UNIT 4

ELECTRONIC INSTRUMENTATION

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Introduction :-

Electronic instruments are the devices which measures various parameters such as voltage, current, resistance etc. Some instruments are also used to measure waveform parameters, to observe waveforms at various points in the circuit, to analyze the given circuits. continuity between two points also needs to be check to rectify the faults.

So, all this can be done with the help of various electronic instrumets such as DMM (digital multimeter), FG (function generator), CRO (cathode ray oscilloscope). etc.

⇒ Multimeters :-

- These are used to measure ac/dc current, ac/dc voltages, Resistance. Also used to test diodes, capacitors & transistors.
- In addition to this multimeters also check continuity between two points to rectify the faults.

* Types of multimeters :-
  1) Analog multimeters
  2) Digital multimeters (DMM).

* Digital Multimeter :- (DMM).

- It is the instrument used to measure ac/dc current, ac/dc voltage, resistance, conductance and display the measured quantity digitally.

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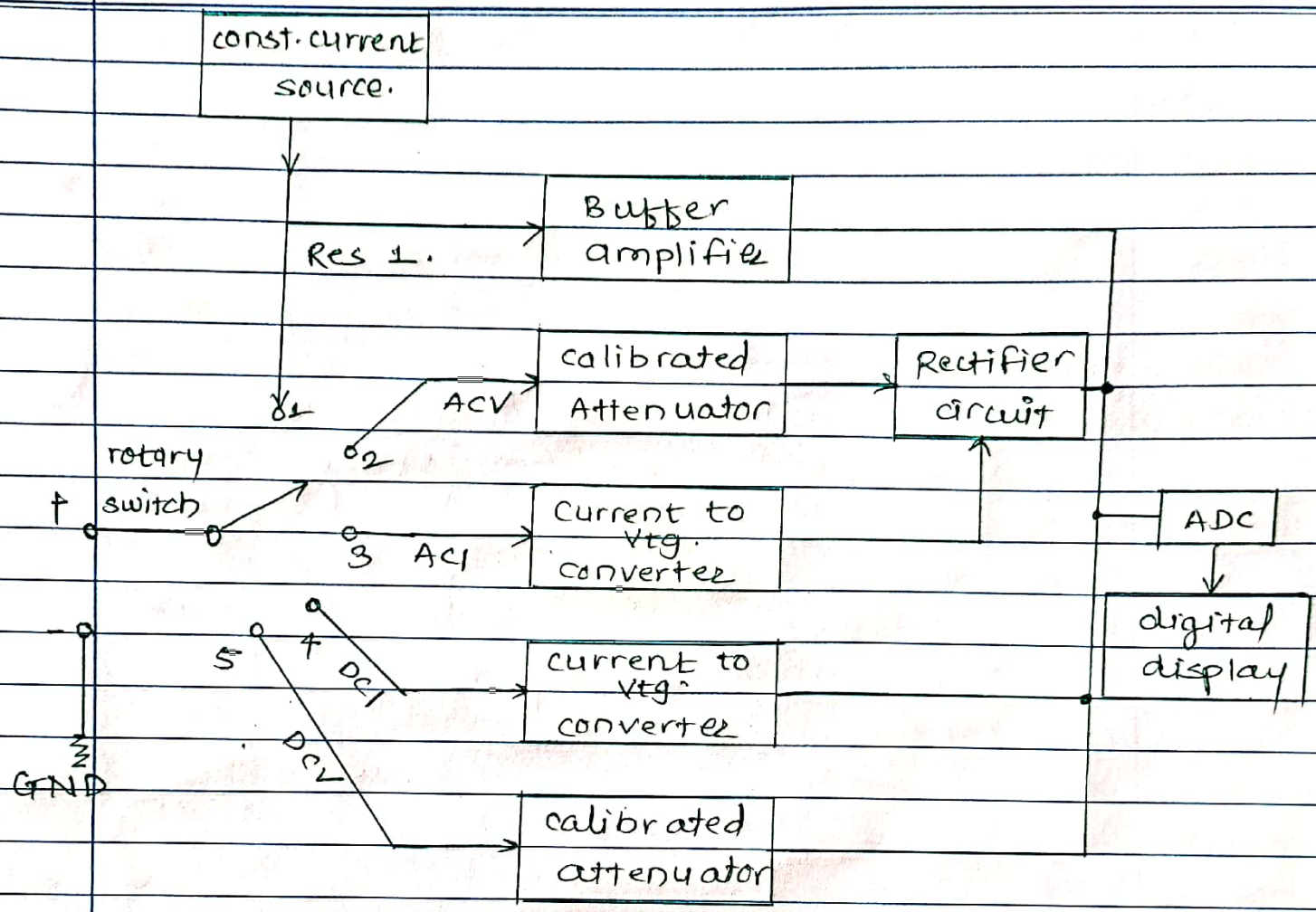

Fig :- Block diagram of Digital Multimeter.

