

Straightening – Course: Technique of Working Sheet Metals, Pipes and Sections. Methodical Guide for Instructors

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Straightening – Course: Technique of Working Sheet Metals, Pipes and Sections. Methodical Guide for Instructors

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1. Aims and Contents of Practical Vocational Training in the Techniques of Straightening

After having completed their vocational training, the trainees shall master the most commonly used techniques of straightening. For this purpose, the following has to be achieved:

Aims

- The trainees have thorough knowledge of the kinds and fields of application of the working means for straightening.
- They master the different techniques that can be used for the straightening of materials in cold and hot condition.
- They are able to decide for the– appropriate technique according to the kind of deformation.
- The trainees are able to choose tools, devices and auxiliary equipment according to the respective purpose and to use them skilfully and observing the regulations on health and labour safety as well as fire protection.
- They are able to assess the quality of their work themselves.

In order to achieve these aims, the instructor has to impart the following contents:

Contents

Knowledge

- Purpose of straightening
- Kinds and fields of application of tools, devices and auxiliary equipment
- Processes in the material
- Techniques of straightening
- Hints on health and labour safety

Skills

- Straightening of bendings and bucklings
- Straightening of distortions
- Straightening of dents and corrugations in metal sheets
- Straightening of cold and heated materials

2. Organizational Preparations

To ensure a trouble-free course of instructions, exercises and vocational practice, it is necessary to prepare the training well, with the following measures to be taken:

2.1. Planning the Training in Straightening Techniques

Starting from the total hour volume, the hours spent on the individual training sections of this vocational unit should be planned in a differentiated manner. For the following training sections it is recommendable to prepare a schedule:

- for the introduction to the techniques in the form of an instruction,
- for required demonstration,
- for the task-related instruction in preparation of the exercises,
- for the implementation of the exercises,
- for recapitulation and controls.

In planning the time, the following additional factors are to be taken into consideration:

- the level of education of the trainees,
- the training conditions,
- the future field of working of the trainees,
- the degree of difficulty of the training sections.

The acquisition of skills and abilities is the focal point of each training section; therefore, the exercises must be given the major portion of time.

2.2. Preparing the Instructions on Labour Safety

Before beginning with the exercises, a brief instruction has to be given on the appropriate use of tools and equipment and on accident-free working. In general, the same regulations are valid as for hammering and bending.

The following points must be especially emphasized:

- Use only clean and intact tools and equipment.
- When using hammers, make sure that the head of the hammer is firmly connected with the shaft by the cotter punch.
- Choose the appropriate support – it must have an inflexible surface.
- The workpieces must be firmly clamped so that they are not torn away by the hammer blows.
- When working at presses make sure that your hands and head are protected.
- The use of welding torches is only allowed after previous instructions given by the instructor.
- Pay attention to fire protection: place water ready for fire fighting; do not work near inflammable materials.

Knowledge of these instructions has to be confirmed by the trainees by signature in the control book.

2.3. Providing the Teaching Aids

- The "Trainees' Handbook of Lessons – Straightening" is to be distributed among the trainees according to their number.

- Especially indicative illustrations from the "Trainees' Handbook of Lessons" should be arranged for as blackboard drawings.
- Workpieces which have been deformed by transport or machining may be used as visual aids.
- Special tools not yet known to the trainees, e.g. moving irons, may be used as visual aids, too.
- If in the field of straightening transparencies for overhead projection are available, they should be included in the lessons.

2.4. Providing the Working Means

- As a theoretical basis of the exercises to be carried out the "Instruction Examples for Practical Vocational Training – Straightening" should be distributed among the trainees.
- The basic material required for the exercises should be prepared and provided in sufficient quantity according to the details given in the "Instruction Examples...".
- The workshop has to be checked as to its complete equipment with tools, devices, measuring and testing instruments as well as auxiliary means according to the exercises planned.
- Recommended basic equipment
 - Locksmith's hammers, straightening hammers, light metal hammers, mallets, rubber hammers
 - Moving irons and tap wrenches
 - Tongs and damps
 - Welding torches with accessories
 - Hand screw presses
 - Vice, straightening plate
- Straightening machines that shall be used for mechanical straightening must be checked as to their serviceability with regard to safety before starting the exercises.

3. Recommendations for Implementing Practical Vocational Training in Straightening Techniques

The following sections contain suggestions for teaching, demonstrating the techniques and carrying out and tests.

3.1. Introductory Instruction

The introductory instruction should be given, if possible, in a classroom. Make sure that the trainees note down supplements and answers to questions in the "Trainees' Handbook of Lessons".

An important precondition for learning the techniques of straightening is the mastery of the techniques of testing and hammering.

This knowledge must be recapitulated, if required.

