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—

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BRISANCE AT CENTRAL POINT OF EXPLOSIVES

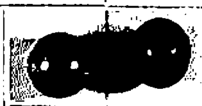
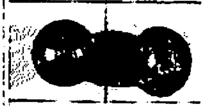
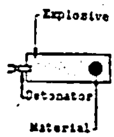
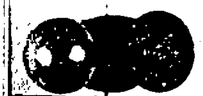
Hideji Sudo*, Sukenori Yamamoto**, and Kenkichi Kiyota***

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 / 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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tion pressure of the explosive is measured by the piezo-electric effect of rock crystal as shown in Fig. 1.

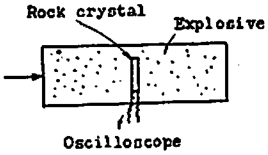


Fig. 1. Method of measuring pressure by piezoelectric effect.

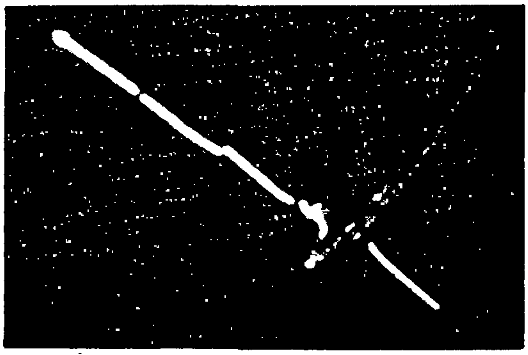


Fig. 2. Working pressure produced by detonation in explosive.

The time duration (τ) thus measured in Fig. 2. is;

$$\tau=7\times10^{-7}\text{ sec.}$$

The intensity of this pressure (p) similarly measured is,

$$p=14{,}000\text{kg/cm}^2$$

It seems however that this pressure is too low perhaps due to the insufficient response of the measuring system.

(1·2) The brass cube, ball or lead ball is charged at the centre of the explosive and the priming is made at both ends simultaneously. The results are shown in T. 2.

Similar to the results shown in T. 1., the metal piece is deformed along the longitudinal axis of the explosive mass, but no destructive phenomenon due to detonaion pressure is found. The time and the intensity of the pressure was measured as shown in Fig. 1.

$$\tau=3.5\times10^{-7}\text{ sec,}$$

$$p=11{,}000\text{kg/cm}^2$$

(1·3) One of the copper pipes having 15 mm external and 3~11mm internal diameter is charged into the explosive cylinder. The results are shown in T. 3.

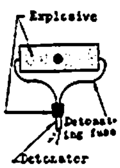
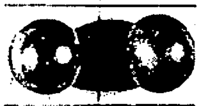
Namely the pipe shows the radial shrinkage without any change in its length. We calculated with some assumptions the statical strength needed for this deformation as 800kg/cm^2.

The strength measured by the piezo-electrical method.

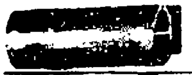
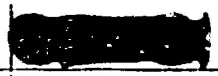
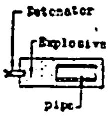
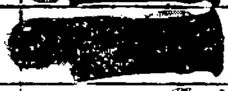
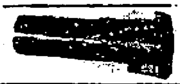
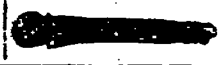
$$\tau=5.5\times10^{-7}\text{ sec.}$$

$$p=140\text{kg/cm}^2$$

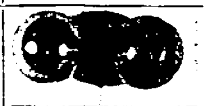
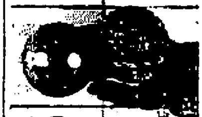
T. 2. Deformation of metal piece charged in cylindrical explosive. (Ⅱ)

No.	Explosives	Meterial which will be compressed	Merhod of Charging	Shape of material: Initial	Final
6	Gelignite	Brass ball			
7	Perchlorate explosive	ditto			
8	Ammonium nitrate explosixe	Brass cube			

