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IIT(BHU) VARANASI

STUDENTS' NOTES

UNDERGROUND MINE ENVIRONMENT

FIFTH SEMESTER

TOPIC-MINE LIGHTING

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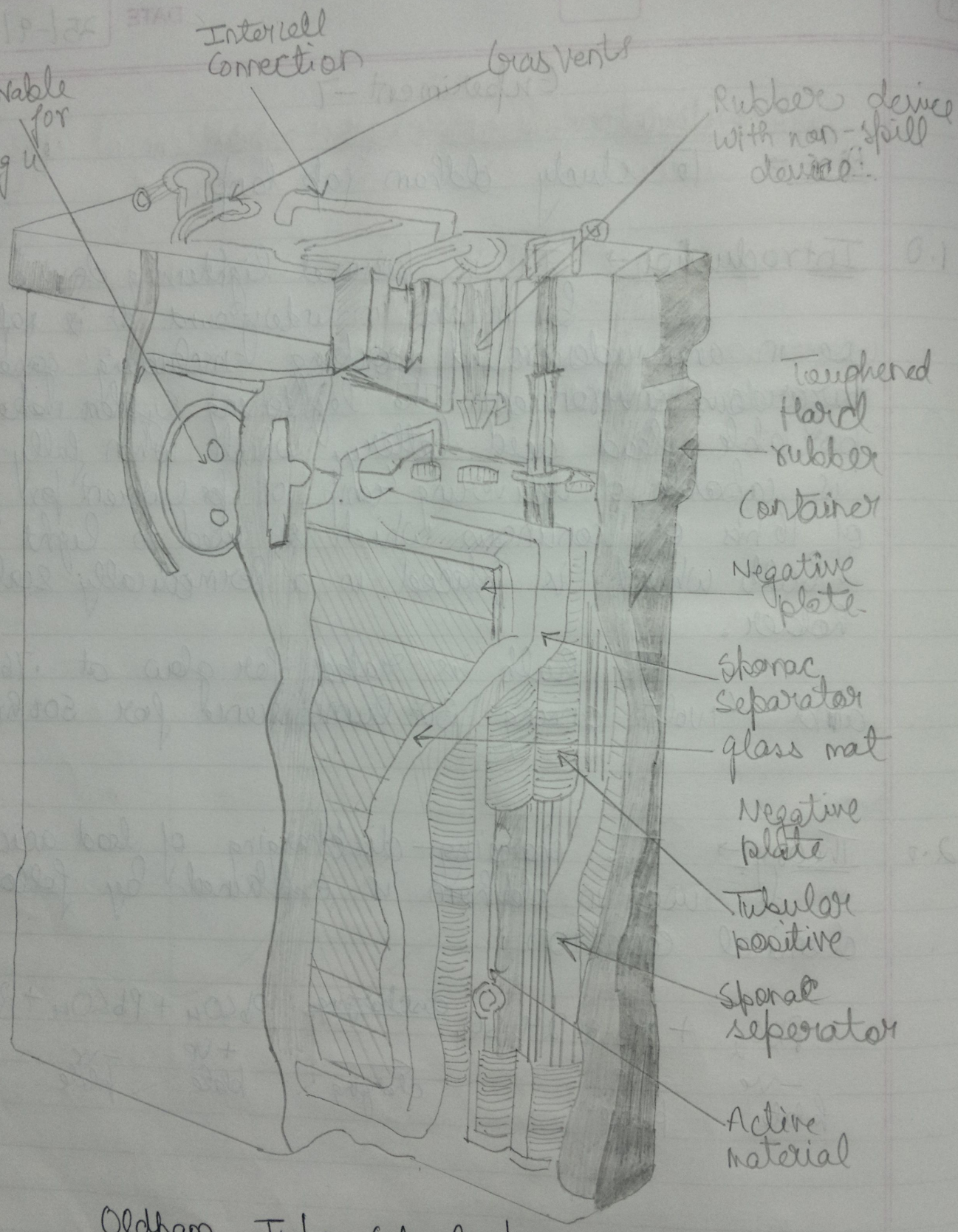

Oldham Type cap lamp

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The main component of lamp are as follows:-

Lead acid battery → The lead acid battery comprises of two cells consisting of 8 plates held upon by porous seperator and surrounded by a strong shock resistance case which also serves to contain the acid electrolyte. The central plate is the positive plate which when charged is mainly PbO_2. The +ve plate is tubular whereas the -ve plates are plane which is formed of lead. Modern separators are highly absorbent so as to reduce free electrolyte in the cell. The battery casing is made of polycarbonic with a provision of topping up holes and non spill vents, which allows release of gas from during the charging process. The non spill vent is effective only if the electrolyte level is correct. The electrolyte is basically 20% sulphuric acid of high purity.