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* How to measure resistance ?
- connect an resistor across its i/p probes. Keep rotary switch in to position 1. The proportional current flows through the resistor, from constant current source.
- According to the ohm's law voltage is produced across it. This vtg. is directly proportional to the resistance. This vtg. is buffered and fed to ADC, to get digital display in ohm's.

* How to measure AC current (AC-I) ?
- current is directly measured by converting it into proportional voltage. connect an unknown AC current across i/p. probes. Keep the switch in position B.
- The current converted into vtg. proportionally with the help of I-V converter & then rectified.
- Now the voltage in terms of AC current is fed to ADC to get Digital display in amperes.

* How to measure AC voltage (AC-V) ?
- connect an unknown AC vtg. across the i/p probes. Keep rotary switch in position-2
- The vtg. is attenuated, if it is above the selected range and then rectified to convert it into proportional DC vtg.
- It is then fed to ADC to get the digital display in Volts.

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* How to measure DC current (DC-I)?

- The DC-I is measured indirectly.
- connect an unknown DC current to i/p probes. keep the rotary switch in to position 4.
- The current is converted in to proportional vtg. with the help of I-V converter. Now the vtg. in terms of DC current is fed to ADC to get the digital display in Amperes.

* How to measure DC vtg? (DC-V).

- connect an unknown DC vtg. across i/p probes. keep the swith in position-5
- The vtg. is attenuated, if it is above the selected range and then directly Fed to ADC to get the digital display in Volts.

⇒ Function generator :-

- A function generator (FG) is a signal source that has the capability of producing different types of waveforms as its output signal.
- The most common output waveforms are sine waves, triangular waves, square waves & sawtooth waves.
- The frequencies of such waveforms may be adjusted from a fraction of Hz (hertz) to several hundred KHz.

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- Many function generators are capable of generating two different waveforms simultaneously. (from different output terminals).
for example;
a triangular wave & a sine wave of equal frequencies can be produced simultaneously.

