79-3

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NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
79-3

Troisième édition
Third edition
1990-12

Matériel électrique pour atmosphères explosives gazeuses

Troisième partie:
Eclateur pour les circuits de sécurité intrinsèque

Electrical apparatus for explosive gas atmospheres

Part 3:
Spark-test apparatus for intrinsically-safe circuits

Numéro de référence
Reference number
CEI/IEC 79-3: 1990

IEC
VOL. 4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES

Part 3: Spark-test apparatus for intrinsically-safe circuits

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This part of the International Standard IEC 79 has been prepared by Sub-Committee 31G: Intrinsically-safe apparatus, of IEC Technical Committee No. 31: Electrical apparatus for explosive atmospheres.

This third edition of IEC 79-3 replaces the second edition issued in 1972.

The text of this part is based on the following documents:

Six Months' Rule	Reports on Voting
31G(CO)23	31G(CO)24 and 24A

Full information on the voting for the approval of this part can be found in the Voting Reports indicated in the above table.

This revision of the second edition embodies technical modifications, principally in clause 4, and changes in wording and presentation to take account of the publication of the second edition of IEC 79-0 and the third edition of IEC 79-11.

The other parts of IEC 79 include those listed in annex B "Bibliography" of this part plus:

IEC 79-4: 1975, Part 4: Electrical apparatus for explosive gas atmospheres - Part 4: Method of test for ignition temperature.

IEC 79-4A: 1970, First supplement (List of established ignition temperatures).

IEC 79-10: 1986, Part 10: Classification of hazardous areas.

IEC 79-12: 1978, Part 12: Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents.

IEC 79-13: 1982, Part 13: Construction and use of rooms or buildings protected by pressurization.

IEC 79-14: 1984, Part 14: Electrical installations in explosive gas atmospheres (other than mines).

IEC 79-8 and 79-9 have been superseded by 79-0 and withdrawn. Parts 12, 13 and 14, and Parts 2 and 15 referred to in annex B have the status of reports.

This part contains two informative annexes:

Annex A - Practical advice on the use of spark-test apparatus.

Annex B - Bibliography.

INTRODUCTION

This part of IEC 79 applies specifically to the testing of intrinsically-safe circuits in electrical apparatus and electrical systems with type of protection "i" to show compliance with IEC 79-11.

NOTE - The spark-test apparatus may also be used for testing to show compliance with other standards when its use and calibration are defined in those other standards.

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES

Part 3: Spark-test apparatus for intrinsically-safe circuits

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1 Scope

This part of IEC 79 prescribes requirements for the spark-test apparatus for the testing of electrical apparatus and electrical systems with type of protection "i" for intrinsically-safe circuits* according to IEC 79-11, in which the rated current does not exceed 2 A (see also 4.4).

IEC 79-11 (clause 9) deals with the use of spark-test apparatus for the spark ignition test, including its calibration and the explosive test mixtures for the groups of apparatus to be tested.

There are no requirements in IEC 79-0 applicable to this part.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of IEC 79. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of IEC 79 International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard listed below. Members of IEC and ISO maintain registers of currently valid standards.

IEC 79-11: 1990, Electrical apparatus for explosive gas atmospheres - Part 11: Intrinsic safety "i".

3 Definitions

For the purpose of this part of IEC 79, the following definitions, which are identical with, or technically equivalent to, the corresponding definitions in IEC 79-0, Chapter 426 (now being printed) of the International Electrotechnical Vocabulary (IEV) and IEC 79-11 apply. For the definitions of any other terms, particularly those of a more general nature, reference should be made to an appropriate chapter of the International Electrotechnical Vocabulary (IEV).

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* Work continues in Sub-Committee 31G on the problems of testing intrinsically-safe circuits in which the rated current exceeds 2 A.

3.1 **intrinsically-safe:** Circuit in which no spark or any thermal effect produced in the test circuit conditions prescribed in IEC 79-11 (which include normal operation and specified fault conditions) is capable of causing ignition of a given explosive gas atmosphere.

