Design of Detonator Plant

Part I. Pot Holder for Initiating Explosives in Charging Room

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I. Introduction

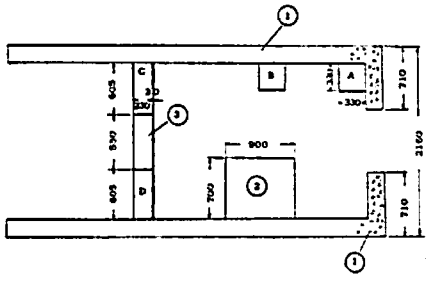
Most of the shops in which initiating explosives are handled have so-called blow-out or semi-blow-out structures.

The room of the shop has thick and rigid walls in three directions, and two light and fragile walls in two directions (forward and upward). The doorway is in the forward direction (blow-out direction). This type is used in the case of comparatively small quantity of initiating explosives. The other type of the structure has doorway in one of the thick and rigid walls. This type is adopted in handling the very small quantity of initiating explosives.

This experiment had the object to get standard rules referring to the safe position and construction of "pot place" in a charging room of the semi-blow-out type. The pot means the container of initiating explosives and pot holder means the seat in which the pot can be settled without danger. The charging is the most dangerous operation. The experiment was carried out on the real size.

II. Pot Holder in Room

The charging room was constructed of ferro-concrete in standard type, i. e. 300mm in depth, 1,500mm in project, 1,760mm in frontage, 740mm in doorway and 200mm in thickness. (Fig. 1)



① : ferro-concrete wall
② : work bench
③ : charging machine

Fig. 1 Location of pot holder (A, B, C and D)

The position A has fallowing advantages and disadvantages.

Advantages

(i) The effective working area is large.

(ii) The pot holder is separated far from the other explosives.

(iii) The two ferro-concrete walls serve as a shelter for the pot.

Disadvantages:

(i) Missiles may gather on the pot holder in the corner when an explosion occurs in the room.

The position B has advantages and disadvantages as follows:

Advantages:

(i) The distance from the pot to a hopper of the charging machine is half of "A". The shortest distance is convenient for work.

(ii) Probability of missile projection by explosion seems to be smaller than that of the case "A".

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Disadvantages:

(i) The effective working area is narrow.

(ii) The distances from the pot to the other explosives are short.

The positions C and D have following advantages and disadvantages

Advantages:

(i) The working area is the widest.

(ii) An operational shield can be constructed so strongly as to protect an operator from death or injury in the case of explosion.

(iii) These positions admit to settle an automatic feeding system which saves a manual labour.

Disadvantages:

(i) The narrow doorway to the charging machine is inconvenient.

(ii) It is unsafe to adopt a manual system in these positions.

(iii) As stagnating charges increase on the blow-out side, a counterplan is necessitated to prevent the sympathetic detonation in the blow-out side.

III. Experimental

The experiment was carried out relating to the following items:

(1) A former pot holder was located in the position A in the corner. Is this pot safe as expected or unsafe?

(2) Is it possible to find a safe position of the pot against an explosion which happens in the room? Is it possible to design an unbreakable pot holder when an explosion occurs within itself?

(3) When the pot holder is not located in the work room, an automatic feedinge system which necessarily holds an increased quantity of charge should be employed.

Will it be possible to prevent a sympathetic detonation in the blow-out side?

1. The Former Pot Holder

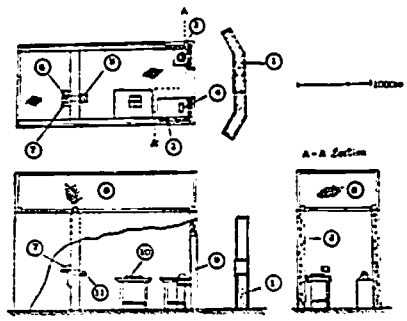
(1) Construction

The pot surrounded by a half-domed operational shield of lead plate (15mm in thickness) is placed on a rubber plate which covers a top of a brick stand of 32cm² in top area and 65cm in height. The pot, a covered cylindrical vessel, is made of conductive rubber, and it is 90mm in outer diameter, 3mm in thickness and 110mm in height.

(2) Case of DDNP (Diazodinitrophenol)

(i) Method

(A) Position A (Fig. 2)



①: sand
②: ferr-concrete wall
③: pot (250g of DDNP)
④: copper shells
⑤: ferro-detonators
⑥: charging plate, 12g of DDNP
⑦: hopper 100g of DDNP
⑧: net to prevent fragment
⑨: entrance
⑩: rubber plate
⑪: feeding stand of charging holder

Fig. 2 Arrangement of the former pot holder

(B) Charge

(a) Pot: DDNP 250g

(b) Work bench: 100 ferro-detonators and 300 ferro-detonators only with base charge.

