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Resistance welding equipment

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Welding Engineering Society (JWES)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS C 9305:1999** is replaced with this Standard, and **JIS C 9303:2005**, **JIS C 9307:1999** and **JIS C 9321:2009** have been withdrawn and replaced with this Standard.

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Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public or utility model right. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public or utility model right.

Resistance welding equipment

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 669** published in 2000 with some modifications of the technical contents to meet the actual situation in Japan, as well as the addition of the specifications of **JIS C 9303:2005**, **JIS C 9307:1999** and **JIS C 9321:2009**.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JF. Annex JA to Annex JE are the matters not stated in the corresponding International Standard.

For specifications not conforming to **ISO 669**, the **JIS**'s own welding equipment and **JIS**'s own requirements are additionally specified as Type J. Type J shall be marked on the rating plate.

1 Scope

This Standard specifies the performance requirements of the following resistance welding equipment including the gun with inbuilt transformers and the movable welding equipment.

- single-phase a.c. welding equipment
- single-phase d.c. welding equipment
- three-phase d.c. welding equipment
- single-phase d.c. inverter welding equipment
- three-phase d.c. inverter welding equipment
- single-phase a.c. inverter welding equipment (Type J)
- three-phase low frequency welding equipment
- capacitor discharge type welding equipment (Type J)

This Standard applies neither to the welding transformers produced separately nor to the safety requirements.

NOTE 1 Safety requirements on the resistance welding equipment are specified in **IEC 62135-1**.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 669:2000 *Resistance welding—Resistance welding equipment—Mechanical and electrical requirements* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent editions (including amendments) shall be applied.

JIS B 0401-2 *ISO system of limits and fits—Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

JIS B 7503 *Dial gauges*

JIS B 7514 *Steel straightedges*

JIS B 7526 *Squares*

JIS B 9960-1 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements*

NOTE : Corresponding International Standard: IEC 60204-1:2005 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements* (MOD)

JIS C 1102-2 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 2: Special requirements for ammeters and voltmeters*

NOTE : Corresponding International Standard: IEC 60051-2:1984 *Direct acting indicating analogue electrical measuring instruments and their accessories. Part 2: Special requirements for ammeters and voltmeters* (IDT)

JIS C 5101-1 *Fixed capacitors for use in electronic equipment—Part 1: Generic specification*

JIS C 9304 *Spot welding electrodes*

NOTE : Corresponding International Standard: ISO 5183-1:1998 *Resistance welding equipment—Electrode adaptors, male taper 1:10—Part 1: Conical fixing, taper 1:10*, ISO 5183-2:1988 *Resistance spot welding—Electrode adaptors, male taper 1:10—Part 2: Parallel shank fixing for end-thrust electrodes*, ISO 5184:1979 *Straight resistance spot welding electrodes*, ISO 5821:1979 *Resistance spot welding electrode caps*, ISO 5829:1984 *Resistance spot welding—Electrode adaptors, female taper 1:10* and ISO 5830:1984 *Resistance spot welding—Male electrode caps* (overall evaluation: MOD)

JIS C 9323 *Electric resistance welding—Transformers—General specifications applicable to all transformers*

NOTE : Corresponding International Standard: ISO 5826:1999 *Resistance welding equipment—Transformers—General specifications applicable to all transformers* (MOD)

JIS C 9325 *Electrode force measuring device for resistance welding equipment*

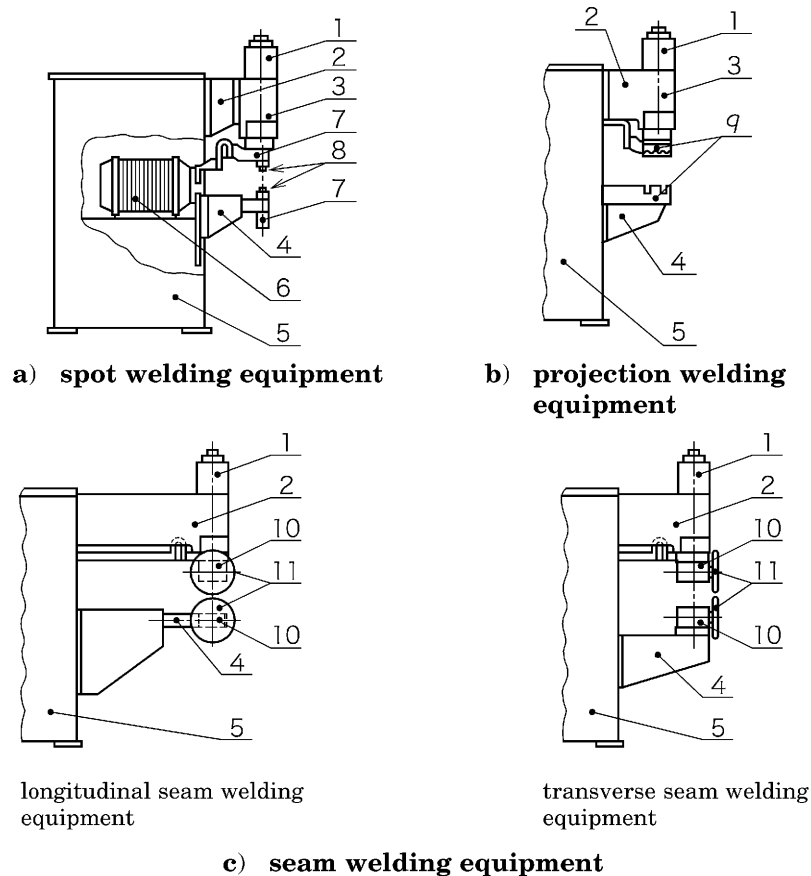
JIS G 3452 *Carbon steel pipes for ordinary piping*

