Московский государственный технический университет
имени Н.Э. Баумана

Учебно-методическое пособие

В.П. Шевченко

Обучение чтению литературы на английском языке по специальности «Сварка»

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Пособие составляют оригинальные научно-технические тексты английских и американских авторов. Каждый текст является описанием одного из процессов сварки. Тексты сопровождаются терминологическими словарями и заданиями. Задания направлены на развитие навыков чтения, изучение лексического и грамматического материала, усвоение специальной лексики, т. е. на развитие умения работать с оригинальным текстом на английском языке.

Для студентов старших курсов, обучающихся на факультете МТ по специальности «Сварка».

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Предисловие

В учебно-методическое пособие включены тексты из оригинальной научно-технической английской и американской литературы по специальности «Сварка» для аудиторной и самостоятельной работы студентов.

Пособие состоит из шести уроков. В каждый урок включены задания по развитию навыков перевода, ведения беседы по основным проблемам, затронутым в текстах, задания по отработке лексических и грамматических конструкций.

Учебно-методическое пособие адресовано студентам старших курсов, обучающимся по специальности «Сварка».

UNIT 1

I. *Learn the words below*:

to abrade – шлифовать; очищать
weld bead – наплавленный валик (сварного шва)
bearings – лезвия ножей (режущего инструмента)
bolting – 1) болтовое соединение; 2) скрепление болтами
to bond – 1) связывать; соединять; 2) присоединять
to build up – наращивать; наплавлять
casting – 1) литье; разлив; отливка; 2) отливка (заготовка)
chatter – дрожание режущего инструмента
deposit – 1) *v* напылять; 2) *n* наплавленный слой
weld deposit – наплавленный металл
deposition – 1) наплавка; 2) покрытие; 3) отложение
to entail – влечь за собой; вызывать
poor finish – низкая чистота поверхности (окончательная обработка)
fumes – пары; испарения; дым
to fuse – плавить; fusion – плавка
to gall – стираться
to impede – препятствовать
item – изделие; (отдельный) предмет; единица оборудования
further metal – другой металл
overexposure – слишком длительное воздействие
to preclude – исключать; предотвращать
riveting – клепка; ряд заклепок; заклепочное соединение
strain relief – снятие (внутренних) напряжений
shears – ножницы
terminal – 1) зажим (сварочной установки, машины); 2) *зд*. электрод
resistance welding – контактная сварка; сварка сопротивлением
weldment – сварная деталь; сварное соединение; сварная конструкция

II. *Read and translate the text*.

Text 1A. Welding: General Conditions

Welding is the joining of two polycrystalline workpieces – usually of metal – by bringing their fitted surfaces into such intimate contact that crystal-to-crystal bonding occurs. Industrial welding usually entails local heat from a burning gas or an electric arc, or heat generated by electrical resistance. The fitted surfaces may melt together, or a filler rod may melt between them to form a connecting bridge. The only nonthermal welding process is cold welding. In this, joining is accomplished through controlled plastic deformation of the members being joined.

Since the heat of the electric arc may be concentrated and effectively controlled for fusion, several welding processes use this method for joining metal. The electric arc consists of a high-current discharge through a thermally ionized gaseous column referred to as[1] a *plasma*. This gas is composed of similar numbers of electrons and ions. The ions flow out of a negative terminal (cathode) and move toward the positive terminal (anode). In addition to the plasma there are other materials such as molten metals, slags, vapors, and neutral and excited gaseous atoms that are mixed together.

Oxides impede welding. A small disk of indium and another of silver will bond at room temperature when pinched between thumb and forefinger – but only if the surfaces are first abraded. Equally, there is the phenomenon of welding that is not wanted. A weld deposit builds up on the edge of a cutting tool, causing chatter or poor finish on the workpiece. Bearings gall when overloaded or underlubricated. The parts of an instrument that rub together while unfolding from a satellite in space bond together despite the cold. One remedy is to pair a metal with a nonmetal.

Some welding involves further metal in addition to the workpiece, as in brazing or soldering. More important is the joining of steel plates with a consumable electrode that penetrates the

joint and deposits a weld bead. Welding equipment can be simple, such as that used in a farm shop or in automotive repair shop or complex, as in an establishment which offers production joining as a business. Such establishments have positioners, shears, annealing furnaces, and booths for sand blasting and painting.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. As an industrial process, welding can be done in different environments, including open air, underwater and space. Regardless of location, however, welding remains dangerous and precautions must be taken to avoid burns, electric shock, poisonous fumes, and overexposure to ultraviolet light.

Note:

[1] referred to as – названный как

III. *Find the corresponding English equivalents from the text*:

авторемонтная мастерская; разряд высокого тока; отливки из серого чугуна; единственный нетепловой сварочный процесс; в равной степени; сварочные манипуляторы; контролируемая пластическая деформация; как в пайке твердым припоем или в пайке мягким припоем; затраты; отрицательный электрод (катод); свариваемые стальные основания; в конечном счете; камеры для пескоструйной очистки и окрашивания; гибка, изгиб; при перегрузке или плохой смазке; паровые котлы высокого давления; термически ионизированный столб газа; несмотря на холод; при осуществлении развертки; тесный контакт; поликристаллические заготовки; печь для отжига; спаривать; литые детали; при сжатии между большим и указательным пальцами; утечка жидкости; сельскохозяйственная мастерская; которые

трутся вместе; в том случае, если; фундаменты моторных генераторов; сварочные конструкции; холодная штамповка; присадочный пруток (при сварке); жесткий, негибкий; межкристаллическое соединение; выполнение технического проектирования; положительный электрод (анод); в дополнение к; предприятие; зажимные приспособления; одинаковый; атомные электростанции; чистовая обработка; преимущество прочности стали; кондиционеры; в сравнении с; не позволяет зазор; станины станков; конкурировать; источники постоянного тока.

