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**Specification and qualification of welding
procedures for metallic materials —
Welding procedure specification —**

**Part 5:
Resistance welding**

*Descriptif et qualification d'un mode opératoire de soudage pour les
matériaux métalliques — Descriptif d'un mode opératoire de
soudage —*

Partie 5: Soudage par résistance



Reference number
ISO 15609-5:2011(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15609-5 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

This second edition cancels and replaces the first edition (ISO 15609-5:2004), which has been technically revised.

ISO 15609 consists of the following parts, under the general title *Specification and qualification of welding procedures for metallic materials — Welding procedure specification*:

- *Part 1: Arc welding*
- *Part 2: Gas welding*
- *Part 3: Electron beam welding*
- *Part 4: Laser beam welding*
- *Part 5: Resistance welding*
- *Part 6: Laser-arc hybrid welding*

This corrected version of ISO 15609-5:2011 incorporates the following corrections:

- correction of the French title on the cover page of the English version;
- removal of "16" at the end of key item 17 in Figure D.1;
- replacement of the graphic in Figure D.5 raising the lower arrow near "10";
- removal of the second key item 13 in Figure D.5.

Requests for official interpretations of any aspect of this part of ISO 15609 should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Specification and qualification of welding procedures for metallic materials — Welding procedure specification —

Part 5: Resistance welding

1 Scope

This part of ISO 15609 specifies requirements for the content of welding procedure specifications for resistance spot, seam, butt and projection welding processes. It is necessary to establish the acceptability of applying the principles of this part of ISO 15609 to other resistance and related welding processes before any qualification is undertaken.

NOTE Details of ISO 15609 (all parts — for titles, see Foreword) are given in ISO 15607:2003, Annex A.

Variables listed in this part of ISO 15609 are those influencing either weld dimensions (quality), weld nugget dimension, weld pattern positioning, mechanical properties or geometry of the welded joint.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 669, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements*

ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 5183 (all parts), *Resistance welding equipment — Electrode adaptors, male taper 1:10*

ISO 5184, *Straight resistance spot welding electrodes*

ISO 5821, *Resistance welding — Spot welding electrode caps*

ISO 5827, *Spot welding — Electrode back-ups and clamps*

ISO 8205-1, *Water-cooled secondary connection cables for resistance welding — Part 1: Dimensions and requirements for double-conductor connection cables*

ISO 8205-2, *Water-cooled secondary connection cables for resistance welding — Part 2: Dimensions and requirements for single-conductor connection cables*

ISO 8430 (all parts), *Resistance spot welding — Electrode holders*

ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15614-12, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 12: Spot, seam and projection welding*

ISO 15614-13, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 13: Resistance butt and flash welding*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 15607, ISO 17677-1 and ISO 669 apply.

4 Technical contents of welding procedure specification

4.1 General

The welding procedure specification (WPS) shall provide all information required to make a weld. The minimum information required in a WPS for resistance welding processes is listed in 4.2 to 4.4.

For some applications, it is necessary to supplement the list. All relevant information shall be specified in the WPS.

Tolerance ranges shall be specified.

Examples of the WPS format are shown in Annexes A, B and C; these forms should be modified according to actual practice.

4.2 Product manufacturer

- Identification of the product manufacturer.
- Identification of the WPS.
- Reference to the welding procedure qualification record (WPQR — see ISO 15614-12 and ISO 15614-13).

4.3 Parent materials

4.3.1 Composition

- Designation and type(s) of the material(s) and referenced standard(s).
- In case of coating(s), type, thickness, single or double sided.

4.3.2 Dimensions

- Thickness of material(s).
- Dimensions of cross-section of pipe or section (butt welding).

