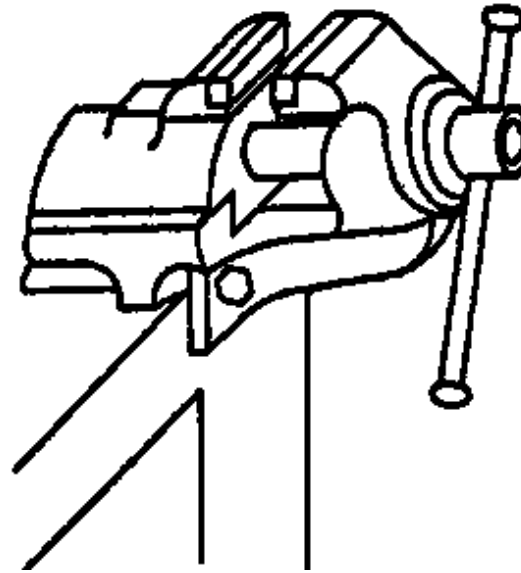


Figure 8 Vice

Anvil

Used are the face, round beak and flat beak of the anvil as supports for straightening work with the locksmith's hammer.

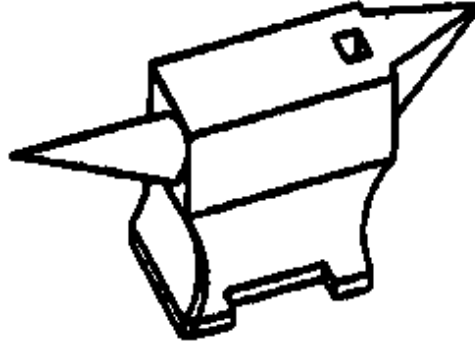


Figure 9 Anvil

Straightening plates Used are straightening plates from cast steel as supports for straightening work with hammers.

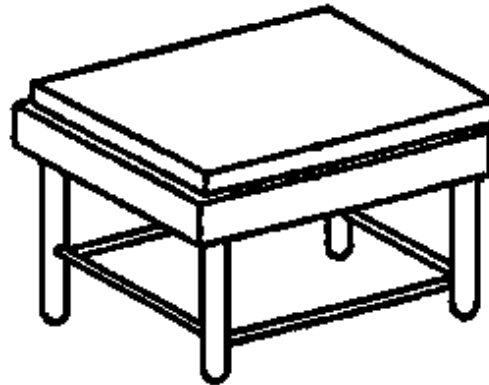


Figure 10 Straightening plate

What is the purpose of straightening?

What are the mainly used techniques for straightening?

What hammers can be used for straightening steel sheets?

What hammers can be used for straightening aluminium sheets?

For what kind of straightening work are moving irons used?

For what kind of straightening work can the hand screw press be used?

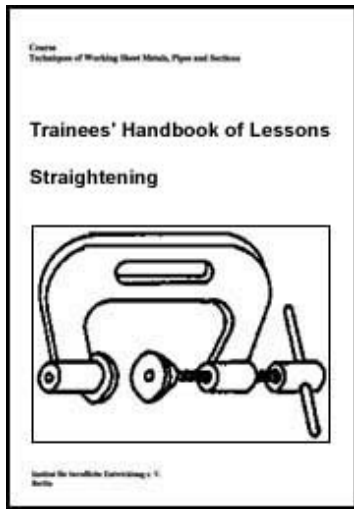


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3. Processes within the Material

At distorted, bent or deformed metal sheets, pipes and sections axial elongations and linear compressions are to be noticed in the material:

At the external radii of bendings, tensile stresses are caused by axial elongation of the material, at the internal radii of bendings, compressive stresses are caused by linear compression of the material.