IV. *Answer the following questions*.

1. What is welding?
2. What does industrial welding entail?
3. What is the only nonthermal welding process?
4. What does the electric arc consist of?
5. What is the plasma?
6. What other materials in addition to the plasma are there?
7. What impedes welding?
8. What phenomenon of welding is undesirable?
9. What is more important in welding?
10. What equipment can be used for welding?
11. What energy sources can be used in welding?

V. *Translate the following sentences with the Subjunctive Mood*.

1. In a number of cases, steel weldments can replace gray iron castings on an economic basis, but good engineering design practice would suggest that a valid decision could only be made if a casting redesign were carried out at the same time.

2. In the liquid and gaseous state, it is essential that no harmful chemical action (such as oxidation and forming of nitrides) occur, that gas occlusions escape, that flux inclusions be avoided, and that the material cool without tearing or cracking.

3. Safety precautions should be taken lest the ultraviolet light from the welding arc should cause the equivalent of sunburn or snow blindness.

4. It is required that the time for assembling and positioning the parts in the spot welder be greater than a few seconds necessary for making a spot weld; therefore, it is common practice to make multiple spot welds.

5. Without it, neither high pressure boilers nor nuclear power plants would be economically possible.

6. It is necessary that welding small sheets into a large sheet from which a car top is made be economical.

VI. *Translate the sentences with the Absolute Nominative Participle Construction*.

1. The arc must not be too long, as this gives an opportunity for contamination by the atmosphere, it being more difficult to control its application to the joint.

2. The current and voltage must be under close control, they being governed by the quality of equipment and its inherent regulating characteristics.

3. The arc being formed between the base metal and the electrode, the immediate surface is melted, and, with the use of an electrode that cannot conduct the heat away rapidly, some of the metal is vaporized.

4. The flux is easily removed, no arc flash appearing.

5. At the end of the flashing process fast convergence of the end faces is performed with a strong upset force, with the molten layer and oxide films being pressed out of the butt and the heated end faces undergo plastic deformation.

6. By flash welding with preheating workpieces are generally preheated with current before flashing, end faces being periodically clamped with a little force and released.

VII. Give a summary of Text 1A.

VIII. *Read and translate the text*.

Text 1B. Welding Versus Other Processes

Since 1920, welding has competed with riveting, bolting, casting. Without it, neither high pressure boilers nor nuclear power plants would be economically possible. A welded joint permits no play; nor, if continuous, will it allow leakage of fluid. The demand for sheet metal products, including items too thin in cross section to be cast, has increased markedly with the development of resistance welding. The cost of fixtures and of cleaning surfaces in preparation for finishing is generally less for welding than for casting, especially if the production quantity is low. Yet welding a given product can cost more in labor than casting it. Sometimes the expense of strain relief precludes a welded design.

In a number of cases, steel weldments can replace gray iron castings on an economical basis, but good engineering design practice would suggest that a valid decision could only be made if a casting redesign were carried out at the same time. A good example of superiority of weldments would be motor generator bases for dc power supplies or air conditioning units. Such welded steel bases are lighter and less expensive for about the same rigidity. On the other hand, most machine tool bases are cast if they are complex and if there are more than a few to be built.

The strength of cast components is equivalent to that of weldments provided equivalent designs and alloys are compared. In tension, gray iron is weaker and less stiff than steel; but in compression, the opposite is true; therefore, when there are combined stresses, as there are in most engineering applications, the strength advantage of steel is considerably reduced. Thus, it is

wise to analyze each design application carefully before deciding which production method is superior.

On balance, the designer of a product must consider both the properties of materials and the characteristics of available equipment. While welding is more costly than casting, bending, or cold forging in some cases, it is often the most useful – particularly if the material in question is easily welded and if suitable welding equipment has already been installed.

IX. *Answer the following questions*.

1. What has welding competed with since 1920?
2. What has increased markedly with the development of resistance welding?
3. What would good engineering casting practice suggest?
4. Is the strength of cast components equivalent to that of weldments provided equivalent designs and alloys are compared?
5. What must the designer of a product consider?

