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Application of Electronics in Fabric Testing Instruments in Textile

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Abstract - The electronics techniques have entered through many fields. In textile industry many electronic components are used and many instruments and machines are fitted with electronic measurement techniques. In this paper fabric testing instruments fitted with electronic components are discussed. How those instruments are working could be found from electronics literature. The working of instruments for determining quality particulars of fabric, fabric tensile strength, seam strength, tear strength, abrasion tester, pill box, drape tester, fabric stiffness, air permeability tester, water repellency tester are discussed. Using these techniques hard calculations are avoided and quick results are obtained. Study of these techniques can be included in the syllabus of new students and it will enhance the knowledge and understanding of subjects and unnecessary training in industry could be lessened.

***Key Words*:** PLC, Bridge circuits, Transducers, Camera, Sensors, Flowmeters.

1. INTRODUCTION

In this paper i.e Textile industry is one of the ancient industries which came into existence along with the mankind. As we all know that during the beginning of Middle Ages humans used to spin and weave cotton using needle and thread. This industry took a giant leap during the industrial revolution during last century and changed the way of spinning and weaving cloths. But these changes remain steady for more than a century until it became a subject for scientific study or need for designing the machines that can complete the complicated tasks of cloth spinning, fabric designing, production etc. automatically and more efficiently. The latest developments in the field of Electronics made it possible to achieve greater efficiency through the electronics machines. Today's textile industry is focusing on implementing these latest technologies in all the sectors of textile industry to increase the efficient production at lesser prices. This is given in reference (1).

2. Programmable Logic Controller (PLC)

A Programmable Logic Controller, or PLC, is a ruggedized computer used for industrial automation. These controllers can automate a specific process, machine function, or even an entire production line.

How does a PLC work?

The PLC receives information from connected sensors or input devices, processes the data, and triggers outputs based on pre-programmed parameters. Depending on the inputs and outputs, a PLC can monitor and record run-time data such as machine productivity or operating temperature, automatically start and stop processes, generate alarms if a machine malfunctions, and more. Programmable Logic Controllers are a flexible and robust control solution, adaptable to almost any application.

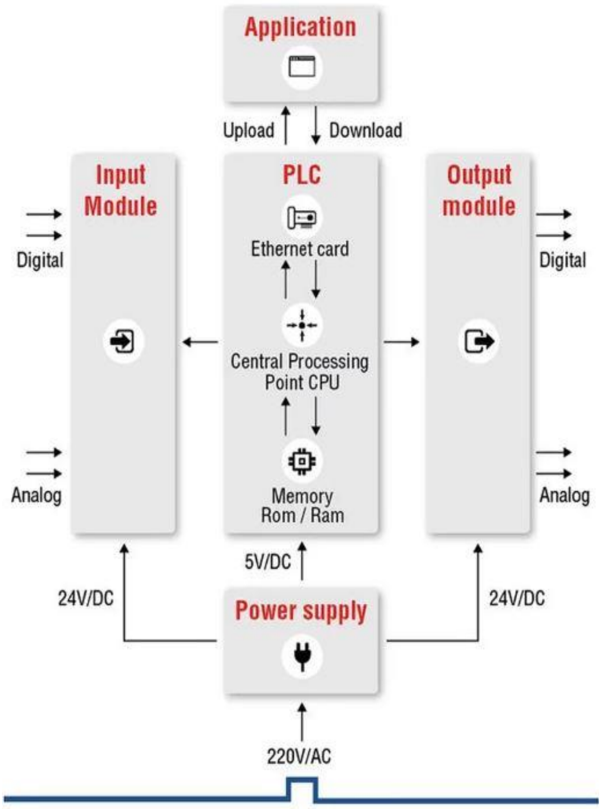

Fig-1:

What is a PLC? – Programmable Logic Controller

A Programmable Logic Controller, also called a PLC or programmable controller, is a computer-type device used to control equipment in an industrial facility.

The kinds of equipment that PLCs can control are as varied as industrial facilities themselves. Utility Plants, Batch

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Control Application, Chemical Processing, Conveyor systems, food processing machinery, auto assembly lines etc…you name it and there's probably a PLC out there controlling it.

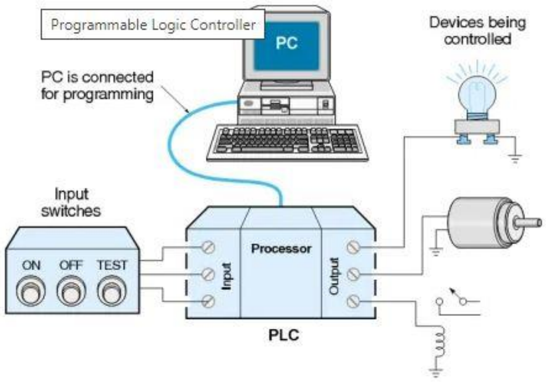

Fig-2: Programmable Logic Controller (PLC)

In a traditional industrial control system, all control devices are wired directly to each other according to how the system is supposed to operate. In a PLC system, however, the PLC replaces the wiring between the devices.

Thus, instead of being wired directly to each other, all equipment is wired to the PLC. Then, the control program inside the PLC provides the "wiring" connection between the devices.

The control program is the computer program stored in the PLC's memory that tells the PLC what's supposed to be going on in the system. The use of a PLC to provide the wiring connections between system devices is called soft wiring.

EXAMPLE

Let's say that a push button is supposed to control the operation of a motor.

In a traditional control system, the push button would be wired directly to the motor. In a PLC system, however, both the push button and the motor would be wired to the PLC instead.

Then, the PLC's control program would complete the electrical circuit between the two, allowing the button to control the motor.

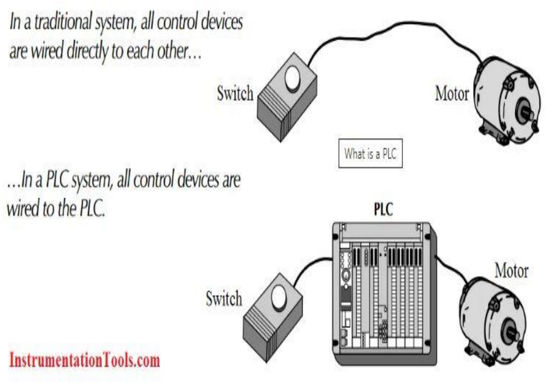

Fig-3:

The soft-wiring advantage provided by programmable controllers is tremendous.

