

EXPLOSIVES

An Introduction

By

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What is an explosive?

- A substance which contains a fuel & a source of oxygen either intimately mixed or in the same molecule. It is able to very rapidly change state(burn!) to produce a volume of gas much larger than the volume of the original substance This change should preferably be “on demand” & NOT at random!

Low & High Explosives

- Low explosives burn more slowly than the speed of sound, from around 40m/s – 1500m/s. This is called deflagration. Eg. Black Powder burns at 500m/s
- When detonated high explosives “burn” faster than the speed of sound, from around 1500 – 9000m/s. Eg. TNT “burns” at 6900m/s or 15,523mph!

Low explosives can set off by;

- A fuse
- An electric detonator
- An electric ignitor or “squib”
- In addition black powder can be set off by static electricity, sparks, heat, shock & friction – don’t be deceived by the term low explosive. All explosives should be treated with the greatest respect, the first time you make a mistake will probably be your last!

Low Explosives

These must be confined to do useful work or they just produce a genie like puff of smoke & flames!

If they are confined in a hole drilled in rock or coal (the burden) & the hole is sealed with clay for instance (the stemming or rommin!) then the large volume of gas released in the explosion blasts the burden apart.

High Explosives

- These do not necessarily need to be confined to do useful work – they will explode when unconfined.

- This is because they burn supersonically – the gas already produced cannot get out of the way of gas being produced quickly enough.

- This also produces a supersonic “shock wave” that shatters whatever the explosive is in contact with.

There are three broad categories of High Explosives

- Primary – these are very sensitive to shock, flame etc so are only “safe” in very small amounts.

- Secondary – these are much less sensitive & usually require the supersonic shock wave from a detonator to initiate them (set them off).

- Blasting Agents – these are very insensitive & usually need a small (“primer” or “booster”) charge of secondary explosive to initiate them.

Primary Explosive

Such as Lead Azide are used in very small (10's of mgs.) amounts as the primary charge in detonators. When lit they very rapidly go from sub to supersonic combustion - they detonate! Detonators initiate explosives.

Secondary Explosives

These are the ones most people would call explosives. They usually constitute the bulk of the explosive charge – except where they are used with Blasting Agents. Some of the cartridges here are “Permitted Explosives” specially for use in the potentially explosive atmospheres found in coal mines.

Fig.1



Blasting Agents

The most commonly used is Ammonium Nitrate Fuel Oil – ANFO. It can be bought ready mixed or more usually mixed onsite. This is used at Staffs last underground mine at Fauld where it's initiated with 100g sticks of Gelignite.

Fig.2



Ready mixed ANFO

Fig.3



ANFO in use at Fauld

- Here the ANFO is mixed in bulk on site and loaded onto an F.S.V. (free steering vehicle) where it is stored in the large rectangular container, seen here with the diamond shaped hazard label. The ANFO is then loaded by compressed air into the shot holes via a flexible hose.
- The F.S.V. also carries the gelignite and detonators used to make up the primer cartridges – in separate compartments of course! In addition the vehicle also carries fire extinguishers.
- Similar “Air Loading” systems mix the ammonium nitrate with the fuel oil as it is being pumped into the shot hole, thus substantially reducing the amount of actual explosive stored on site. In the UK this system is widely used in quarries where otherwise very large quantities of explosive would require secure and safe storage.