3.2 **intrinsically-safe system:** Assembly of interconnected items of apparatus, which may comprise intrinsically-safe apparatus, associated apparatus and other apparatus, and interconnecting cables in which the circuits within those parts of the system which may be exposed to explosive gas atmospheres are intrinsically-safe circuits.

3.3 **explosive gas atmosphere:** Mixture with air, under atmospheric conditions (as defined in 1.2 of IEC 79-0), of flammable substances in the form of gas, vapour or mist in which, after ignition, combustion spreads throughout the unconsumed mixture.

3.4 **explosive test mixture:** Explosive mixture used in the testing of intrinsically-safe circuits.

3.5 **electrical apparatus for explosive gas atmospheres:** Electrical apparatus in conformity with one or more parts of IEC 79.

NOTE - The parts of IEC 79 containing requirements or recommendations for electrical apparatus are listed in annex B.

4 Spark ignition testing

4.1 *Principle*

The circuit to be tested is connected to the contacts of the spark-test apparatus, which are in an explosion chamber that is filled with the appropriate explosive test mixture according to 9.1.2 of IEC 79-11.

In accordance with IEC 79-11 the parameters of the circuit are adjusted to achieve a prescribed safety factor and a test is made to determine whether or not ignition of the explosive test mixture takes place within a defined number of operations of the contact mechanism.

4.2 *Spark-test apparatus*

The spark-test apparatus consists of a contact mechanism in an explosion chamber having a volume of at least 250 cm^3. It produces make-sparks and break-sparks in the prescribed explosive test mixture. An example of a practical design of the spark-test apparatus is shown in figure 1 (for the details of the contact mechanism see figures 2, 3 and 4).

One of the two electrodes consists of a rotating cadmium disc with two slots in it as illustrated in figure 2. Cadmium as supplied for electroplating may be used for casting cadmium discs.

The other electrode consists of four tungsten wires with a diameter of 0,2 mm clamped on a circle of 50 mm diameter to a wire holder as illustrated in figure 3.

NOTE - It is advantageous to round off the corners of the holder slightly at the points where the wires are clamped to avoid premature breakage of the wires at the sharp edge.

The contact mechanism is mounted as shown in figure 4. The wire holder rotates so that the tungsten wires slide over the slotted cadmium disc. The distance between the wire holder and the cadmium disc is 10 mm. The free length of the tungsten wires is 11 mm. The tungsten wires are straight and fitted so as to be normal to the surface of the cadmium disc when not in contact with it. The preparation of the tungsten wires is described in clause A.1 of appendix A.

The axes of the shafts driving the cadmium disc and the wire holder are 31 mm apart and are electrically insulated from each other and from the base-plate of the apparatus. The current is led in and out through sliding contacts on the shafts which are geared together by non-conductive gears with a ratio of 50:12. The wire holder is rotated by an electric motor, with suitable reduction gearing if necessary, at 80 rev/min. The cadmium disc then turns in the opposite direction at 19,2 rev/min.

Gas-tight bearings in the base-plate are required unless a gas flow system is used.

A counting device is provided to record the number of revolutions of the motor-driven shaft of the wire holder. Alternatively, a timing device may be used to determine the test duration, from which the number of revolutions of the shaft of the wire holder can be calculated.

It is advantageous to stop the driving motor, or at least the counting device, automatically after an ignition of the explosive test mixture, for example by means of a photocell or an explosion-pressure switch (see figures 5 and 6).

The explosion chamber shall be designed for an explosion pressure of at least 1 500 kPa (15 bar).

At the terminals (see figure 4) of the contact mechanism, the capacitance of the test apparatus shall not exceed 30 pF with the contacts open and with the contacts closed, the resistance shall not exceed 0,15 Ω at a current of 1 A d.c. and the inductance shall not exceed 3 μH.

4.3 *Calibration of spark-test apparatus*

IEC 79-11 specifies in 9.1.3 how the sensitivity of the spark-test apparatus is to be checked using a calibration circuit, before and after each series of tests.

