International Standard 669

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Rating of resistance welding equipment

Spécifications du matériel de soudage par résistance

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 669 was developed by Technical Committee ISO/TC 44, *Welding and allied processes*, and was circulated to the member bodies in March 1979.

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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
France
Italy
South Africa, Rep. of

This International Standard cancels and replaces ISO Recommendation R 669-1968, of which it constitutes a technical revision.

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Rating of resistance welding equipment

1 Scope and field of application

This International Standard defines and specifies the characteristics of single-phase resistance welding equipment. It includes the information to appear on the equipment nameplate and specifies the test methods to be used to verify the compliance of the equipment with the requirements of this International Standard.

It is applicable to single-phase resistance welding machines, including all types of complete portable equipment[1], for use under the following conditions :

a) altitude : in the absence of any information concerning the height above sea level at which the machine is intended for use in ordinary service, the altitude shall be assumed not to exceed 1 000 m;

b) temperature of the cooling medium : in the absence of any information to the contrary, it shall be assumed that, for water-cooled machines, the temperature of the cooling water does not exceed 30 °C at the inlet of the machine and, in the case of air-cooled machines, that none of the following limits are exceeded :

1) maximum ambient air temperature 40 °C,

2) daily average ambient air temperature 30 °C,

3) yearly average ambient air temperature 20 °C;

c) pressure of cooling water : in the absence of any information to the contrary, it shall be assumed that the pressure of the cooling water is not less than that which is necessary to supply the rated quantity of cooling water (see 2.3.5).

This International Standard does not apply to multi-spot welding machines, to transformers sold separately or to capacitor discharge or rectifier machines.

2 Definitions and symbols

2.1 Electrical and thermal characteristics

For a given voltage and frequency the characteristics of the equipment are calculated, constructed and tested, as a function of the following characteristic operations :

a) intermittent operation at a duty cycle (see 2.1.5) of 50 %, the values of current and power being termed nominal and rated;

b) continuous operation, the values of current and power being termed permanent (continuous).

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2.1.1 operating conditions : All quantities defining the performance of a machine.

2.1.2 rated : A qualifying term applied to a value used in the designation of resistance welding equipment.

2.1.3 duty : A schedule of the loads on an apparatus or machine, taking into account their respective duration and sequence.

2.1.4 periodic duty : A duty which is repeated periodically, the sum of one load time and no-load time being termed the weld cycle time.

NOTE — The periodic duty referred to in this International Standard comprises, for each cycle, a given working time under load, followed by a given no-load time. The load is constant, i.e. without any preheating and/or postheating period.

2.1.5 duty cycle (symbol X) : The ratio of the duration of work under load to the duration of the welding cycle time, this ratio lying between 0 and 1, and possibly expressed as a percentage.

1) A complete portable machine is one containing all elements required for operation.

2.1.6 nominal welding cycle time : A cycle having a duration of 60 s and a duty cycle of 50 %.

2.1.7 rated supply voltage (symbol U_{1n}) : The supply voltage for which the machine is constructed.

2.1.8 secondary open-circuit voltage (symbol U_{20}) : The voltage between the electrodes when the rated supply voltage is applied to the terminals of the machine at its various settings with the secondary circuit open.

2.1.9 maximum short-circuit current (primary, symbol I_{1cc} and secondary, symbol I_{2cc}) : The root mean square current at the rated supply voltage and at the highest regulator (tap) setting, the electrodes being short-circuited according to conditions laid down in the test method (see 5.2.1) and the machine being arranged so as to have successively :

a) minimum impedance (minimum throat depth and gap);

b) maximum impedance (maximum throat depth and gap).

2.1.10 maximum short-circuit power (symbol S_{cc}) : The maximum apparent power at the terminals of the machine, expressed in kilovoltamperes, measured at the highest regulator (tap) setting, the electrodes being short-circuited according to conditions laid down in the test method (see 5.2.1), and the machine being arranged in such a manner as to have the minimum secondary impedance compatible with this method of short-circuit.

$$S_{cc} = U_{1n} \times I_{1cc}$$

2.1.11 maximum welding power (symbol $S_{max.}$) : The power equal to 80 % of the maximum short-circuit power.

