

CH0302 Process Instrumentation

Lecture 4 – Introduction



Department of Chemical Engineering
School of Bioengineering
SRM University
Kattankulathur 603203

Introduction - outline

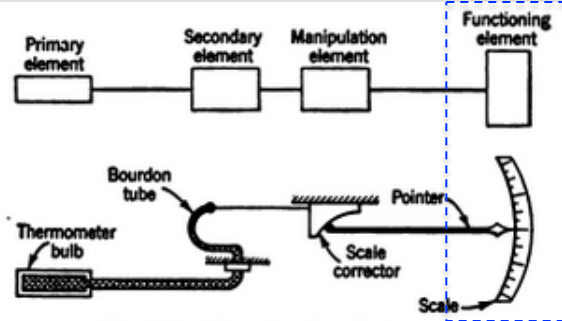
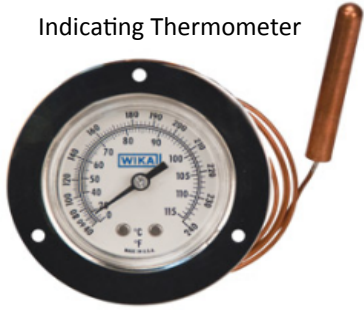
- Features of Functioning Elements
- Control Center
- Instrumentation diagram
- Diagrammatic control-center layer
- Process analysis and Instrumentation in modern plant

Introduction - outline

- **Functioning Elements**
- Control Center
- Instrumentation diagram
- Diagrammatic control-center layer
- Process analysis and Instrumentation in modern plant

Introduction - Elements of a measuring instrument

Indicating Thermometer



- Functioning element

Recap

- This element simply denotes the part of an instrument **used for transmitting, signaling, registering, indicating or recording.**
- In the above figure **pointer and the scale** is the example for the functioning element

Introduction – Functioning elements

- Recording
- Indicating
- Signaling
- Transmission of readings

Introduction – Functioning elements

- **Recording**
- Indicating
- Signaling
- Transmission of readings

- Recording

A part of measuring instrument (**functioning element**) that makes a **written record of value of the measured quantity** against some other variable or time **usually on paper**(ECG papers).

- Recording

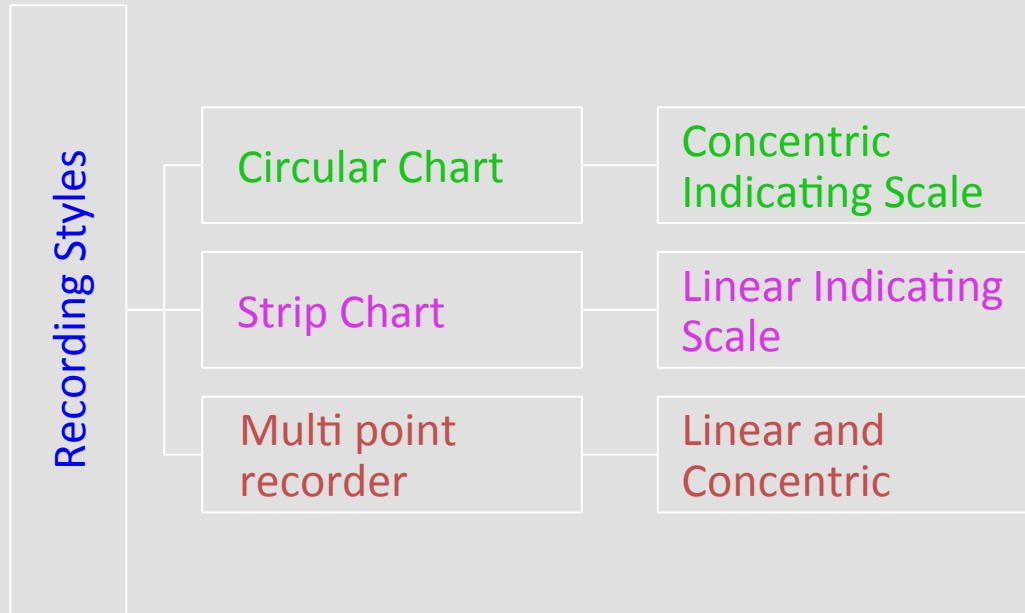
A recording instrument should be employed **when a permanent record of the variable is desirable.**

A record is useful for three main reason:

1. the process operator may refer to the instrument to **observe the trend of the variable as a guide to process operation.**
2. the record may be useful in **locating trouble on the job.**
3. the record may be required for **reference to past performance.**

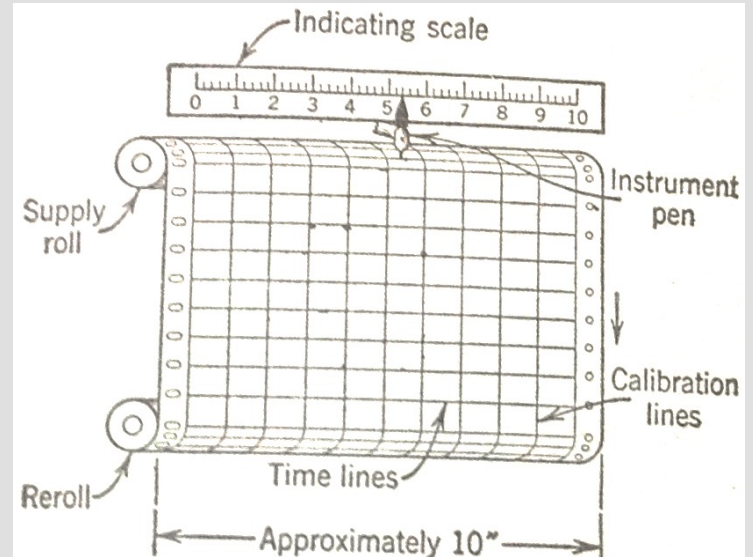
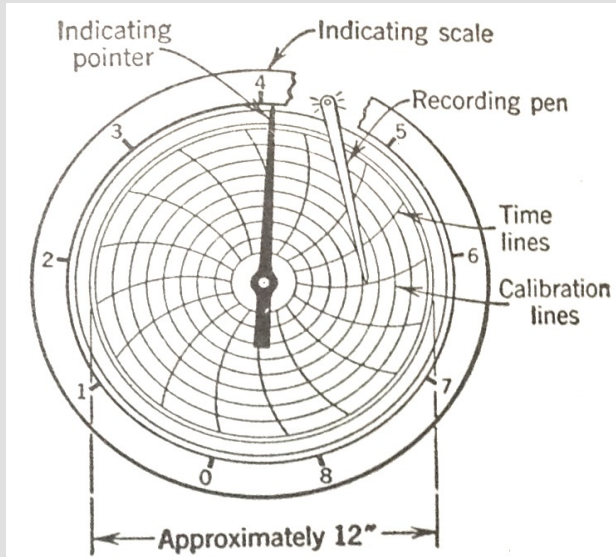
Introduction – Functioning Elements

