
WELDING

Project name: Mobile laboratories for improvement of STEM knowledge
Project acronym: Lab4Stem,
No. 2020-1-LV01-KA201-077502
Project duration: 27 month,
October 1st 2020 – December 31th 2022

More information ERASMUS+

EML, Federation of Estonian Engineering Industry (Estonia); LINPRA, Lithuanian engineering industries association (Lithuania); Tehnobuss Latvia (Latvia); Vilnius Jeruzalem Labour Market Training centre (Lithuania); Merkuur OÜ (Estonia)

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Lab4STEM

Co-funded by the Erasmus+ Programme of the European Union

Main objectives of the project are:

1) Promotion of pupils' achievements in STEM in attractive way.
2) Strengthening support for educators by open source, interactive, digital training materials about STEM.
3) Strengthening responsibility and involvement of sector business representatives in education process.

Main activities/ results of the project are:

1) Open source, interactive, digital training materials about STEM for pupils in four languages – English, Latvian, Lithuanian and Estonian.
2) Teacher's manual to support educators about usage of interactive, digital training materials in four languages – English, Latvian, Lithuanian and Estonian.
3) Guidelines for sector representatives for improvement of STEM knowledge in four languages – English, Latvian, Lithuanian and Estonian.
4) 3 promotional and testing events for educators about usage of interactive, digital training materials.
5) At least 100 pupils trained in pilot trainings in each country covering all regions of involved countries.
6) National competition of pupils about improvement of training materials
7) 3 project final events.

Table of Contents

Module name: WELDING

Purpose: the purpose is to give students an overview of the nature and necessity of welding, to understand the developments of technology and to create a connection between the history of technology and the achievements of modern science. To analyze the possibilities and dangers of welding, to integrate theoretical materials with practical assignments and solve real-life problems; to introduce possible further learning and career opportunities related to welding; to solve individual/pair/group assignments related to welding.

The student:

- Can see and understand natural science and technology connections and express their opinion on the development of technology and the working world.
- Can choose and analyze technical and creative solutions and realize the effects and dangers of them.
- Can choose the suitable materials, equipment and processing methods to put their ideas into life, also understands the importance of safe and economical usage of their materials.
- Has an overview of the working opportunities and professions in the field in the past and present, know the further learning opportunities in the production and processing field.
- Integrates the field of welding with other learning subjects and areas of life.
- The length of the module should be two lessons 4x45 minutes) that include theoretical and interactive assignments + 1 practical hands-on assignment. 2x45 minutes for each module, that can be used in both school lessons and mobile solutions.

Name of learning subject in which module can be used: technology, career studies, business studies

THEMES/SUBSECTIONS:

- **General information:**
  definitions, introduction, history, interdisciplinarity, real-life connections (plastics, metals). Devices and safety information. Technology, the human and the environment. The importance and usage of welding. The future perspective and innovation of welding.
- **Technical information:**
  types of welding. Schemes and diagrams.
- **Future studies and career information:**
  being a welder, career and learning opportunities, company stories and fields of work.

I GENERAL INFORMATION:

Purpose:

- To give students an overview of the meaning and necessity of welding.
- To understand the future developments of technology and create connections between the history of technology and modern achievements of science.
- To analyse the possibilities and dangers of welding.
- o integrate the theoretical materials with practical assignments and solve real-life problems.

The student:

- Can see and understand the connections between natural sciences and the development of technology, can express their opinion on the development of technology and the changing of the working world.
- Can integrate welding with other subjects and areas of life.
- Analyse the possible opportunities and dangers of welding.
- Obtains the knowledge of the importance, usage fields and future perspectives of welding.

II TECHNICAL INFORMATION

Purpose:

- To give students an overview of the types of welding and usage areas.
- To analyse the possibilities and dangers of different types of welding.
- To connect types of welding with other subjects and areas of life.
- To integrate theoretical materials with practical assignments and solve real-life problems.

The student:

- Can see and understand the connection between natural sciences and the development of technology, can express their opinion on the development of technology and the changing of the working world.
- Can integrate welding with other subjects and areas of life.
- Obtains the knowledge of the importance, usage fields and future perspectives of welding.
- Chooses and analyses technical and creative solutions and the effects and dangers of these.
- Chooses the right materials, equipment and processing methods to put their ideas into life and prioritises the safe and conservative usage of materials.

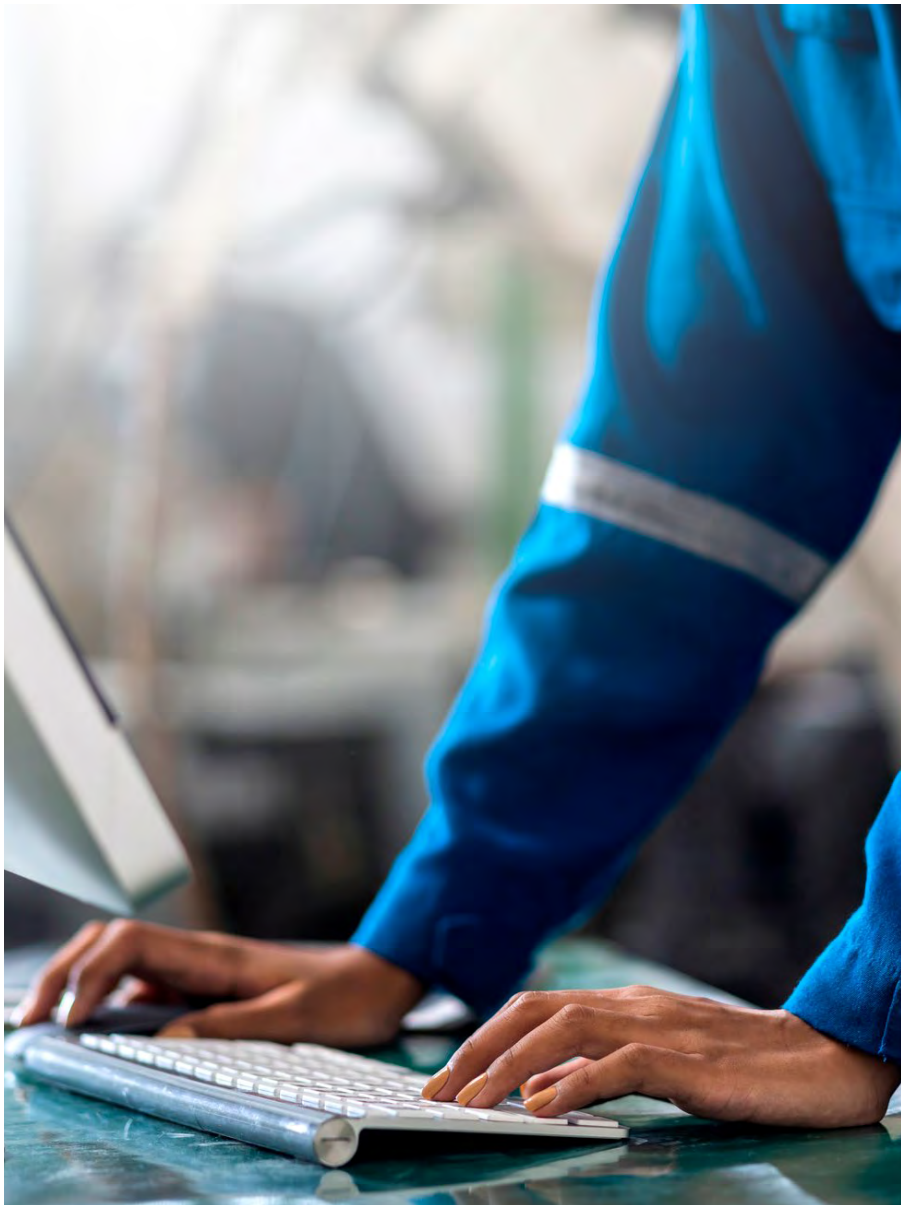
III FUTURE STUDIES AND CAREER INFORMATION

Purpose:

- To introduce the future studying and career opportunities in the field of welding.
- To emphasize the success stories of Estonian and other companies and describe the welder's role, tasks and importance in modern production fields.
- To integrate the theoretical materials with practical assignments and solve real-life problems.

