

Welding is...



Welding and Allied Processes



ИСТОРИЯ РАЗВИ





Nikolay Nikolayevich Benardos

(Russian: Никола́й Никола́евич
Бернардо́с)

(1842–1905)

was a Russian inventor
of Greek origin who in
1881 introduced
carbon arc welding,
which was the first
practical arc welding
method.

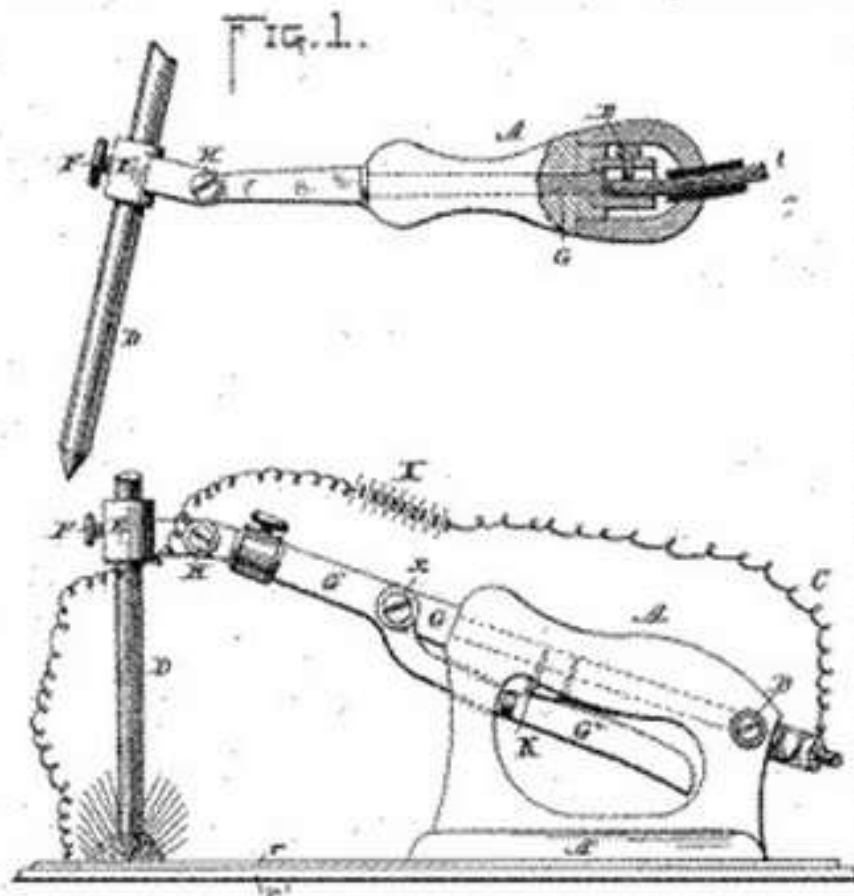
https://en.wikipedia.org/wiki/Nikolay_Benardos

N. DE BENARDOS & S. OLSZEWSKI.

PROCESS OF AND APPARATUS FOR WORKING METALS BY THE DIRECT APPLICATION OF THE ELECTRIC CURRENT.

No. 363,320.

Patented May 17, 1887.



Witnesses—
E. W. ...
Marvin A. Curtis

Inventors—
Nicholas de Benardos
& Stanislas Olszewski
by Maurice ...

Установка Н. Н. Бенардоса для сварки неплавящимся угольным электродом





Nikolay Gavrilovich Slavyanov

(Russian: Никола́й Гаври́лович
Слава́нов:

(5 May 1854 – 17 October 1897)
was a Russian inventor who
in 1888 introduced arc
welding with consumable
metal electrodes,
or shielded metal arc
welding, the second
historical arc welding
method after carbon arc
welding invented earlier
by Nikolay Benardos.

https://en.wikipedia.org/wiki/Nikolay_Slavyanov



Professor Evgeny Oscarovich Paton

(Russian: Евгений Оскарович Патон)
(1870–1953)

was a Russian and Soviet engineer who established the E. O. Paton Electric Welding Institute in Kiev. Paton was a people's deputy of the Supreme Soviet of the Soviet Union (1946–1953). He was the father of Borys Paton.

Borys Yevhenovych Paton

(Ukrainian: Борис Євгенович Патон)
(born November 27, 1918)

is the long-term chairman of the National Academy of Sciences of Ukraine. He was appointed to this post in 1962. Paton was re-appointed for another term in office in 2015.





