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IIT(BHU) VARANASI
STUDENTS' NOTES
UNDERGROUND MINE ENVIRONMENT
FIFTH SEMESTER

TOPIC EXPLOSIVE

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Explosive:— An explosive is a substance or mixture having high temp., heat, energy and pressure. This is chemical transformation into enormous volume of gases which causes disturbances in the surrounding that may be solid, liquid, gas or their combination. The substance in the air is called air blast and this is heard as loud bang. The disturbance here in solid structures results in shattering and demolition. During war time, this property is utilised for destruction purposes but the same energy is utilised for demolishing, breaking or tunnelling or excavation works in day-to-day following operations:-

- 1) Rock fragmentation
- 2) Rock displacement
- 3) Seismic vibration

4) Air blast.

Mine Development (SKS)

Explosive

↓
Deflagration Detonation.

Deflagration: - It is the process of propagation of shock waves through explosive charge whereby the velocity of detonation is in the range of 1500-9000 m/sec well above speed of sound.

Detonation: - It is the process of burning at extremely rapid rate. the explosive ingredients but the rate of burning is well below the velocity of sound.

The decomposition of explosive is self propagating exothermic reaction which is known as explosion. This explosion with an elevated temp and pressure causes certain rise from ambient condition to a detonation or shock waves travelling through unreactive explosive charges.

Common Ingredients of an explosive:-

- 1) Fuel
- 2) Oxidizers
- 3) Sensitizers
- 4) Energizers
- 5) Other Miscellaneous ingredients with varying

percent
fuels:

- a) A
b) S
c)

Sens

En

percentages.

