3.3 MASS SPECTROMETERS:

- The essential components of mass spectrometer are
  - Inlet system
  - Ionization chamber
  - Mass analyzer
  - Ion transducer
  - Vacuum system

INLET SYSTEM:

- Inlet system is used for introducing the sample is to the Ion source, so this inlet system is also called as sampling system or sample handling system.
- The sample is converted in to the gaseous state in the inlet system into the ionization chamber.
- To achieve this conversion the system is usually heated.
- There are number of methods for introducing sample into the ionization chamber, the choices depending upon the physical properties of the sample.
- The input to the ionization chamber is of gaseous type.

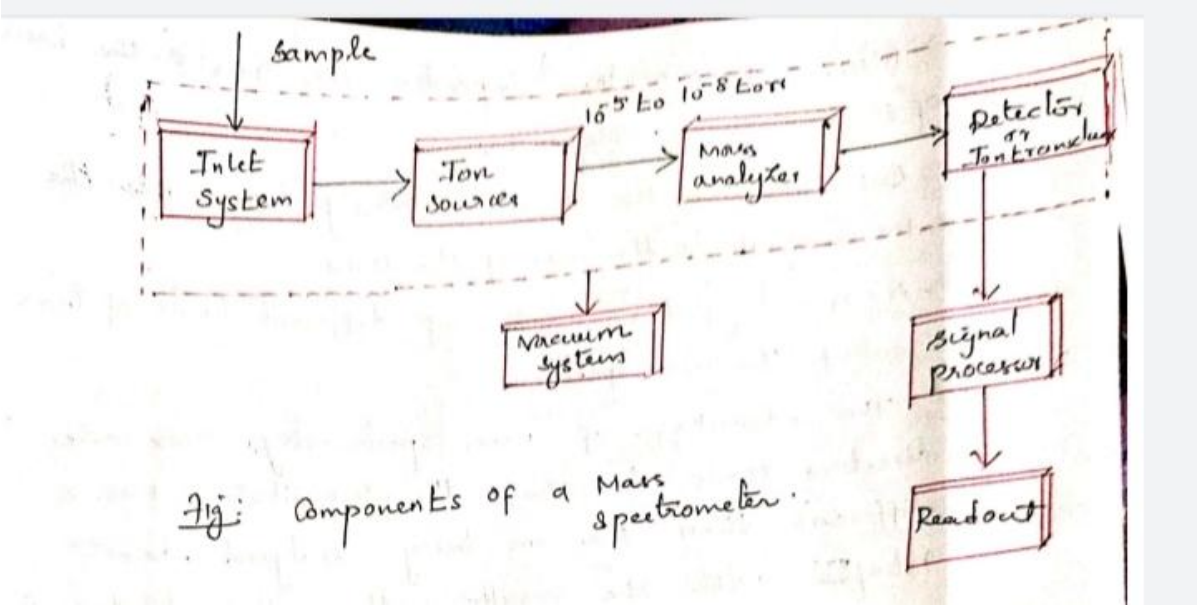


Fig: Components of a Mass spectrometer.

- So there is no need of conversion for the gaseous sample. The liquids or liquid samples are heated to produce gaseous particles & this is allowed to pass through the ionization chamber.
- The solid samples with a very low vapor pressure can be introduced directly into an entrance to the ionization chamber on a platinum or silicon probe & then voltalized by heating the probe until sufficient vapor pressure formation.

IONIZATION CHAMBER:

- Mass analyzer can utilize only the gaseous ions, so the ionization chamber is necessary to convert the gaseous particles into gaseous ions.
- Ionization is alternately brought about by the thermal or electrical energy.
- The output of the ion source is a stream of positive & negative ions that are then accelerated towards the mass analyzer.
- There are many types of ionizations are possible such as
    - Field ionization
    - Spark ionization
    - Chemical ionization etc..

MASS ANALYZERS:

- The function of the mass analyzer is to separate the ions produced in the ion source according to their different mass/charge ratios.
- The ionizer should allow passage of a sufficient number of ions to produce measurable ion currents.
- Mass analyzer is analogous to the monochromator is an optimal spectrometer.
- In the former the dispersion is based upon mass to charge ratio of the analyte ions rather than upon wavelength of photons.
- There are many devices available for mass analysis.
- The mass spectrometer is based upon the type of mass analyzer used.
- The types of mass analyzer are

- Magnetic sector analyzers
- Double focusing spectrometers
- Time of flight analyzers
- Quadruple mass spectrometer.

ION TRANSDRUCER:

❖ Ion beams, after passing through a mass analyzer strike a detector or ion transducer.