2.1.12 nominal power at 50 % duty cycle (symbol S_n) : The maximum electrical input (apparent power), expressed in kilovoltamperes, at the nominal welding cycle time without exceeding the specified temperature rise, when measured by the appropriate test method (see clause 5).

2.1.13 permanent (continuous) power (symbol S_p) : The power corresponding to a 100 % duty cycle, the relationship with the nominal power at 50 % duty cycle being given by the formula

$$S_p = \frac{S_n}{\sqrt{2}}$$

2.1.14 nominal current at 50 % duty cycle (symbol I_{2n}) : The highest current that can be drawn from the transformer, on all settings of the regulator, during actual or assumed operation at the nominal welding cycle, without exceeding the specified temperature rises (see clause 4).

2.1.15 permanent (continuous) current (symbol I_{2p}) : The current supplied for continuous operation, its value being given by the formula

$$I_{2p} = \frac{I_{2n}}{\sqrt{2}}$$

2.2 Geometrical characteristics (see figure 1)

2.2.1 throat gap of the machine (symbol e) (see figure 1) :

a) *for spot and seam welding machines* : the usable distance between the arms or the external current-carrying parts of the secondary, when the electrodes are in contact.

NOTE — The space requirements of the electrode-holders are not included for the purposes of this definition.

b) *for projection welding machines* : the usable distance between the platens.

c) *for butt welding machines* : the free accessible distance between both pairs of clamping jaws.

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2.2.2 throat depth (symbol l) (see figure 1) :

a) *for spot, projection and seam welding machines* : the usable distance between the axis of the electrodes, the platens or the centre of the contact line of the wheels and the nearest element of the machine.

NOTE — This definition does not take into account any offset of the electrode tips.

b) *for butt welding machines* : the distance perpendicular to the direction of the upsetting force between the housing wall of the machine and the part of the clamping area located furthest from the machine.

2.2.3 stroke of the electrode (symbol c) :

a) where the electrode or the moving jaw is attached to the driving cylinder, the maximum stroke of the electrode, by convention, equals the total stroke of the driving cylinder.

b) where the moving electrode is attached to a hinged lever moved by a driving cylinder, the maximum stroke of the electrode, by convention, equals the length of the chord of the arc generated by a point on the axis of the moving electrode for a full stroke of the cylinder. This point is at the intersection of the axis of the moving electrode and the contact face for the tip of this electrode, and the electrode is arranged to give the maximum stroke.

NOTE — On certain machines, the stroke of the electrode may be composed of an "approach" with wide amplitude and without any contact, facilitating the introduction of the parts to be welded between the arms of the machine, and a "working stroke", in general, with less amplitude.