The Electric Detonator – How it works

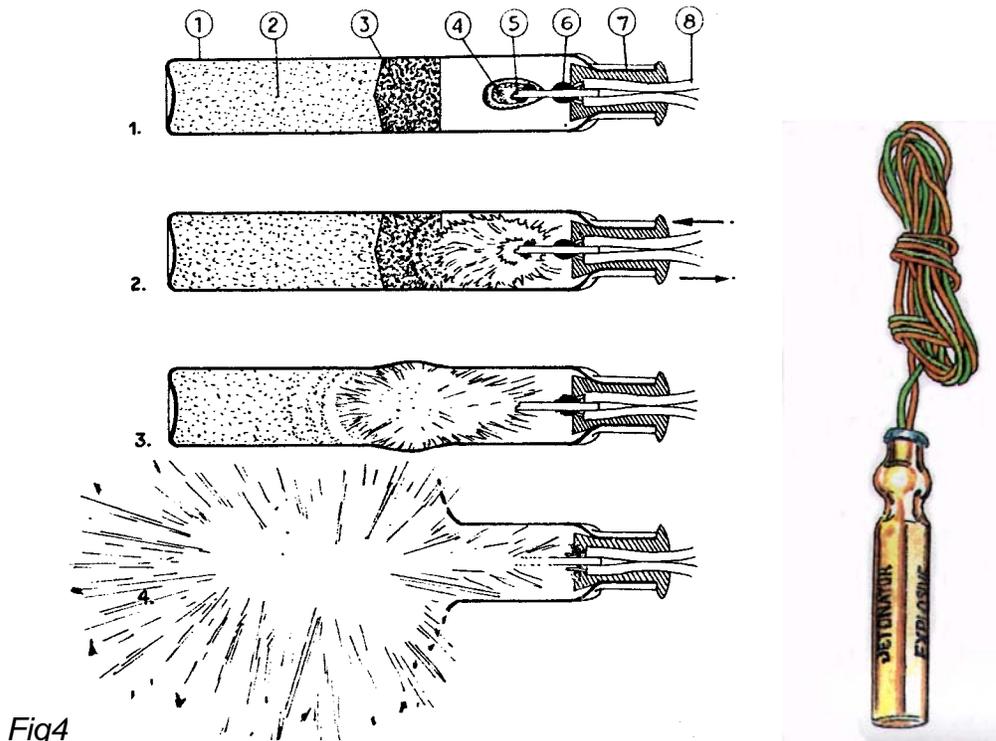


Fig4

1 Copper tube, 2 Base charge (eg. P.E.T.N.), 3 Primary charge (eg. Lead azide), 4 Match or Fuse head, 5 Bridge wire, 6 Solder, 7 Neoprene plug, 8 Lead wires.

Electric current from an exploder applied to the lead wires causes the bridge wire to “blow”, in the manner of a normal electric fuse. This ignites the match (or fuse) head, which in turn ignites the primary charge. As this charge consists of primary explosive it almost instantly burns to detonation (see above), which then detonates the less sensitive but more powerful base charge.

NB Plain detonators consist of just items 1,2&3 – a fuse is crimped into the tube instead of the other items & this then ignites the primary charge.