4.4 Common to all welding procedures

4.4.1 Welding process

- Welding process(es) specified shall be designated as listed in ISO 4063:

- a) Spot welding (21):
 - manual,
 - multi,
 - direct
 - indirect
 - push-pull
 - series,
 - mechanized,
 - automated,
 - robotic,
 - weld bonding;
- b) Seam welding (22) (roll spot welding):
 - manual/mechanized/automatic/robotic;
- c) Projection welding (23):
 - single/multiple,
 - embossed/solid;
- d) Flash welding (24):
 - flashing/upsetting,
 - with/without preheating;
- e) Upset welding (Resistance butt welding) (25).

4.4.2 Machine specification

Type of machine used and appropriate identification.

4.4.3 Joint design

The overlap, edge distance, pitch, sequence and pattern, spot or projection dimensions, shall be specified and shall comply with the appropriate standards, as applicable.

NOTE A sketch can be used to show the joint design/configuration.

4.4.4 Surface and edge preparation

- Degreasing, wire brushing, chemical etching, etc.
- For butt welding, any mechanical edge/joint-face preparation (e.g. facing, finishing).
- For spot, seam and projection welding any removal of edge burrs to avoid shunting.

4.4.5 Welding technique

- Manual, mechanized, automated, robotic welding.
- Access details, weld sequence and/or pattern.
- Clamping or guidance systems, tack welding, etc.
- Procedures to minimize distortion, indentation, contamination, corrosion, etc. (e.g. use of face or backing electrodes).

Operator protection shall be taken into consideration.

4.4.6 Resistance welding electrodes and auxiliaries

- Geometry and material composition of electrodes (see ISO 5184), caps (see ISO 5821), and adaptors (see ISO 5183).
- Geometry and material composition of backing electrodes (see ISO 5827).
- Geometry and material composition of auxiliaries, e.g. electrode holder (see ISO 8430), cables (see ISO 8205-1 and ISO 8205-2).
- Applicable tolerances for the maintenance of the specified quality requirements.

4.4.7 Machine parameters and control settings

- Type of power source (alternating current, direct current, capacitor discharge).
- Transformer setting(s).
- Controller settings (see Annex D), e.g.:
 - welding current value(s);
 - squeeze time;
 - heat time;
 - number of impulses, cool time;
 - hold time;
 - off time;
 - post-weld heat treatment (chill time, post heat time, post heat current);
 - up-slope, down-slope.
- Electrode force.
- Secondary voltage readings (for flash welding – recorded for information only).
- Seam welding speed.
- Cooling requirements for electrical components and electrodes.

NOTE For further information see ISO 14327.

Annex A (informative)

Example of a WPS — I: Planned process requirements

No.: _____

Issue/Revision: _____	No. of welding procedure specification for next operational sequence for this joint/assembly: _____
Date: _____	
Customer: _____	
Manufacturer: _____	
Product	
Description: _____	Quality requirements: _____
Assembly name: _____	Product identification No. ^a : _____
Joint location/operation	Assembly No. ^a : _____
Number/identification code ^a : _____	Joint type: _____
Parent material: _____	Form: _____
Surface condition: _____	Weld pattern/sequence (sketch) ^a : _____
Number of welds per joint: _____	Quality acceptance specification: _____ Annex B
Welding Procedure Specification	
Process: _____	Welding rate (welds/min or m/min): _____
Environmental constraints: _____	Location: _____
Machine identification No.: _____	Machine type: _____ ^b
Manual/mechanized/automated:	Machine size/capacity: _____
Electrode set-up ^a : _____	Tooling ^a : _____
Special services needed: _____	Electrode change/dressing program: _____ Annex C
Machine control type: _____	Control settings (program) chart No.: _____
Electrode holder drilled/not drilled: _____	Welding current form: _____
Machine control identification number: _____	Monitor type: _____
Auxiliary services: _____	Welding current (kA): _____
Type of actuator (air cylinder): _____ ^c	Secondary voltage (V): _____
	Electrode force (kN): _____
	Forge force: _____
	Cooling type/flow rate (l/min): _____
	Specified post-weld treatment: _____ Annex C
	Post-weld treatment equipment: _____

Special instructions: _____
 Prepared by: _____
 Date: _____

^a Insert drawing number.