T. 3. Shrinkage of metal charged in cylindrical explosive.

No.	Diameter mm		Thickness	Method of	Shape of pipe	
	External	Internal	mm	Charging	Initial	Final
9	15.0	11.0	2.0			
10	15.0	9.0	3.0			
11	15.0	6.0	4.5			
12	15.0	3.0	6.0			
13	10.0	8.0	1.0			

T. 4. Destroyed metal put at the end of cylindrical explosive.

No.	Explosives	Material which will be Compressed	Method of Charging	Shape of material	
				Initial	Final
14	Ammonia gelatine dynamite	Steel ball-			
15	ditto	ditto			
16	ditto	Steel cube			
17	ditto	Brass cube			
18	Ammonium nitrate explosive	Brass ball			
19	ditto	Steel ball			
20	Ammonia gelatine dynamite	Copper solid cylinder			

Also there are no destructive phenomena found in this case.

(1·4) The cube and the ball made of a steel or brass, or a copper cylinder is charged at one end of the cylindrical mass of the explosive and the priminh is made at the opposite end. The metal pieces are destroyed as shown in T. 4.

The time duration of pressure is approximately equal to the above mentioned case.

$\pi = 7 \times 10^{-7}$ sec

$p = 90 kg/cm^2$

II. The spherical mass of the explosive is prepared by loading the explosive in a rubber ball with 60~100mm diameter as shown in Fig. 3.

(2·1) The steel, brass, lead or synthetic resin ball is at the centre of this sperical explosive.

a) The spherical explosive is primed simultaneously at six points on its surface in the way shown as in Fig. 4. All the tested balls are subject to no change.

b) In case the spherical explosive is primed at only one point of its surface, the brass or lead ball becomes a little elliptic in form.

The results are shown in T. 5.

The time and the pressure are shown as

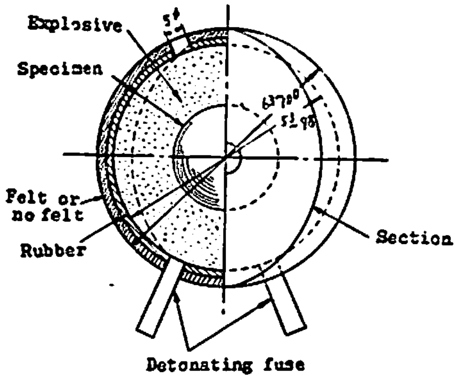


Fig. 3. A set of specimen, explosive and detonation fuse.

follows;

$\tau = 2 \times 10^{-7}$sec

$p = 2,000 kg/cm^2$

(2·2) A hollow brass ball with screw is prepared by combining two parts as shown in

T. 5. Deformation of piece charged at the centre of the globular explosive.

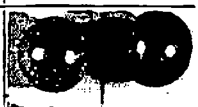
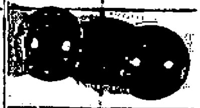
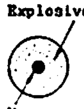
No.	Explosives	Material which will be Compressed	Method of Charging	Shape of material	
				Initial	Final
21	Gelignite	Brass ball	Primed from one point		
22	ditto	Steel ball			
23	ditto	Brass ball			
24	ditto	Lead ball			
25	ditto	Synthetic resin ball			
26	ditto	Brass cube			
27	Ammoniun nitrate explosives	Lead ball	primed from six points		

Fig. 4. Simultaneons priming method.

Fig. 5. This hollow ball is charged in the spherical explosive and the explosive is primed at six points on its surface.

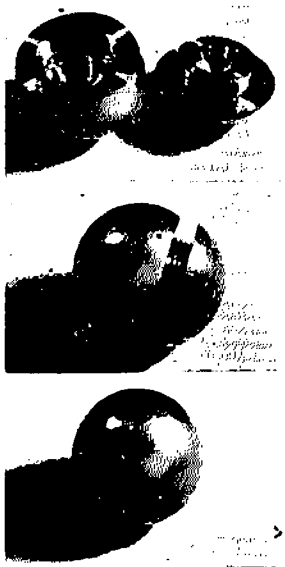


Fig. 5. Construction of hollow brass ball.