- ISO 8430-1:1988 *Resistance spot welding—Electrode holders—Part 1: Taper fixing 1:10*
- ISO 8430-2:1988 *Resistance spot welding—Electrode holders—Part 2: Morse taper fixing*
- ISO 8430-3:1988 *Resistance spot welding—Electrode holders—Part 3: Parallel shank fixing for end thrust*
- IEC 62135-1 *Resistance welding equipment—Part 1: Safety requirements for design, manufacture and installation*

3 Terms and definitions

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

3.1 Mechanical parts of spot welding equipment, projection welding equipment and seam welding equipment



- | | | |
|---------------------------|--------------------|-------------------------|
| 1 Force generation system | 5 Frame | 9 Platen |
| 2 Upper arm | 6 Transformer | 10 Electrode wheel head |
| 3 Welding head | 7 Electrode holder | 11 Electrode wheel |
| 4 Lower arm | 8 Electrode | |

Figure 1 Elements of spot, projection and seam welding equipment

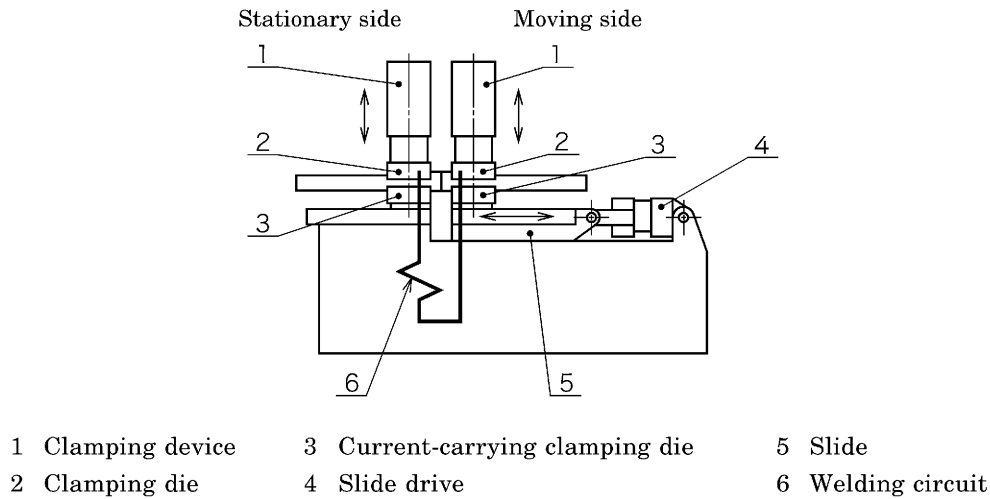


Figure 2 Elements of butt welding equipment

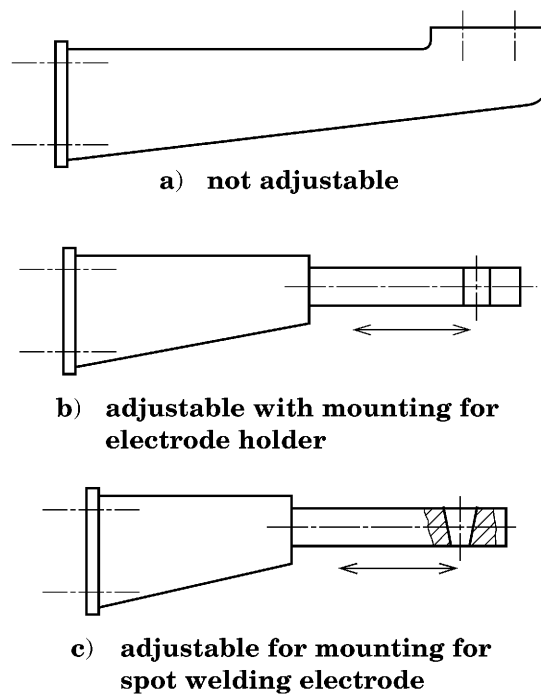


Figure 3 Arms (lower arms)