- Recording Styles



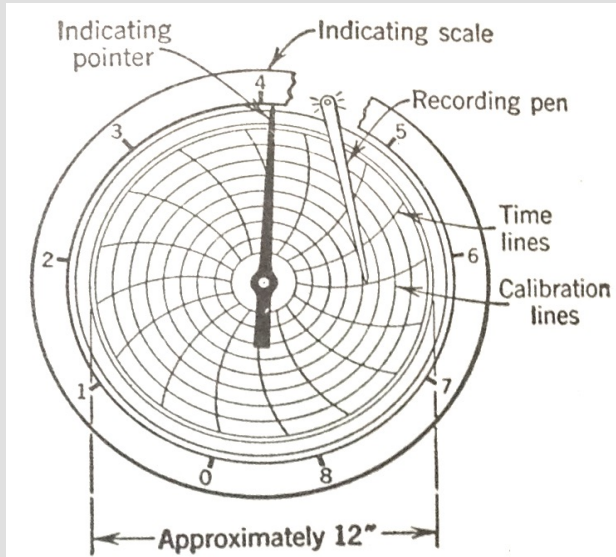
Introduction – Functioning Elements

- Recording Styles

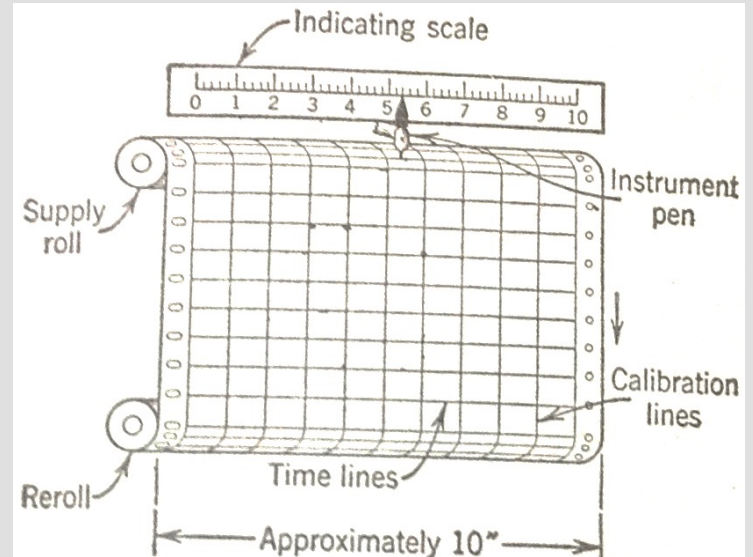


Introduction – Functioning Elements

- Recording Styles



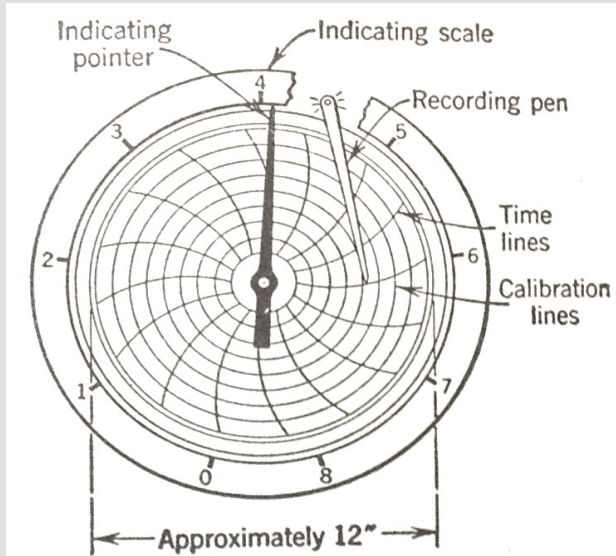
Circular Chart



Strip Chart

Introduction – Functioning Elements

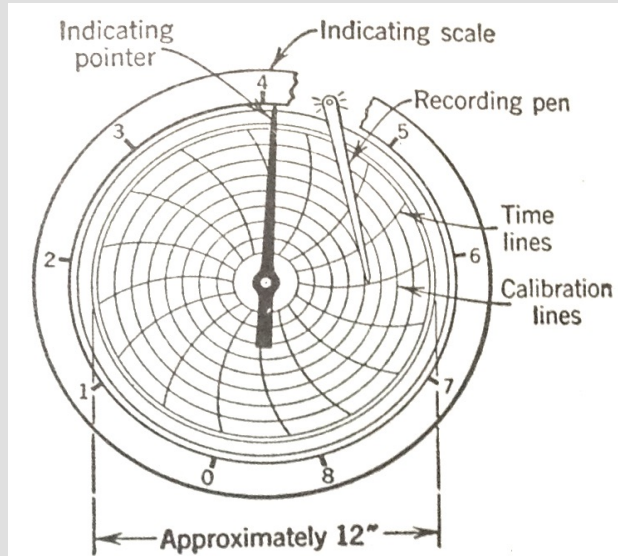
- Recording Styles (Circular Chart)



Circular chart is based essentially on **polar co ordinates** with the exception that “zero” is located away from the center and the **time lines are segments of an arc** instead of straight lines.

Introduction – Functioning Elements

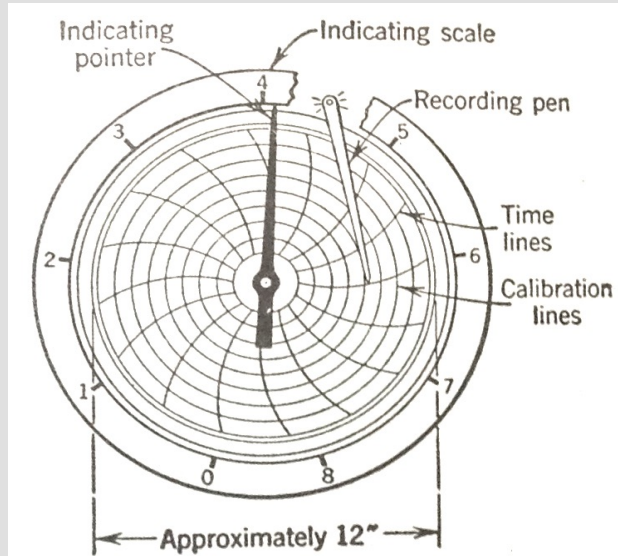
- Recording Styles (Circular Chart)



- The chart is clamped at geometric center and rotate about the center.
- The period of rotation is usually 8h, 24h, or 7 days.
- The speed of rotation can be obtained by choosing a properly geared synchronous motor.

Introduction – Functioning Elements

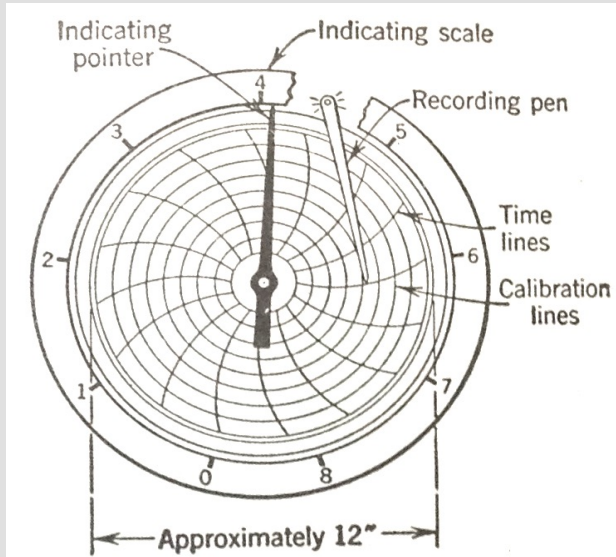
- Recording Styles (Circular Chart)



- Charts are made in two sizes (8" and 12").
- 12" – is most common in industrial work.
- 8" – is used in recording ambient temperature and humidity, where accuracy of reading is not essential.