The student:

- Can see and understand the connections between natural sciences and the development of technology, can express their opinion on the development of technology and the changing of the working world.
- Can connect welding with other subjects and areas of life.
- Has an overview of the possible jobs related to welding in the past and present, knows the future learning opportunities regarding production and processing.



PART I

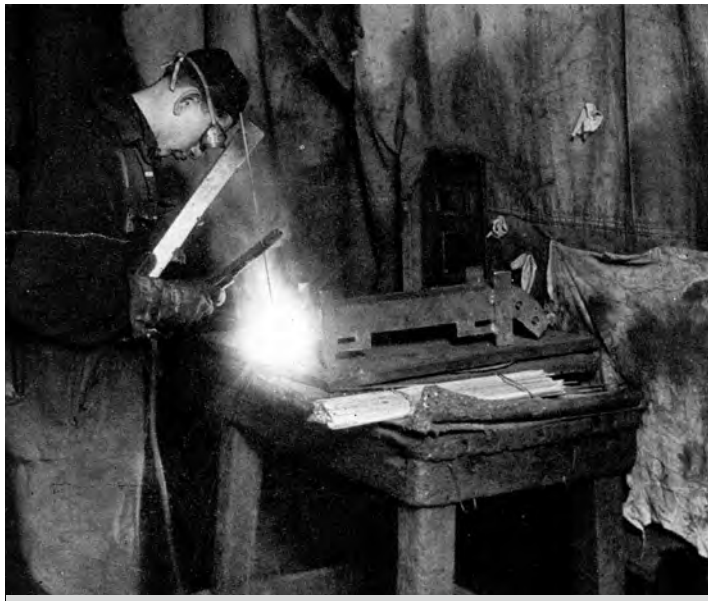
General information

Welding is a method in which two or more parts are given a permanent shape. This is done in particular by heating or pressure. A person who is professionally involved in welding is **a welder**. The welding profession has remained the most sought after professional in the top ten for years and is a highly paid profession. Welding is very important today because many industries use a lot of metals, so their proper operation and functionality is important. **Properly welded metals work correctly and safely.**

Materials that are chemically similar may be used in welding. The base material and the filler material are welded, as a result of which the two materials are mixed and a welded joint is formed. Many materials can be welded, such as metals, glass, plastics, composites, and more.

History and background

The development of welding can be traced back to ancient times. **Earlier examples of welding date back to the Bronze Age.** Small golden round boxes were made by compressing the joints. It is estimated that these sauces were made more than 2,000 years ago. The Egyptians and the people of the eastern Mediterranean learned to weld pieces of iron together. Many tools were found, made around 1000 BC.



An example of welding in the late 19th century.

It was not until the 19th century that welding was invented as we know it today. In the middle of the 19th century, **an electric generator** was invented and **arc lighting** became popular.

In the late 1800s, **gas welding and cutting** were developed. Arc welding with carbon arc and metal arc was developed and resistance welding became a practical process.Prantsusmaal Cabot'i laboris töötav

Auguste De Meritens, who worked in a cabot laboratory in France, used **arc heat** in 1881 to connect lead plates for batteries. **Nikolai N. Benadros**, a student who worked with him, was the first to receive a patent for welding. **This was the beginning of carbon arc welding.**

The production of oxygen and later the liquefaction of air with the introduction of the blowpipe or torch in 1887 contributed to the development of welding. The First World War brought a huge demand for the production of weapons, and

welding began to be introduced. Many companies emerged in America and Europe to manufacture compliant welding machines and electrodes.

In 1920, automatic welding was introduced. It was used to build worn motor shafts and worn crane wheels. The automotive industry also used it to produce rear axle housings.

In the middle of the century, many new welding methods were invented. In 1930, Kyle Taylor was responsible for nail welding, which soon became popular in shipbuilding and shipbuilding. In the same year, submerged arc welding was invented and is still popular today.

Other recent welding developments include **the breakthrough in electron beam welding** in 1958, which allows deep and narrow welding through a concentrated heat source. After **the invention of the laser** in 1960, laser beam welding debuted several decades later and has proven to be particularly useful in high-speed automated welding.


Thes story of welding

Short history of welding

How does welding work?

Welding is performed by a welder who has completed the relevant training and has sufficient competence to engage in welding. The purpose of the welder›s work is to manufacture metal products and structures. Welding is the joining of metals into an inseparable joint in which local fusion or co-deformation of parts is applied. **There are more than 60 different welding methods, which are classified into two main groups:**

- fusion welding
- pressure welding

The main work of a welder is the preparation of welding work (workpieces), fitting up and tacking the works, assembling the preparation of a structure according to the drawing, the performance of welded joints, and post-processing and control of the result. **The work requires the ability to read drawings, knowledge of processing technology and material properties.** Welders work on construction sites with builders, in car repair shops with car mechanics, also in welding pipes, gas supplies and energetics. They also work in various industries in repairing many objects.

In the welding process, the heat is directed to the metal parts by fusing them together into an integral whole. **Therefore, welding work has many applications in the shipbuilding, automotive and aerospace industries, as well as in the joining of beams in the construction of buildings and bridges, as well as in repair and restoration work.**

The following specializations can be distinguished in the field of welding:

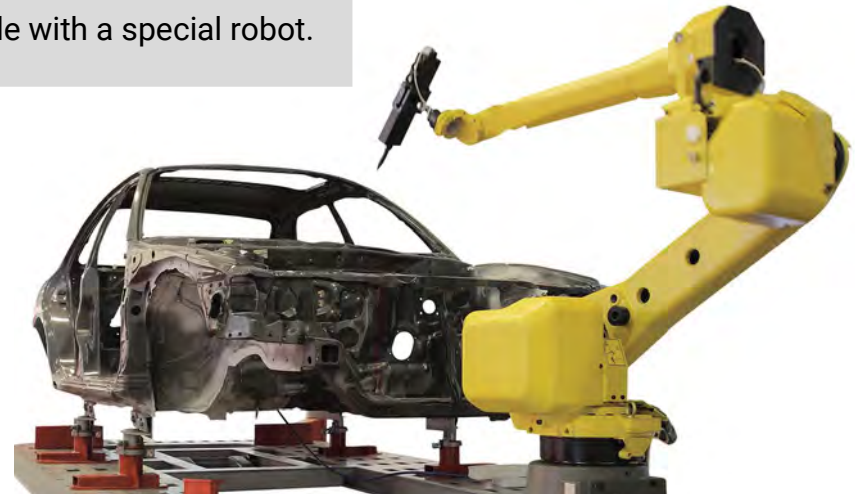
- welder
- soldering and brazing personnel, operators
- flame cutter
- spot welder
- termite welder

Highly qualified welders use a wide variety of materials in their work: titanium, aluminum, plastic, etc. Welders organize their work in cooperation with other construction workers, choosing the necessary tools themselves. Less skilled welders often have limited tasks. They are assigned specific welding tasks, the necessity and possibility of

which have been decided in advance. Less skilled welders have the opportunity to improve their vocational skills by moving from less advanced welding objects to more advanced objects.

As technology develops, new opportunities for higher quality welding work are constantly being created. **Welding mechanization, welding robots, welding tractors are implemented,** where the role of the welder becomes the activity of the welding operator that monitors the process and corrects it if necessary.

Robotic welding is an automatic welding made with a special robot.



GECKO portable welding tractor

RAILBULL welding tractor

K.Met spot welding devices

Working conditions and safety

Working conditions can be variable – working both indoors and outdoors. You must be prepared to work in an awkward position, to withstand temperature fluctuations, altitude and noise. Harmful gases and aerosols are released into the environment, which is why high-quality ventilation is essential. Arc welding involves ultraviolet and infrared radiation. When welding in hazardous rooms, the risk of electric shock must also be taken into account. By organizing the workplace appropriately and using proper equipment and safety procedures, risks can be reduced.