* Block diagram of function generator :-

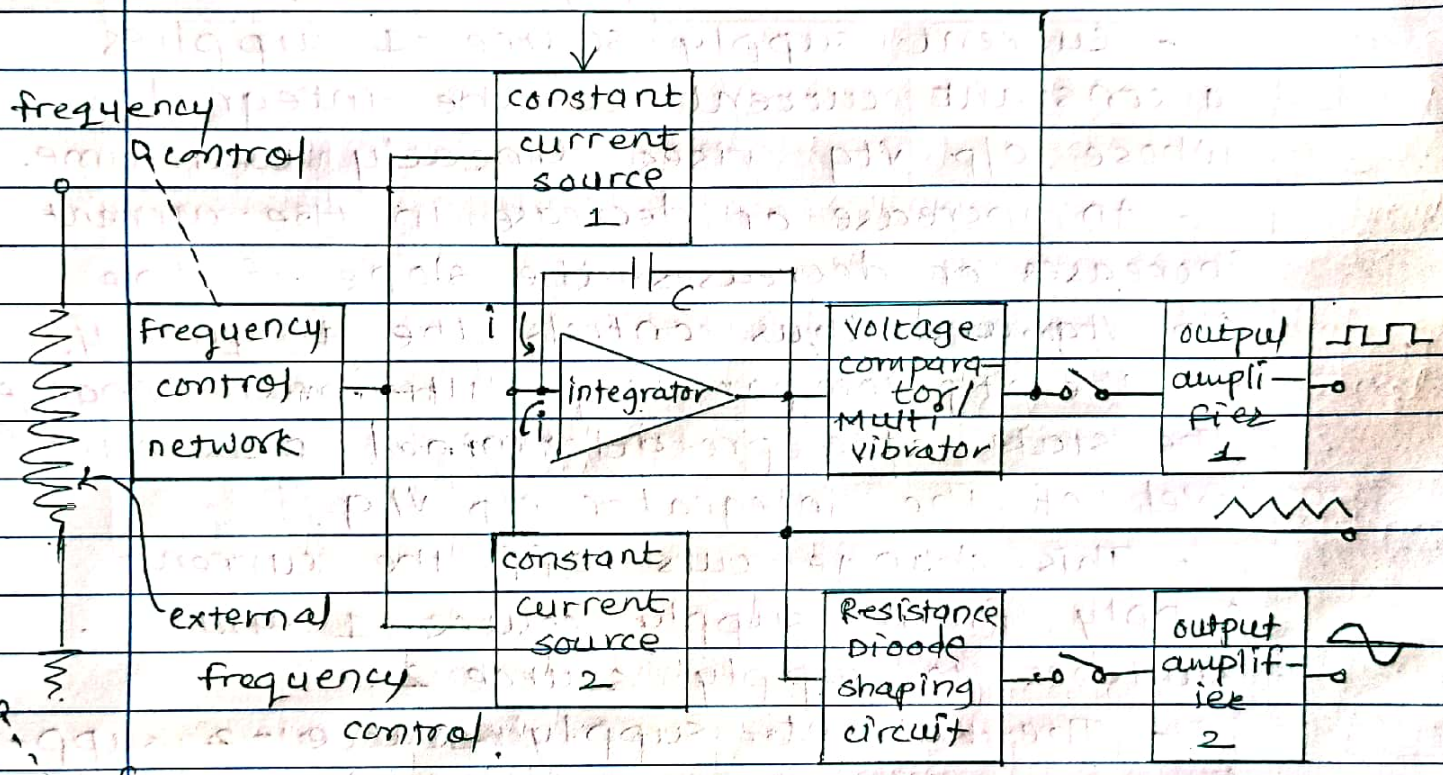

Fig:- Block diagram of function generator.

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- The bbck diagram of FG is given above. In this the frequency is controlled by varying the magnitude of the current that drives the integrator.
- This instrument provides different types of wave forms as its output signal with a range of frequencies 0.01 Hz to 100 KHz.
- The frequency controlled vtg. regulates 2 current supply sources.
- Current supply source - 1 supplies a constant current to the integrator whose o/p vtg rises linearly with time.
- An increase or decrease in the current increases or decreases the slope of the o/p vtg and thus controls the frequency.
- The vtg. comparator/multivibrator changes the state at a pre-determined maximum level, of the integrator o/p vtg.
- This change cuts off the current supply from supply source 1 and switches to supply source 2.
- The current supply source - 2 supplies a reverse current to the integrator so that the o/p drops linearly with time.
- When the o/p attains pre-determined level, the vtg. comparator again changes state and switches on to the current supply source.

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- The o/p of the integrator is triangular wave whose frequency depends on the current supplied by the constant current supply sources.
- The comparator o/p provides a square wave of the same frequency as output.
- The resistance-diode network changes the slope of the triangular wave as its amplitude changes and produces a sinusoidal wave with less than 1% distortion.

⇒ Digital storage Osilloscope (DSO):-

- The DSO is defined as the osilloscope which stores & analyze the signal digitally, i.e in the form of 1 or 0, preferably storing them as analogue signals.
- The digital osilloscope takes an input signal, store them and then display it on the screen.
- The digital osilloscope has advanced features of storage, triggering and measurement. Also, it displays the signal visually as well as numerically.

Working principle of DSO :-

- The DSO digitises and stores the input signal. This can be done by using CRT (cathode ray tube). & digital memory

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- The digitization can be done by taking the sample input signal at periodic waveforms.