X. *Explain why welding is thought of as one of the most effective methods for joining metals.*

UNIT 2

I. *Learn the words below*:

adaptor – адаптер; переходник
blindness – слепота; ослепление
consumable – плавящийся; non-consumable – неплавящийся (об электроде)
core – электродный стержень
designation – обозначение
hard facing – наплавка твердым сплавом
ferrous – железистый; ferrous metals – черные металлы; nonferrous – цветной
light-gage – тонколистовой (о материале)
ground – заземленный провод
volumetric loss – объемные потери
occlusion – 1) окклюзия; 2) газовые включения; 3) механическое удержание газов твердыми металлами или расплавами
offshore – прибрежный, береговой
penetration – проплавление, проплав; глубина проплавления
molten pool – сварочная ванна
to shield – ограждать
speciality (specialty) – особенность; специфика
sunburn – солнечный ожог
torch – сварочная горелка
arc spot weld – дуговой точечный шов
shielded metal arc welding – дуговая сварка (плавящимся) покрытым электродом
gas tungsten arc welding – дуговая сварка вольфрамовым электродом в среде защитного (инертного) газа

II. *Read and translate the text*.

Text 2A. Arc Welding – Consumable Electrodes

SHIELDED METAL ARC WELDING

Manual arc welding is widely used in the construction and fabrication of metal sheets, plates, and roll formed products. The equipment includes a source of direct or alternating electric current, a ground, an electrode holder, and proper safety equipment. The latter consists of a helmet with dark eye protection, long sleeves, and a leather apron. Safety precautions should be taken lest the ultraviolet light from the welding arc should cause the equivalent of sunburn or snow blindness.

A conventional electrode forms a molten pool in the joint area. A gaseous shield and slag protect the weld deposit from oxidation and rapid loss of heat. Unskilled operators find the drag-type electrode, with large amounts of iron powder in the electrode coating, much easier to use. The iron powder increases the rate of deposition, but reduces the penetration and permits the core to burn away so that the coating can drag along the surface, with the arc length staying constant. Thereby a good deposit can be made by an operator with relatively little skill.

In shielded metal arc welding the arc is started by momentarily striking the electrode against the base metal and quickly withdrawing to form an arc. The arc must not be too long, as this gives an opportunity for contamination by the atmosphere, it being more difficult to control its application to the joint. The current and voltage must be under close control, they being governed by the quality of equipment and its inherent regulating characteristics.

The arc being formed between the base metal and the electrode, the immediate surface is melted, and, with the use of an electrode that cannot conduct the heat away rapidly, some of the metal is vaporized. These droplets and the vaporized metal flow

along the stream of the arc path to the base metal where they condense, build up, and solidify. (Motion-picture studies of this action have been made and are available from leading welding equipment suppliers.) Therefore, the arc process is primarily a localized casting process that is influenced by the action of the electrode, current, flux, and operator. In the liquid and gaseous state, it is essential that no harmful chemical action (such as oxidation and forming of nitrides) occur, that gas occlusions escape, that flux inclusions be avoided, and that the material cool without tearing or cracking.

Shielded metal arc welding is versatile and can be performed with relatively inexpensive equipment, making it well suited to shop jobs and field work. It is also often used in underwater welding in the construction and repair of ships, offshore platforms, pipelines, and in space. But it has the following disadvantages: weld times are rather slow, since the consumable electrodes must be frequently replaced and because slag, the residue from the flux, must be chipped away after welding. Furthermore, the process is generally limited to welding ferrous materials, though speciality electrodes have made possible the welding of cast iron, nickel, aluminum, copper, and other metals.

III. *Give the corresponding English equivalents from the text*:

ручная дуговая сварка; источник постоянного и переменного электрического тока; последний (из названных); разнородные металлы; шлем с защитными очками; строительство; изношенные и поврежденные штампы; локализованный процесс отливки; скорость наплавки; поддающийся сварке, сваривающийся; остаток от флюса; изделия проката; электрод с толстой обмазкой или с толстым покрытием.

IV. *Answer the following questions*.

1. Where is manual arc welding widely used?
2. What does the equipment include?

3. What does proper safety equipment consist of?

4. What can the ultraviolet light from the welding arc cause?

5. What protects the weld deposit from oxidation and rapid loss of heat?

6. What increases the rate of deposition but reduces the penetration?

7. What is the arc process influenced by?

V. *Translate the sentences with the Objective Infinitive Construction*.

1. The material is raised to a temperature that causes it actually to melt and, under pressure, it is fused or forged together.

2. By making a series of spot welds in rapid succession, the operator finds slight variations in contact pressure, surface conditions, and electrode contact resistance to result in a better weld.

3. The iron powder increases the rate of deposition, but reduces the penetration and permits the core to burn away so that the coating can drag along the surface, with arc length staying constant.

VI. *Translate the sentences with the Predicative Infinitive Construction*.

1. Automatic welding is reported to have been made possible due to the development of welding heads that strike the arc, feed the electrode, and maintain an arc of proper length and current.

2. A manually operated submerged arc welder is known to have been developed for the flexibility of hand operation and for the advantages of automatic welding.

3. Copper is known to be the best electrode material for general application.

4. Formerly a carbon electrode was also used, but in the 1950s the tungsten inert gas (TIG) process proved to be economically superior.

5. The operator is sure to be much more comfortable because of the absence of smoke, spatter, and visible arc rays.

VII. *Read and translate the text*.

Text 2B. Arc Welding – Non-consumable Electrodes

GAS TUNGSTEN ARC WELDING

In this process, the arc usually passes between a tungsten electrode and the metal joint. High temperature (up to 10,000 °F) is concentrated at the end of the arc, where a small pool of molten metal is formed. The arc passes from the electrode to the work and is shielded by an inert gas such as helium or argon or a mixture of the two. Formerly a carbon electrode was also used, but in the 1950s the tungsten inert gas (TIG) process proved to be economically superior. The TIG name is still used in the shop but the AWS[1] designation is technically gas tungsten arc welding.