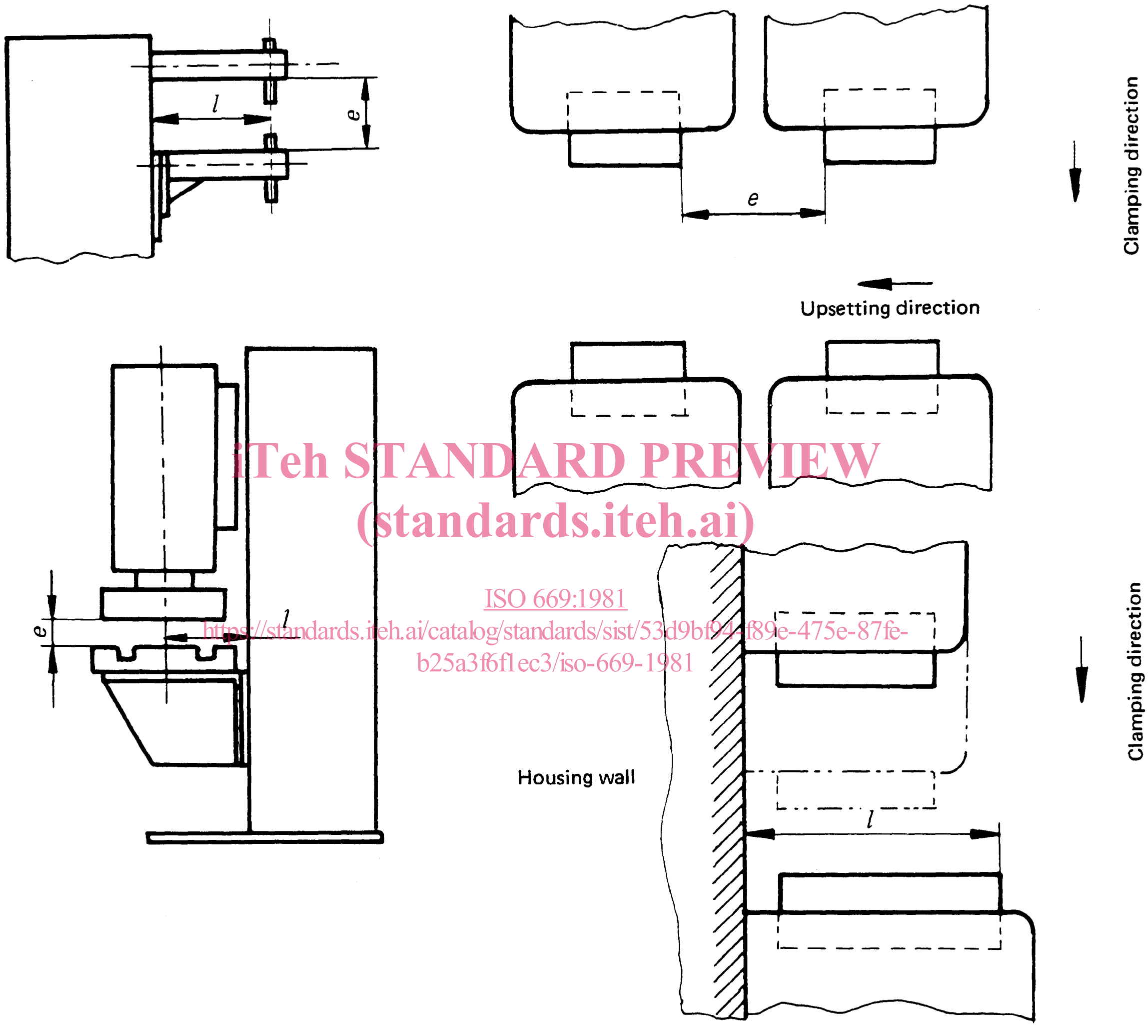

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Figure 1 — Geometrical characteristics of resistance welding equipment

2.3 Mechanical characteristics

2.3.1 maximum and minimum electrode force (symbol F, for spot, projection and seam welding machines)

2.3.1.1 maximum electrode force (symbol $F_{max.}$) : The maximum force, applied to the parts to be assembled during welding, which can be withstood by the welding equipment without deleterious deformations of its mechanical parts.

2.3.1.2 minimum electrode force (symbol $F_{min.}$) : The minimum force which can be used for proper functioning of the machine.

2.3.2 maximum and minimum upsetting and maximum clamping force of butt welding machines

2.3.2.1 maximum upsetting force (symbol $F_{1\ max.}$) : The maximum compressive force, which can be used for proper functioning of the machine, applied to the parts to be assembled during welding, which can be withstood by the welding equipment without deleterious deformations of its mechanical parts.

2.3.2.2 minimum upsetting force (symbol $F_{1\ min.}$) : The minimum force which can be used for proper functioning of the machine.

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2.3.2.3 maximum clamping force (symbol $F_{2\ max.}$) : The maximum force, acting through the jaws 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.

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2.3.3 supply pressure of the energizing medium (symbol p_a) : The required supply pressure of the energizing medium taken at the supply to the machine.

2.3.4 pressure of the energizing medium (symbol p) : The pressure of the medium in the driving cylinder or cylinders, at established conditions, required to obtain the maximum forces.

2.3.5 required total rate of flow of cooling agent (symbol Q) : The total quantity of circulating cooling agent, in cubic decimetres (litres) per minute, which has to be present in the cooling circuit in order to ensure that the permitted maximum temperature rise (see clause 4) is not exceeded when the equipment is operated at nominal power, S_n.

NOTE — The quantity of the cooling agent required for each circuit may also be indicated on the equipment nameplate.

2.3.6 contact fault between the working electrodes faces :

a) *for spot and seam welding machines* (see figure 2) : for any load, the misalignment between the centres of the working faces of the electrodes, expressed in millimetres.

NOTE — This definition may be expressed by indication of the angle α, in radians.