^b Enter identification letter from chart, e.g.:

SP = pedestal spot weld equipment;	D = dual stroke;
PW = projection weld equipment;	H = hydraulic;
CG = portable C-gun;	S = soft descent;
MW = multiweld equipment;	n = other (e. g. electromagnetic).
SG = portable scissor gun;	
PS = portable seam weld equipment;	
RW = welding robot;	
SW = seam weld equipment.	

Optional subgroups:

D = dual stroke;	D = dual stroke;
H = hydraulic;	H = hydraulic;
S = soft descent;	S = soft descent;
n = other (e. g. electromagnetic).	n = other (e. g. electromagnetic).

^c S = single stroke;
 D = dual stroke;
 P = diaphragm;
 R = flow restrictors.

Annex B
(informative)

Example of a WPS — II: Quality acceptance criteria

No.: _____

Issue/Revision: _____

Date: _____

Customer: _____

Manufacturer: _____

Product

Description: _____

Product identification No.^a: _____

Assembly name: _____

Assembly No.^a: _____

Joint location/operation
number/identification code^a: _____

Joint type: _____

Quality requirements

Product: _____

Type of weld: _____

Welds quality rating: _____

Appearance: _____

Geometrical and physical properties of joint

Specified test values	value (mm)
Nugget diameter (min.):	
Nugget indentation (min./max.):	
Electrode indentation diameter (nominal):	
Electrode indentation depth (max.):	
Sheet separation (max.):	

	min. value (kN)	min. weld diameter (mm)	fracture type
Chisel test:	-		
Peel force:			
Shear force:			
Cross tension force:			
Impact force:			

Fatigue force (kN) and cycles: _____

Special instructions: _____

Corrosion test: _____

Prepared by: _____

Date: _____

^a Insert drawing number.

Annex C (informative)

