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UGC-NET

Paper - 2

NATIONAL TESTING AGENCY (NTA)

ELECTRONIC SCIENCE

Paper 2 – Volume 8

SIERRA INNOVATIONS

Index

Unit – 10

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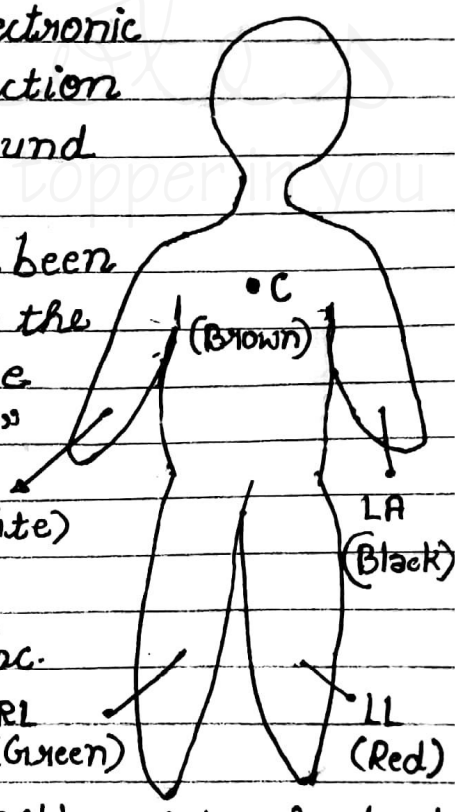
The voltage generated by the pumping action of heart is actually a vector whose magnitude as well as spatial orientation changes with temperature.

In a normal ECG enamination, the electro-cucehogram is recorded from a number of different leads usually 12 to ensure that no important detail of the wave from missed placement of electrodes a names and Configura-tors of the leads have become standardized and are used the same way throughout the world

Electreodes

With the introduction of the Electronic amphitier, an additional Connection to the body was needed as a ground reference.

Although an electrode could have been positioned almost anywhere on the body for this purpose, It became convention to use the "frcee" Right leg (RL)



(Abbreviaters & colord codes used for ECG Electrodes)

Leads

There are two types of leadsfoc. ECG Recording.

→ Leads
- Unipolar leads
- Bipular leads

(i) Bipolar leads / Bipolar Limb Leads

- Bipolar leads have one +ve and one -ve pole.
- In bipolar leads, ECG is recorded by using two electrodes such that +ve final trace corresponds to the difference of Electrical potentials Emirting between them.
- They are called Standard leads and have been universally adopted. They are also referred to as Einthoven leads.
- In a 12 Lead ECG, the limb lead I, II, and III are biopolar leads
- This reference part is Conventionally taken as the 'Right Leg'.
- Therefore, the records are made by using three Electrodes at a time, the right leg Connection being always present.

ELECTROCARDIOGRAPH

→ The Electrocardiograph (ECG are EKG) is a graphic recording are display of the time-Varient Voltages preoduled by the myocardium during the cardiac cycle.

→ The electrocardiogram is used clinically in diagnosing Various diseases & conditions associated with the heart.

→ It also serves as a timing reference for other measurements.

→ for diagrams, a cardiologist would typically look first at the heart rate. The normal values lies in the range of 60 to 100 beats per minute.