Figure 2 illustrates the definition and corresponds either to two aspects of the figure or to two successive loads as represented by the formulae

1) $\alpha = \alpha_2 - \alpha_1$

2) $g = b - a$

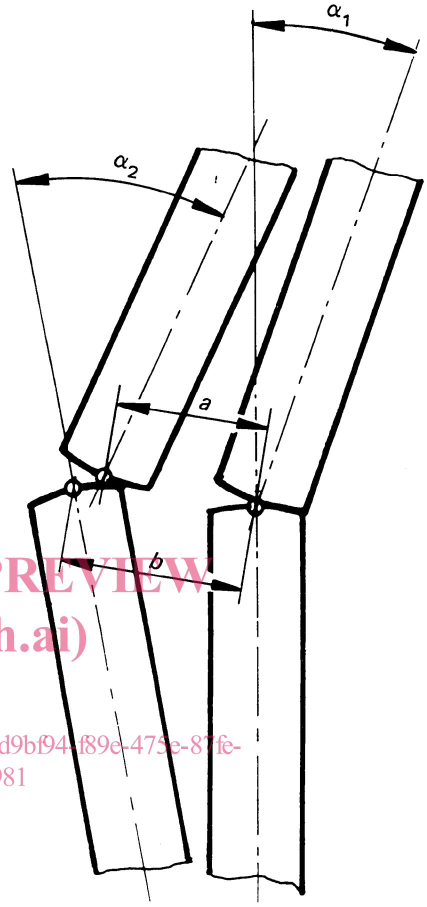

Figure 2 — Contact fault in spot or seam welding as a result of deformation of machine

b) *for projection welding machines* (see figure 3) : for any electrode force, the difference, h, between the clamping plates obtained by application of the nominal electrode force in relation to the unloaded state, and the eccentricity g, h being given by the formula

$$h = b_1 - b_2$$

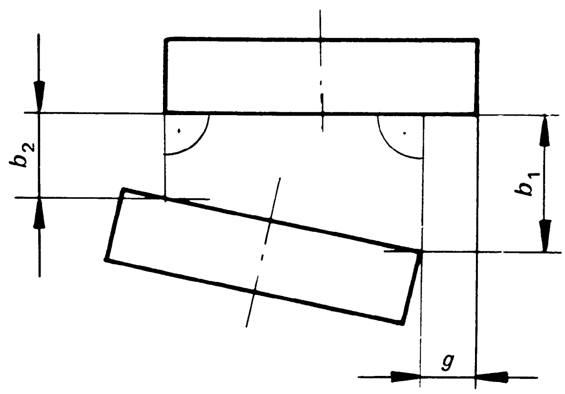

Figure 3 — Contact fault in projection welding as a result of deformation of machine

c) *for butt welding machines* (see figure 4) : the displacement, *b*, at a perpendicular to the upsetting direction, expressed in millimetres, or, alternatively, in milliradians.

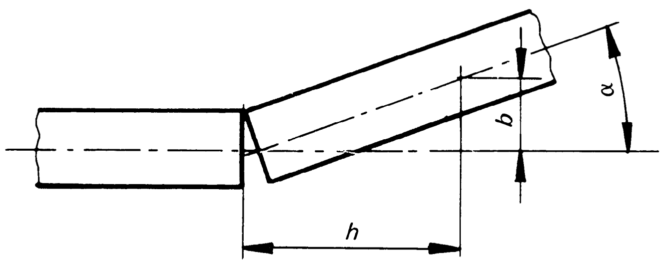

Figure 4 — Contact fault in butt welding as a result of deformation of machine

3 Conditions for temperature measurement

3.1 Air-cooled transformers

The test shall be performed at an ambient temperature of at least 10 °C. It is assumed that the rise in temperature is the same for ambient temperatures between 10 and 40 °C. The ambient temperature shall be taken as the average recorded during the last quarter of the test.

The rise in temperature shall be measured by either the resistance or thermocouple method in the case of primary windings, provided that, when using the thermocouple method, the measurement is taken at the hottest accessible point.

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3.2 Water-cooled transformers

In determining the temperature rise, the actual water inlet temperature at the time of the test shall be taken into account.

The water inlet temperature shall be taken as the average recorded during the last quarter of the test. The maximum water inlet temperature shall not be higher than 30 °C.

The temperature rise shall be measured by either the resistance or thermocouple method in the case of primary windings, and by the thermocouple method or by a probe thermometer in the case of secondary windings.