Introduction – Functioning Elements

- Recording Styles (Circular Chart)



Text book



Industry

Introduction – Functioning Elements

- Recording Styles (Circular Chart)

Temperature indicator

Calibration lines

Recording pen

Front opening door

Time scale in day

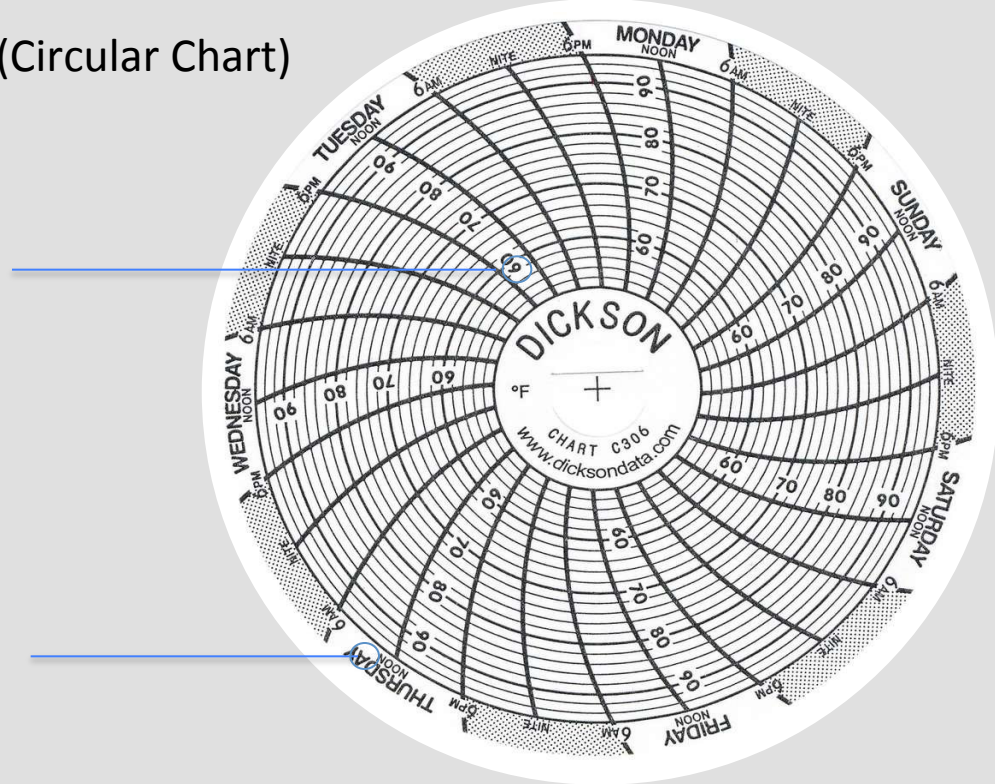


Introduction – Functioning Elements

- Recording Styles (Circular Chart)

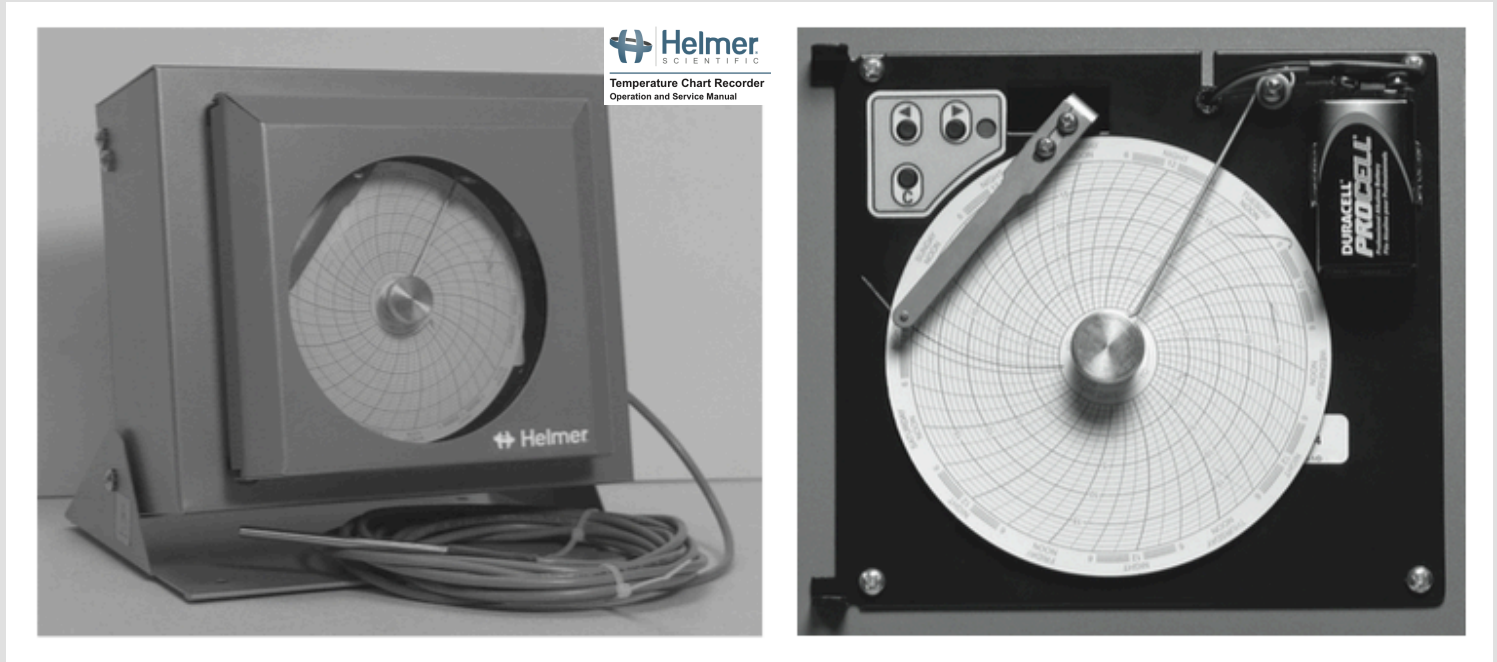
Calibration lines

Time scale in day

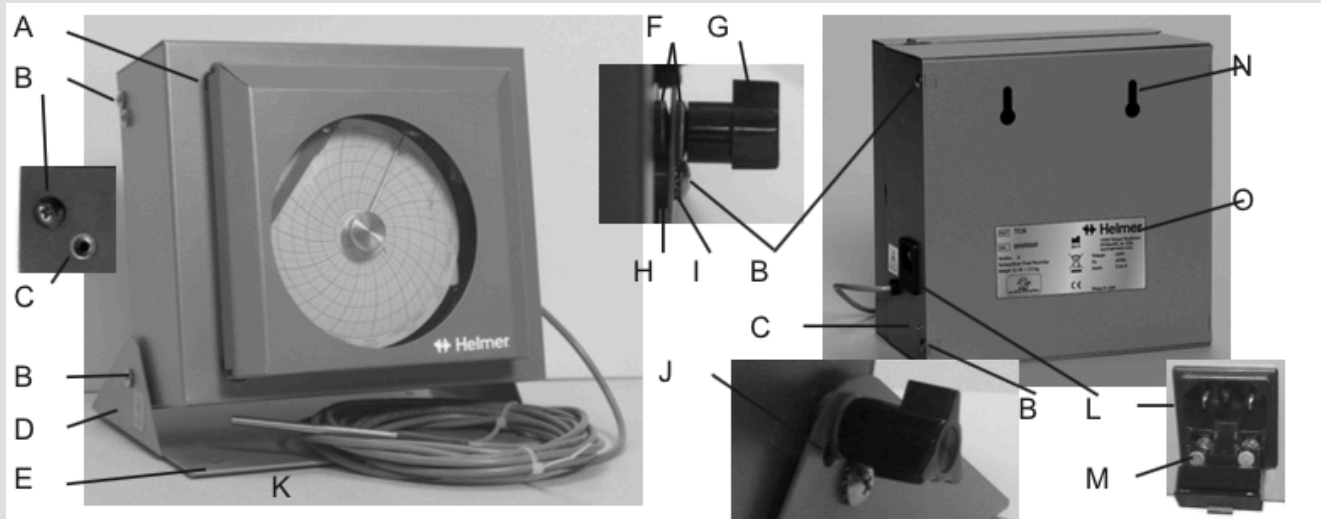


Introduction – Functioning Elements

- Recording Styles (Circular Chart)