- Fuels:-
a) Fuel oil (Petrol, Diesel)
b) Carbon
c) Aluminium
d) TNT

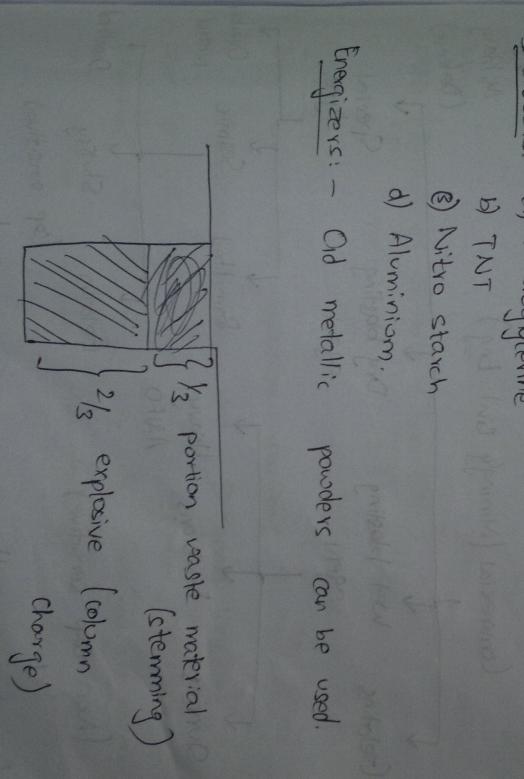
Oxidizers:- Common oxidizers are

- a) Ammonium nitrate
b) Sodium nitrate
d) Calcium carbonate

Sensitizers:-

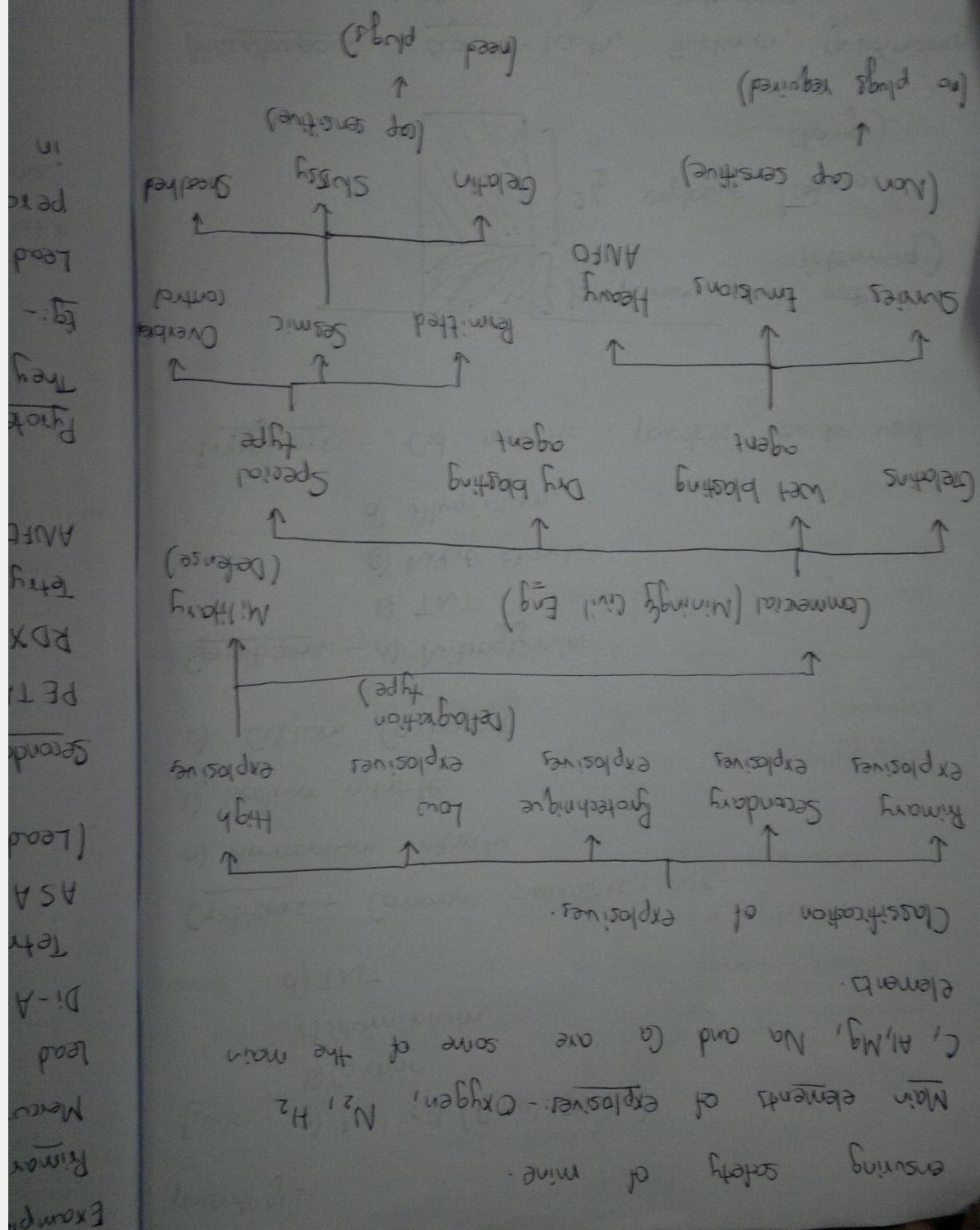
- a) Nitroglycerine
b) TNT
③ Nitro starch
d) Aluminium

Energizers:- Old metallic powders can be used.



Miscellaneous agents:- Water, thickener, gelatinizers, emulsifiers, stabilizers, flame retardants.

Explosives used in coal mines are called permitted explosives. We need permission from DMS



Pyrotechnique:-

in delay element manufacturing.

Peroxide of Ba, fuels like Si, charcoal are used

lead peroxide, red lead, chlorates of potassium

Eg:- Zincium, cerium and Oxygen like

They retard the explosion reactions.

93.1.