Example of a WPS — III: Welding machine set-up

No.: _____

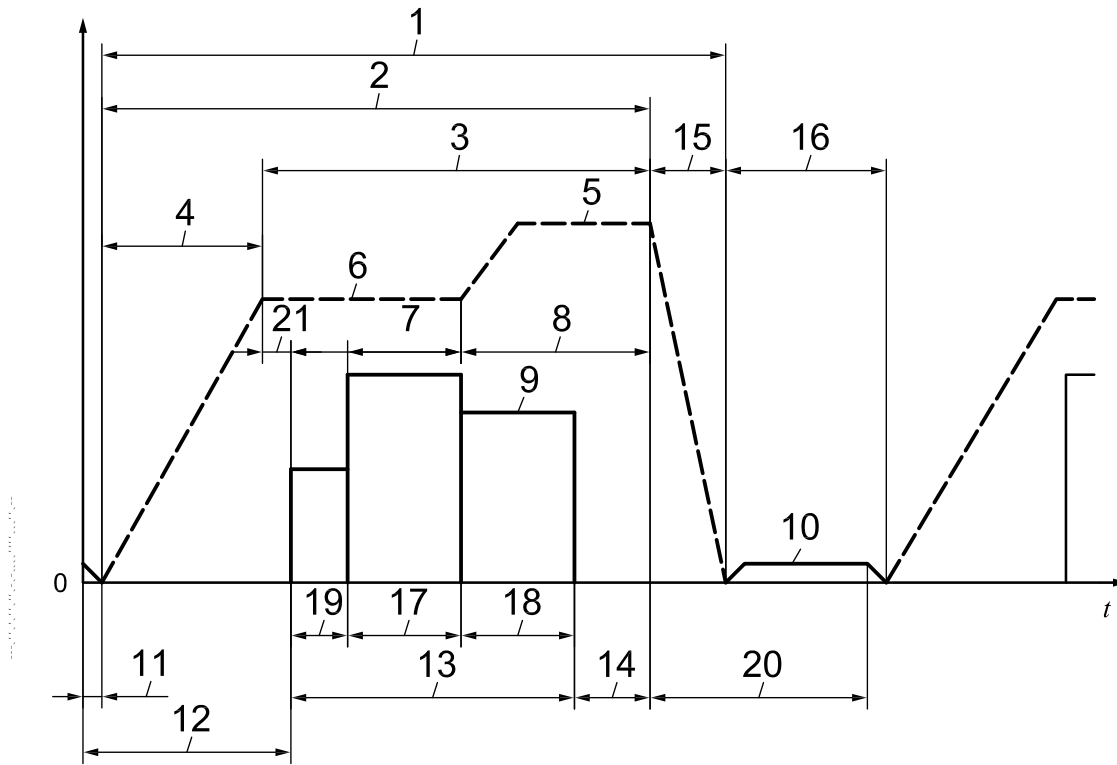
Issue/Revision: _____ Date: _____ Customer: _____ Manufacturer: _____ Product Description: _____ Assembly name: _____ Joint location/operation number/identification code ^a : _____ Machine Machine/Gun type: _____ Platen/electrode dimension (mm): _____ Transformer rating (kVA): _____ Tap No.: _____ Control timer/programmer: _____ Cylinder type: _____ High lift: _____ Electrode set-up ^a : _____ Check of auxiliaries: _____ Electrode force (kN): _____ Safety guard: _____ Location (work station): _____ Weld control parameters Pre-squeeze time (cycles with 50 Hz or 60 Hz): _____ Squeeze time (cycles or milliseconds): _____ Weld time (cycles or milliseconds): _____ Off time (cycles or milliseconds): _____ Repeat weld time (cycles or milliseconds): _____ Hold time (cycles or milliseconds): _____ Off time (cycles or milliseconds): _____ Monitor type: _____ Stepper control type: _____ Machine/tooling Machine control settings: _____ Conditions of auxiliary services: _____ Post-weld treatment: _____	Product identification No. ^a : _____ Assembly No. ^a : _____ Joint type: _____ Machine identification No.: _____ Secondary cable/shunt size (mm × mm): _____ Secondary cable(s) type × length (m): _____ Transformer identification No.: _____ Control timer/programmer identification No.: _____ Tooling ^a : _____ Cooling type/flow rate (l/min): _____ Electrode approach rate (mm/s): _____ Source of start signal: _____ End of cycle trigger signal: _____ Throat dimensions: _____ Weld current (kA): _____ Heat setting: _____ Number of impulses: _____ Weld current (kA): _____ Heat setting: _____ Up-slope: _____ Down-slope: _____ Recorder active: _____ Stepper control active: _____ Stepper control program: _____ Condition of electrodes: _____ Condition of tooling: _____
--	---

Special instructions: _____
 Prepared by: _____
 Date: _____

^a Insert drawing number.

Annex D
(informative)