завод металлоконструкций

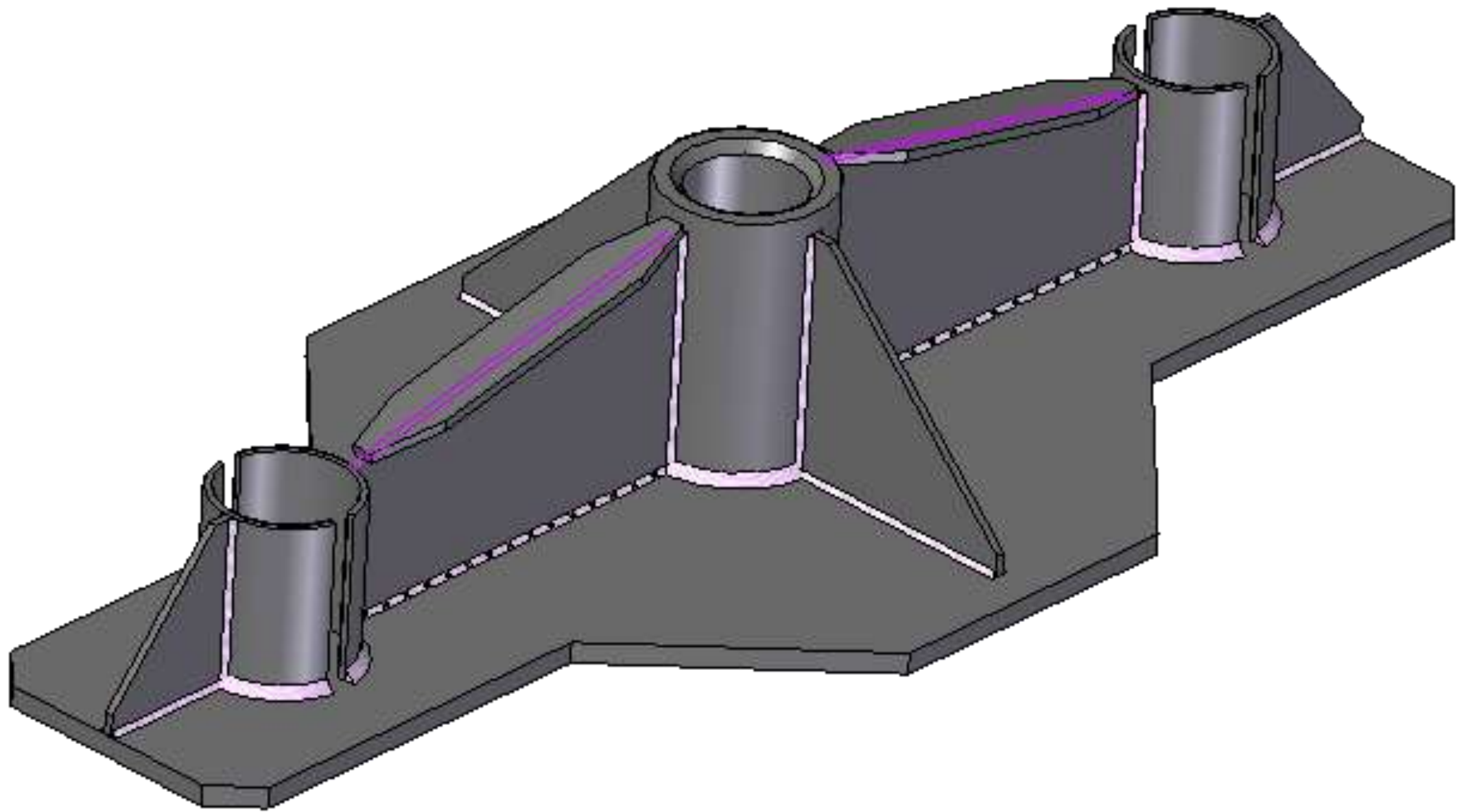
 **КРОНВЕРК**

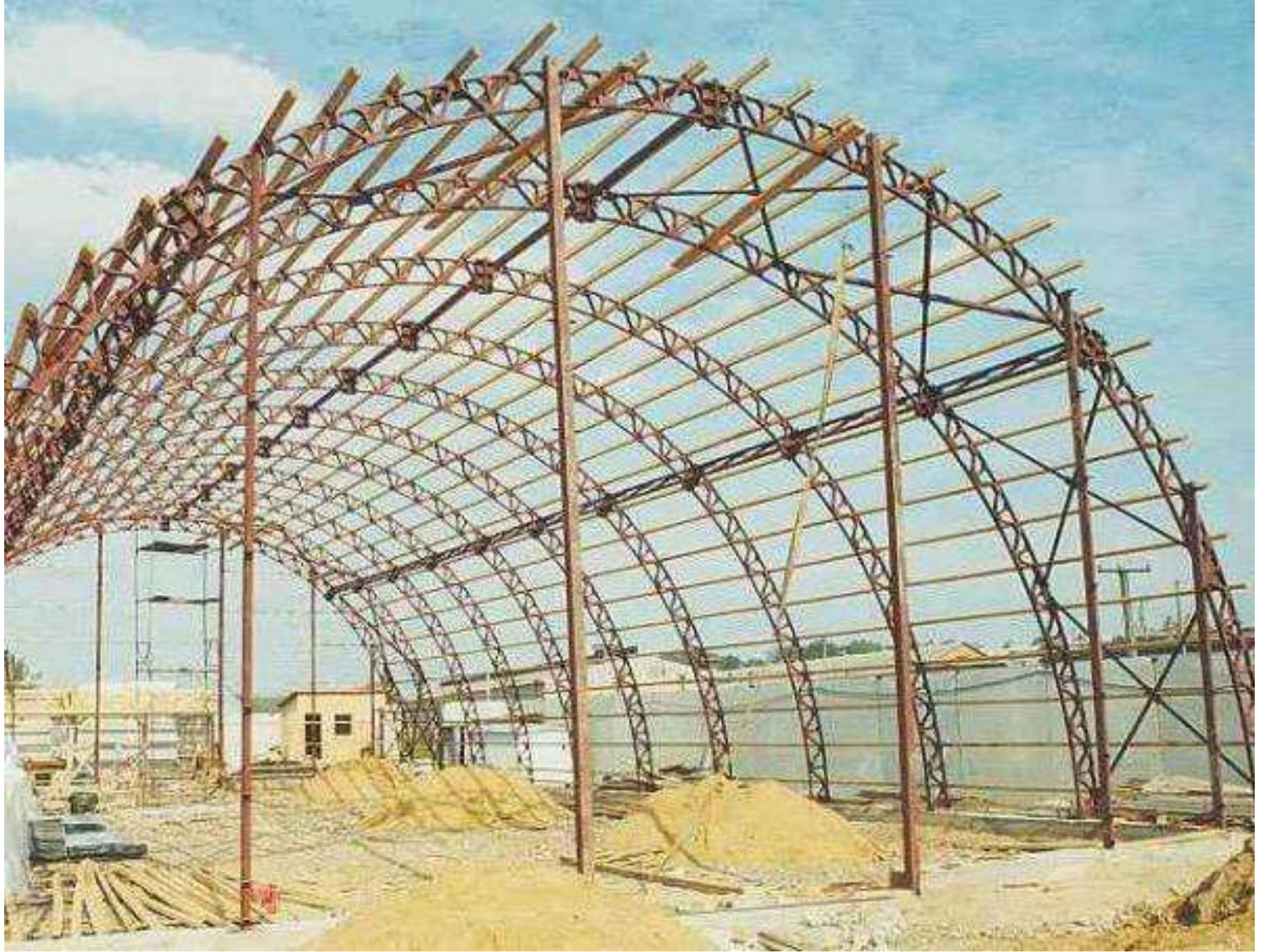


Frontal
Woodworks











Paton Bridge across the Dnieper in Kiev, Ukraine

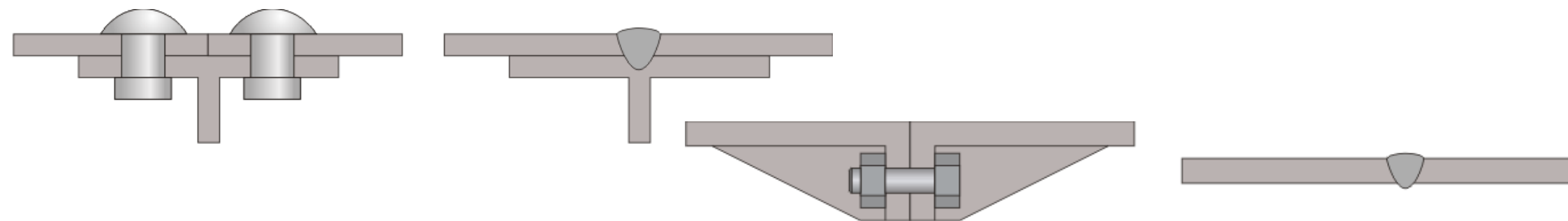
Paton Bridge is one of the bridges across the [Dnieper](https://en.wikipedia.org/wiki/Dnieper) in [Kiev](https://en.wikipedia.org/wiki/Kiev), [Ukraine](https://en.wikipedia.org/wiki/Ukraine) named after its constructor [Evgeny Paton](https://en.wikipedia.org/wiki/Evgeny_Paton). Built between 1941 and 1953, it is the world's first all-welded bridge and is also the longest bridge in Kiev having a length of 1,543 metres (5,062 ft).

https://en.wikipedia.org/wiki/Paton_Bridge

https://en.wikipedia.org/wiki/Maurzyce_Bridge

Advantages of welding as compared with riveting and bolting

1. Welding enables weight and material savings.
2. Welding is easier to mechanized.
3. Welded joints are easy to renew. Parts with loose rivets need to be replaced, but welded parts can be repaired by welding.
4. Welded joint can be stronger than the parent materials; if a filler material is used that has strength properties superior to those of the parents, and proper welding techniques are used.
5. Welding is not restricted to the factory environment. Portable welding machine equipments are available, so portability of welding machine can be avoided. It can be accomplished in the field.
6. Welding is usually the most economical way to join components in terms of capital and equipment operating costs.