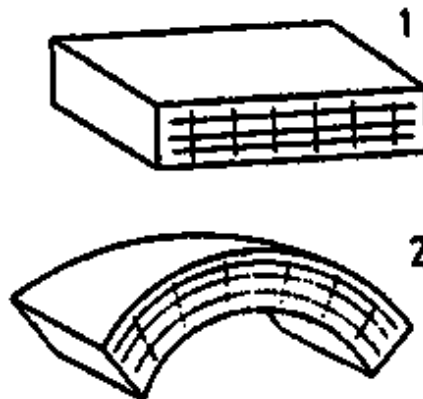


Figure 11 Axial elongation and compression when bending *1 before bending, 2 after*

bending

Materials put up resistance to any sort of deformation.

If they are exposed to little force only, the resistance of the material is not overcome. The material springs back to its original position - the strain was elastic. This process is called "elastic recovery".

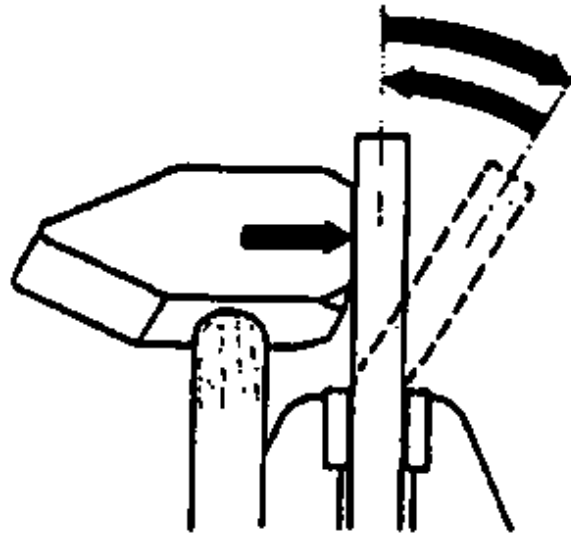


Figure 12 Elastic recovery after too little action of force

If the force affecting the material is stronger than the resistance which the material offers, it comes to a plastic deformation with the material springing back by the size of its elastic strain afterwards. Therefore the measure of the elastic recovery must always be taken into consideration during bending and twisting.

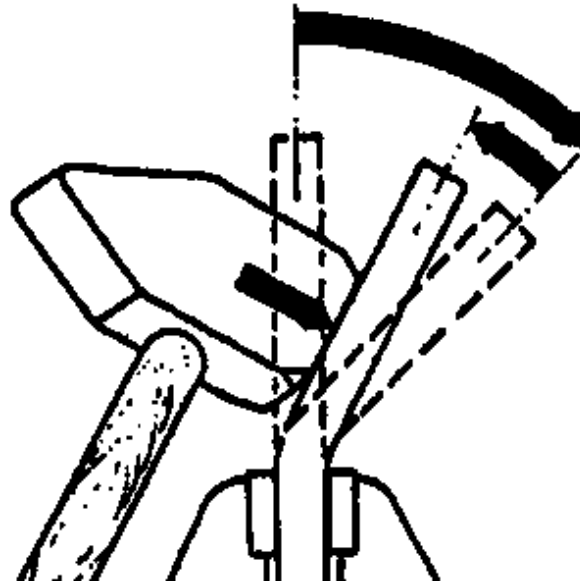


Figure 13 Elastic recovery with action of more force

In case of distorted or bent workpieces, tensile and compressive stresses must be eliminated by systematic action of force. This happens, if - by appropriate tools and devices - another force is exerted opposite to the original one which can be recognized from the direction of the distortion or bending. Here again, the elastic recovery of the workpiece must be considered.

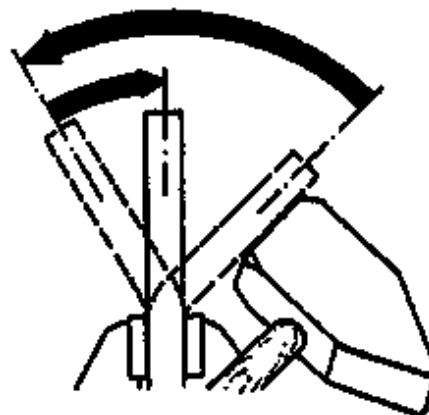


Figure 14 Elastic recovery after action of counterforce

In case of deformed or dented metal sheets, the compressive and tensile stresses mostly occur in a few places only, where the original action of force cannot always be seen.

