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APPARATUS USED FOR KYMOGRAPHIC RECORDINGS

INTRODUCTION

The basic principle of the working of the instruments, the uses of the apparatus, and the instructions for the safe use of the apparatus must be known. As electric current is used as the stimulus to perform most of the experiments, proper earthing (grounding) and insulation of the wires must be ensured before starting the experiment.

In most of the experimental work, especially of the study of the response of tissues to various stimuli, four setups are needed:
the source of stimulation, a stimulating device, the tissue preparation and a recording device.

Advantages of electrical stimulation:

- It is easy to deliver the stimulus. The operator can handle it conveniently.
- The apparatus for delivering the stimulus is tidy.
- The stimulus is easily controlled by the break or make of a key.
- It is possible to stimulate the tissue with the desired strength, frequency and duration, accurately and easily.
- The stimulus can be accurately localised on the tissue.
- The stimulus can be controlled from a long distance.
- The stimulus is the least injurious to the tissue.

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Tissue preparation :

For amphibian nerve muscle experiments, the sciatic nerve and the gastrocnemius muscle of the toad are usually used.

Advantages of using the toad :

- It is easily available.
- It is easy to handle.
- It is harmless.
- It is inexpensive.
- To maintain the tissue preparation of toad, no extra supply of oxygen is needed as the toad muscles can directly imbibe oxygen from the environment.
- The tissue preparation of a toad can be maintained for a long duration if handled properly.
- It is easy to dissect the toad.

Advantages of using gastrocnemius – sciatic preparation :

The sciatic nerve and gastrocnemius muscle are easy to locate and dissect.

The sciatic nerve is the longest nerve and is therefore easy to place on the electrodes that are kept a short distance away from the muscle.

The gastrocnemius muscle is a big muscle (has more cross sectional area) and therefore on contraction, produces more force to lift the lever and records a good magnitude of contraction.