In fact, it is one of the most important features of PLCs. Soft-wiring makes changes in the control system easy and cheap.

If you want a device in a PLC system to behave differently or to control a different process element, all you have to do is change the control program.

In a traditional system, making this type of change would involve physically changing the wiring between the devices, a costly and time-consuming endeavor. This is given in reference (3).

In textile instruments many PLC are employed and the working of the instruments is made easy with digital output. In this paper testing of fabrics are done using the modern electronic equipments. These are analysed and given here.

3. Testing of Fabrics

The various types of instruments used in textile industry for Fabrics are given in reference (2). The modern developments are given in reference (4). How they are working is not taught for textile persons. The working and circuit of some instruments are analysed and presented in the following paper.

The various tests used for textile fabrics are given below.

i. Quality particulars of fabrics
ii. Fabric strength
iii. Fabric abrasion, handle
iv. Air and water permeability
v. Objective measurement using KES-F, FAST, sensory Handmatry or colorimetry

4. Quality particulars of fabric

The fabric length & width of fabric, thickness, threads per inch, fabric weight, yarn crimp using Shirley crimp tester are tested in old instruments. Various fabric inspection machines are available for measuring the length and width of the fabric and also the defects in the fabric. For counting threads/inch, counting glass was used. Now counting glass with LED light facility and traverse thread counter are available in market. Fabric weight GSM was previously done with weighing piece of fabric and calculating the GSM using basic definitions. Now GSM cutter, weighing balance and direct reading is obtained without calculations. The crimp of yarn can be read digitally in crimp tester.

Motor rotates the roller and fabric is unwound & collected in the back roller. During its path the length and width measurement is carried out. The length is measured using ultrasonic rule.

The ultrasonic rule consists of an ultrasonic energy source, an ultrasonic energy detector and battery-powered, electronic circuitry housed within a hand-held box, as shown in Fig-4. Both source and detector often consists of the same type

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of piezoelectric crystal excited at a typical frequency of 40 kHz. Energy travels from the source to a target object and is then reflected back into the detector. The time of flight of this energy is measured and this is converted into a distance reading by the enclosed electronics. Maximum measurement inaccuracy of ±1% of the full-scale reading is claimed. This is only a modest level of accuracy, but it is sufficient for such purposes as measuring rooms by estate agents prior to producing sales literature, where the ease and speed of making measurements is of great value.

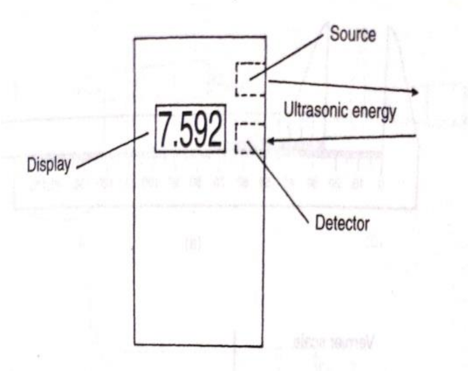

Fig-4: Ultrasonic rule

A fundamental problem in the use of ultrasonic energy of this type is the limited measurement resolution (7mm) imposed by the 7mm wavelength of sound at this frequency. Further problems are caused by the variation in the speed of sound with humidity (variations of ±0.5% possible) and the temperature-induced variation of 0.2% per ^{0}C. Therefore, the conditions of use must be carefully controlled if the claimed accuracy figure is to be met.

The width measurement is done with gauge blocks and length bars.

Gauge Blocks (Slip Gauges) and Length Bars

Gauge blocks, also known as slip gauges (see Fig-5 (a)), consist of rectangular blocks of hardened steel that have flat and parallel end faces. These faces are machined to very high standards of accuracy in terms of their surface finish and flatness. The purpose of gauge blocks is to provide a means of checking whether a particular dimension in a component is within the allowable tolerance rather than actually measuring what the dimension is. To do this, a number of gauge blocks are joined together to make up the required dimension to be checked. Gauge blocks are available in five grades of accuracy known as calibration, 00, 0, 1 and 2. Grades 1 and 2 are used for normal production and inspection measurements, with the other grades being intended only for calibration procedures at various levels.

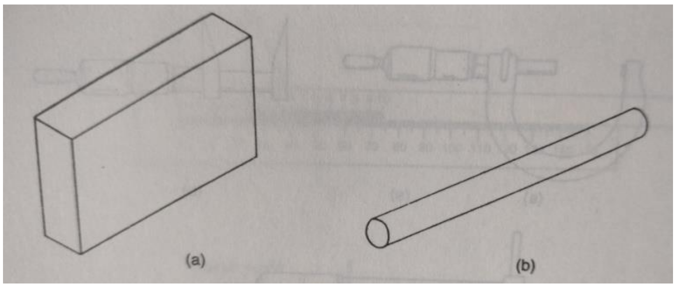

Fig-5: (a) Gauge Block; (b) Length Bar

Gauge blocks are available in boxed sets containing a range of block sizes, which allows any dimension up to 200 mm to be constructed by joining together an appropriate number of blocks. Whilst 200 mm is the maximum dimension that should be set up with gauge blocks alone, they can be used in conjunction with length bars to set up much greater standard dimensions. Blocks are joined by 'wringing', a procedure in which the two end faces are rotated slowly against each other. This removes the air film and allows adhesion to develop by intermolecular attraction. Adhesion is so good in fact that, if groups of blocks were not separated within a few hours, the molecular diffusion process would continue to the point where the blocks would be permanently welded together The typical inter block gap resulting from wringing has been measured 0.001 µm, which is effectively zero. Thus, any number of blocks can be joined without creating any significant measurement error. It is fairly common practice with blocks of grades 0, 1 and 2 to include an extra pair of 2 mm thick blocks in the set that an made from wear-resisting tungsten carbide. These are marked with a letter P and are designed to protect the other blocks from wear during use. Where such protector blocks are used, due allowance has to be made for their thickness (4 mm) in calculating the sizes of block needed to make up the required length.