4.4 *Limitations of spark-test apparatus*

The spark-test apparatus is suitable for testing intrinsically-safe circuits with the following parameters (see also notes 1 and 2):

- rated current not exceeding 2 A;
- test voltage in resistive or capacitive circuits not exceeding 300 V;
- inductance in inductive circuits not exceeding 1 H.

NOTES

1 If the test current, that is the rated current after taking account of faults multiplied by the safety factor (see 9.1.5 of IEC 79-11), exceeds some value in the range 2,5 A to 3 A, the temperature rise of the tungsten wires may lead to additional ignition effects invalidating the test results.

2 With capacitive and inductive circuits, care should be exercised that circuit time constants do not adversely affect the results. Such circuits with large time constants may be tested, for example by reducing the speed at which the spark-test apparatus is driven or, in the case of capacitive circuits only, by removing two or three of the tungsten wires. However, attention is drawn to the fact that reducing the speed of the spark-test apparatus may change its sensitivity.

Annex A
(informative)

Practical advice on the use of the spark-test apparatus

A.1 Preparation of tungsten wires

Tungsten is a very brittle material and tungsten wires often tend to split at the ends after a relatively short period of operation.

To resolve this difficulty it is recommended to follow the procedure in a) or b).

a) Divide the tungsten wire by fusion in a simple device as shown in figure 7. When this is done, a small sphere, which can easily be removed by slight pressure in tweezers, is formed on each end of the wire.

When prepared in this way, experience has shown that in general the life of tungsten wires exceeds 25 000 revolutions of the wire holder.

b) Cut the tungsten wire with a shearing action, for example using heavy duty scissors in good condition.

A.2 Conditioning of new cadmium disc

Experience has shown that it is generally necessary to condition a new cadmium disc before use in order to achieve the required sensitivity of the spark-test apparatus. The following procedure is recommended:

a) fit the new disc into the spark-test apparatus;

b) connect the terminals of the spark-test apparatus to a 95 mH/24 V d.c./100 mA circuit and run the spark-test apparatus with the contact mechanism in air for 20 000 revolutions of the wire holder;

c) fit new tungsten wires (see clause A.1 for the preparation) and connect the terminals of the spark-test apparatus to a 2 µF non-electrolytic capacitor charged through a 2 kΩ resistor;

d) using the Group IIA (or Group I) explosive test mixture (see 4.1) apply 70 V d.c. (or 95 V d.c. for Group I) to the capacitive circuit and operate the spark-test apparatus for 400 revolutions of the wire holder or until ignition occurs. If ignition occurs, reduce the voltage by 5 % and repeat until no ignition occurs in 400 revolutions;

e) repeat d) but starting at 60 V d.c. (80 V d.c. for Group I);

f) repeat e) but starting at 50 V d.c. (70 V d.c. for Group I);

g) the lowest voltage at which ignition occurs should not be greater than 40 V d.c. (55 V d.c. for Group I);

h) if no ignition occurs at 60 V (80 V) in step e), at 50 V (70 V) in step f) or at 40 V (55 V) in step g), go back to step d).

A.3 Recommended actions when sensitivity is not as specified

The following recommended list of actions is given as a guide:

a) check the parameters of the calibration circuit (see 4.3) and the parameters for the spark-test apparatus in the last paragraph of 4.2;

b) check the composition of the explosive test mixture (see 4.1);

c) remove the wire holder, inspect the tungsten wires and, if the ends are not split, straighten and clean them to remove deposits by manually rubbing the surface, including the ends of the wires, with abrasive cloth.

NOTE - A suitable specification for the particle size distribution of the abrasive grains is given below. The sieve aperture sizes are nominal values from the R40 series in ISO 2194.

Requirements	*Sieve aperture size (µm)*
All grains to pass	106
Not more than 24 % to be retained on	75
At least 40 % to be retained on	53
Not more than 10 % to pass	45

d) fit new tungsten wires;

e) repeat step b) in clause A.2;

f) replace the cadmium disc.

Annex B
(informative)

Bibliography

The parts of IEC 79 dealing with types of protection for electrical apparatus in explosive gas atmospheres are listed below:

IEC 79: Electrical apparatus for explosive gas atmospheres.