The welder uses welding, gas cutting, metal cutting and lifting equipment, electrical and mechanical hand tools and aids in his work. The working positions vary according to the task, work both in the longitudinal and upright positions, the position of the hands can also be above the head.

The work of persons engaged in welding and soldering work is associated with a constant risk due to the burning arc of a bright flame, the release of toxic fumes and the handling of hot materials. They wear special work clothes, gloves, hand protection and footwear, a head and hand protection mask, goggles, a protective hood, to which an additional pair of goggles is attached. All items are made of fireproof material. The goggles must protect the eyes from radiation as well as sparks and slag particles.

Welding gas and welding fumes can cause allergic reactions. Welding of painted surfaces and alloy steels releases toxic compounds. Shielding gas welding releases a large amount of ozone. The welder is also exposed to dust and other contaminants in his work, as well as to various chemicals that can cause allergies in hypersensitive people.

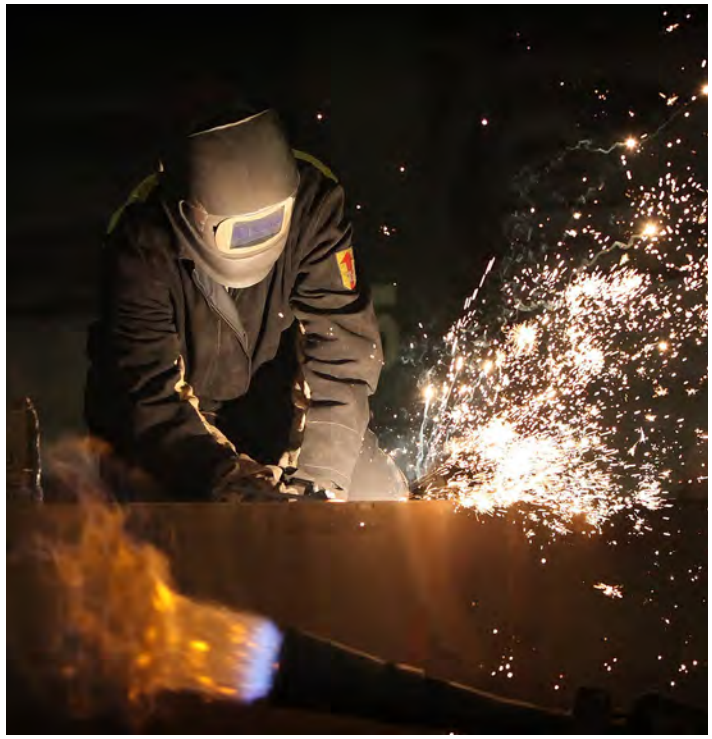
The welder's working time is spent on assembling parts, removing slag and splashes, and visually inspecting the results.

WELDERS SAFETY EQUIPMENT

Welder must take into account **various hazards**, such as optical radiation, electrical hazards, handling errors, fire from volatile sparks and contaminants.

Because welders work on construction sites, shift work is common. The profession also requires readiness to work on holidays, public holidays, as well as early in the morning, late at night and at night (eg in emergency response).

Companies in the machinery, metal and apparatus industries value occupational safety knowledge the most from the general skills of a welder. **The most important basic skills and knowledge are considered to be the knowledge of different working methods and the knowledge of the equipment and aids used in welding.** Knowledge of different materials and reading of technical drawings and knowledge of welding norms and standards are considered almost as important. According to employers, more attention should be paid to the ability to know different materials and their behaviour during welding. Locksmithing



and driving skills are considered necessary as additional skills. **The most important personal qualities are punctuality and a sense of duty and responsibility, as well as physical endurance.**

The welder must be familiar with construction-related, professional safety techniques and protective equipment and with knowledge of the harmful effects of welding on the human body.

The qualification of a welder is based on the ability to know and know the variables related to welding, such as the welding process, product shape, weld profile, additional materials, sheet and pipe dimensions, welding position.

Personal protective equipment

Fumes and gases

Fire and explosions

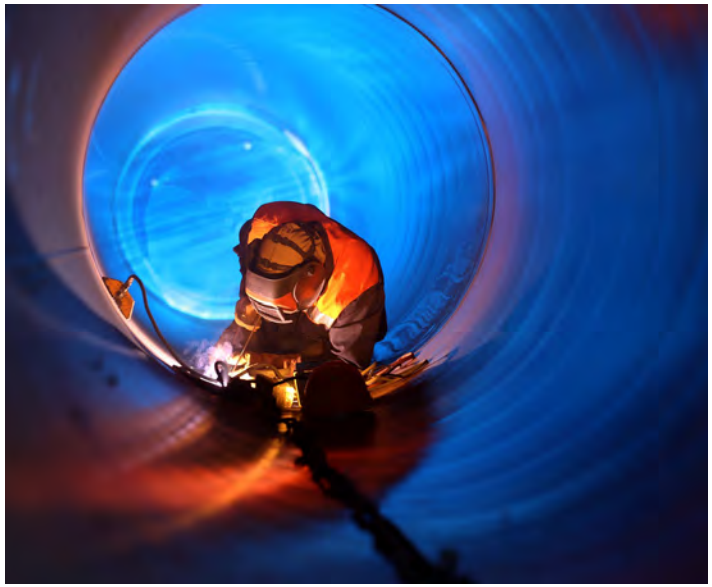
Electric shock

PART II

Technical information

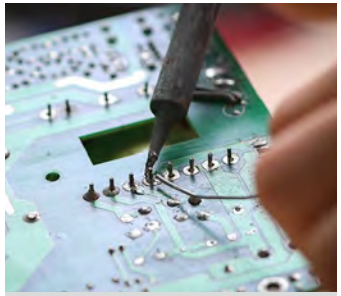
Welding as a method of joining materials is widely used in mechanical engineering, energy and construction companies. The industrial manufacture of welded metal structures and mechanical products is called **welded manufacturing.**

The purpose of welding is to obtain a welded joint equivalent to the parts to be joined, the mechanical properties of which (eg tensile strength, elongation, impact) would not be lower than those of the parent metal.



Advantages of welding compared to other joining technologies (eg soldering, brazing, bolted joint, riveted joint):

- the cheapest method of joining to make permanent joints.
- high mechanical properties of joints.
- joints can be made both indoors and outdoors.
- the joints are light in weight and small in size.
- high productivity.
- suitable for various materials, including composites and plastics.
- can be used in different environments, eg air, vacuum, under water.
- possibility to automate processes, eg use of welding robots.



Soldering

Riveting

Disadvantages of welding :

- most activities are done by hand, so welding involves high labor costs.
- the quality of many welding processes depends on the professional skills of the welder.
- dangerous for the welder due to the use of high energy and high voltage electricity.
- welding defects may occur.
- it is often necessary to carry out a non-destructive inspection of the joints after welding.
- toxic compounds are released into the environment.

A weld is a part of a welded joint that is formed by the crystallization of molten metal in a welding bath. Main welds are classified as **butt** and **corner welds**.

Welded joints are non-detachable joints made by welding. Welding is mainly used to join metal parts, but it is also possible to use welded joints to join non-metallic parts (eg ceramic and plastic parts) or to combine joints between metal and non-metallic parts.

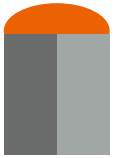
Welding Joint Types

Butt joint

Lap joint

T-joint

Corner joint



Edge joint

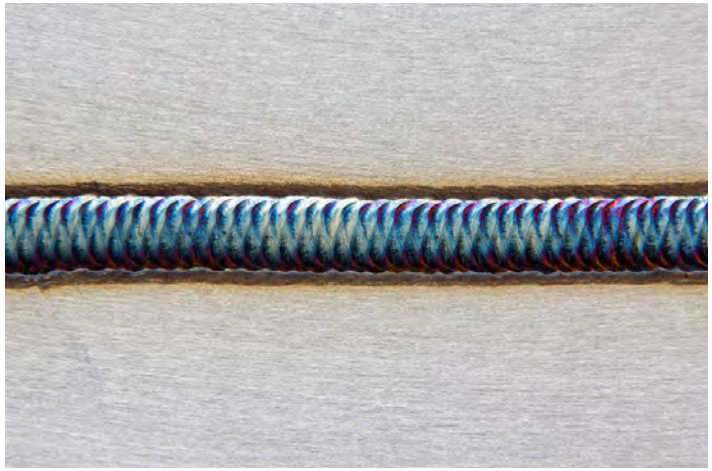
The types of welded joints are distinguished by the reciprocal position of the welded parts:

- **butt joints –** the parts lie approximately in the same plane and about against one another and butt joints are one of the most common welds in production.
- **lap joints –** the welded elements are located in parallel and partially overlap each other.
- **T-joint –** the end of one part is connected to the side surface of another part forming a T-shape.
- **corner joints –** joints in which the parts to be joined are at right angles or less to each other and are welded along a common edge.
- **edge joints,** where two parts the joints are brought into contact along the edge side surfaces, and the welded ends are fused during welding.