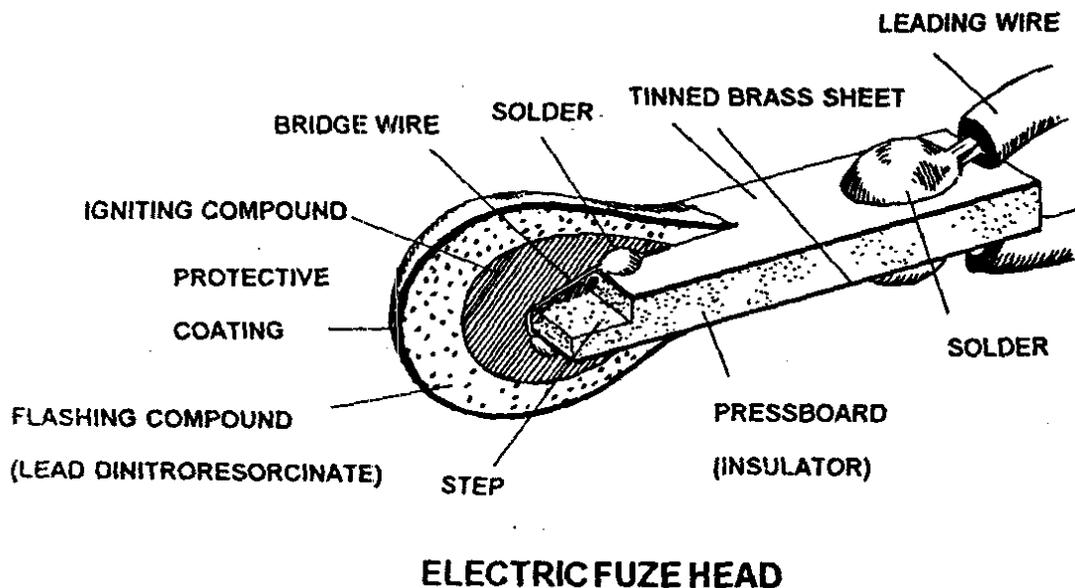


fig.5

Delay Detonators

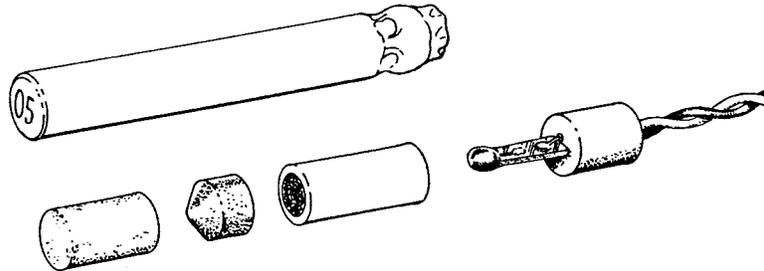


Fig.6

These are the same as ordinary or “instantaneous” electric detonators but have a short delay fuse between the fuse head & primary charge. The period of this delay depends on the dets series & number. For the “half second delay series” detonators the delay varies from no. 0–10 in 0.5s steps i.e. a no. 10 det gives a 5 s delay. In the “millisecond delay series” the range goes from no 0-15, the delay interval between no. 0 & 15 being 750ms

The Exploder – or Battery

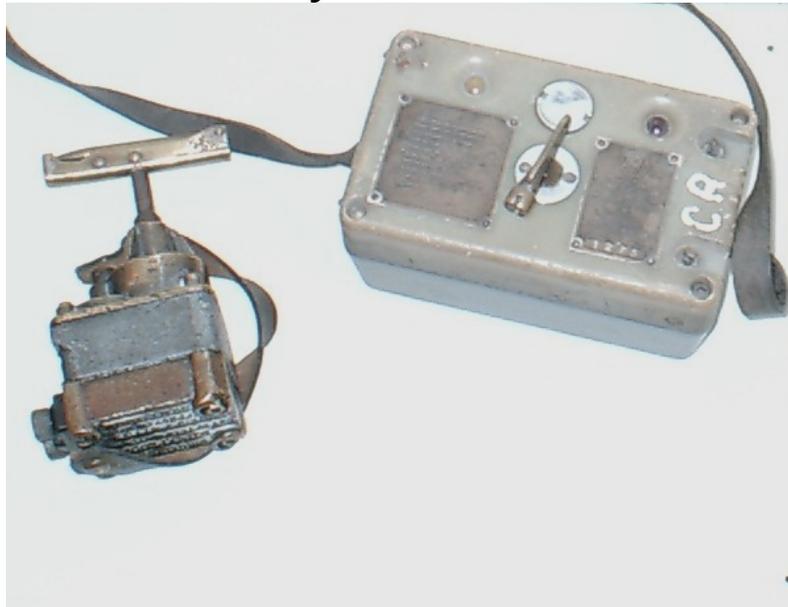


fig.7

This provides the electric current to fire the fuse head. Here are two types – the dynamo type “Little Demon” left & the condenser type “ME12” right.