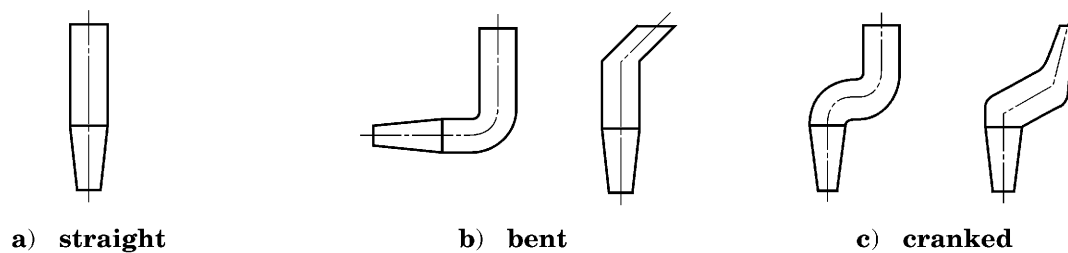


Figure 4 Spot welding electrodes with male taper at flat tip

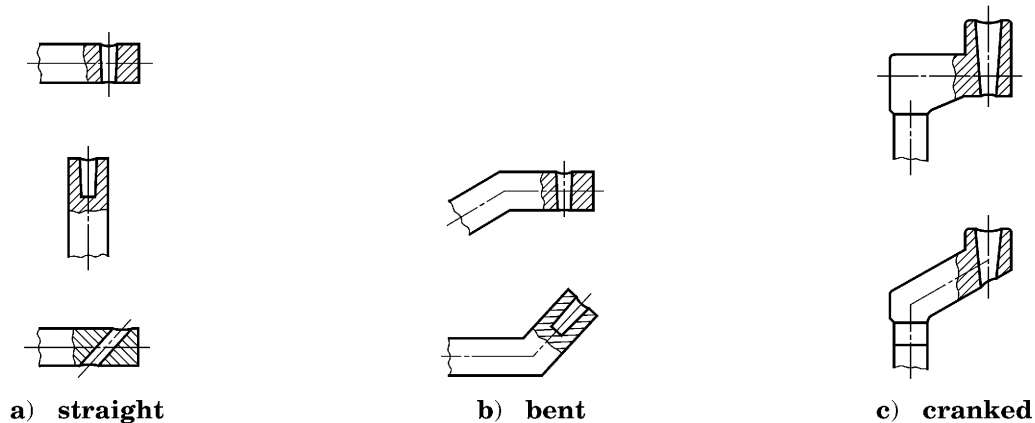


Figure 5 Electrode holders with female taper for spot welding electrodes (fluid cooling hole is not illustrated)

3.1.1 arm

device that transmits the electrode force and conducts the welding current, or supports a separate conductor (see figure 1 and figure 3)

3.1.2 welding head

device comprising the electrode force generation system and the guiding system, which carries an electrode holder, platen or electrode wheel head and is mounted to the upper arm or directly to the machine body (see figure 1)

3.1.3 electrode holder

device holding a spot welding electrode or an electrode adaptor (see figure 1 and figure 5) (**ISO 8430-1**, **ISO 8430-2** and **ISO 8430-3**)

3.1.4 spot welding electrode

electrode designed for spot welding (see figure 1 and figure 4) (**JIS C 9304**)

3.1.5 electrode adaptor

device holding an electrode cap by means of male or female taper (**JIS C 9304**)

3.1.6 electrode cap

replaceable working end of the spot welding electrode to which the electrode cap adaptor is mounted by means of male or female taper (**JIS C 9304**)

3.1.7 platen

conductive flat plate normally having T-slots and to which the projection welding electrodes or welding tools are mounted (see figure 1)

3.1.8 electrode wheel head

device comprising an electrode wheel bearing, which is mounted on the upper arm and lower arm for longitudinal seam welding equipment and/or transverse seam welding (see figure 1)

3.1.9 electrode wheel bearing

device guiding the electrode wheel shaft, which transmits the electrode force and conducts the welding current

3.1.10 electrode wheel

electrode as a rotating disc (see figure 1)

NOTE : The electrode wheel may be driven by a motor directly or by an idler workpiece. The direct drive method is such as the direct drive to the electrode shaft or the knurl drive to its circumference of electrode wheel (see figure 6).

3.1.11 electrode wheel profile

profile of the electrode wheel circumference being single or double sided bevelled or radiused depending on the welding conditions or the profile of workpiece (see figure 7)