...and disadvantages of welding as compared with riveting and bolting

- 1. The biggest one is that welds often contain defects. Welding requires much more hands-on oversight than other methods, and much stricter manufacturing controls. Some weld defects are difficult to detect. This requires special methods like X-raying to control quality. So in practice welding is less reliable, less predictable than other methods.**
- 2. Welding of very thin sheets is difficult, in some situation rivets or screws are more cost-effective for thin sheet metal.**
- 3. Welding creates a permanent joint, not desirable if parts need to be fixed or replaced later.**
- 4. Most welding operations are performed manually and are expensive in terms of labour cost.**
- 5. Most welding processes, involving the use of high energy, are inherently dangerous.**

American National Standard Letter Designations for Welding and Allied Processes
ANSI/AWS A2.4-91

Letter Designation	Welding and Allied Processes	Letter Designation	Welding and Allied Processes
AAC	air carbon arc cutting	HPW	hot pressure welding
AAW	air acetylene welding	IB	induction brazing
AB	arc brazing	INS	iron soldering
ABD	adhesive bonding	IRB	infrared brazing
AC	arc cutting	IRS	infrared soldering
AHW	atomic hydrogen welding	IS	induction soldering
AOC	oxygen arc cutting	IW	induction welding
ASP	arc spraying	LBC	laser beam cutting
AW	carbon arc welding	LBC-A	laser beam cutting—air
B	brazing	LBC-EV	laser beam cutting— evaporative
BB	block brazing	LBC-IG	laser beam cutting— inert gas
BMAW	bare metal arc welding	LBC-O	laser beam cutting—oxygen
CAB	carbon arc brazing	LBW	laser beam welding
CAC	carbon arc cutting	LOC	oxygen lance cutting
CAW	carbon arc welding	MAC	metal arc cutting
CAW-G	gas carbon arc welding	OAW	oxyacetylene welding
CAW-S	shielded carbon arc welding	OC	oxygen cutting
CAW-T	twist carbon arc welding	OFC	oxyfuel gas cutting
CEW	coextrusion welding	OFC-A	oxyacetylene cutting
CW	cold welding	OFC-H	oxyhydrogen cutting
DB	dip brazing	OFC-N	oxynatural gas cutting
DFB	diffusion brazing	OFC-P	oxypropane cutting
DFW	diffusion welding	OFW	oxyfuel gas cutting
DS	dip soldering	OHW	oxyhydrogen welding
EBC	electron beam cutting	PAC	plasma arc cutting
EBW	electron beam welding	PAW	plasma arc welding
EBW-HV	electron beam welding— high vacuum	PEW	percussion welding
EBW-MV	electron beam welding— medium vacuum	PGW	pressure gas welding
EBW-NV	electron beam welding— nonvacuum	POC	metal powder cutting
EGW	electrodeless welding	PSP	plasma spraying
ESW	electroslag welding	PW	projection welding
EXW	explosion welding	RB	resistance brazing
FB	furnace brazing	RS	resistance soldering
FCAW	flux-cored arc welding	RSEW	resistance seam welding
FLB	flow brazing	RSEW-HF	resistance seam welding— high frequency
FLOW	flow welding	RSEW-I	resistance seam welding— induction
FLSP	flame spraying	RSW	resistance spot welding
FOC	chemical flux cutting	ROW	roll welding
FOW	forge welding	RW	resistance welding
FRW	friction welding	S	soldering
FS	furnace soldering	SAW	submerged arc welding
FW	flash welding	SAW-S	series submerged arc welding
GMAC	gas metal arc cutting	SMAC	shielded metal arc cutting
GMAW	gas metal arc welding	SMAW	shielded metal arc welding
GMAW-P	gas metal arc welding—pulsed arc	SSW	solid state welding
GMAW-S	gas metal arc welding— short-circuiting arc	SW	stud arc welding
GTAC	gas tungsten arc cutting		
GTAW	gas tungsten arc welding		
GTAW-P	gas tungsten arc welding— pulsed arc		

**American National Standard Letter Designations for Welding and Allied Processes
ANSI/AWS A2.4-91**

Letter Designation	Welding and Allied Processes	Letter Designation	Welding and Allied Processes
AAC	air carbon arc cutting	HPW	hot pressure welding
AAW	air acetylene welding	IB	induction brazing
AB	arc brazing	INS	iron soldering
ABD	adhesive bonding	IRB	infrared brazing
AC	arc cutting	IRS	infrared soldering
AHW	atomic hydrogen welding	IS	induction soldering
AOC	oxygen arc cutting	IW	induction welding
ASP	arc spraying	LBC	laser beam cutting
AW	carbon arc welding	LBC-A	laser beam cutting—air
B	brazing	LBC-EV	laser beam cutting— evaporative
BB	block brazing	LBC-IG	laser beam cutting— inert gas
BMAW	bare metal arc welding	LBC-O	laser beam cutting—oxygen
CAB	carbon arc brazing	LBW	laser beam welding
CAC	carbon arc cutting	LOC	oxygen lance cutting
CAW	carbon arc welding	MAC	metal arc cutting
CAW-G	gas carbon arc welding	OAW	oxyacetylene welding
CAW-S	shielded carbon arc welding	OC	oxygen cutting
CAW-T	twin carbon arc welding	OFC	oxyfuel gas cutting
CEW	coextrusion welding	OFC-A	oxyacetylene cutting
CW	cold welding	OFC-H	oxyhydrogen cutting
DB	dip brazing	OFC-N	oxynatural gas cutting
DFB	diffusion brazing	OFC-P	oxypropane cutting
DFW	diffusion welding	OFW	oxyfuel gas cutting
DS	dip soldering	OHW	oxyhydrogen welding
EBC	electron beam cutting	PAC	plasma arc cutting
EBW	electron beam welding	PAW	plasma arc welding
EBW-HV	electron beam welding— high vacuum	PEW	percussion welding
EBW-MV	electron beam welding— medium vacuum	PGW	pressure gas welding
EBW-NV	electron beam welding— nonvacuum	POC	metal powder cutting
EGW	electrode gas welding	PSP	plasma spraying
ESW	electroslag welding	PW	projection welding
EXW	explosion welding	RB	resistance brazing
FB	furnace brazing	RS	resistance soldering
FCAW	flux-cored arc welding	RSEW	resistance seam welding
FLB	flow brazing	RSEW-HF	resistance seam welding— high frequency
FLOW	flow welding	RSEW-I	resistance seam welding— induction
FLSP	flame spraying	RSW	resistance spot welding
FOC	chemical flux cutting	ROW	roll welding
FOW	forge welding	RW	resistance welding
FRW	friction welding	S	soldering
FS	furnace soldering	SAW	submerged arc welding
FW	flash welding	SAW-S	series submerged arc welding
GMAC	gas metal arc cutting	SMAC	shielded metal arc cutting
GMAW	gas metal arc welding	SMAW	shielded metal arc welding
GMAW-P	gas metal arc welding—pulsed arc	SSW	solid state welding
GMAW-S	gas metal arc welding— short-circuiting arc	SW	stud arc welding
GTAC	gas tungsten arc cutting		
GTAW	gas tungsten arc welding		
GTAW-P	gas tungsten arc welding— pulsed arc		

BRITISH STANDARD

Welding and allied processes — Nomenclature of processes and reference numbers

(ISO 4063:2009)

BS EN ISO 4063:2009

AMERICAN WELDING SOCIETY

Standard Welding Terms and Definitions

Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

AWS A3.0M/A3.0:2010

UKRAINIAN STANDARD

ДСТУ 3761.2-98

Зварювання та споріднені процеси.