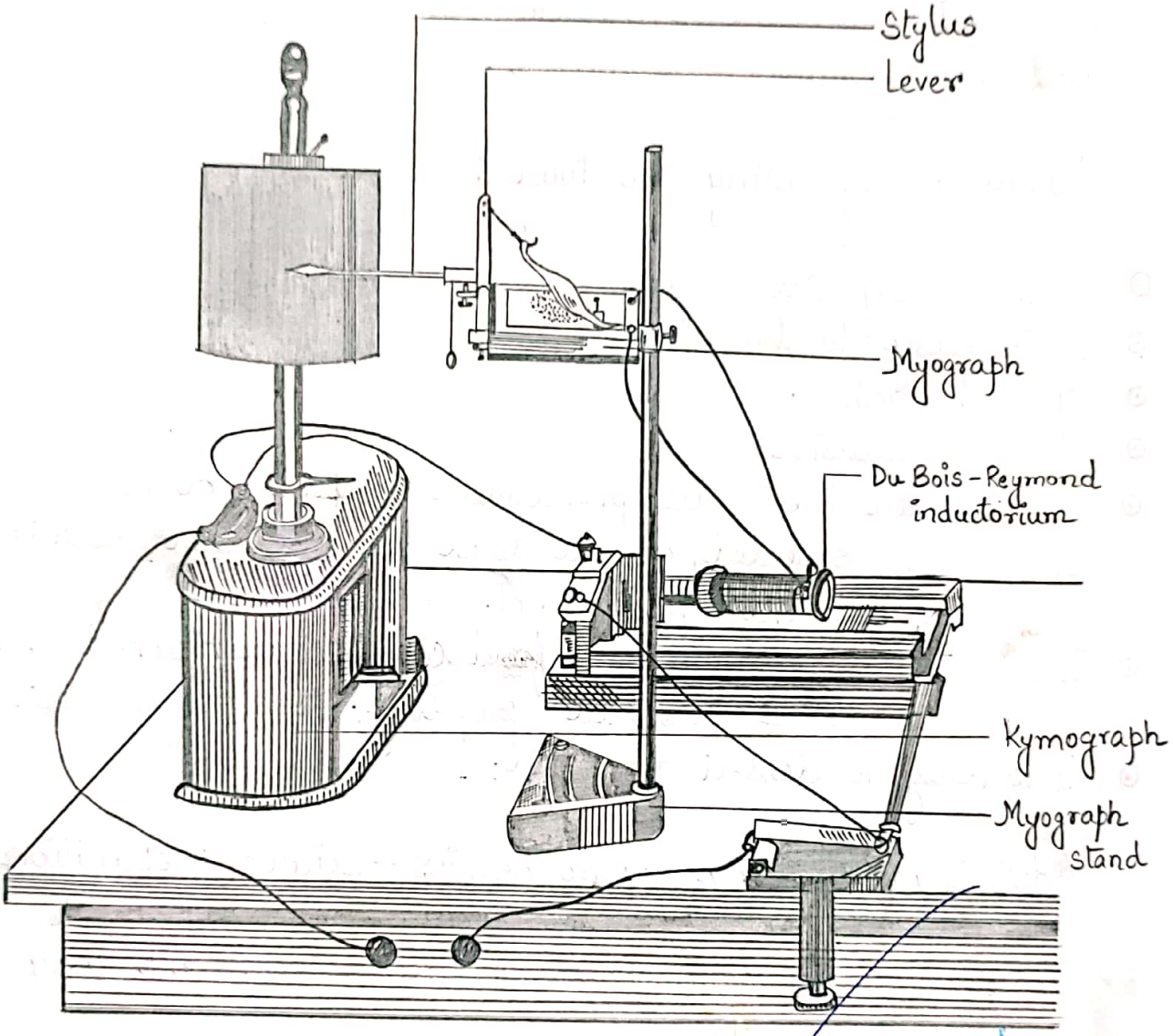

FIG: KYMOGRAPHIC APPARATUS WITH ALL ITS ACCESSORIES

The gastrocnemius muscle cannot be easily fatigued.

Recording device :
Recording of the muscle contractions in done by using a writing lever which inscribes on the smoked surface of a moving drum, fitted to a kymograph.

DESCRIPTION AND USES OF APPLIANCES :

Source of current :
Electrical stimulation can be given either with a direct current (DC) source and a pair of stimulating electrodes (Galvanic current) or by using an induction coil and the electrodes (Faradic current or induced current). In most experiments, direct current is used. The direct current (6 volts) is available at the battery terminals of all the experimental tables. To get an induced current, a constant current (Galvanic) of low voltage is fed into the primary coil of the inductorium. To supply the low voltage direct current, a central low voltage unit is installed. The output terminals feed a direct current of 3-15 volts to all the working seats in the table. This direct current is a rectified current coming from the central eli-minator. The direct current can also be obtained from dry cells connected in series.

Wires :
Usually copper or aluminium wires are used in laboratories to carry electrical current. A single thick wire is used to

supply direct current. The wires are insulated by cotton, silk, or enamel. For connection or to supply current, the insulation from the tip of the wires is removed and polished with the help of a fine sand paper to give a good contact. Copper wires are usually used. There should not be any damage or crack in the wire. The wires are usually rolled on the glass rod into spirals.

Keys :
The key is a device which is used for completing or interrupting a circuit. Two types of keys are used : the simple or tap key, and the short circuiting key.

The tap key : This is connected in the primary circuit in series with the DC source. The key is pressed gently and released to make and break the circuit.

The short circuiting : This is connected in the secondary circuit in parallel to prevent accidental leakage of current into the tissues. This also prevents unipolar induction. The key is kept closed to check unnecessary stimulation of the tissue, and when stimulation is required it is left open. Different types of short circuiting keys are available, but the DuBois-Reymond key is usually used in the laboratory.

The reversing key : is also used in the laboratory when two electrodes are required for shunting the current from one electrode to the other.