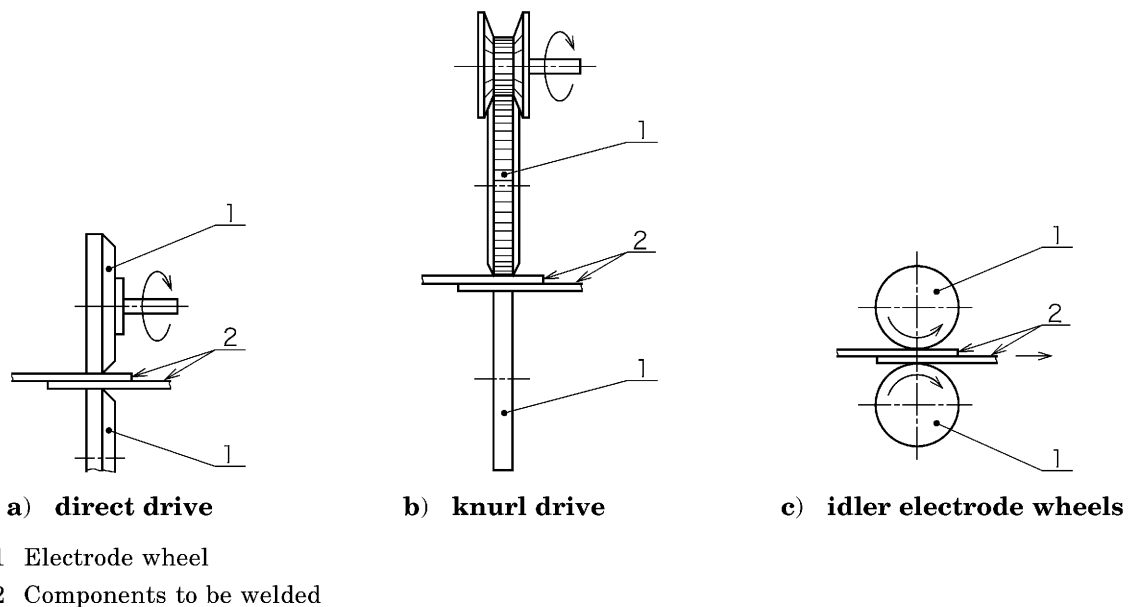


Figure 6 Drive types of electrode wheels

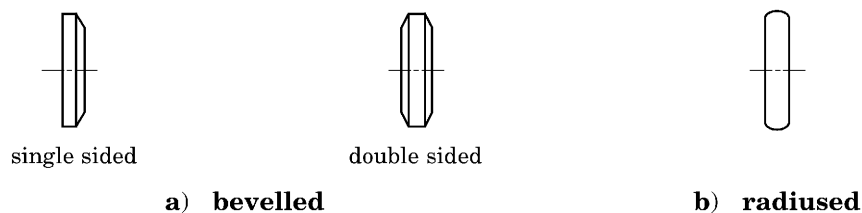


Figure 7 Electrode wheel profiles

3.1.12 electrode wheel speed of direct drive n

rotation speed of wheel

3.1.13 electrode wheel speed of knurl drive v

tangential speed on peripheral of wheel

3.1.14 throat gap (spot welding equipment and seam welding equipment) e
usable distance between the upper and lower arms or the current-conducting parts of the welding circuit (see figure 8)

3.1.14A reference throat gap

in spot welding equipment and seam welding equipment, spatial distance between upper and lower arm structures when movable parts of upper arm and lower arm of the welding equipment are placed at their stand positions, respectively

The stand positions of upper arm and lower arm mean the positions where the upper arm is raised by 15 mm above the lowest position of the stroke of electrode and the lower arm is so adjusted that the space between arms becomes the minimum.

3.1.15 platen distance (projection welding equipment) e

distance between platens (see figure 8)

3.1.15A reference platen distance

in projection welding equipment, distance between top and bottom platens when they are positioned at respective platen positions

The stand positions of top platen and bottom platen mean the positions where the top platen is raised by 15 mm above the lowest position and the bottom platen is placed 800 mm above the floor.

3.1.15B reference work position

height from the floor surface to the centreline of the reference throat gap or the reference platen distance

3.1.16 throat depth l

usable distance between the centre of the platens, the axes of the electrodes, the point of intersection of the electrode shafts in the case of oblique electrodes, or the contact line of electrode wheels and that part of the equipment body located closest to it (see figure 8)

NOTE : This definition does not consider any offset of the electrode tip.

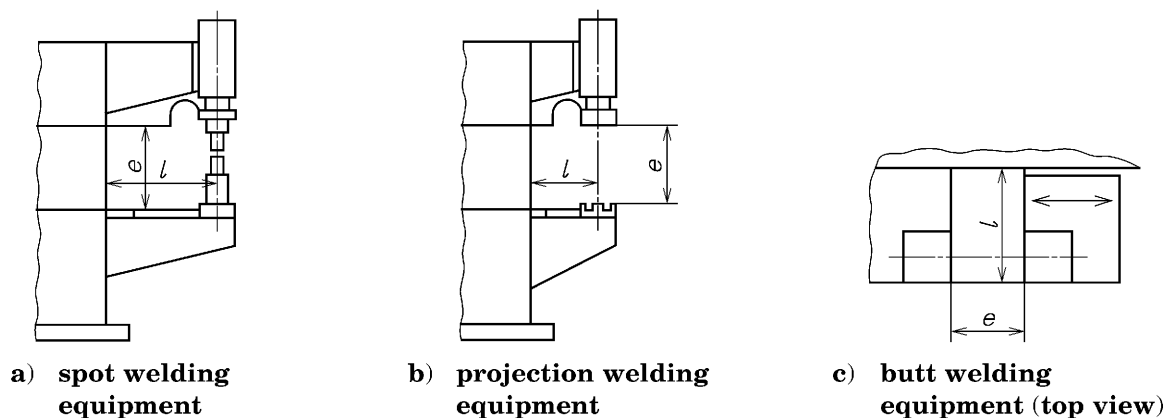


Figure 8 Main dimensions

3.1.17 electrode stroke c, c_1, c_2

physical movement of electrodes during processing

- NOTE 1 When the upper and lower electrodes are set so that they do not touch each other, possible physical movement of electrodes from the open end to the pressuring end is called the maximum stroke (c).
- NOTE 2 When the electrode of moving side is attached to a hinged lever driven by the pressuring device, the maximum stroke of the electrode, by convention, equals the length of the chord of arc generated by the tip of the moving electrode for the maximum stroke of the pressuring device.
- NOTE 3 The electrode stroke is composed of a “work clearance stroke (c_1)” for facilitating the introduction of the workpiece between the electrodes without any contact, and a smaller “working stroke (c_2)”.

