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HAZARD ASSESSMENT OF EXPLOSIVE SUBSTANCES.

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INTRODUCTION.

In France, the Explosive Materials Laboratory (EML) at CERCHAR deals mainly with the safety of explosive materials and related items.

At the request of the Ministry of Industry, approval tests are performed on civil explosive materials : explosives, detonators, detonating cords, propellants, pyrotechnics and other substances or articles.

The Laboratory also performs tests requested by the Government Agencies or under contrat with manufacturers : classification for transport, approval for use, ... on explosives materials or on more or less unstable substances (chemicals).

Because of this large field of activities and of frequent contacts with similar foreign laboratories, EML has developped a wide experience in explosives testing methods.

There are now 60 different test methods used for approval in France for different kinds of civil explosive materials and articles. They have been edited in a manual published by the Ministry of Industry. Supplementary tests on pyrotechnics are under development. It could be also noted that efforts are in progress to make tests on civil and military materials compatible.

Some of the civil tests have been chosen in 1981 to define a classification scheme which is required by the French regulation for safety

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of workers in the explosives industry. This scheme gives the acceptance procedure into class 1 and the hazard division assignment from 1.1 to 1.5.

Among all the tests, three seem us of particular importance for classification purposes. They are safety tests but are also of interest in characterizing the explosive properties. Our aim is here to present and comment on these three tests.

1./ A RELIABLE SHOCK SENSITIVITY TEST : THE FRENCH GAP TEST.

The shock sensitivity is a fundamental feature used to assess the hazards of substances from manufacturing process to their final use, especially the mass explosion hazard. A convenient method to determine the shock sensitivity is the gap test. An initiating explosive generates a calibrated shock in the test substance. The intensity of the shock is more or less reduced by interposition of an inert barrier (or "gap") of variable thickness between the initiating booster and the test substance.

The test is applicable to any substance.

Based on a similar US test, this test has been performed in France for twenty years (Ref. 1) ; there is thus many data available.

1.1.- Apparatus and materials.

The test apparatus and materials are shown in Figure 1. A steel tube (length 200 mm, internal diameter 40 mm, and 4 mm wall thickness) is placed vertically between two boosters. A gap, consisting in a given pile of cellulose acetate cards (thickness of one card : 0.19 mm), is placed between the initiating booster and the sample in the steel tube. The second (or reference) booster is in contact with the lower end of the tube and with a steel witness plate.

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For liquids, the lower end of the tube is directly in contact with a lead witness plate. Such a witness allows low-order detonations to be taken into account.

1.2.- Procedure.

The steel tube is filled with the substance to be tested. As shown in Figure 1, the different parts are assembled and the whole assembly is suspended above the ground. A detonator is inserted in the initiating booster.

1.3.- Method of assessing results and criteria.

The substance is deemed to have propagated detonation if the steel witness plate is punctured. In this case the result is said to be "positive". If not, the result is "negative".

The first trial is performed with a 200 cards pile.

Depending of the result, the gap is reduced or increased by choosing a new gap in the range defined by the following numbers of cards : 1, 2, 3, 4, 5 then 5 n (n from 2 to 80).

The value n1 which gives a "negative" result with a "positive" result for the next lower value in the range is then determined.

The test is carried out to obtain the minimal number N (minimal thickness of the gap) giving 3 "negative" in 3 trials, by beginning with n1 and increasing if necessary step by step in the above range. The test result is the limiting number N.

For classification purpose, the test procedure is simplified by fixing a given number of cards. Then, the test is carried out with 1 card or 240 cards to answer respectively the questions "Is it an explosive substance ?" or "Is the substance too insensitive for acceptance into class 1 ?".

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Under these conditions, the test is in good agreement with the USBM gap test (Ref. 2) performed without the gap (zero gap) or with the 2 inch gap.

Examples of our results are shown in Table 1.

SUBSTANCE	RESULT limiting number of cards
pentaerythrol tetranitrate	400
octogen	355
hexogen	335
trinitrotoluene, ships	300
m-dinitrobenzene	240
ammonium perchlorate, mean size 0.012 mm	235
ammonium perchlorate, mean size 0.1 mm	220
dinitrotoluene, crystallized	220
ammonium nitrate, very porous	215
trinitrotoluene, cast	175
slurry explosive, composition B sensitized	135
plasticized nitrocelluloses and various gun propellants	50 - 185
explosive reinforced, double base or composite propellants	50 - 100
composite propellants, non explosive reinforced	1
AN fertilizer, high density prills	1

Table 1 : Examples of results in the French gap test.