Частина 2. Процеси зварювання та паяння.

Терміни та визначення. Зміна № 1

RUSSIAN STANDARD

ГОСТ Р ИСО 857-1-2009

Сварка и родственные процессы.

Словарь. Часть 1

ПРОЦЕССЫ СВАРКИ МЕТАЛЛОВ

Термины и определения.

Online Browsing Platform (OBP) Sign in Language Help

ISO

Search ISO/TR 25901-1:2016(en)

ISO/TR 25901-1:2016(en) Welding and allied processes — Vocabulary — Part 1: General terms Buy Follow

Table of contents Available in: en fr Redlines

Foreword
1 Scope
2 Terms and definitions
2.1 Terms related to welding and allied processes
2.1.1 General terms
2.1.1.1 General terms
2.1.1.1.1 **welding**
joining process in which two or more parts are united producing a continuity in the nature of the workpiece material(s) by means of heat or pressure or both, and with or without the use of **filler material** (2.1.10.4)
Note 1 to entry: Welding processes may be used also for **surfacing** (2.1.9.1) and remelting.
2.1.1.1.2 **fusion welding**
welding (2.1.1.1) involving localized melting without the application of external force in which the fusion surface(s) has (have) to be melted with or without addition of **filler material** (2.1.10.4)
2.1.1.1.3 **weld**
result of **welding** (2.1.1.1)
Note 1 to entry: The weld includes the **weld metal** (2.1.2.1) and the **heat-affected zone** (2.1.2.2).
2.1.1.2 Types of welds
2.1.1.3 Weld details
2.1.1.4 Welding execution
2.1.1.5 Surfacing
2.1.1.6 Welding consumables
2.1.1.7 Welding materials
2.2 Terms related to testing
2.3 Terms related to welding equipment
2.4 Terms related to welding parameters

2.1.1.1 welding

joining process in which two or more parts are united producing a continuity in the nature of the workpiece material(s) by means of heat or pressure or both, and with or without the use of **filler material** (2.1.10.4)

Note 1 to entry: Welding processes may be used also for **surfacing** (2.1.9.1) and remelting.

2.1.1.3 weld

result of **welding** (2.1.1.1)

Note 1 to entry: The weld includes the **weld metal** (2.1.2.1) and the **heat-affected zone** (2.1.2.2).

2.1.1.4 weldment

assembly incorporating one or more **welded joint(s)** (2.1.4.2)

2.1.4.2 welded joint

assembly that is produced by **welding** (2.1.1.1) together two or more parts

- Table of contents
- Foreword
- Introduction
- 1 Scope
- 2 Normative references
- 3 Terms and definitions**
- 4 Use of equivalent terms
- 5 Types of joint
- 6 Types of joint preparation and joint geometry
- 7 Fusion welds
- 8 Throat thicknesses for fillet welds
- 9 Welds made using pressure
- 10 Examples of fusion welds made with pressure
- Annex A Comparison of terms used in the ISO 857-1

Available in: en fr

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1 joint
the junction of workpieces or the edges of workpieces that are to be joined or have been joined

3.2 fusion welding
welding involving localized melting without the application of external force in which the fusion surface(s) has (have) to be melted
Note 1 to entry: filler metal may or may not be added.

3.3 welding using pressure
welding in which sufficient external force is applied to cause more or less plastic deformation of both the contact surfaces, generally without the addition of filler metal
Note 1 to entry: The faying surfaces may be heated to permit or facilitate joining.
[SOURCE: ISO 857-1]

3.4 faying surface
surface of one component that is intended to be in contact with a surface of another component to form a joint

3.5 partial penetration
penetration that is intentionally not full penetration

3.6 incomplete penetration
penetration that is less than that required or specified

3.7 butt joint
type of joint where the parts lie approximately in the same plane and abut against one another

3.2 fusion welding

welding involving localized melting without the application of external force in which the fusion surface(s) has (have) to be melted

Note 1 to entry: filler metal may or may not be added.

3.3 welding using pressure

welding in which sufficient external force is applied to cause more or less plastic deformation of both the contact surfaces, generally without the addition of filler metal

Note 1 to entry: The faying surfaces may be heated to permit or facilitate joining.
[SOURCE: ISO 857-1]

3.2

сварка плавлением: Сварка, осуществляемая оплавлением сопрягаемых поверхностей без приложения внешней силы, обычно, но необязательно, добавляется расплавленный присадочный металл.

3.3

сварка давлением: Сварка, осуществляемая приложением внешней силы и сопровождаемая пластическим деформированием сопрягаемых поверхностей, обычно без присадочного металла.

Примечание — Сопрягаемые поверхности допускается нагревать, чтобы облегчить получение соединения (ИСО 857-1).

3.2

fusion welding

welding involving localized melting without the application of external force in which the fusion surface(s) has (have) to be melted

NOTE Filler metal may or may not be added

3.3

welding using pressure

welding in which sufficient external force is applied to cause more or less plastic deformation of both the contact surfaces, generally without the addition of filler metal

NOTE The faying surfaces may be heated to permit or facilitate joining.

[ISO 857-1]

<http://www.gost->

[svarka.ru/svarka_termini_opredeleniya/svarkaTermini.htm#%D0%92%D0%98%D0%94%D0%AB_%D0%A1%D0%92%D0%90%D0%A0%D0%9A%D0%98](http://www.gost-svarka.ru/svarka_termini_opredeleniya/svarkaTermini.htm#%D0%92%D0%98%D0%94%D0%AB_%D0%A1%D0%92%D0%90%D0%A0%D0%9A%D0%98)

http://www.gost-svarka.ru/klassifikaciya_svarka/klassifikaciya_svarki.htm

http://www.gost-svarka.ru/klassifikaciya_svarka/klassifikaciya_svarki_energositel.htm

welding. A joining process producing coalescence of materials by heating them to the welding temperature, with or without the application of pressure or by the application of pressure alone, and with or without the use of filler metal.

See Figures A.1 and A.3 through A.5.