3.1.17A platen stroke c, c_1, c_2

in projection welding equipment, movable distance of top platen in vertical direction

- NOTE 1 The platen stroke when the platen is attached to the pressuring device is called the maximum stroke (c).
- NOTE 2 The platen stroke is composed of a “work clearance stroke (c_1)” facilitating the introduction of the workpiece between electrodes without any contact, and a smaller “working stroke (c_2)”.

3.1.17B adjustable range of bottom platen e_p

in projection welding equipment, distance between the highest end position and the lowest end position within the adjustable range of bottom platen

3.1.18 electrode force F

force applied to the component to be welded by the electrodes

3.1.18A rated electrode force F_{rat}

guaranteed value of maximum electrode force applied to the electrodes at the stand arrangement of electrodes of welding equipment

This rated electrode force corresponds to the maximum electrode force in a lap resistance welding equipment, and the maximum upsetting force in a butt resistance welding equipment. Unless otherwise specified, this is the guaranteed electrode force when the compressed air of 0.49 MPa is used for the equipment using the compressed air.

3.1.19 maximum electrode force F_{max}

electrode force of maximum which can be generated by the welding equipment without causing permanent damage to its mechanical parts

3.1.20 minimum electrode force F_{min}

electrode force of minimum which can be used for proper functioning of the welding equipment

3.2 Mechanical parts of butt welding equipment

3.2.1 slide drive

drive generating the movements and upsetting forces necessary for welding the clamped workpiece (see figure 2)

NOTE : For flash welding, the drive may be required to reciprocate the slide for preheating by following the flashing movement and to provide the upsetting force.

3.2.2 clamping device

device generating the contact force necessary for current flow and providing the clamping force necessary to withstand the upsetting force, if no supplementary clamping devices or backstops exist (see figure 2)

3.2.3 supplementary clamping device

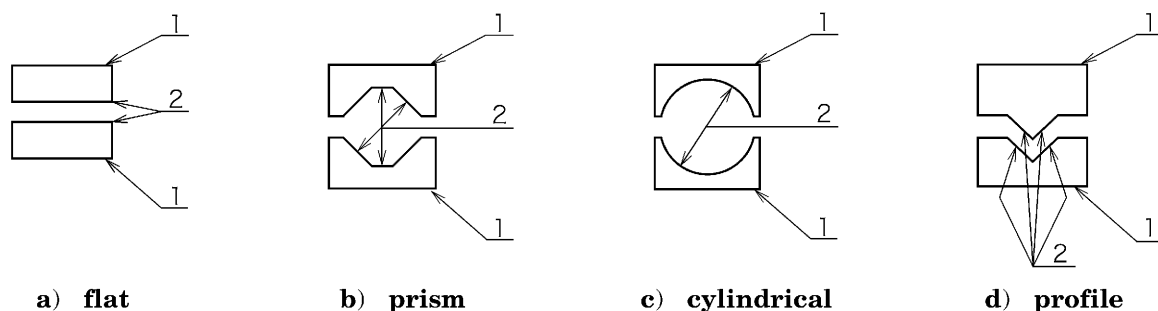
non-current-carrying device to provide the clamping force necessary to withstand the upsetting force

3.2.4 backstop

device to support the total or a part of the upsetting force to a workpiece in order to prevent a workpiece from sliding during upsetting

3.2.5 clamping die

device designed to transfer all forces to the workpiece in contacting with its clamping face (see figure 2 and figure 9)



- 1 Mounting face or support face
- 2 Contact face and/or clamping face

Figure 9 Types of clamping dies (profiles in upsetting direction)

3.2.6 die length G

effective length of the die in the upsetting direction (see figure 10)

3.2.7 die width W

effective width of a clamping die perpendicular to the upsetting and clamping direction (see figure 10)

3.2.8 die thickness C

dimension in the clamping direction (see figure 10)

3.2.9 die stroke q

difference between the smallest opening and the largest opening (see figure 10)

3.2.10 opening gap f

effective distance between flat clamping faces (see figure 10)

NOTE : If the component to be welded is loaded perpendicular to the upsetting direction, the effective distance of profile dies is smaller than that of flat dies (see figure 9).