A necessary precaution when using gauge blocks is to avoid handling them more than is necessary. The length of a bar that was 100 mm long at 20°C would increase to 100.02 mm at 37°C (body temperature). Hence, after wringing bars together, they should be left to stabilize back to the ambient room temperature before use. This wait might need to be several hours if the blocks have been handled in any significant extent.

Where a greater dimension than 200 mm is required, gauge blocks are used in conjunction with length bars (Fig-5: (b)). Length bars consist of straight, hardened high-quality steel bars of a uniform 22 mm diameter and in a range of lengths between 100 mm and 1200 mm. They are available in four grades of accuracy, reference, bration, grade 1 and grade 2. Reference and calibration grades have accurately flat end faces, which allows a number of bars to be wrung together to obtain the required standard length. Bars of grades 1 and 2 have threaded ends that allow them to be screwed together Grade 2 bars are used for general measurement duties, with grade 1 bars being reserved for inspection duties. By combining length bars with gauge blocks, any dimension up to about 2 m can be set up with a resolution of 0.0005 mm.

These readings are automatically sent to PLC with sensors and then digital output is given from PLC.

The defects over the fabric can be automatically counted and presented in digital form.

Optical sensors (fibre-optic)

As an alternative to using air as the transmission medium, optical sensors can use fibre optic cable instead to transmit light between a source and a detector. In such sensors, the variable being measured causes some measurable change in the characteristics of the light transmitted by the cable. However, the problems and solutions that were described in Chapter 8 for fibre-optic signal transmission, in ensuring that at the proportion of light entering the cable is maximized, apply equally when optical fibres are used as sensors. The basis of operation of fibre-optic sensors is the translation of the physical quantity measured into a change in one or more parameters of a light beam. The light parameters that can be modulated are one or more of the following:

- intensity
- phase
- polarization
- wavelength
- transmission time

Fibre-optic sensors usually incorporate either glass/plastic cables or all plastic cables. All glass types are rarely used because of their fragility. Plastic cables have particular advantages for sensor applications because they are cheap and have a relatively large diameter of 0.5-1.0 mm, making connection to the transmitter and receiver easy. However, plastic cables should not be used in certain hostile environments where they may be severely damaged. The cost of the fibre-optic cable itself is insignificant for sensing applications, as the total cost of the sensor is dominated by the con of the transmitter and receiver.

Fibre-optic sensors characteristically enjoy long life. For example, the life expectancy of reflective fibre-optic switches is quoted at ten million operations. Their accuracy also good, with, for instance, ±1% of full-scale reading being quoted as a typical in curacy level for a fibre-optic pressure sensor Further advantages are their simplicity low cost, small size, high reliability and capability of working in many kinds of hostile environment.

Two major classes of fibre-optic sensor exist, intrinsic sensors and extrinsic sensors. In intrinsic sensors, the fibre-optic cable itself is the sensor, whereas in extrinsic sensors, the fibre-optic cable is only used to guide light to/from a conventional sensor.

Intrinsic Sensors

Intrinsic sensors can modulate either the intensity, phase, polarization, wavelength or transit time of light. Sensors that modulate light intensity tend to use mainly multimode fibres, but only monomode cables are used to modulate other light parameters. A particularly useful feature of intrinsic fibre-optic sensors is that they can, if required, provide distributed sensing over distances of up to 1 metre.

Light intensity is the simplest parameter to manipulate in intrinsic sensors because only a simple source and detector are required. The various forms of switches shown in Fig-6: are perhaps the simplest form of these, as the light path is simply blocked and unblocked as the switch changes state.

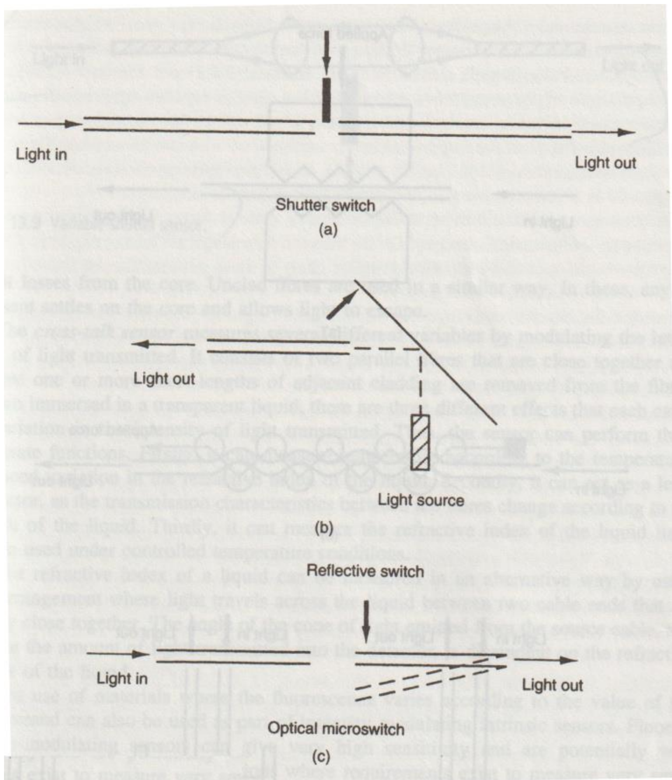

Fig-6: Intrinsic Fibre-Optic Sensors

Modulation of the intensity of transmitted light takes place in various simple forms of proximity, displacement, pressure, pH and smoke sensors. Some of these are sketched in Fig-7:.

In proximity and displacement sensors (the latter are often given the special name fotonic sensors), the amount of reflected light varies with the distance between the fibre ends and a boundary. In pressure sensors, the refractive index of the fibre and hence the intensity of light transmitted, varies according to the mechanical deformation of the fibres caused by pressure. In the pH probe , the amount of light reflected back into the fibres depends on the pH-dependent colour of the chemical indicator in the solution around the probe tip. Finally, in a form of smoke detector, two fibre-optic cables placed either side of a space detect any reduction in the intensity of light transmission between them caused by the presence of smoke.