Such tensions can only be eliminated by countertensions the effect of which blots out the original tension.

The more the workpiece has been deformed, the greater are the internal tensions in the material.

Internal tensions can also be eliminated by local heating up or soft annealing of the entire workpiece:

- Steel parts must slowly cool down in the air after heating.**
- Copper parts are water-quenched immediately after having been heated up.**

Often, locally heated sectional steels or metal sheets return to their right initial positions themselves when cooling. If this does not happen, they are deformed in the desired way in red-hot condition.

Generally, thick sections and pipes with thick walls should be straightened in red-hot condition, because the resistance of the material decreases with increasing temperature. Therefore, the force required for straightening is less, the brittleness of the already deformed material is reduced, so that fissures or fractures during the renewed deformation are avoided.

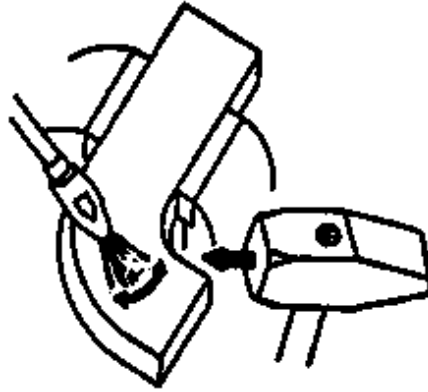


Figure 15 Straightening of heated material

What tensions occur at the bending radii of deformed materials?

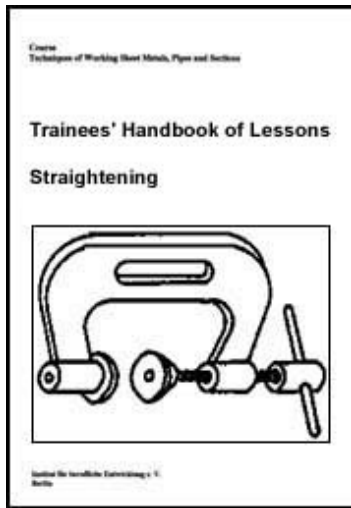
What happens if a too little force acts on the material?

How are tensile and compressive stresses eliminated at bent workpieces?

Why is it better to straighten thick sections and pipes with thick walls in red-hot conditions?



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4. Techniques of Straightening

According to the intensity and kind of deformation of metal sheets and pipes and the shape of sections, the most useful and effective techniques are applied leading to the restoration of the original form in cold as well as red-hot condition of the material.

4.1. Techniques of Eliminating Bendings and Bucklings

Long, slightly bent, thin sections and thin pipes can be straightened by hand in a vice. For this purpose, the materials are firmly clamped in the vice and drawn into the desired direction. The deformed spot must be placed directly beside the vice.

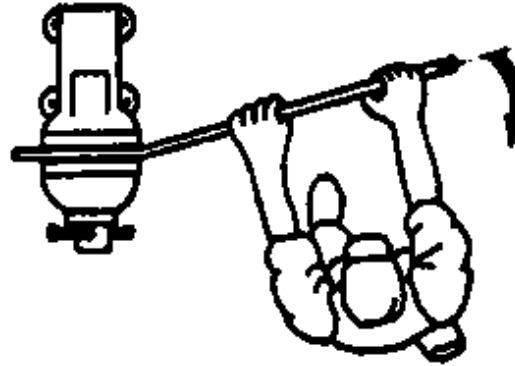


Figure 16 Straightening of long sections by hand in the vice

Bendings and bucklings at short sections and narrow strips of metal sheets are evened out by simple fastening of the vice jaws. For this purpose, the respective spot of the material is directly clamped into the jaws of the vice. However, the degree of elastic recovery must be equalized afterwards by hammering on a support