3.2.11 die distance e

the distance between both die pairs in upsetting direction (see figure 10)

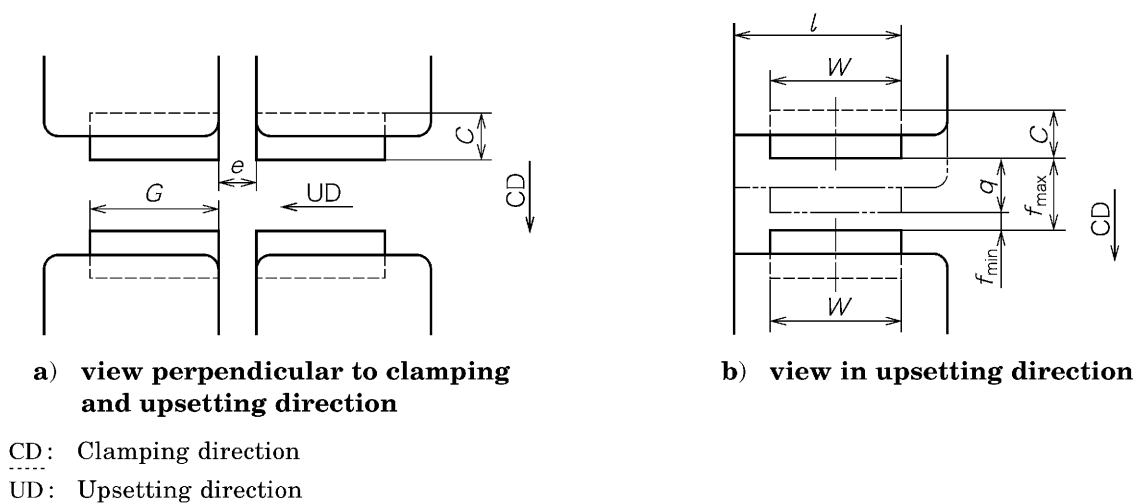


Figure 10 Die measurements

3.2.12 upsetting stroke

difference between the largest and the smallest of die distance

3.2.13 throat depth l

distance between the machine body and the outer edge of the clamping dies measured perpendicular to the upsetting direction (see figure 8 and figure 10)

3.2.14 clamping force F_2

force applied to the workpiece by the clamping dies

3.2.15 maximum clamping force F_{2max}

clamping force of maximum acting through the clamping dies on each part to be assembled, to prevent any sliding and to maintain good electrical contact with the electrodes when the maximum upsetting force is applied

3.2.15A minimum clamping force F_{2min}

clamping force of minimum used for proper functioning of the welding equipment

3.2.16 upsetting force F_1

force acting in the upsetting direction to press the workpieces together

3.2.17 maximum upsetting force $F_{1\max}$

upsetting force of maximum which can be generated by the welding equipment without damage to its mechanical parts

3.2.18 minimum upsetting force $F_{1\min}$

upsetting force of minimum used for proper functioning of the welding equipment

3.2.19 preheating force F_{c1}

force acting in the upsetting direction during preheating

3.2.20 upsetting pressure p_{F1}

pressure created by the upsetting force on the welding cross-section

3.3 Static mechanical, electrical and thermal characteristics

3.3.1 contact faults

faults in contact of electrodes relating to eccentricity or deflection

3.3.2 eccentricity g

distance to which the central points of the electrode end faces or the clamping platens are displaced each other by the electrode force (see figure 11 and figure 12)

- The eccentricity of spot welding equipment and seam welding equipment is calculated according to the following formula (see figure 11).

$$g = b - a$$

- The eccentricity of projection welding equipment is measured in accordance with **15.2.2** (see figure 12).

3.3.3 deflection α

angle of the electrode axis line, the clamping platen face or the axis line of component to be welded deviate from the reference position due to the electrode force or upsetting force (see figure 11 to figure 13)

The deflection is calculated according to the following formula.

- The deflection of spot welding equipment and seam welding equipment is calculated according to the following formula (see figure 11).

$$\alpha = \alpha_2 - \alpha_1$$

- The deflection of projection welding equipment is calculated according to the following formula (see figure 12).

$$\alpha = \tan \alpha = \frac{b_1 - b_2}{b_3}$$

- The deflection of butt welding equipment is calculated according to the following formula (see figure 13).