2./ AN ORIGINAL MECHANICAL STIMULUS SENSITIVITY TEST : THE 30 KG FALLHAMMER TEST.

Impact tests often used very small samples which are not necessarily representative of the test substance. In addition, it is not easy in

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those tests to gain an idea on how the reaction propagates following the impact. The large scale sensitivity tests , e.g. Suzan Test, are more convenient from this point of view, but they are often quite expensive and not applicable to all substances. The 30 kg fallhammer test presents the advantage of being inexpensive and applicable to any explosive including powdered substances. With only a few procedure modifications, this test has been performed in France for more than thirty years (Ref. 3).

2.1.- Apparatus and materials.

The test apparatus and materials are shown in detail in Figure 2.

A steel tray (wall thickness 0.4 mm), 8 mm deep, 50 mm wide and 150 mm long (volume 60 cm^3), uniformly filled with the test substance is placed on an anvil. The sample is impacted by the vertically falling hammer onto a point located at 25 mm from one end on the axis of the tray (Figure 2).

2.2.- Procedure.

The sample is said to have propagated explosion if the reaction length in the tray is greater than 100 mm from the impact point. Evidence of explosion is given by impression and deformation of the tray. If this condition is not fulfilled, the result is "no propagation". The drop height is in meter(s) :

$$h = 0.25\ k \quad \text{with } k = 1 \text{ to } 16.$$

The limiting height of propagation, is defined as the maximum height at which 3 failures in 3 trials are obtained. If one propagation is observed at the minimum height value (0.25 m), the result is reported as the limiting height lower than 0.25 m.

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2.3.- Method of assessing results and criteria.

To answer the question : "Is the substance too hazardous for transport (in the form in which it was tested) ?", the test may be reduced to a maximum of three trials at the fixed drop height 0.75 m. But in order to get more information on the sensitivity of the substance it could be of interest to carry out the extended test.

Some results in this test are given in Table 2.

SUBSTANCE	RESULT limiting height (m)
hydrazine nitrate, melted	0.25
nitroglycerine, pure	0.50
pentaerythrol tetranitrate, fine and dry	0.50
hexogen, dry	1
octogen, dry	1.75
trinitrotoluene, flakes	⩾ 4
trinitrotoluene, cast	⩾ 4
ammonium perchlorate	⩾ 4
nitroguanidine	⩾ 4
gun propellants	⩾ 4
solid composite and cast propellants	⩾ 4
composite explosives	⩾ 4

Table 2 : Examples of results in the 30 kg fallhammer test.

3./ HOW TO DETERMINE THE TENDENCY FOR A SUBSTANCE TO UNDERGO THE TRANSITION FROM DEFLAGRATION TO DETONATION : THE FRENCH TEST.

After the accident in Pont-de-Buis plant in 1975, stress has been placed in France on studying the possibility for small gun propellants to undergo the transition from deflagration to detonation. In addition, this hazard does exist, generally, for all propellants and a variety of other

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substances. It has been extensively studied by different laboratories in different countries.

For these reasons, taking into account the manufacturers experience, we designed a special test in 1977. In this test, the transition is made easier by the confinement brought by a steel pipe.

The test is applicable to all substances provided that they are able to detonate in the test tube.

3.1.- Apparatus and materials.

The experimental layout is shown in figure 3.

The sample is filled in a 42 mm inner diameter, 1 220 mm long, 3.2 mm wall thickness, seamless steel pipe.

This pipe is closed at one end by a cast iron screwed cap. The electric wire of the ignition device is fitted into a little hole drilled into the cap. At the other end the substance is held in the pipe at a given location by a cardboard disk.

The pipe is placed horizontally onto lead witness plates.

A probe monitoring the shock wave velocity may be placed in the sample.

3.2.- Procedure.

The charge length is one of the following : 100 - 150 - 200 - 300 - 400 - 500 - 600 - 800 - 1 000 - 1 200 mm.

Ignition at the cap end of the pipe is obtained by electric squib or by hot wire. If the transition occurs, it is determined normally after the

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impression on the lead. The predetonation length is noted.

The first trial is performed with a 1 200 mm charge length. If the transition occurs, the test is carried on with trials at stepwise charge length until the transition is obtained at one level and no transition in two trials is obtained at the immediately lower level.

3.3.- Method of assessing results and criteria.

This test can be used to select the very insensitive substances, candidates for hazard division 1.5, among the class 1 explosives with mass explosion hazard. For this purpose it could be decided that substances for which transition occurs with a charge length below 1 200 mm will be rejected.