For your instruction you can use the "Trainees' Handbook of Lessons" with the following focal points:

Purpose of straightening

It is recommendable to start the lessons by explaining the trainees the purpose of straightening with the help of visual aids. In doing so, it must be made clear that due to transport or machining of the materials deformations may occur, which – for the moment – prevent a further quality processing of the respective workpiece. The trainees shall understand that the various kinds of deformations can be eliminated by different techniques of hammering, bending and local heating up.

Tools, devices and auxiliary equipment

The possibility to straighten thin metal sheets, pipes and sections by hand has to be mentioned and, in addition, the most commonly used working means have to be introduced and/or repeated, such as:

- Locksmith's hammers, straightening hammers, light metal hammers, mallets and rubber hammers
- Welding torches, blacksmith's fire, annealing furnace
- Screw presses, straightening machines
- Vice, anvil, straightening plates

These working means may also be dealt with in a question – answer talk with the trainees, provided that the trainees have previous knowledge. Already here, special distinctive features in the use of the working means may be pointed out

If no tools can be shown, the trainees should look at the corresponding illustrations in the "Trainees' Handbook of Lessons". After this, it is recommendable to have the trainees answer the questions in the "Trainees' Handbook of Lessons" in writing in order to apply the knowledge acquired in this field.

Processes in the material

It is very important to deal with this point thoroughly to explain the trainees basic processes which take place within the material when it is exposed to external forces.

Make sure that the terms of "axial elongation", "compression and elastic recovery" are correctly and clearly explained.

It is recommendable to draw the simple illustrations from the 'Trainees' Handbook of Lessons" on the ' blackboard in order to show the sequences of motions by the individual steps.

As a practical proof, a simple demonstration can be given: A square section – if possible from a very soft material – is given a lattice-shaped marking on the side as is to be seen in Figure 11 of the "Trainees' Handbook of Lessons". Then, the square section is bent. The changed pattern of the lines, which had been parallel before, impressively demonstrates the effects of tensile and compressive stresses.

This must be followed by an explanation of the possibilities of neutralizing these stresses by systematic counterstresses as well as local heating up. Especially it must be emphasized that the internal resistance of a material is reduced by heating it up and that – as a result of this – the workpiece is easier to form. The utilization of this quality should be immediately described on the basis of examples showing the deformation of thick sections and pipes with thick walls.

Techniques of straightening

The various techniques should always be described in connection with the thickness and kind of deformation of metal sheets, pipes and the shape of sections.

In the 'Trainees' Handbook of Lessons", these techniques are described according to the kind of deformation. It is not recommendable to explain all techniques together. Rather should the explanation of the straightening of bendings and buckings be immediately followed by a practical exercise, for which the 1st instruction example can be used. This way, the theoretical knowledge is consolidated by practical exercise without delay.

Especially for weak trainees or for those who have only a small previous knowledge, it is better to impart the knowledge in small steps followed by corresponding practical exercises.

The following sections – straightening of twistings, dents and corrugations in metal sheets – can be treated in the same manner.

The "Instruction Examples for Practical Vocational Training" offer exercises for each of these focal points.

The mentioned instruction mainly describe the straightening by hand.

If straightening machines are available, this instruction is to be supplemented with the help of the operating instructions of the respective machine. The instruction directly at the machine would be the most effective one.

Hints on Labour Safety

Taking into consideration the hints on labour safety of the hammering and bending techniques especially applicable points have to be emphasized and supplemented. These focal points are included in the "Trainees' Handbook of Lessons".

3.2. Practical Exercises

On principle, the necessary hints on labour safety must be given prior to the practical exercises. Then, the working places are assigned to the trainees and the technical equipment of the workshop is tested as to its serviceability.

It is recommended to start every exercise with a demonstration by the instructor in connection with an instruction related to the respective instruction example. In doing so, the trainees should be motivated to implement the exercise in a good quality. It must be pointed to difficulties that may perhaps occur. The criteria of assessment must also be mentioned.

It is necessary that the instructor himself has done the exercise before.
Only then he will know the difficulties of the exercise.

Instructions on the special techniques and corresponding practical exercises may alternate.

On the basis of the "Instruction Examples for Practical Vocational Training – Straightening" 5 exercises can be carried out using different techniques. For this, the "Instruction Examples" include a list of the required materials (basic material, tools devices, measuring and testing instruments as well as auxiliary equipment), the sequence of operations for carrying out the exercises and an illustrative working drawing.

Thus the trainees get all necessary information for systematically implementing the exercises.

The basic material must be deformed according to the defects indicated in the working drawing, so that the exercises can be done according to the respective sequence of operations. If there are workpieces available showing similar deformations they may be used as well.

The following instruction examples give a survey of those practising pieces which should be manufactured for putting the previously imparted knowledge into practice.