$$\alpha = \tan \alpha = \frac{b}{k}$$

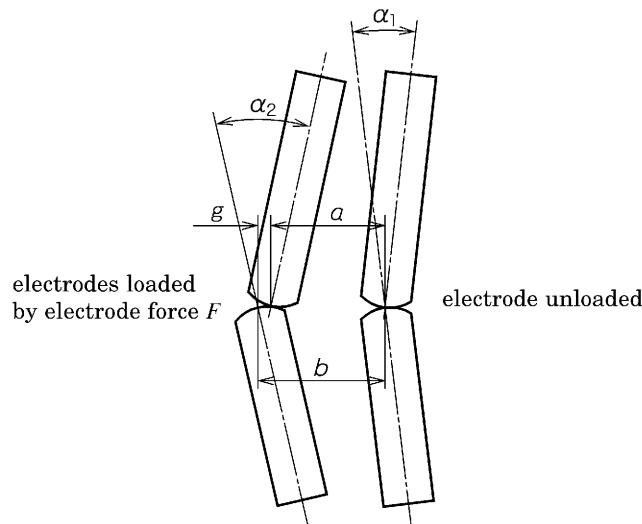


Figure 11 Contact fault of spot welding equipment and seam welding equipment

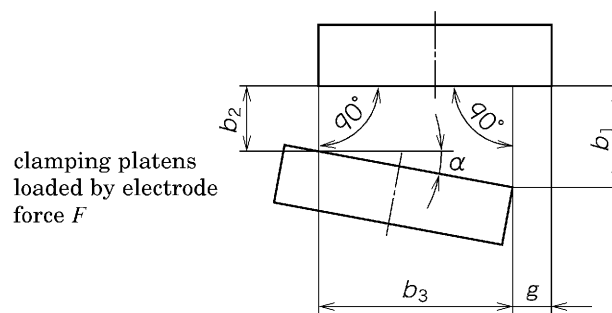


Figure 12 Contact fault of projection welding equipment

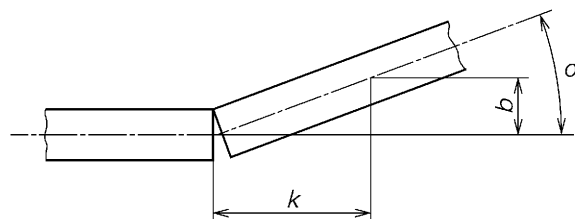


Figure 13 Contact fault of butt welding equipment

3.3.3A deflection of upper arm δ_1

in spot welding equipment and seam welding equipment, displacement due to the deflection of upper arm caused by electrode force which appears in the direction of electrode force (see figure 13A)

3.3.3B deflection of lower arm δ_2

in spot welding equipment and seam welding equipment, displacement due to the deflection of lower arm caused by electrode force which appears in the direction of electrode force (see figure 13A)

3.3.3C parallelism of top and bottom platens δ_3

in projection welding equipment, parallelism of top platen in right and left direction and in front and rear direction with the bottom platen being the reference (see figure 13B)

3.3.3D perpendicularity of top platen δ_4

in projection welding equipment, perpendicularity of movable top platen in right and left direction and in front and rear direction of trace with the bottom platen being the reference (see figure 13C)

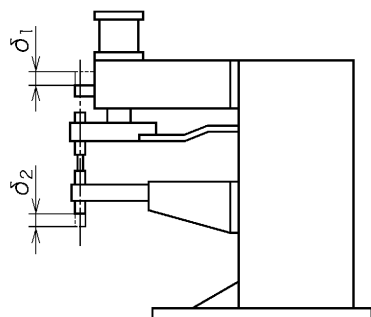


Figure 13A
Deflection of welding equipment

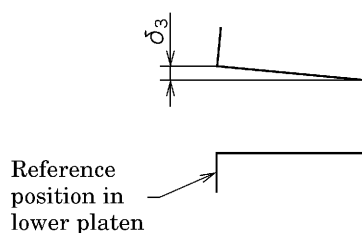


Figure 13B
Parallelism of upper and lower platen faces

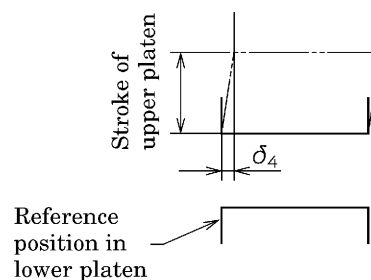


Figure 13C
Squareness of upper platen

3.3.4 duty

operation and schedule, and respective durations and sequences of the welding equipment

3.3.5 continuous duty

duty corresponding to a permanent on-load operation without interruption, where the duty factor is 100 %

3.3.6 periodic duty

duty in which identical cycles of constant load time and no-load time are repeated

The sum of one load time and one no-load time is called the weld cycle time.

NOTE : The load is considered to be constant, and pre-heating and/or post-heating period are excluded.

3.3.7 duty factor X

ratio of the current-carrying time of on-load interval to the total time

NOTE : This ratio, lying between 0 and 1, may be expressed as a percentage (%).

3.3.8 rated supply voltage U_{IN}

rated value of supply voltage necessary to activate the welding equipment

3.3.8A maximum no-load voltage U_{2max}

open-circuit output voltage when the rated supply voltage is applied to the welding transformer tap to which the maximum output current is applicable

3.3.9 rated no-load voltage at the output

U_{20} , U_{2di} , U_{2d} or U_{2a}

3.3.9.1 a.c. no-load voltage U_{20}

voltage of one a.c. output winding of the transformer when the external circuit is open and the rated supply voltage is applied

NOTE : Several settings of the input winding result in relevant values of the no-load voltage.

3.3.9.2 d.c. no-load voltage U_{2di}

voltage of d.c. output calculated when the external circuit is open and the rated supply voltage is applied, ignoring the rectifier voltage drop

NOTE : U_{2di} depends on the rectifying circuit.