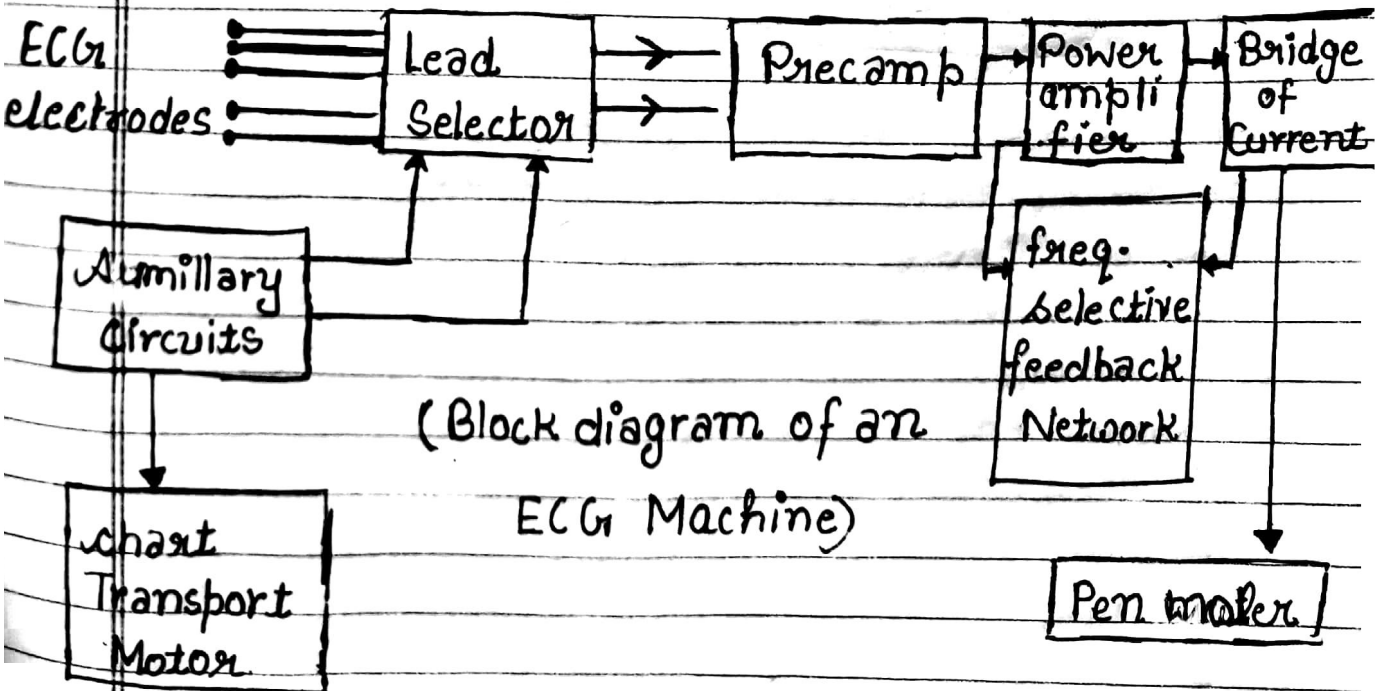
→ A Slower Rate than this is called bready-cardia (Slow heart) and a higher rate is called tachycardia (fast heart)

→ Then the (cardiologist) will see if the cycles are evenly spared are not. If not an arrhythmia may be indicated.

→ In healthy individuals the Electrocardiogram remains reasonably constant Even though the heart rate changes with the demands of the body.

→ for ECG, the diagnostically useful frequency range is usually accepted as 0.05 to 150 Hz

Block diagram discription of an Electrocardiograph



(Block diagram of an ECG Machine)

→ The potentials picked up by the patient electrodes cure taken to the lead selector switch.
→ In the lead selector, the electrodes are selected two by two according to the lead program.
→ By means of capacitive coupling, the signal is connected symmetrically to the long tail pairs of differential procamp
→ The amplified o/p signal is picked up single ended is given to the power amplifiere power amphifier is generally of the push-pull differential type.
→ The base of one c/p transfor of this amphifier is drawn by the preamphified unsymmetrical signal.
→ The transfer of the other transitor is driven by the feedback signal restructing from the pen position and connected via frequency selective
→ The o/p of the power amphifier is single ended and is led to the pen motor which deflects the writing cucm. on the paper.
→ A direct writing recorder is usually adequate since the BCG signal of intersect has limited Bw.
→ frequency selective n/w is an R-C n/w which provides necessary damping of the pen motor and is present by the manufacturanse.