❖ Ion transducer is a device which will produce current at its output side when the presence of ions at its input side. There are many types of detectors are available. They are;

- Electron multiplier
- Faraday cup collector
- Photographic plates.

a) Electron multiplier transducer:

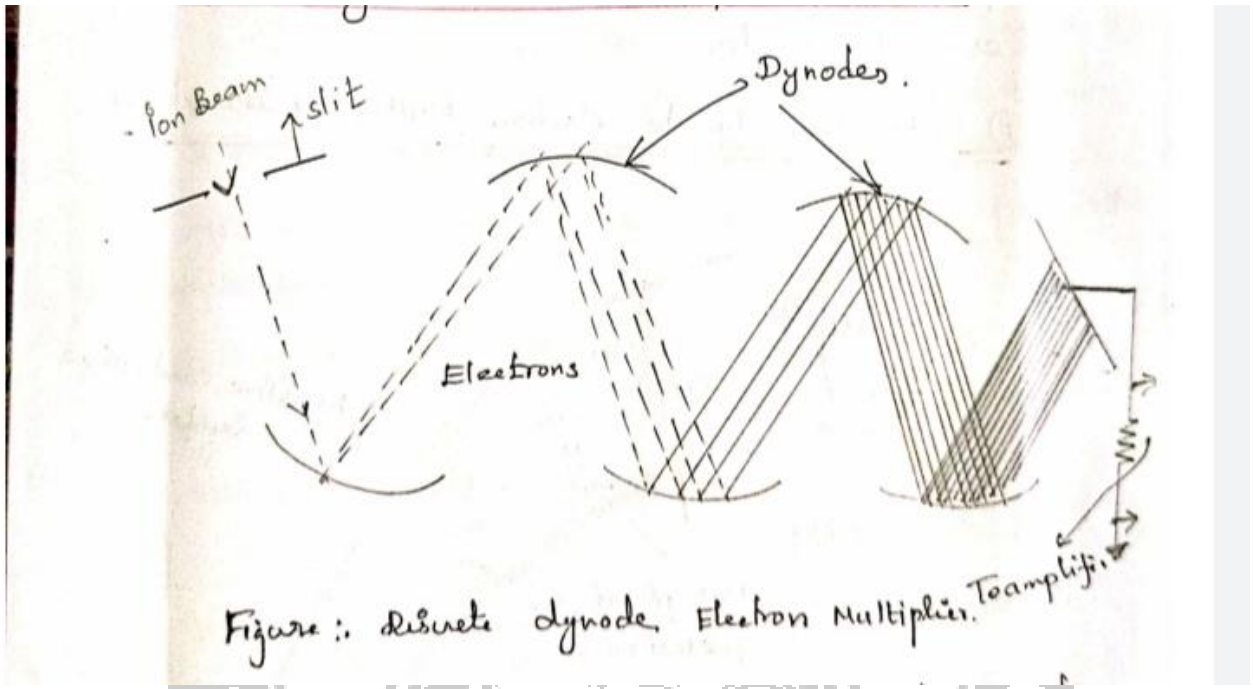
➢ It is similar to photo multiplier transducer but it has the primary cathode optimized for the detection of ions rather than photons.

➢ It is used in places where the ion currents are very low.

➢ There are two types of electron multiplier transducers are available.

i. Discrete dynode electron multiplier
ii. Continuous dynode electron multiplier

Discrete dynode electron multiplier transducer:



- The figure shown above is the discrete dynode electron multiplier transducer.
- Here many numbers of dynodes are used for the amplification of ion current.
- Each dynode being held at successively high voltage. Dynodes are metal plates which have copper/beryllium surfaces.
- These electrons are multiplied by the dynodes which are placed successively.
- Discrete type electron multiplier transducers up to 20 dynodes are available that provide current gain of 10^7.
- Thus amplified ion current is recorded as a function of mass/charge ratio on an oscilloscope or chart recorder.

Continuous dynode electron multiplier transducer:

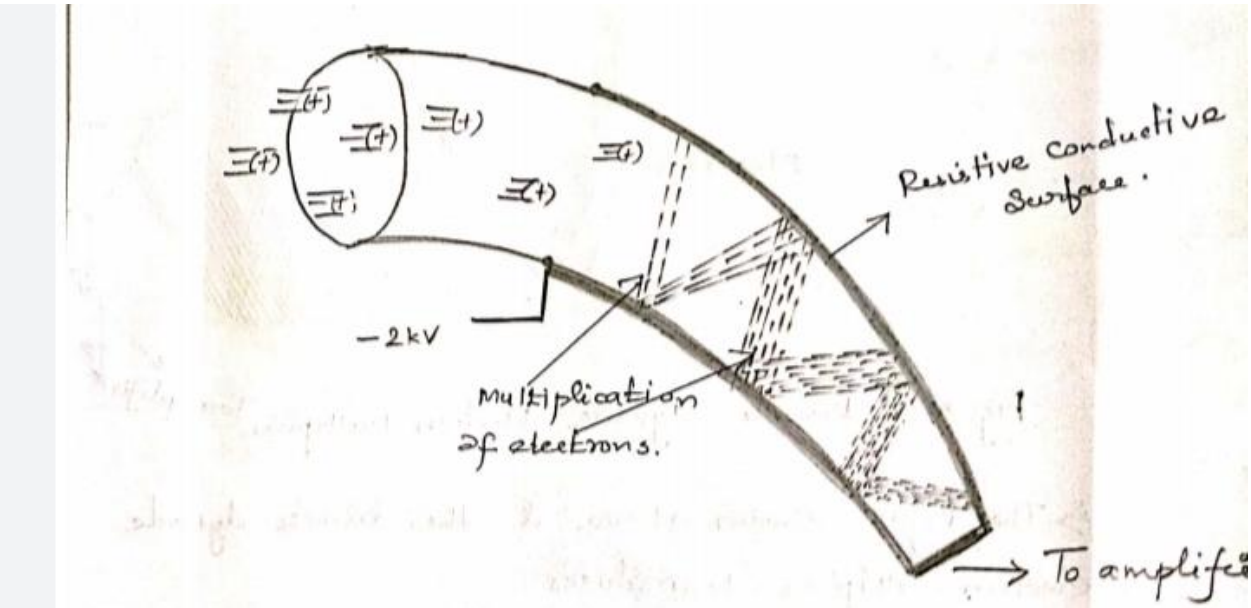


Figure :. Continuous dynode electron Multiplier.

- The figure shown is the continuous dynode electron multiplier transducer.
- It is a trumpet shaped device made of glass that is heavily doped with load.
- The tube is curved to prevent the ion feedback.
- Electrons cascade down the tube attracted by the voltage characteristics established by the inherent resistivity of the glass.
- Potential of 1.8 to 2kv is maintained across the transducer.
- This type gives current gain of 10^5 but certain applications gives the gain of 10^8.
- The electron multiplier transducers are rugged and reliable cable of providing high current gains and Nano second of response time only required.
- These transducers can be placed directly at the exit slit of analyzer.

b) Faraday cup collector:

- The faraday cup collector is a simple & effective means of monitoring the ion current.

- It consists of entrance slit, ion suppressor electrode, Faraday cage (Faraday cup) & collector electrode.
- The transducer is aligned in such a way that the ions exiting the analyzer strike the collector electrode.
- The electrode is surrounded by a cup that prevents the escape of reflected ions & ejected secondary electrons.
- Suppressor electrode is used to suppress the secondary emission of ions.
- The collector electrode is placed in an inclined manner with respect to the path of entering ions, so that particles striking or leaving the electrode are reflected away from the entrance to the cup.
- An insulated conductor from the Faraday cut is directly connected to an amplifier.
- It is a sensitive ion detector &used in spectrometers where great sensitivity is not required.

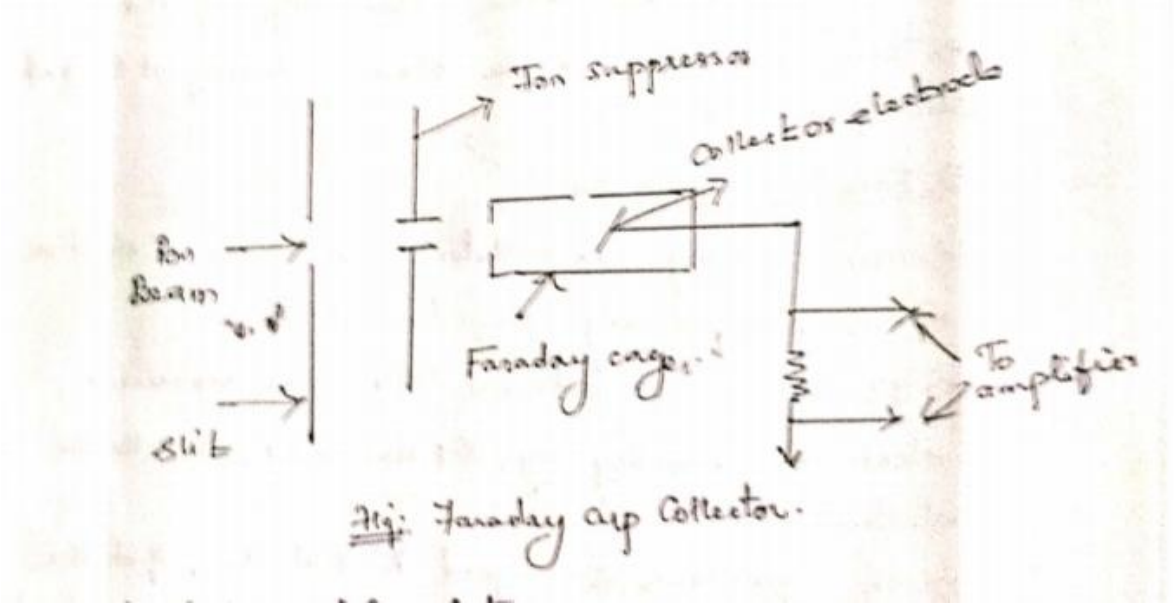


Fig: Faraday cup Collector.

c) Photographic plates:

- ❖ Photographic plates are coated with a silver bromide are sensitive to energetic ions.
- ❖ These type of detection is well suited in spark

Source pustruments.

- ➢ Because the photon plate integrates the p on signal over a period of time, it is capable of greater sensitivity & resolution then electron multiples.
- ➢ Spectra from extremely small samples, samples with low pressure & ions with a short life time can be detected.