The Primed Cartridge

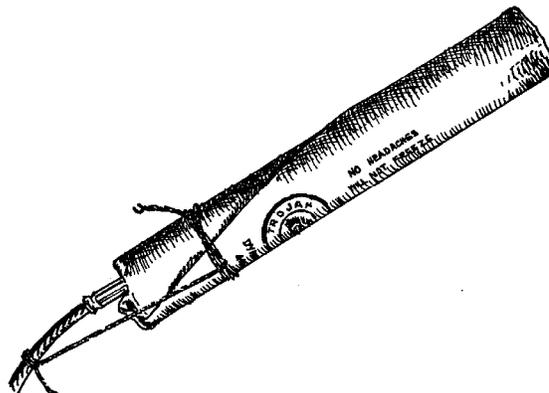


fig.8

The paper at the one end of the cartridge is peeled back & a hole made in the explosive to receive the (in this picture) plain detonator, which is inserted & secured with string. If an electric detonator was used instead, it would be secured with the lead wires half hitched around the cartridge.

The Primed Cartridge In Use

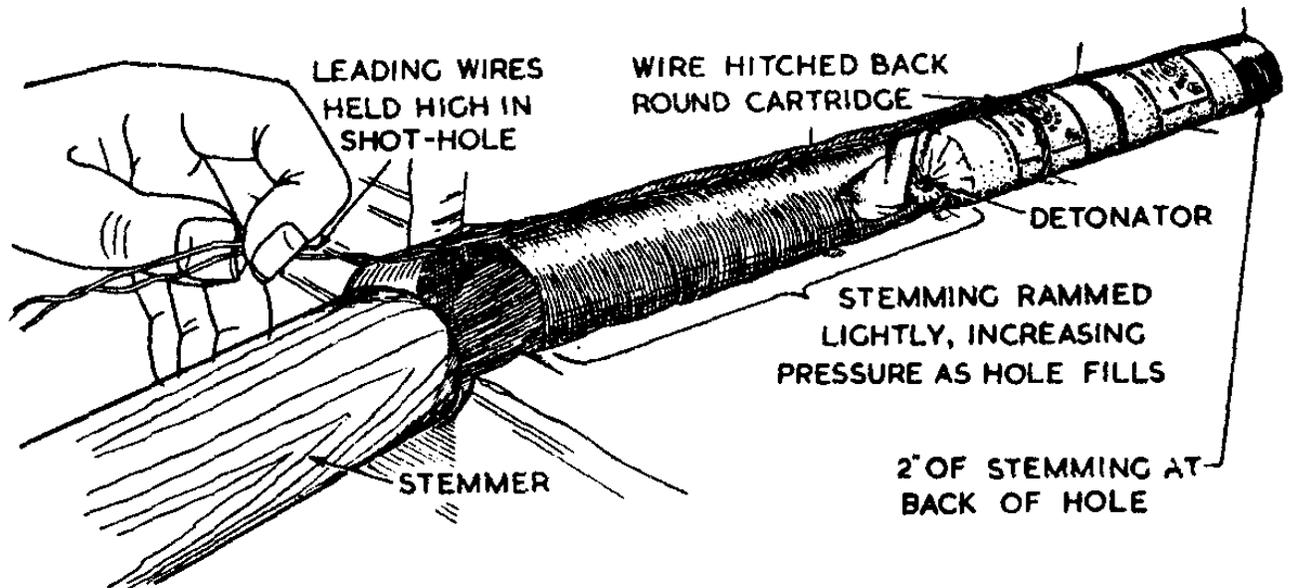


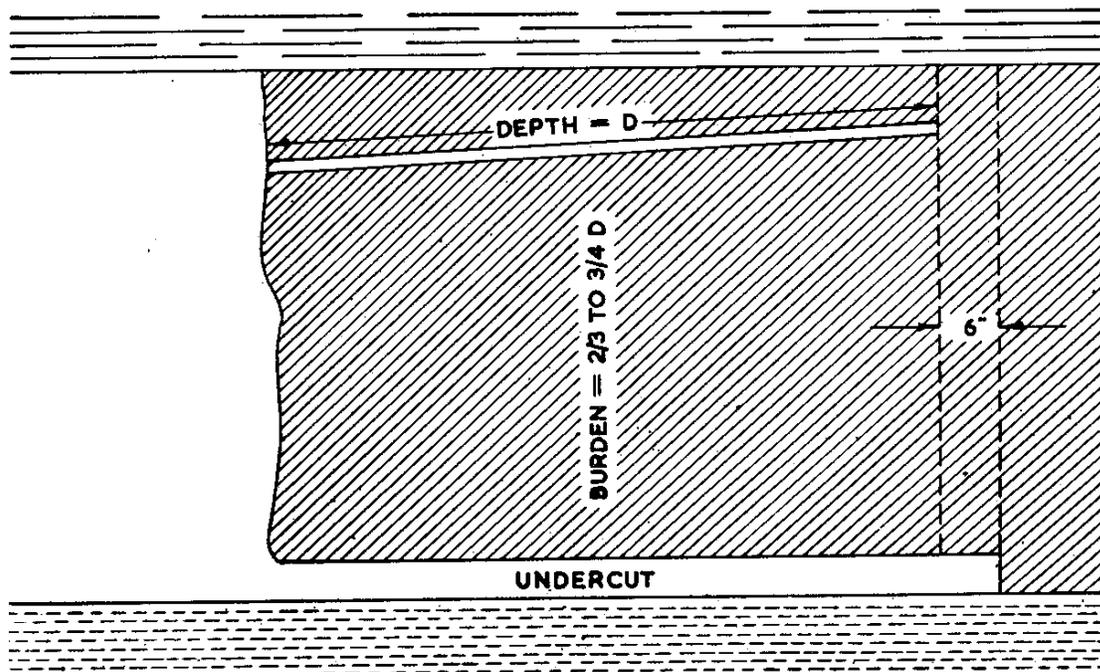
fig.9

The primed cartridge is inserted into a sound clean shot hole, along with any additional cartridges required to make up the charge as shown. When used with additional cartridges in this way, it is referred to as the Primer Cartridge.

Typical Uses Of Explosives in Coal Mining