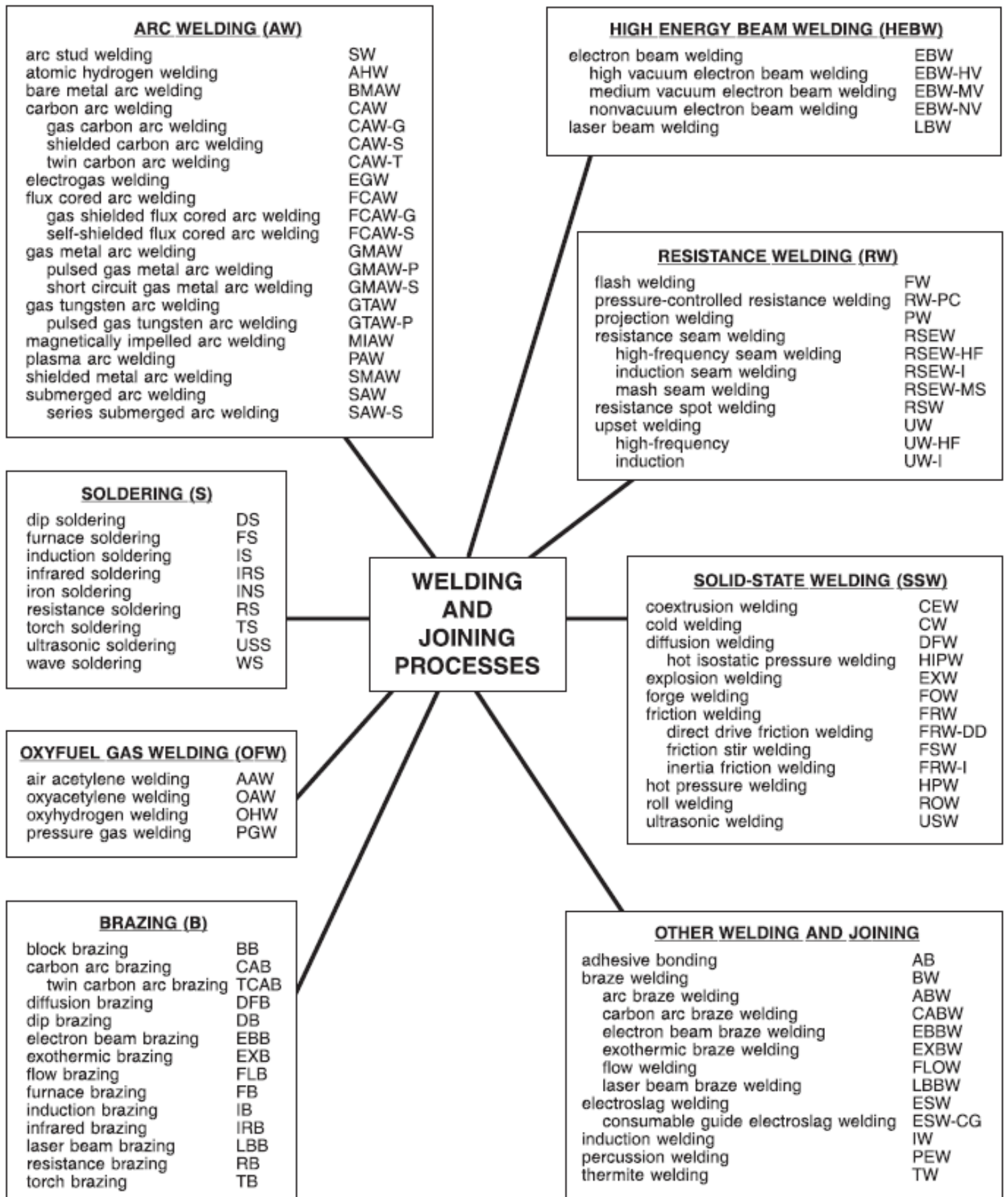
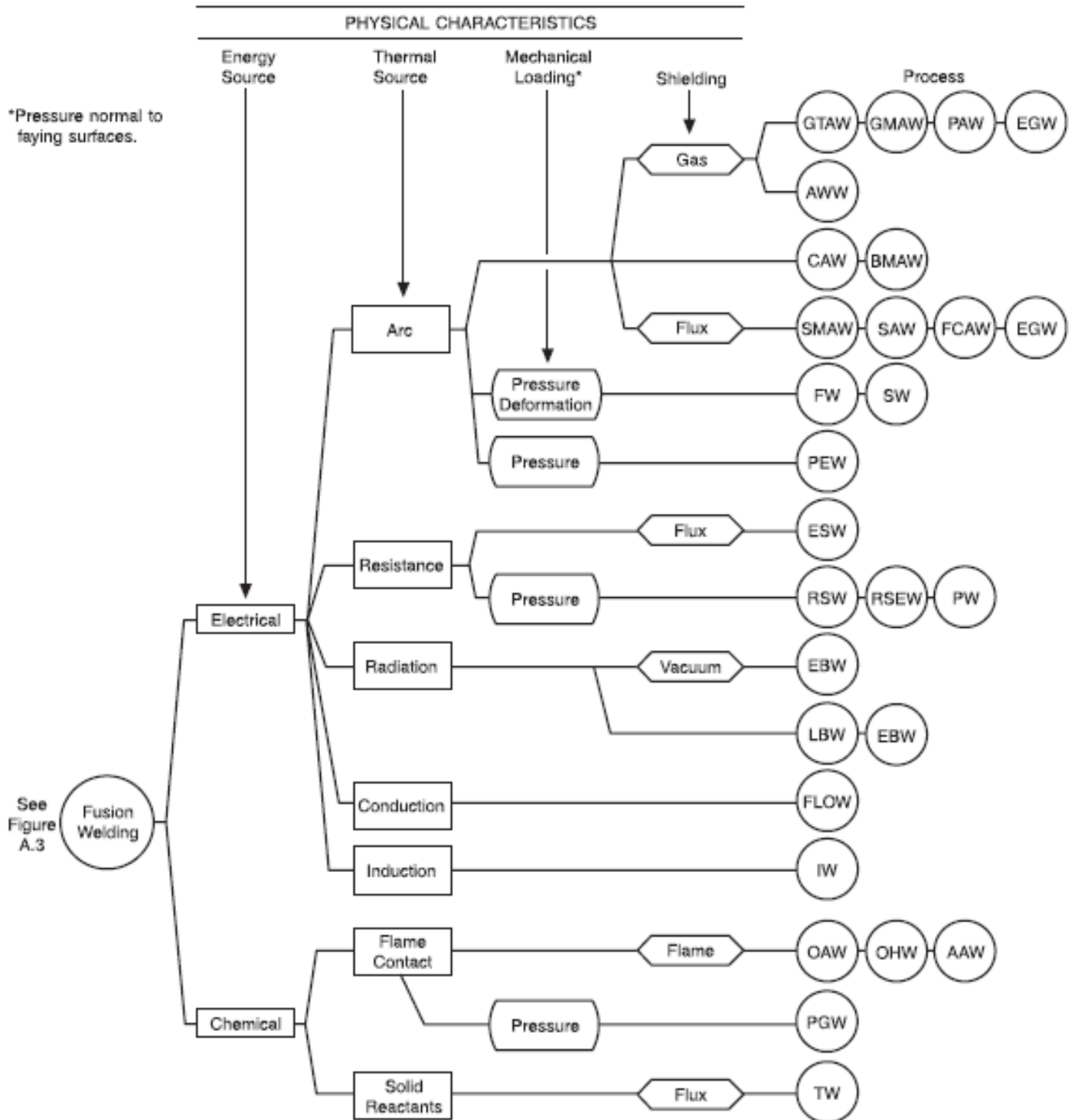
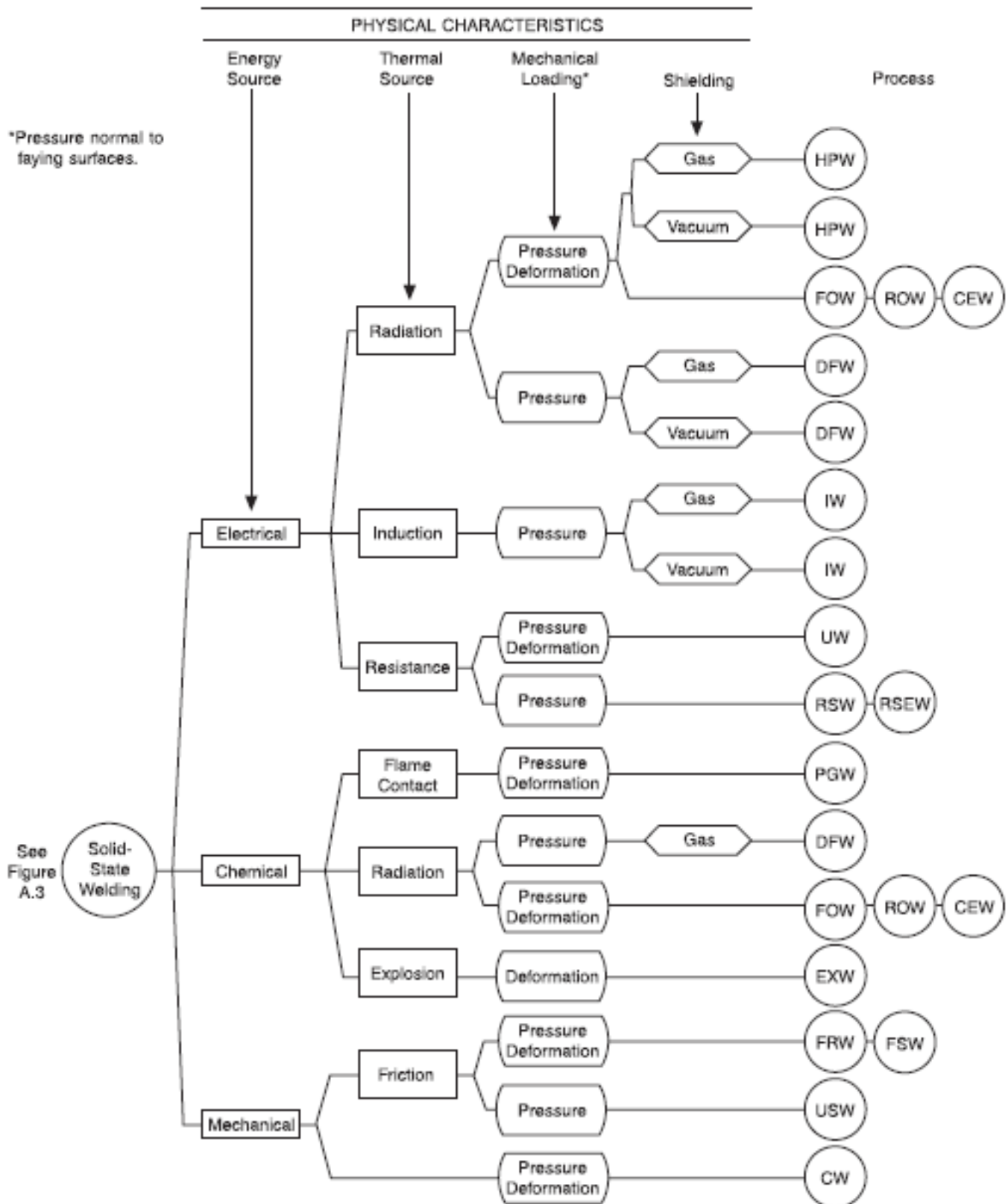