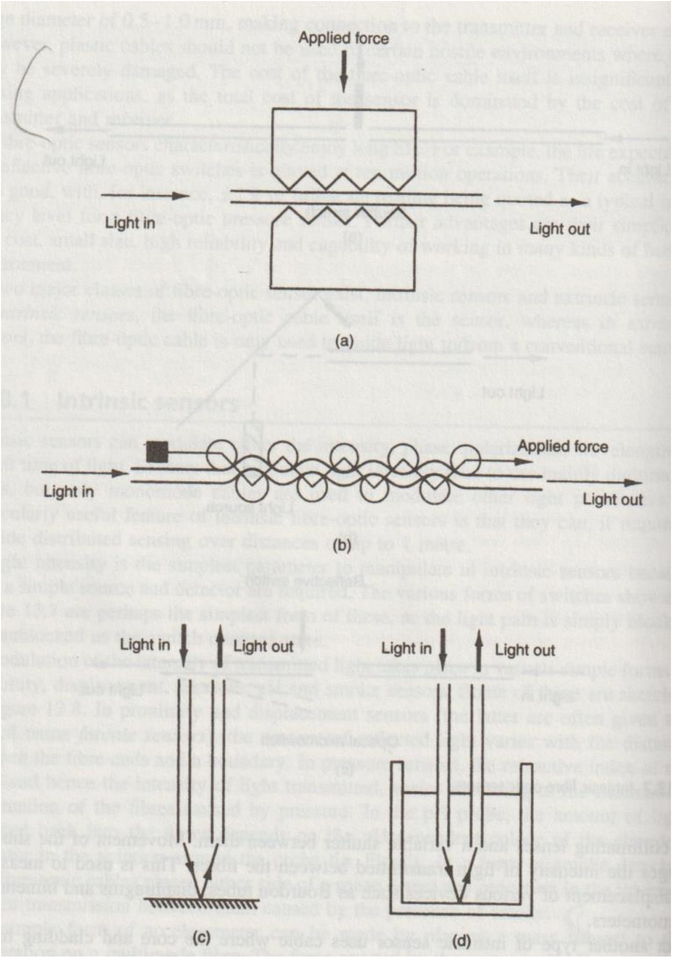

Fig-7: Intensity Modulating Sensor:
(a) Simple Pressure Sensor
(b) Roller-Chain Pressure Sensor (Microbend Sensor)
(c) Proximity Sensor (d) pH Sensor

A simple form of accelerometer can be made by placing a mass subject to the acceleration on a multimode fibre. The force exerted by the mass on the fibre causes a change in the intensity of light transmitted, hence allowing the acceleration to be determined. The typical inaccuracy quoted for this device is ±0.02g in the measurement range ±5 g and ±2% in the measurement range up to 100 g.

A similar principle is used in probes that measure the internal diameter of tubes. The probe consists of eight strain-gauged cantilever beams that track changes in a diameter, giving a measurement resolution of 20 µm.

A slightly more complicated method of effecting light intensity modulation is the variable shutter sensor shown in Fig-8:

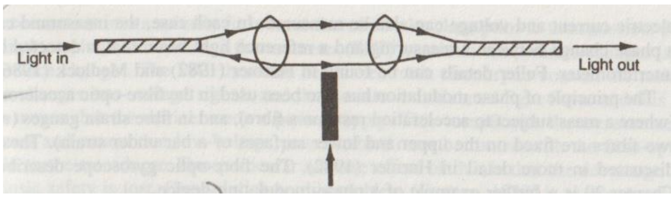

Fig-8: Variable-Shutter Sensor

This consists of two fixed fibres with two collimating lenses and a variable shutter between them. Movement of the shutter changes the intensity of light transmitted between the fibres. This is used to measure the displacement of various devices such as Bourdon tubes, diaphragms and bimetallic thermometers.

Various types of intensity modulating sensors are available. The defects in fabrics are counted using the light. After that it is given as digital output using PLC.

The counting glass are fitted with LED. When switch is pressed light glows and clearly the threads are visible and hence counting of warp/inch, weft/inch can be counted easily.

Traverse thread counter is used to count the thread/inch by the rotational movement of instrument telescope and finding the reading by pressing the switch for every thread movement.

Electronic Load Cell (Electronic Balance)

In an electronic load cell, the gravitational force on the body being measured is applied to an elastic element. This deflects according to the magnitude of the body ma Mass measurement is thereby translated into a displacement measurement task. Electronic load cells have significant advantages over most other forms of mass-measuring instrument in terms of their relatively low cost, wide measurement range, tolerance of dusty and corrosive environments, remote measurement capability, tolerance of shock loading and ease of installation. The electronic load cell uses the physical principle that a force applied to an elastic element produces a measurable deflection. The elastic elements used are specially shaped and designed, some examples of which are shove in Fig-9. The design aims are to obtain a linear output relationship between the applied force and the measured deflection and to make the instrument insensitive forces that are not applied directly along the sensing axis. Load cells exist in both compression and tension forms. In the compression type, the measured mass is plan on top of a platform resting on the load cell, which therefore compresses the well. It the alternative tension type, the mass is hung from the load cell, thereby putting the cell into tension.

One problem that can affect the performance of load cells is the phenomenon of creep. Creep describes the permanent deformation that an elastic element und after it has been under load for a period of time. This can lead to significant measurement errors in the form of a bias on all readings if the instrument is not recalibrated from time to time. However, careful design and choice of materials can largely eliminate the problem.