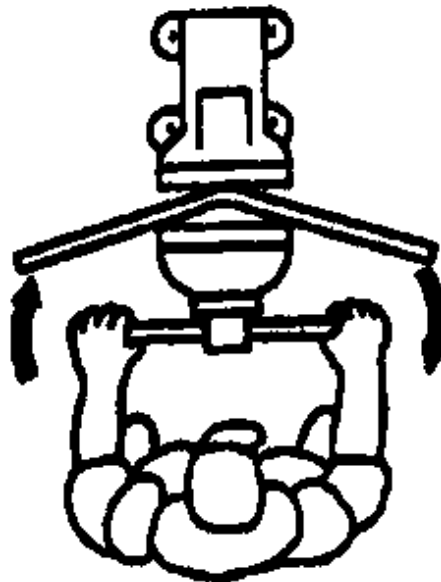


Figure 17 Straightening of short sections directly with the help of the vice

Bent buckled sections can be straightened under section punches of the hand screw press or hydraulic press.

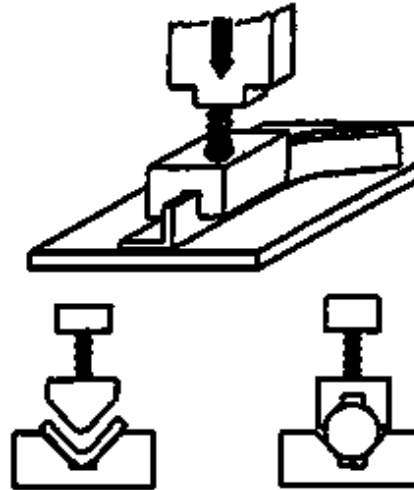


Figure 18 Straightening of bent sections by the press using different sectional punches

Bent or buckled thin flat materials and metal sheets can be straightened by hammer blows in the vice or under the flat punch of the hand screw press.

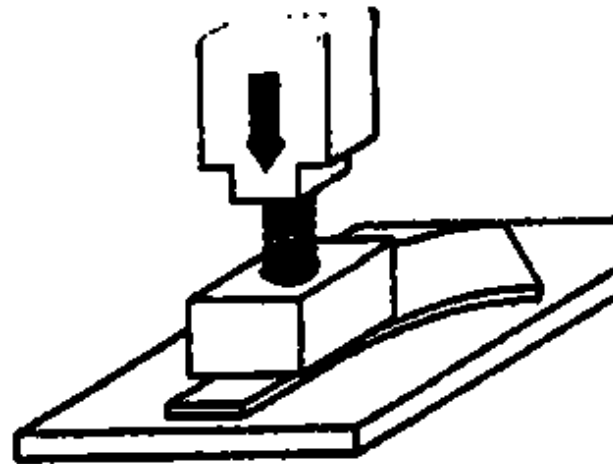


Figure 19 Straightening of bent flat material by the press using the flat punch

Bent or buckled stronger flat materials are evenly worked by the face of the locksmith's hammer over the entire spot which is deformed. With soft materials, a wooden, rubber or light metal hammer is used.

Suitable backings are the anvil or the straightening plate.

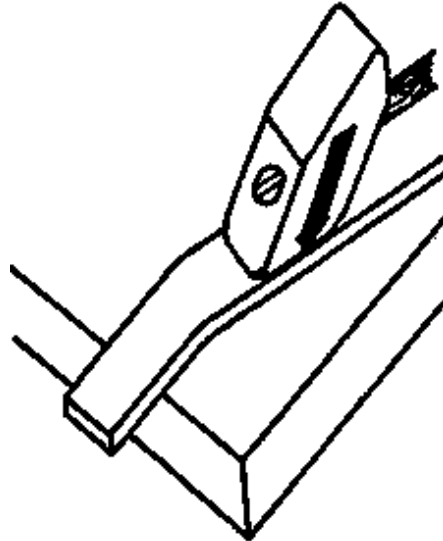


Figure 20 Straightening of thicker flat material by the locksmith's hammer

Bent flat materials and thin angle sections can be straightened by hammer blows from one side by the peen of the locksmith's hammer or by the sweeping hammer. The blows are done evenly from the head end to the end on the compressed side of the material. Suitable backings are the anvil or the straightening plate.