Block diagram of DSO :-

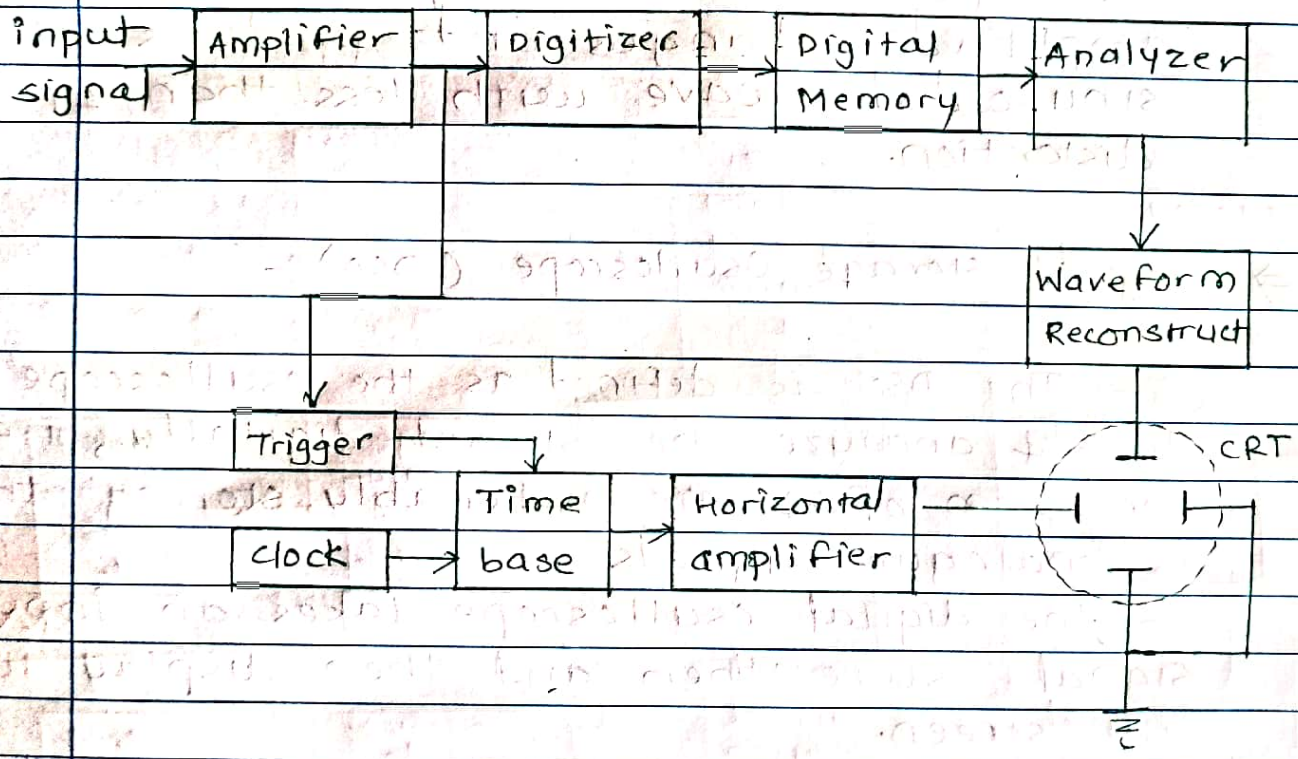

fig:- Block diagram of digital storage oscilloscope (DSO).

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- The amplified analog signal is applied to the digitizer. The digitizer has 2 blocks: a sampler & an ADC.
- The sampler samples the amplified analog signal at regular sample intervals to produce its sampled version.
- The ADC converts each sampled value into an equivalent digital word. Thus i/p signal is digitized.
- The digitized signal is stored in the memory of DSO.
- The analyzer circuit fetches the stored data (waveforms) from the memory and analyzes it to produce a variety of different information.
- The waveform reconstructor reconstructs the waveform from the digital information in a rapid and repetative manner and applies it to the pair of vertical deflecting plates.
- The time base signal is a saw tooth waveform that is amplified by the horizontal amplifier and applied to the horizontal deflecting plates at CRT.

* Advantages of DSO :-

1) DSO has in-built signal processing function.
2) You can use cursors / markers for measurement.
3) Digitized waveforms can be stored for long time.

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⇒ Powerscope

- It is an oscilloscope used to measure power of the given waveform.
- With its combination of oscilloscope & power analyzer, that enables users to measure power, efficiency, transient responses and many parameters. that cannot be measured with available instruments.
- Normal osuilloscopes are not designed to measure power. Powerscope prodes the calibrated power measurement even with the reactive kind of loads.
- It is generally a dual trace oscilloscope. That means it can display two waveforms simultaneously.
- It incorporates very special safety features such as fully grounded front panel and controls to minimize the operator's shock hazard.
- It has the ability to withstand a transient voltage of upto 2kV at all the vertical amplifier inputs.

Input channels :-

- In a conventional dual channel osuillos-cope, the two i/p channels have a common reference point (-ve terminal) which is also connected to the CRO body & earthpt.

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- But this arrangement is not suitable to simultaneously display 2 signals with separate isolated ground points.