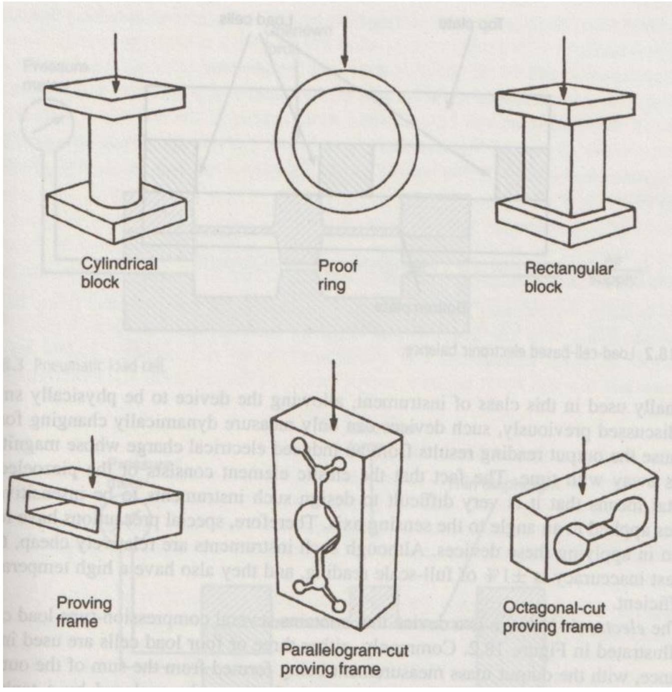

Fig-9: Elastic elements used in load cells

Various types of displacement transducer are used to measure the deflection of the elastic elements. Of these, the strain gauge is used most commonly, since this gives the best measurement accuracy, with an inaccuracy figure less than ±0.05% of full-scale reading being obtainable. Load cells including strain gauges are used to measure masses over a very wide range between 0 and 3000 tonnes. The measurement capability of an individual instrument designed to measure masses at the bottom end of this range would typically be 0.1-5kg, whereas instruments designed for the top of the range would have a typical measurement span of 10-3000 tonnes.

Elastic force transducers based on differential transformers (LVDTs) to measure defections are used to measure masses up to 25 tonnes. Apart from having a lower maximum measuring capability, they are also inferior to strain gauge-based instruments in terms of their ±0.2% inaccuracy figure. Their major advantage is their longevity and almost total lack of maintenance requirements.

The final type of displacement transducer used in this class of instrument is the piezoelectric device. Such instruments are used to measure masses in the range 0 to 1000 tonnes. Piezoelectric crystals replace the specially designed elastic member normally used in this class of instrument, allowing the device to be physically small As discussed previously, such devices can only measure dynamically changing forces because the output reading results from an induced electrical charge whose magnitude leaks away with time. The fact that the elastic element consists of the piezoelectric crystal means that it is very difficult to design such instruments to be insensitive to forces applied at an angle to the sensing axis. Therefore, special precautions have to be taken in applying these devices. Although such instruments are relatively cheap, their lowest inaccuracy is ±1% of full-scale reading, and they also have a high temperature coefficient.

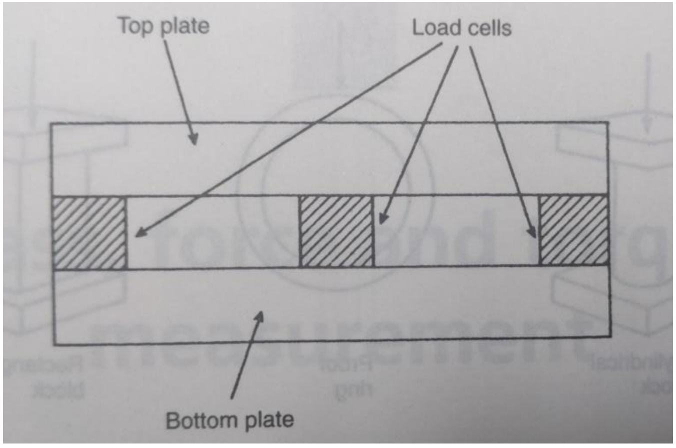

Fig-10: Load-cell based electronic balance

The electronic balance is a device that contains several compression-type load cells, as illustrated in Fig-10. Commonly, either three or four load cells are used in the balance, with the output mass measurement being formed from the sum of the outputs of each cell. Where appropriate, the upper platform can be replaced by a tank for weighing liquids, powders etc.

Electromagnetic Balance

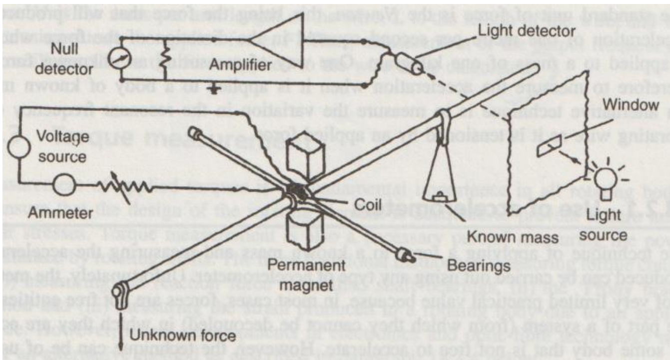

Fig-11: Electromagnetic Balance

The electromagnetic balance uses the torque developed by a current-carrying coil suspended in a permanent magnetic field to balance the unknown mass against the known gravitational force produced on a standard mass, as shown in Figure 18.8. A light source and detector system is used to determine the null balance point. The voltage output from the light detector is amplified and applied to the coil, thus creating a servo system where the deflection of the coil in equilibrium is proportional to the applied force. Its advantages over beam balances, weigh beams and pendulum scales include its smaller

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size, its insensitivity to environmental changes (modifying inputs) and its electrical form of output.

Using load cell or electromagnetic balance the GSM of fabric is automatically found out.

The crimp is measured using the translational motion transducers.

Translational Motion Transducers

Displacement

Translational displacement transducers are instruments that measure the motion of a body in a straight line between two points. Apart from their use as a primary transducer measuring the motion of a body, translational displacement transducers are also widely used as a secondary component in measurement systems, where some other physical quantity such as pressure, force, acceleration or temperature is translated into a translational motion by the primary measurement transducer. Many different types of translational displacement transducer exist and these, along with their relative merits and characteristics, are discussed in the following sections of this chapter. The factors governing the choice of a suitable type of instrument in any particular measurement situation are considered in the final section at the end of the chapter.