TIG welding was originally developed for joining magnesium alloys, but it is now used for all alloys. It is particularly adapted to welding dissimilar metals and for hard facing worn or damaged dies. It can also be adapted to welding light-gage sheet. It is often used when quality welds are extremely important, such as in bicycle, aircraft and naval applications.

In general, an ac power source is best for TIG welding nonferrous alloys except deoxidized copper. For ferrous alloys, the dc power source with straight polarity (electrode negative) is better for gas tungsten arc welding because it greatly reduces the volumetric loss from the tungsten electrode. For example, a TIG torch that has a rating of 250 A when used with straight polarity

(dcsp) must be de-rated to 15 to 25 A when used with reverse polarity (dcrp-electrode positive).

Arc spot welds can also be made with a TIG torch fitted with special adaptors. In this case a 1/8 in. electrode is often used for a total cycle time of 1/2 to 3 s depending on the alloy and its thickness.

Note:

[1]AWS (American Welding Society) – Американское общество специалистов по сварке

VIII. *Answer the following questions*.

1. What gas is used in TIG welding?
2. What process was TIG welding originally developed for?
3. What is it particularly adapted to now?
4. What power sources are best for TIG welding nonferrous and ferrous alloys?
5. How can arc spot welds also be made?

IX. *Speak about the difference between the consumable electrode arc welding and non-consumable electrode arc welding.*

UNIT 3

I. *Learn the words below*:

series arc – косвенная дуга (между двумя электродами)
welding gun – 1) сварочный пистолет; сварочная горелка; 2) сварочные клещи
reverse polarity – обратная полярность
straight polarity – прямая полярность
spatter – 1) брызги (при сварке); всплески (при плавке); 2) разбрызгивание
tooling – технологическая оснастка; инструментальная оснастка
pressure vessel – сосуд высокого давления; камера высокого давления
gas metal arc welding – дуговая сварка металлическим (плавящимся) электродом в среде защитного газа
metal active gas (MAG) welding – дуговая сварка плавящимся электродом
metal inert gas (MIG) welding – дуговая сварка плавящимся электродом в среде инертного газа
submerged arc welding – дуговая сварка под флюсом

II. *Read and translate the text. Retell the text.*

Text 3A. Submerged Arc Welding

Automatic welding in conjunction with proper tooling has three broad types of applications: circular welds, linear welds, and mass production of identical parts. Automatic welding is reported to have been made possible due to the development of welding heads that strike the arc, feed the electrode, and maintain an arc of proper length and current. The metal electrode wire is coiled on reels and fed continuously. These heads are mounted on adjustable supports that may move along the welded

joint, or the part to be welded may move under the head. Various kinds of equipment are available for clamping the parts into position, for positioning the part, and for feeding the wire electrode.

The submerged arc is an important process used with automatic welding equipment. The automatic submerged arc processes include:

1) single ac or dc – straight or reverse polarity (this is the most common method);

2) series arc – ac (used for cladding);

3) three-phase, two-wire – ac, dc, or combination ac and dc;

4) multiwire – ac for high deposition rates.

Submerged arc welding is used in connection with automatic and semi-automatic welding equipment. The submerged arc process uses a mineral powdered flux that surrounds the electrode and arc. The electrode can melt rapidly and fuse with the parent metal under a protective atmosphere. The flux is easily removed, no arc flash appearing. The operator judges the proper location by observing the general direction of the wire and the welded material. High current densities (up to 40,000 A/in.^{2}) and high rates of metal deposition are possible with high quality, deep penetration, and high welding speed.

Direct current automatic welding seldom uses currents above 600 to 1000 A, and is used usually for alloy and stainless steels. Alternating current welding, which predominates, uses currents up to 2000 A for standard equipment, and more for special equipment; ac welding is usually used for low carbon steels.

A manually operated submerged arc welder is known to have been developed for the flexibility of hand operation and for the advantages of automatic welding. The electrode wire (1/8 in.) is fed through a flexible tube up to 55 in./min, and with 450 A of current applied at the nozzle. The powdered flux is fed around the electrode at the nozzle by compressed gas which carries the

powder through a tube connected to the nozzle. The operator is sure to be much more comfortable because of the absence of smoke, spatter, and visible arc rays.

Submerged arc welding is a high productivity welding method in which the arc is struck beneath a covering layer of flux. This increases arc quality since contaminants in the atmosphere are blocked by the flux. The slag that forms on the weld generally comes off by itself, and combined with the use of a continuous wire feed, the weld deposition rate is high. Working conditions are much improved over other arc welding processes since the flux hides the arc and almost no smoke is produced. The process is commonly used in industry, especially for large products and in the manufacture of welded pressure vessels. The process of arc welding is widely used because of its low capital and running costs.

