不純物による 1.8-DNN の晶出の妨害も起つていないようである。

4. 結　　論

1.5-DNN と 1.8DNN との混合物のX線回折強度を平板圧塡試料に就いてとり，組成による変化を求めた。1.5-DNN はここで行つた処理ではアセトンからの晶出を 1.8-DNN と同じ溶液からさせた時の他は常に安定なピーク高を示して分析の可能性を示したが 1.8-DNN は処理法によつてその結晶の示すピークは著しく変化し，特に工場製品の含む不純物の存在下での熔融冷却からはその大部分が予期された結晶を作らぬことと及び単独にアセトンに溶解して水から晶出させた微結晶は帯電が著しく取扱いは困難であるが，工場製品の状態に酷似していた。これは逆に 1.8-DNN の化成時の挙動の一部を伺はせるものである。この様に平板状に圧塡する試料容器によつて定性或は定量をなす場合は，物質の変化のみでなく単なる配列の変化が著しく結果に影響することは当然のこと乍ら注意すべきことと思はれた。

X-ray study of nitronaphthalenes

III Preferred orientation of 1.8-DNN

Keiho Namba and Masaru Sasaki

The X-ray diffraction intensity profile of pure crystalline powders of 1.8-DNN, recorded with the Geigerflex, differs from that of the industrial product. This comes from the preferred orientation of the pure crystalline sample of 1.8-DNN. We tried to prepare an appropriate sample of the pure compound, in order to search the relation between a standard concentration and a diffraction peak height for the sake of quantitative analysis of the industrial DNN. It is concluded from several trials that a method of recrystallization to pour the saturated acetone solution of the pure 1.8-DNN into a proper amount of water under stirring gives a favorable result. (Univ. of Tokyo)

AN APPLICATION OF "THE THEORY OF THE VARIABLE REACTION ZONES IN THE DETONATION OF SOLID EXPLOSIVES" TO THE DESIGN OF THE ELECTRIC DETONATOR.

by Shiro Kinoshita*

(1) Introduction

The critical condition of the transition from combustion to detonation of solid explosives has been examined by the aid of "The theory of the variable reaction zones in the detonation of solid explosives.[1]"

This theory shows that the following approximation formula holds for the relation between the maximum detonation velocity D_m, any stable detonation velocity D, the radius of cartridges R, the thickness of the

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1) K. Hino: Theory of relations between the detonation velocity of solid explosives and the thickness of cases or the diameter of the charges. J. Industrial Explosives Soc, Japan 19 3 (1958).

wall Y, the velocity of the shock wave within wall material V_W, the velocity of sound in detonation products V_e, the maximum reaction time t_m, the maximum reaction zone length X_m, the critical reaction time t_c, the critical reaction zone length X_c, the critical radius R_c, and the critical detonation velocity D_c.

$$\left.\begin{array}{l}\left(\dfrac{D}{D_m}\right)^2=\dfrac{1}{t_m}\left(t_c-\dfrac{R_c}{V_e}+\dfrac{Y}{V_W}\right)+\left(\dfrac{1}{t_mV_e}\right)R\\ X\equiv Dt,\ X_m=D_mt_m,\ X_c\equiv D_ct_c\end{array}\right\}\quad(1)$$

(2) Experimental data on the relation between the detonation velocity and the radius of DDNP. (diazodinitrophenol)

The detonation velocity of several DDNP cartridges of different radii has been observed by the streak camera (Fig. 1), whose sweeping speed is about 100 meters per second.

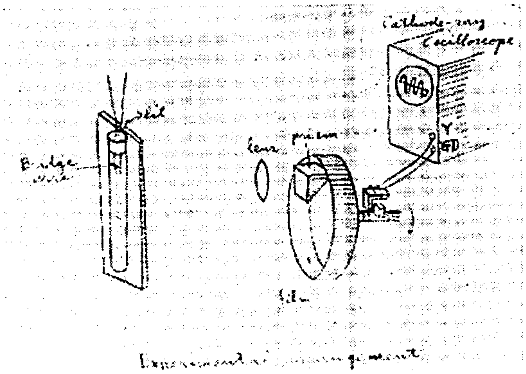


Fig. 1.

