TECHNICAL REPORT

ISO/TR 13950

First edition
1997-12-01

Plastics pipes and fittings — Automatic recognition systems for electrofusion

Tubes et raccords en matières plastiques — Procédés de reconnaissance automatique d'un électrosoudage

Reference number
ISO/TR 13950:1997(E)

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 13950, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications.*

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Annexes A to G form an integral part of this Technical Report.

This study was undertaken by working group ISO/TC 138/WG9 at the request of the manufacturers of electrofusion fittings.

The purpose of the study was to collect together all the automatic recognition systems for electrofusion and to draw up a description of these different systems, attempting to harmonize the terminology used.

This document has been drawn up on the basis of pre-standardization work carried out by an expert group (PC3) within GERG (European Gas Research Group).

If necessary, a performance standard may be added to this document at a later stage.

Introduction

The electrofusion process for the assembly of thermoplastic pipes consists of heating the interface between the pre-assembled pipe and fitting using electrical energy. This is generated by a heating element which forms part of the fitting. The temperature will eventually reach a level high enough to ensure the fusion of the solid material.

The two melted surfaces are then pressed together for a given time. The fusion occurs during cooling by the recrystallization of the material through the interface.

Because of the difficulties encountered by ISO/TC 138/SC 4 with the standardization of the fusion parameters and dimensions of the electric connections of thermoplastic electrofusion fittings on one hand, and because of the growing number of products on the market on the other, users considered it preferable to establish rules for the manufacture of fusion machines usable with the different products.

To ensure the correct operation of these machines, and to limit user errors, it was decided to focus on the automatic identification of the fusion parameters.

This document presents the automatic recognition systems available today.

Any manufactured electrofusion fittings using one of these identification methods must be compatible with one of the systems described in this document.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this Technical Report may involve the use of patents (see clause 5).

ISO takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured ISO that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights other than those identified in clause 5. ISO shall not be held responsible for identifying any or all such patent rights.

Plastics pipes and fittings — Automatic recognition systems for electrofusion

1 Scope

This document describes the 6 systems examined and specifies for each one the characteristics enabling the energy supply to be delivered automatically to the thermoplastic electrofusion fittings used in pipe connection, in compliance with the appropriate ISO standards.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 7810:1995, *Identification cards — Physical characteristics.*

ISO/IEC 7811-1:1995, *Identification cards — Recording technique — Part 1: Embossing.*

ISO/IEC 7811-2:1995, *Identification cards — Recording technique — Part 2: Magnetic stripe.*

ISO/IEC 7811-3:1995, *Identification cards — Recording technique — Part 3: Location of embossed characters on ID-1 cards.*

ISO/IEC 7811-4:1995, *Identification cards — Recording technique — Part 4: Location of read-only magnetic tracks — Tracks 1 and 2.*

ISO/IEC 7811-5:1995, *Identification cards — Recording technique — Part 5: Location of read-write magnetic track — Track 3.*

3 Definitions

For the purposes of this Technical Report, the following definitions apply.

3.1 fitting: Accessory for the connection by fusion of thermoplastic pipes and/or other accessories.

3.2 socket: Female part of a fitting in which the fusion is performed.

3.3 coupler: Fitting constituted by two sockets.

3.4 monofilar coupler: Fitting constituted of two sockets for which fusion is performed in a single operation.

3.5 bifilar coupler: Fitting constituted of two sockets for which fusion is performed separately.

3.6 saddle: Electrofusion fitting for by-passing, branching, ballooning or other operations.

3.7 reduction: Electrofusion fitting for the assembly of two pipes and/or male terminating fittings of different dimensions.

3.8 elbow: Electrofusion fitting with two sockets with an angle.

3.9 tee: Electrofusion fitting with three electrofusion sockets or two sockets and one male end.

3.10 plug: Electrofusion fitting with one socket for plugging tubes and other accessories.

3.11 connector: End of the cable connecting the electrofusion accessory to the fusion machine.

3.12 terminal: Fixed part of the heating element located on the outside of the fitting to enable electrical connection to be made with the fitting.

3.13 terminal shroud: Part of the fitting enabling the connector to be mounted externally.

3.14 nominal fusion time: Fusion time, in seconds, specified by the fitting manufacturer at the reference temperature and for the electrical parameters, such as nominal resistance, voltage and current, specified by the manufacturer.

3.15 real fusion time: Fusion time, in seconds, used in reality, taking account, if necessary, of the ambient temperature and/or the real electrical parameters.

3.16 fusion voltage: The voltage, in volts, applied to the fitting during the fusion cycle.

3.17 fusion current: The current, in amps, flowing in the fitting and its supply circuit during the fusion cycle.

3.18 nominal fusion energy: The energy, in kilojoules, specified by the fitting manufacturer at the reference temperature and for the electrical parameters whose values fall within the tolerance ranges specified by the manufacturer.

3.19 real fusion energy: The energy, in kilojoules, consumed by the fitting at a given ambient temperature and for electrical parameters whose values fall within the tolerance ranges specified by the manufacturer.

3.20 resistance of the heating element

3.20.1 nominal resistance: ohmic resistance of the heating element at 23 °C used in the basic design calculations for the electrofusion fitting, as specified by the manufacturer.

3.20.2 identification resistance: ohmic resistance of the heating element at 20 °C measured on any electrofusion fitting.

3.20.3 measured resistance: ohmic resistance at the ambient temperature measured on any electrofusion fitting.

3.21 resistivity: Reciprocal of the conductivity of the heating element, in ohm metres.

3.22 temperature coefficient of the heating element: Gradient of the change in resistance versus temperature, in reciprocal kelvins.

3.23 MEMO electrofusion elements: Electrofusion elements with a special terminal shroud containing an integrated microchip, enabling these electrofusion elements to be fused with units equipped with a MEMO facility.

4 Description of procedures

4.1 Numerical recognition

4.1.1 Principle

Methods for numerical recognition are based on systems such as bar codes, magnetic cards and microchips. Fusion parameters are recorded in code form on the data medium. At the manufacturer's initiative or in response to user request, other information may also be encoded for fitting identification, identification of test data, fusion cycle optimization, additional safety measures, etc.

For a heating cycle, the system reads, processes and memorizes the information recorded on the data medium.

Successive messages are displayed or signal tones emitted to request the operator to follow a procedure, defined by the fitting manufacturer, specific to the fitting in question and including its recognition.

4.1.2 Field of application and limits

Numerically controlled fusion machines capable of reading fusion parameters can be used for all electrofusion and electroheating assembly techniques.

The limits of this type of fusion control unit shall be detailed by the manufacturer in terms of

— the maximum energy to be delivered;

— the fusion programmes incorporated;

— the fusion adaptations incorporated;

— the limits of the programmable parameters.

4.1.3 Bar codes

The system for entering data using bar codes offers a number of different possibilities for use, both for fitting suppliers and manufacturers of the fusion machine:

— The fitting manufacturer records on the bar code the data he considers will be needed to ensure correct assembly. The amount of data can depend on particular requirements or if there is a new technical development.

— The control unit manufacturer is free to develop his own software and the technical design of the unit. He can choose which data to display, which commands will be available, the criteria for fusion cycle emergency stop, and the display and recording of the various faults, the memorization method for fusion data, etc.

4.1.3.1 Description of the technique

The bar codes used are:

— the 24-character "2-in-5" interleaved type as summarized in table 1;

— the 32-character "2-in-5" interleaved type including traceability coding as summarized in table 2.

4.1.3.2 Description of coding

The coding used has 24 or 32 characters. One of these characters is a control character. A complementary character set can be added if further data is required.

Table 1 — Coding diagram for the 24-digit structure

24	CONTROL
23	Δ t LEVEL CORRECTION regulation at a pre set temperature
22	
21	t s ⩽ 899
20	min ⩾900 or ε or θ inf = 000
19	
18	**K** or **K'** (± %) + (± ρ) f θ °C
17	
16	Ω OHMIC VALUE FOR THE ACCESSORY
15	
14	level **U** or **I**
13	
12	**U, I** or **P** and **Position** **","** **for Ω**
11	
10	∅ of the ACCESSORY EXPRESSED IN mm and " or N°
9	
8	. trademark
7	. types: tapping tee — coupler — sockets
6	others * < J Y C T
5	. Δ : correction ε.f of θ °C
4	. heating cycle
3	. calculation of ε
2	. reference θ °C
1	. cooling time

The meaning of the characters is given in clauses A.1 to A.9.

Table 2 — Coding diagram for the 32-digit structure

The 32-digit bar code is divided in two parts:

Common part (digits 1 to 19) which describes all data related to the characteristics of the element to be fused.

Specific part (digits 20 to 32) which describes all data related to the technique used to fuse the element.

< ------------ Common Part ---------------->	< -------- Specific to the technique -------->
1...19	20...32

Common part format:

Manufacturer				Type		Diameter			Batch code						SDR	Material		
A		B																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Electrofusion format: U or I Regulation

U-I		Ω			ΔΩ	φθ	t			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

Electrofusion format: Energy regulation

U-I		Ω			ΔΩ	φθ	Σ			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

Electrofusion format: Power regulation

U-I		Watt			ΔΩ	φθ	Σ			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

The meanings of the symbols used is given in annex G.

4.1.4 Magnetic cards

The system of data insertion by means of magnetic cards offers different possibilities for the fitting supplier as well as for the user and for the control unit manufacturer.

— The fitting manufacturer records on the card the number of items of data necessary for the completion of an optimal fusion joint. In order to establish the fusion programme he can choose between the functions described in clause B.4. He can adapt the data according to his wishes using nominal or real values. A fusion programme can contain up to 90 characters.

— The control unit manufacturer is completely free to develop his own software as well as the technological concept of his unit. He can choose, among others, the data appearing on the display, the different commands, the emergency stop of the fusion cycle as well as the display and recording of the different faults, the fusion data storage mode, etc., unless prescribed in other standards.

— With respect to the quality assurance of every fusion a record containing all or part of the fusion process data can be stored either on the magnetic card or in the control box memory. When the fusion has been completed successfully and recorded on the magnetic card, the magnetic card cannot be used again to carry out another fusion.

4.1.4.1 Description of the technique

The use of the magnetic card for the transmission of data to a fusion control unit requires the following information:

— the card format;

— the magnetic tracks to be used;

— the recording technique;

— the data storage mode;

— the variables and the units in which they are expressed.

4.1.4.2 Physical characteristics of the magnetic card

The magnetic card (ID-1) used is described in ISO/IEC 7810 and the various parts of ISO/IEC 7811. The card shall not contain embossed characters. The 3 tracks as described in ISO/IEC 7811-4 and ISO/IEC 7811-5 can be used to store data (fusion programme: tracks 1 and 2 only, and a fusion record: tracks 1, 2 and 3) on the card.

4.1.4.3 Description of the encoding

ISO/IEC 7811-2 specifies the characteristics of the magnetic stripe. The structure of the information on tracks 1, 2 and 3 is given in clause B.1.

4.1.4.4 Data storage

For the data storage the basic rules indicated in clause B.4 shall be followed.

4.1.5 Recognition using a MEMO microchip

4.1.5.1 Principle

The electrofusion element is equipped with an integrated microchip. The electrofusion element makes possible the fully automatic recognition of fusion parameters and bi-directional data exchange.

Individual production and fusion parameters are stored directly in the electrofusion element. After the operation the fusion protocol is thus directly registered in the electrofusion element. It is also possible to record additional data such as time and date of installation, the name of the technician as well as the exact geographical location of the fusion element. At any time and throughout its entire life cycle this data can be retrieved from the electrofusion element and reprocessed by analysis software. Integration of all recorded data in a central database provides clear advantages such as systematic localisation of incorrect pipeline elements, statistical evaluation of distributed pipe network data and optimisation of the planning and the extent of pipeline renewal programs.

4.1.5.2 Field of application

Fusion units equipped with a MEMO facility are able to fuse MEMO electrofusion elements having an integrated microchip.

4.1.5.3 Electrofusion element with an integrated microchip

Electrofusion elements need to have a special terminal shroud designed to reach and locate the microchip (see figure F.1).

4.1.5.4 Description of the system

Each MEMO electrofusion element terminal shroud has a moulded flexible ring and notch to reach and locate the integrated microchip (see figure F.1).

The microchip contains the electrofusion element fusion parameters. The fusion parameters are recognised by a special connector. The special connector makes data exchange possible and delivers the required power to the electrofusion element.

The recognition system is shown in table F.1.

4.2 Electromechanical recognition

4.2.1 Principle

The primary function of the electromechanical recognition method consists of converting the measured value of an identifying resistance into a fusion time.

Other functions can be carried out, such as fitting identification by the implanted resistance method.

4.2.2 Field of application and limits

Electromechanical recognition can be used when fittings are provided with the correct terminal housing and terminal pin configurations.

The value of the implanted resistance or the displacement of keying features on the terminal shrouds determine the fusion jointing times.

The limits of the system are:

— the key switch is limited to 36 fixed values;

— the implanted resistor is limited to the range of resistors available from resistor manufacturers.

4.2.3 "Key switch" connectors

On each electrofusion fitting the cylindrical part of the terminal shroud has a moulded key and a notch.

For each cylindrical part, the key is moulded to fit the notch according to one of eight configurations which depend on the fitting fusion time.

The positions between the key and notch are determined by the connectors, and this positioning is marked by the fusion control unit to ensure the correct fusion time. When the moulded cavity has been designed with the terminal configuration specified, recognition of fitting fusion can then be copied.

4.2.3.1 Description of the system

Each electrofusion fitting terminal shroud has a moulded key and a notch as shown in figures C.1 and C.2. The fusion time for each key-notch configuration is given in table C.1.

A special connector is used to determine the direction of the key and the notch and then deliver the required power to the fittings.

There is a specific recognition method for each terminal shroud which is configured in one of the 8 circular positions connected to the 8 resistors.

When connected to the fitting, the position of the key is determined by the moulded notch inside the connector, and the control unit measures the value of the selected resistor. These two values are digitized and used to determine the fusion time read off from a table stored in the control unit.

By sequential switching between the connectors, the value of the resistance can be considerably increased to produce a significant difference in voltage levels and thereby reducing the effects of short-circuits and electrical drift caused by foreign matter.

This recognition system is shown in diagram form in figure C.2.

4.2.4 "Implanted resistor" connector

A high value resistor is implanted in one of the terminal pins of an electrofusion fitting. The value of this resistor is read by the control unit and the fusion time is determined automatically by the control box from stored data.

4.2.4.1 Description of the system

A high value resistor is placed in the fitting terminal as shown in figure D.1. This terminal is moulded into the fitting together with a second plain terminal in the other fitting connector, see figure D.2.

The values of the implanted resistor together with the equivalent fusion times are given in table D.2.

The connector (see figure D.3) from the control box to the fitting is used to recognise the resistor value and to supply power to fittings. The fusion control unit determines the fusion time from the recognised resistance value using stored data.

4.3 Self-regulation

4.3.1 Principle

This fusion control process functions using the physico-chemical state of the material at the fitting/pipe interface. It automatically incorporates variations in fit, assembly temperature, supply voltages and the electrical resistance of the fitting.

During the fusion of a fitting to a pipe, the energy supplied causes an increase in temperature in the area around the heating element: the thermoplastic material therefore passes from the solid to the liquid state. This change in state is accompanied by a volume expansion which increases the pressure in the fusion zone. The quality of the fusion is essentially governed by the triple set (P = pressure, T = temperature, t^* = time during which the temperature of the material is less than the fusion temperature). The principle of self-regulation is to use the data terms (P, T) to govern the fusion time and thus to calculate the optimum t^*.

This requires no adjustment or fusion time correction. The pressure built up in the melted material interrupts the supply circuit.

4.3.2 Field of application and limits

The automatic regulation system enables fittings equipped with the appropriate terminal shroud to be processed.

The limits of this recognition system are:

— either specific to the system:

fixed value for the fusion parameter "fusion voltage".

— or specific to the machine:

maximum available energy.

4.3.3 System description

Each fitting has two calibrated wells positioned above the fusion zone. When the voltage is applied, the heating wire melts the material in the well, firstly at the level of the wire itself, then over a greater area. Figure E.1 shows the melted zone at a given moment: this zone continues to spread in time [in figure E.1 from zone limit (a) to zone limit (b) at the end of fusion]. The wells are designed with the optimum dimensions and geometry for each fitting, ensuring that the melted material in the well bottom rises only when the correct physico-chemical state has been attained at the interface. A sensor located in the connector and being an integral part of the supply cable is fitted over each well. It detects the rising level of molten material and transmits a signal to the fusion control unit which cuts the electricity supply. A diagrammatic representation of the whole detection process is given in figure E.2 for a flat-bottomed well.