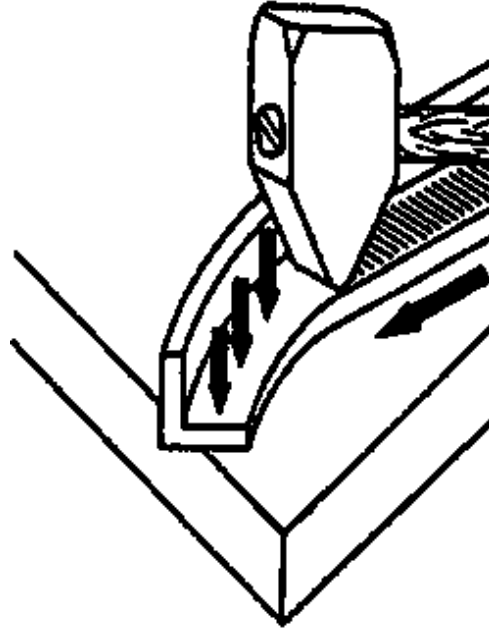


Figure 21 Straightening of thin angle sections by the locksmith's hammer

Bent and buckled thicker angle sections can also be straightened by local heating up by the welding torch. The straight material is quickly heated up by the welding torch till it is red-hot, the neighbouring spots are cooled by pieces of cloth that are constantly kept wet, so that the heat is not abstracted. The heated material is compressed, because it cannot expand to the sides. When cooling down, it shrinks in the compressed spot - the bending disappears.

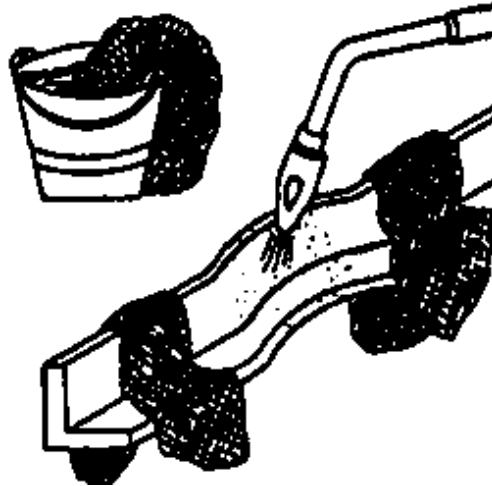


Figure 22 High-temperature straightening of strong angle sections with the welding torch

Bent and slightly buckled short pipe sections can be straightened by filling the pipe with fine-grained sand and closing it firmly on either side. Then, it is bent back in cold condition in the vice or straightened in warm condition after having been heated up by the welding torch, in the smith's hearth or furnace. The sand filling prevents a new deformation of the pipe section.

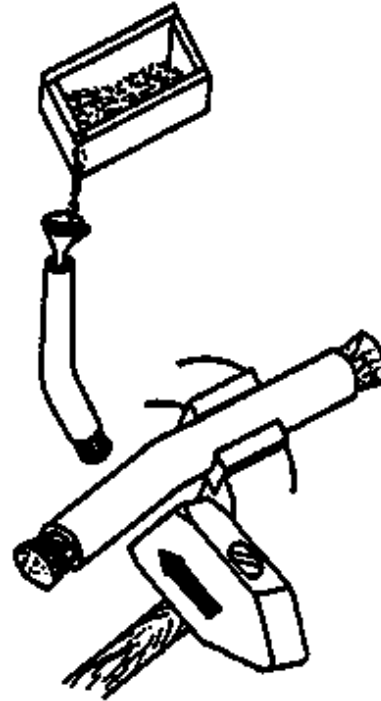


Figure 23 Straightening of pipes that had been filled with sand and firmly closed before
How can slightly bent thin sections be straightened?