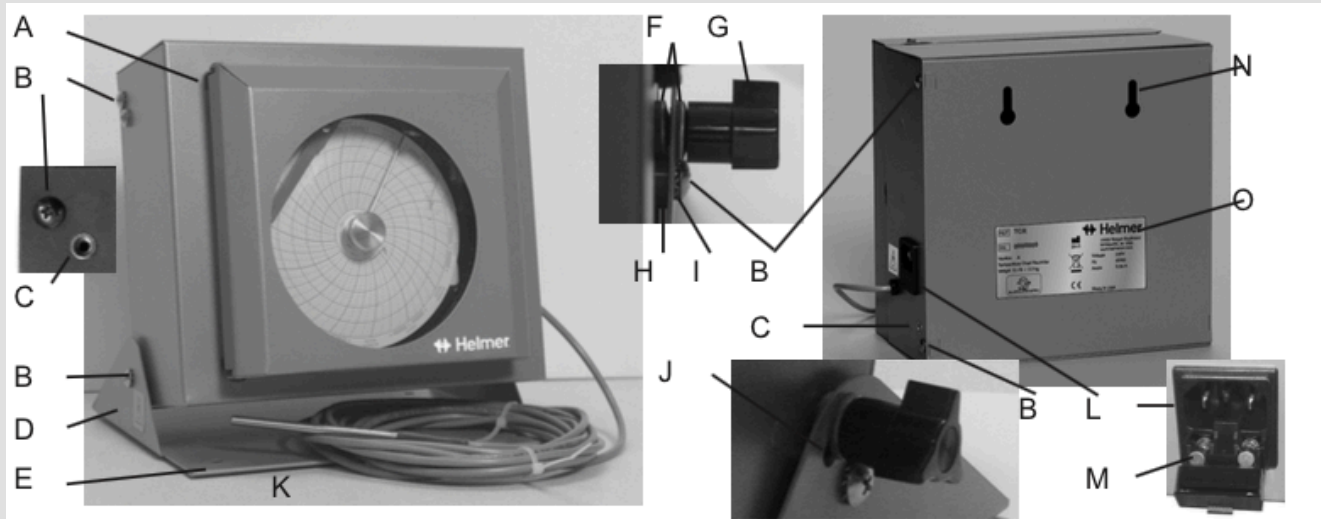


Introduction – Functioning Elements (Recording Chart)



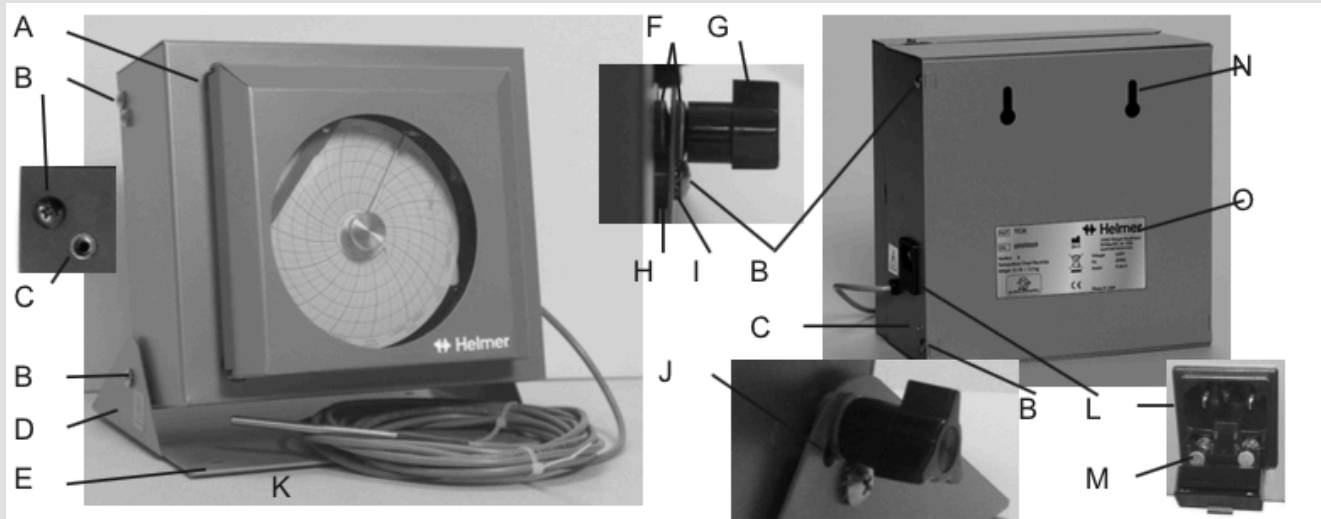
Label	Description	Function
A	Chart recorder door and cover	Used to protect and access the chart recorder
B	Pivot screw	Used to adjust the position of the chart recorder and fasten the cover

Introduction – Functioning Elements (Recording Chart)



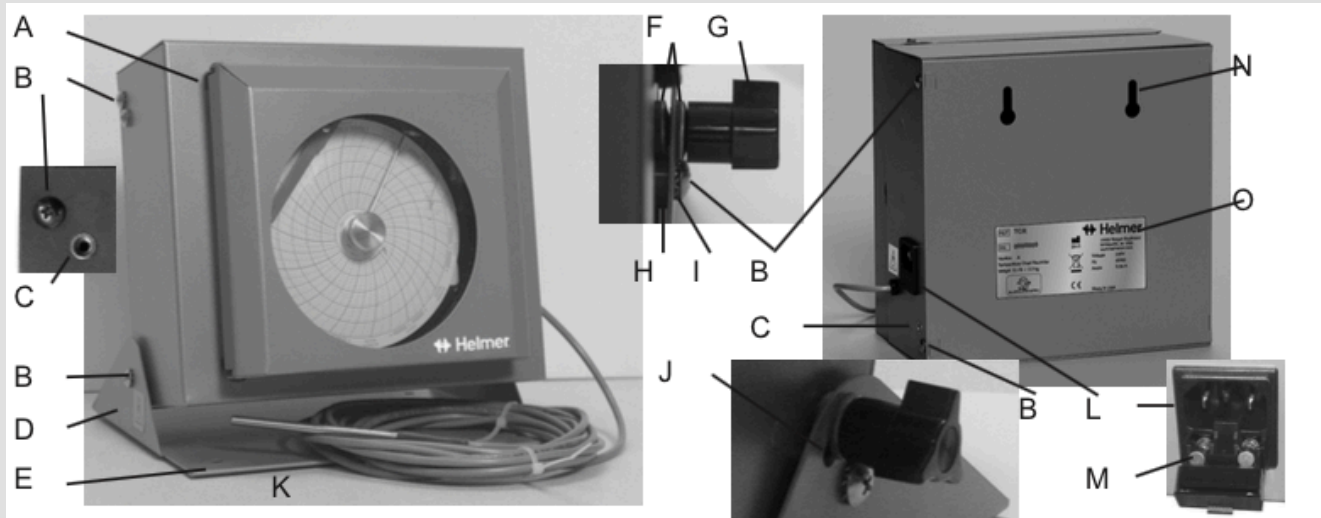
Label	Description	Function
C	Adjustment hole	Used to adjust the position of the chart recorder
D	Stand	Used to adjust the position of the chart recorder, and to mount the chart recorder under a cabinet

Introduction – Functioning Elements (Recording Chart)