The screw of this brass ball is tightened so that it is not dismantled by hand, although its external appearance is scarcely changed.

(2·3) A rock crystal ball is loaded in the hollow part of the brass ball and the entire body is charged at the centre of spherical explosive as shown in Fig. 6.

The rock crystal ball is subject to no deformation at all.

But when the rock crystal ball is loaded

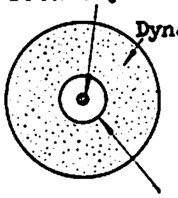


Fig.6. Method of charging.

eccentrically in the lead ball, it is crushed finely by the detonation pressure though the appearance of the lead surface is not at all changed.

(2·4) The explosive is loaded in the part of the brass ball and the entire body is charged in the spherical explosive as shown in Fig. 6.

The enclosed explosive in the brass ball detonated sympathetically by the influence of the outer explosive but the surface of brass ball is not changed.

The result is shown in Fig. 7.

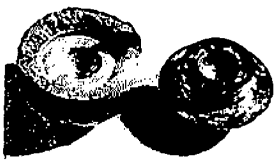


Fig. 7. Destroyed metal ball by explosion of inner explosive influenced by outer explosive.

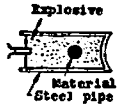
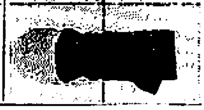
Ⅲ. The explosive is loaded in a convex-bottomed steel pipe and the brass ball or copper pipe is charged in the explosive.

When this explosive is primed at the open end, there are two cases to be observed.

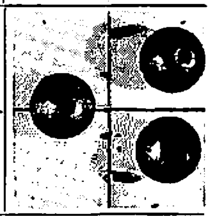
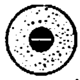
(3·1) On the brass ball surface, a small cavity is produced at the point facing the convex bottom.

(3·2) The results are shown in Table 6.

Ⅳ. A hole of 3mm diameter penetrating the brass ball is made through the centre and this ball is chaged at the centre of the

No.	Explosives	Material which will be Compressed	Method of Charging	Shape of material	
				Initial	Final
28	Gelignite	Brass ball			
29	Ammonium nitrate explosive	Lead ball			
30	Ammonia gelatine dynamite	Copper pipe			

T. 6. Deformation of metal charged in cylindrical explosive sn bottomed pipe.

No.	Explosives	Material which will be Compressed	Method of Charging	Shape of material	
				Initial	Final
31	Gelignite	Brass ball with hole			
32	ditto	ditto			

T. 7. Deformation of the hole of metal ball charged at the centre of globular explosive.

spherical exposive.

(4·1) When the same explosive is loaded in this hole and is charged at the centre of the sphere of the same explosive and the outer spherical explosive is primed, the hole is enlarged a little but is not destroyed.

(4·2) When the hole is empty, the both ends of the hole are collapsed by a hot jet which expands into the empty hole, the results of which are shown in Table 7.

Ⅴ. Conclusion.

(5.1) It seems that the brisance of the explosive mass is produced by the high temperature and high velocity jet flowing outwards from the surface of the mass.

(5·2) The materials loaded at the centre of the spherical explosive do not change at all in shape and appearance, when the dynamic pressure works uniformly and immediately thereafter it turns into the tension produced by the uniform expansion of explosion products.

術語解説

"Memory Effect"

火薬類が加熱により発火感度の上昇を示す場合に用いられる言葉で，ある温度に対する発火待時間がt_1の試料を，先ずその温度でt_1より短時間のt_2だけ加熱した後に冷却し，ついでもとの温度で再加熱したときの発火待時間がt_3になつたとすれば，ほぼ$t_1=t_2+t_3$の関係を示すようになる効果をいう。従来は起爆薬についてのみ報告されていたが，もつと一般的に起る現象である。起爆薬ではスチフニン酸鉛，DDNP等，二次爆薬ではPETN，テトリル等がこの効果を示し，これらはその熱分解反応が自触的なものである。

〔Explosivstoffe 7, 177～183 (1959) より〕(岡崎)