The discharging process →

A fully charged cell has a +ve active material PbO_2 whereas the -ve active material is Pb. The electrolyte is at its strongest concentration with specic gravity of 1.29. During discharging process which starts with nominal voltage of 2 volt per cell. The +ve and the -ve plates are transformed

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slowly into lead sulphate, the process is explained in equation. When the battery is fully discharged the specific gravity of the electrolyte is reduced to 1.1V. It is recommended that the battery should not be normally discharged below 1.7V per cell. If further discharge is allowed. It could lead to sulphation of the battery if not immediately recharged.

2 Head set → The head set of the lamp comprises of a glass holder, a glass reflector, electrical bulb, a switch and a +ve and -ve terminal, the -ve terminal appears on the outer surface of the head set whereas the +ve terminal is placed inside the headset. The contact between the two terminals is established through the charging head which is provided in the charging section of the cap lamp room

The reflector are of two type:

(a) diffuse reflector
(b) spot reflector-

Diffuse reflector are use in those lamp which are meant for uses by those miner requiring proper illumination in the travel path without causing glare. However the spot reflector are usefull for those user who required to inspect the areas, with focussed light.

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Modern cap lamp are provided with two electrical bulbs; main bulb and pilot bulb.

The main bulb is rated to glow at 4V, 1-0.6A At lamp of current drawage, it provides normal full brightness whereas the current reduces to .6A the light is no longer usable. The pilot bulb is rated to glow at 4V, .46 - .6A, main bulb is used during the normal working face while the pilot bulb is used to save the electrical energy while taking rest or during the period of emergency. When it is desirable to keep the battery for extended period.

3.3 Cable → Electrical cables used in electric cap lamp make uses of spirally wound short lay type conductors with a central textile chord to reduce the stress. Length of the cable is 1.3 m with specific resistance of 0.03 Ω/m

3.4 Battery Cover → Cover of the battery is interchangeable in design and is made of stainless steel to incorporate some form of cable grip and grommate, where the cable leaves the cover. Covers are held on by a simple locking device with a special screw, is sealed with wax.

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Important Safety Features:-

1→ An Oldham cap lamp is neither a F&P device nor intringically safe nor hermatically sealed. In fact the safe operation of the lighting system is totaly dependent on electrical fuse which is placed inside the battery cover b/w the two terminal of the battery. In case of short circuit of the cable it is quit possible that an electrical current of very high energy may flow through the remaining circuit and cause an electrical spark sufficient to ignite air-CH_4 mixture in the mine environment. To prevent this, the fuse is rated to glow at 4amp of current, whereas a current of 26 A is required to ignite the air-CH_4 mixture.

2→ All screw head are filled with red-wax. This gives the indication whether the battery has been mishandled or any unauthorised attempts to open it.

3→ All cap lamps bear a unique no. the same lamp is issued to an individual. Therefore the person receiving the cap lamp is totally responsible for proper handling.

4→ The +ve & -ve terminals of the ~~battery~~ head piece are carefully seperated. The -ve end is in a barrain which can be opened by the charging head only in the rack.

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5.0) Some special features :→

1) Modern cap lamps are having weight of 2.5 kg as compared to 4.5 kg of the original oldham cap lamp.

2) The endurance period of the battery is 16 hr for continous usage. Therefore after charging for 8 hr the battery can be used comfortable for the period of 1 shift per day.

Precaution

1) Proper handling of the cap lamp is very important
2) All cap lamp must be handled only by cap lamp room - incharge for the purpose of maintanence and repair.
3) Any accidental damage to the cap lamp must be reported by the individual to the imediate supervisor underground and the mine manager as soon as possible so that the lamp is properly maintained before the next issue.