Figure A.1—Master Chart of Welding and Joining Processes



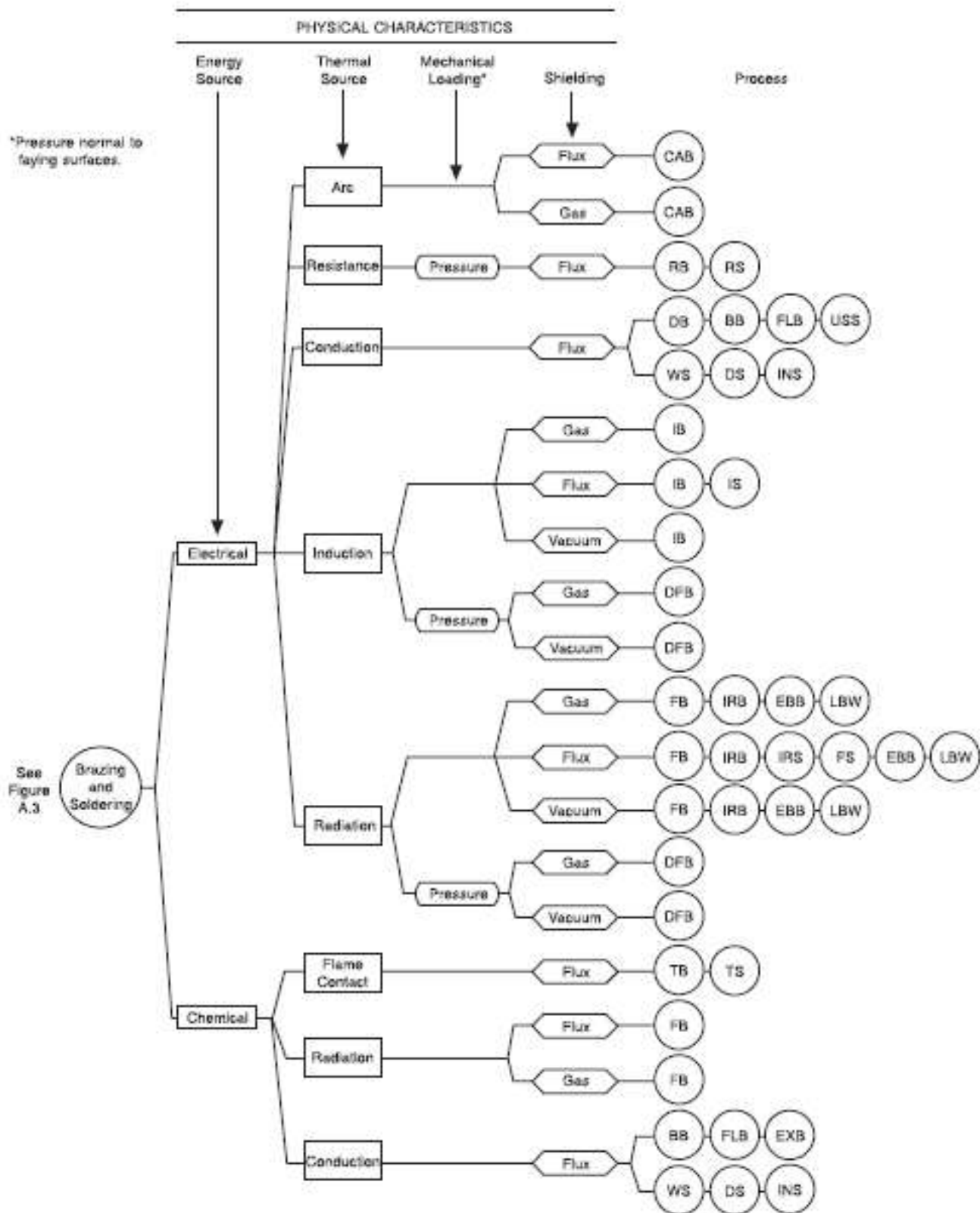
Designation	Welding Process	Designation	Welding Process	Designation	Welding Process
AAW	air acetylene welding	FW	flash welding	PGW	pressure gas welding
AHW	atomic hydrogen welding	GMAW	gas metal arc welding	PW	projection welding
BMAW	bare metal arc welding	GTAW	gas tungsten arc welding	RSEW	resistance seam welding
CAW	carbon arc welding	IW	induction welding	RSW	resistance spot welding
EBW	electron beam welding	LBW	laser beam welding	SAW	submerged arc welding
EGW	electrode gas welding	OAW	oxyacetylene welding	SMAW	shielded metal arc welding
ESW	electroslag welding	OHW	oxyhydrogen welding	SW	stud arc welding
FLOW	flow welding	PAW	plasma arc welding	TW	thermite welding
FCAW	flux cored arc welding	PEW	percussion welding		