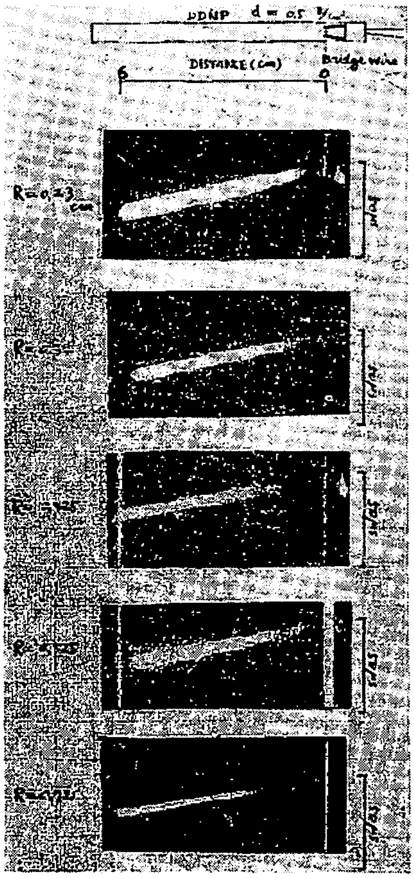


Fig. 2.

2.1) DDNP is enclosed within a glass tube 1mm thick with the loading density of 0.5 gram per cubic centimeter and it is ignited by a bridge wire.

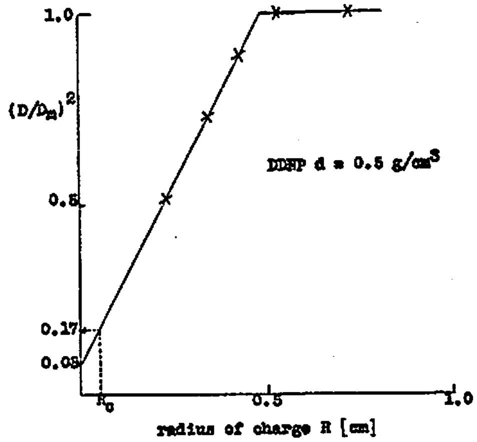


Fig. 3.

Rcm	0.05	0.11	0.23	0.34	0.425	0.525	0.72
Dm/s	comb.	det.	2,500	3,000	3,300	3,500	3,500

$D_m=3{,}500$m/s

$R_c=0.05$cm

$$A=\frac{1}{t_m}\left(t_c-\frac{R_c}{V_e}+\frac{Y}{V_W}\right)=0.08$$

$$B=\frac{1}{t_mV_e}=\tan\ \alpha=1.91$$

$$V_e=\frac{5}{6}D_m=0.292\times10^6\text{cm/sec}$$

$$t_m=\frac{1}{BV_e}=1.79\mu s$$

$D_c=0.144\times10^6$cm/sec from Fig. 3.

$X_m=D_mt_m=0.63$cm

$$t_c=At_m+\frac{R_c}{V_e}=0.31\mu s$$

$X_c=D_ct_c=0.04$cm

2.2) DDPN is enclosed within a glass tube 1mm thick with the loading density of 0.9 gram per cubic centimeter and it is ignited by a bridge wire.

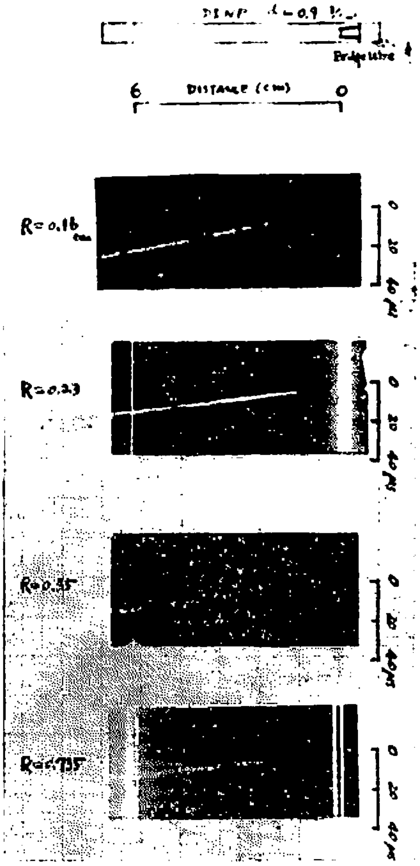


Fig. 4.