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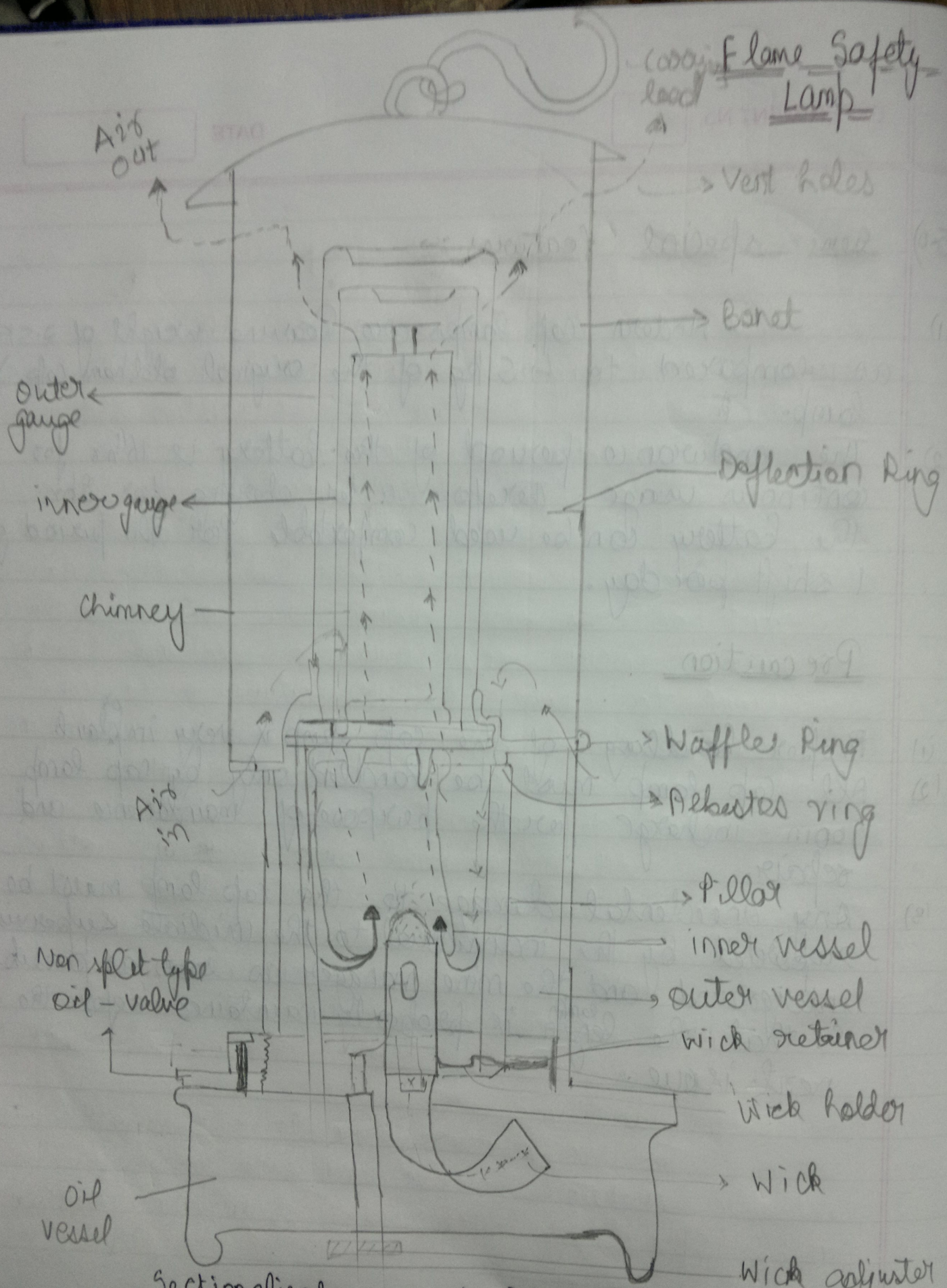
Flame Safety Lamp



Sectionalised view of Flame Safety lamp (along with airflow direction)

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Aim → Study of flame safety lamp.

Introduction →

The basic design of the flame safety lamp was first conceived by Davey. The purpose of flame safety lamp are as follows.

→ It is used for the detection of highly inflammable gases such as methane (CH_4)

→ It is used for the determination of approximate concentration of CH_4 between 1.5% to 4.5%

→ It is used to detect the deficiency of oxygen in mine air.

Types of flame safety lamp →

Flame safety lamps are categorized into two types —

→ top feed lamp

→ bottom feed lamp.

Top feed lamp →

A top feed lamp consists of a deflection in the top of the bonnet of lamp. Its main purpose is to separate the intake air from exhaust. The fresh air is drawn through the top perforations, moves down, aids in burning and finally comes out as exhaust.