4.3.4 Dimensional characteristics

The terminal shroud shown in figure E.3 is universal and can be used with all self-regulating fittings.

5 Patents

In conformity with the ISO Directives, Part 2, annex A, the rules for references to patents on items described in International Standards have been observed. The companies British Gas, Fusion Plastics, Gaz de France, NKK, PE Industries, Sauron and Wavin have notified the working group that their patents cover totally or partially some items described in this Technical Report. Those companies have expressed the wish that their product should be integrated in the Technical Report.

5.1 British Gas, letter 26 March 1991

Patent	UK	2151858 B	16 December 1983
	Europe	0151340	19 November 1984

Application date: see patent

Title: Coupling devices for use with electrofusion fittings of thermoplastic material.

5.2 Fusion Plastics, letter 17 September 1993 and 31 March 1994

Patent	UK	2137026	March 1983
	Europe	0076043	September 1982
	Canada	1193819	September 1985
	USA	4486650	December 1984
	South Africa	82/7746	October 1982
	Japan	1603737	September 1982
	Australia	567083	September 1982
	Denmark	5626/82	December 1982
	Indonesia	9161	February 1983
	Japan	267002/1988	October 1988

Application date: see patent

Title: Electro-Fusion fitting

5.3 Gaz de France (J. Sauron), letter 9 July 1991

Patent	France	8416691

Application date: 31 October 1984

Title: Procédé et machine pour la réalisation de soudures automatiques de pièces en matière plastique comportant un bobinage intégré.

5.4 Gaz de France (J. Sauron), letter 9 July 1991

Patent	France	8618117
	Europe	87402868.1
	US	133478
	Canada	554160
	Japan	324171
	China	87108163
	South Korea	8714828

Application date: 23 December 1986

Title: Procédé pour conduire et contrôler l'élévation de température de pièces chauffées électriquement.

5.5 NKK Corporation, letter 27 September 1991

Patent	Japan	6324820
	Europe	0149410 and extensions

Application date: 23 May 1988

Title: Process and device for the control of the welding time of an electrically welded union

5.6 PE Industries, letter 28 May 1991

Patent	France	8320420	19 December 1983
		8416782	30 October 1984
		8608822	16 June 1986
	Monaco	1677	2 December 1983
		202	15 January 1985

These patents have been extended, in whole or in part, to several countries: USA, China, Austria, Belgium, Italy, Luxembourg, Netherlands, Germany, United Kingdom, Switzerland, Liechtenstein, Sweden, South Africa, Algeria, Argentina, Australia, Canada, South Korea, Denmark, Egypt, Arabian Emirates, Spain, India, Iran, Japan, Morocco, Mexico, Pakistan, Taiwan, Tunisia

Application date: see patent

Title: Microswitch

5.7 PE Industries, letter 28 May 1991

Patent	France	8817420
	Extended to Europe	89403330.7

Application date: 29 December 1989

Title: Dispositif pour détecter au cours du soudage des variations dans l'état de la matière plastique d'une pièce de raccordement

5.8 Wavin, letter 27 April 1995

Patent PCT/EP 94/03158 — AT, AU, BB, BG, BR, BY, CA, CH, LI, CN, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, EE, LR, SI, KE, LT, TT

Application date: 24 September 1993

Title: Quality assurance for electrofusable jointing elements

5.9 Wavin, letter 27 April 1995

Patent PCT/EP 94/01338 — AT, AU, BB, BG, BR, BY, CA, CH, LI, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, CN, LV, NE, TT, KE, LT, SI

Application date: 10 May 1993

Title: Electrical connector for thermoplastic electrofusion elements

Should it be revealed after publication of this Technical Report that licences under patent rights, which appear to cover items included in the Technical Report, cannot be obtained under reasonable and non-discriminatory terms and conditions, the Technical Report shall be referred back to the technical committee for further consideration.

Annex A
(normative)

Description of bar code

A.1 Characters 1 to 8: Trademark — Accessory type — Type Δ f θ °C — Cycle type — Range θ °C

<u>**PRINCIPLE**</u>

Basic alphabet code					
A = 01	F = 06	K = 11	P = 16	U = 21	Z = 26
B = 02	G = 07	L = 12	Q = 17	V = 22	+ = 27
C = 03	H = 08	M = 13	R = 18	W = 23	= 28
D = 04	I = 09	N = 14	S = 19	X = 24	■ = 29
E = 05	J = 10	O = 15	T = 20	Y = 25	

These 8 characters are used to describe:

1) The trademark by contraction of the logo:

— To 4 letters for accessories in case A for the first character, without indication of the cooling time.

NOTE — If the logo requires fewer than 4 alphabetic characters, the filler characters are +, , ■.

— To 2 letters for accessories in case B with indication of the cooling time, the first letter beginning at position 3.

EXAMPLES:	4 letters	2 letters
DUPONT		DP
DURAPIPE	DURA	DU
EUROSTANDARD	EUR	EU
FRIATEC	FRIA	FR
GEORG FISCHER	+ GF+	GF
INNOGAZ	INNO	IN
RAYCHEM	RAY	RY
WAVIN, ROLLMAPLAST	RMP	VR
etc.		

2) Each odd character of the 8 (1, 3, 5 and 7) contains additional data.

1st and 2nd character: the accessory TYPE

Case A

+ 0 = TAPPING TEE OR SADDLE .†.
+ 3 = monofilar or monobloc COUPLER I
+ 6 = single SOCKET J

Case B

9, controls the 2nd character to express an accessory type symbol
90 = ⋆, Request of a heating cycle request with a flip-flop type dividing box
91 = < RAYTRANS 92 = J T.D.W. tapping tee
93 = Y reduction 94 = .†. tapping tee 95 = I Coupler
96 = [single socket 97 = T Tees 98 = C Elbow
99 = Waiting for a definition, current display ERROR.

3rd character: Δ energy correction (apply to characters 19, 20 and 21)

+ 0 = U or I controlled by Δ of 19..21,
+ 3 = U or I controlled by Δ of 13..14,
+ 6 = U or I controlled by Δ of 19..21:
  — control the independent expression of the temperature coefficient and of the manufacturing tolerance % grouped into K or K' character 18;
  — 10 levels of manufacturing precision available;
  — 10 temperature coefficients available;
  — when non-active, display ERROR.

Additional possibilities

5th character:

+ 0 = uniform cycle
+ 3 = sequential cycle, available waiting for a definition
+ 6 = Temperature cycle

NOTE — + 3 and + 6, when non-active, display ERROR.

7th character:

Time control (characters 19, 20 and 21 express the time values)

+ 0, 1, 2 Without cooling time indication,
Logo 4 letters,
3 With indication of cooling time,
Logo 2 letters,
(see table below)

Energy control (characters 19, 20 and 21 express the energy values)

4 Regulation with energy where energy is expressed as (character 19, character 20) × $10^{\text{character 21}}$ (joules)
Example: 123 = 12 × 10^3 J or 12 000 J

5, 6, 7, 8, 9 — With indication of cooling time or message referring to external table,
Logo 2 letters, Energy control N.10^x joules, Expression of the exponent in accordance with 10^x.
$5 = 10^1$, $6 = 10^2$, $7 = 10^3$, $8 = 10^4$, $9 = 10^5$.
characters 19, 20 and 21 are expressing the energy N value
character 8 refers to cooling time
when non-active, display ERROR.

8th character: cooling time

Cooling time in minutes					
0 = 5	1 = 10	2 = 15	3 = 20	4 = 30	5 = 45
6 = 60	7 = 75	8 = 90	9 = Message referring to table		

A.2 Characters 9-10-11: Accessory diameter

PRINCIPLE

The diameter of the accessory is expressed by the external diameter of the pipe on which it is fitted.

1) 000 to 014

Makes 15 numbers available to the electro-heating accessories.

2) The diameter of the accessory expressed in mm

Figures usable: **015 to 799**

— character 9 indicates hundreds of mm

— character 10 indicates tens of mm

— character 11 indicates units of mm

EXAMPLE:

∅ 20 mm = 020 — ∅ 63 mm = 063- ∅ 110 mm = 110

3) The diameter of the accessory expressed in inches with IPS or CTS precision

Figures used: **800 to 999**

— character 9 indicates tens of inches

— character 10 indicates inch units

— character 11 indicates the fraction of an inch according to:

IPS system	CTS system
0 = whole inch 1 = 1/4 inch 2 = 3/8 inch 3 = 1/2 inch 4 = 3/4 inch	5 = whole inch 6 = 1/4 inch 7 = 3/8 inch 8 = 1/2 inch 9 = 3/4 inch

NOTE — 000 is used for accessories not described by their diameter.

4) Expression of the two diameters of a reduction or a monofilar tapping tee

PRINCIPLE:

Code = 93 or 94   Symbol = Y or .†.

Calculation of the two diameters is done using the following table:

∅ in mm	∅ in " CTS	∅ in " IPS
20 mm = 0	1/2 CTS = 19	1/2 IPS = 22
25 mm = 1	1 CTS = 20	3/4 IPS = 23
32 mm = 2	1" 1/4 CTS = 21	1 IPS = 24
40 mm = 3		1" 1/4 IPS = 25
50 mm = 4		2 IPS = 26
63 mm = 5		3 IPS = 27
75 mm = 6		4 IPS = 28
90 mm = 7		6 IPS = 29
110 mm = 8		8 IPS = 30
125 mm = 9		
140 mm = 10		
160 mm = 11		
180 mm = 12		
200 mm = 13		
225 mm = 14		
250 mm = 15		
315 mm = 16		
= 17		
= 18		

The reduction is described by:

(Coded figure of max ∅ × 31) + (coded figure of min ∅) = characters 9-10-11 of the code.

EXAMPLE:

Reduction   ∅ 110 – ∅ 63

(8 x 31) + (5) = 253

A.3 Character 12: Position of comma for the resistor value and type of regulation, U or I

PRINCIPLE

1) Controls, depending on the operating mode specified by the manufacturer, how the heating current is regulated:

In U-mode: Voltage control Volt, if character 3 has a value < 3.

In I-mode: Intensity control Amp, if character 3 has a value < 3.

2) Indicates the number of decimal places in the nominal value for the accessory resistance:

Whole Ω, tenths of an Ω, hundredths of an Ω, according to the table below:

K	U	I
K	1: --- 2: --,- 3: -,--	4: --- 5: --,- 6: -,--
K'	7: --,- 8: -,--	9: --,- 0: -,--

3) **Mode P**: Power control, if character 3 has a value ⩾ 3 and < 6.

The decimal place for the Ω value of the accessory is taken into account together with the choice of:

— U for the calculation of power by U^2/R;

— I for the calculation of power by RI^2.

A.4 Characters 13-14: Level of regulation

PRINCIPLE

Depending on the mode, U or I, described in character 12, characters 13 and 14 define in volts or amps the value of the regulation level selected.

Mode U

Characters 13-14 = 06 to 89

This gives a direct expression of the nominal useful voltage selected and kept constant during the heating cycle at the accessory terminals.

EXAMPLE:

35 volts

Character 13 = 3

Character 14 = 5

Mode I

Characters 13-14 = 02 to 99

This gives a direct expression of the intensity selected and kept constant during the heating cycle.

EXAMPLE:

4 amps	12 amps
Character 13 = 0	Character 13 = 1
Character 14 = 4	Character 14 = 2

Mode P

The selected level of U or I is used as a basis for the calculation of P which is then kept constant at the terminals of the accessory resistor.

Characters 90 to 99

They are available to express in volts or amps particular values.

99 = 39,5 volts

90 to 98 Waiting for definition, display ERROR.

A.5 Characters 15-16-17: Value of Ω for the accessory

The value contained here must be the most precise average value obtained at manufacture from the different batches of the same accessory.

PRINCIPLE

The number of decimal places is determined by character 12:

Whole Ω, tenths of an Ω and hundredths of an Ω.

These three figures indicate

— either the theoretical value of the accessory resistance at 20 °C measured in d.c.

— or the impedance measured at a low 50 Hz sinusoidal alternating voltage (e.g. less than 5 V). This method eliminates the influence of the self-induction effect in the accessories and consequently improves the selectivity of the CONTROL stage.

EXAMPLE:

002 corresponds to 002 Ω if 1, 4 selected for 12

002 corresponds to 00,2 Ω if 2, 5, 7, 9 selected for 12

002 corresponds to 0,02 Ω if 3, 6, 8, 0 selected for 12

NOTE — 000 indicates a value that is ignored, with no CONTROL stage (control cycle of the resistance value Ω).

A.6 Character 18: K = correction coefficient for value of Ω expressed in 15-16-17

PRINCIPLE

Two things affect the theoretical ohmic value of an accessory at an ambient temperature other than 20 °C described in the code in characters 15-16-17. Firstly, the manufactured tolerance of the accessory resistor element; secondly the variation with temperature of the ohmic value which depends on the nature of the resisting wire.

1) Standard K:

Levels are assigned according to the sum of the two elements mentioned above.

They are used, as a ± % range, in the calculation that compares the theoretical value at 20 °C with the measurement at the CONTROL stage for the accessory before the heating cycle.

Figures and corresponding % expressed in the code: VALUES

1 = ± 6%	6 = ± 19%
2 = ± 8%	7 = ± 24%
3 = ± 10%	8 = ± 30%
4 = ± 12%	9 = see note
5 = ± 15%	0 = ignored, used with 15-16-17 = 000.

EXAMPLE 1:

Possible working conditions for θ °C:

— (− 10 °C to + 40 °C) ± 5 °C measurement error

(therefore 35 °C maximum to be corrected vis-à-vis 20 °C)

— Manufacturing tolerance: ± 5 %

— Wire variation coefficient per °C = $+ 3 \times 10^{-3} \leqslant \ \leqslant + 4 \times 10^{-3}$

% sum used: ± 19% = code figure: 6.

EXAMPLE 2:

Possible working conditions for θ °C:

— (− 10 °C to + 40 °C) ± 5°C measurement error

(therefore 35 °C maximum to be corrected vis-à-vis 20 °C)

— Manufacturing tolerance: ± 5 %

— Wire variation coefficient per °C = $\leqslant \pm 0{,}5 \times 10^{-3}$

% sum used: ± 8% = code figure: 2.

NOTE — Code figure 9: Reserved for requesting the calculation of the accessory's real temperature compared with the theoretical bar code value at 20 °C, and the value measured in testing.

This formula only applies to accessories for which the resistor wire is made of pure copper (99,9% electrolytic) with a resistivity of $4{,}1 \times 10^{-3}$ per °C used in the calculation.

— When non-active, display ERROR.

2) K'

— 3 scales of manufacturing precision are pre-defined:

± 7%, ± 12%, ± 20%

— 4 types of variation of ρ of the resistor element f of θ °C are pre-defined and represented by gradients:

per θ °C

$0,0 \leqslant 10^{-3}$, $10^{-3} \leqslant 4 \times 10^{-3}$, $4 \times 10^{-3} \leqslant 6 \times 10^{-3}$

Code figure =	Tolerance %	+ Temp. coeff. 10^{-3}
0	± 7	0
1 2 3	± 7 ± 7 ± 7	0 ⩽ 1 1 ⩽ 4 4 ⩽ 6
4 5 6	± 12 ± 12 ± 12	0 ⩽ 1 1 ⩽ 4 4 ⩽ 6
7 8 9	± 20 ± 20 ± 20	0 ⩽ 1 1 ⩽ 4 4 ⩽ 6

NOTE — The use of K' includes the obligatory "temperature measurement" stage for the pipe except if K' = 0 (figure 0 in the table).

A.7 Characters 19-20-21: Heating time — Energy — Stop temperature

PRINCIPLE

1) Heating time

Heating time is expressed from **003 to 999**.

Case A: Time expressed in seconds

Characters usable: **003 to 899**

— character 19 represents hundreds of seconds

— character 20 represents tens of seconds

— character 21 represents second units

Case B: Time expressed in minutes

Characters usable: **900 to 999**

— character 19 is always set to 9

— character 20 represents tens of minutes

— character 21 represents minute units

NOTE — 000 = infinite heating time indicated by the display "t = infinity" during the heating cycle.