- Bringing down coal which been "under-cut".
- Bringing down stone (Ripping) above void left when coal is removed, in order to create head room for gate roads.
- The driving of road ways & drifts etc.

Bringing Down Coal



Shothole in normal seam.

fig.10

Here the coal is under-cut to provide a “free face” – literally to give the explosive somewhere to chuck to coal, rather than just blowing out round the stemming. Note how the shot hole is drilled short of the undercut to ensure a totally free face – not “firing on the solid”.

Ripping

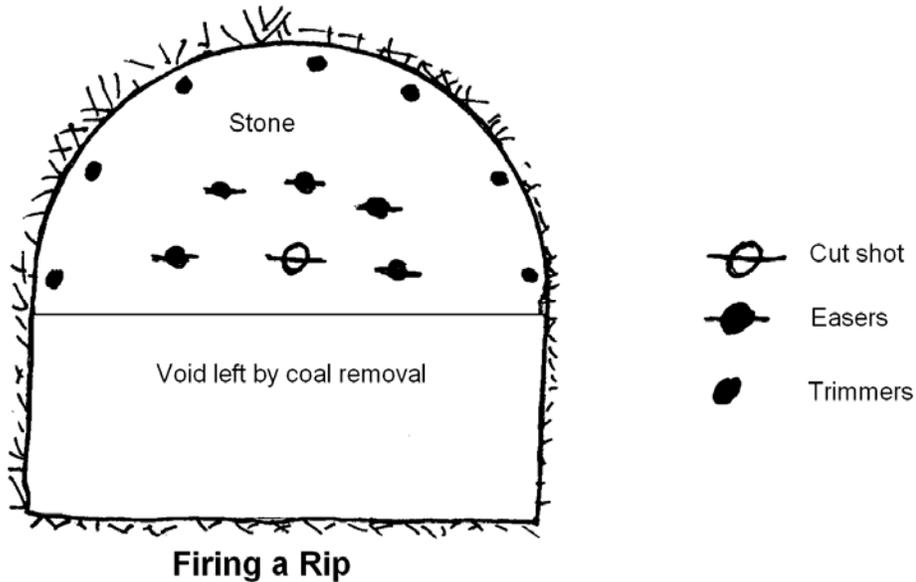


fig.11

Here the void provides the free face for the first shot in the round – the cut shot. All the dets are wired together in series as a “round”.