The Resistive Potentiometer

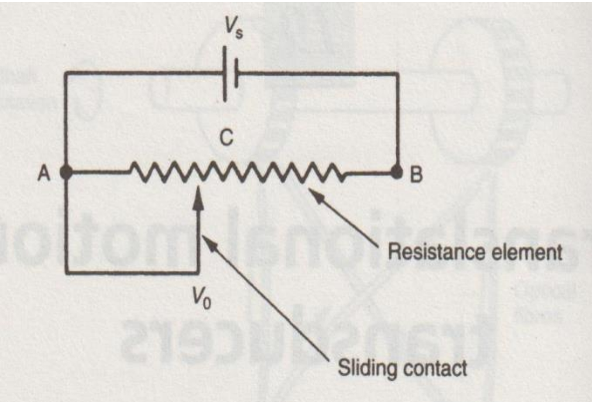

Fig-12: The Resistive Potentiometer

The resistive potentiometer is perhaps the best-known displacement-measuring device. It consists of a resistance element with a movable contact as shown in Fig-12. A voltage V_s, is applied across the two ends A and B of the resistance element and an output voltage V_o is measured between the point of contact C of the sliding element and the end of the resistance element A. A linear relationship exists between the output voltage V_o and the distance AC, which can be expressed by:

$$\frac{Vo}{Vs} = \frac{AC}{AB}$$

The body whose motion is being measured is connected to the sliding element of the potentiometer, so that translational motion of the body causes a motion of equal magnitude of the slider along the resistance element and a corresponding change in the output voltage V_o.

Three different types of potentiometer exist, wire-wound, carbon-film and plastic-film, so named according to the material used to construct the resistance element. Wire-wound potentiometers consist of a coil of resistance wire round on a non-conducting former. As the slider moves along the potentiometer track, it makes contact with successive turns of the wire coil. This limits the resolution of the instrument to the distance from one to the next. Much better measurement resolution is obtained from potentiometers using either a carbon film or a conducting plastic film for the resistance element. Theoretically the resolution of these is limited only by the grain size of the particles in the film, suggesting that measurement resolutions up to 10^{-4} ought to be attainable. In practice, the resolution is limited by mechanical difficulties in constructing the spring system maintains the slider in contact with the resistance track, although these types are considerably better than wire-wound types.

Operational problems of potentiometers all occur at the point of contact between the sliding element and the resistance track. The most common problem is dirt under the slider, which increases the resistance and thereby gives a false output voltage reading or in the worst case causes a total loss of output. High-speed motion of the slider can also cause the contact to bounce, giving an intermittent output. Friction between the slider and the track can also be a problem in some measurement systems where the body whose motion is being measured is moved by only a small force of a similar magnitude to these friction forces.

The life expectancy of potentiometers is normally quoted as a number of reversals, i.e. as the number of times the slider can be moved backwards and forwards along the track. The figures quoted for wire-wound, carbon-film and plastic-film types an respectively 1 million, 5 million and 30 million. In terms of both life expectancy and measurement resolution, therefore, the carbon and plastic film types are clearly superior, although wire-wound types do have one advantage in respect of their lower temperature coefficient. This means that wire-wound types exhibit much less variation in their characteristics in the presence of varying ambient temperature conditions.

A typical inaccuracy figure that is quoted for translational motion resistive potentiometers is ±1% of full-scale reading. Manufacturers produce potentiometers to cover a large span of measurement ranges. At the bottom end of this span, instruments with range of ±2 mm are available whilst at the top end, instruments with a range of ±1 mm are produced.

The resistance of the instrument measuring the output voltage at the potentiometer slider can affect the value of the output reading, as discussed in Chapter 3. As the slider moves along the potentiometer track, the ratio of the measured resistance to that of the measuring instrument varies, and thus the linear relationship between the measured displacement and the voltage output is distorted as well. This effect is minimized when the potentiometer resistance is small relative to that of the measuring instrument. This is achieved firstly by using a very high-impedance measuring instrument and secondly by keeping the potentiometer resistance as small as possible. Unfortunately, the latter is incompatible with achieving high measurement sensitivity since this requires a high potentiometer resistance. A compromise between these two factors is therefore necessary. The alternative strategy of of obtaining high measurement sensitivity by keeping the potentiometer resistance low and increasing the excitation voltage is not possible in practice because of the power rating limitation. This restricts the allowable power loss in the potentiometer to its heat dissipation capacity.

This gives the actual value of crimp automatically. Other types such as LVDT, variable capacitance transducers, variable inductance transducers, strain gauges, nozzle flapper, piezoelectric transducers, can be used for displacement measurements. Other methods are linear inductosyn, laser interferometer, fotonic sensor, evanescent field fibre optic sensor, non-contacting optical sensors can be used for displacement measurements.

5. Fabric Strength

In old methods fabric strength is determined by tensile strength. In tensile strength type many different methods used are ravel strip, cut strip, grab methods. The fabric strength can also be determined using tear strength. In tear strength different methods used are tongue tear test, double rip, trapezoid tear, ballistic tear, wing rip tear, elemedorf tear.

Fabric strength can also be determined using bursting strength. All old methods is calculated on the mechanical motorized machine in traditional one. Now load cell, touch screen monitor or LCD display or LED display machine are available for fabric tensile strength tester. The strength of seam can also be done with seam strength tester. Fabric bursting strength tester with digital display is available. The tearing strength of the fabric were previously available with mechanical types. Now digital tearing strength tester with elmendorf type is available. Auto calculate, test and analyse result, print report are available. Other tear tests can be carried out in load cell machine with special attachments.

The force measurement is done with electronic equipment.

Force Measurement

If a force of magnitude, F, is applied to a body of mass, M, the body will accelerate at a rate, A, according to the equation:

$$F = MA$$

The standard unit of force is the Newton, this being the force that will produce an acceleration of one metre per second squared in the direction of the force when it is applied to a mass of one kilogram. One way of measuring an unknown force is therefore to measure the acceleration when it is applied to a body of known mass. An alternative technique is to measure the variation in the resonant frequency of a vibrating wire as it is tensioned by an applied force.

Use of accelerometers

The technique of applying a force to a known mass and measuring the acceleration produced can be carried out using any type of accelerometer. Unfortunately, the method is of very limited practical value because, in most cases, forces are not free entities but are part of a system (from which they cannot be decoupled) in which they are acting on some body that is not free to accelerate. However, the technique can be of use in measuring some transient forces, and also for calibrating the forces produced by thrust motors in space vehicles.