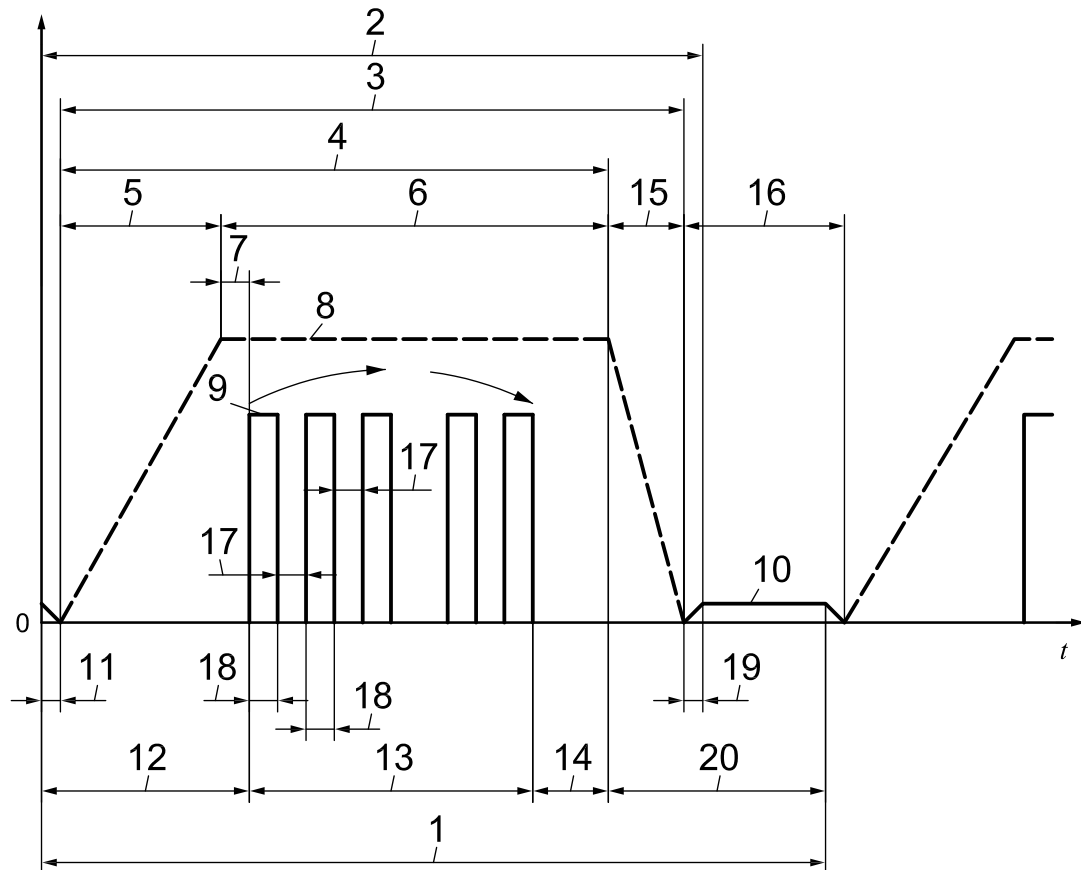
Examples of parameters in resistance welding



Key

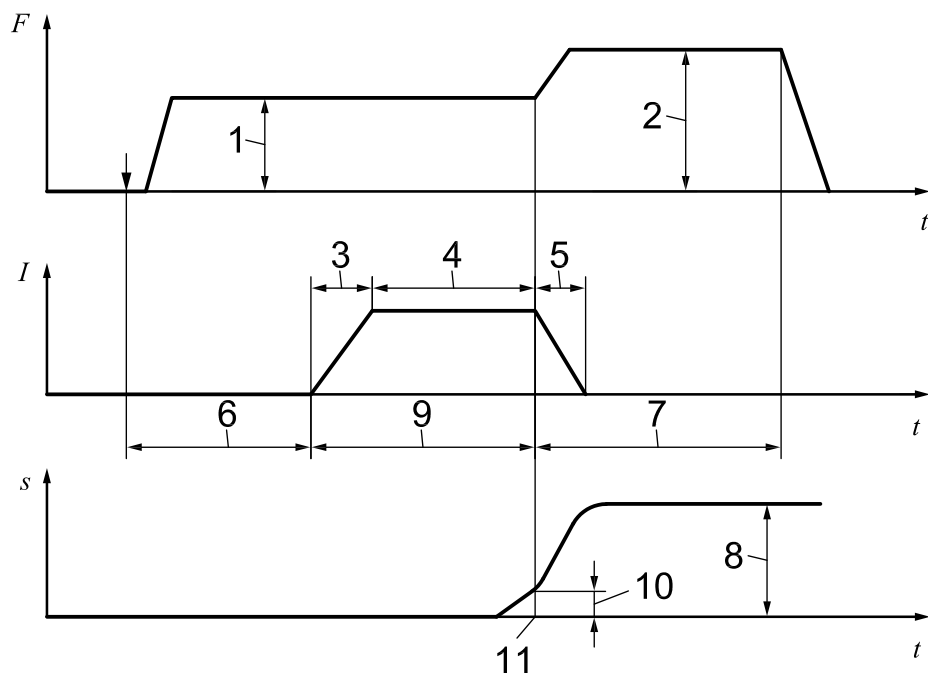
- 1 force application time
- 2 electrode force time
- 3 force maintenance time
- 4 force rise time
- 5 force fall time
- 6 electrode force
- 7 force delay time
- 8 force time
- 9 current
- 10 electrode movement
- 11 head approach time
- 12 squeeze time
- 13 total weld time
- 14 hold time
- 15 force fall time
- 16 actual force off-time
- 17 heat time/individual weld time
- 18 post-heat time
- 19 preheat time
- 20 off time
- 21 current delay time
- t* time