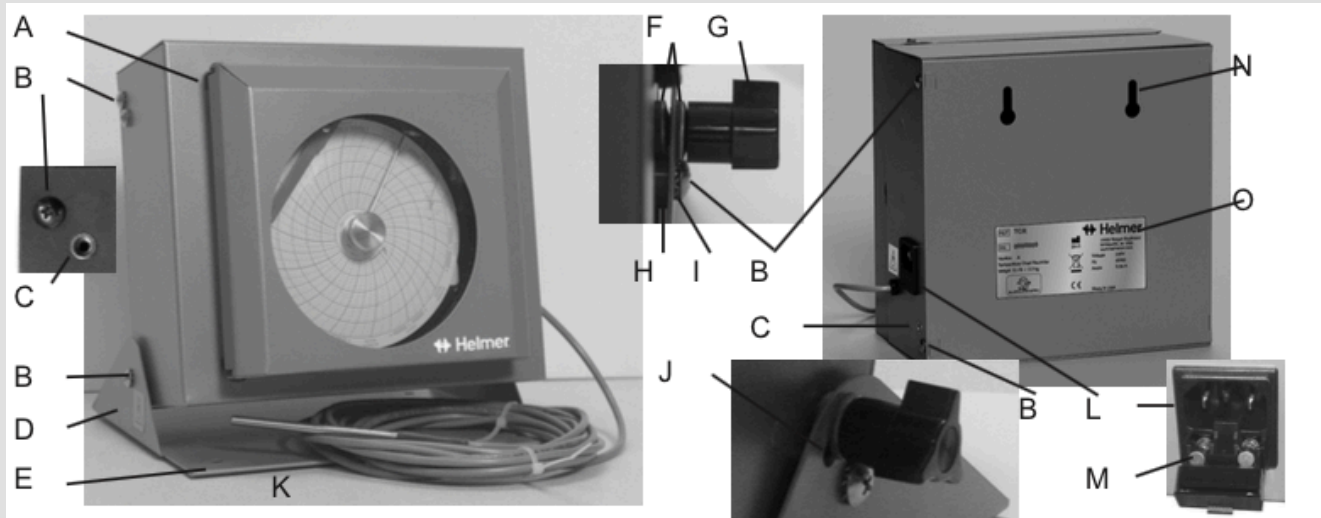
Label	Description	Function
E	Mounting hole on stand	Used to mount the chart recorder under a cabinet
F	Compression washer	Used with the adjustment knob to adjust the position of the chart recorder

Introduction – Functioning Elements (Recording Chart)



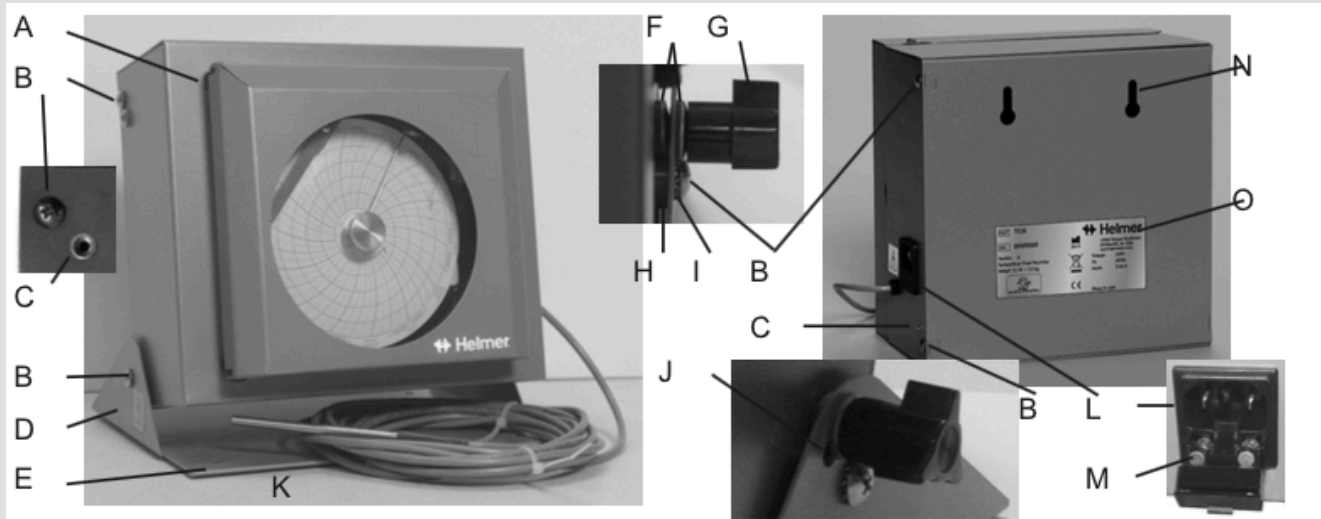
Label	Description	Function
G	Adjustment knob	Used to adjust the position of the chart recorder
H	Nylon washer	Used with the pivot screws to adjust the position of the chart recorder

Introduction – Functioning Elements (Recording Chart)



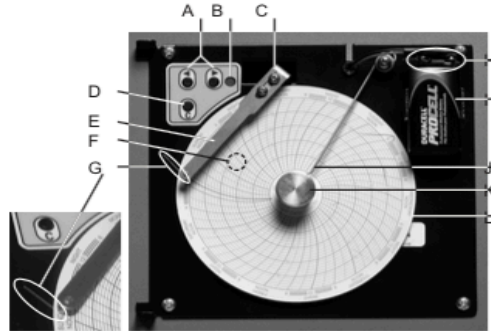
Label	Description	Function
I	Lock washer	Used with the pivot screws to adjust the position of the chart recorder
J	Adjustment slot	Used to adjust the position of the chart recorder

Introduction – Functioning Elements (Recording Chart)



Label	Description	Function
N	Wall mounting hole	Used to mount the chart recorder on a wall
O	Product Specification label	Provides the model number, serial number, and electrical requirements for the chart recorder

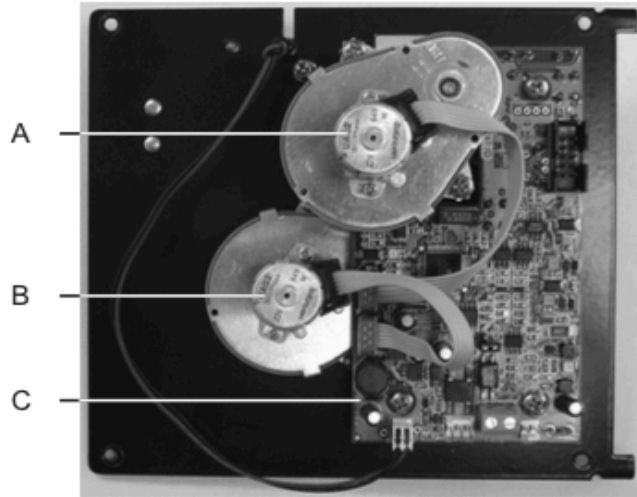
Introduction – Functioning Elements (Recording Chart)



Front of chart recorder with chart paper and battery installed

Label	Description	Function
A	Left and Right Arrow buttons	Used to adjust settings and the stylus position
B	LED (light-emitting diode)	Indicates the status of the chart recorder while in operating mode, or the selected temperature range value in paper change mode
C	Mounting bracket	Maintains the angle of the stylus
D	C (Chart Change) button	Used to adjust the position of the stylus when changing the chart paper, or to run a test pattern
E	Stylus	Marks the temperature line on the paper
F	Reset button	Used to restart the chart recorder
G	Time line groove	Used to calibrate the chart paper to the correct time
H	Battery leads	Connects the backup battery to the chart recorder
I	Backup battery	Provides power if AC power fails
J	Chart knob holder	Prevents loss of the chart knob
K	Chart knob	Holds the chart paper in place
L	Chart paper	Used to record temperature information