IEC 79-1: 1990, Part 1: Construction and test of flameproof enclosures of electrical apparatus.

IEC 79-2: 1983, Part 2: Electrical apparatus - Type of protection "p".

IEC 79-5: 1967, Part 5: Sand-filled apparatus (incorporates first supplement).

IEC 79-6: 1968, Part 6: Oil-immersed apparatus.

IEC 79-7: 1990, Part 7: Increased safety "e".

IEC 79-11: 1990, Part 11: Intrinsic safety "i".

IEC 79-15: 1987, Part 15: Electrical apparatus, with type of protection "n".

Some parts, for example Parts 7 and 11, are in course of revision and the titles are those of the approved texts.

ISO 2194: 1972, Wire screens and plate screens for industrial purposes - Nominal sizes of apertures.

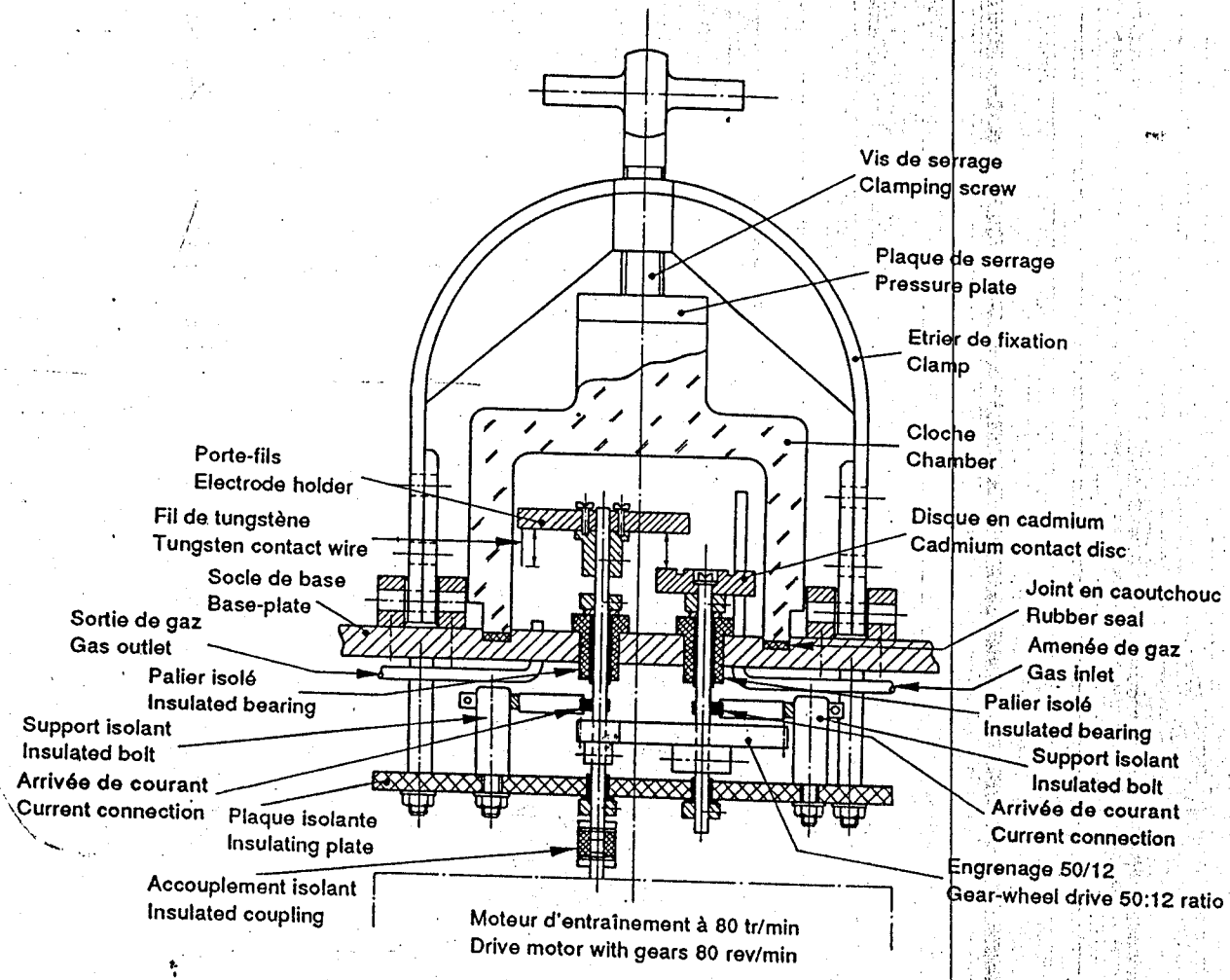
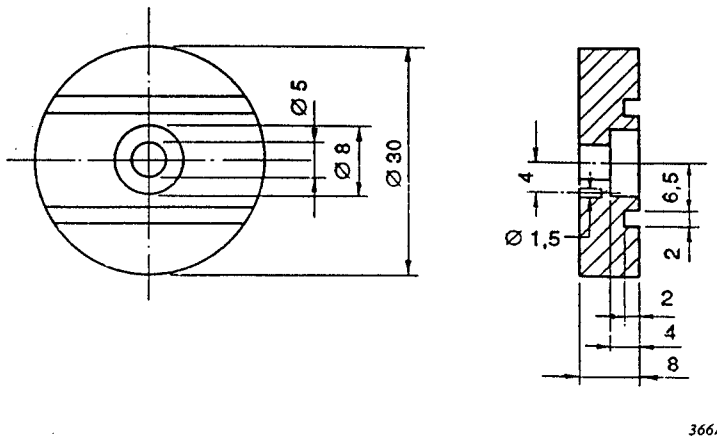