III. *Give the corresponding English equivalents from the text*:

минеральный порошковый флюс; поддерживает дугу надлежащей длины и ток; проволока наматывается на катушки и подается непрерывно; плакирование, покрытие; массовое производство одинаковых деталей; зажигает дугу; основной металл (сплава); отсоединяется; совместно с надлежащей инструментальной оснасткой; загрязняющие вещества; высокопроизводительный сварочный метод; низкие капитальные затраты и эксплуатационные расходы; углекислый газ; на улице, на открытом воздухе; ручной сварочный аппарат для дуговой сварки под флюсом; низкоуглеродистая сталь; кольцевой (круговой) сварной шов; летучесть; легированная сталь; сварочная головка; хрупкость; сопло, наконечник (горелки).

IV. *Answer the following questions*.

1. What is meant by submerged arc welding?
2. What do the automatic submerged arc processes include?
3. What is the principle of operation of a manually operated submerged arc welder?
4. Where is the submerged arc welding used?

V. *Translate Participles I and II in the function of an attribute*:

burning gas; heat generated by electrical resistance; connecting bridge; controlled plastic deformation; members being joined; thermally ionized gaseous column; arc being formed between the base metal and the electrode; equipment used in a farm shop; unskilled operators; inherent regulating characteristics; vaporized metal; leading welding equipment suppliers; compressed gas tube connected to the nozzle; process used with automatic welding equipment; mineral powdered flux; current applied at the nozzle; electrical equipment producing the current; originally developed for welding.

VI. *Translate the sentences with Participles I and II in the function of an adverbial modifier*.

1. A small disk of indium and another of silver will bond at room temperature when pinched between thumb and forefinger – but only if the surfaces are first abraded.
2. A weld deposit builds up on the edge of a cutting tool, causing chatter or poor finish on the workpiece.
3. Bearings gall when overloaded or underlubricated.
4. The parts of an instrument that rub together while unfolding from a satellite in space bond together despite the cold.
5. For example, a TIG torch that has a rating (номинальный предел) of 250 A when used with straight polarity (dcsp) must

be de-rated (разгрузить) to 15 to 25 A when used with reverse polarity (dcrp-electrode positive).

VII. *Read and translate the text. Put three questions to the text.*

Text 3B. Gas Metal Arc Welding

Gas metal arc welding, sometimes referred to by its subtypes *metal inert gas (MIG) welding* or *metal active gas (MAG) welding*, is a semi-automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. Shielding gases (argon and carbon dioxide) are necessary for gas metal arc welding to protect the welding area from atmospheric gases such as nitrogen and oxygen, which can cause fusion defects, porosity, and weld metal embrittlement if they come in contact with the electrode, the arc, or the welding metal. At constant voltage, direct current power source is most commonly used with gas metal arc welding, but direct current systems, as well as alternating current ones, can be used.

Originally developed for welding aluminum and other nonferrous materials in the 1940s, gas metal arc welding was soon applied to steels because it allowed for lower welding time compared to other welding processes. The cost of inert gas limited its use in steels until several years later, when the use of semi-inert gases such as carbon dioxide became common. Further developments during the 1950s and 1960s gave the process more versatility and as a result, it became a highly used industrial process. Today, gas metal arc welding is commonly used in industries such as the automobile industry, where it is preferred for its versatility and speed. Unlike welding processes that do not employ a shielding gas, such as shielded metal arc welding, it is rarely used outdoors or in other areas of air volatility.

VIII. *Name and explain which of the four arc welding processes is the most popular one now.*

UNIT 4

I. *Learn the words below*:

circuit – контур; цепь; схема
consistent – 1) подходящий; совместимый; 2) последовательный
consistency – 1) стабильность; 2) последовательность; 3) согласованность
resistivity force – (удельное) давление
impedance – полное сопротивление
to necessitate – 1) требовать; 2) неизбежно влечь за собой
mating parts – сопряженные детали
shot – выплеск; заряд (тока); ввод; взрыв
resistance weld – соединение, полученное контактной сваркой
butt welding – стыковая сварка; сварка встык
flash welding – стыковая сварка оплавлением
percussion welding – ударная сварка
projection welding – рельефная сварка
seam welding – шовная сварка
spot welding – точечная сварка

II. *Read and translate the text*.

Text 4A. Resistance Welding (Part I)

Resistance welding is the heating of material at the junction to be welded by local resistance to passage of electric current. Spot, projection, seam, flash, percussion, and butt welding are forms of resistance welding. The material is raised to a temperature that causes it actually to melt and, under pressure, it is fused or forged together. The principle is the same as that used in any blacksmith-forged joint.

The amount of heat depends upon the amount of current and the length of time it is applied ($H = I^2RT$). The amount of current depends upon the voltage applied and the total resistance or impedance of the circuit; therefore, voltage must be consistent regardless of variations in the power required. Some welding equipment, especially that used for welding aluminum, places heavy demands on power lines and often requires special feeders and transformers to maintain suitable electrical capacity and voltage. The total resistance or impedance of the welding or welding equipment's circuit depends upon the following factors.

1. The impedance of the welding circuit varies as the position of the part within the welder changes. If the part is magnetic, the lines of force will pass through the material and reduce the current. Therefore, if a resistance weld is made when a small portion of the part is near the electric circuit, it will receive more current than it does when the part is moved, so that a large portion is included in the electric circuit.