Vibrating wire sensor

This instrument, illustrated in Fig-13, consists of a wire that is kept vibrating at its resonant frequency by a variable-frequency oscillator.

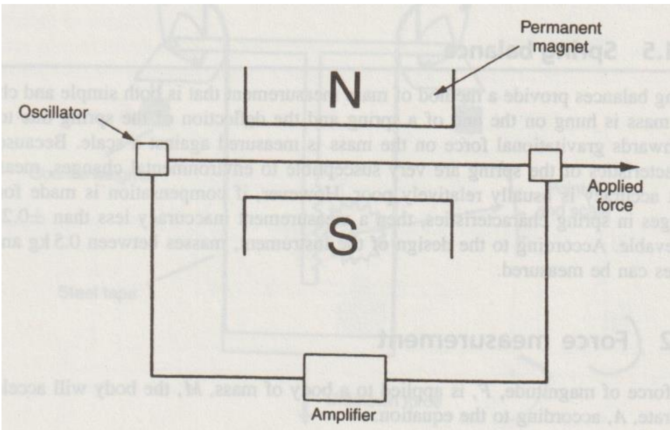

Fig-13: Vibrating wire sensor

The resonant frequency of a wire under tension is given by:

$$f = \frac{0.5}{L}\sqrt{\left(\frac{M}{T}\right)}$$

Where M is the mass per unit length of the wire, L is the length of the wire, and T is the tension due to the applied force, F. Thus, measurement of the output frequency of the oscillator allows the force applied to the wire to be calculated.

The load cell type measurement of fabric strength is done with bridge circuits. The various bridge circuits that can be used are null type, DC bridge (Wheatstone bridge) deflection type DC bridge, AC bridge, Null type impedance bridge, Maxwell bridge, deflection type AC bridge. Appropriate circuit is selected and it is used for fabric strength measurements. After that the information are transferred through sensors and given to printer and printout is taken out.

6. Seam Strength

The seam strength of the fabric is also tested in the same way as the fabric strength testing method. The fibre strength and fibre bundle strength is also tested in the same type of instruments.

7. Tear Strength

The tear test is done with pendulum scale. Various types of tear test are done with pendulum scale principle. The deflection is automatically measured by sensors and it is transferred to digital output. The Elmendorf, tongue tear, double rip, trapezoid, Ballistic, wing rip tear all are found out using the pendulum type tear tester.

Pendulum Scale

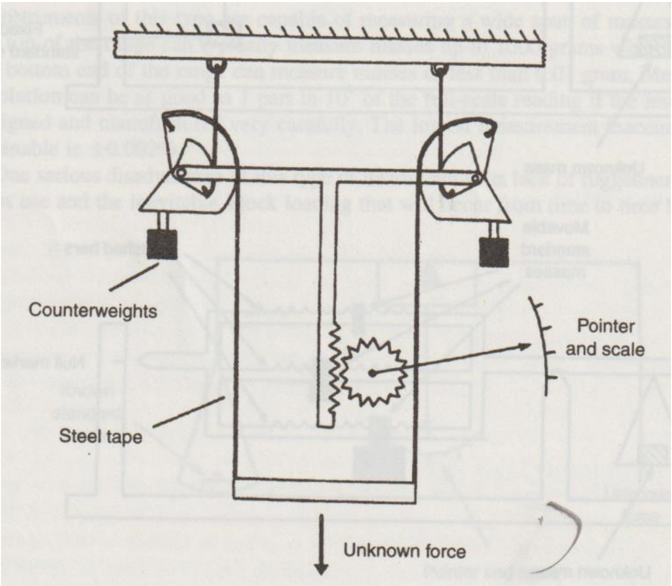

Fig-14: Pendulum scale

The pendulum scale, sketched in Fig-14. Is another instrument that works on the mass-balance principle. The unknown mass is put on a platform that is attached by steel tapes to a pair of cams. Downward motion of the platform, and hence rotation of the cams, under the influence of the gravitational force on the mass, is opposed by the gravitational force acting on two pendulum type masses attached to the cams. The amount of rotation of the cams when the equilibrium position is reached is determined by the deflection of a pointer against a scale. The shape of the cams is such that this output deflection is linearly proportional to the applied mass.

This instrument is particularly useful in some applications because it is a relatively simple matter to replace the pointer and scale system by a rotational displacement transducer that gives an electrical output. Various versions of the instrument can measure masses in the range between 1 kg and 500 tonnes, with a typical measurement in accuracy of ±0.1%.

One potential source of difficulty with the instrument is oscillation of the weigh platform when the mass is applied. Where necessary, in instruments measuring larger masses, dashpots are incorporated into the cam system to damp out such oscillations. A further possible problem can arise, mainly when measuring large masses, if the mass is not placed centrally on the platform. This can be avoided by designing a second platform to hold the mass, which is hung from the first platform by knife edges. This lessens the criticality of mass placement.

Using bridge circuits all calculations are made. The bursting strength was previously calculated using common liquid pressure deflecting the scale. But now digital bursting strength tester are available. The pressure can be defined with following points.

Absolute pressure

This is the difference between the pressure of the fluid and the absolute zero of pressure.

Gauge pressure

This describes the difference between the pressure of a fluid and atmospheric pressure. Absolute and gauge pressure are therefore related by the expression:

Absolute pressure = Gauge pressure + Atmospheric pressure

Thus, gauge pressure varies as the atmospheric pressure changes and is therefore not a fixed quantity.

Differential pressure

This term is used to describe the difference between two absolute pressure values, such as the pressures at two different points within the same fluid (often between the two sides of a flow restrictor in a system measuring volume flow rate).

Diaphragms

The diaphragm, shown schematically in Fig-15, is one of three types of elastic- element pressure transducer. Applied pressure causes displacement of the diaphragm and this movement is measured by a displacement transducer. Different versions of diaphragm sensors can measure both absolute pressure (up to 50 bar) and gauge pressure (up to 2000 bar) according to whether the space on one side of the diaphragm is respectively evacuated or is open to the atmosphere. A diaphragm can also be used to measure differential pressure (up to 2.5 bar) by applying the two pressures to the two sides of the diaphragm. The diaphragm can be either plastic, metal alloy, stainless steel or ceramic. Plastic diaphragms are cheapest, but metal diaphragms give better accuracy. Stainless steel is normally used in high temperature or corrosive environments. Ceramic diaphragms are resistant even to strong acids and alkalis, and are used when the operating environment is particularly harsh.