When joining metals, two types of welding are distinguished:

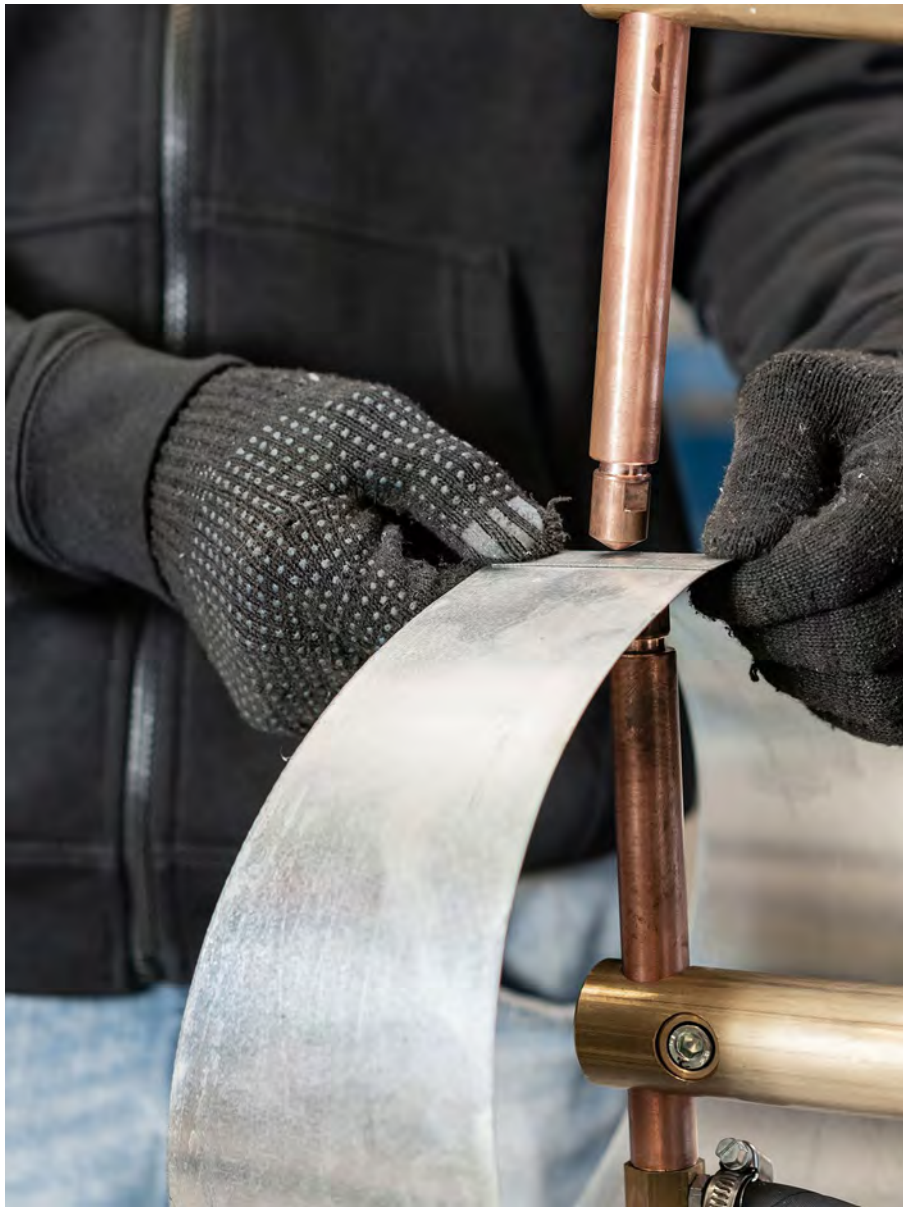
- in **FUSION WELDING,** the edges of the two parts to be joined are melted by heat source and additional melted metal (filler metal) is added to the molten metal and common volume of molten metal is formed, called a weld bath, which in turn cools and forms a weld.

  Examples of fusion welding include manual arc welding, gas welding, laser welding, plasma welding.



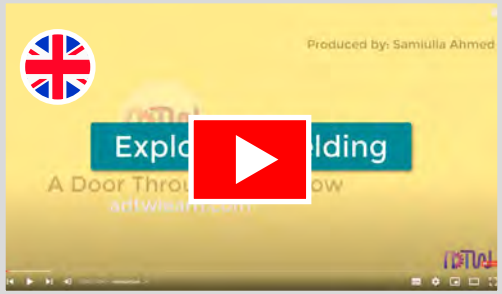
- **PRESSURE WELDING** involves the plastic deformation of the edges of the parts to be joined, through which the interatomic bonds of the parts of the parts to be joined are formed, and this surface is called **the weld**. Pressure welding takes more time than fusion welding, as this process depends on the physico- chemical properties of the joining materials, the surface condition, the external environment and other means of activation (eg friction, ultrasound).

  Pressure welding includes, for example, spot contact welding, linear contact welding, friction welding, explosion welding.



Spot welding

Friction welding



Explosion welding

Ultrasonic welding

Basic welding methods and applications

1. Coated electrode manual arc welding (MMA-manual metal arc welding, in USA SMAW (shielded metal arc welding)) or electrode welding

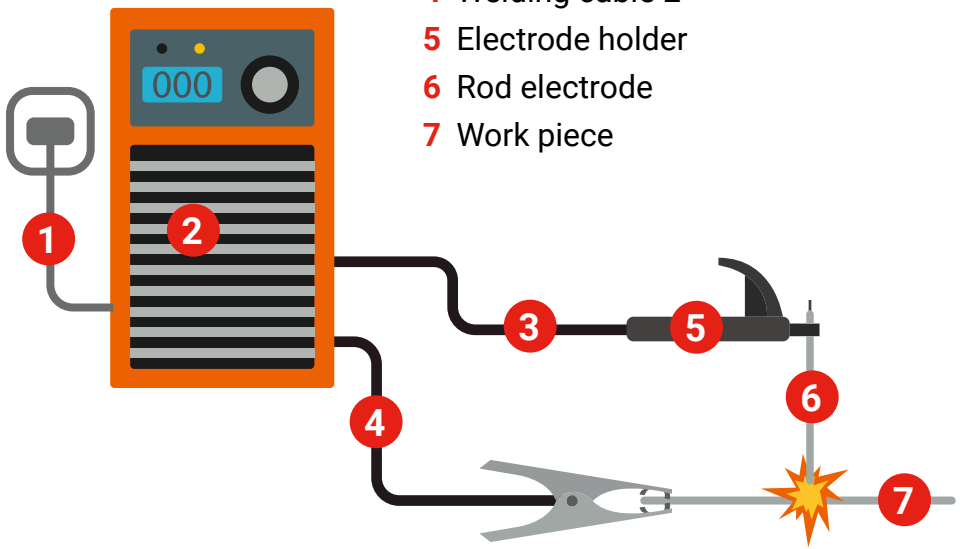
Manual arc welding is used for welding all types of steel, cast iron, nickel, copper alloys and to a limited extent for repair welding of aluminum. Manual arc welding is suitable for welding in almost all welding positions, and manual arc welding can be used for indoor, outdoor and underwater welding.

Application: fabrication of metal structures in different spatial positions.