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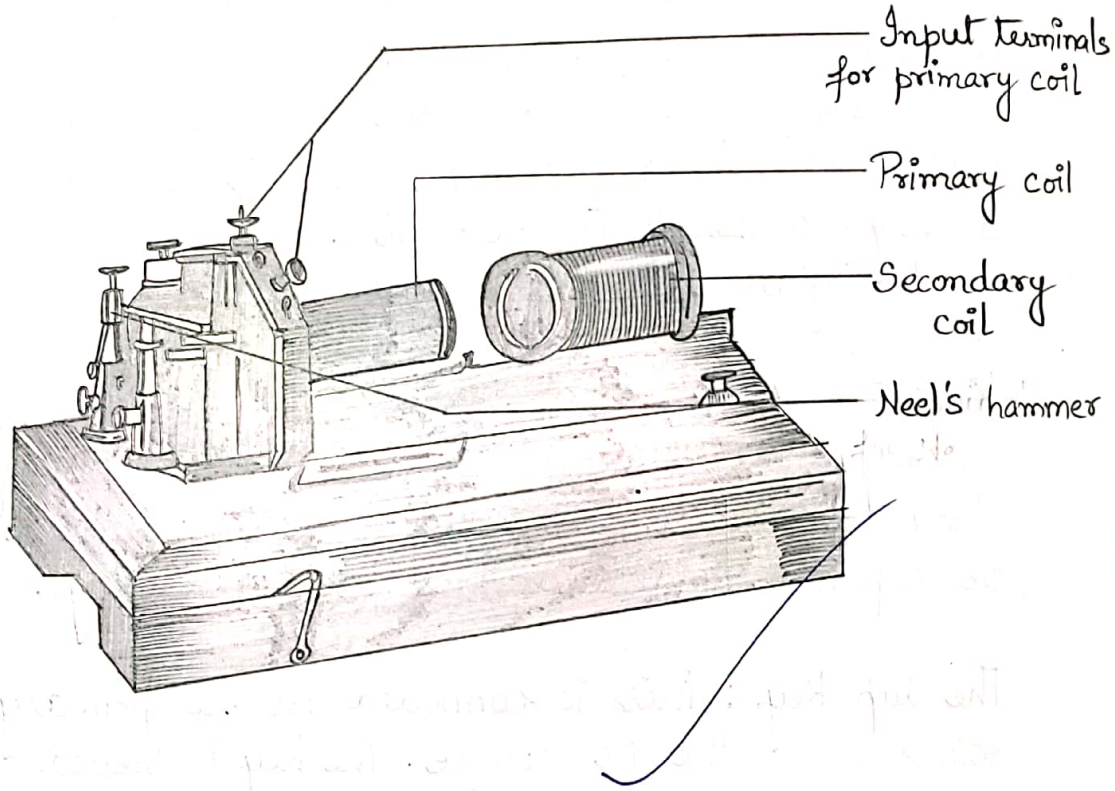

DU BOIS - REYMOND INDUCTORIUM

Inductorium :

This is a simple device for transforming direct current into the induced current. This is basically a step-up transformer used for obtaining a high voltage stimulus from the low voltage of direct current source, by using the principle of Faraday's electromagnetic induction.

The primary coil :

The primary coil consists of 300 turns of insulated thick copper wire wound around a soft iron core. The primary coil, the direct current source and the tap key are connected in series and this constitutes the primary circuit.

The secondary coil :

The secondary coil is made of 5000 turns of very fine copper wire. The secondary coil can slide on two horizontal metal slide rods. On one of the slide rods, a scale is marked (in cm) by which the distance between the coils can be measured. The two terminals of the secondary coil are connected to the stimulating electrodes. The secondary coil and the stimulating electrodes. The secondary coil and the stimulating electrodes form the secondary circuit.

Factors that affect the strength of the induced current :

The distance between the two coils : When the distance between the two coils increases, the strength of the

stimulating current decreases and when the distance decreases, the strength of the current increases.

The angle between the coils : When the two coils are placed straight, the strength of the current is maximum. The strength of the current reduces by turning the secondary coil away from the primary coil. When the secondary coil is placed at right angles to the primary coil, there is no induction of current.

Number of turns in the coils (usually it is fixed).

The strength of direct current fed into the primary coil.

Stimulating electrodes :
Electrodes used in biological experiments differ depending on their manufacture and use. They are designed to provide a low resistance between the preparation and the amplifier input. Stimulating electrodes are used for delivering the electrical stimulus to the tissues. It consists of two copper wires held together by a piece of perspex.

Kymograph :
Kymograph is the name given to any instrument, which records movements on a moving surface. It consists of a metal gear box to which a vertical rotating shaft is connected. The shaft is powered by a horizontal axis running through the

FIG : AFTER - LOAD LEVER

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metal case. To this axis, on one side, a series of pulleys are attached. A belt connects one of these pulleys to one of the pulleys in the power shaft. A cylinder (6" x 6"), also called as drum is fixed to the shaft. The drum rotates with the shaft. A gear switch on the left side of the kymograph provides high and low gears. In each gear, different speeds of the drum can be obtained by connecting different - sized pulleys of the kymograph and the power shaft. The drum can be started or stopped by turning a clutch on the left side of the metal gear box.

There are two horizontal contact arms that project from the lower end of the vertical shaft. These contact arms can be separated and fixed with various angles between them. The tips of the arms, when they revolve, make contact with a spring at the left side of the top of the kymograph. The insulated carrier of the spring is adjustable and is clamped by a screw. There are two terminals for electrical connection: one is attached to the insulated spring and the other to the metal case of the gear box. By means of these connecting terminals, the insulated carrier along with the spring can be made to act as a key in the primary circuit. The circuit is 'made' or 'broken' when the tip of the contact arms makes and breaks contact with the insulated spring.

