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Measurement of the Time Scatter of Explosive Trains with an Inexpensive Method

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Abstract: The time differences of a simultaneous initiation device including the initiation time differences of the detonators, build-up time differences of the detonation waves of the boosters and finally the main charge can be measured by the distances of the Dautriche line grooves imprinted in a target block-mild steel disc-by the intersection of detonation waves. Accuracy time differences of better than 0.1 μs can be achieved by carefully arranging the test set-up.

Key words: measurement method; simultaneous initiation device; time difference
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1 Introduction

The response time of electric detonators is mostly measured with electric circuits and fast writing oscilloscopes or counters, transient recorders with high time resolutions or optically with fast writing rotating mirror streak cameras[1]. But these techniques analyse the response times of the electric detonators only. In simultaneous initiation devices the overall explosive trains have to be considered and the time differences have to be measured beginning with the electric detonator, sometimes lead charges, to boosters and up to the full detonation of the main charge. A simple test set-up will be described which allows the analysis of these total time differences with enough precision and which requires no costly investments of expensive diagnostic tools.

2 Test set-up

A round or a rectangular disc of the main charge lies on a mild steel plate which is supported by a heavy steel block (Fig. 1). The sample detonators with their boosters are arranged around this disc. Four simultaneously initiated electro-explosive-detonators are used in the example shown. But it can easily be extended to six or eight or even more detonators on a circular disc.

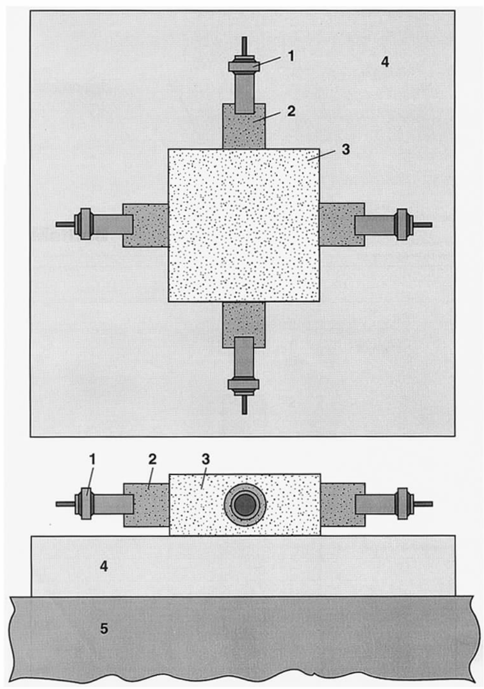

Fig. 1 Test set-up for measuring the time differences of several initiation devices by the Dautriche effect
1—electric detonator, 2—booster, 3—main charge, 4—mild steel block, 5—supporting steel block

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Biography: Dr. Manfred Held (1933 –), Professor of Military University of München, Germany. He is a world-famous expert in research, design, development and test of different advanced missile warheads and the related science and technology. He is also an internationally recognized authority in the field of dynamic response of materials as well as advanced armor and anti-armor.

3 Test results

Fig. 2 shows a test result of such an experiment where four thin film detonators, so-called PaMz 20, are fired serially connected to a capacitor of 2 μF, charged to 2 kV. The collision of the detonation waves in the main charge creates higher pressure. This pressure, which is higher than the de-tonation pressure produces grooves on the steel disc which are called Dautriche effects[2]. The time differences analysed by comparing the distances of the Dautriche lines to the theoretically symmetrical lines are marked on the original booster positions. This picture demonstrates that the lower detonator was responding first, because the collision lines have achieved the maximum distances of this detonator to the others and the right-hand detonator with 0.7 μs delay time was the latest. From the deltas Δs of the collision lines compared to the theoretical cross sedion between the initiation points, the time difference Δt can be simply calculated with $\Delta t = 2\Delta s/D$, where D is the detonation velocity of the used main charge. The mild steel blocks are slightly deformed by the detonation of the high explosive charge. To analyse more accurately the distances of the Dautriche lines to the theoretically perfect symmetrical positions, a grid is cut in the mild steel block as small grooves.