Advantages: wide range of welding materials, versatility, simplicity of equipment, can be used in different environments, good transportability of equipment, easy setting of welding parameters, good weld quality, low noise level and purchase price.

Disadvantages: low productivity, use of handicrafts (cannot be mechanized), welding defects can occur (eg many starting and finishing points), a lot of welding gases are emitted.

PRINCIPLES OF MANUAL ARC WELDING



Manual arc welding 1

Manual arc welding 2

2. Gas welding

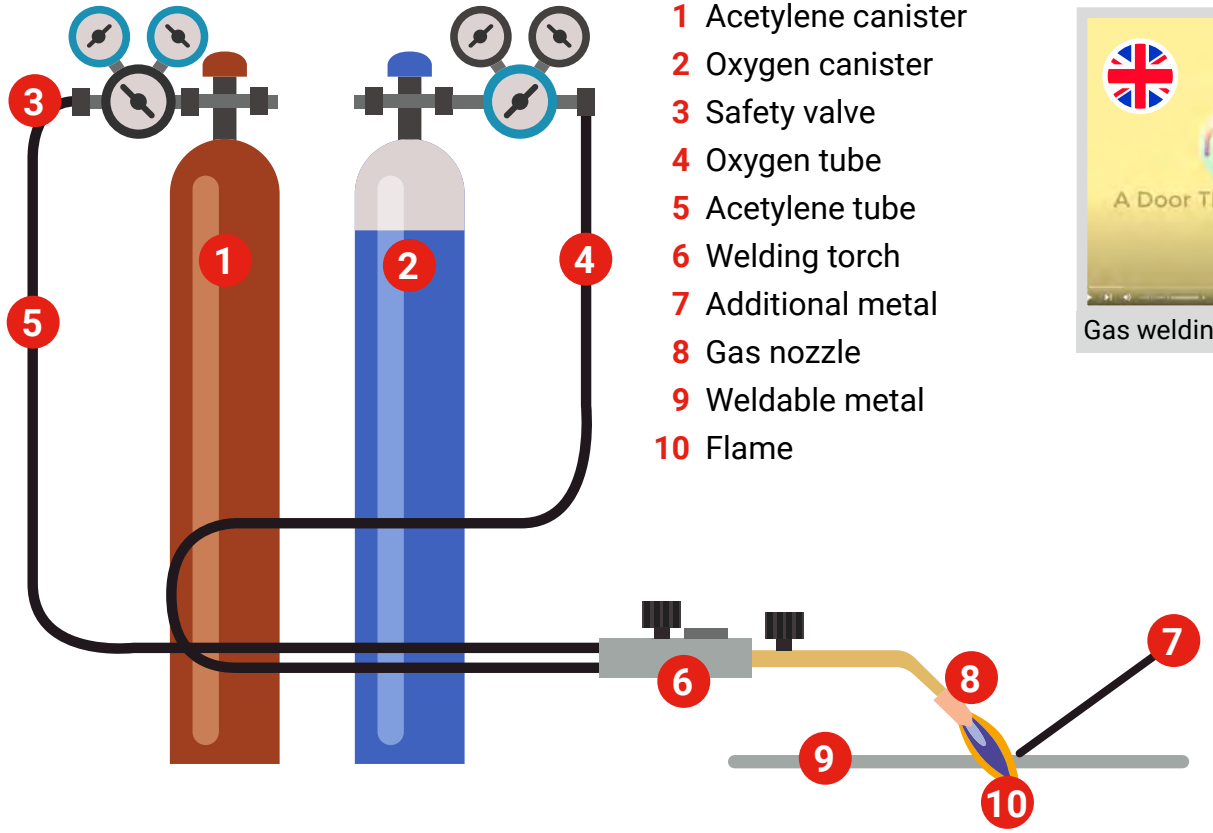
Gas welding is a process that does not require complex equipment or a source of electricity, and gas welding can weld almost all metals and their alloys used in modern industries. Combustible gases from gas welding include acetylene, propane, natural gas, hydrogen, gasoline, kerosene vapors and oxygen. Gas welding is mostly used in construction, agriculture and repair work.

Application: for welding small diameter pipes, especially for the installation of heating and hot water systems, for connecting water and gas pipes and other pipe structures.

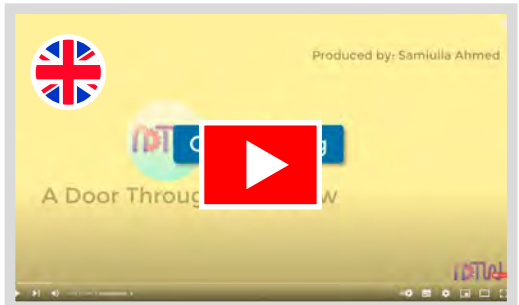
Advantages: suitable for welding almost all widely used metals, can be welded in cramped conditions, welding seams are visible to the welder, gas welding equipment is relatively inexpensive and easy to move.

Disadvantages: low productivity, low welding speed, high gas price and high explosion hazard, difficulties in ensuring stable quality.

PRINCIPLES OF GAS WELDING



1 Acetylene canister
2 Oxygen canister
3 Safety valve
4 Oxygen tube
5 Acetylene tube
6 Welding torch
7 Additional metal
8 Gas nozzle
9 Weldable metal
10 Flame



Gas welding

3. Shielded arc welding with fusible electrode (MIG / MAG, USA GMAW))

When welding with a melting electrode, a weld is formed by melting the base metal and the additional metal (electrode wire). For this reason, MIG / MAG welding is also called wire welding. This type of welding is called semi-automatic because the electrode feed is mechanized and the welding movement is done by the welder›s hand.

Arc welding in shielding gas is classified into two groups according to the properties of the shielding gas used:

MIG or inert gas arc welding (eg argon and helium, used for welding aluminum and copper alloys);

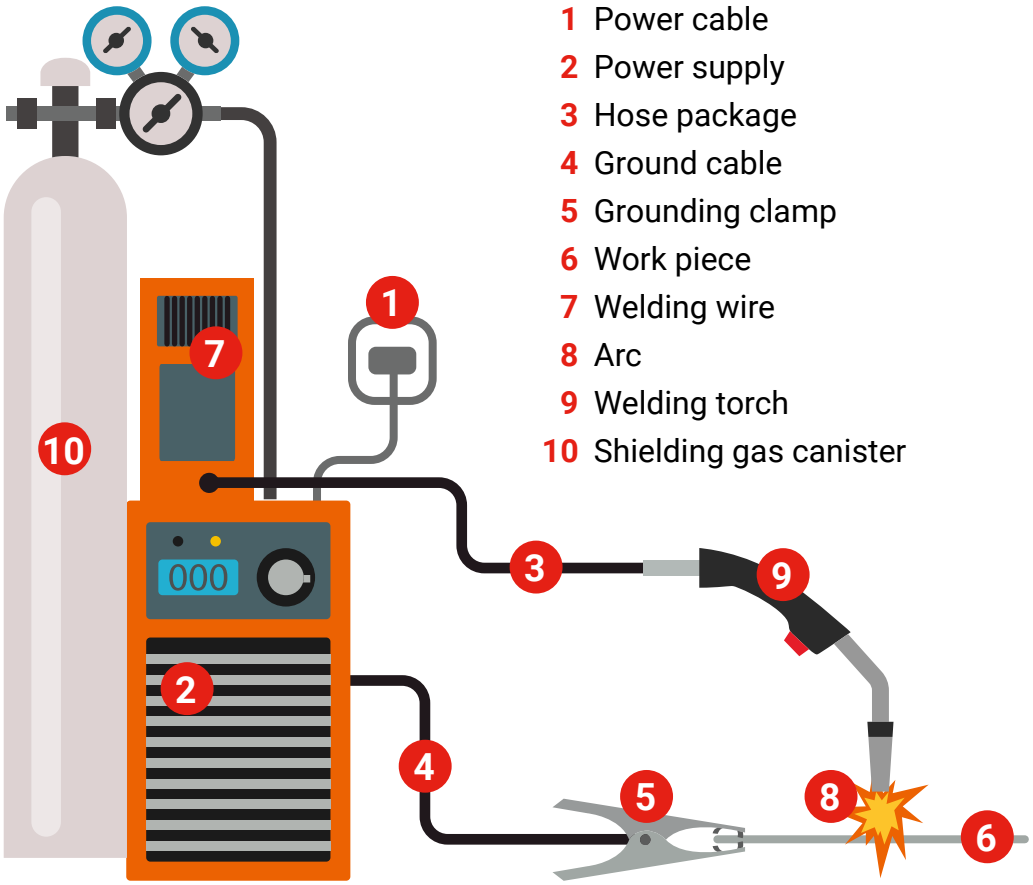
MAG or arc welding in active gas (eg carbon dioxide and its mixtures with other gases, used for welding structural and stainless steels).