Some results in the test are shown in Table 3.

SUBSTANCE	RESULT	
	transition	predetonation length (m)
ANFO	no	-
slurry explosive	no	-
aluminized gel	no	-
dynamite, gelatine	yes	0.82
dynamite, guhr	yes	0.30
small gun propellants	yes	0.15 to 1.?

Table 3 : Examples of results in the deflagration to detonation transition test.

CONCLUSION.

In connection with IPE (Inspection de l'Armement pour les Poudres et Explosifs) from the Ministry of Defense, EML is concerned with the discussions of the UN Group of Experts on Explosives (GEX). A classification scheme

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has been developed to identify the hazards presented by articles, packaged articles and substances. This scheme refers to series of tests and it was agreed that a few countries would propose test methods for inclusion into a test manual in preparation.

The three tests presented here have been proposed. They give important information on the explosives hazards. In order to be used in series of tests to answer a particular question about the flow chart, the method of assessing results in each test has been simplified : the test is so performed at one level and the result is "go" or "no go". Nevertheless, it is emphasized the interest to perform the extended test in each case is to get more information on the behaviour of the materials.

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<u>REFERENCES.</u>

(1) Note technique n° 333 du Laboratoire de la Commission des Substances Explosives (L.C.S.E.) de Sevran, Modes opératoires codifiés des épreuves de substances explosives, mise à jour le 3 janvier 1972.

(2) WATSON R.W., Card-Gap and Projectile Sensitivity Measurements, A Compilation, IC-8605, Bureau of Mines Information Circular/1973, United States Department of the Interior.

(3) MEDARD L., Modes opératoires normalisés des essais d'explosifs, Mémorial des Poudres, tome XXXIII, 1951, p. 323-355.