Figure D.1 — Time and electrode force diagram for spot welding — Current and electrode force programme control

**Key**

- 1 working cycle time
- 2 welding cycle time
- 3 force application time
- 4 electrode force time
- 5 force rise time
- 6 force maintenance time
- 7 current delay time
- 8 electrode force
- 9 current
- 10 electrode movement
- 11 head approach time
- 12 squeeze time
- 13 total weld time
- 14 hold time
- 15 force fall time
- 16 actual force off-time
- 17 cool time
- 18 heat time/individual weld time
- 19 electrode return time
- 20 off time
- t* time

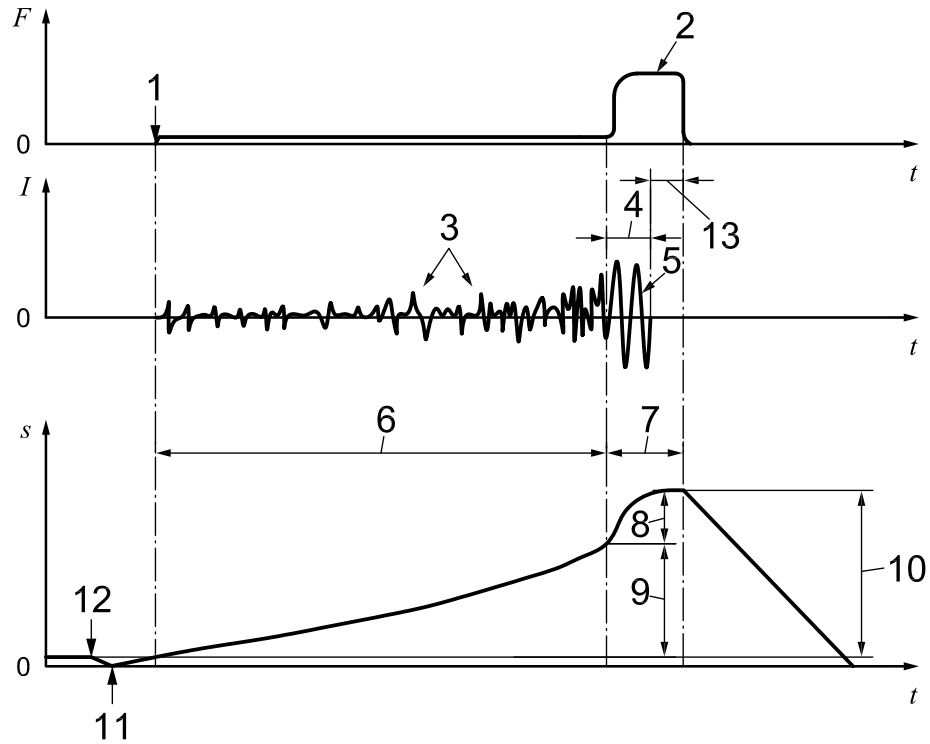
Figure D.2 — Time and electrode force diagram for seam welding



Key

- F force
- I current
- s platen movement
- t time
- 1 welding force
- 2 forge force
- 3 upslope time
- 4 heat time
- 5 downslope time
- 6 squeeze time
- 7 forge time
- 8 start forging
- 9 forge delay
- 10 start forge travel
- 11 start of forging