Field of application: vehicle construction and repair, steel structures, bridge construction and mechanical engineering.

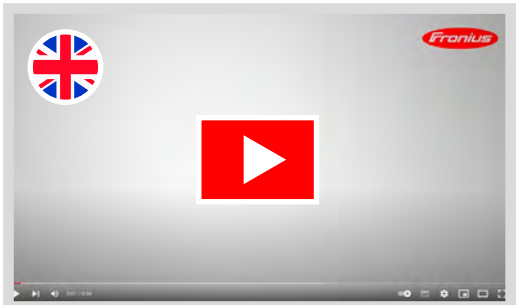
Advantages: higher productivity and welding speed, can be welded in all welding positions, better weld quality, easier to mechanize and automate, easy to use and short welder training, good protection of molten metal from ambient air.

Disadvantages: the necessary gas cylinder, which must be filled periodically, it is difficult to carry out welding outdoors.

PRINCIPLES OF MIG/MAG WELDING



1 Power cable
2 Power supply
3 Hose package
4 Ground cable
5 Grounding clamp
6 Work piece
7 Welding wire
8 Arc
9 Welding torch
10 Shielding gas canister



MIG/MAG welding 1

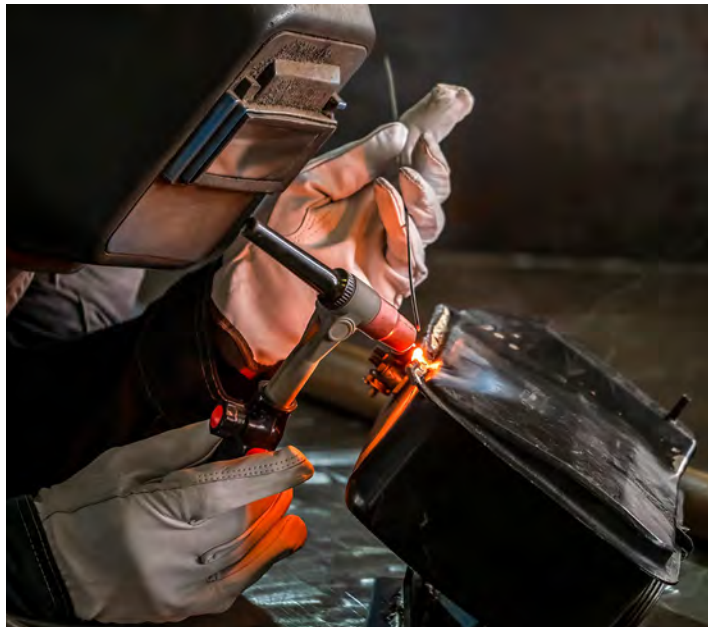
MIG/MAG welding 2

MIG/MAG welding 3

4. Non-fusible electrode shielding gas welding (TIG- welding, USA GTAW)

TIG welding (tungsten inert gas welding) is arc welding that takes place with a non-fusible (non consumable) electrode (tungsten) in an inert gas environment. Argon and helium or a mixture of argon and helium are used as shielding gases. All metals can be welded with TIG welding.

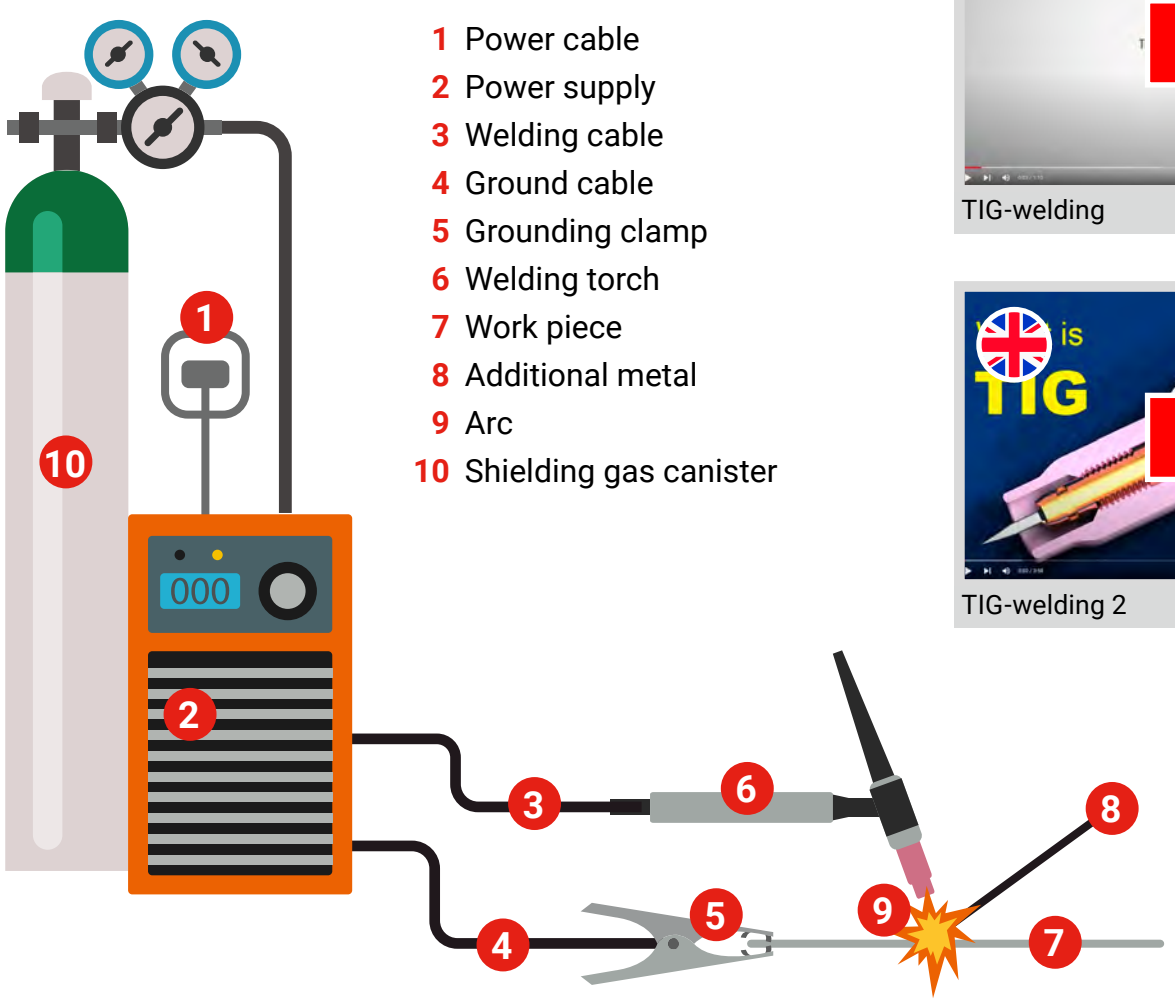
Areas of application: automotive industry, chemical industry, repair work (aluminum and magnesium and their alloys), metal structures, food industry, shipbuilding, pipeline construction, construction of pressure vessels and boilers, repair work (steels, stainless steels, nickel alloys, copper and its alloys), titanium alloys.



Advantages: suitable for welding all metals, very good quality, even weld, no additional metal is absolutely necessary, possibility of automation, can be used in all welding positions, suitable for welding thin metal.