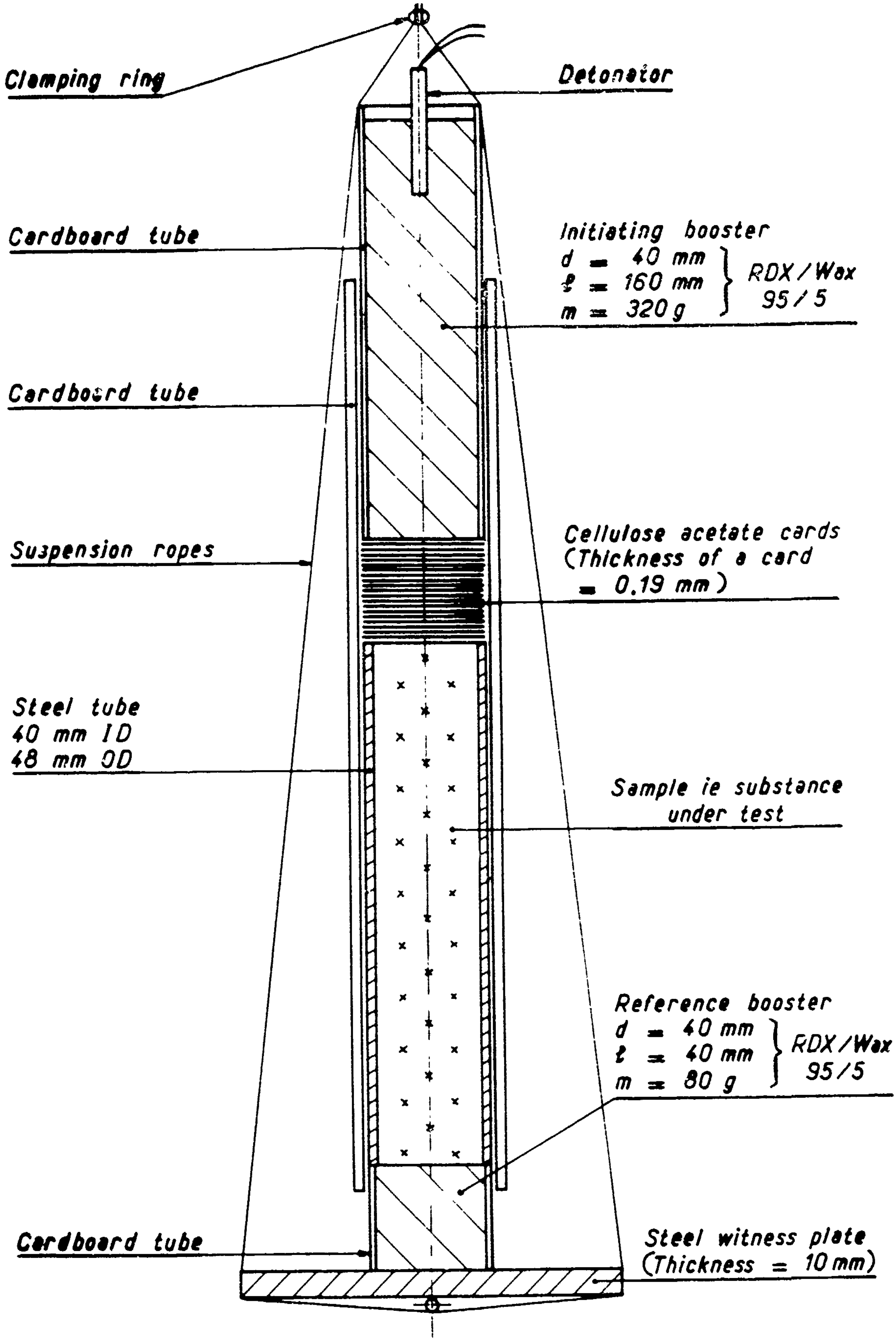

Fig. 1 _ FRENCH GAP TEST

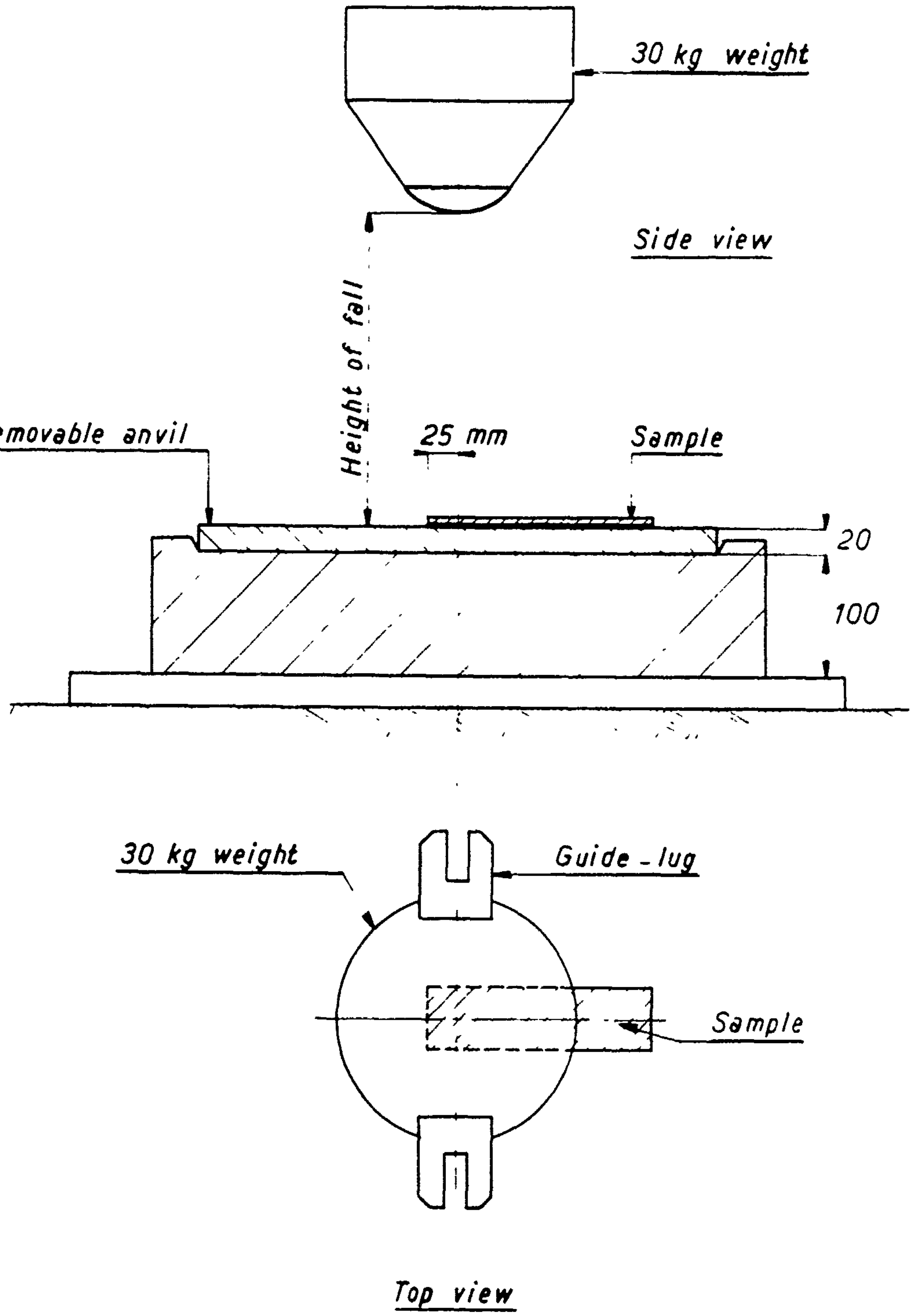

Fig. 2 _ TEST LAYOUT _ 