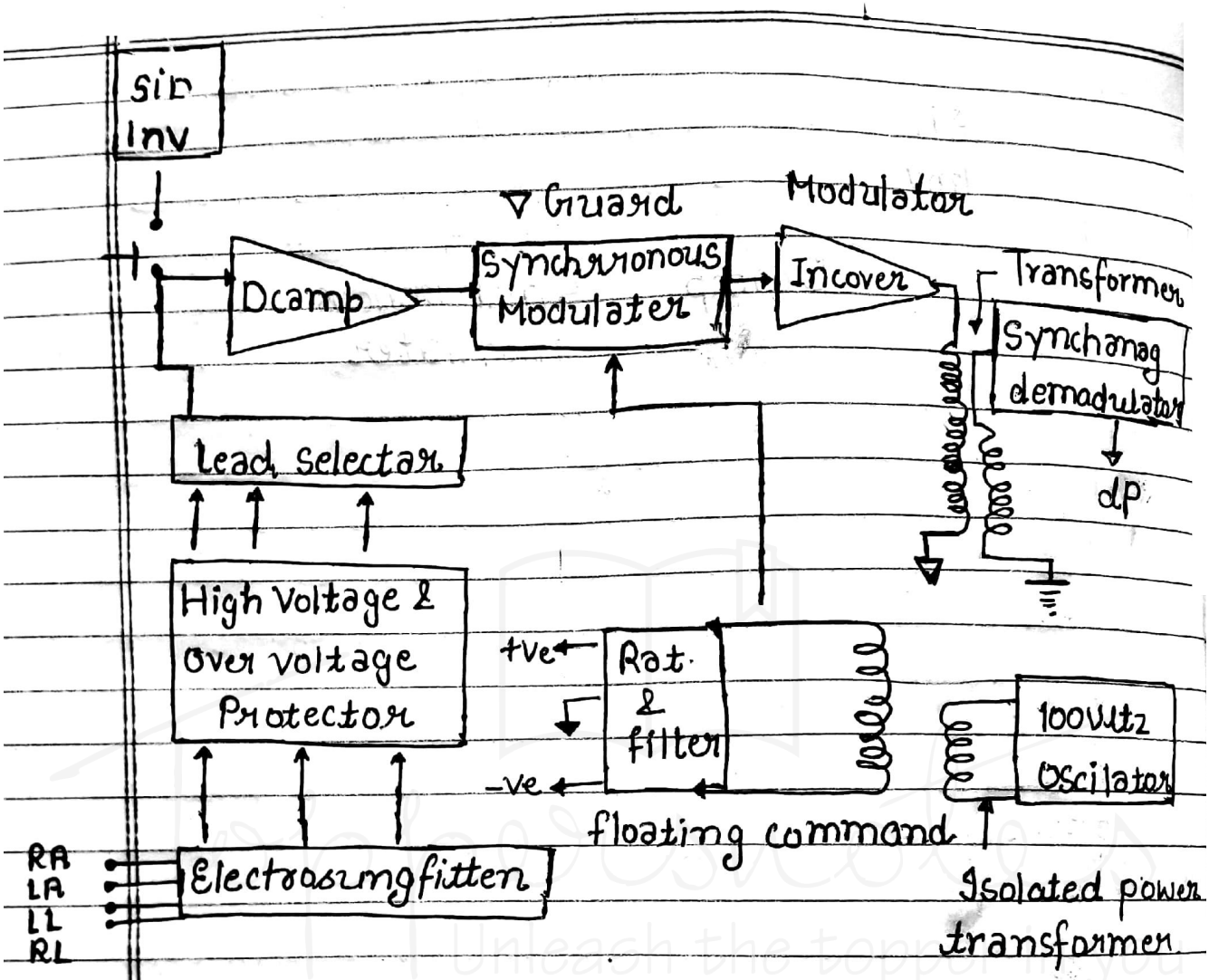
→ The aumillary circuits provide a 1mv calibration signal a automatic blocking of the amphifier during a change in the position at the lead switch. It may include a speed Control Cut for the chart drive motor.