This implies that

— character 22 = 1

— character 23 = 1

2) Energy

1) When the 7th character is 5, 6, 7, 8 or 9, energy is expressed according to $N \times 10^x$ joules

— Use of 7th character to define the exponent: 10^x

— Characters 19-20-21 represent the energy N value.

EXAMPLE:

When the 7th character = 6 then 10^3

Characters 19-20-21 = 234

Cycle will be performed with a total value of 234 000 joules.

2) When the 7th character is 4, energy is expressed as

(character 19, character 20) $\times$ $10^{\text{character 21}}$ (joules)

When non-active, display ERROR.

3) Temperature

Use 5th character to use this mode.

Case A: Expression of the temperature without a progressive rise in power in the U range: regulated voltage

Characters 19-20-21 represent the temperature in °C at which the heating cycle must stop, with a maximum of 299 °C.

EXAMPLE:

165 = 165 °C – 200 = 200 °C

Case B: Expression of the temperature with a progressive rise in power in the U range: regulated voltage

Character 19, always greater than 2, represents the time in seconds for the progressive rise (see table below):

Progressive rise in temperature			
3 = 3	5 = 10	7 = 20	9 = 30
4 = 6	6 = 15	8 =25	

— characters 20-21 describe the temperature in hundreds and tens of °C.

EXAMPLE:

Characters 19- 20- 21

Figures 3 1 5 = a progressive rise of 3 s at 150 °C

NOTE — Characters 22 and 23 should be used for a heating cycle at a pre-selected temperature.

When non-active, display ERROR.

A.8 Characters 22 - 23: Energy correction — Regulation to a pre-defined temperature

1) ENERGY CORRECTION

PRINCIPLE

The heating time or power is corrected according to the temperature of the elements to be assembled.

The basic energy is corrected to take into account the different climatic conditions of the worksite:

— at the reference temperature of 20 °C, no correction is made;

— below 20 °C the correction is, per °C, a **POSITIVE** correction % of the initial parameter;

— above 20 °C the correction is, per °C, a **NEGATIVE** correction % of the initial parameter.

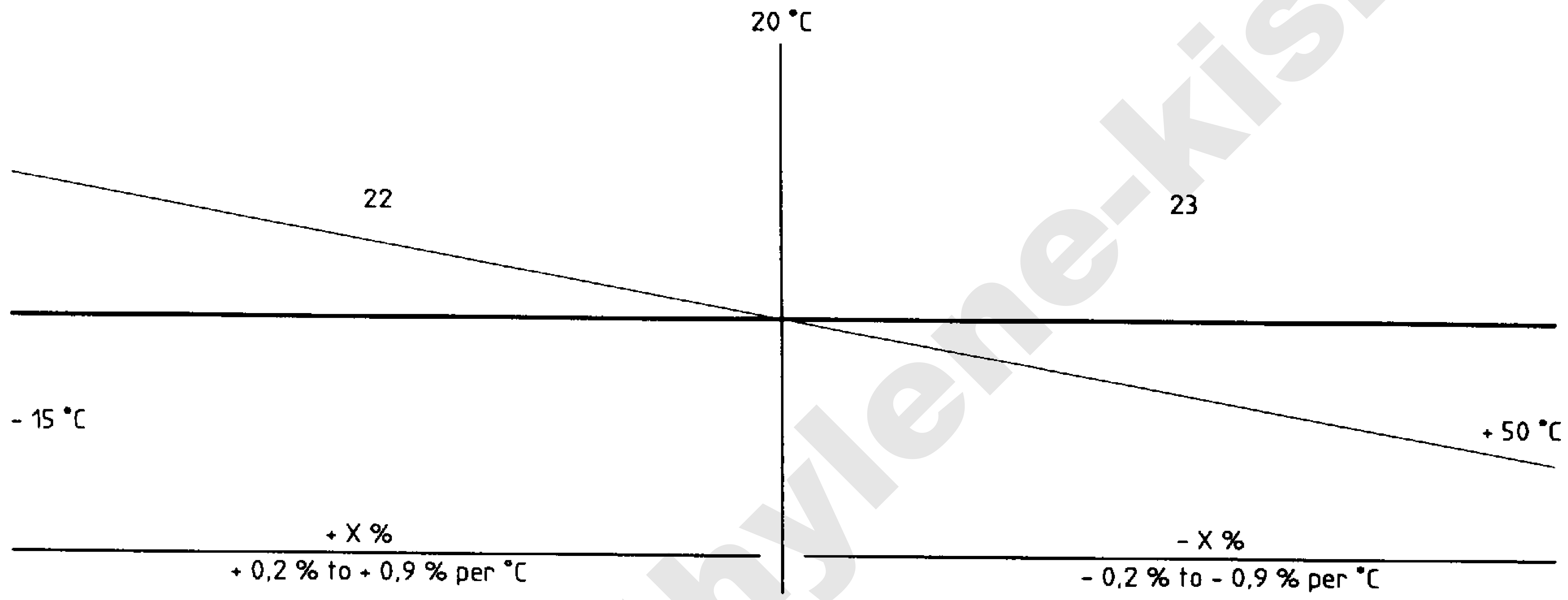


Figure A.1

EXPRESSIONS

1 Character 22: figures 2 to 9

Character 23: figures 2 to 9

This expresses, with Δ of t or Δ of E, one tenth of the correction % per °C.

22 - 23 equal: the correction is a straight line that passes by 0 % at 20 °C

22 - 23 not equal: the correction is a broken line around 0 % at 20 °C

2 Character 22 = 0

Character 23 = 0

Waiting for definition, display ERROR.

3 Character 22 = 0

Character 23 = 1 to 9

Available for safety thresholds on "flags" for accessories with automatic cycle cut-out.

Waiting for definition, display ERROR.

4 — Character 22 = 1

Character 23 = 1

This expresses that there is no need for Δt or for ΔP.

no accounting for θ °C, stage jumped

used with: accessory with uncompensated energy

manual cycle accessory: "t = infinite"

5 — Character 22 = 1

Character 23 = 2 to 9

Waiting for definition, display ERROR.

6 — Character 22 = 1 to 9

Character 23 = 0

Waiting for definition, display ERROR.

7 — Character 22 = 2 to 9

Character 23 = 1

Waiting for definition, display ERROR.

2) Heating cycle regulated at a pre-set temperature

Table showing the heating cycle maintenance time regulated by the pre-set temperature.

Characters 22-23	Space[1)]	Corresponding time in seconds or minutes									
00 to 09	1	00	01	02	03	04	05	06	07	08	09
10 to 19	1	10	11	12	13	14	15	16	17	18	19
20 to 29	2	20	22	24	26	28	30	32	34	36	38
30 to 39	4	40	44	48	52	57	60	64	68	72	76
40 to 49	10	80	90	100	110	120	130	140	150	160	170
50 to 59	20	190	210	230	250	270	290	310	330	350	370
60 to 69	40	400	440	480	520	560	600	640	680	720	760
70 to 79	1'	13'	14'	15'	16'	18'	19'	20'	21'	22'	23'
80 to 89	2'	24'	26'	28'	30'	32'	34'	36'	38'	40'	42'
90 to 99	4'	46'	50'	54'	58'	62'	66'	70'	74'	78'	82'

1) Interval, in seconds or minutes, between two consecutive times.

When non-active, display ERROR.

A.9 Character 24: Control character

The 24th character states that the message is read in its entirety and recognised as being significant.

The value of the control character is determined as follows:

1 Addition of the numerical values of the odd positions in the message read from left to right, followed by multiplication of this total by a factor of 3.

2 Addition of the numerical values of the even positions in the message read from left to right.

3 Addition of the odd and even totals of stages 1 and 2.

4 Determination of the smallest figure which, when added to the sum of stage 3 produces a multiple of 10.

5 This figure is then the control value, and is placed in the 24th position of the message read from left to right.

Annex B
(normative)
Magnetic cards

B.1 Data structure

The magnetic card system enables 226 characters in all to be stored on the three tracks. Table B.1 shows the number of characters stored per track.

Table B.1

Track	Density bit per inch	Max. number of characters including the start and end sentinels and the LRC character
1	210	79
2	75	40
3	210	107

TRACK 1

For this technical application it is necessary to use specific characters. In order to store data on track 1 table 4 (coded character set for track 1) in ISO/IEC 7811-2:1995 is extended as shown in clause B.2.

The structure of track 1 is given in table B.2.

EXAMPLE:

Fusion programme M1 with a constant voltage of 24 volt and a fusion time of 180 seconds.

Table B.2

Character	Binary code		Signification
1	%	1000101	start sentinel
2	M	1101101	identification code
3	1	1010001	index number
4	,	1001100	comma symbol (,)
5	2	1010010	) 1st parameter
6	4	1010100	(
7	,	1001100	comma symbol (,)
8	1	1010001	)
9	8	1011000	(2nd parameter
10	0	1010000	)
.	.		
.	.		
.	.		
77			sentinel of the last data
78	?		end sentinel
79		0011111	LRC

TRACKS 2 and 3

If track 2 or 3 is not used to store data (fusion programme or record) the start and end sentinels and the LRC must be programmed on the respective track.

In order to store data on track 2 or 3 table 7 (coded character set for track 2 and 3) of ISO/IEC 7811-2:1995 is extended as presented in clause B.3.

This extended set of coded characters only enables numerical characters and the symbol for the comma (,), the full stop (.) and the minus sign (–) to be stored.

As a result the extended character set described in clause B.2 is used to transform an alphanumerical code in to a numerical character coded at 2-bit.

This transformation procedure is shown in tables B.3A and B.3B.

The first character of a data series is always a separation sentinel (HEX D), the second and third character are the identification code composed at first by the 3-bits of the inferior level (b1-b3) and then by the superior level (b4-b6) of the respective data.

Table B.3A

Bit number				
4	3	2	1	0
Parity bit	0	b3	b2	b1
Parity bit	0	b6	b5	b4

EXAMPLE:

Identification code X

Table B.3B

Bit number				
4	3	2	1	0
1	0	0	0	0
0	0	1	1	1

The structure of tracks 2 and 3 is shown in table B.4.

EXAMPLE:

Fusion programme M1 with constant voltage of 24 volt and a fusion time of 180 seconds.

Table B.4

Character Track 2	Character Track 3	Binary code		Signification
1	1	HEX B	01011	start sentinel
2	2	HEX D	01101	separation sentinel
3	3	5	10101	) identification code (M)
4	4	5	10101	(
5	5	1	00001	index number
6	6	HEX E	01110	comma symbol (,)
7	7	2	00010	) 1st parameter
8	8	4	00100	(
9	9	HEX E	01110	comma symbol (,)
10	10	1	00001	)
11	11	8	01000	(2 nd parameter
12	12	0	10000	)
13	13	HEX D	01101	separation sentinel
14	14			following identification code
15	15			
.	.			
.	.			
.	.			
38	105			last data sentinel
39	106	HEX F	11111	end sentinel
40	107			LRC

B.2 Extended set of coded characters for track 1

Table B.5

				b6	0	0	1	1
				b5	0	1	0	1
				Column	0	1	2	3
b4	b3	b2	b1	Row				
0	0	0	0	0	SP	0	@	P
0	0	0	1	1	!	1	A	Q
0	0	1	0	2	"	2	B	R
0	0	1	1	3	#	3	C	S
0	1	0	0	4	$	4	D	T
0	1	0	1	5	%	5	E	U
0	1	1	0	6	&	6	F	V
0	1	1	1	7	'	7	G	W
1	0	0	0	8	(	8	H	X
1	0	0	1	9	)	9	I	Y
1	0	1	0	10	*	:	J	Z
1	0	1	1	11	+	;	K	[
1	1	0	0	12	,	<	L	\
1	1	0	1	13	–	=	M	]
1	1	1	0	14	.	>	N	^
1	1	1	1	15	/	?	O	–

Position 0/5 % represents the "start sentinel"
1/15 ? represents the "end sentinel"

B.3 Extended set of coded characters for tracks 2 and 3

Table B.6

Bits					Row	Character
p	b4	b3	b2	b1		
1	0	0	0	0	0	0
0	0	0	0	1	1	1
0	0	0	1	0	2	2
1	0	0	1	1	3	3
0	0	1	0	0	4	4
1	0	1	0	1	5	5
1	0	1	1	0	6	6
0	0	1	1	1	7	7
0	1	0	0	0	8	8
1	1	0	0	1	9	9
1	1	0	1	0	10	.
0	1	0	1	1	11	HEX B
1	1	1	0	0	12	–
0	1	1	0	1	13	HEX D
0	1	1	1	0	14	,
1	1	1	1	1	15	HEX F

Position 11 (HEX B) represents the "start sentinel"
13 (HEX D) represents the "separation sentinel"
15 (HEX F) represents the "end sentinel"

B.4 Data storage

B.4.1 Basic rules

In order to store data the following basic rules must be observed:

— The fusion programme can be stored on track 1 or on tracks 1 and 2.

— Every data series is preceded by an identification code.

— The identification code is composed of a letter followed, as necessary, by an index number.

— The comma symbol (,) is used to separate the different data as well as the coded initial if followed by an index number.

— For certain data series, numbers, letters and other characters are allowed. In this case the use of the semicolon (;) is obligatory to indicate the end of a data series. These data series must be stored on track 1.

— Every identification code of a data series on track 2 and 3 must be preceded by a separation sentinel.

— The dot symbol (.) precedes a decimal. The leading zero can be omitted.

— A parameter block belonging to the identification code cannot be separated at the end of the track.

B.4.2 Variables and units

The units for the different variables to use for the establishment of a fusion programme are indicated in table B.7.

Table B.7

Parameter	Unit
Time	Second
Voltage	Volt
Current	Ampere
Power	Watt
Energy	Kilojoule
Temperature	Degree Celsius
Ohmic resistance	Ohm
Temperature coefficient of heating wire	10^{-5}/Kelvin
Cooling time	Minute

B.4.3 Identification data

All or some of these data may appear on the control unit display. The fusion control unit software must contain all the identification data described below.

B.4.3.1 Physical identification

B.4.3.1.1 Name of manufacturer or product

The variable that follows the identification code indicates the name of the manufacturer and/or his logo or the name of the product.

Table B.8

Data	Description
Identification code	F
Variable format	alphanumerical
Parameter	Name/logo of manufacturer or product
— Variable length	2
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
Example	F12;

B.4.3.1.2 Product type and dimension

The variable following the identification code indicates the fitting dimension(s).

Table B.9

Data	Description
Identification code	P(i)
(i) = index number	
Variable format	alphanumerical
Parameter	Fitting dimension(s)
— Variable length	10 (variable)
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
Example	P1,1234567890;

The symbols for the indication of the product type on the control unit display are shown in clause B.5.

B.4.3.1.3 Product series identification

The variable(s) following the identification code indicate(s) in some way the product series identification.

Table B.10

Data	Description
Identification code	S
Variable format	alpha-numerical
1st Parameter	Production lot identification
— Variable length	max. 16 (variable)
2nd Parameter	Product type *)
— Variable length	2
3rd Parameter	SDR series *)
— Variable length	1
4th Parameter	Raw material type *)
— Variable length	2
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
Examples	S123456; S123456,12,1,12;
*) According to traceability coding	

When the traceability coding is used, all parameters have to be coded.

B.4.3.2 Electrical identification

B.4.3.2.1 Ohmic resistance

The variables following the identification code indicate the identification resistance at 20 °C and the tolerance allowed on the fitting resistance value, measured by the control unit at ambient temperature, up to which the fusion process can be carried out.

Table B.11

Data	Description
Identification code	R1
Variable format	numerical
1st parameter	Identification resistance at 20 °C
— Variable length	5 (variable)
— Number of decimals	max. 3
2nd parameter	Admitted tolerance in %
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
Example	R1,12.12,12

B.4.3.2.2 Temperature coefficient of the heating wire

The numbers following the identification code indicate the temperature coefficient value of the heating wire.

Table B.12

Data	Description
Identification code	A
Variable format	numerical
Parameter	Real temperature coefficient
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
Examples	A123
	A390 corresponds to 390×10^{-5}/K (0,0039/K)

B.4.4 Fusion data

B.4.4.1 Fusion programme

A fusion control unit must include in its software at least fusion programmes M1 and M3.