How can smaller bucklings at sections and metal sheet strips be straightened?

What must be considered when straightening bent pipes?

4.2. Techniques for Eliminating Twistings

Twisted smaller flat materials can be straightened by means of tongs. They can also be placed between the jaws of the vice and straightened by closing the jaws. The hand screw press may be used as well.

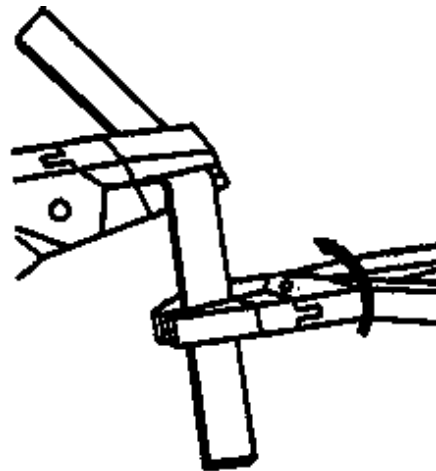


Figure 24 Straightening of thin flat material by means of tongs

Larger twisted flat material are clamped in the vice and turned back into their normal form by means of the moving iron. The respective spot must be directly beside the vice, the moving iron is applied closely beside, too.

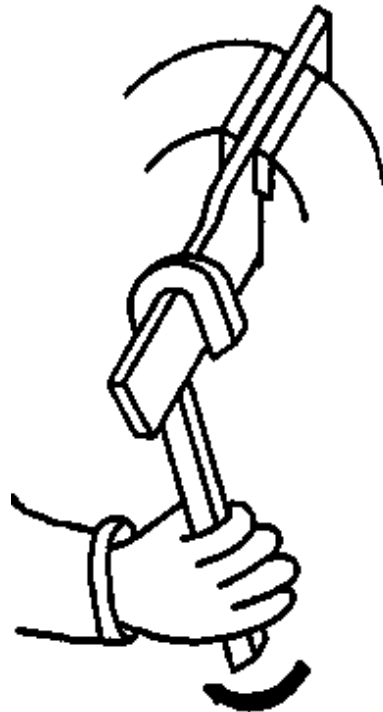


Figure 25 Straightening of distorted flat material by means of the moving iron

Twisted smaller square sections can be straightened with appropriate moving irons in the same manner. Larger square materials are straightened on the turning machine. Twisted angle and T-sections can be clamped in the vice and straightened by clamps.

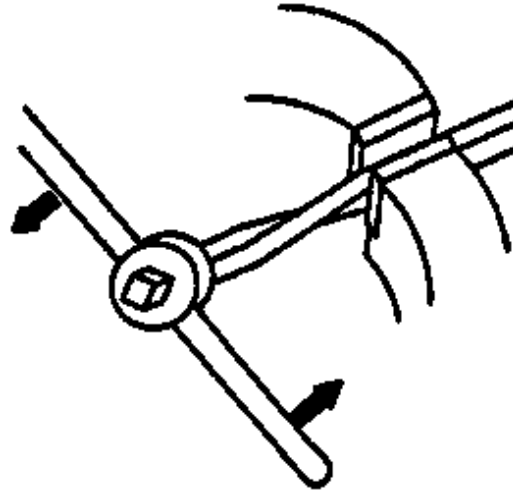


Figure 26 Straightening of distorted square sections by means of the moving iron

4.3. Techniques of Eliminating Dents and Corrugations in Metal Sheets

Small dents in metal sheets are straightened by beating with the face of the hammer directly on the dent. Pay attention, that the face of the hammer is larger than the surface of the dent. Smaller dents can also be straightened under the flat punch of a hand screw press.