2. The resistance or impedance of the electrical equipment producing the current influences the amount of current. These parts can be designed with suitable electronic control, so that variations in current can be compensated for, to a great extent, even variations in position of part, line voltage, and resistance of the joint.

3. Resistance of the joint is composed of:

a) contact resistance between electrodes or clamps and material;

b) contact resistance at joint of mating parts;

c) base resistance of mating material;

d) resistance of the electrodes.

Contact resistances (3.a and 3.b above) are significantly affected by the surface conditions such as cleanliness, uniformity, and freedom from oxides and other compounds. Also, contact

resistances are directly related to the resistivity of the materials being joined and resistivity force.

The base material resistance is proportional to the resistivity of the metal and the length of the current path.

III. *Give the following English equivalents from the text*:

в значительной степени; требовать; соединение, выполненное кузнечной сваркой; пропорционально сопротивлению металла; электрическое распределительное устройство; предъявляет огромные требования; вызывает искажение; смежный; публика, общественность.

IV. *Answer the following questions*.

1. What is resistance welding?
2. What forms of resistance welding do we know?
3. What does the amount of heat depend on?
4. What does the amount of current depend on?
5. What are contact resistances significantly affected by?

V. *Translate the sentences paying attention to the functions of the Infinitive*.

1. First, mechanical devices were developed to apply proper pressure and control the length of time the current was applied.
2. Sometimes the parts do not have proper contact at the joint of the weld and considerable pressure is required to force the two surfaces together and make a weld at the place desired.
3. In all projection welding, it is necessary to have point or line contact in order to start a weld.
4. The initial pressure should be great enough to obtain contact and then provide a forging action.

5. As outlined under the general principles of resistance welding, the greatest resistance should be between the two parts to be joined.

6. The important factor to control the metal properties is the time at those temperatures.

VI. *Discuss three factors that affect the total resistance or impedance of the welding and welding equipment's circuit*.

VII. *Read and translate the text*.

Text 4B. Resistance Welding (Part II)

One should understand that in resistance welding high resistivity materials necessitate greater consideration of base material resistances, while low resistivity materials such as aluminum call for more consideration of contact resistances. Successful application of resistance welding to designs depends upon consistency of material composition, surface, pressure and current applied, and time of their application. Low carbon steel is known to be the most common material welded by resistance welding.

Resistance welding is usually performed with alternating current. The greatest advance in the use of various forms of resistance welding came in the early 1920s when engineers realized that consistency in each of the related factors would assure good welds. First, mechanical devices were developed to apply proper pressure and control the length of time the current was applied. Recently, with air and hydraulic systems for applying pressure at the correct time and in the right amount through electronic controls, resistance welding has been advanced. The length of time for applying current can be controlled from one-half cycle to as many cycles as desired. A shot of high current for a short time produces the best weld, since the heat is concentrated at the

joint and does not have time to spread, cause distortion, or affect the material adjacent to the joint. Resistance welds in automobiles, airplanes, passenger cars, and all forms of sheet metal equipment are accepted without question on the part of the public and in many cases have replaced arc welding and riveting. Equipment designed for resistance welding (such as electrical switch gear) has reduced scrap, weight, and labor, and has increased the use of standard parts. In general, resistance welding methods are efficient and cause little pollution, but their applications are limited to relatively thin materials and the equipment cost can be high.

VIII. *Answer the following questions*.

1. What do high resistivity materials necessitate?
2. What do low resistivity materials such as aluminum call for?
3. What does successful application of resistance welding to designs depend on?
4. What is the most common material welded by resistance welding?
5. What current is applied in resistance welding?
6. What advantages does equipment designed for resistance welding offer?

IX. *Give a summary to Text 4B*.

UNIT 5

I. *Learn the words below*:

assembling – сборка, монтаж
to file – опиливать; зачищать напильником
guide – (*техн*.) справочник; руководство; инструкция (по эксплуатации)
to machine – обрабатывать на станке
to mushroom – расплющивать (расклепывать) в виде шляпки гриба (об электроде)
positioning – размещение; расположение
to regain – восстановить; получить обратно
softening – размягчение
squeezing – сжатие; сдавливание; обжатие; обжим
shear strength – предел прочности при сдвиге
tensile strength – предел прочности на растяжение
gas-tight – газонепроницаемый; герметичный
liquid-tight – непроницаемый для жидкости; герметичный
portable welder – 1) дуговой сварочный полуавтомат; 2) переносная (сварочная) машина для точечной сварки
projection weld – соединение, полученное при рельефной сварке

II. *Read and translate the text. Retell the text*.

Text 5A. Spot Welding

Spot welding, the most common form of resistance welding, consists of joining two pieces of material by placing them between two electrodes and passing a current to heat the material sufficiently at the joint to cause plastic flow and the union of the two parts. The parts are held together while they cool sufficiently to regain mechanical strength. As outlined under the general principles of resistance welding, the greatest resistance

should be between the two parts to be joined. The initial pressure should be great enough to obtain contact and then provide a forging action. The current must be controlled to give sufficient heat yet not melt or burn the material.