Disadvantages: low productivity and low welding speed, necessary removal of rust and dirt before welding, not suitable for processing thick materials, the process requires skill, high cost of shielding gas.

PRINCIPLES ON TIG-WELDING



1 Power cable
2 Power supply
3 Welding cable
4 Ground cable
5 Grounding clamp
6 Welding torch
7 Work piece
8 Additional metal
9 Arc
10 Shielding gas canister

TIG-welding

TIG-welding 2

5. Plasma welding

Plasma welding is an arc welding process that uses compressed plasma arc energy as a heat source.

Field of application: automotive industry, manufacture of furniture accessories. In addition, various titanium, nickel and aluminum alloys are welded, such as stainless steel and aluminum pressure vessels and piping.

Advantages: high welding speed, good welding quality, possibility of automation.

Disadvantages: high cost of equipment, large dimensions of the plasma torch, which can restrict access to the welding site in tight conditions, wear of the plasma torch nozzles.

Plasma Arc Welding

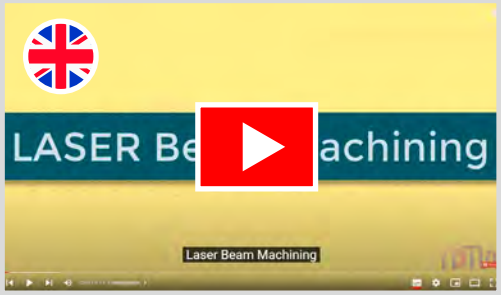
6. Laser welding

Laser welding uses a laser beam directed at the joint of metals. The source of the light beam is an optical quantum generator or laser. Laser welding is also used for cutting material.

Application: For joining metals, plastics and composites, for example in the electronics industry, shipbuilding and the automotive industry. Laser welding is also used, for example, in the repair of jewelery and spectacle frames.

Advantages: high welding speed and productivity, good welding quality, good mechanical properties of the weld, possibility of automation.

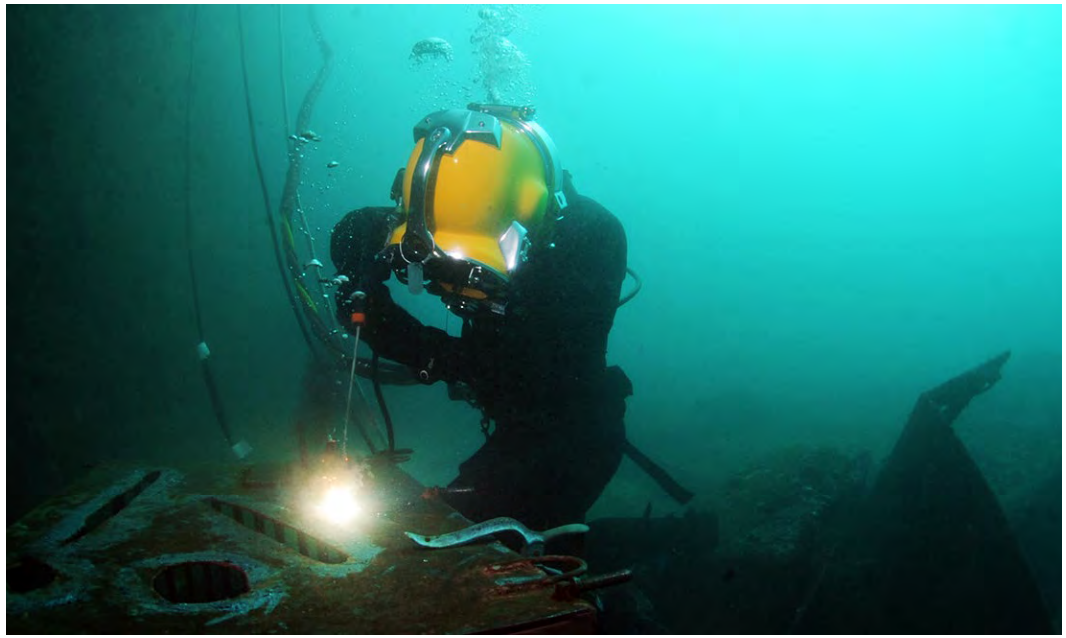
Disadvantages: high cost of equipment and relatively low efficiency, the need to use precise blanks.



Laser Beam Machining

Interesting examples!

1. Underwater welding



Saturation diving

Underwater welding

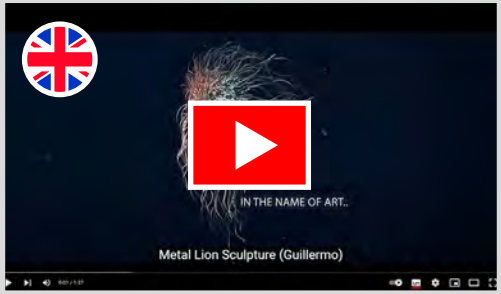
Underwater corrosion damage repair

Dangers of underwater welding

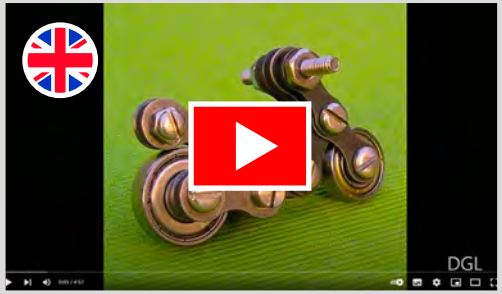
Pealtnägija: Estonian divers in Norway

2. Art of welding

40 Awesome Welding Art Projects Ideas



Unique Metal Sculptures



Scrap convert Into Motorbikes

PART III

Future studies and career information

OSKA Labor Force Survey 2016 said that 4370 welders work in Estonia and the demand for labor remains stable. The study can be found here.

Welding can be studied in the following vocational schools in both Estonian and Russian:

- Tallinn Lasnamäe School of Mechanics
- Ida-Virumaa Vocational Education Center
- Pärnu County Vocational Education Center
- Viljandimaa Vocational Education Center
- Tartumaa Vocational Education Center
- Rakvere Vocational School
- Võrumaa Vocational Education Center

The professional certificates of a welder are issued by the Estonian Association of Machinery Industry to both recent vocational school graduates and representatives of the world of work. More information: www.emliit.ee

It is possible to obtain a professional certificate:

1. **Welder, level 3**
   Unit invitations:
   a) Hand arc welder, level 3
   b) Semi-automatic welder, level 3

2. **Welder, level 4**
   Unit invitations:
   a) Hand arc welder, level 4
   b) Semi-automatic welder, level 4
   c) TIG welder, level 4

3. **Welder, level 5**

In the future, the **use of welding robots will increase**, as it will avoid human apse, the quality is guaranteed and stable, and the robots will be able to work 24 hours a day, 7 days a week.

Welding technology is used by many Estonian companies:

- BLRT
- ESTANC
- Viljandi Metall
- AQ Lasertool
- Maru Metall
- Fortaco Estonia
- Baltic Workboats
- Metalboss

Good examples!

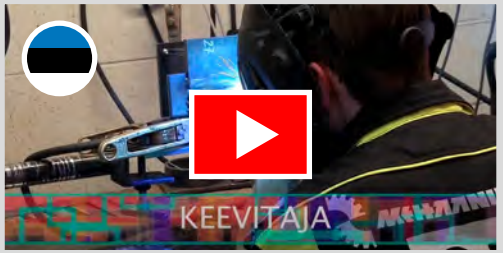
Under the leadership of Ida-Virumaa Vocational Education Center, the international **welding competition Viru Welder** is organized, which is popular both in Estonia and neighboring countries.

Many companies involved in the machine and metal industry work on a project basis, which means that if larger procurements are won, a large workforce is urgently needed who can come to the rescue immediately. Therefore, many welders are willing to work as temporary workers to provide flexible solutions for companies. **Good welders are very expensive.** Particularly high salaries are paid to submarine welders.