Standardised fusion programmes:

Table B.13

Code	Variable 1	Variable 2	Variable 3	Variable 4	Variable 5
M1	Voltage	Time			
M2	Current	Time			
M3	Voltage	Energy			
M4	Current	Energy			
M5	Power (U^2/R)	Time			
M6	Power (U^2/R)	Energy			
M7	Voltage	Time	Time 1	Time 2	Time 3
M8	Current	Time	Time 1	Time 2	Time 3
M9	Power (U^2/R)	Time	Time 1	Time 2	Time 3
M10	Voltage	Energy	Time 1	Time 2	Time 3
M11	Current	Energy	Time 1	Time 2	Time 3
M12	Power (U^2/R)	Energy	Time 1	Time 2	Time 3
M13					

The numbers following the identification code indicate the variable parameters of a fusion programme in the order shown in table B.13.

Table B.14

Data	Description
Identification code	M(i)
(i) = index number	
Variable format	numerical
1st parameter	Fusion voltage, current or power
— Variable length	
— Voltage	4 (variable)
— Number of decimals	max. 1
— Current	4 (variable)
— Number of decimals	max. 1
— Power	4 (variable)
— Number of decimals	0
2nd parameter	Total energy or nominal time of a fusion cycle including the stop times of a sequential cycle
— Variable length	
— Time	4 (variable)
— Number of decimals	0
— Energy	6 (variable)
— Number of decimals	
— E ⩽ 650 kJ	max. 2
— 650 kJ < E ⩽ 6500 kJ	max. 1
— E > 6500 kJ	0
3rd parameter	First load time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
4th parameter	Stop time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
5th parameter	Repeating load time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
Examples	M1,12.1,1234 M3,12.1,123.12 M6,1234,123.12 M12,1234,123.12,123,123,123

B.4.4.2 Starting phase of a fusion cycle

In order to vary the power at the beginning of the fusion cycle the control unit must offer the attenuation or load increase functions shown in table B.15. The function influences the variable 1 according to table B.13 of a fusion programme in fixed blocks of 10% during a defined variable period. The use of two load level functions must be possible. In such a case the function with the higher index number starts after the function with the lower index number.

Standardised blocks:

Table B.15

Code	Nominal load value
B5	50 %
B6	60 %
B7	70 %
B8	80 %
B9	90 %
B11	110 %
B12	120 %
B13	130 %
B14	140 %
B15	150 %

The numbers following the identification code indicate the period during which the function is active.

Table B.16

Data	Description
Identification code	B(i)
(i) = index number	
Variable format	numerical
Parameter	variable time of the function
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
Examples	B8,20
— Superposition	B8,20B12,10

B.4.4.3 Safety against overheating

In order to avoid excessive heating caused by an unintended short-circuit the fusion control unit must offer the load limitation functions in fixed blocks of 10 % shown in table B.17.

Standardised blocks:

Table B.17

Code	Reduction
H0	0 %
H1	10 %
H2	20 %
H3	30 %
H4	40 %
H5	50 %

The numbers following the identification code indicate the time starting with the fusion cycle launch when the function has just been activated.

Table B.18

Data	Description
Identification code	H(i)
(i) = index number	
Variable format	numerical
Parameter	Time from which on the function is activated
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
Example	H8,50

B.4.4.4 Temperature compensation

In order to vary the energy according the ambient temperature the fusion control unit must offer the compensation functions shown in table B.19. The use of compensation must be possible for one or two variables of a fusion programme. The use of two compensation functions must be possible. In such a case one function must have an even index number and the other an odd index number.

Standardised compensation programmes:

Table B.19

Code	Ambient temperature			Variable to be compensated in fusion programmes in table B.13
	< 0 °C	< 20 °C	> 20 °C	
K1		x		1
K2		x		2
K3		x	x	1
K4		x	x	2
K5	x	x	x	1
K6	x	x	x	2
K7	x			1
K8	x			2

The numbers following the identification code indicate the values for the correction coefficients in o/oo per °C of the unit concerned.

Table B.20

Data	Description
Identification code	K(i)
(i) = index number	
Variable format	numerical
1st parameter	Correction coefficient for the lowest temperature range in the compensation programme
— Variable length	2 (variable)
— Number of decimals	0
2nd parameter	Correction coefficient for the temperature range next to the 1st programme parameter if existing
— Variable length	2 (variable)
— Number of decimals	0
3rd parameter	Correction coefficient for the temperature range next to the 2nd programme parameter if existing
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
Examples	K2,12
— Superposition	K4,12,12K7,12

B.4.4.5 Fusibility limits of the fitting

The fusion control unit must offer the fusibility limitation programmes shown in table B.21.

Standardised fusibility limitation programmes:

Table B.21

Code	Ambient temperature		Notes
	Min.	Max.	
V1	≤ 0 °C	> 0 °C	Temperature limits to be specified
V2	≥ 0 °C	> 0 °C	Temperature limits to be specified
V3	– 10 °C	+ 45 °C	Fixed temperature limits

The numbers following the identification code indicate the values for the limit temperature of the fusibility range.

Table B.22

Data	Description
Identification code	V(i)
(i) = index number	
Variable format	numerical
1st parameter	Minimum temperature of the fusibility limitation range
— Variable length	2 (variable)
— Number of decimals	0
2nd parameter	Maximum temperature of the fusibility limitation range
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
Examples	V1,12,12
— Fixed temperature limits	V3

The limits of use of the control unit cannot be extended.

B.4.5 Cooling time

The fusion control unit must offer the possibility of indicating the minimal cooling time on the display.

Table B.23

Data	Description
Identification code	X
Variable format	numerical
Parameter	Cooling time of the respective fitting
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
Example	X123

B.4.6 Fusion record

For efficient fusion joint control and follow-up of control unit performance a fusion record can be established. The record may contain any of the data mentioned in table B.24.

Standardised codes for the fusion record:

Table B.24

Code	Description
F	Name of manufacturer or product
P	Product type and dimensions
S	Production series
R1	Identification resistance
R2	Resistance measured by the control unit at ambient temperature
G	Control unit number and date of latest revision
D	Minimum and maximum primary voltage measured during fusion cycle
U	Date and time of fusion
N	Consecutive fusion number
T	Ambient temperature measured by the fusion unit before starting the cycle
C	Total duration of the fusion
W	Energy supplied to the fitting
E	Indication of any error which appeared during the fusion cycle
Z	Particular functions offered by the control unit manufacturer

B.4.7 Particular functions

The letter Z is at the disposal of the control unit manufacturer for free use regarding particular functions.

Table B.25

Data	Description
Identification code	Z
Variable format	alphanumerical or numerical
Storage on track	1

B.4.8 Available letters

The letters I, J, L, O, Q and Y are still available for a codification within the same standardisation.

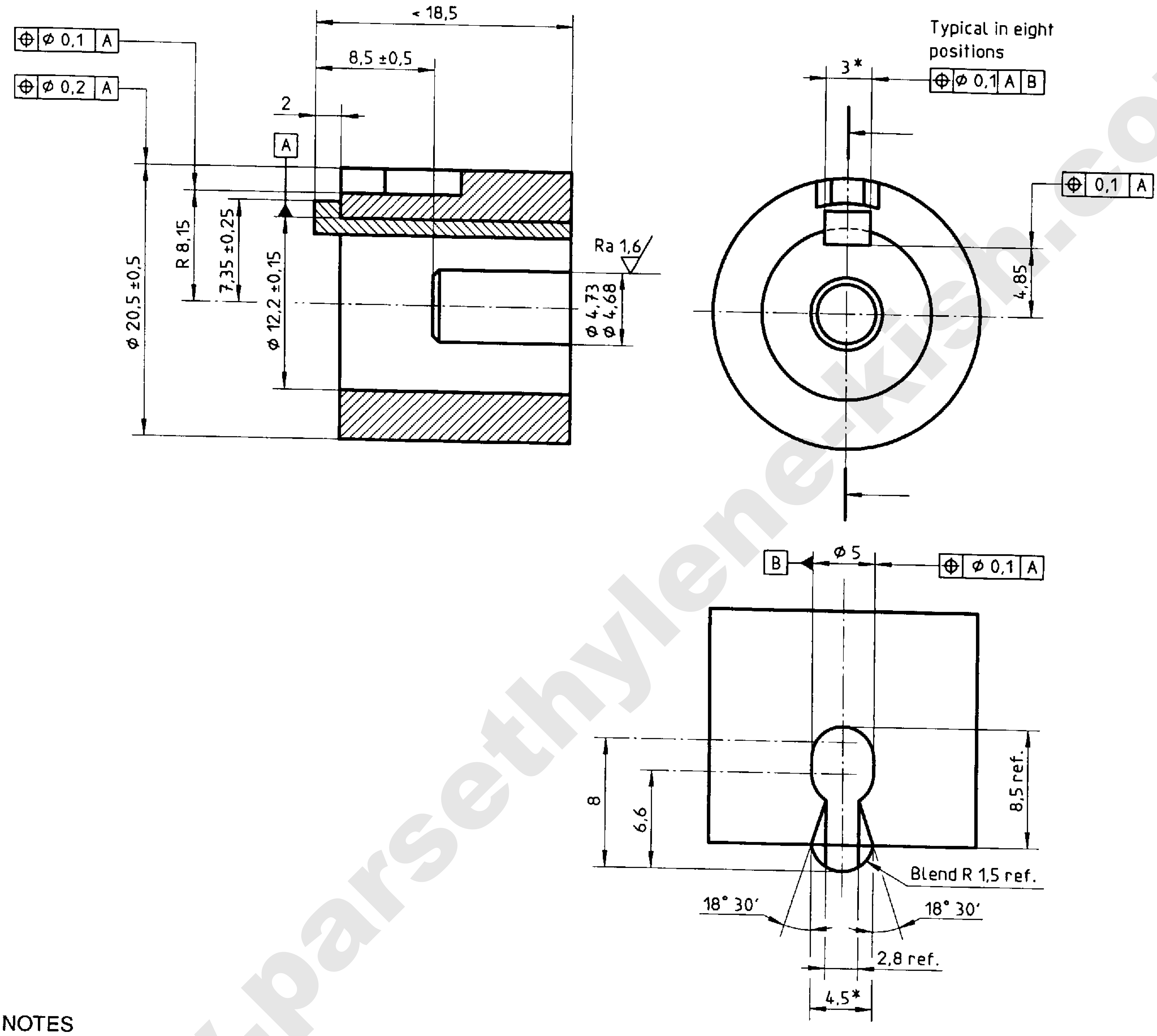
B.5 Standardised product types

Table B.26

Code	Product type	Symbol on the fusion control unit display
P0	Others	*
P1	Monofilar socket	I
P2	Bifilar socket	]
P3	Saddle	.†.
P4	Monofilar reduction	Y
P5	Monofilar elbow	L
P6	Monofilar tee	T

Annex C
(normative)

"Key switch" connectors



NOTES

1 All dimensions in millimetres; surface roughness in micrometres.

2 Tolerances on dimensions (unless otherwise specified):

a) Dimensions identified by *: ± 0,1.

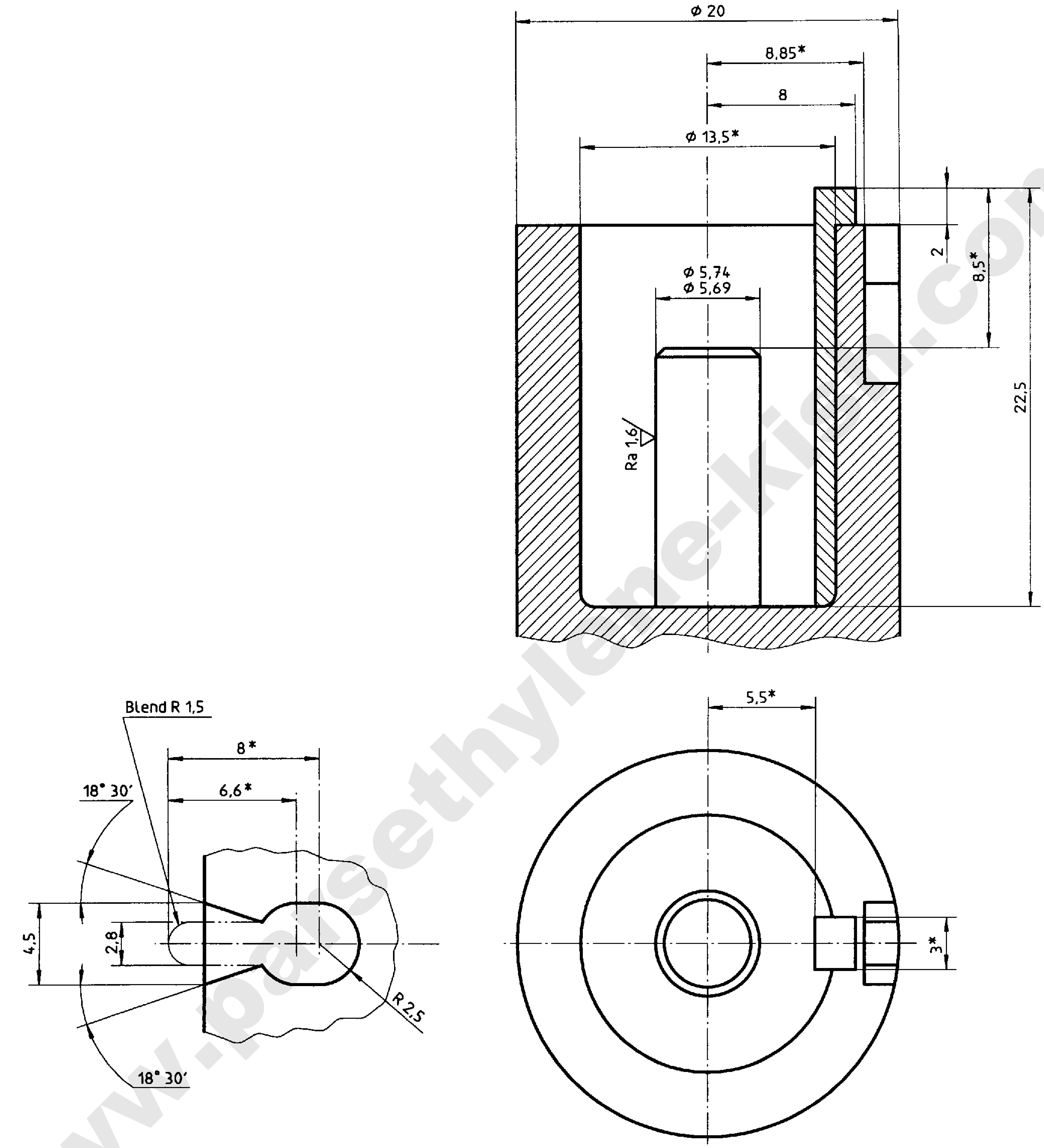
b) Other linear dimensions: ± 0,2.

c) Angular dimensions: ± 1°.

3 Dimension 7,35 ± 0,25 for the inner key may alternatively be R 7, 35 ± 0,25.

4 To allow engagement of the fitting connectors, the area within a 20 mm radius of the centre line of each terminal pin shall be kept free from any protrusions higher than the fitting terminal shroud, e.g. tapping tee stack or branch outlet.