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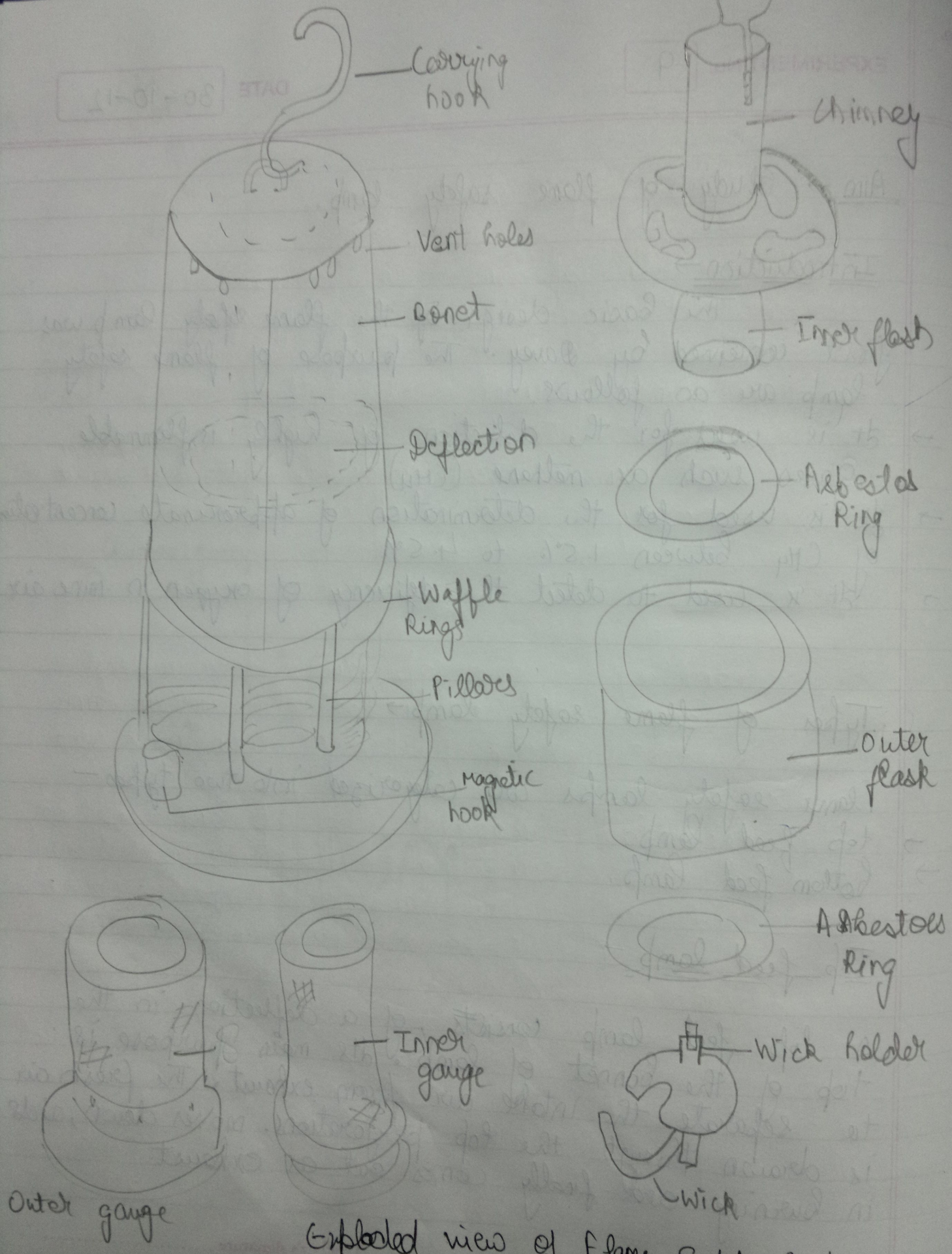

Exploded view of flame Safety lamp.

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Bottom feed lamp →

The bottom feed lamp has perforations in base which allows the entry of coal mine air. The air after burning becomes hot, rises up and comes out through the top holes.

Functional difference →

The top feed lamp is used for accumulation test whereas the bottom feed lamp is used for percentage test.

Principal →

The basic principal involved in the working of the flame safety lamp is that the height of the burning flame increases in proportion to the concentration of combustible gases, produced it is between 1.5 to 4.5%. Beyond 4.5% the height of the flame will increase in an abrupt manner. It will immediately flare up and extinguist.