→ Electrocardiograms are almost zhvarwashy recorded on graph paper with horizontal and Vertical line at 1mm interval with a tricuer line at 5mm intervals

→ for routine work, the paper recording speed is 25 mm/s Amphitude measurements are made Vertically in mv.

ECG Amphifier

- Right leg (RL) Electrode in BCG is Connected to the classes and from there to the ground
- This provided a ready path for any ground seeming current through the patient a presented an Electrical hazard.
- The American Heart Association guidelines states that the leakage current should not be greater than 10 pest when measured from the patient's leads to the ground. Or through the main instrument grounding wire with the ground open or last
- for this patient leads would have p be isolated from the ground for all operated units.



Block diagram of an Isolation preamp

⊙ isolation preamphifier used in modern electro-cardiograph difference signals obtained from the RA, LA and RL is given to LPF. frequency is recorded on the z/p leads to reduce interference caused by Electro-coscugency and Radio frequency emissions and sometimes from the 50 Hz current.

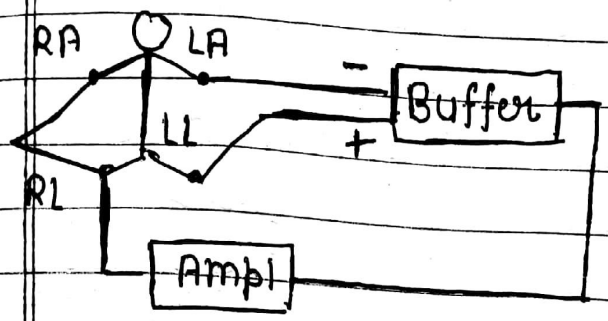
⊙ filter circuit is followed by high Voltage and over voltage protection circuits so that the amphifier can with land large Voltages during defibricullation.

- The lead selector switch is used to derive the recqd. lead configurations and give it to a dc-coupled amphifier.
- A dc-level of 1mv is obtained by dividing down the power supply which can be given to this amphifier through a push button for calibration of the amphifier.
- Isolation patient circuit is obtained using a low capacitance transformer whose primary winding is drawn from a 100KHz oscillator.
- The transformer secondary is used to obtain an isolated power supply for operating the devices in the isolated portion of the cnt and to drave the synchorconous modulator which nearly modulates an ECG signal given to it.
- The oscillator frequency of transformers could be used and that the switching time is not too fast, so that chempersive transistors a logic circuittary can be utilized.
- A synchronus demodulate is chosen to given low noise performance using switching FETS.

ECG Electrodes and Leads

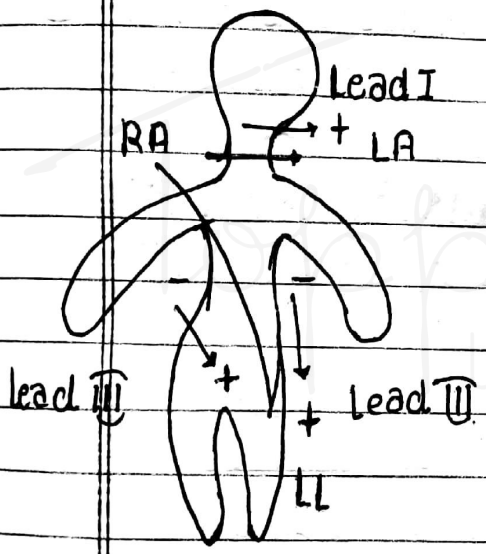
- To record ECG usually five no. of Electrodes are asfined to the body of patient.