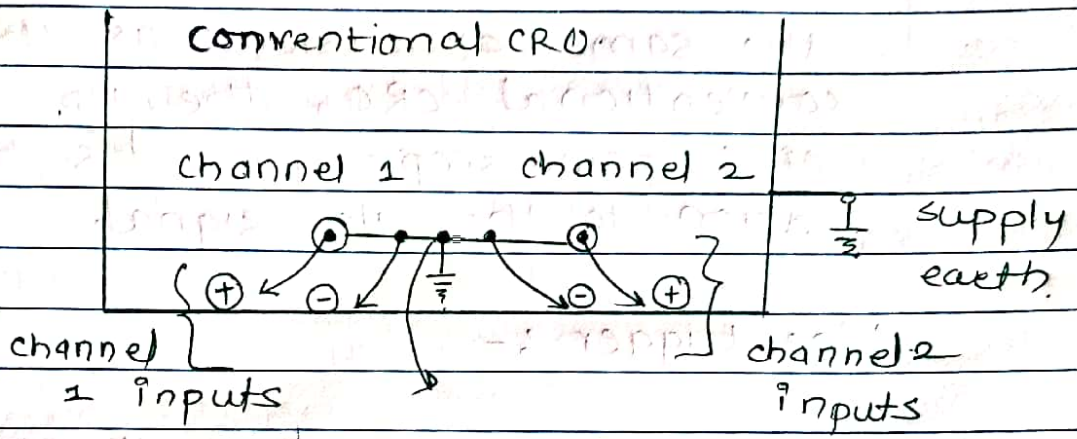

Fig: conventional dual trace osilloscope inputs

- This problem is overcome in powerscopes, by completely isolating the two channels from each other & from the powerscope body as well.

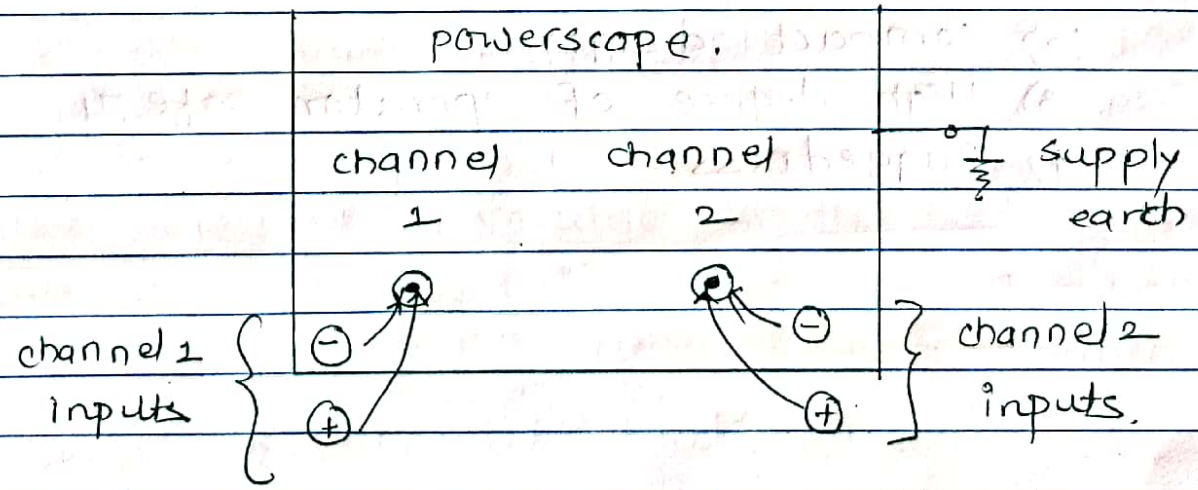

fig: Powerscope inputs.

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Input attenuator :-

- In order to display very high voltage waveforms on the screen of almost the same dimensions as that of a conventional CRO, the i/p attenuator of a powerscope provides higher attenuation to the i/p signal.

Line trigger :-

- A powerscope needs to display high voltage signals at power frequency (50Hz). Therefore, a special control called line trigger is provided to stabilize the displayed high voltage waveform at line frequency.

* Features :-

1) wide range of measurement.
2) compact design.
3) High degree of operator safety.
4) Ruggedness.

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⇒ Power supply :-

- A power supply is an electrical device that supplies electric power to an electrical load.
- The primary function of a power supply is to convert electrtric current from a source to the correct voltage, current and frequency to power the load.
- A simple general purpose desktop power supply used in electronic labs, with power output connectors seen at lower-left and power input connectors (not shown) located at the rear end.