The diameter of the electrode end must remain the same and not mushroom and increase the area of contact. When this happens, the current density is reduced. The area increases in proportion to the square of the diameter, and the heat generated is reduced in proportion to the square of the current (I^2R); therefore, the electrodes should be machined to size and should not be filed by an operator. The contact surface should meet the material surface evenly. The electrodes are usually water-cooled to prevent softening. Electrodes of special alloys are stronger, but have more electrical resistance. Copper is known to be the best electrode material for general application.

Spot welds, unlike rivets, require no holes or riveting, heading, or squeezing operations. The spot can be placed easily because the operator can see the work as the weld is made. It is required that the time for assembling and positioning the parts in the spot welder be greater than a few seconds necessary for making a spot weld; therefore, it is common practice to make multiple spot welds. Strength equivalent to that of riveted joints can be obtained by an equivalent spot welded structure. Since there is no movement of joints, squeaks are avoided. Shear and tensile strength are close to that of the material welded. The strength of spot welds should be determined by experiment, using material and equipment suppliers' data as a guide. Portable spot welders are used to join members in large structures. They permit the same flexibility that is obtained with riveting air hammers.

Sometimes the parts do not have proper contact at the joint of the weld and considerable pressure is required to force the two surfaces together and make a weld at the place desired. This

condition may cause a poor weld. Multiple welds made with electrodes in series or parallel are difficult to make unless all factors are controlled. For this reason, projection welding has come into general use.

The advantages of spot welding include efficient energy use, limited workpiece deformation, high production rates, easy automation, and no required filler materials. Weld strength is significantly lower than with other welding methods, making the process suitable for only certain applications. It is extensively used in the automotive industry – ordinary cars can have several thousand spot welds.

III. *Give the corresponding English equivalents from the text*:

согласно общим принципам; вошла в общее использование; множественные швы, сделанные электродами последовательно и параллельно; пневматический молот; рельеф (рельефной сварки); самая распространенная форма контактной сварки; высадка (головок); пропорционально квадрату диаметра; позволяют ту же гибкость; пластическая деформация; присадочные материалы; без окалины.

IV. *Answer the following questions*.

1. What does spot welding consist of?
2. When is the current density reduced?
3. Why shouldn't the electrodes be filed by an operator?
4. What is used to join members in large structures?
5. When is it difficult to make multiple welds?

V. *Translate the following sentences from Russian into English*.

1. Сваривать два куска металла значит соединить их под воздействием (under the influence) тепла, обеспечивая со-

единение как можно более однородным (as homogeneous as possible).

2. Точечная сварка обычно используется при сварке определенных типов тонколистового металла.

3. Вскоре за дуговой и газовой сваркой последовала сварка сопротивлением.

4. Томсон первый усовершенствовал (to perfect) процесс контактной сварки и разработал его до практического применения.

5. Образование усадочной раковины (shrinkage) может вызывать остаточные напряжения (residual stresses) как в радиальном (radial), так и в окружном (rotational) направлениях.

VI. *Read and translate the text*.

Text 5B. Projection Welding

Projection welding is the use of a projection on one or both pieces to be welded, which forms a spot weld. More than one projection weld can be made at a time, as the area and location of the spot weld and contact pressures can be controlled. The current will be distributed uniformly between the multiple spots and good welds will result. Spot- and projection-welded joints, like riveted joints, are not liquid- or gas-tight; therefore, seam welding was developed to make a continuous joint.

In all projection welding, it is necessary to have point or line contact in order to start a weld. When joining dissimilar sections, the projection should be placed on the heavier part. Heavy sections lend to joining by projection welding. The American Welding Society's "Recommended Practices for Resistance Welding" include recommended projections for sheet and plate sections up to 0.50 in. It should be remembered that as sections

increase in thickness, the diameter and height of projections are increased to develop greater strength.

Only clean, scale-free surfaces should be used in projection welding. A dirty surface will cause considerable variation in the resistance between the parts being joined, with resulting variation in current flow and weld strength.

Line projection welds are recommended over point welds when sections are subject to heavy static or dynamic loads.

VII. *Answer the following questions*.

1. What is projection welding?
2. Is it necessary to have a point or line contact in order to start a weld?
3. When should the projection be placed on the heavier parts?
4. What surfaces should be used in projection welding?
5. When is projection welding recommended?

VIII. *Translate the text in written form without a dictionary (time – 10 min)*.

Percussion welding is similar to flash, stud[1], and spot welding in that a very high current is passed instantaneously through the surfaces to be joined, and the parts are joined immediately thereafter. The parts are moved toward one another rapidly. Just prior to contact the current is passed through the two conductors being joined. This is usually accomplished by the discharge of a condenser. Dissimilar metals are welded with very little penetration of the heat within the parts.

Stored energy welding[2] involves an electrical means of storing and releasing large amounts of energy. Spot or percussion welding utilizes a condenser or a transformer circuit, or a combination of the two. Thus, less capacity is required in feeder

lines and transformers. Stored energy systems are used frequently for welding aluminum.