ANFO (Ammonium Nitrate + Fuel Oil)

RDX

PETN (Fenta Erythritol Tetra Nitrate)

Secondary:-

(Lead Styphnate + PBO + Al)

ASA mixtire

Tetrazene

Di-Alc - Nitrophenol (DNP)

Lead Styphnate

Mercry Fulminate

Binary Explosives:-

Examples of

Semi-gelatinous
Blasting gelatinous
subdivided as - Dynamites

In 3 categories - gelatinous, semi-gelatinous and powdered form. They are explosive and detonated by further detonation.

The various NG based explosives are explosive - NG based and sticky explosives - TNT.

of stick / pressure or detonation may
impact, friction or flame by self ignition
cannot be initiated by any stimulus such as
These are the explosive substances that
High explosive -

All has good blasting effect.

Blastign Nitrate = 75% Charcoal = 15% Sulphur = 10%

Formation of ignitables -

Black powders belong to this category.
The earliest known gun powder - low explosives.

Dynamites

Dynamites:- In this explosive, N_2 may absorb
in natural mineral like glass and formed of
strategic dynamite. In place of
Ammonium nitrate if used is called as
ammonia dynamite
Blasting gelatines:- This is the most powerful
explosive containing 92% N_2 + Nitrocellulose
(12.2%) N_2 + charcoal + ZnO + air bubbles + acetone
Semi-gelatines:- These are formed as low N_2 or
high Ammonium Nitrate (AN) explosive. AN is
mixed with which is mixed with AN in various
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percentages.

Silky explosives are replacing gelatin explosives due to following reasons:-

- 1) BiH in safety against fire, friction and impact
- 2) Water compatibility
- 3) Reduction in the production of toxic gases like CO_2 , Nitrous oxides.

Emulsions:- They are two liquid phase (containing microscopic droplets of ~~Ammonium~~ Ammonium Nitrate) emulsions using emulsifying agents.

Ammonium Nitrate dispersed in fuel oil, water or paraffins using emulsifying agents.

Microspheres, microscopic glass or plastic air bubbles by NH_4NO_3 droplets form emulsions.

The oxidiser in emulsion are mixed at 45-50% NH_4NO_3 .

prior to charging into hole.

Heavy ANFO - Ti is 45-50%. NH_4NO_3

emulsion mixed with parallel ANFO. This is done to increase density of ANFO. Ti is mostly mixed at the prior to changing into holes.

but it is available in cartridge forms also.

Strength-Energy released by the explosive per unit key unit volume. If is measured with reference to the MPE then quantity ANFE, highly Strength explosive else VIE VERGE.

1. Strength of carbon dioxide gas.

2. Velocity of diffusion of future derivatives.

3. Density of oxygen relative.

4. Definition of pressure.

Any explosive can be easily ignited above a certain temperature.

These explosives are treated as dry blasting agents. One of the major applications of pressed NH_4NO_3 caked with anti-caking agent is in the manufacturing of powder explosives. They are used as powder or in the form of cartridges. Caking, Bad fumes, poor weather compatibility and low density are some of its drawbacks. It is not too easy to handle and handling is something but explosive ANFO (ery pressed ANFO).

Velocity of Detonation: - It is the shock wave travelling.

Density : - Higher the density, greater the strength.

ANFO - 1 gm/cc (low strength) To TNT
- 1.78 gm/cc

Variety of detonation waves from 0.5 gm/cc - 2 gm/cc

Detonation pressure : - At which detonation waves pass and cause explosion. It varies from 10-60 kbar (~~100~~ - 6 Ma)

Critical Diameter : - Higher the diameter higher will be explosive strength but after some diameter it will be reducing. Above which diameter is critical diameter.

Fume characteristics : - Toxic gases like (CO , CO_2 , SO_2 etc.) are emitted in form of fumes.