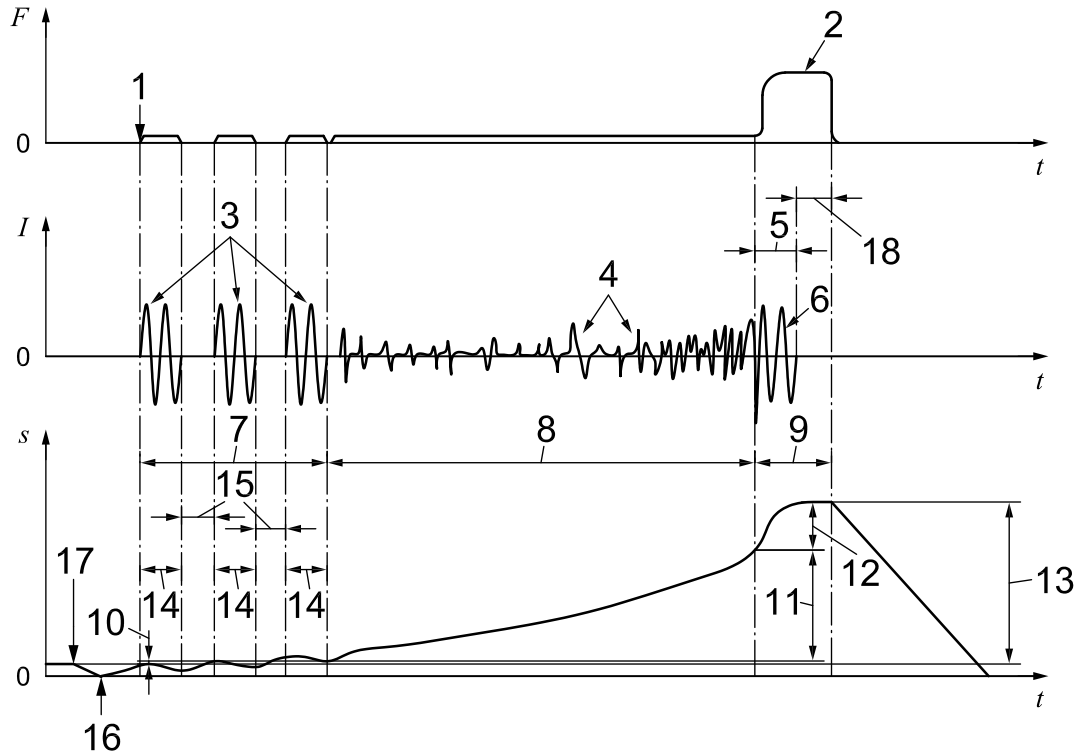
Figure D.3 — Force-current-travel diagram for upset welding



Key

- F force
 I current
 s platen movement
 t time
- 1 start of contact
 - 2 upset force
 - 3 flashing current or flash current
 - 4 upset current time
 - 5 upset current
 - 6 flashing time or flash time
 - 7 upset time
 - 8 upset travel
 - 9 flashing travel
 - 10 total travel
 - 11 start of platen movement
 - 12 setback position of platen
 - 13 hold time

Figure D.4 — Force-current-travel diagram for flash welding



Key

- F force
- I current
- s platen movement
- t time
- 1 start of contact
- 2 upset force
- 3 preheating current
- 4 flashing current, or flash current
- 5 upset current time
- 6 upset current
- 7 preheating time
- 8 flashing time, or flash time
- 9 upset time
- 10 preheating travel
- 11 flashing travel
- 12 upset travel
- 13 total travel
- 14 heat time
- 15 cool time
- 16 start of platen movement
- 17 setback position of platen
- 18 hold time

Figure D.5 — Force-current-travel diagram for flash welding with preheating

Bibliography

- [1] ISO 14327, *Resistance welding — Procedures for determining the weldability lobe for resistance spot, projection and seam welding*

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