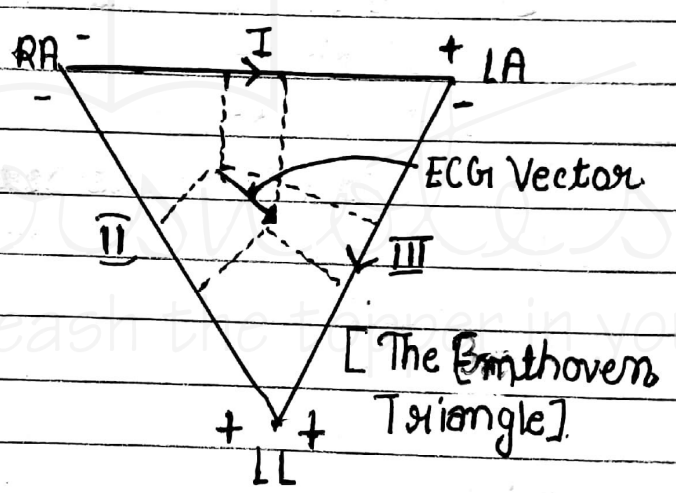
(c.) Lead III



Here the electrodes are placed on LA and LL.

Q) In Each of these lead positions, the QRS of a normal heart is such that the R wave is the :→





[The Emthoven Triangle]

- In defining the bipolar leads, Emthoven portulated that as any given instant of the cardiac cycle, the electrical an's of the heart can be represented as a two dimensional Vector.
- The ECG measured from any of the three basic limb leads is a time-Variant Single-dimensional component of the Vector.
- He proposed that the electric field of the heart could be represented diagrammatically as a

triangle with the heart c'deally located at the Centre. The triangle is known as the "Einthoven Triangle".

- The apenes of triangle are right and left shoulders and the crotch.
- By assuming that the ECG potentials at the shoulders are essentially the same as the writs and the potentials at the crotch differ from those at either angle.
- He let the points of the angle represent the electrode positions for the 3 limb leads
- The sides of the angle represent the lines along which the three projections of the ECG vector are measured.
- Einthoven showed that the instantaneous voltage measured from any one of the three limb lead positions is approximes equal to the algebric sum of the othr two or that +ve vector sum of the projections on all three lines is equal to Zero.
- for this the polarity of lead II measurement must be reversed.
- Of the three limb leads, lead II produces the greatest R-Wave potential.
- Thus, when the amplitude of the 3 limb leads are measured, the R-wave amplitude of lead II equal to the sum of the R-wave amplitude of lead I, III.

- Einthoven's Law states that
  $I + (-II) + III = 0$
  or, $I + III = II$

(ii) **Unipolar leads**

- Unipolar leads also have two poles, as a voltage is measured but the -ve pole is a composite pole made up of the signals from lots of other electrodes.
- This composite pole is known as wilson's Central Terminal introduced by wilson in 1894
- If the Electrodes is placed on the chest close to the heart, higher potentials can be detected than normally available at the limbs. This lead to the development of unipolar leads introduced by wilson.
- for unipolar leads, the ECG is recorded between a single exploratory electrode and the Central terminal, which has a potential corresponding to the Centre of the body
- Wilson's Central terminal (Vw) is produced by connecting the electrodes RA, LA, LL together.
- A simple transitive n/w to give an average potential across the body which appreciminates the potential at infinity i.e., Zero.
  $V_W = 1/3\ (RA + LA + LL)$

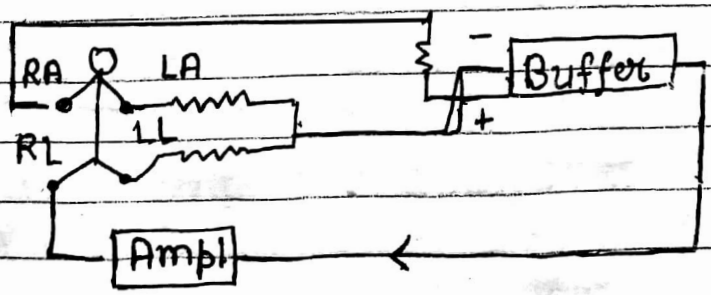
⊙ unipolar leads are of two types:-

(i). Limb leads
(ii) Precordial leads/chest leads.