There are 2 types of power supplies
1) AC power supply
2) DC power supply

* AC power supply :-

- An AC power supply typically takes the voltage from a wall outlet (mains supply) and uses a transformer to step up or step down the voltage to the desired vtg.
- In some cases, the source voltage is the same as that the output voltage; this is called an isolation transformer.
- Other AC power supply transformers don't provide mains isolation; these are called autotransformers.

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- A variable output auto transformer is known as a variac. Other kinds of AC power supplies are designed to provide a nearly constant current, & o/p vtg. may vary depending on impedance of the load.
- In some cases when the power source is direct current, (like an automobile storage battery), an inverter & step-up transformer may be used to convert it to AC power.

* DC power supply :-

- A DC power supply is one that supplies a constant DC voltage to its load.
- Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains.

* Block diagram of DC power supply :-

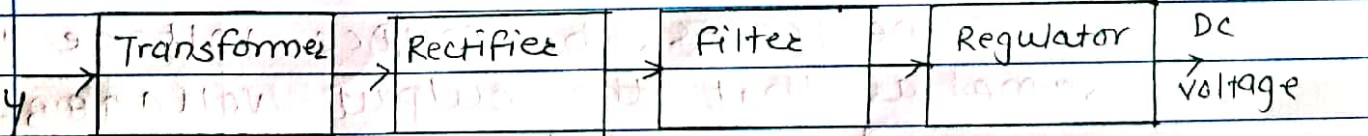

Fig: Block diagram of DC power supply

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- Block diagram of DC power supply consists of AC mains, transformer (step up / step down) rectifier, filter, regulator.
- DC power supply use AC mains electricity as an energy source. such power supplies will employ a transformer to convert the i/p voltage to a higher or lower AC voltage.
- A rectifier is used to convert the transformer output voltage to a pulsating DC voltage which contains some AC ripples in it.
- Which in turns passed through an electronic filters to convert it in to an unregulated DC voltage.
- After filtering ripple contents, unregulated DC voltage is passed trough regulator to make it regulated DC voltage.

⇒ Autotransformer :-

- The transformer in which there will be only one winding which is common to both primary and secondary is called Autotransformer.
- The term Auto here referes to that the voltage i/p variations will be automatically can be improved or can be reduced utilizing the single winding.
- These are popular for industrial automation and marine applications.

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There are 2 types of autotransformers
1) Step-Down autotransformer.
2) step-up autotransformer.

1) step-down autotransformer.

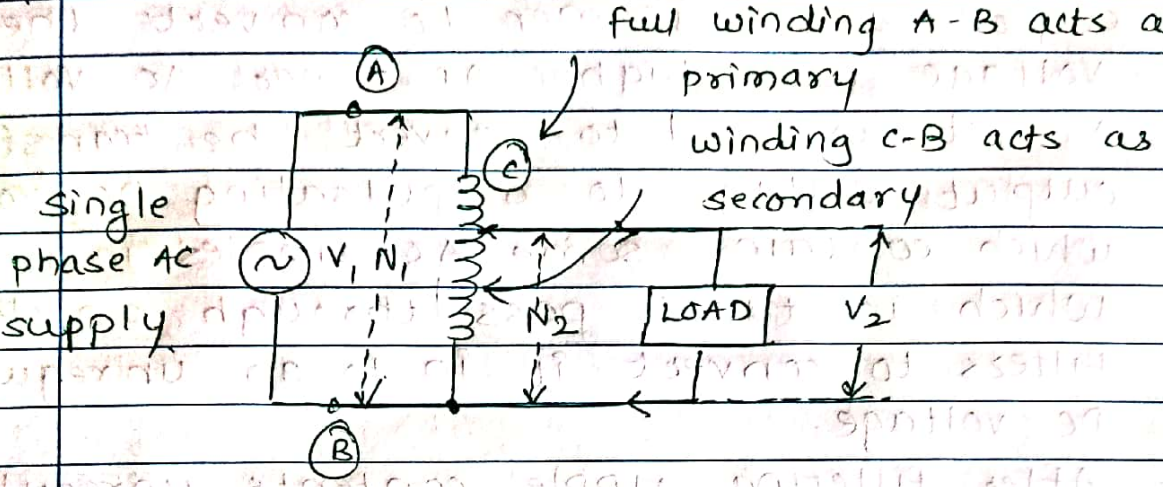

fig: Auto transformer acts as a step-down transformer.