Rakvere Vocational School welding specialty intra-school professional competitions

Viru Welder keevitajate kutsevõistlused

Introduction to welding and metalworking classes at Pärnu County Vocational Education Center



Video introducing the profession of welder of Ida-Virumaa Vocational Education Center

Questions

Find the correct answers and add to the text:

1. Welding is classified into two groups: .... and ....

2. ..... are non-detachable joints made by welding.

3. A welded joint is used, for example, ... , ... and ....

4. The main work of a welder is ...., ..., ... and ..... .

5. The work of people engaged in welding work involves a constant risk due to, for example, ... , ... and ..... They wear special working clothes, gloves, hand protectors, boots, head- and hand masks and protective goggles and hoods, which are made of fireproof materials.

6. With the development of technology, new possibilities for higher quality welding work are constantly created, for example, automatic welding made with a special robot, which is called .....

7. .... by adding an additional heat source, the edges of the two parts to be joined are joined to the molten metal or to the alloy of the introduced additional metal and a common volume of molten metal, called ....., is formed. , Which in turn will be cooled and formed ....

Multiple choice (multiple selectable answers)

8. Which types of welding are included in fusion welding?
Choose one or more answers:
A. MIG / MAG welding
B. explosion welding
C. plasmwelding
D. gas welding

9. Which types of welding are included in pressure welding?
Choose one or more answers:
A. friction welding
B. laser welding
C. spot welding
D. gas welding

10. What are the advantages of welding compare to other joining technologies (for example soldering, bolting, riveting)?
Choose one or more answers:
A. speeancheapness
B. The quality of many welding processes depends on the professional skills of the welder
C. releases toxicompounds into the environment
D. can be usein various environments: air, vacuum, under water

11. What are the disadvantages of welding compareto other joining technologies (eg soldering, boltejoint, rivet joint)?
Choose one or more answers:
A. way to automate processes, eg welding robots
B. dangerous for the welder due to the use of high energy anhigh voltage electricity
C. high productivity
D. Welding defects may occur

12. In which jobs is manual arc welding or electrode welding used with coated electrode?
Choose one or more answers:

A. jewellery and spectacle frame repair
B. fabrication of metal structures in different spatial positions
C. for welding small diameter pipes
D. is used for welding all types of steel, cast iron, nickel, copper alloys and to limited extent for repair welding of aluminium

13. What are the advantages of gas welding compared to other types of welding? Choose one or more answers:

A. is suitable for welding almost all widely used metals
B. welding seams are visible to the welder
C. gas welding equipment is relatively inexpensive and easily portable
D. high cost of gases and high explosiveness

14. What are the disadvantages of laser welding compared to other types of welding?
Choose one or more answers:

A. high price of equipment
B. good mechanical properties of welded joint possibility of automation.
C. the need to use precise blanks

15. What shielding gases are used in TIG welding?
Choose one or more answers:

A. argon and helium
B. propan and helium or mixture of argon and helium
C. mixture of argon and helium
D. carbon dioxide and its mixtures with other gases

16. Which type of welding does not necessarily require additional material? Choose one or more answers:

A. Coated electrode manual arwelding (MMA) or electrode welding
B. Gas welding
C. Shielded arwelding with fusible electrode (MIG / MAG)
D. TIG welding

Short answer (find the correct answer)

17. Which welding process does not require complex equipment and electricity and can be used to weld almost all metals and their alloys used in modern industry?

18. What is arc welding inert gas (inert gas (eg argon and helium, used in welding aluminum and copper alloys) called?

19. What is arc welding in active gas (eg carbon dioxide and its mixtures with other gases, used for welding stainless steels)?

20. What is an arc welding process that takes place with an insoluble electrode in an inert gas environment using argon and helium or a mixture of argon and helium as a shielding gas?

21. What is arc welding where compressed plasma energy is used as a heat source?

22. What type of welding is also called wire welding?

Correct answers

1. fusion welding and pressure welding

2. welded joints

3. in mechanical engineering, production of metal structures, repair and restoration works.

4. preparation of welding work, preparation of construction according to the drawing, performance of welded joints, post-processing and control of results

5. bright flame from burning arched flame, emitted toxic smoke and handling of hot materials

6. robot welding

7. fusion welding, welding bath, weld

8. A, C, D

9. A, C

10. A, D

11. B, D

12. B

13. A, B, C

14. A, D

15. A, C

16. D

17. gas welding

18. MIG welding

19. 1MAG welding

20. TIG welding

21. plasma welding

22. Shielded arc welding with fusible electrode (MIG / MAG)

Practical tasks

Introduction to the welding machine and practical welding tasks

1. Project

Weld your name

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Draw down image on sheet of metal that you want to be welded.
3. Set up the welding machine.
4. Weld the desired image to the piece of sheet metal.
5. If necessary, clean / finish the welds.

Tools / utensils:

- welding machine,
- hammer,
- small table guillotine,
- dremel grinder.

Materials:

- piece of sheet metal (blank).

2. Project

Whistle

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Mark and cut the required blank from the pipe AISI304.
3. Clean the cutting degrees and cut / file the groove shown in the figure.
4. Prepare the lip section.
5. Set up the welding machine.
6. Weld mouthpiece.
7. Clean / finish welds.
8. If necessary, polish the product.

Tools / utensils:

- welding machine,
- hammer,
- band saw,
- file,
- Dremel grinder.

Materials:

- round pipe 20x2mm L30mm;
- round material d15mm L10mm.

3. Project

Hanger d6mm

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Mark and use a template and bend it to the desired shape
3. Set up the welding machine.
4. Weld the necessary welds.
5. Clean / finish welds.
6. If necessary, polish the product.

Tools / utensils:

- welding machine,
- hammer,
- bending machine,
- bending tool,
- Dremel grinder,
- metal band saw,
- file.

Materials:

- roundpipe d6mm L1000mm.

4. Project

Light Star

Tasks:

1. Familiarize yourself with welding safety requirements,
2. Mark and use a template and bend it to the desired shape.
3. Set up the welding machine.
4. Weld the necessary welds.
5. Weld staples to attach your plexiglass to your star image.
6. Clean / finish welds.
7. If necessary, polish the product.
8. Install LED lighting on your product.
9. Install a plexiglass cover on your product.

Tools / utensils:

- welding machine,
- metal guillotine,
- sheet metal bender,
- drill or cordless drill,
- hammer,
- mounting brackets,
- bending tool,
- dremel grinder,
- sheet metal scissors,
- file,
- pliers,
- screwdriver.

Materials:

- aluminum strip 1x100x500mm;
- plexiglass detail s3mm;
- LED strip;
- sheet metal screws.

5. Project

Reuse of sculptures

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Assemble an image you like.
3. If necessary, bend and modify the components.
4. Set up the welding machine.
5. Weld the necessary welds.
6. Clean / finish welds.
7. If desired, color your product.

Tools / utensils:

- welding machine,
- metal guillotine,
- sheet metal bender,
- drill or cordless drill,
- hammer,
- mounting brackets,
- bending tool,
- Dremel grinder,
- sheet metal scissors ,
- file,
- pliers,
- screwdriver,
- wire bender,
- spray paint.

Materials:

- choice of details.

6. Project

Snowflake sculptures

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Cut the necessary details from d6mm round material and create your own image.
3. If necessary, bend and modify the components.
4. Set up the welding machine.
5. Weld the necessary welds.
6. Clean / finish welds.
7. If desired, color your product.

Tools / utensils:

- welding machine,
- metal guillotine,
- hammer,
- mounting brackets,
- bending tool,
- dremel grinder,
- cutting pliers,
- file,
- pliers,
- band saw,
- wire bender,
- spray paint.

Materials:

- d6mm L1000mm.

7. Project

Spinner

Tasks:

1. Familiarize yourself with welding safety requirements.
2. Mark and d20mm required blanks L8mm - 3pcs.
3. Clean cutting degrees.
4. Set up the welding machine.
5. Ball bearing protection against splashes.
6. Weld saw blanks for ball bearings.
7. Clean / finish welds.
8. If necessary, polish the product.

Tools / utensils:

- welding machine,
- hammer,
- band saw,
- file,
- Dremel grinder.

Materials:

- ball bearing d25mm;
- d20mm required blanks L8mm - 3pcs.

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