(i) **Limb leads** } In unipolar limb leads, two of the limb leads are tried together and recorded with respect to the third limb.

- They are also called arguemented limb leads/ averaging leads.
- The resistances presented between the electrodes-machine connections are known as 'averaging resistances'.
- Lead aVR, lead aVL and lead aVf are arguemented limb leads or Goldberger's leads.
- They are derived from the same 3 electrodes as leads I, II and III.

Lead AVR (Arguemented Vector Right)

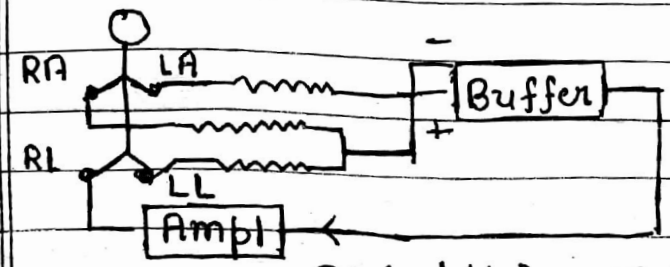


Here RA is recorded with respect to a reference established by joining LA and LL electrodes.

⇝ i.e, here the +ve electrode (white) on the RA and the -ve electrode is a combination of LA (black) and LL (Red) electrode which arguements the signal strength of the electrode on the right arm.

$$aVR = RA - \frac{1}{2}(LA + LL)$$

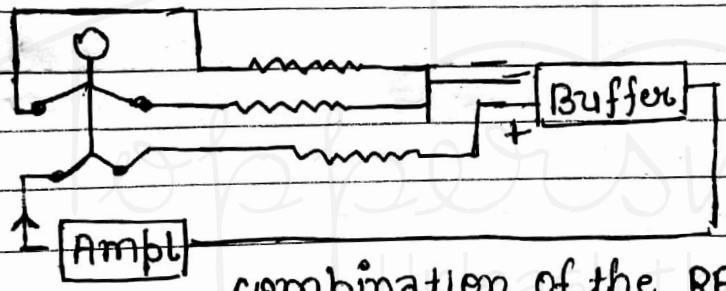
(ii) Lead avL (Argumented Vector left)



Here the +ve electrode (black) on the LA and the (-ve electrodes is a combination of the RA (white) a LA (Red) electrode which arguments the signal strength of the electrode on LA.

$$avL = LA - 1/2\ (RA+LL)$$

(iii) Lead AVF (Argumented Vector foot)



Here the +ve (Red) electrodes on the left leg (LL) & the +ve electrode is a combination of the RA (white) electrode and the LA (Black) electrode which arguments the signal of the two electrode on the LL.

$$avf = LL - 1/2\ (RA+LA)$$

~~> The argumented limb leads avR, avL and avF are amplified in this way because the signal is too small to be useful when +ve -ve electrode is wilson's Central terminal.

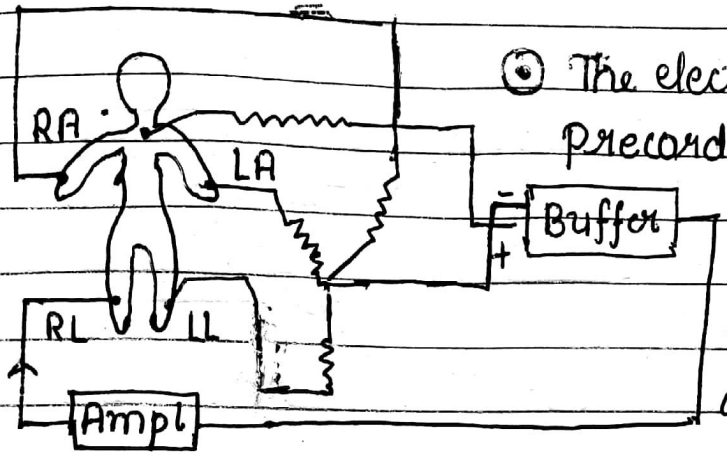
~~> Lead avR, avL and avf can also be represented using Lead I & Lead II.