Construction →

Based on the process of igniting, the flame safety lamp is categorised into

→ Conventional Type →

This is done through conventional process of lighting. Incase the flame gas, the safety lamp has

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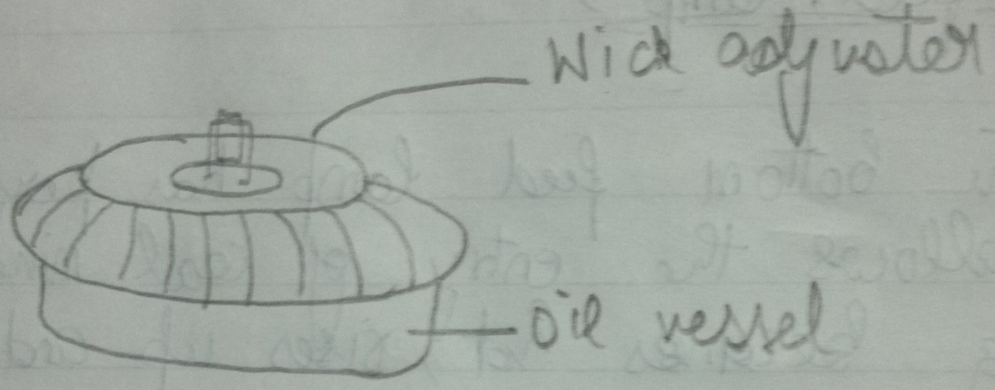

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to be taken out of the mine to relight it again.

Re-igniting type
It involves lighting through electrical circuits. Its advantage is that it can be re-lighted inside a mine without any danger of mine gas explosion.

Main Components →

→ LOCK → The lock used in flame safety lamp is magnetic in nature. In order to open the lamp, it has to be brought in contact with a magnetic box and the base has to be turned.

→ Lower part → It is made of brass. It consist of

1→ WICK ADJUSTER → It is spring operated.
2→ WICK HOLDER " " made of steel
3→ OIL VESSEL → " " used for the storage of special type of oil, ESSO solvent 1447.

→ Upper PART →

1- Bonnet → It is made of steel and in case of top feed lamp there is provision of deflectors

2→ PILLARS → There are five pillars which are used to

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connect the base structure with the bonnet. These are made of brass. These pillars provide physical safety against accidental breakage of glass. The angular arrangement of pillars ensures that only very angular rocks can cause breakage.

Glass holding Ring → It holds the glass and has a packing made of asbestos on it which ensures no air leakage.

Glass cover.

Chimney → The two wire meshes of a flame safety lamp enclose a chimney. The purpose of the chimney is to increase the height from which we want to release the exhaust gas.

WIRE MESH →

Its main aim is to disripate heat to sufficient levels so that the exhaust is cooled down preventing any chances of surrounding gas mixture.

There are two types of wire mesh
→ Internal gauge
→ External gauge.

The inner wire mesh absorbs heat from the heated gas by the process of convection. It provides large

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surface area so cooling capability is improved. If there is any spark coming off, inner wire mesh will prevent them. The outer wire mesh eliminates any possibility of sparks coming out.

TYPES OF FLAMES:

Normal Flames → In normal flame, we see an yellow light on top of wick when we keep the lamp at eye-level. The height of wick is higher in normal flame as compared to in test flame. It is used in accumulation test.

TEST FLAME → It refers to that type of flame which is just required for normal burning. It does not give any yellow light. Testing flame is used for percentage test.

Tests → The accumulation test is performed first to confirm the presence of inflammable gas. Then concentration test is done to determine its percentage.

Accumulation test → It is carried out starting from floor to the roof of galleries since CH_4 is lighter than air using normal flame. It gives an indication if the gas is present or not, and if it is present its concentration is below 4.5%. If concentration is

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Observation table

Percentage of CH_4	Length of Gas cap (mm)	Remarks.
1.5	Not detectable through the normal eye	Gas cap noticed for the first time
2	Not detectable	Full gas cap developed with round top.
2.5	8	First triangular cap
3	12	Triangular cap.
3.5	18	triangular cap
4	28	Triangular cap
4.5	—	Flattening of the vortex

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more than 4.5%, then the flame flares up, light intensity suddenly increases, which causes more exhaust to be produced which leads to extinguition of flame due to higher percentage of CO_2.

Percentage Test →

It is performed after the accumulation test is done to know the percentage of inflammable gas. The safety lamp is firstly carried to normal air (lamp taken to junction area) and then the wick is lowered in such a manner so as to convert the normal flame into test flame. Then the testing flame moved to testing location. The same. The same process is carried out at in case of accumulation test, and is repeated and the gas cap formation is observed. The principle involved in the percentage test is that the concentration of gas is directly proportional to the height of the flame

Advantages →

→ It is robust in built
→ It provides operational safety
→ It provides working safety

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Pre caution →

* The person handling the lamp should be well trained and should have a safety lamp handling certificate.

* Accumulation test should be done first and then concentration test.

* The testing should be initiated from the floor to the roof, and not from any arbitrary position.

* Incase the flame ~~safety~~ suddenly flares up, the person handling the lamp should not panic and should slowly retreat from the position.

* The lamp should be handled properly with care.

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