(c) The feeding stand: 100 ferro-detonators.

(d) The charging plate: 12g of DDNP. The hopper: 100g of DDNP.

(C) Initiation

The one hundred ferro-detonators on the work bench initiated by an.

electric detonator.

(ii) Results

(A) DDNP in the pot, ferro-detonators on the feeding stand, DDNP on the charging plate and in the hopper in the blow-out side detonated.

(B) Three hundred ferro-detonators with compressed base charges on the work bench did not detonate.

Two hundred and eighty-five pieces of them were recovered.

These results probably depend upon the fact that the explosion pressure, the size and the duration of DDNP flame are much larger than those mercury fulminate.

(3) Case of mercury fulminate

(i) Method

(A) Layout: the position A; the process of explosion was photographed by an 8mm cinecamera.

(B) Charge

(a) Pot: mercury fulminate 300g, the density of which is greater than that of DDNP.

(b) Work bench: 40 mercury fulminate ferro-detonators.

This layout of the charges had the largest possibility of sympathetic detonation from the work bench to the pot of the position A.

(C) Initiation

The four hundred ferro-detonators on the work bench were initiated by an electric detonator.

(ii) Results

(A) Mercury fulminate in the pot detonated as DDNP did.

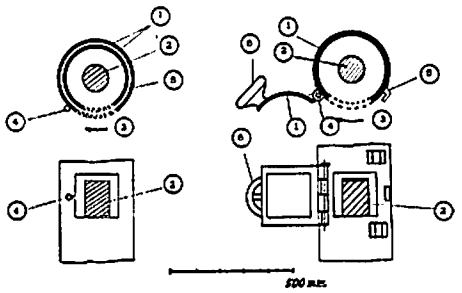
The position A proved to be hazardous which had been regarded as safe for the past thirty years.

(B) Photographs by the 8mm cinecamera showed that the charge in the pot detonated after 0.35 sec (22 frames) from the initiation.

(C) The concentration of missiles was supposed to be the main cause of the sympathetic detonation.

2. Cylindrical Pot Holder

Two types of cylindrical pot holder, (1) a double cylinder type, and (2) a hinged-door type were situated on the position A. (Fig. 3)



(a) double-cylinder type (b) hinged-door type

①: steel, ②: pot, ③: open

(a) ④: opening door lever, ⑤: clearance, 2mm

(b) ④: hinge, ⑤: door clasp, ⑥: opening handle, cast iron

Fig. 3 Cylindrical pot holder

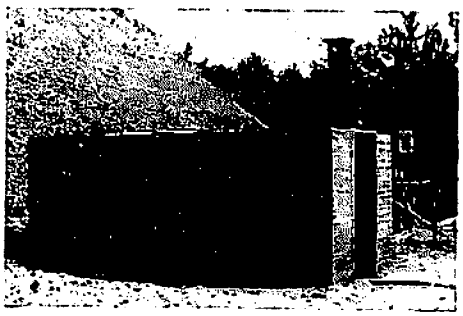


Fig. 4 The general view of experimental room

The blow-out direction of the cylindrical pot holder is upward. The top of the pot holder is higher than the roof of the room.

(1) Construction

(i) Double-cylinder type

The inner cylinder lined with rubber was 26cm in outer diameter, 12mm in

thickness and 51cm in length, and was set in the outer steel pipe which was 32cm in outer diameter, 10mm in thickness, 288cm in length. An opening was composed of superposed slits (holes) which were cut in the inner and the outer cylinders.

(ii) Hinged-door type

The hinged-door (29cm² in area, 10 mm in thickness) with a door clasp is attached to a steel cylinder which is equal in size to that of the outer cylinder of type (i).

(2) Method

(i) Layout

The layout had the shortest distance of about one metre from the pot to the work bench, because the bench located in the opposite corner of the pot holder. Four explosion tests of the same charge were carried out with different initiating points and with two types of the pot holder.

(ii) Charge

(A) Pot: DDNP 250g.

(B) Work bench: 400 ferro-detonators

(iii) Initiation

(A) The four hundred ferro-detonators on the bench were initiated by an electric detonator.

(B) The 250g DDNP in the cylindrical pot was initiated by an electric detonator.

(3) Results

In all cases no sympathetic detonation occurred.

(i) Double-cylinder type

(A) Explosion of detonatros on the work bench.

Through the door clearance, fragments of a loading plate made of bakelite and the wooden bench, dashed into the inner cylinder, and a cover of the pot was moved about 10mm.