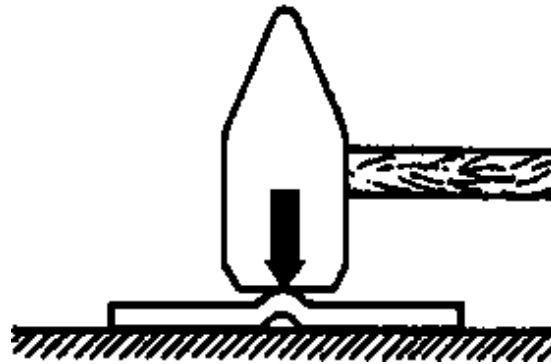


Figure 27 Straightening of a large bulge in sheet metal by means of the locksmith's hammer

Larger dents in metal sheets are straightened by drawing blows struck with the face of the locksmith's hammer, the straightening hammer or with the mallet or light metal hammer from the rim of the dents outwards. Outwards the blows must be placed denser and denser.

Large dents can also be straightened by precise local heating of the metal sheet with the blowpipe.

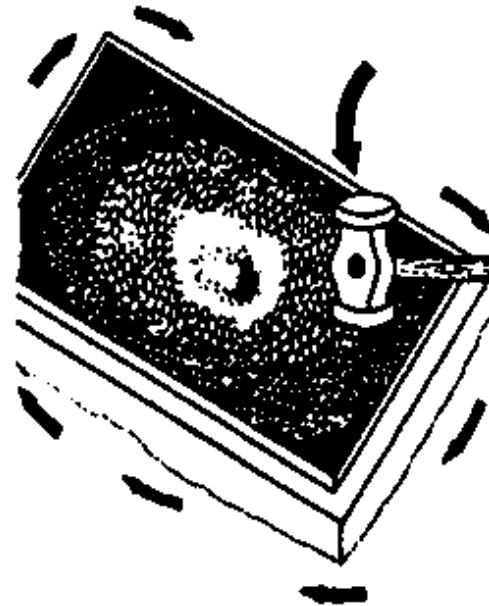


Figure 28 Straightening of a large bulge in a piece of sheet metal by means of the straightening hammer

Corrugated metal sheets are straightened by hand by striking hammer blows from the rim of the material towards the centre. In doing so, the blows of the hammer must be placed more directly towards the centre in order to stretch the material more in this place.

A straightened metal sheet must lie evenly and must not buckle when slightly bent to and from.

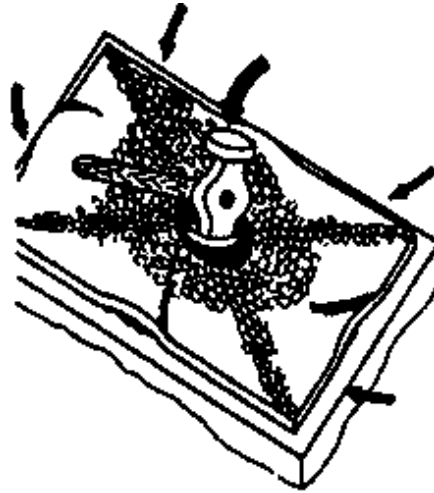


Figure 29 Straightening of a corrugated metal sheet by means of the straightening hammer

Corrugated and warped metal sheets and sections can be straightened by means of the roller straightening machine.

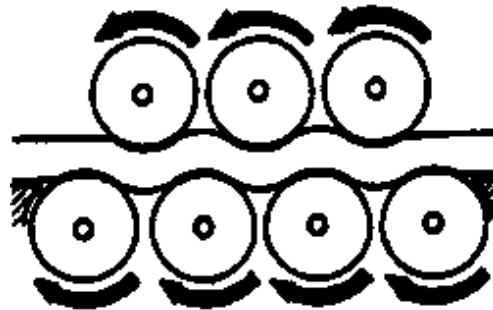


Figure 30 Straightening by means of roller straightening machines

Note:

By hammering, the density of the material is increased causing an increased hardness and brittleness. If hammered workpieces shall be bent afterwards, it may come to fissures or fractures.

Therefore applies:

Do not use too many hammer blows.

Should many hammer blows be required nevertheless, the workpiece should be soft-annealed in between times.

How are large bulges straightened in metal sheets?

Why is it not recommendable to strike many hammer blows when straightening materials?