$$avR = \frac{-I+II}{2}$$

$$avf = II - I/2$$

$$avL = I - \frac{II}{2}$$

(2.) Precordial leads/chest leads

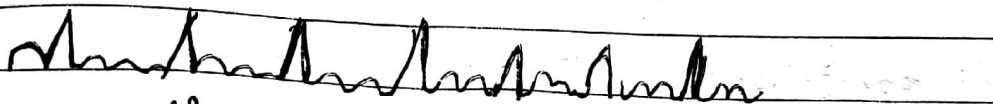


- The electrodes for the precordial leads are placed directly on the chest.
- precordial leads are V_1, V_2, V_3, V_4, V_5 & V_6.
- Because of their close precomintry to the heart they don't require arguementation.
- welson's central terminal is used for the -ve electrodes and these leads are considered to be unipolar.
- The precordial leads view the hearts electrical activity in horizontal plane.
- The heart's electrical am's in the horizontal plane is referred to as the x-axis.

EFFECTS OF ARTEFACTS ON ECG RECORDINGS

- Abnormal patterns of ECG may be due to pathological states are on Ocassion they may be due to artefacts.
- To diagnose the presence of undesirable artefacts on the ECG those, a few recordings are illustrated below:

(i) Interference from power Lines :→



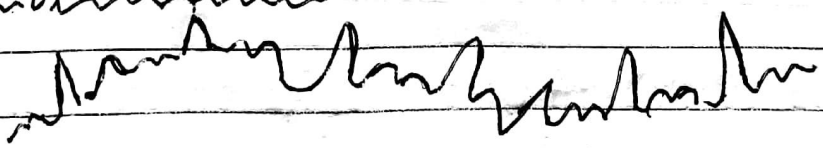
power line enterference cs easily recognizable since the enterfering Voltage ch the ECG would have a frequency of 50Hz

This interference may be duc to :-

- Strong effect of the alternating current on the patient
- Alternating current field due to loops in the patient.
- Loose Contact of the patient cause.
- Denty electrodes and disconnected electrodes.
- If tve Machine or patient is not properly grounded

Sometimes Static changes on the Synthetic uniform of the

(ii) Shifting of the baseline :-

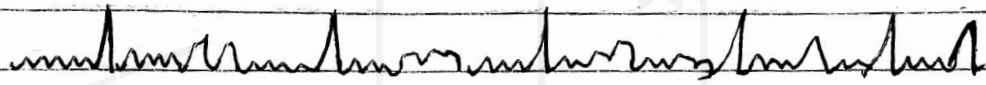


- Wondering are shifting baseline of ECG trace is usually due to the movement of the patient or electrods.
- Shifting of baseline Is usually observed immediatel after appn of electrodes and can be eliminated by ensuring that the patient tries re elaned and tve electrodes are properly.

attached.

- Shifting of baseline is due to a relatively slow establishment of electrochemical equilibrium at the electrode. sub interface.
- This can be minimized by selecting the proper electrode Material which will reach equilibrium quickly with a good electrode jelly

(iii) Muscle Tremore



- Irregular trembling of the ECG trace occur when the patient is n't relamed is coid.
- Muscle Tremor generally found in a case of older patients
- Muscle tremor is generally due to limb leads when the patient moves or the muscles are stretched.
- for normal routine ECG Recordings the patient must be advised to get warm and to relax So, that the muscle tremor from shiverang are tengin is eliminated.

MICROPROCESSOR BASED ECG MACHINES

Microprocessor technology has been employed in the ECG machines to attain certain desirable features like removal of artifacts, baseline wander, automatic centring of the. Hearing