When using the resistance method, the temperature shall be measured with the cooling water shut off and the load removed. The readings shall be taken as soon as possible after the measuring current has stabilized.

When using the thermocouple or thermometer method, the temperature shall be measured with the cooling water flowing and the load applied.

3.3 End of the test

The end of the test shall be the instant at which the last period under load comes to an end. The measuring methods described in 3.1 and 3.2 shall be applied as soon as possible after this instant to ensure that the temperatures of the windings are measured at their highest values.

4 Limits of temperature rise

4.1 Transformer windings

The limits of temperature rise for air-cooled and water-cooled transformers shall be in accordance with table 1.

Table 1 — Limits of temperature rise[1) 2)]

Transformer cooling medium	Method of determination	Limits of temperature rise °C for classes of insulation				
		A	E	B	F	H
Air	Resistance	60	75	85	105	130
	Thermocouple	60	75	85	110	135
	Thermometer	55	70	80	100	120
Water	Resistance	70	85	95	115	140
	Thermocouple	70	85	95	120	145
	Thermometer	65	80	90	110	130

1) The values given in this table take into account IEC Publication 85* (but are adjusted to suit resistance welding transformers).

2) For the probe thermometer and thermocouple methods, the temperature shall be measured at the hottest point of the winding.

4.2 Temperature rise in core and other parts

The temperature rises shall not exceed the limits specified in table 1 in any of the components of the transformer, whether it is air-cooled or water-cooled.

The temperature rises of the core, and other parts of the transformer in contact with the windings, shall not exceed those laid down for these windings when the tests are carried out by means of a thermometer or detachable thermocouple applied to the core.

4.3 Secondary circuit

For parts of the circuit outside the transformer, excluding the electrodes, the temperature rise shall not be greater than 60 °C.

* IEC Publication 85, *Recommendations for the classification of materials for the insulation of electrical machinery and apparatus in relation to their thermal stability in service.*

5 Test methods and requirements

5.1 General

The machine shall be new.

In determining the maximum short-circuit power, the rated primary voltage of the machine shall be used. The supply voltage under load, measured at the terminals of the machine, shall not differ by more than + 5 % or − 10 % from the rated supply voltage. Corrections may be made by taking the current as being proportional to the voltage.

Where the mains conditions make such a measurement impossible, a reduced primary voltage may be used.

If the measured short-circuit current I'_{cc} is determined at a voltage U'_1, the true value of I_{cc}, valid for the rated supply voltage U_{1n}, is given by the formula

$$I_{cc} = I'_{cc} \frac{U_{1n}}{U'_1}$$

If the equipment is fitted with an ignitron contactor control, the corresponding voltage, u, shall be subtracted from the voltage U_{1n} and U'_1 as follows.

$$I_{cc} = I'_{cc} \frac{U_{1n} - u}{U'_1 - u}$$

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5.2 Determination of short-circuit secondary currents

5.2.1 Conditions of short-circuit

5.2.1.1 Spot welding and seam welding equipment

With the throat gap and the throat depth adjusted to obtain the maximum and the minimum values of impedance successively, the short-circuit shall be effected by bringing together the electrodes, having regard to the conditions given in the formula

$$d = \left(0,5 \pm 0,05\right) \sqrt{0,1\, F_{max.}} > 2,5$$

where

d is the diameter of the tip of the electrode, or the width of the thread of the wheel, in millimetres;

$F_{max.}$ is the maximum electrode force, in newtons, developed by the machine.

The spot welding electrode tips shall be flat. The wheels of the seam welding machine shall be rotating.

The electrodes and wheels shall be made from an alloy having a conductivity of not less than 80 % of that of standard annealed copper.[1)]

5.2.1.2 Projection welding machines

The short-circuit shall be effected by inserting a bar of copper between, and directly under, the centre of the platens of the machine, the cross-sectional area of the bar being sufficient to prevent it overheating. The maximum electrode force shall be applied to the machine.

The length l, in millimetres, of the copper bar placed between the platens shall be as given by the formula

$$l = 122\, F_{max.} \times 10^{-5} + 75$$

where $F_{max.}$ is the maximum electrode force, in newtons, developed by the machine.