Notes:

[1] stud welding – приварка шпилек или шипов

[2] stored energy welding – сварка накопленной энергией, импульсная сварка

UNIT 6

I. *Learn the words below*:

abutting – стыкуемый; примыкающий; смежный; упирающийся торцом
to blast – 1) взрывать; 2) дуть; продувать
butt – 1) стык; соединение встык; 2) конец; торец
cabinet – корпус; ящик; шкаф; отделение; секция
to converge – 1) сходиться, сливаться; сводить в одну точку; 2) *зд*. сближать(ся)
movable die – 1) подвижная половина формы; 2) подвижная матрица
end face – торец
flashing – 1) вспыхивание; блеск; сверкание; искрение; 2) оплавление
upset force – усилие усадки
interface – поверхность контакта; граница раздела
intermittent – прерывистый (о шве)
overlapping – перекрытие
lap-joint seam – шов соединения внахлестку
seam weld – сварной шов
flash butt resistance welding – стыковая контактная сварка оплавлением
upset butt welding – стыковая сварка сопротивлением
upset welding – стыковая сварка с осадкой (методом сопротивления)

II. *Read and translate the text*.

Text 6A. Flash Butt Welding

Flash welding is a resistance welding process where joining is produced simultaneously over the entire area of abutting surfaces.

The flash butt welding process produces a homogeneous weld between two sheets, wires, or bars, without overlapping and without the addition of any materials. Dissimilar materials may be flash- and butt-welded. Flash welding is limited only by the amount of current available to heat the surfaces and the pressure available for forging the parts together. Flash welding joins sheets together in fabricating the typical automobile body. It is necessary that welding small sheets into a large sheet from which a car top is made be economical.

Flash butt resistance welding, in its turn, is divided into continuous flash welding and flash welding with preheating.

By continuous flash welding voltage is supplied from the welding transformer to upset welding dies and workpieces, respectively, and the workpieces start converging at an initial comparatively low speed. Convergence of workpieces is performed due to movement of the movable die ensured by the flashing drive. When the workpieces contact each other, separate contact connectors are formed between their end faces, get melted down with current, blast and escape from the butt in the form of sparks. Further convergence of workpieces results in formation of new contacts and their meltdown to take place continuously within the flashing process, which leads to heating of the end faces and formation on them of a molten metal layer. At the end of the flashing process, fast convergence of the end faces is performed with a strong upset force, with the molten layer and oxide films being pressed out of the butt and the heated end faces undergo plastic deformation.

By flash welding with preheating workpieces are generally preheated with current before flashing, end faces being periodically clamped with a little force and released. In this case, heating during clamping of the workpieces is similar to that of during upset butt resistance welding. The welding process is further performed similarly to continuous flash welding.

III. *Give the corresponding English equivalents from the text*:

в производстве обычного автомобильного корпуса; предварительный нагрев; расплавление; заклепка; цилиндрические цистерны (баки); консервная банка для напитков; в свою очередь; привод для оплавления; подвергаются пластической деформации; сближение; за один прием, за один раз.

IV. *Answer the following questions*.

1. What is flash welding?
2. What does the flash butt welding process produce?
3. Where is flash butt welding used?
4. What is flash butt resistance welding divided into?
5. What takes place during continuous flash welding?
6. What occurs during flash welding with preheating?

V. *Translate the word groups in Russian by their English equivalents using the Infinitive*.

1. Уместно (wise) проанализировать each design application carefully before deciding which production method is superior.

2. Most machine tool bases are cast if they are complex and if there are more than a few, которые нужно построить.

3. The parts are held together while they cool sufficiently, чтобы получить (gain) механическую прочность.

4. Portable spot welders are used для соединения элементов (members) in large structures.

VI. *Give a summary of Text 6A*.

VII. *Read and translate the text*.

Text 6B. Seam Welding

A seam weld is a joint being continuously welded by the resistance welding process. The electrodes are disks which are driven as the two pieces to be welded pass between them. Pressure and current are applied to the joint, as in spot welding. When seam or continuous welding was first developed, the current was continuous, but the heat was difficult to control. It was soon discovered that overlapping spot welds was more successful. By making a series of spot welds in rapid succession, the operator finds slight variations in contact pressure, surface conditions, and electrode contact resistance to result in a better weld. Representative seam welds are 12 spots per inch on stock 0.01 in. thick at a speed of 100 in./min, and 5 spots per inch for 1/8 in. thickness at a speed of 25 in./min. Water is sprayed on the electrodes to cool them and the weld material. Sometimes only one roller is used and a bar is substituted for the lower roller. More than one seam weld can be made at a time on special machines. An example of this is welding parallel seams in refrigerator radiator shells. Most seam welding is limited to sheet metals 0.01 to 0.125 in. thick. Intermittent spots are made rapidly on seam welding equipment – 600 spots per minute, 1/2 in. apart.

In the past, this process was used in the manufacture of beverage cans, but now its uses are more limited. Now seam welding is applied to lap-joint seams of cylinders and cabinets and to circular seams for welding bottoms in ends of cylindrical tanks.

VIII. *Answer the following questions*.

1. What is a seam weld?
2. What are electrodes?

3. What is applied to the joint?

4. Why was overlapping spot welds more successful?

5. How many seam welds can be made at a time on special machines?

6. Where is seam welding applied?

IX. *Speak on the following topics*.

1. The applications of all forms of resistance welding in industry.

2. The advantages and disadvantages of all forms of resistance welding.

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Contents

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