Figure 1 - Exemple de réalisation pratique de l'éclateur

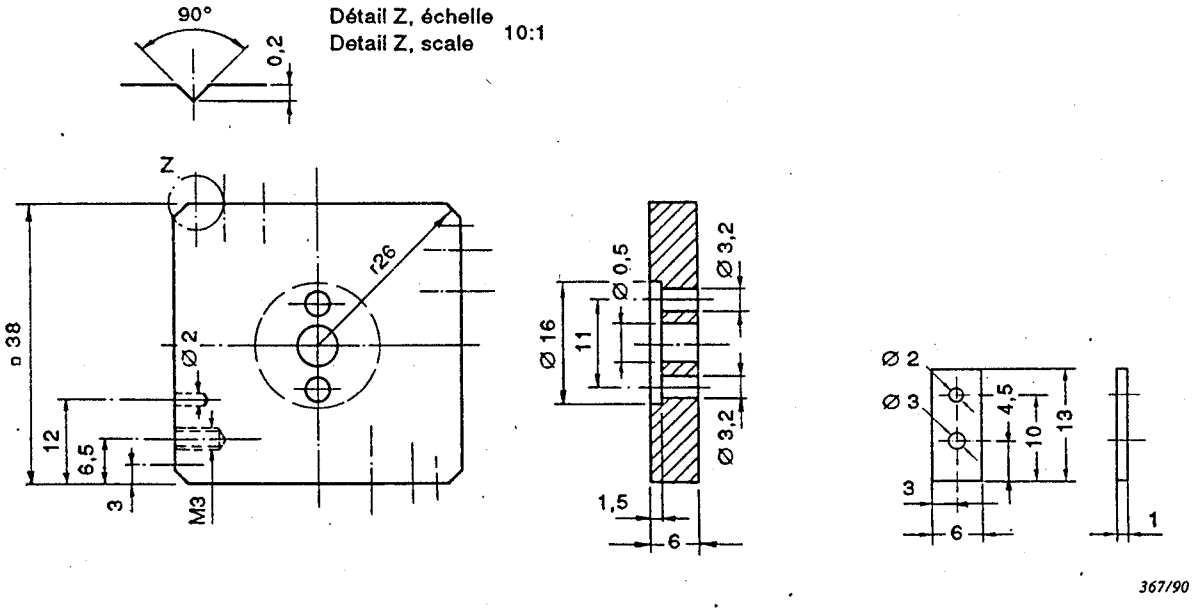
Example of practical design of spark-test apparatus