Instruction examples

Instruction example 15.1. Straightening of bendings and bucklings

This instruction example includes three individual exercises:

A 2 mm thick
buckled steel
sheet has to
be
straightened

with the help of
the flat punch
of the hand
screw press;

An 8 mm thick
buckled flat
material has to
be
straightened
by means of
the locksmith's
hammer in the
vice;

A 15 mm thick
bent square
section has to
be heated up
with the
welding torch
and then
straightened
by means of
the locksmith's
hammer.

(Figure 1)

Instruction example 15.2. Twistings

This instruction example includes 2 individual exercises:

A 5 mm thick
distorted flat
material has to
be
straightened
with the help of
a moving iron
in the vice;

A 10 mm thick
distorted
square section
has to be
straightened
by means of a
moving iron in
the vice.

(Figure 2)

Instruction example 15.3. Bent angle section

This instruction example includes 2 individual exercises:

A unilaterally
bent angle
section of a width
of leg of 20 mm
has to be
straightened by

the hammer
peen;

A double-sidedly
bent angle
section of a leg
width of 45 mm
has to be heated
up locally by
means of a
welding torch and
straightened.

(Figure 3)

Instruction example 15.4. Bent pipe

A bent steel
pipe of a
diameter of 1
inch has to be
filled with
fine-grained
sand, to be
firmly closed
and then
straightened in
the vice.

(Figure 4)

Instruction example 15.5. Dented and corrugated metal sheets

Steel sheets of
3 mm in
thickness each
and with
various defects
– such as small
dents, one big
dent,
completely
corrugated
surface – have
to be
straightened by
means of the
straightening
hammer. The
same metal
sheets may
also be
straightened by
means of the
roller
straightening
machine.

(Figure 5)

All trainees can do the exercises at the same time, provided that materials and equipment are available in sufficient quantity and number.

In this case, the trainees can do their exercises individually, i.e. each trainee should get as much time as he needs. If there are not enough working means, groups must be formed. The trainees should be divided into groups according to the use of the different tools and devices.

If you do not like to use the instruction examples offered for the purpose of exercise, you may choose other practising pieces. If this is the case, make sure that all techniques that had previously been explained are practised with these pieces.

Focal points for practical execution

It is recommendable to fix certain criteria for the assessment of the exercises. These could be the following:

- Do the trainees prepare their working places properly?
- Do they select the right tools – as to size and form?
- Are the workpieces clamped firmly enough?
- Do the trainees meet the quality requirements?

Especially:

- Do the workpieces get their correct form?
 - Can the workpieces be used for further treatment after straightening?
-
- Do the trainees use the correct testing method?
 - Are the trainees able to assess their own work properly?
 - Do the trainees observe the regulations on labour safety?

3.3. Questions for Recapitulation

In this section, tasks are compiled to improve and check the acquired knowledge. These tasks are also included in the "Trainees' Handbook of Lessons":

1. What is the purpose of straightening?

(Materials which had been twisted, bent or deformed during transport or machining are given back their original form.)

2. What are the techniques which are mainly used for straightening?

(Hammering, bending, local heating up)

3. What hammers can be used for straightening steel sheets?

(Locksmith's hammers, straightening hammers)

4. What hammers can be used for straightening aluminium sheets?

(Light metal hammers, mallets, rubber hammers)

5. For what sort of straightening work are moving irons used?

(For the elimination of twistings in flat sections.)

6. For what sort of straightening work can the hand screw press be used?

(For straightening bent sections and dented metal sheets.)

7. What tensions occur at the bending radii of deformed materials?

(At the external radii it comes to tensile stresses – axial elongations; at the internal radii it comes to compressive stresses – linear compressions.)

8. What happens, if a too little force affects the material?

(The material springs back elastically into its initial position – the extension was elastic.)

9. How are tensile and compressive stresses eliminated at bent workpieces?

(The effects of the systematic application of force or local heating followed by cooling put the workpiece back to its normal form.)

10. What is the advantage of straightening thick sections and pipes with thick walls in red-hot condition?

(The resistance of the material is reduced with increasing heating up this requiring less force for straightening.)

11. How can slightly bent thin sections be straightened?

(Manually in the vice or by means of the press.)

12. How can little bucklings at sections and strips of metal sheets be straightened?

(By clamping the buckled spot in the vice and fastening the jaws or by hammering on a rigid and plane support.)

13. What must be borne in mind when straightening bent pipers?

(Before being straightened, the pipe must be filled with fine-grained sand and firmly closed on either side.)

14. How are large dents eliminated in metal sheets?

(By hammer blows starting from the rim of the bulge and drawing outwards or by local heating up with the welding torch.)

15. Why are better not too many hammer blows applied when straightening with hammers?

(Because by hammer blows the material becomes harder and more brittle, which may lead to the formation of fissures or to fracture.)