If the minimum distance attainable between the platens is greater than the calculated length, the length shall be equal to the minimum distance + 5 mm.

A further test shall be made by inserting a bar of copper between the platens, the length of the bar being $l + e'$, where e' is the vertical distance between the lowest and highest position of the lower platen.

5.2.1.3 Flash and resistance butt welding machines (see figure 5)

The short-circuit shall be effected by inserting a bar of copper between the jaws of the machine, the cross-sectional area of the bar being sufficient to prevent it overheating and the contact surfaces being as large as is practicable. The maximum clamping force shall be applied to the machine.

1) The following resistivity laid down in IEC Publication 28, *International Standard of resistance for copper*, is taken as the normal value for standard annealed copper :

At a temperature of 20 °C the volume resistivity of standard annealed copper is 1/58 = 0,017 242 $\Omega \cdot mm^2 \cdot m^{-1}$ (ohm square millimetre per metre).

The length of the copper bar shall be determined by the distance L, in millimetres, (see figure 5) separating the opposed faces of the jaws, as given by the formula

$$L = 1{,}5 \frac{F}{W} + 2$$

where

$F = F_{1\ max.}/30$, in newtons, for machines which operate with preheating;

$F = F_{1\ max.}/150$, in newtons, for machines which operate without preheating;

W is the maximum width of the jaws, in millimetres, measured perpendicular to the direction of movement, whether the jaws are mounted horizontally or vertically on the machines.

If the length L so determined is not adjustable, it shall equal the minimum distance (throat gap e) + 5 mm.

For machines which operate with or without preheating the lowest figure shall be the basic one.

5.3 Measurement of the maximum short-circuit secondary current

This current shall be expressed as the root mean square value of the current in amperes.

5.3.1 Indirect measurement

A tolerance of − 10 % is given for the maximum secondary short-circuit current. The primary current shall be measured as shown above.

NOTE — The product of turn ratio (the ratio of the number of primary turns to the number of secondary turns) and primary current tends to give too high a value for the maximum short-circuit secondary current, if the maximum induction is close to the saturation point of the magnetizing curve. In this case, any small increase of the voltage may produce an important increase of the magnetizing current.

5.3.2 Direct measurement

A tolerance of ± 5 % is permitted for the maximum short-circuit current.

The current shall be measured as described in 5.2.1.

5.4 No-load measurement

Until the publication of an International Standard relating to separately supplied transformers for use with resistance welding machines, the following arrangements shall be applicable to transformers fitted to machines.

5.4.1 Definitions

5.4.1.1 no-load apparent power S_0 (in voltamperes) : The power absorbed when the rated voltage U_{1T} at the rated frequency of the transformer is applied to the terminals of the primary winding corresponding to the highest secondary voltage, the secondary winding(s) being open-circuited.

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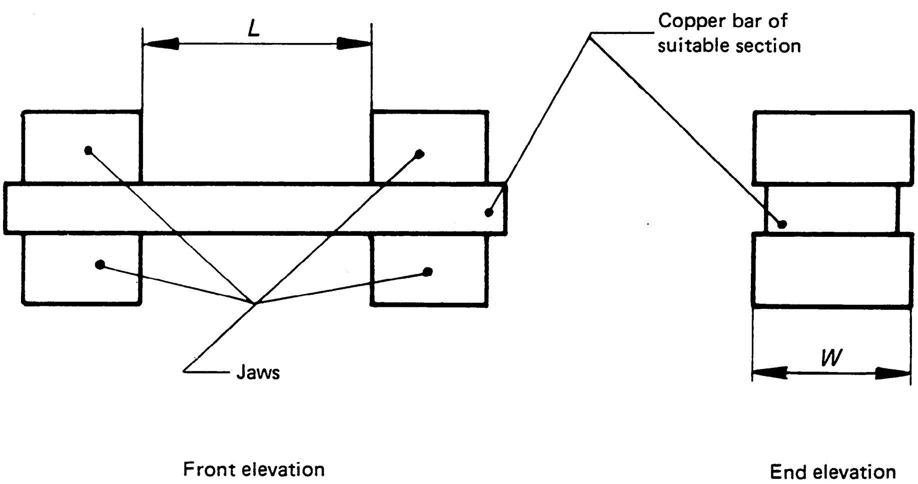

Figure 5 — Short-circuiting bar for butt welding machines