Dimensions en millimètres *Dimensions in millimetres*

Figure 2 - Disque en cadmium

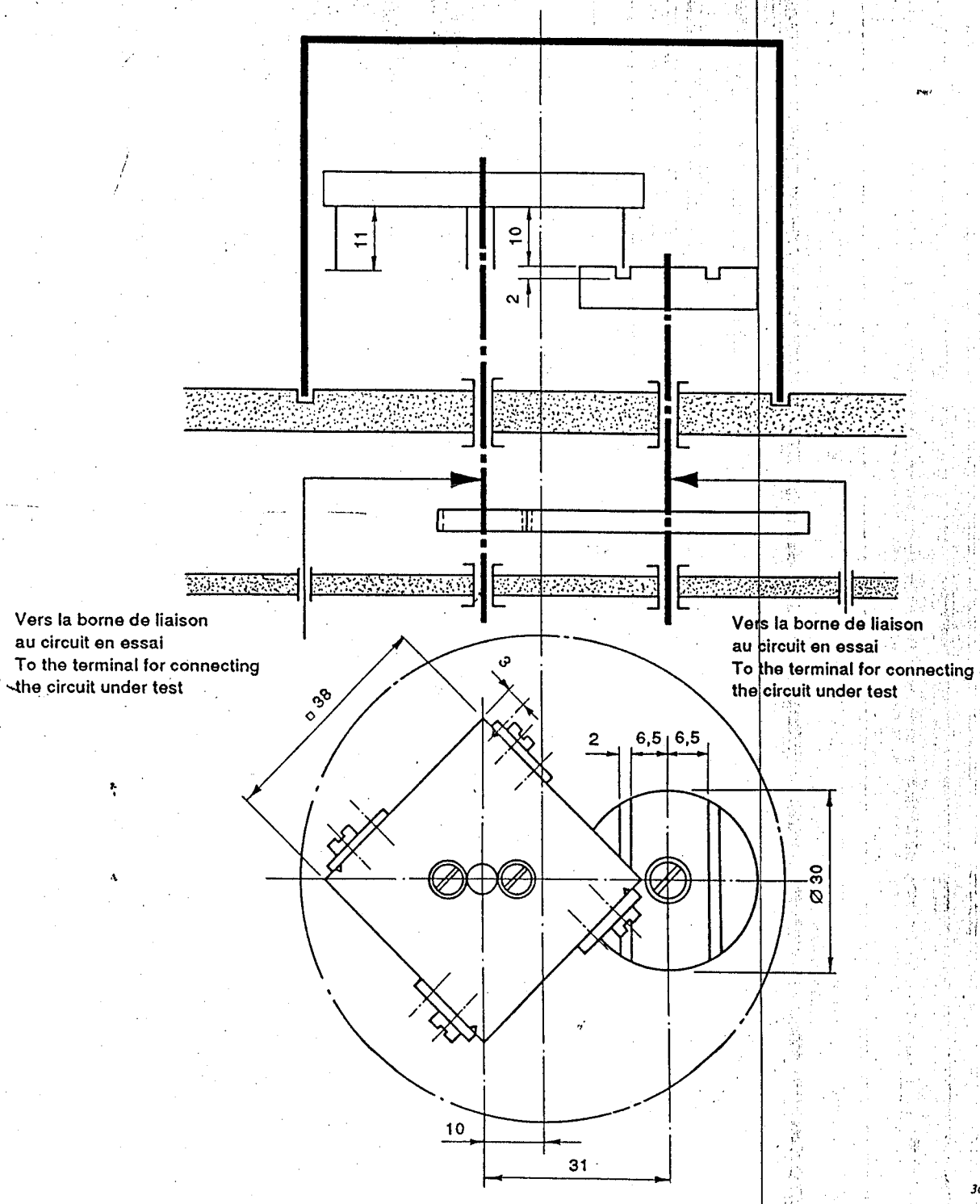
Cadmium contact disc



Dimensions en millimètres *Dimensions in millimetres*

Figure 3 - Porte-fils (par exemple: laiton)