Figure C.1a — Automatic recognition terminals and shroud



NOTES

1 All dimensions in millimetres; surface roughness in micrometres.

2 Tolerances on dimensions (unless otherwise specified):

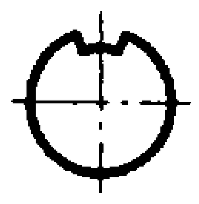
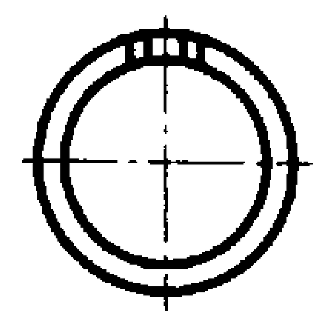
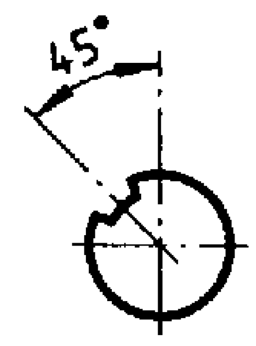
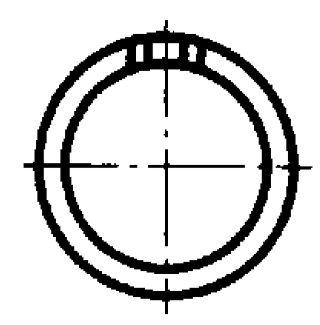
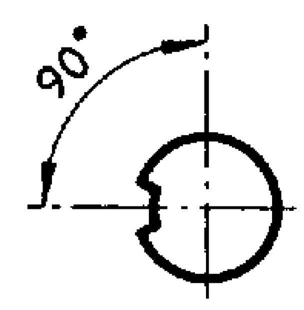
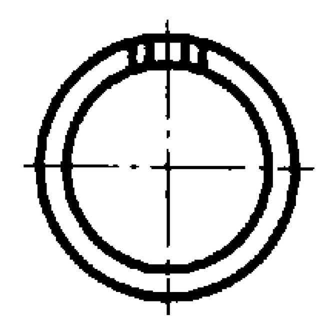
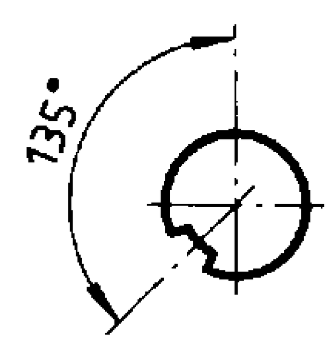
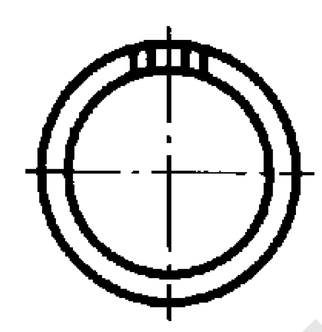
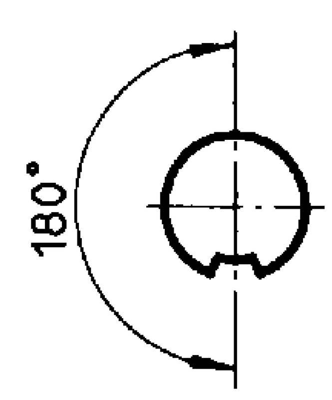
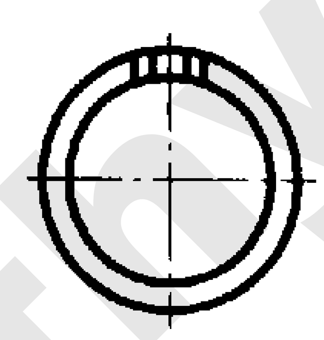
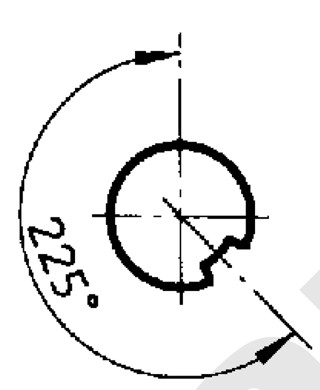
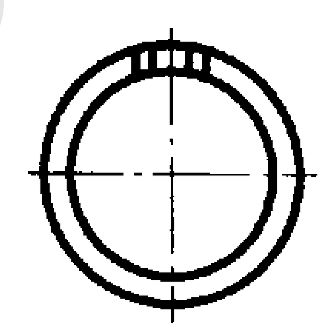
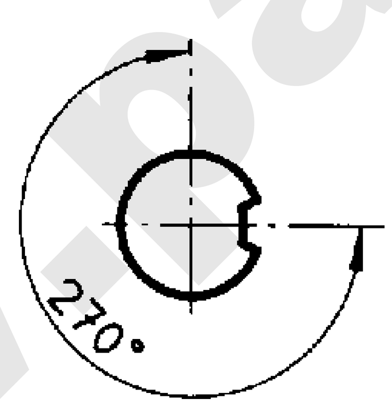
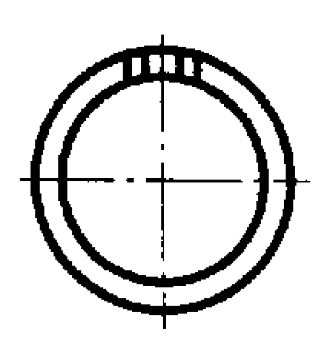
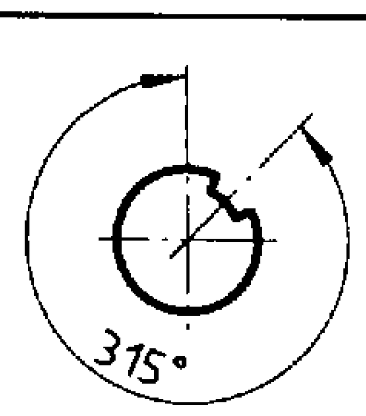
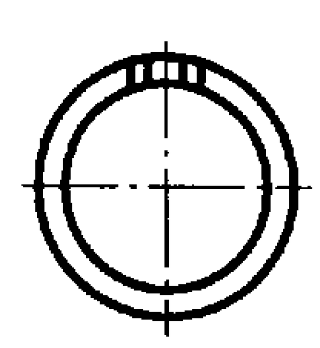
a) Dimensions identified by *: ± 0,1.

b) Other linear dimensions: ± 0,2.

c) Angular dimensions: ± 1°.

Figure C.1b — Terminal arrangement for 80 V system

Table C.1 — Fusion time identification for 40 V and 80 V systems

Positions	Keys	Snap joint
1		
2		
3		
4		
5		
6		
7		
8		

NOTE — Angular tolerance ±1°

Automatic recognition terminal positions	Fusion time s	
	40 V system	80 V system
1 - 1	20	200
1 - 2	22	220
1 - 3	24	240
1 - 4	26	260
1 - 5	28	280
1 - 6	30	300
1 - 7	32	320
1 - 8	34	340
2 - 2	36	360
2 - 3	40	380
2 - 4	42	400
2 - 5	44	420
2 - 6	46	440
2 - 7	50	460
2 - 8	55	480
3 - 3	60	500
3 - 4	70	520
3 - 5	80	540
3 - 6	85	560
3 - 7	90	580
3 - 8	110	600
4 - 4	120	620
4 - 5	130	640
4 - 6	140	660
4 - 7	160	680
4 - 8	180	700
5 - 5	200	720
5 - 6	220	740
5 - 7	240	760
5 - 8	260	780
6 - 6	300	800
6 - 7	360	820
6 - 8	400	840
7 - 7	440	860
7 - 8	500	880
8 - 8	600	900

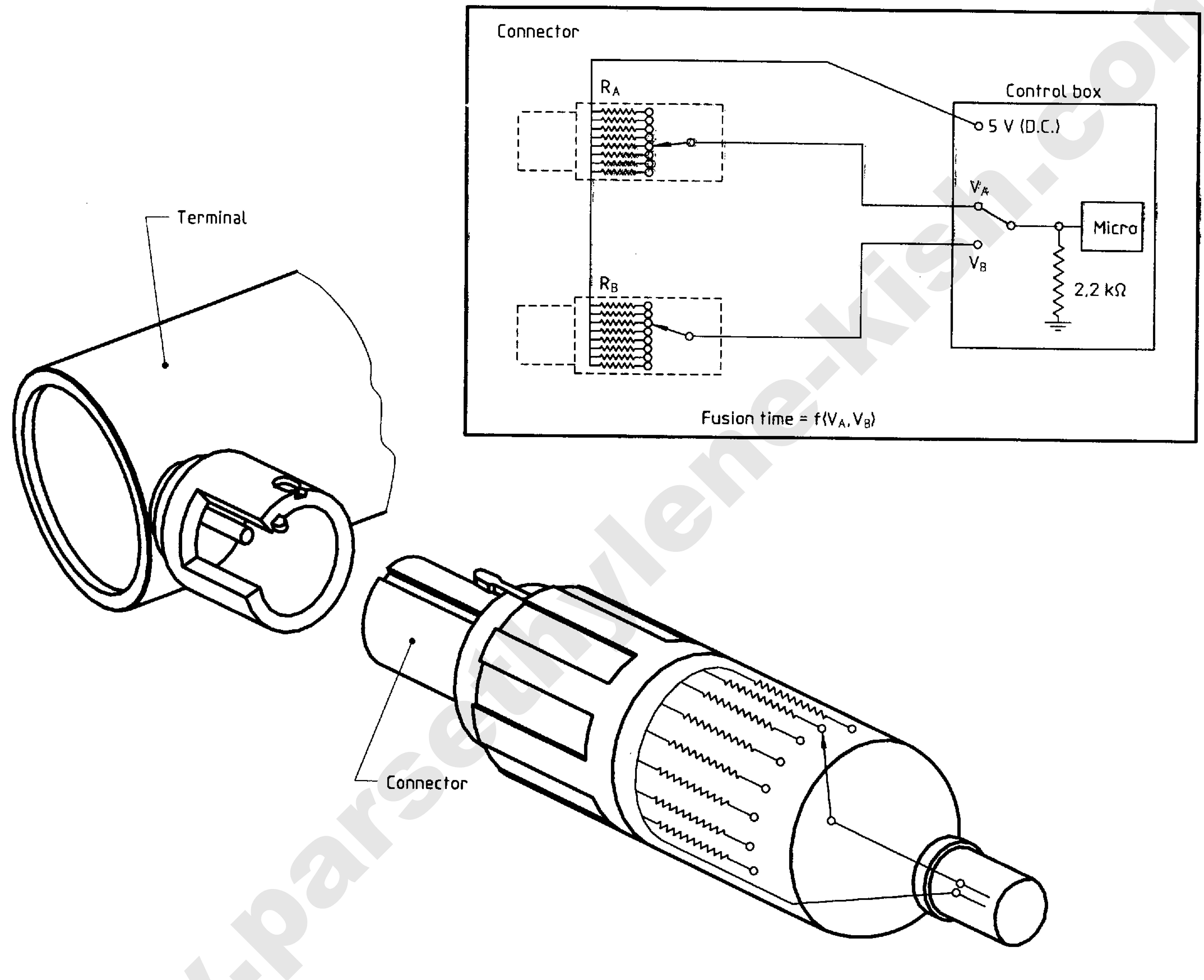
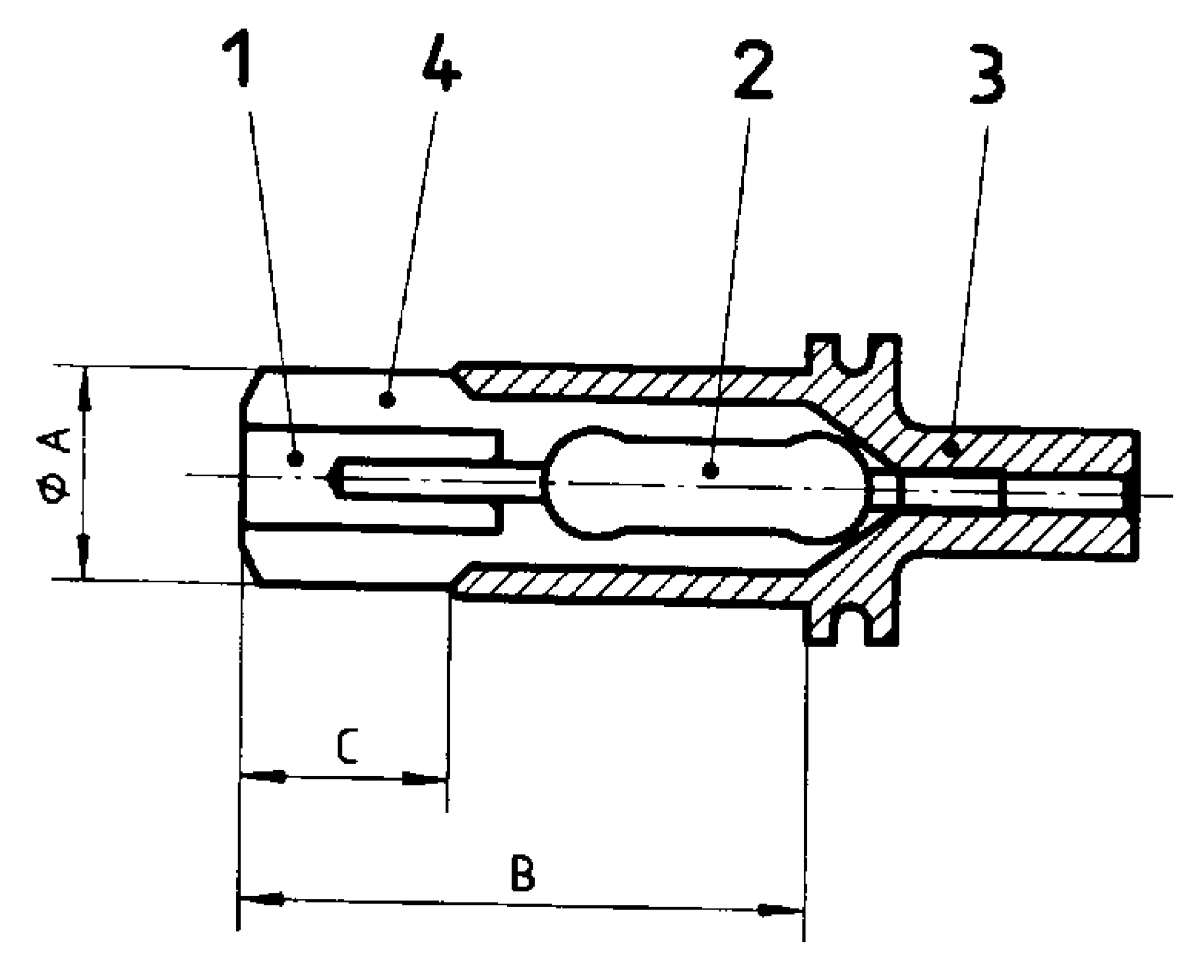


Figure C.2 — Self-recognition electrofusion

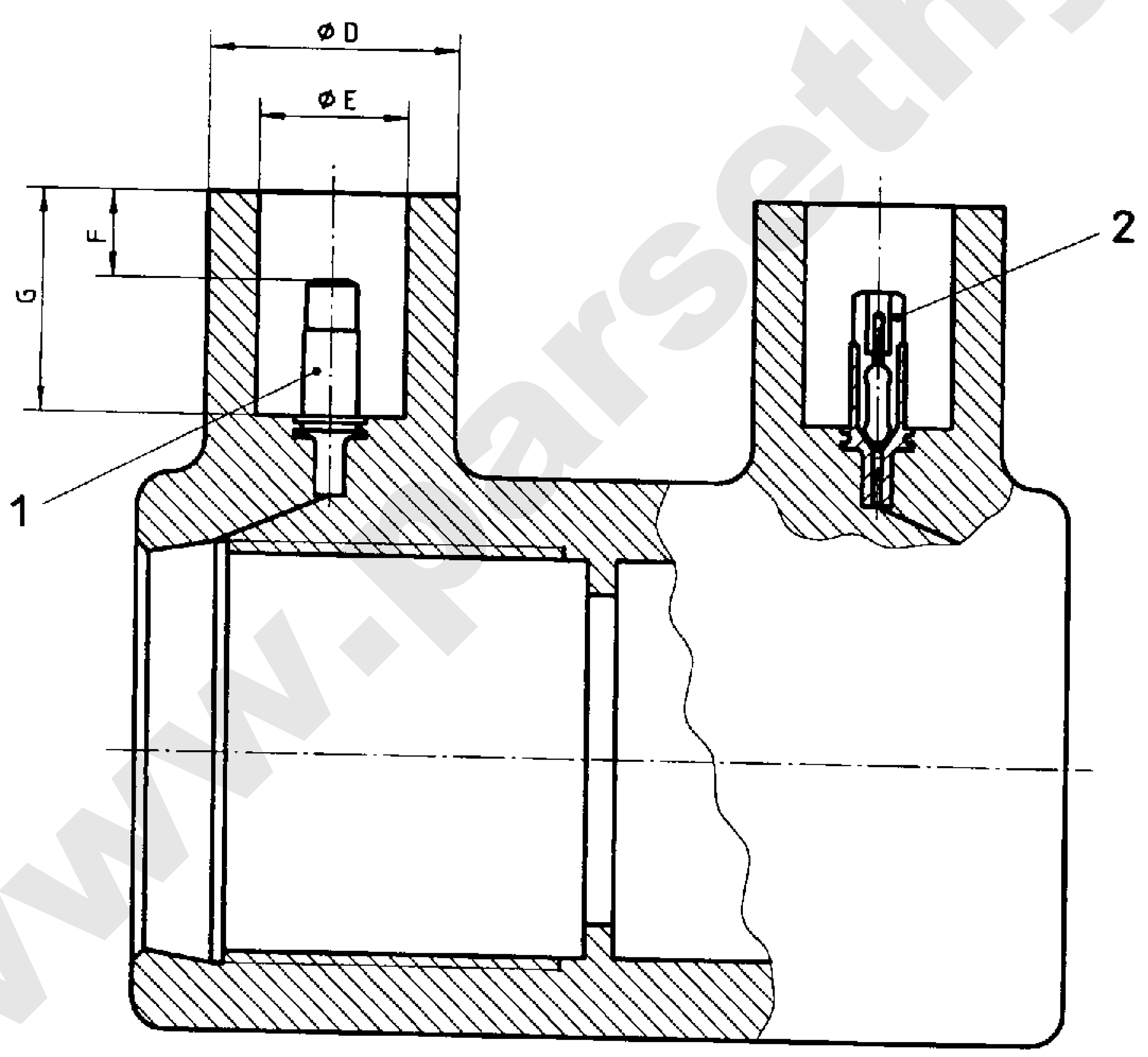
Annex D
(normative)
"Implanted-resistor" connector



Item	Description
1	End contact
2	Resistor
3	Terminal-pin body
4	Insulation

NOTE — For the dimensions, in millimetres, see table D.1.