Introduction – Functioning Elements (Recording Chart)

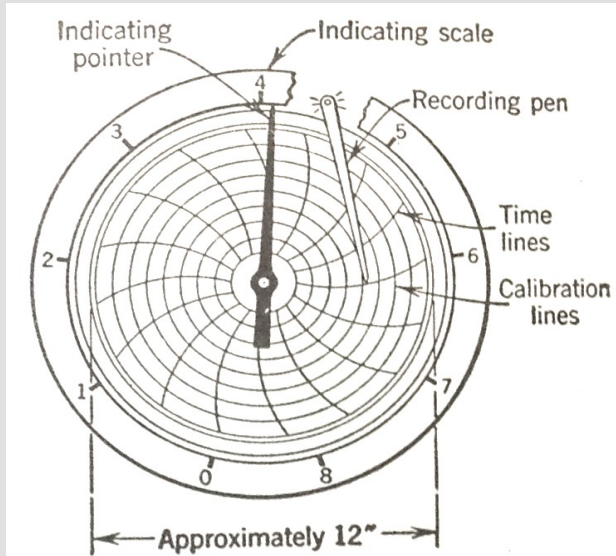


Rear of chart recorder

Label	Description	Function
A	Stylus (pin) motor	Moves the stylus
B	Paper motor	Rotates the paper
C	Circuit board	Controls chart recorder operation

Introduction – Functioning Elements (Recording Chart)

- Recording Styles (Circular Chart)

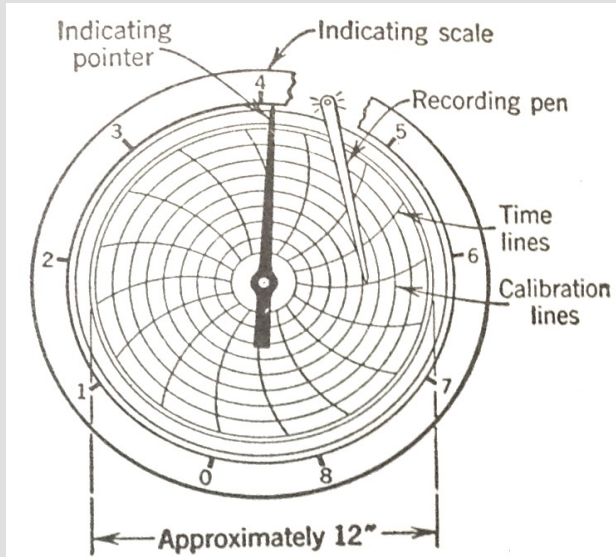


Advantages

- **Entire record** of one process period (4h, 8h, 12h etc.) **is available at a glance.**
- **Long chart length** is available for one process period.
- It is **easily filed** for future reference.
- Most advantageously used to record a **wildly fluctuating variable** where the process period is not greater than 24h

Introduction – Functioning Elements (Recording Chart)

- Recording Styles (Circular Chart)

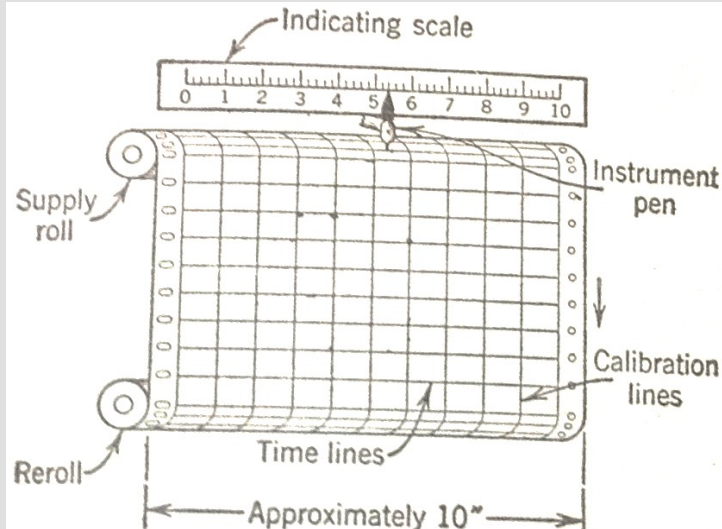


Disadvantages

- Requires a careful controlled environment (temperature and humidity conditions) on a high grade paper.
- Humidity under actual use causes the paper to expand and contract into elliptical shape.

Introduction – Types

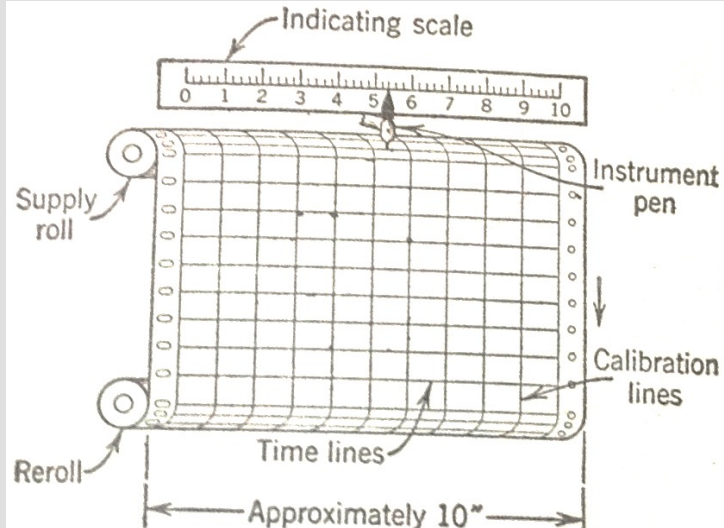
- Recording Styles (Strip/Rectangular Chart)



- The **chart** is driven from **supply roll** to the **reroll** by a synchronous motor.
- The speed of movement of paper is usually given in **inches per hour**.
- Normally used speed are 1, 2, and 4" per hour
- Even speed **upto 20"/h** are available

Introduction – Types

- Recording Styles (Strip Chart)

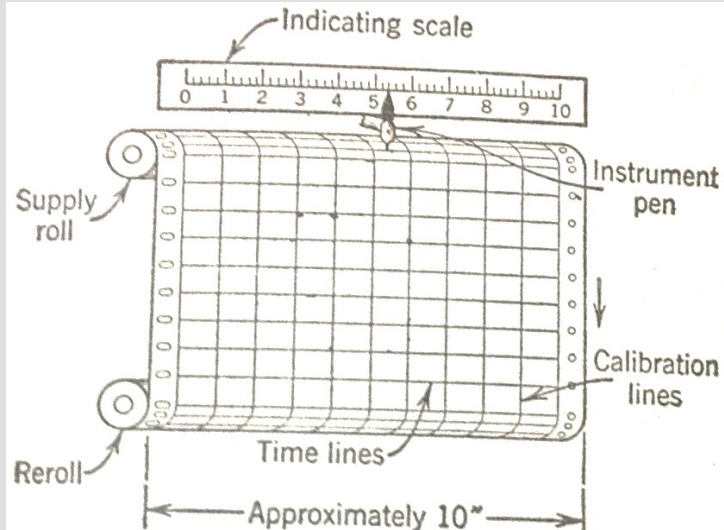


Advantages

- Does not require frequent changing
- Long process (24h or longer) are easily recorded
- Easy readability

Introduction – Types

- Recording Styles (Strip Chart)