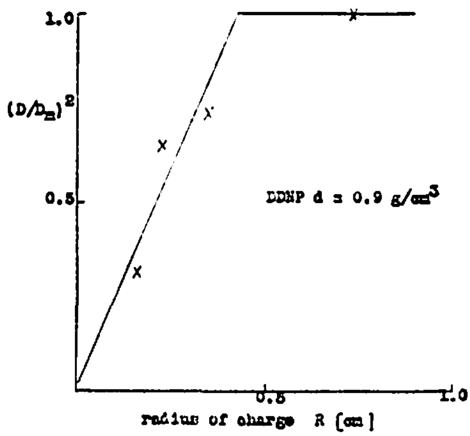


Fig. 5.

R cm	0.05	0.11	0.16	0.23	0.35	0.735
D m/s	comb.	det.	3,200	4,600	4,900	5,700

$D_m = 5,700\text{m/s}$

$R_c = 0.05$

$A \fallingdotseq 0$

$B = \tan\alpha = 2.32$

$V_e = 0.475 \times 10^4\text{cm/sec}$

$t_m = 0.9\mu s$

$D_c = 0.197 \times 10^5\text{cm/sec}$

$X_m = 0.51\text{cm}$

$t_c = 0.1\mu s$

$X_c = 0.02\text{cm}$

2.3) Tetryl is enclosed within a copper tube 0.15mm thick with the loading density of 1.55 gram per cubic centimeter and it is initiated by a detonator which contains DDNP of 0.2gram.

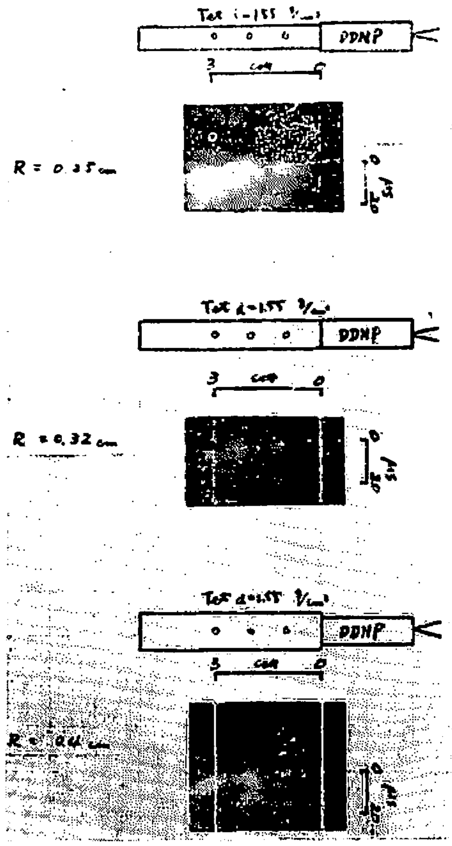


Fig. 6.

The values of the detonation velocity observed for cartridges of different radii are about 6,300m/s. The result shows that the critical radius is to be smaller than 0.25cm. But, as it is difficult to prepare a copper tube of a radius smaller than 0.25cm, the accurate value of the critical radius cannot be determined by this experiment.

2.4) Tetryl is enclosed within a glass tube 1mm thick with the loading density of 0.8 gram per cubic centimeter and it is initiated by a detonator which contains DDNP of 0.2gram.

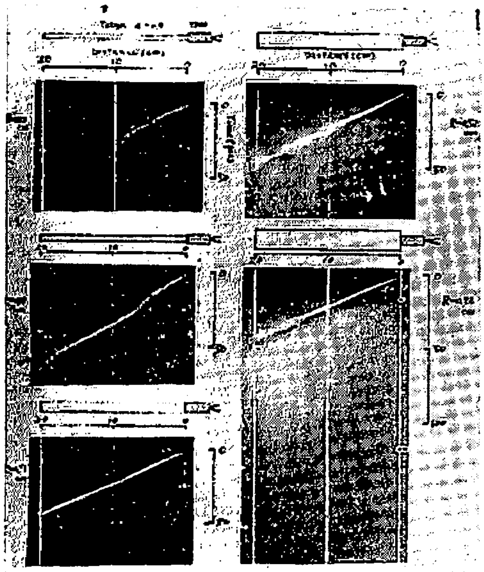


Fig. 7.