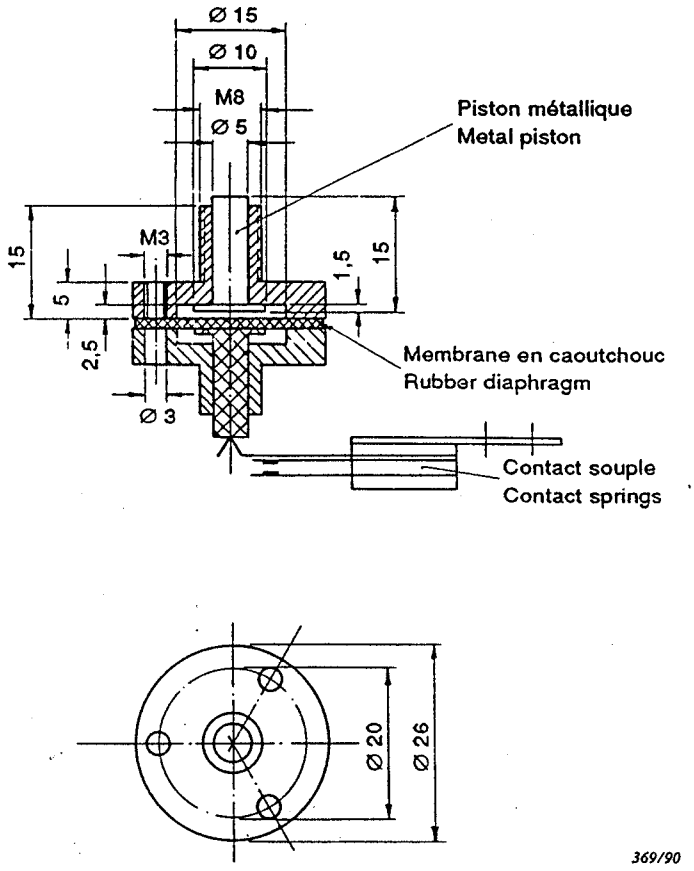
Wire holder (brass, for example)



Dimensions en millimètres *Dimensions in millimetres*

Figure 4 - Aménagement du mécanisme de contacts

Arrangement of contact mechanism



Dimensions en millimètres *Dimensions in millimetres*

Figure 5 - Exemple d'interrupteur sensible à la pression d'explosion

Example of an explosion pressure switch

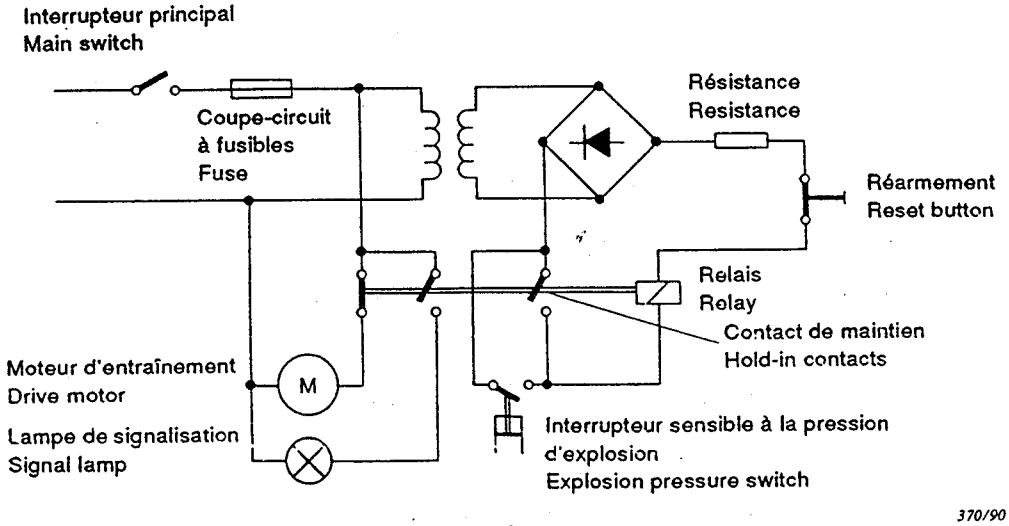


Figure 6 - Exemple de circuit d'arrêt automatique par un interrupteur sensible à la pression d'explosion