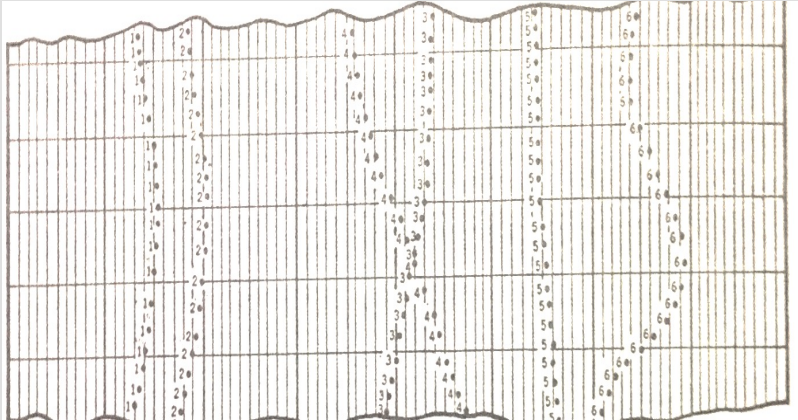


Disadvantages

- Limited length of chart is visible
- Difficult to file and not easily used for reference.
- Easy readability.
- Humidity variations can cause strip to change its width

Introduction – Types

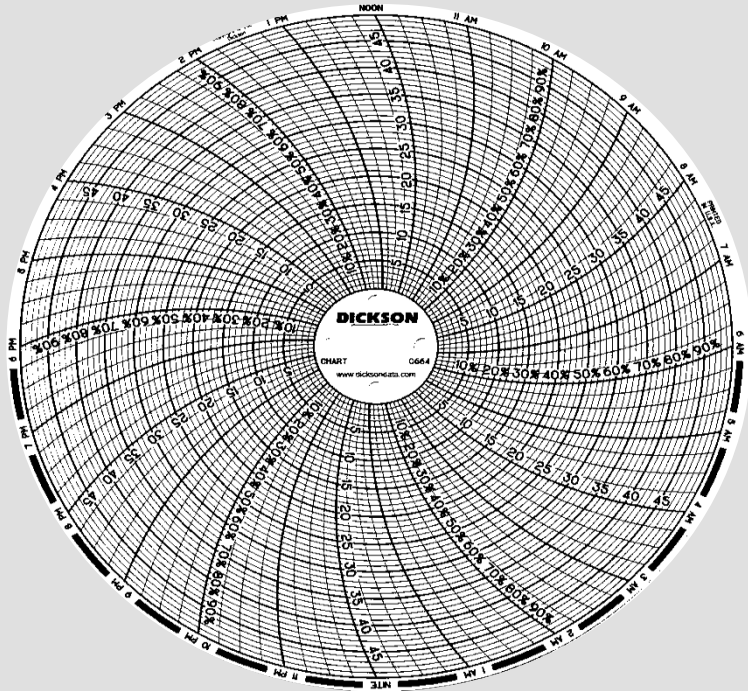
- Recording Styles (Multipoint – Strip chart type)



- Used to record **Several variable** on one chart
- Used when **the variable do not greatly vary with time** .
- Uses **circular or strip charts**
- Continuously record up to **2 - 16 variable**.

Introduction – Types

- Recording Styles (Multipoint- Circular type)



- Used to record Several variable on one chart
- Used when the variable do not greatly vary with time .
- Uses circular or strip charts
- Continuously record up to 2 - 16 variable.

Introduction – Functioning elements

- Recording
- **Indicating**
- Signaling
- Transmission of readings

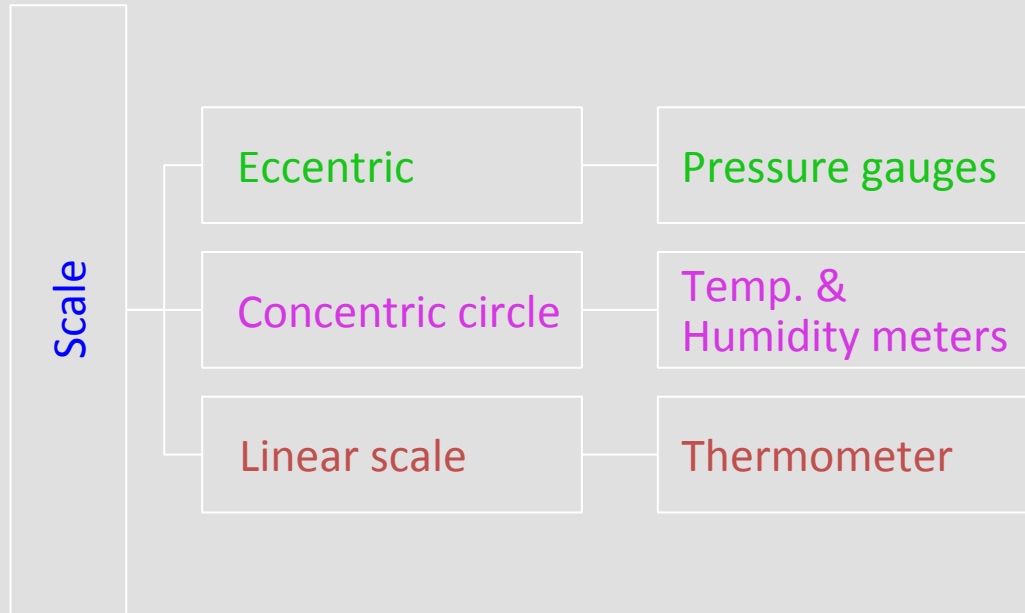
Introduction – Functioning elements

- Indicating

An indicating instrument is used **when only the present value of the variable has the meaning and the past record is of no consequence.**

Introduction – Functioning elements

- Indicating



Introduction – Functioning Elements

- Indicating

Eccentric Scale



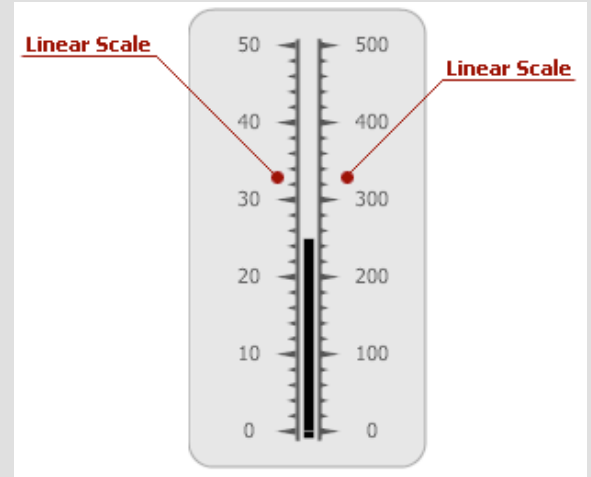
Galvanometer

Eccentric Scale



Steam Pressure gauges

Linear Scale



Linear Scale

Thermometer scale

Introduction – Types

- Indicating

For readability there is no doubt that **concentric scale** offers greatest scale length in the smallest place.