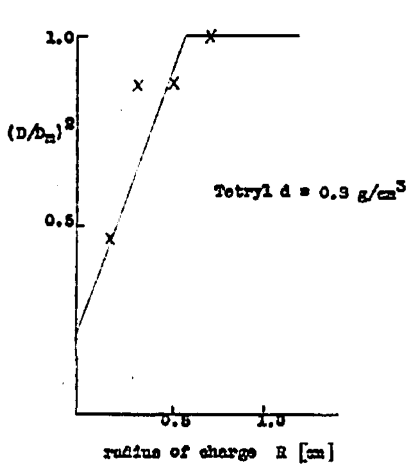


Fig. 8.

Rc m	0.11	0.18	0.33	0.52	0.72
D m/s	failed	3,300	4,500	4,500	4,830

$D_m=4{,}830$m/s

$R_c=0.11$cm

$A=0.22$

$B=\tan\alpha=1.34$

$V_e=0.402\times10^6$cm/sec

$t_m=1.85\mu s$

$D_c=0.294\times10^6$cm/sec

$X_m=0.89$cm

$t_c=0.68\mu s$

$X_c=0.20$cm

(3) Discussion

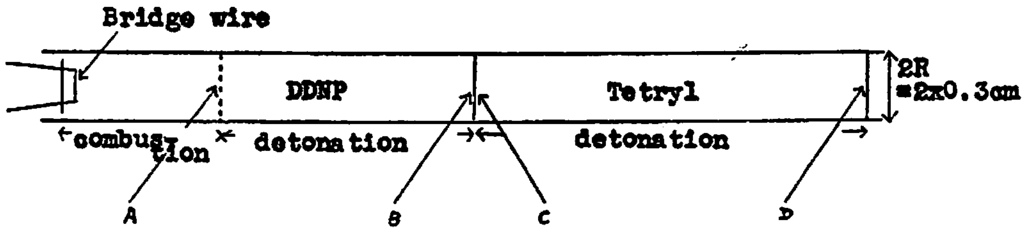
By the aid of the theory of the variable reaction zones in the detonation of solid explosives, the critical mass and critical detonation velocity necessary to the transition from combustion to detonation can be obtained.

The critical mass that must be initiated in order to maintain steady detonation in the initial explosives is smaller than that in the high explosives. For example the critical mass of the DDNP of the loading density of 0.5g/cm³ is $\pi R_c^2X_cd=\pi\times(0.05)^2\times0.04\times0.5=0.16$mg, the critical mass of the RDX[2] of the loading density of 1.2g/cm³ is $\pi R_c^2X_cd=\pi\times(0.159)^2\times0.455\times1.2=44$mg, and the critical mass of the Tetryl of the loading density of 0.8 g/cm³ is $\pi R_c^2X_cd=\pi\times(0.11)^2\times0.20\times0.8=6$mg.

The critical detonation velocity (D_c) of the DDNP obtained by the above experiments (1,400m/s at $d=0.5$g/cm³, 1,970m/s at $d=0.9$g/cm³) coincides with the value of 5.5 ~6.3 Mach necessary to initiate DDNP by

2) K. Hino, Theory of the variable reaction zones in the detonation of solid explosives: Extrait du Compte-rendu du XXXI Congrés International de Chimie Industrielle-Liège-September 1958.

Table I



critical condition necssary to detonation of DDNP	value of length of reaction zone X and detonation velocity D at the end of DDNP cartridge	critical condition necessary to detonation of Tetryl	value of length of reaction zone X and detonation velocity D at the end of Tetryl cartridge
$d=0.5g/cm^3$ $R_c=0.05cm$ $X_c=0.04cm$ critical mass=0.16mg $D_c=1,440m/s$ (from Fig. 3.)	$R_1=0.3cm$ $D_1=2,840m/s$ (from Fig. 3.) $X_1^*=0.32cm$ (Fail)	$d=0.8g/cm^3$ $R_c=0.11cm$ $X_c=0.20cm$ critical mass=6mg $D_c=2,940m/s$ (from Fig. 8.)	$R_1=0.3cm$ $D_1=3,860m/s$ (from Fig. 8.) $X_1^*=0.36cm$
$d=0.9g/cm^3$ $R_c=0.05cm$ $X_c=0.02cm$ critical mass=0.14mg $D_c=1,970m/s$ (from Fig. 5.)	$R_1=0.3cm$ $D_1=4,970m/s$ (from Fig. 5.) $X_1^*=0.30cm$		

$$^*X_1=D_1t_1=D_1\left\{At_m+\frac{R_1}{V_e}\right\}$$

shock wave, which was found by Gey et al.[3)]