Strength :- Energy released per unit weight of explosive to ANFO. High strength is needed in hard rocks to shatter the rock mass but is used in weak rock of soft rock. The excessive energy will be move through a column of explosive. Velocity with which the detonation wave moves through a column of explosive. Following are the factors affecting detonation velocity:-

ii) Explosive types

In general higher the velocity of detonation (VOD) better the shattering effect. The explosive's detonation velocity varies from 1500-6000 m/sec. In general higher the detonation velocity the detonator the shattering effect.

iii) Temperature

iv) Detonator

v) Temperature

vi) Explosive

vii) Velocity of detonation

viii) Detonation velocity

ix) Detonation velocity

x) Detonation velocity

xi) Detonation velocity

xii) Detonation velocity

xiii) Detonation velocity

xiv) Detonation velocity

xv) Detonation velocity

xvi) Detonation velocity

Due to the large difference between pressure and temperature, the density of the air is very low at the surface. This causes the air to expand upwards, creating a low-pressure zone at the surface. As the air rises, it cools and expands, causing the pressure to decrease further. This process continues until the air reaches the tropopause, where the pressure is approximately 1013 hPa. At this point, the air has lost most of its initial energy and is no longer able to rise, forming a stable layer of air.

The tropopause is a thin layer of air that separates the troposphere from the stratosphere. It is characterized by a sharp increase in temperature with altitude, which is called the tropopause. The temperature in the stratosphere is much higher than in the troposphere, and the air is more stable. This makes the stratosphere a good place for aircraft to fly.

The stratosphere is divided into several layers based on temperature. The bottom layer is the tropopause, followed by the troposphere, then the stratosphere, and finally the mesosphere. The temperature in the stratosphere increases with altitude, while it decreases in the troposphere. This creates a stable layer of air that is good for flying.

The mesosphere is the layer of air above the stratosphere. It is characterized by a sharp decrease in temperature with altitude, which is called the mesopause. The temperature in the mesosphere is much lower than in the stratosphere, and the air is more stable. This makes the mesosphere a good place for aircraft to fly.

The thermosphere is the layer of air above the mesosphere. It is characterized by a sharp increase in temperature with altitude, which is called the thermopause. The temperature in the thermosphere is much higher than in the mesosphere, and the air is more stable. This makes the thermosphere a good place for aircraft to fly.

Bole hole pressure and critical diameter is an explosive is measured by Sensitivity of on which is measured by important property the detonation its ability to propagate waves tends to wave. These detonation diameters of explosive fode of fall when decreases. The min diameter of a charge below which detonation doesn't occur is called pacred , resulting in mishre is called pacred diameter. At lower diameter, although the explosive is very sensitive but detonation doesn't completes.