Levers :

Different types of levers are used in experimental physiology for various purposes. Commonly used levers are: the writing

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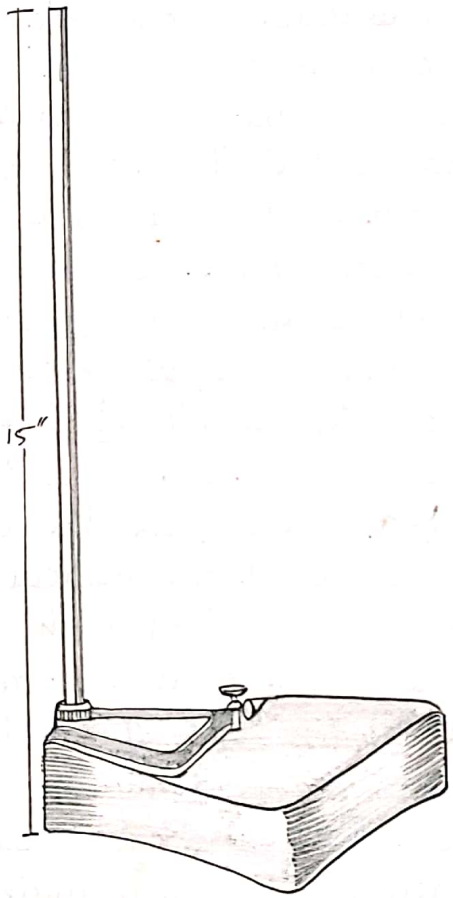

FIG: MYOGRAPH STAND

simple lever, the starling heart lever, the isometric lever, the afterload lever, and the frontal lever.

The writing lever : The writing (simple lever) is used to magnify and record the muscle contraction on the drum. The lever consists of a horizontal arm, which bears holes and notches for hanging the weights. The lever is fixed to the side wall of the muscle trough. The writing point of the lever is made up of a triangular piece of photographic film.

The starling heart lever : This is used for recording cardio-gram of frog's heart. This lever is more sensitive than the writing lever, as it records the contractions of the heart which is weaker than contraction of the gastrocnemius muscle. It consists of a frame carrying a light steel lever, with holes and notches, supported by a fine adjustable nickel silver spring.

Myograph stand :
This is a vertical rod fixed to a heavy and triangular base. The muscle trough can be fitted to the rod and can be moved up and down with the help of a fitted screw. The rod can be turned on its axis so that the writing point of the muscle lever can be made to touch or be removed from the drum without disturbing other adjustments.

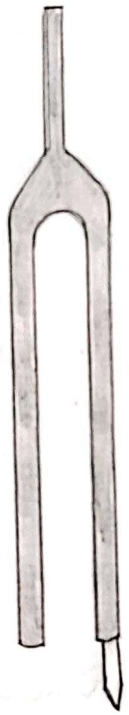

FIG : TUNING FORK

Tuning Fork :

A tuning fork with a frequency of 100 vibrations per second (100 Hz) is used for measuring different time intervals. To the end of one arm of the tuning fork, a writing point is attached. The tuning fork is set to vibrate and then is made to write on the fast rotating drum to get a tracing. The tracing that is obtained consists of different waves. Each wave of the tracing (from crest to the crest) measures 0.01 seconds (10 ms).

Student's stimulator :

This is an electronic stimulator with a DC output ranging from 0-15 volts. The strength (volts), frequency and duration of the stimulus are indicated on the apparatus. More advanced stimulators are also available, which are required for special experiments and research.

Smoking :

Before smoking the drum, a piece of glazed paper is properly pasted on the drum. Then the drum is placed on the horizontal arm of the smoking stand. The burner is put on and the drum is smoked uniformly by rotating manually on the flame. A thin and uniformly black smoking is aimed at.

Varnishing :

Varnishing is done to fix the recording on the smoked paper. Labelling of the recording is done before varnishing. The paper

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is cut at the jointed portion and taken out of the drum and dipped in the 2 percent solution of resin or methylated spirit. Then the paper is clipped and hung till it is completely dry.

PRECAUTIONS :

The primary and secondary circuits should be made perfectly. Loose connections in the circuits should be detected and dealt accordingly.
The wires used for making the circuit should be as short as possible. Long wires can be shortened by winding them around a glass rod or a pencil.
The kymograph should be properly leveled by using the leveling screws at its base.
The drum should be tightly fixed to the vertical shaft.
The drum should always be rotated clockwise.
The writing lever should always be arranged on the right side of the drum.
The writing lever should be tangential with the recording surface.
The tip of the writing lever should touch the smoked surface evenly and lightly.
The initial and resting position of the writing lever should always be horizontal.
The tracing should be taken at least one inch above the lower edge of the drum.
The contact arm should be tightly fixed.

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