The load voltage for this is given by;

$$V_2 = \frac{N_2}{N_1} \times V_1$$

where;
N_2 - No. of turns corresponding to secondary i.e (C)-(B).
N_1 - No. of turns corresponding to primary i.e (A)-(B).
V_1 - Voltage corresponding to primary.
$N_2 < N_1$ - so called as step-down transformer.

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2) Step - up autotransformer :-

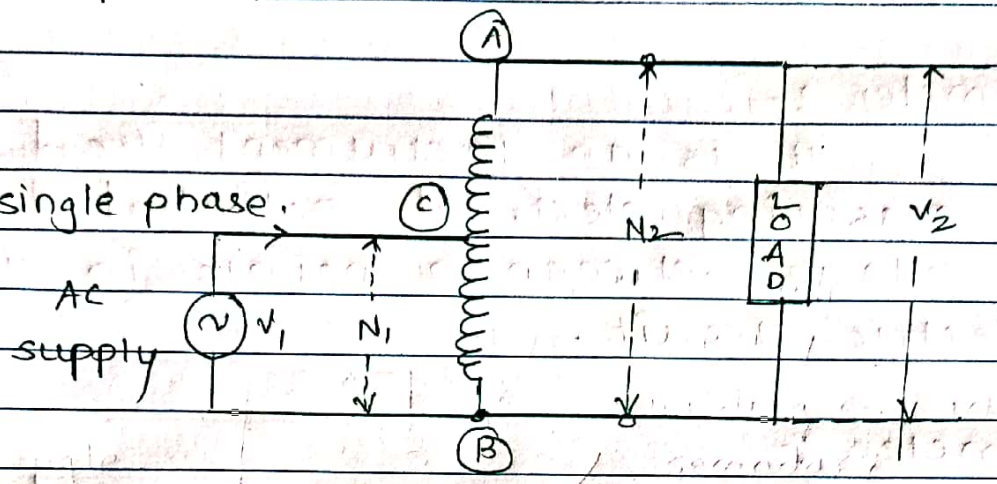

fig :- Auto transformer acts as a step-up transformer.

Load voltage for this can be given by

$$V_2 = \frac{N_2}{N_1} \times V_1$$

Applications :-

1) can be used as variac. (variable Ac supply).
2) Used in order to start Ac machines such as induction / synchronous motors.
3) To vary AC supply voltage
4) As a dimmerstat. (i.e to control the intensity of lamps.).

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⇒ Analog ammeter and voltmeter :-

Voltmeter :-
It is an instrument used for measuring electrical potential difference i.e voltage between 2 points in an electric circuit.

Ammeter :-
It is an instrument used for measurement of electrical current.

- Voltmeter is always connected in parallel with device to measure voltage.
- Ammeter is always connected in series with device to measure current.

connection diagrams :-

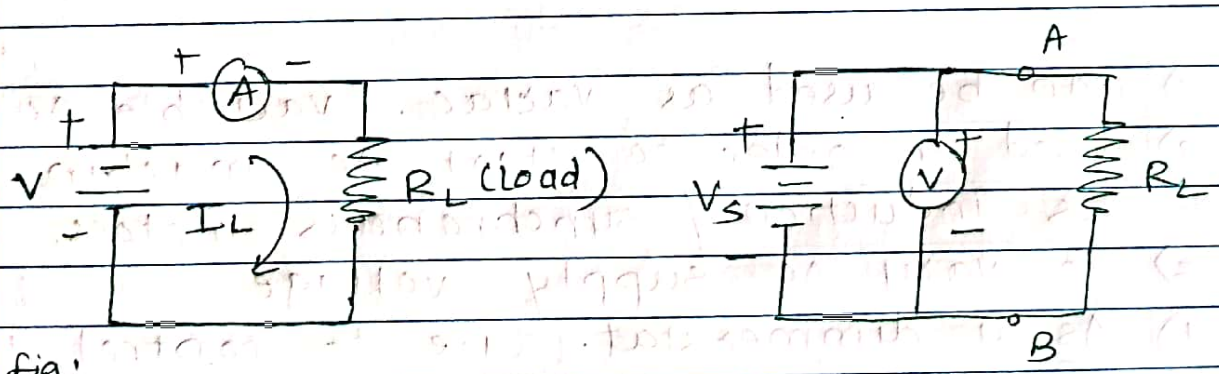

fig:
(a) connection for ammeter

fig (b) connection for voltmeter.

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