Figure D.1 — Implanted-resistor terminal



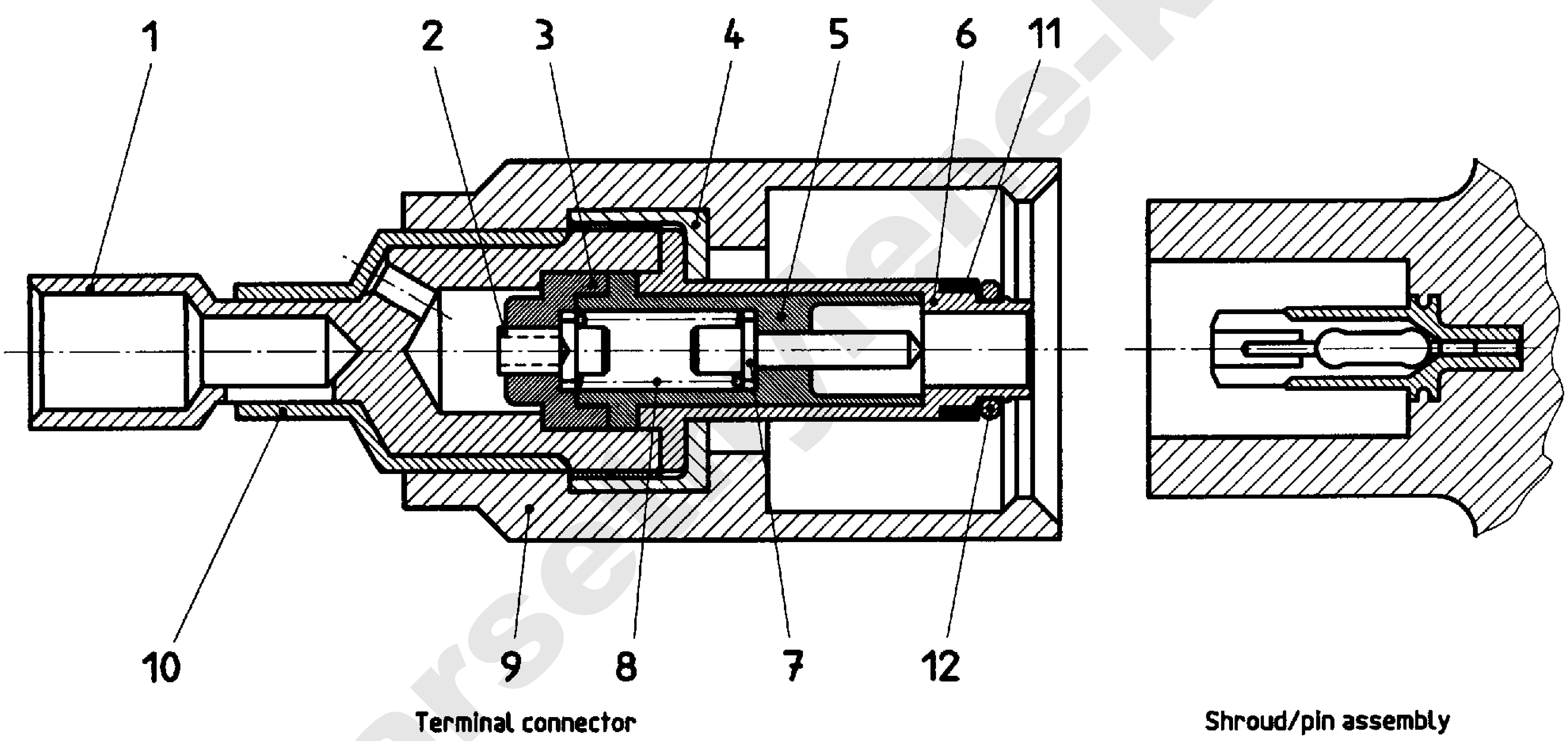
Item	Description
1	Plain terminal
2	Implanted-resistor terminal

NOTE — For the dimensions, in millimetres, see table D.1.

Figure D.2 — Typical assembly of fitting

Table D.1 — Dimensions

Dimension	39/40 volt system	78/80 volt system	39/40 volt system (4 mm terminal pin)
A	4,68/4,73	5,74/5,69	4,00
B	11,25/11,00	14,25/14,00	11,25/11,00
C	4,25/4,15	4,1/4,0	NA
D	20,5	20,0	13
E	12,2	13,5	8,9
F	8,5	6,5	3,2
G	18,5	20,5	14,3



Item	Description	Item	Description
1	Connector, fixed end	7	Probe
2	Sensor	8	Compression spring
3	Bush	9	Shroud
4	Retaining collar	10	Heat shrink
5	Bush	11	Collar
6	Connector, contact front	12	Retaining spring

Figure D.3 — Connector

Table D.2 — Table of implanted-resistance values and equivalent fusion times

39/40 Volts - Resistance value, Ω nominal	Fusion time	78/80 Volts - Resistance value, Ω nominal
73,2K	20	
43K	25	
30K	30	
22,6K	35	
18,2K	40	
15K	45	
12,7	50	
9,76K	60	
7,68K	70	
6,19K	80	
5,1K	90	
4,22K	100	
3,9K	110	
3,57K	120	
3,01K	140	
2,61K	160	
2,21K	180	
1,91K	200	1,91K
1,74K	220	1,74K
1,62K	240	1,62K
	260	73,2K
1,37K	280	1,37K
1,24K	300	1,24K
1,15K	320	1,15K
	340	43K
976	360	976
	380	30K
806	400	806
	420	22,6K
649	440	649
	460	18,2K
	480	15K
453	500	453
	520	12,7K
	540	9,76K
	560	7,68K
	580	6,19K
300	600	300
	650	5,1K
	700	4,22K
	740	3,9K
150	750	150
	800	3,57K
	840	3,01K
	850	2,61K
100	900	100
	950	2,21K

Annex E
(normative)
Self-regulation

E.1 Start of fusion

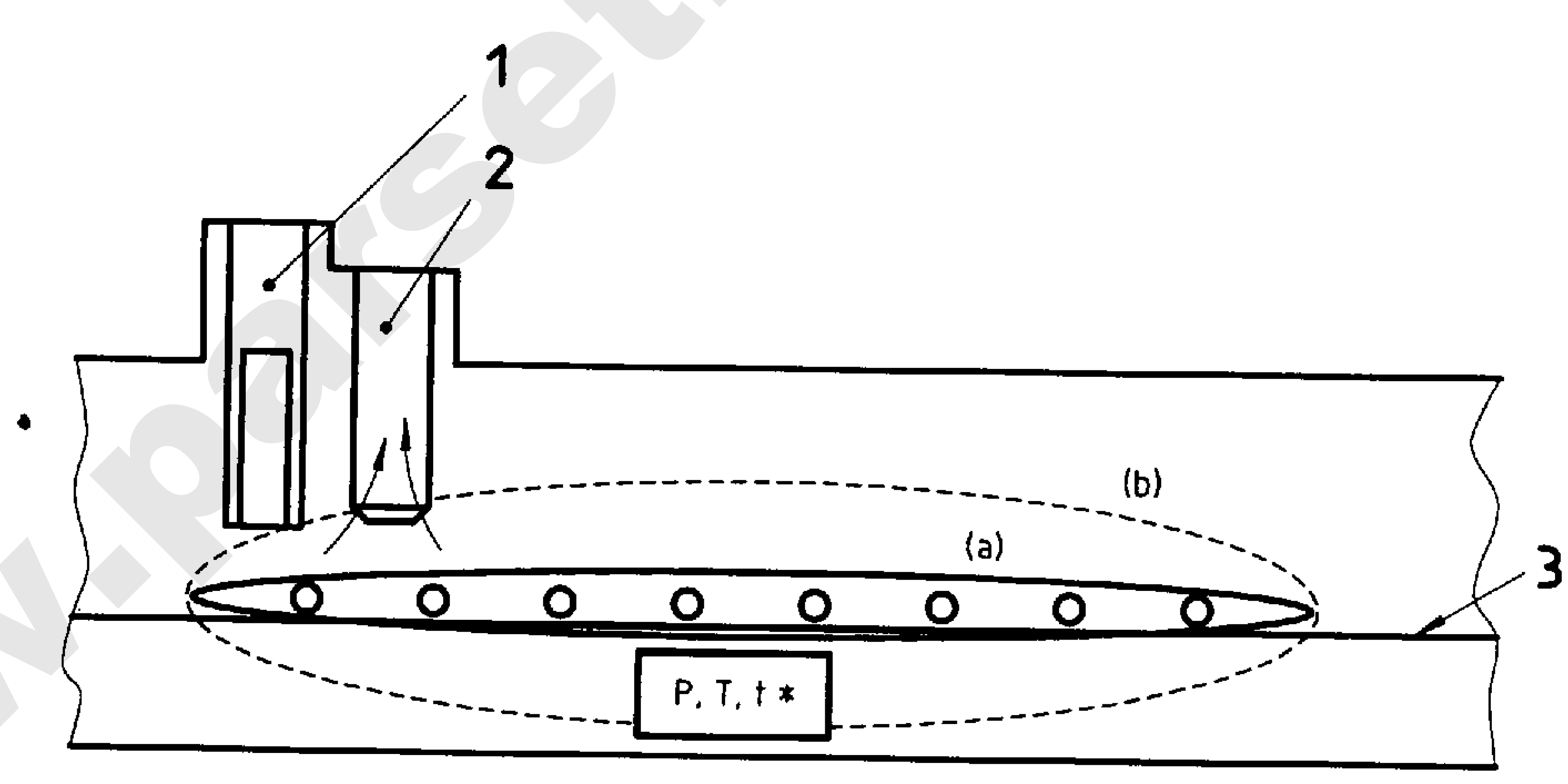
The sensor is in place in the well, the material in the base of the well is still in the solid state and the piston is still at its lowest position. At the interface, the pressure is P_0 and the temperature T_0.

E.2 Middle of fusion

The material begins to rise in the well and pushes the piston up. This will eventually trigger the sensor, but contact has not yet been made between the piston and the sensor. At the interface, the temperature is T_1 and the pressure is P_1.

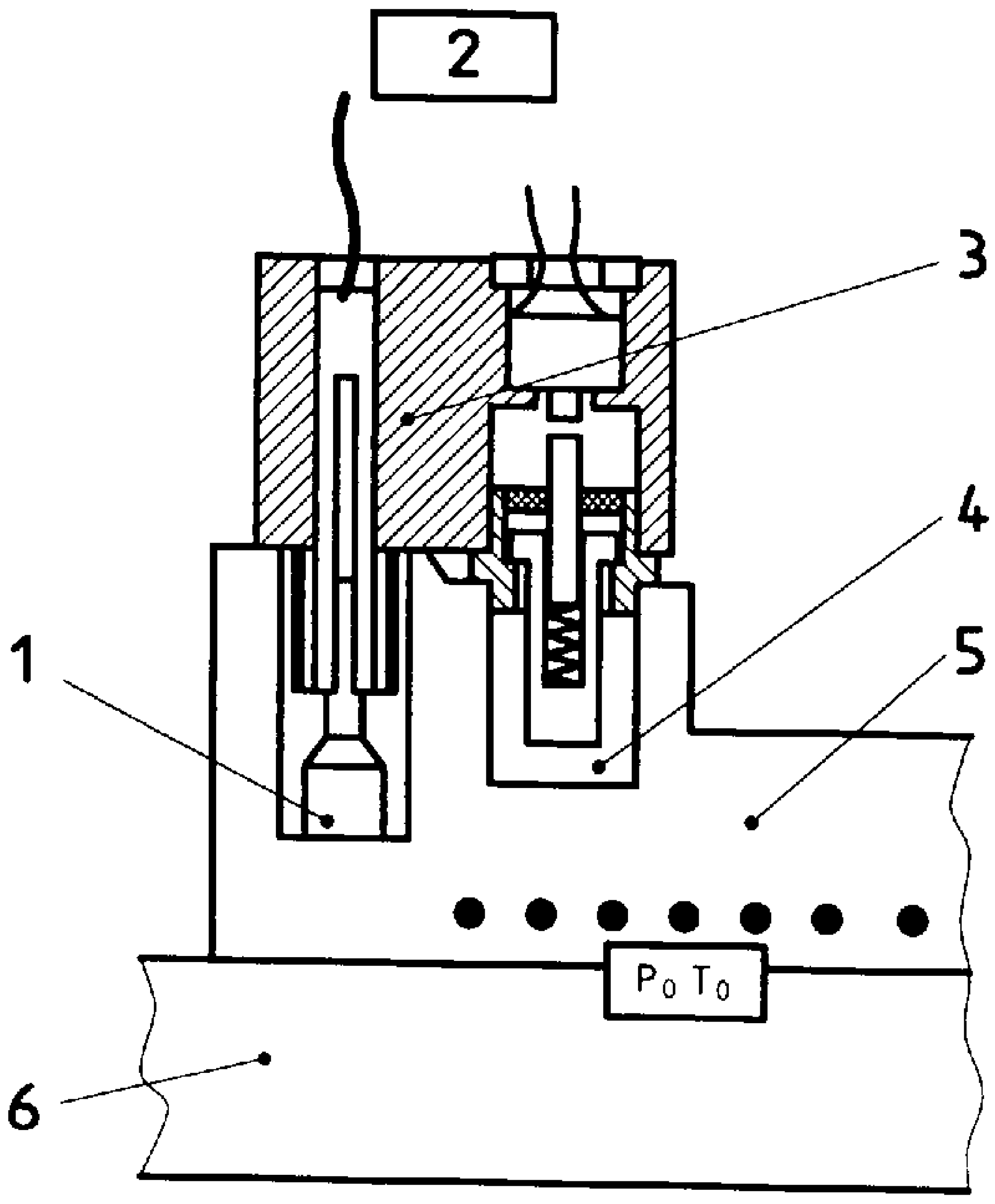
E.3 End of fusion

The expanding material has pushed the piston all the way up, and this has triggered the sensor. At the interface, the conditions made possible by the values for pressure P_2 and for temperature T_2 have produced sufficient molecular diffusion to ensure a good-quality join.