Figure A.4—Fusion Welding Classification Chart



Designation	Welding Process	Designation	Welding Process	Designation	Welding Process
CEW	coextrusion welding	FRW	friction welding	RSEW	resistance seam welding
CW	cold welding	FSW	friction stir welding	RSW	resistance spot welding
DFW	diffusion welding	HPW	hot pressure welding	ROW	roll welding
EXW	explosion welding	IW	induction welding	USW	ultrasonic welding
FOW	forge welding	PGW	pressure gas welding	UW	upset welding

Figure A.5—Solid-State Welding Classification Chart



Designation	Joining Process	Designation	Joining Process	Designation	Joining Process
AB	arc brazing	FS	furnace soldering	RB	resistance brazing
BB	block brazing	FLB	flow brazing	RS	resistance soldering
CAB	carbon arc brazing	IB	induction brazing	TB	torch brazing
DB	dip brazing	IS	induction soldering	TS	torch soldering
DS	dip soldering	IRB	infrared brazing	USS	ultrasonic soldering
DFB	diffusion brazing	IRS	infrared soldering	WS	wave soldering
FB	furnace brazing	INS	iron soldering		

Figure A.6—Brazing and Soldering Classification Chart

КЛАССИФИКАЦИЯ СВАРКИ МЕТАЛЛОВ по основным признакам

ГРУППА ПРИЗНАКОВ

Физические

Технические

Технологические

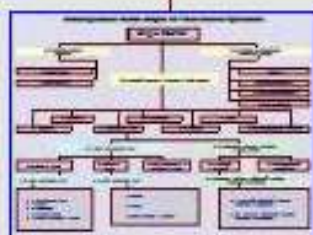
наименование признаков

Форма энергии, используемой для образования сварного соединения

Способ защиты металла в зоне сварки
Непрерывность сварки
Степень механизации сварки

Установлены для каждого вида сварки отдельно

класс сварки



Термический

Термомеханический

Механический

Признак: вид источника энергии, непосредственно используемого для образования сварного соединения

Виды сварки, осуществляемые плавлением с использованием тепловой энергии

Виды сварки, осуществляемые с использованием тепловой энергии и давления

Виды сварки, осуществляемые с использованием механической энергии и давления

- Дуговая
- Электрошлаковая
- Электронно-лучевая
- Плазменно-лучевая
- Ионно-лучевая
- Тлеющим разрядом
- Световая
- Индукционная
- Газовая
- Термитная
- Литейная

- Контактная
- Диффузионная
- Индукционнопрессовая
- Газопрессовая
- Термокомпрессионная
- Дугопрессовая
- Шлакопрессовая
- Термитнопрессовая
- Печная