Example of automatic stopping by means of an explosion pressure switch

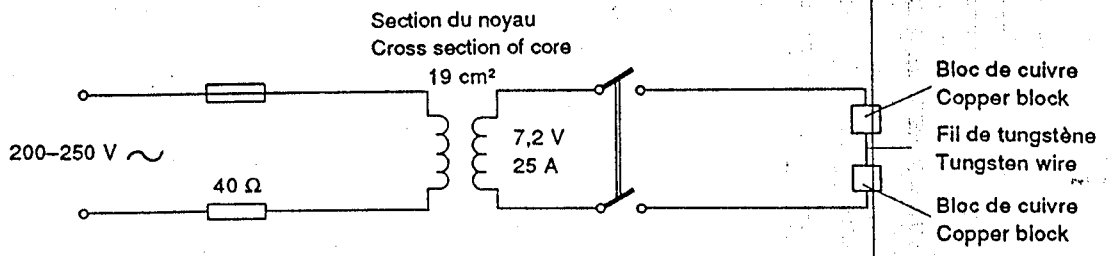
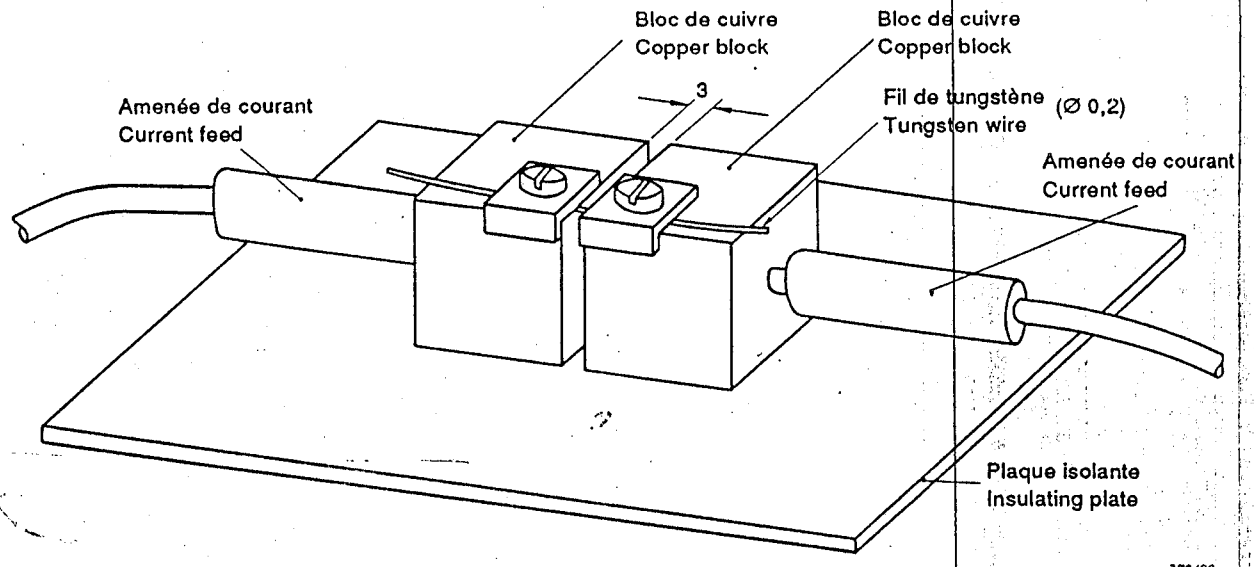


Schéma électrique / Circuit diagram



Dimensions en millimètres *Dimensions in millimeters*

Enlever la perle de fusion aux extrémités des fils au moyen d'une pince

Remove melted droplets with tweezers

Figure 7 - Dispositif de fabrication des fils de tungstène par fusion

Arrangement for preparing tungsten contact wires by fusion