(B) Explosion of DDNP in the pot at the inner cylinder.

The inner cylinder was moved up about 8 mm, and the door was split into three parts.

Forty detonators tumbled on the loading plate and they were not damaged.

(ii) Hinged-door type

(A) Explosion of the detonators on the work bench

The charge in the pot did not detonate. The door and the pot did not be affected. Fragments were not found in the pot.

(B) Explosion of DDNP in the cylindrical pot

The hinge of cast iron was cut. The door is slightly deformed and opened. Detonators on the bench did not detonate and were scattered on the bench. One of them dropped down on the floor.

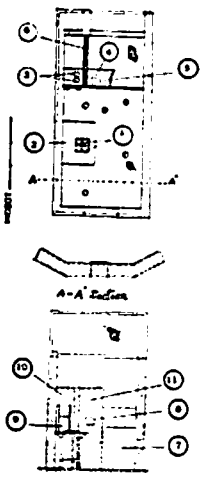
It is possible to design an unbreakable pot against inner explosion by employing steel instead of cast iron.

3. Automatic Feeding System in the Blow-out Side of the Room.

(1) Construction (Fig. 5)

An operational shield (30mm in thickness) was constructed and a door through which initiating explosive was fed to the pot was attached to the shield. A wall for preventing a vibration caused by explosion was constructed between the pot and the charging machine.

The wall was made of a pair of steel plates (6mm in thickness), whose interspace of 10mm was filled with saw dust. To feed initiating explosive from the pot to the hopper automatically, two pots containing 500g of DDNP were necessary.



① : DDNP has been weighed
② : DDNP has not been yet
③ : pot (DDNP 250g×2)
④ : DDNP 100g in hopper
⑤ : 100 detonators
⑥ : sawdust
⑦ : door of entrance
⑧ : doorway of feeding stand
⑨ : door
⑩ : automatic feeder
⑪ : charging machine

○ : rabbit ◉ : rabbit with ear-plug ⓜ : monkey

Fig. 5 Arrangement of automatic feeder on blow-out side

(2) Method

(i) Layout

A charge on the blow-out side was about 700g, including 500g in the pot. To check the effect of explosion on an operator's ears, four rabbits and a monkey were placed in the room as follows:

(A) In front of the operational shield of the pot: one rabbit

(B) In front of the operational shield of the charging machine: one rabbit with ear-plugs.

(C) In front of the entrance door: one monkey.

(D) In the centre of the side: one rabbit.

(E) In the corner of the room: one rabbit.

(ii) Charge

(A) Pot: DDNP 500g

(B) Charging machine

(a) In the hopper: DDNP 100g.

(b) On the feeding stand: 100 ferro-detonators.

(C) On the work bench

(a) 200 ferro-detonators.

(b) 100 ferro-detonators with base charge only.

(iii) Initiation

The charge in one of the two pots was initiated by an electric detonator.

(3) Results

(i) DDNP in the hopper of the charging machine and the detonators on the feeding stand did not detonate.

It was confirmed that the wall to prevent sympathetic detonation in the blow-out side was effective.

(ii) No change was found on the detonators on the work bench.

(iii) The rabbits and the monkey had no hurt.

This proves that the operational shield and the door did well.

IV. Summery

1. The former half-domed pot holder in the corner had many possibilities of sympathetic detonation that would be caused by explosion in the room.

2. A new cylindrical pot holder whose blow-out direction was upward, was designed with a success. The charge in the pot did not sympathetically detonate by the explosion in the room. Even if the pot should be exploded, the pot holder was not destroyed and sympathetic detonation was not induced.

3. A standard design of the new automatic feeding system was obtained, which was free from sympathetic detonation in the blow-out side and between the workroom and the blow-out side.

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火工品工場の危険工室の設計

第Ⅰ報　起爆薬計量工室の薬壺仮置場の設定

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火工品工場の危険工室は，放爆式特に準放爆式構造のものが多いが，準放爆式構造の１つであり，爆発頻度が最も多い起爆薬計量工室の薬壺仮置の位置および構造の保安上の設定基準を得るため実験を行なつた。

その結果，従来の工室の隅に設定していた半ドーム式の薬壺仮置場は工室内の爆発により殉爆の可能性が大であることを確かめ得た。

工室内の爆発により殉爆せず，かつ何らかの原因で薬壺が爆発しても工室内で殉爆が起らず，仮置場も壊れない円筒式薬室仮置場の設定基準を得た。

また放爆面に自動供給薬壺仮置場を設け，放爆面相互間，作業工室間の殉爆を防止得る設計基準を得た。