Each group of shots out from the cut shot is primed with longer delay detonators – so the cut shot firing first provides the free face for the easers & so on.

It is normal for the cut shot to have a zero delay (instantaneous) detonator. However some shotfirers prefer to use a No1 short delay det. instead. This ensures all the fuse heads have fired before the ground starts to move, thus reducing the chance of an unfired shot remaining after the round has fired.

Roadways & Drifts etc.

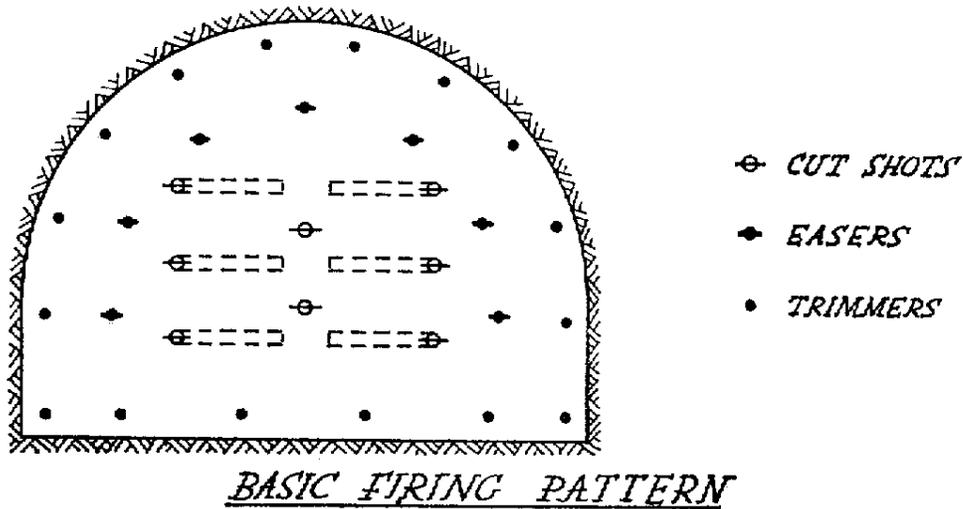


fig.12

Here the cut shots are drilled at an angle to the rock face thus providing a free face for the first shots in the round. This wedges out the center of the rock to provide a free face for the rest of the round, which then fires as the “rip shown previously.

Typically a round fired in this way would advance a roadway by about 2m given favorable conditions. This is referred to as the round giving a pull of 2m.

“Jumbo” Drill Rig for Large Rounds



fig.13

This is the rig used to drill the shot holes at British Gypsums' Fauld Mine in Staffordshire. Mounted on caterpillar tracks, it allows one man to drill two 3m long holes simultaneously. It is electronically controlled to give a very accurate drill pattern.

And Finally

Whilst I sincerely hope you have enjoyed this introduction to explosives, please remember that it not intended to instruct people in the use of explosives.

Anyone contemplating using explosive should be correctly trained by a competent body (contact The Institute of Explosives Engineers for further info.) & be in possession of

the relevant Licenses & Documentation i.e. Police Acquire / Acquire & Keep Certificate, HSE R.C.A. Document, Storage License etc.

For Further info contact the Explosives Liaison Officer in the Chief Constables Office of your Police Authority.

Failure to comply with the above will almost certainly result in death or imprisonment and/or very heavy fines!

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B.S. 5607 Safe Use Of Explosives in the Construction Industry (good section on shaft sinking & tunneling)

The Miners Dictionary, W. Hooson 1747 (description of earliest use of explosives for mining in U.K. & in N. Staffs!)

The Initiation of Explosives, Explosives in Tunneling & Shaft Sinking, both ICI Nobel Explosives Data Sheets (undated)

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