As an example, in Table I is shown a detonator model which consists of DDNP and Tetryl. The DDNP is ignited with a bridge wire and the base charge Tetryl is initiated by the DDNP.

Table I shows that DDNP of the loading density of $0.5g/cm^3$ can transit more easily to detonation than DDNP of the loading density of $0.9g/cm^3$, but DDNP of the loading density of $0.5g/cm^3$ can not initiate Tetryl of the loading density of $0.8g/cm^3$. Tetryl of loading density of $0.8g/cm^3$ can be initiated by DDNP of $0.9g/cm^3$.

From a consideration of these characters of DDNP a new type of an electric detonator can be designed.

3) Wm. A. Gey and Arthur L. Bennett, J. Chem. Phys. **23**, 1979~80 (1955) CA **50**, 2174.

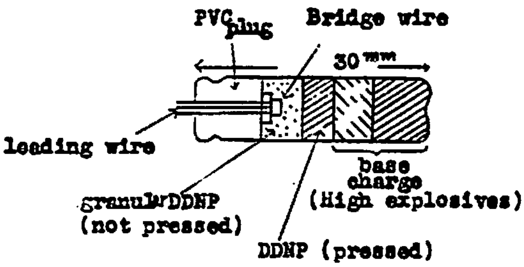


Fig. 9.

Fig. 9. shows the crosssectional sketch of this detonator.

The Nippon Kayaku Co. Ltd. has been manufacturing of this type of an electric detonator since 1959.

The characters of this detonator are as follows:

1) It can be manufactured at lower cost because this type of a detonator has not the fuse head and an inner cap and the shell is shorter than that of a convent-

ional detonator.

2) The blasting power of this detonator cap is higher than that of the normal No. 6 detonator cap in our country.

Acknowledgements—

The author wishes to express his thanks to Dr. K. Hino, Chief, Explosives Research Section of the Nippon Kayaku Co. Ltd. for many helpful advices during the preparation of this paper.

BRISANCE AT CENTRAL POINT OF EXPLOSIVES

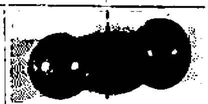
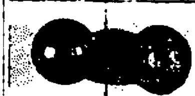
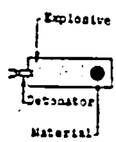
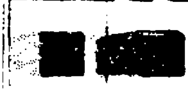
Hideji Sudo*, Sukenori Yamamoto**, and Kenkichi Kiyota***

The writers of this report charged a piece of steel, copper, brass, lead, synthetic resin or rubber in an explosive mass and measured the deformation of the piece caused by the dynamic pressure of detonation.

(1·1) A brass cube or ball, or a lead ball is charged in the cylindrical mass of the explosive (diameter 32mm. length 100mm.) to be situated at the distance of two thirds from the end of priming detonator

The results are shown in Table 1.

T. 1. Deformation of metal piece charged in cylindrical explosive. (I)

No.	Explosives	Material which will be compressed.	Method of Charging	Shape of material Initial	Shape of material Final
1	Gelignite	Brass ball			
2	ditto	Laed ball			
3	Percolorate explosive	Brass ball			
4	PETN	ditto			
5	Ammonia gelatine dynamite	Brass cube			

Namely the ball is deformed into an elliptic shape and the cube is a little deformed due to compression. It is not, however, destroyed in the explosive mass. Calibration of the strength required for this deformation is measured by the Amsler's testing machine, the results of which are as below.

Ammonia gelatine dynamite 3.5 Tons

Ammonium nitrate explosive 4.9 Tons

The time duration of the work imposed on the central piece by the dynamic detona-

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