3.3.9.3 d.c. no-load voltage of inverter type equipment U_{2d}

voltage of output of d.c. inverter type when the external circuit is open and the rated supply voltage is applied

3.3.9.3A a.c. no-load voltage of inverter type equipment U_{2a}

voltage of output of a.c. inverter type when the external circuit is open and the rated supply voltage is applied

3.3.10 permanent supply current I_{Ip} or I_{LP}

supply current (phase current) corresponding to the permanent output current, where I_{Ip} for single-phase and I_{LP} for three-phase of input side

NOTE : The relationship between the supply current and the output current depends on the type of welding equipment.

3.3.11 permanent output current I_{2p}

maximum output current on all settings of the regulator for continuous operation at a duty factor 100 %

3.3.12 permanent power S_p

maximum input power at a duty factor 100 % where the thermal rating specified for the welding equipment is not exceeded, which is expressed in kVA

3.3.12A rated power S_{50}

input power at such a load that the specified temperature rise is conformed when the current is applied at a duty factor 50 % by regulating the load of the welding equipment at the rated supply voltage and at the rated frequency, which is expressed in kVA

NOTE : $S_{50} = S_p \sqrt{2}$ will only be given for a transition period.

3.3.13 maximum time per pulse t_i

maximum time during which the output current flows without interruption at given output current or voltage regulation

NOTE : This time is limited by one of the following.

- saturation of the magnetic circuit of welding equipment with rectification of input side
- temperature rise of the rectifier of welding equipment with rectification of output side

3.3.14 supply current at a given duty factor I_{IX} or I_{LX}

the maximum supply current when operating at a given duty factor X where the thermal rating specified for the welding equipment is not exceeded

The maximum setting of the output voltage is calculated according to the following formula.

$$I_{IX} = I_{ip} \sqrt{\frac{100}{X}} \quad \text{for single-phase transformer}$$

or

$$I_{LX} = I_{lp} \sqrt{\frac{100}{X}} \quad \text{for three-phase transformer}$$

3.3.15 maximum short-circuit current input I_{icc} or I_{Lcc}

r.m.s. value of the input current at rated supply voltage at the highest output voltage tapping, the electrodes being short-circuited in accordance with clause 10 in the reference output circuit layout

Two values correspond to the minimum and the maximum value of the impedance are given.

NOTE : I_{Lcc} shows the line current used for three-phase welding equipment.

3.3.16 maximum short-circuit current output I_{2cc} , I_{2ccA} , I_{2ccB}

r.m.s. value of the output current at rated supply voltage at the highest output voltage tapping, the electrodes being short-circuited in accordance with clause 10 in the reference output circuit layout

Two values correspond to the minimum and the maximum value of the impedance are given.

The maximum short-circuit current output is indicated by I_{2cc} , in general. According to the impedance, the maximum short-circuit current output at minimum impedance is indicated by I_{2ccA} , and the maximum short-circuit current output at maximum impedance is indicated by I_{2ccB} .

3.3.17 supply pressure of the energizing medium p_1

pressure of the energizing medium supplied to the welding equipment

3.3.18 pressure of the energizing medium p_2

pressure of the energizing medium in the driving cylinder or cylinders to obtain maximum output performance

3.3.19 rated cooling liquid flow Q

quantity of cooling liquid necessary for the permanent operation of welding equipment where the rated temperature specified for the welding equipment is not exceeded

3.3.20 cooling liquid pressure drop Δp

pressure drop at the rated cooling liquid flow

3.3A Capacitor discharge type welding equipment

3.3A.1 maximum charge voltage U_{cmax}

maximum value of the voltage for charging the capacitor for welding of the welding equipment at the rated supply voltage

3.3A.2 nominal energy H_E

value of stored energy charged in the capacitor for welding

It is indicated as $CV^2/2$ in the unit of kilojoule (kJ), where the nominal capacitance of the capacitor for welding is indicated as C and the maximum charge voltage as V . The nominal capacitance means the value of capacitance indicated in accordance with JIS C 5101-1.

3.3A.3 peak value of output short-circuit current I_p

peak value of the current which flows between the electrodes when the upper electrode and the lower electrode are short-circuited at a prescribed throat depth and throat gap, while the maximum charge voltage is applied to the input side of welding transformer (see figure 13D)

3.3A.4 arrival time to peak value of output short-circuit current t_p

time necessary for short-circuit current to reach from zero to the peak value (see figure 13D)

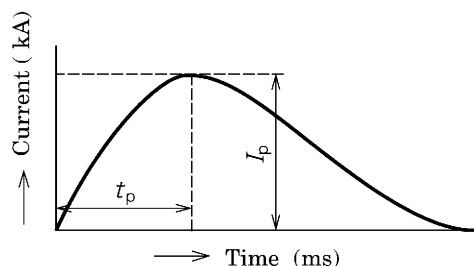


Figure 13D Waveform of short-circuit current of capacitor discharge type welding equipment

3.3A.5 minimum arrival time to peak value of output short-circuit current t'_p

arrival time to peak value of output short-circuit current at the tap where the arrival time to peak value of output short-circuit current is minimum