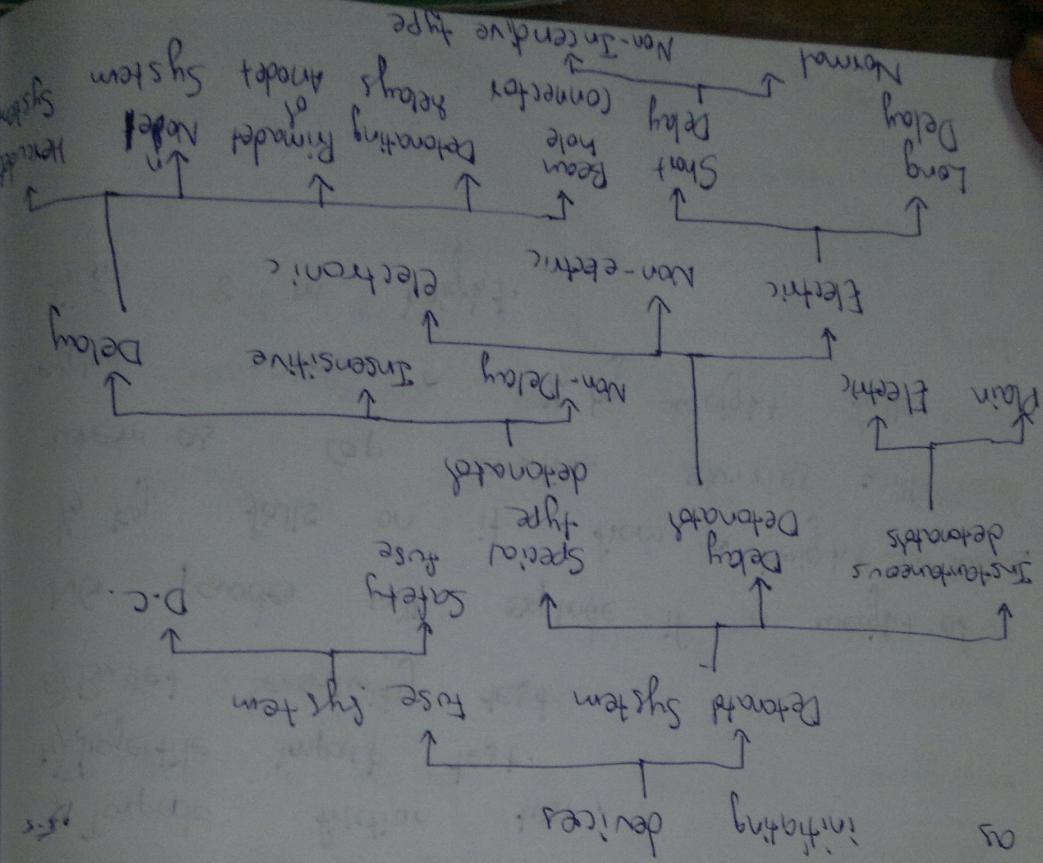
Sensitivity :- It is measured as the explosive sensitivity between explosive & conservative properties to bridge a gap between columns of explosive cartridges of a gun.

~~Breather~~ Safety in storage and Quality: ANFO is having poor storage quality being hygroscopic in nature. ANFO if handled without gloves can cause ignition. Also salt of some sort of explosives under extreme conditions.

conditions explosives making its cartridges load and defined. By proper waxing of cartridges the effect of moisture on them can be minimised. One is that it can be stored, transported and used under normal conditions to the persons handling it and carrying out the blasting operations. In order to have a safe manufacturing plant, handling and use of an explosive various tests are made on the ingredients and final product. The tests include:-

1) Impact test / Fall hammer test
2) Friction pendulum test.
3) Torpedo friction test.
4) Explosive impact test.
5) Bullet sensitivity test.

NG powder will explode if a weight of $\frac{1}{2}$ kg falls on it from a height 20-30cm where as cap sensitive series will explode when a $\frac{1}{2}$ kg weight falls from 8 m height.



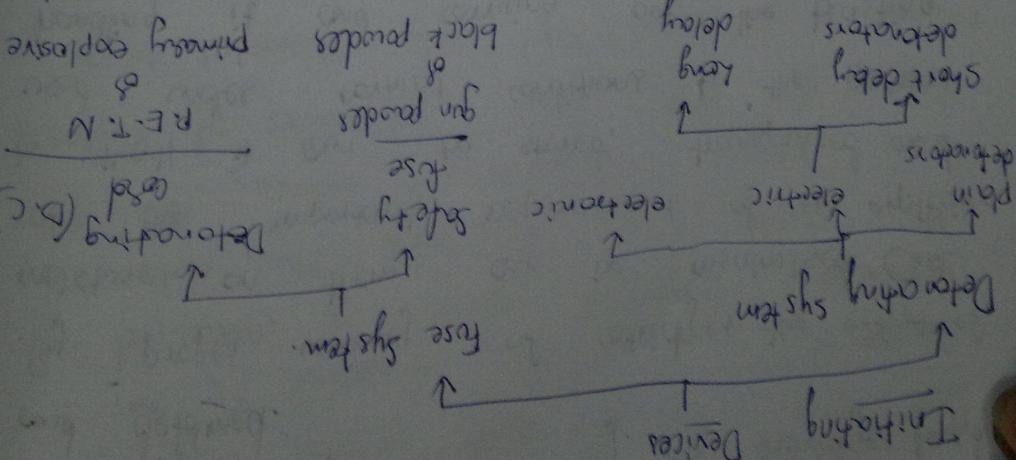
to carry out these operations are known as initiating devices.