- Холодная
- Взрывом
- Ультразвуковая
- Трением
- Магнитно-импульсная

Плазменно-лучевая сварка >>>



Электронно-лучевая сварка >>>

Печная сварка >>>

Ультразвуковая сварка >>>

Дуговая сварка >>>



Диффузионная сварка >>>



Световая сварка >>>



Газовая сварка >>>



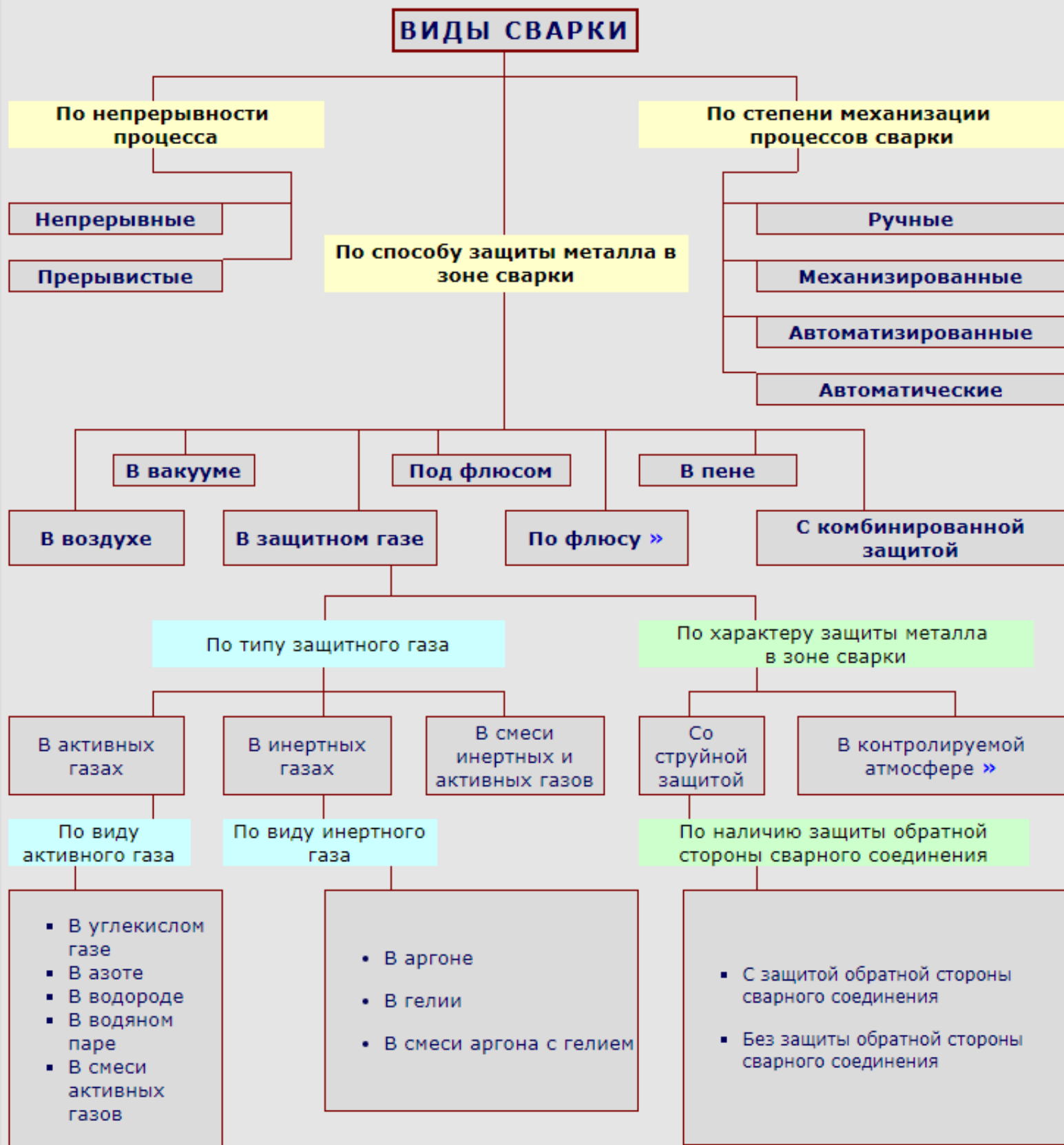
Электрошлаковая сварка >>>

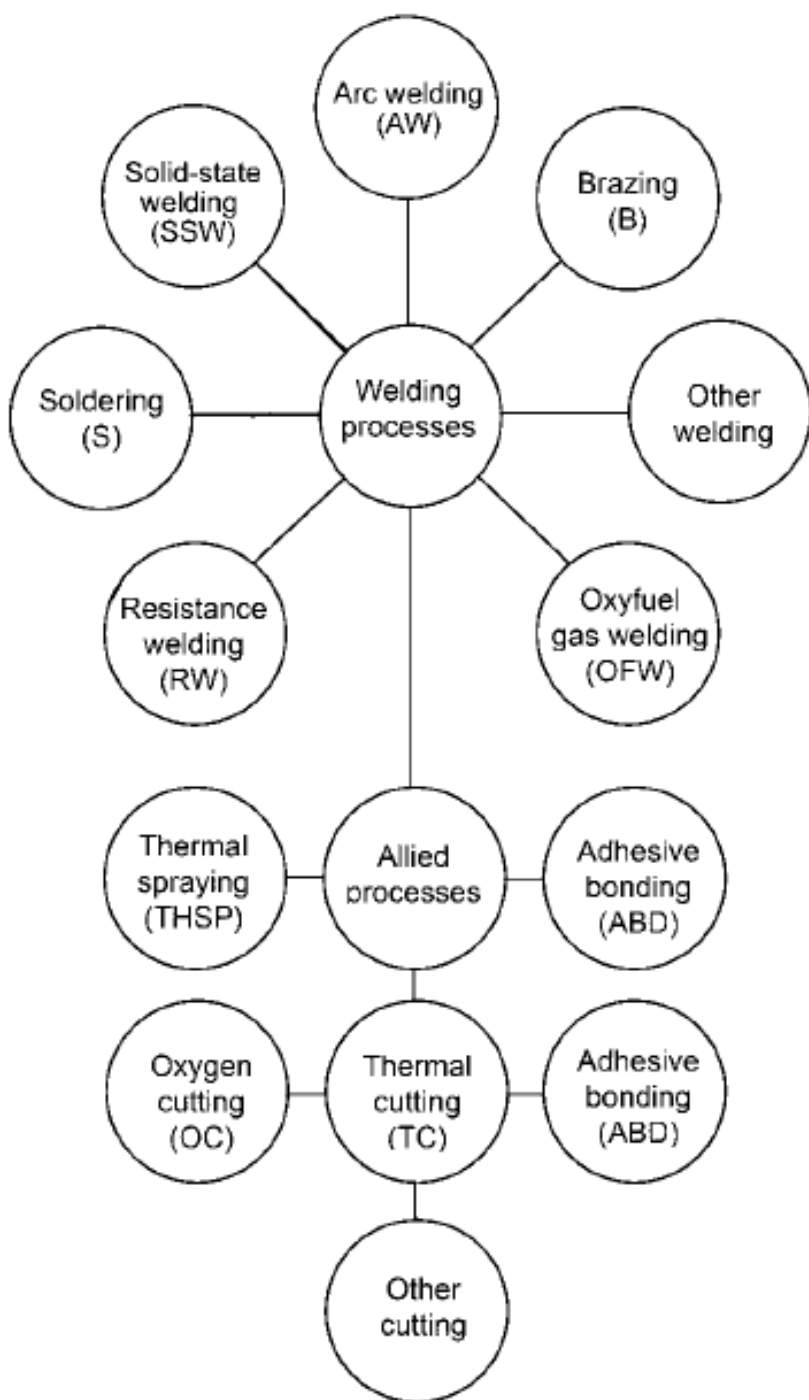


Холодная сварка >>>



Классификация видов сварки по техническим признакам





(a)

Group	Welding process	Letter designation
Arc welding	Carbon arc	CAW
	Electrogas	EGW
	Flux-colored arc	FCAW
	Gas metal arc	GMAW
	Gas tungsten arc	GTAW
	Plasma arc	PAW
	Shielded metal arc	SMAW
	Stud arc	SW
	Submerged arc	SAW
Brazing	Diffusion brazing	DFB
	Dip brazing	DB
	Furnace brazing	IB
	Induction brazing	IRB
	Resistance brazing	RB
	Torch brazing	TB
Oxyfuel gas welding	Oxyacetylene welding	OAW
	Oxyhydrogen welding	OHW
	Air acetylene	...
	Pressure gas welding	PGW
Resistance welding	Flash welding	FW
	Projection welding	DFW
	Resistance seam welding	RSEW
	Resistance spot welding	RSW
	Upset welding	UW
Solid-state welding	Cold welding	CW
	Diffusion welding	DFW
	Explosion welding	EXW
	Forge welding	FOW
	Friction welding	FRW
	Hot pressure welding	HPW
	Roll welding	ROW
	Ultrasonic welding	USW
Soldering	Dip soldering	DS
	Furnace soldering	FS
	Induction soldering	IS
	Infrared soldering	IRS
	Iron soldering	INS
	Resistance soldering	RS
	Torch soldering	TS
	Wave soldering	WS
Other welding processes	Electron beam	EBW
	Electroslag	ESW
	Flow	FLOW
	Induction	IW
	Laser beam	LBW
	Percussion	PEW
	Thermit	TW

(b)

Fig. 1 (a) Master chart of welding and allied processes used by the American Welding Society (AWS).

(b) List of the abbreviations used by the AWS for various welding, brazing, and soldering processes. Source: Ref 1