30 kg FALLHAMMER TEST

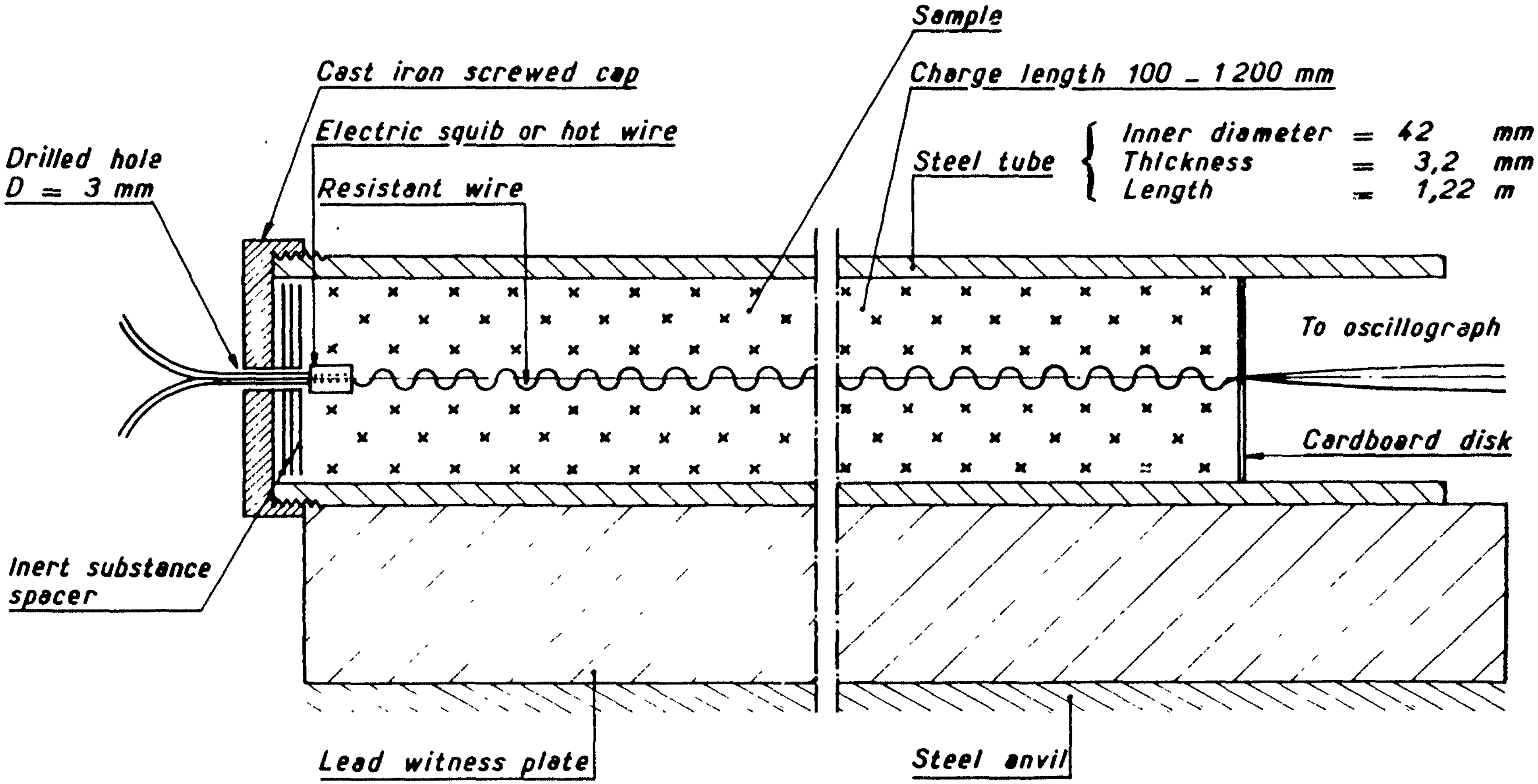

Fig. 3_DEFLAGRATION TO DETONATION TRANSITION TEST

EXPERIMENTAL LAYOUT