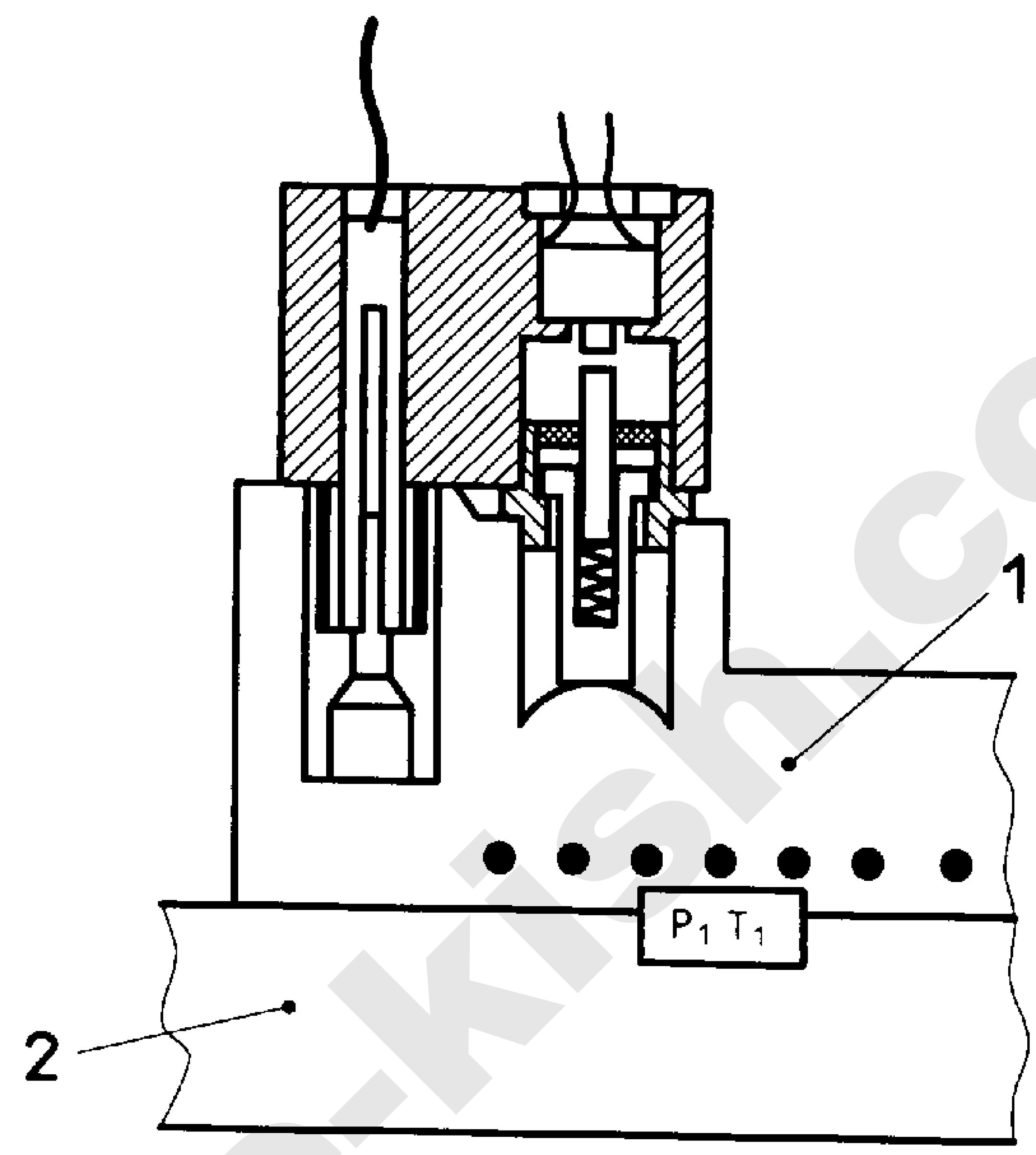
1 Fitting terminal
2 Well
3 Interface

Figure E.1



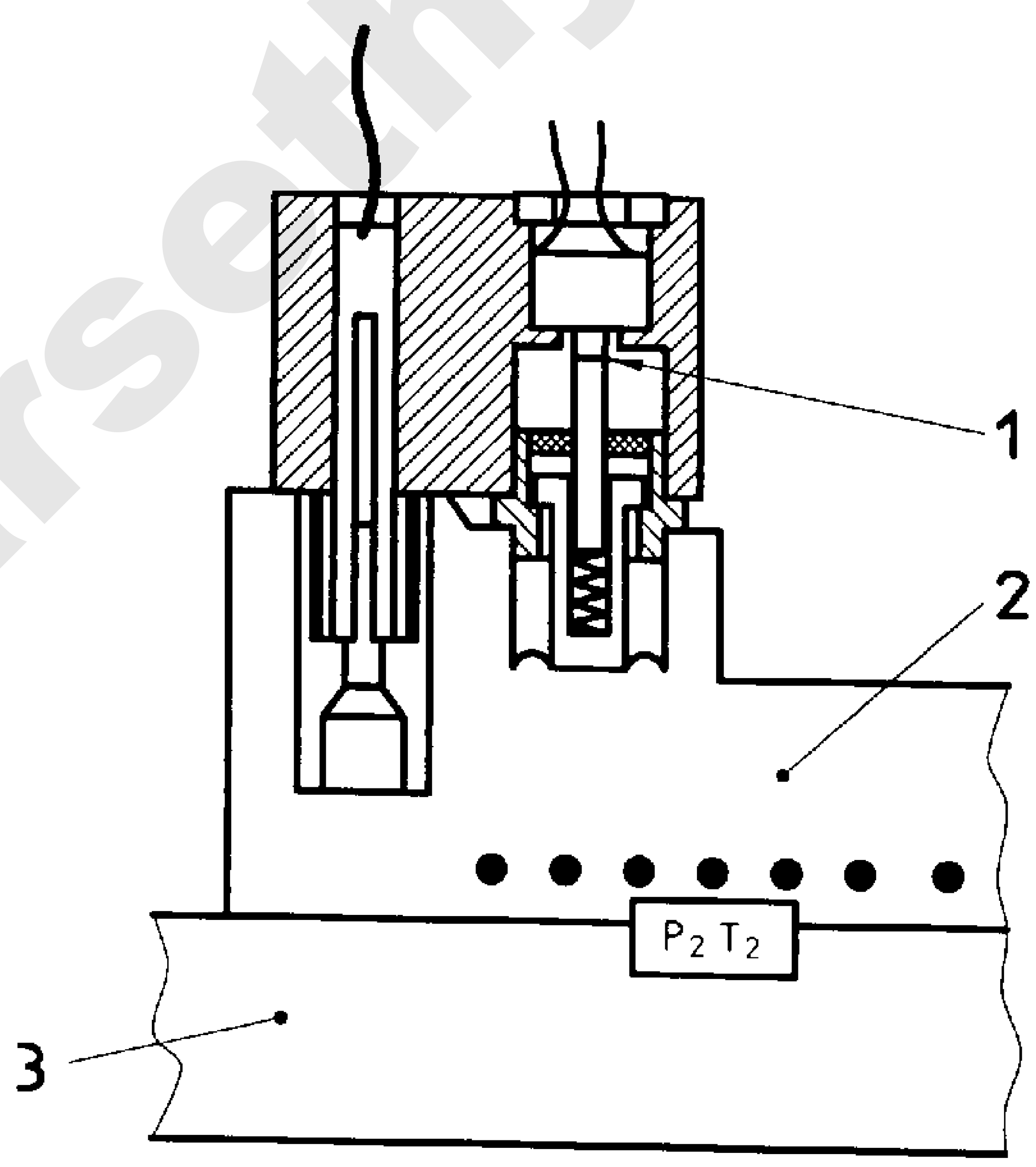
1 Terminal pin
2 Control unit
3 Connector (schematic representation)
4 Well (exact geometry depends on fitting)
5 Fitting
6 Pipe

a)



1 Fitting
2 Pipe

b)

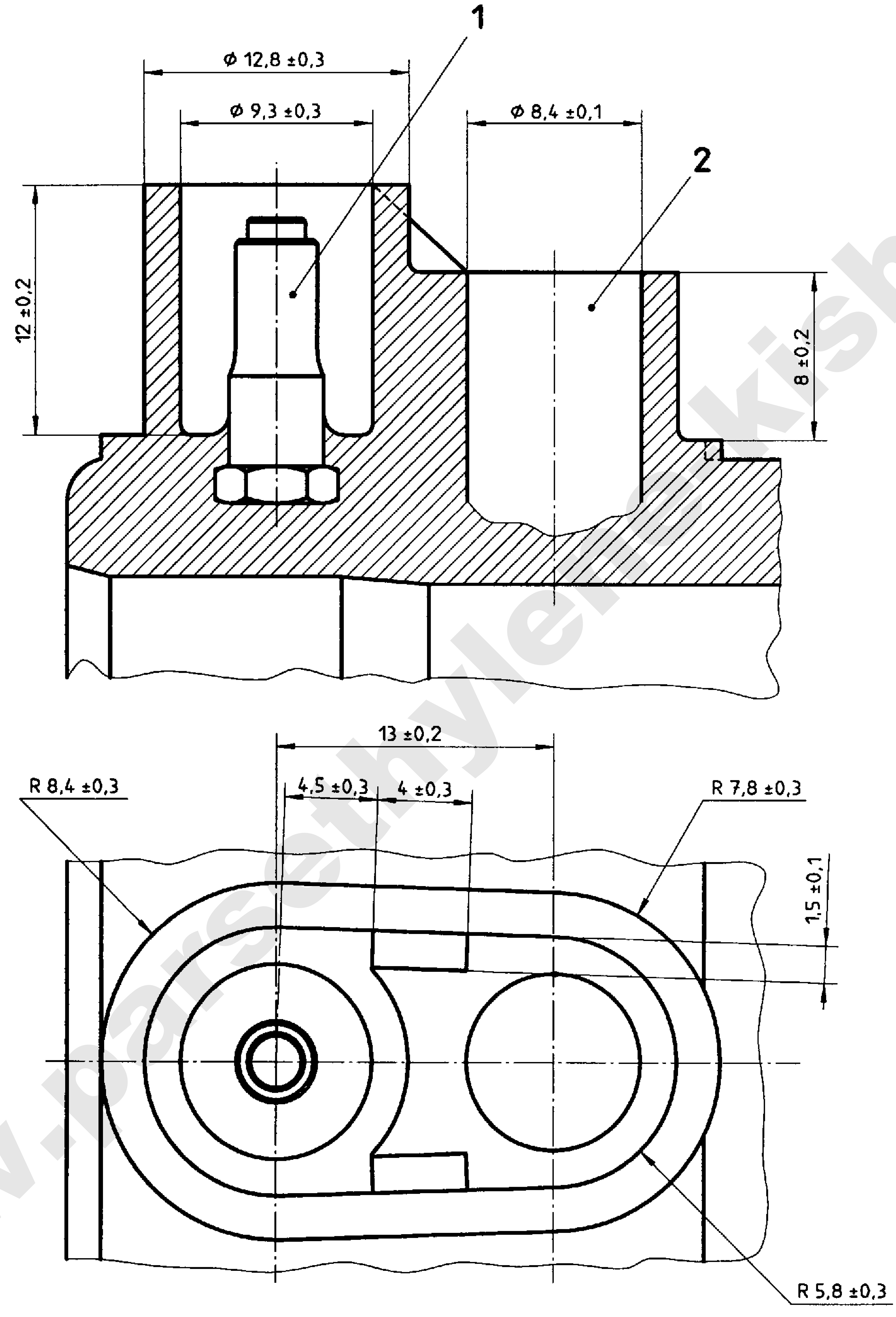


1 Contact
2 Fitting
3 Pipe

c)

Figure E.2

Dimensions in millimetres



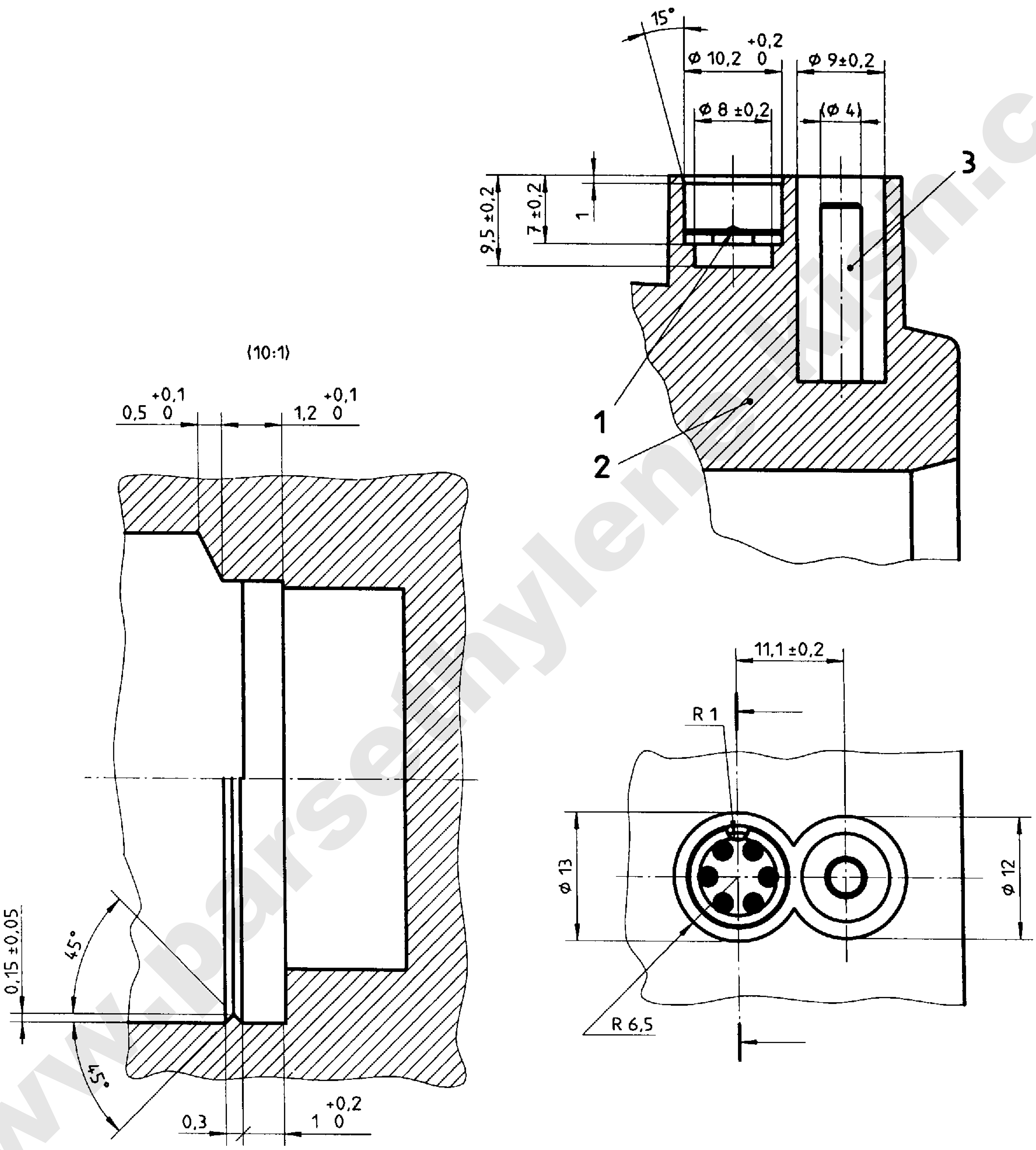
1 Terminal pin, diameter 4 mm or 4,7 mm

2 Geometry of well depends on type of fitting

Figure E.3

Annex F
(normative)

Recognition using a MEMO microchip



1 Microchip position

2 Fitting

3 Fitting terminal

Figure F.1

Table F.1 — MEMO data-exchange concept for fittings with integrated microchip

Position	Specification	1	2	3	4	5
		Number of 4 Bit	Character of 8 Bit	Bit Total	Address Lines/ Position	Address No.
	1. Fitting - Load Memory					
	1.1 During Fitting Manufacture					
	1.1.1 Automatically Loaded Data					
1	Program-version	4----		16	1	0
2	Fitting-manufacturer-code (refer to table)	TC	2	16	1	1
3	Production-date	6--.--.--		24	2	2
4	Production-hour	4--.--		16	1	4
5	Serial number + (11000101>B+ BBB)	5-----+ C	1	8 + 20	2	5
6	Resistance-value (Ohm)	4--.--		16	1	7
	1.1.2 Manually loaded data (from disk)					
7	Diameter-code (refer to table)	3--- TC		12	1	8
	(transform to ISO-Standard in 3 character-code)					
8	Pipe series-code (refer to table)	TC	1		1	9
9	Fusion voltage (nominal) (V)	4---.-		16	1	10
10	Fusion energy (after fusion) (kJ)	4----		16	1	11
11	Fusion time (nominal) (s)	4----		16	1	12
12	Energy-compensation >/<20 °C(–+ %0/°C)	4--/++		16	1	13
	transform and write to address	>/<20 °C				
13	Resistance-temperature factor (1/K)	4----		16	1	14
14	Resistance-tolerance (+– %)	3---.-		12	1	15
15	Cooling-time (min.)	3---		12	1	16
16	Fitting-type-code (refer to table)	TC	2	16	1	17
17	Production-batch-code (refer to table)	TC	6	48	3	18
18	Raw material-code (refer to table)	TC	2	16	1	21
19	Article-number + (10100011>B+ BBB)	6------+ C		8 + 24	2	22
	Subtotal				24	
	1.2 During installation of fitting					
	(automatic)		0			
10	Fusion-energy (kJ)	4----		16	1	11
20	Operating company		8	64	4	24
21	Welding unit-number (type/series/No.)	6--.--.--		24	2	28
22	Operator-code		6	48	3	30
23	Fusion-date	6--.--.--		24	2	33
24	Fusion-hour (end of fusion)	4--.--		16	1	35
25	Ambient-temperature +– XX (°C)	2--	(+–) 1	16	1	36

Table F.1 — MEMO data-exchange concept for fittings with integrated microchip (*concluded*)

Position	Specification	1	2	3	4	5
		Number of 4 Bit	Character of 8 Bit	Bit Total	Address Lines/ Position	Address No.
26	Fusion-number	4----		16	1	37
27	Fusion-time (real) (s)	4----		16	1	38
28	Number of fusions + first error code	4--.--		16	1	39
29	Name construction site or GPS-ordinate		8	64	4	40
30	Name section or GPS-ABCIS		8	64	4	44
	Traceability element "A"					
31	A-manufacturer-code (refer to table)	TC	2	16	1	48
32	A-fitting-type-code (refer to table)	TC	2	16	1	49
33	A-diameter-code (refer to table)	TC	3	24	1,5	50
34	A-pipe series-code (refer to table)	TC	1	8	0,5	51
35	A-raw material-code (refer to table)	TC	2	16	1	52
36	A-production-batch-code (refer to table)	TC	6	48	3	53
	Traceability element "B"					
37	B-manufacturer-code (refer to table)	TC	2	16	1	56
38	B-fitting-type-code (refer to table)	TC	2	16	1	57
39	B-diameter-code (refer to table)	TC	3	24	1,5	58
40	B-pipe series-code (refer to table)	TC	1	8	0,5	59
41	B-raw material-code (refer to table)	TC	2	16	1	60
42	B-production-batch-code (refer to table)	TC	6	48	3	61
	Traceability-code: 16 characters/8 Addr.					
	Subtotal				40	
	Total				64	
	Fitting: 1024 Bit = 16 × 64 Addresses > 0 Addr. Res.					
		MEMO data				

Annex G
(normative)
32-Digit bar code

General format

The 32-digit bar code is divided into two parts:

Common part (digits 1 to 19) which describes all data related to the characteristics of the element to be fused.