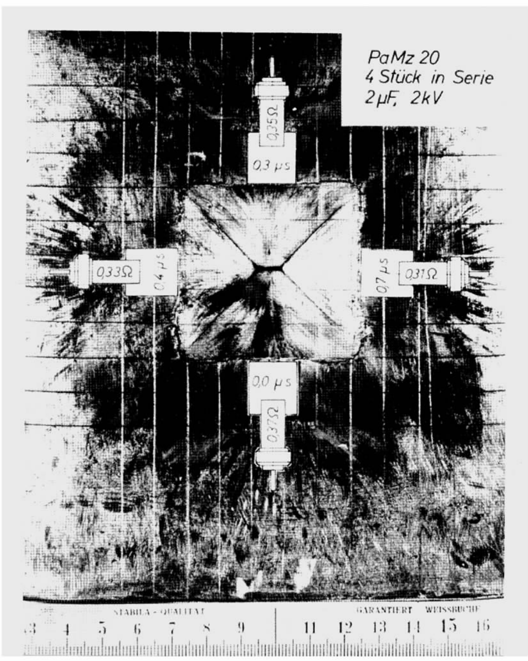

Fig. 2 Test result of a 4 times simultaneously initiated high explosive charge

Care is necessary to make these grooves accurate. This can be totally avoided if a grid with known distances is placed between the high explosive charge and the mild steel disk. This measuring grid is diredly imprinted on the steel disc by the detonation of the main charge, before any deformation starts. The Dautriche lines can be analysed directly to these known grid lines. An example with this technique is presented in Fig. 3.

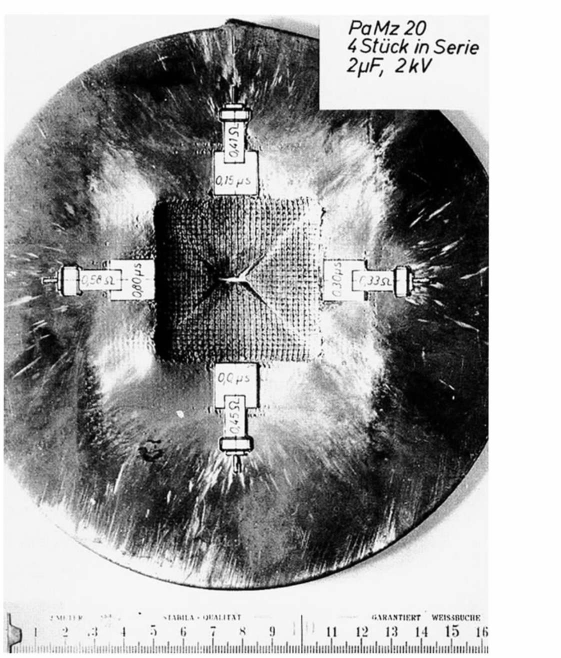

Fig. 3 Picture of a mild steel disc on which the Dautriche lines of a fourfold initiation are imprinted and where a grid with known distances was arranged between the high explosive charge and the mild steel disc.

4 Accuracy of this test method

With this method the intersection difference Δs to an ideal behaviour can be read out with an accuracy of at least 0.3 mm to 0.4 mm. With a high explosive charge with a detonation velocity D of 7.8 mm/μs this provides an accuracy in the range of 0.1 μs, which is accurate enough for applications in praxis.

5 Conclusion

A relatively simple method of defining the time differences of initiation devices including the buildup times of boosters and the main charge is demonstrated by using the

Dautriche effect creating sharp marks by colliding detonation waves, acting on a strongly supported steel disk. This method allows to measure time differences with at least 0.1 μs accuracy.

REFERENCES:

[1] Held M. Simultane Initiierung Teil il (Simultaneous initiation, Part Ⅱ)[J]. Wehrtechnische Monatsheft, 1968, 65: 263 - 274.

[2] Meyer R. Explosives[M]. New York: Verlag Chemie, Weinheim 1977.

用简单方法测定爆轰序列时间差

摘要: 同步起爆装置的时间差、包括不同雷管的起爆时间差、传爆药爆轰波成长的时间差以及爆轰波最后到达主炸药的时间差,可通过印在柔性圆盘钢靶板上的道氏沟槽线的距离来测量,测量误差小于0.1 μs.

关键词: 测试方法; 同步起爆装置; 时间差