Introduction – Functioning elements

- Recording
- Indicating
- **Signaling**
- Transmission of readings

Introduction – Types

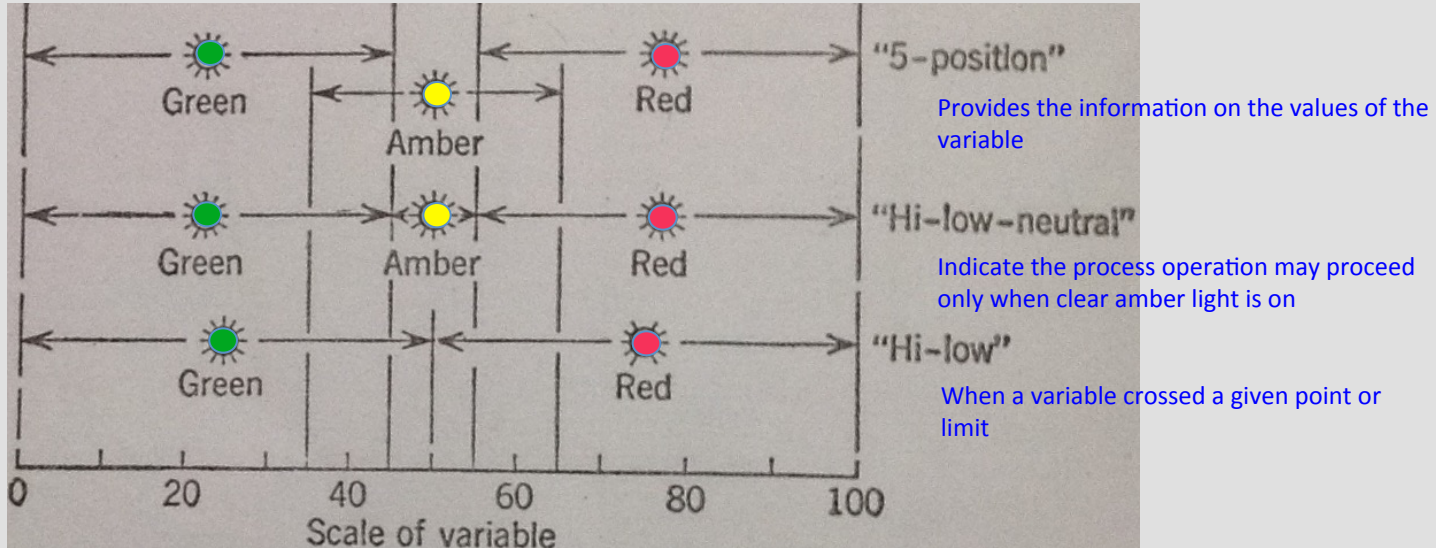
- Signaling

Indicates whether the **variables are within certain limits**

Signal light **lights and horns** are used as visual and audible signals

Introduction – Types

- Signaling



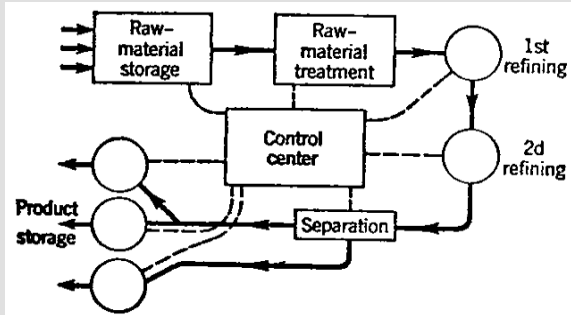
Introduction – Control Center

- Control center
- Instrumentation diagram
- Symbols
- Process analysis

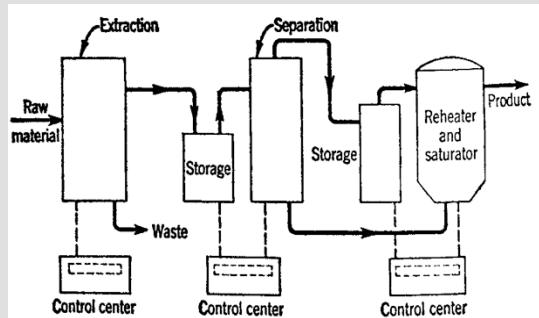
Introduction – Control Center

- Control center
- Instrumentation **devices or equipment grouped** at **one location** near the **processing unit or manufacturing operation**.
 1. **Centrally** located – in order to obtain best co ordination in operations. Preferably used for large scale production process.
 2. **Unit** located – Small size plants where operations requires no co-ordination.
 3. **Unit** control-center enclosed **with concrete**

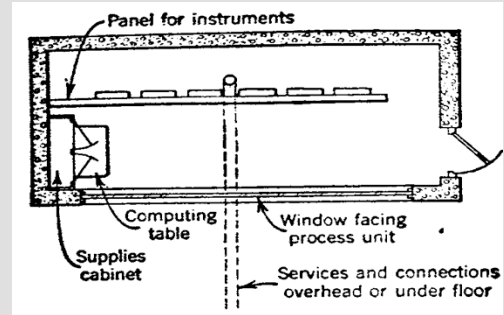
Introduction – Control Center



Centrally located



Unit located



Unit control-center enclosed with concrete

- Control center

At any event the control center must have the following

1. Clean and dry atmosphere
2. Relatively constant temperature and humidity
3. No vibration
4. Adequate light

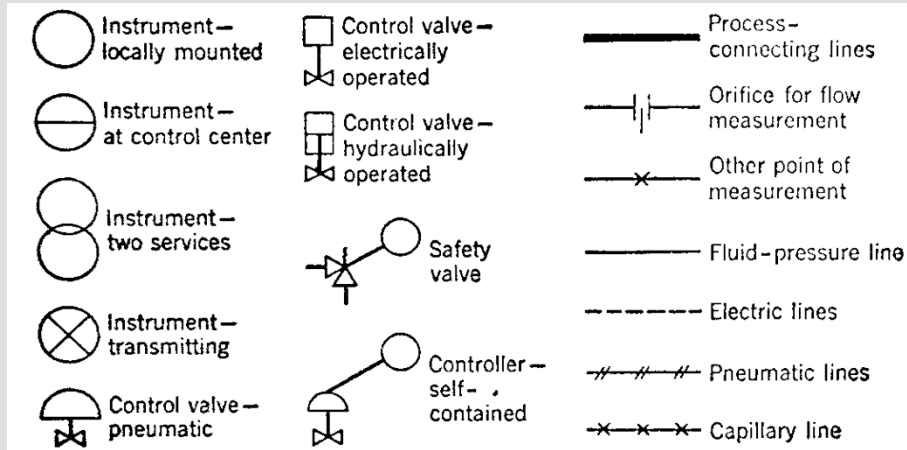
- Instrumentation Diagram

Minimum requirements of instrumentation diagram, i.e. the diagram should indicate

1. the **variable being measured**
2. whether **indicating recording or other services is required**
3. whether **control or alarm functions** are required
4. the auxiliary **functions of instruments and controller**
5. type of **connection lines**
6. **approximate location of point of measurement**

Introduction – Instrumentation diagram symbols

- Instrumentation Diagram (Additional Symbols)



- Process Analysis

- 1 Divide the plant functions into **smallest operation elements or units**
- 2 List **all the variables** (temperature, pressure, composition so on and so forth) **that may affect each process** operation element.
- 3 Add **ambient temperature, pressure, humidity and wind** conditions to the above list.
- 4 Divide the list of **variables into four groups**:

Introduction – Process Analysis

- a) Variables to be controlled **automatically**
- b) Variables to be measured **continuously**
- c) Variable to be measured **periodically**
- d) Variables **neither measured nor controlled**

5. For each variable of **automatic control** group, select:

- a) A **method of measurement** that will provide data most **indicative of the desired process performance**.
- b) A **Mode of control** that will provide the desired performance in view of process dynamics.
- c) A **location for the controller** – centrally located or unit located.
- d) A **style of controller** – non-indicating, indicating or recording.

6. For each variable of the **continuous measurement** group, select:
- a) What method will provide data of the **desired process performance**.
 - b) **Whether signaling, indicating or recording** – is most desirable.
 - c) Whether signaling, indicating or recording **should be located at the control center or at the unit**.

7. For each variable of the **periodic measurement** group, select:
 - a) Decide on a **method of performing measurement** and **frequency with which the measurement** must be made.

8. **Construct** an instrumentation diagram

References

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6. Instrumentation Systems and Automation society ISA-5.1-1984 Standards.