Specific part (digits 20 to 32) which describes all data related to the technique used to fuse the element.

< --------------- Common Part --------------------->	< ----- Specific to the technique ------>
1...19	20 32

Common part format:

Manufacturer				Type		Diameter			Batch Code						SDR	Material		
A		B																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Characters A (digits 1 and 2) and B (digits 3 and 4): Manufacturer's Name / Trademark

The characters are coded using the following table:

Basic alphabet code					
A=01	F=06	K=11	P=16	U=21	Z=26
B=02	G=07	L=12	Q=17	V=22	+ =27
C=03	H=08	M=13	R=18	W=23	=28
D=04	I=09	N=14	S=19	X=24	■=29
E=05	J=10	O=15	T=20	Y=25	

The manufacturer will be identified by a unique codification composed by two alpha-characters and based on geographical tables divided into continents. The manufacturer's tables are managed by recognized organisations such as GERG (see table below) for Europe or GRI for USA.

GERG "manufacturer's" table

Code	Manufacturer	Code	Manufacturer
AG	AGRU	IN	INNOGAZ
AL	ALPHACAN	KO	KOGAZ
BA	BANNINGER	NK	NKK
CP	CENTRAL PLASTICS	MA	MANIBS
DE	DEGAZ	PL	PLASSON
DP	DUPONT	RY	RAYCHEM
DU	DURAPIPE	RM	ROLLMAPLAST
EU	EUROSTANDARD	RS	RIESELMAN
FU	FUSION	SL	STEWARTS & LLOYDS PLASTICS
FR	FRIATEC	SW	STRENGWELD
FT	FRIAFIT	UP	UPONOR
GF	GEORG FISCHER	VU	VULCATHENE
GI	GIRPI	WA	WAVIN
		WI	WAVIN INDUSTRIE PLASTICS

As the representation of characters A and B cannot be higher than 29, + 3 or + 6 is added to digit 1 and 3 to indicate other points according to the table below:

Digit 1: Process	Digit 3
+ 0: ELECTROFUSION PROCESS	+ 0: U or I Regulation + 3: Energy Regulation + 6: Power Regulation
+ 3: HEATED TOOL PROCESS	+ 0: Butt Fusion + 3: Socket Fusion + 6: Saddle Fusion
+ 6: PROCESS NOT SPECIFIED	+ 0: Mechanical Fitting + 3: Induction + 6: Others

Digits 5 and 6: Type of fitting

Type	Symbol	Code
Pipe, straight		01
Pipe, coiled		02
Socket	I	03
Tapping Saddle	.†.	04
Branching Saddle	.†.	05
Elbow, 90°	C	06
Elbow, 45°	C	07
Elbow, Undefined	C	08
T	T	09
End Cap	[	10
Reducer	Y	11
Swept Bend		12
Flange Adaptor		13
Mechanical Fitting		14
PE Body Valve,Quarter Turn	V	15
PE Body valve, Multi Turn	V	16
Not PE Body valve, Quarter Turn		17
Not PE Body valve, Multi Turn		18
Repair Fitting		19

Digits 7, 8 and 9: Diameter(s)

See following "Diameters" table
The diameter (D) field is calculated with 3 digits
If 2 sizes are used: differentiate $D1 \geqslant D2$
to the two diameters are associated two codes D1 give C1 and D2 give C2
If 2 sizes are equal D1 = D2 (coupler) the two diameter codes are used
If 2 mm sizes are used then $D = (C1 * 31) + C2$
If 2 Inches sizes are used then $D = (C2 * 31) + C1 + 1$
If a coupler is used in inch sizes, the inch values may be given directly, if less than 31 inches

"Diameters" table

Code	mm	Inch CTS	Inch IPS
01	16	½	
02	20	1	
03	25	1 ¼	
04	32		
05	40		
06	50		
07	63		
08	75		
09	90		
10	110		
11	125		½
12	140		¾
13	160		1
14	180		1 ¼
15	200		1 ½
16	225		2
17	250		3
18	280		4
19	315		6
20	355		8
21	400		10
22	450		11
23	500		12
24	560		13
25	630		14
26	710		
27	800		
28	900		
29	1000		
30	1200		
31	⩾ 1400		

Examples:

33: (31 * 1) + 1 + 1 = ½ Inch CTS
480: (31 * 15) + 15 = 200 mm
358: (31 * 11) + 16 + 1 = 2 * ½ Inch IPS
286 = (31* 9) + 7 = 90 x 63 mm
21 = 21 Inch IPS Coupler

Digits 10, 11, 12, 13, 14 and 15: Product batch code

To be defined by the manufacturer.

Digit 16: SDR

SDR	Code
> 33	0
33	1
26	2
21	3
17,6	4
17	5
13,6	6
11	7
9	8
< 9	9

Digits 17, 18 and 19: Material

1 alphabetical character and 1 numerical character: refer to continent area table. The material tables are managed by recognized organisations such as GERG (see table below) for Europe or GRI for USA.

GERG "material" table

Manufacturer	Trade mark	Code
BP Chemicals	**Rigidex 002-40** RC 002-500	**B1** B2
Fina	**Finathene 3802B** HP 401	**F1** F2
Hoechst	**Hostalen GM 5010 T2** GM 5040 T12/50 GM 7040 G	**H1** H2 H3
Hüls	**Vestolen A 5041 R** A 4042R	**V1** V2
Neste	**Neste DGDS 2467 BL** 2418/2420	**N1** N2
Solvay	**Eltex TUB 71/72** TUB 121/124 TUB 131	**E1** E2 E3

General format

< --------------- Common Part --------------------->	< ----- Specific to the technique ------->
1...19	20 32

There are three types of regulation, depending on digits 1 and 3:

U or I Regulation

Energy Regulation

Power Regulation

Electrofusion format: U or I Regulation

U-I		Ω			ΔΩ	φθ	t			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

Digits 20 and 21: U or I Level

Code Digits 20-21	
00	39,5 V
01	79 V
02	Not Used
03	03 Amps
04	04 Amps
05	Not Used
06	Not Used
07	Not Used
08 ⇨ 49	Voltage Level
50 ⇨ 99	Not Used

Digits 22, 23 and 24: Ω value (if 000 no Ω value to be tested)

For RRR < 333, Ω = RRR × 0,01 ⇨ (0,01Ω to 3,32Ω)

For RRR < 666, Ω = (RRR - 333) × 0,05 ⇨ (0,05Ω to 16,60Ω)

For RRR ⩾ 666, Ω = (RRR - 666) × 0,30 ⇨ (0,30Ω to 99,90Ω)

Digit 25: Tolerance on the Ω value

0: 2,5 %	5: Not Used
1: 5 %	6: Not Used
2: 7,5 %	7: Not Used
3: 10 %	8: Not Used
4: 15 %	9: Not Used

Digit 26: Type of variation of the resistor element

0: $\varphi = 0$	5: $1,8 < \varphi \leqslant 2,4$
1: $0 < \varphi \leqslant 0,5$	6: $2,4 < \varphi \leqslant 3,2$
2: $0,5 < \varphi \leqslant 1$	7: $3,2 < \varphi \leqslant 4$
3: $1 < \varphi \leqslant 1,4$	8: $4 < \varphi \leqslant 5$
4: $1,4 < \varphi \leqslant 1,8$	9: $5 < \varphi \leqslant 6$

φ in 10^{-3} by °C difference with 20 °C

After correction of the nominal Ω value (digits 22 to 23) with digit 26, the corrected value is checked at ± digit 25.

Digits 27, 28 and 29: Fusion time

001 ⇨899: Fusion time in seconds
900 ⇨ 999: Fusion time in minutes (00 ⇨ 99 minutes)

This value is corrected with regard to the ambient temperature and is indicated by the digits 30 and 31.

Digits 30 and 31: Fusion time correction

Digits 30 and 31 are used to correct the energy with regard to the ambient temperature by correcting the fusion time.

At the reference temperature of 20 °C, no correction is made.

Below 20 °C the correction is, per °C, a positive correction (0,x % of the initial value of the fusion time), indicated by digit 30.

Above 20 °C the correction is, per °C, a negative correction (0,x % of the initial value of the fusion time), indicated by digit 31.

Digit 32 Check

1 Addition of the odd digits * 3

2 Addition of the even digits

3 Addition of the totals of stages 1 and 2

4 Determination of the smallest figure which, when added to the sum of stage 3, produces a multiple of 10

Electrofusion format: Energy Regulation

U-I		Ω			ΔΩ	φθ	Σ			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

Digits 20 and 21: U or I Level and level of energy index (x)

Digits 20 - 21	Voltage - current	Digits 20 - 21	Voltage - current
x = 0		x = 2	
00	39,5V	50	39,5V
01	79V	51	79V
02	Not Used	52	Not Used
03	03 Amps	53	03 Amps
04	04 Amps	54	04 Amps
05	Not Used	55	Not Used
06	Not Used	56	Not Used
07	Not Used	57	Not Used
08 ⇨ 49	Voltage	58 ⇨ 99	Voltage level – 50

Digits 22, 23 and 24: Ω value (if 000 no Ω value to be tested)

For RRR < 333, Ω = RRR x 0,01 ⇨ (0,01Ω to 3,32Ω)

For RRR < 666, Ω = (RRR - 333) x 0,05 ⇨ (0,05Ω to 16,60Ω)

For RRR ≥ 666, Ω = (RRR - 666) x 0,30 ⇨ (0,30Ω to 99,90Ω)

Digit 25: Tolerance on Ω value and level of energy index (x)

x = x + 1	x = x + 2
0: 2,5 %	5: 2,5%
1: 5 %	6: 5%
2: 7,5 %	7: 7,5%
3: 10 %	8: 10%
4: 15 %	9: 15%

Digit 26: Type of variation of the resistor element

0: $\varphi = 0$	5: $1{,}8 < \varphi \leqslant 2{,}4$
1: $0 < \varphi \leqslant 0{,}5$	6: $2{,}4 < \varphi \leqslant 3{,}2$
2: $0{,}5 < \varphi \leqslant 1$	7: $3{,}2 < \varphi \leqslant 4$
3: $1 < \varphi \leqslant 1{,}4$	8: $4 < \varphi \leqslant 5$
4: $1{,}4 < \varphi \leqslant 1{,}8$	9: $5 < \varphi \leqslant 6$

φ in 10^{-3} by °C difference with 20 °C

After correction of the nominal Ω value (digits 22 to 23) with digit 26, the corrected value is checked at ± digit 25.

Digits 27, 28 and 29: Energy Level

xxx 10^{x} Joules

This value is corrected with regard to the ambient temperature and is indicated by the digits 30 and 31.

Digits 30 and 31: Energy correction

Digits 30 and 31 are used to correct the energy with regard to the ambient temperature.

At the reference temperature of 20 °C, no correction is made.

Below 20 °C the correction is, per °C, a positive correction (0,x % of the initial value of the energy), indicated by digit 30.

Above 20 °C the correction is, per °C, a negative correction (0,x % of the initial value of the energy), indicated by digit 31.

Digit 32: Check

1 Addition of the odd digits * 3

2 Addition of the even digits

3 Addition of the totals of stages 1 and 2

4 Determination of the smallest figure which, when added to the sum of stage 3, produces a multiple of 10

Electrofusion format: Power regulation

U-I		Watts			ΔΩ	φθ	Σ			θ		CK
20	21	22	23	24	25	26	27	28	29	30	31	32

Digits 20 and 21: U or I Level and level of energy index (x)

Digits 20-21	Voltage - current	Digits 20 - 21	Voltage - current
x = 0		x = 2	
00	39,5V	50	39,5V
01	79V	51	79V
02	Not Used	52	Not Used
03	03 Amps	53	03 Amps
04	04 Amps	54	04 Amps
05	Not Used	55	Not Used
06	Not Used	56	Not Used
07	Not Used	57	Not Used
08 ⇨ 49	Voltage	58 ⇨ 99	Voltage level -50

Digits 22, 23 and 24: Number of Watts

For WWW < 500, W = RRR ⇨ (000 W to 500)

For WWW ⩾ 500, W = [(RRR - 500) x 100] + 500 ⇨ (500W to 5490 W)

Digit 25: Tolerance on Ω value and level of energy index (x)

x = x + 1	x = x + 2
0: 2,5 %	5: 2,5%
1: 5 %	6: 5%
2: 7,5 %	7: 7,5%
3: 10 %	8: 10%
4: 15 %	9: 15%

Digit 26: Type of variation of the resistor element

0: $\varphi = 0$	5: $1{,}8 < \varphi \leqslant 2{,}4$
1: $0 < \varphi \leqslant 0{,}5$	6: $2{,}4 < \varphi \leqslant 3{,}2$
2: $0{,}5 < \varphi \leqslant 1$	7: $3{,}2 < \varphi \leqslant 4$
3: $1 < \varphi \leqslant 1{,}4$	8: $4 < \varphi \leqslant 5$
4: $1{,}4 < \varphi \leqslant 1{,}8$	9: $5 < \varphi \leqslant 6$

φ in 10^{-3} by °C difference with 20 °C

The Ω value is calculated with regard to the number of watts and the voltage/current level.

Digits 27, 28 and 29: Energy

xxx 10^x Joules

This value is corrected with regard to the ambient temperature and is indicated by the digits 30 and 31.

Digits 30 and 31: Energy correction

Digits 30 and 31 are used to correct the energy with regard to the ambient temperature.

At the reference temperature of 20 °C, no correction is made.

Below 20 °C the correction is, per °C, a positive correction (0,x % of the initial value of the energy), indicated by digit 30.

Above 20 °C the correction is, per °C, a negative correction (0,x % of the initial value of the energy), indicated by digit 31.

Digit 32: Check

1 Addition of the odd digits * 3

2 Addition of the even digits

3 Addition of the totals of stages 1 and 2

4 Determination of the smallest figure which, when added to the sum of stage 3, produces a multiple of 10

ICS 23.040.01

Descriptors: piping, thermoplastic resins, plastic tubes, pipe fittings, pipe joints, electric welding, fusion welding, welding equipment, characteristics, identification methods.

Price based on 60 pages