Indicate in it and the devices used in the initiation of fusing for the reaction to

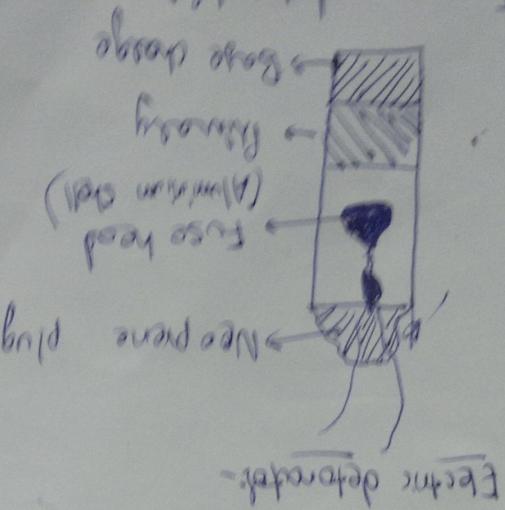
Any explosive needs stimuli like shocking,

6500V/sec.

10 gm PETN/m

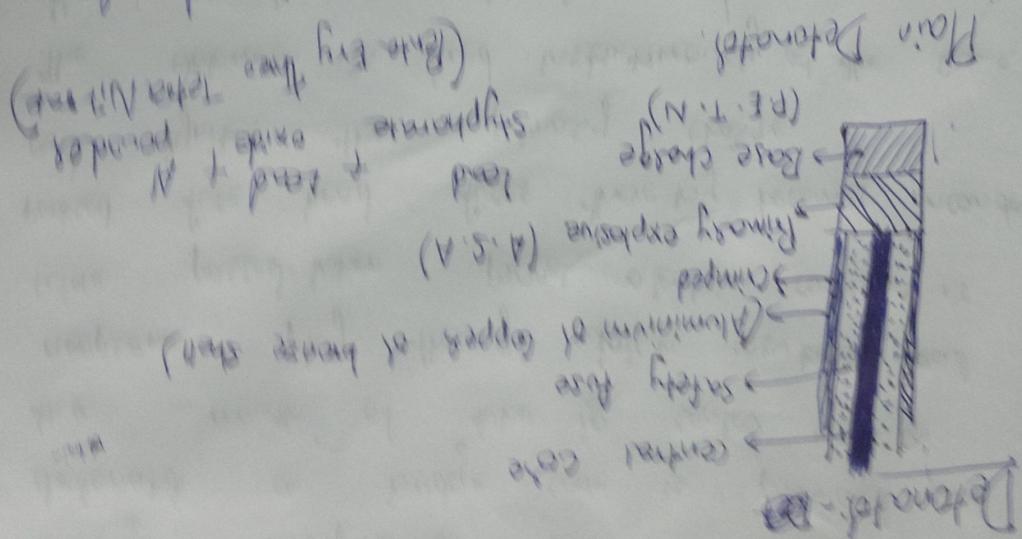


The plain detonators have some combination of



Electric detonator -

This is simple in construction and made of thin aluminum foil closed at the bottom and open at the other end. It is used dry and non-gelatinous explosives and initiated by safety fuse. It is inserted in its open end and crimped



Plain Detonator -

long delay - & see delay
delay - with second delay.

explosive device often called a fuse head is used to initiate the primary explosive charge incorporated within it. In this detonation a bridge wire is provided and the mouth of tube is sealed with a fuse head fuses thereby becomes incendecent and ignites the primary charge. The detonator is fired instantaneously at the same time as the circuit is passed. Based on the quantity of base charge and A.S.A. mixture the detonators are designated as detonators no. 1 to detonator no. 8.