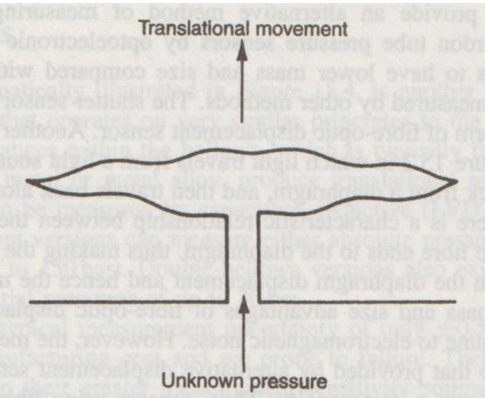

Fig-15: Schematic representation of diaphragm pressure sensor

The typical magnitude of diaphragm displacement is 0.1 mm, which is well suited to a strain-gauge type of displacement-measuring transducer, although other forms of displacement measurement are also used in some kinds of diaphragm-based sensors. If the displacement is measured with strain gauges, it is normal to use four strain gauges arranged in a bridge circuit configuration. The output voltage from the bridge is a function of the resistance change due to the strain in the diaphragm. This arrangement automatically provides compensation for environmental temperature changes. Older pressure transducers of this type used metallic strain gauges bonded to a diaphragm typically made of stainless steel. However, apart from manufacturing difficulties arising from the problem of bonding the gauges, metallic strain gauges have a low gauge factor, which means that the low output from the strain gauge bridge has to be amplified by an expensive DC amplifier. The development of semiconductor (piezoresistive) strain gauges provided a solution to the low-output problem, as they have gauge factors up to one hundred times greater than metallic gauges. However, the difficulty of bonding gauges to the diaphragm remained and a new problem emerged regarding the highly non-linear characteristic of the strain-output relationship.

The problem of strain-gauge bonding was solved with the emergence of monolithic piezoresistive pressure transducers. These have a typical measurement uncertainty of ±0.5% and are now the most commonly used type of diaphragm pressure transducer. The monolithic cell consists of a diaphragm made of a silicon sheet into which resistors are diffused during the manufacturing process. Such pressure transducers can be made to be very small and are often known as micro-sensors. Also, besides avoiding the difficulty with bonding, such monolithic silicon measuring cells have the advantage of being very cheap to manufacture in large quantities. Although the inconvenience of a non-linear characteristic remains, this is normally overcome by processing the output signal with an active linearization circuit or incorporating the cell into a microprocessor- based intelligent measuring transducer. The latter usually provides analogue-to-digital conversion and interrupt facilities within a single chip and gives a digital output that is readily integrated into computer control schemes. Such instruments can also offer automatic temperature compensation, built-in diagnostics and simple calibration procedures. These features allow measurement inaccuracy to be reduced to a figure as low as ±0.1% of full-scale reading.

The other sensors are capacitive, fibre-optic, bellows, bourdon tube manometery, resonant wire devices, Dead-weight gauge, thermocouple gauge, pirani gauge, McLeod gauge, ionization gauge, high pressure transducers. The suitable pressure measurement and intelligent pressure measurement device is used for bursting strength & digital output is obtained.

Selection of Pressure Sensors

Choice between the various types of instrument available for measuring mid-range pressures (1.013-7000 bar) is usually strongly influenced by the intended application. Manometers are commonly used when just a visual indication of pressure level is required, and deadweight gauges, because of their superior accuracy, are used in calibration procedures of other pressure-measuring devices. When an electrical form of output is required, the choice is usually either one of the several types of diaphragm sensor (strain gauge, capacitive or fibre optic) or, less commonly, a Bourdon tube. Bellows-type instruments are also sometimes used for this purpose, but much less frequently. If very high measurement accuracy is required, the resonant-wire device is a popular choice.

In the case of pressure measurement in the vacuum range (less than atmospheric pressure, i.e. below 1.013 bar), adaptations of most of the types of pressure transducer described earlier can be used. Special forms of Bourdon tubes measure pressures down to 10 mbar, manometers and bellows-type instruments measure pressures down to 0.1 mbar, and diaphragms can be designed to measure pressures down to 0.001 mbar. However, a number of more specialized instruments have also been developed to measure vacuum pressures. These generally give better measurement accuracy and sensitivity compared with instruments that are primarily designed for measuring mid-range pressures. This improved accuracy is particularly evident at low pressures. Therefore, only the special instruments described are used to measure pressures below 10^{-4} mbar. At high pressures (>7000 bar), the

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only devices in common use are the manganin- wire sensor and similar devices based on alternative alloys to manganin.

For differential pressure measurement, diaphragm-type sensors are the preferred option, with double-bellows sensors being used occasionally. Manometers are also sometimes used to give visual indication of differential pressure values (especially in liquid flow-rate indicators). These are passive instruments that have the advantage of not needing a power supply.)

8. Abrasion Tester

In old method B.F.T abrasion testing machine and Martindale abrasion tester are used. Traditional method of abrasion resistance of fabrics is done by Martindale abrasion tester. Now Wyzenbeck (Oscillatory cylinder) abrasion tester is available. In this fabric is rubbed against cotton duck fabric for testing purpose. Martindale with digital display is available now. 8 samples can be done at a time with new model abrasion tester. BFT abrasion tester for flex, ball and flat abrasion is available in market.

The translational motion transducers are used for the displacement measurements in abrasion tester. The resistive potentiometer is used for displacement measuring device. Other measurement methods are linear variable differential transformer LVDT, variable capacitance transducers, variable inductance transducers, strain gauges, piezoelectric transducers, nozzle flapper, linear inductosyn, laser interferometer, fotonic sensor, measurement of large displacements (range sensor) proximity sensors. Using the appropriate sensors in the abrasion testing machine the number of cycle of movement is obtained. The digital display of number of cycles is obtained. The fabric surface with hole point is observed directly using sensors. So correct number of cycles are obtained.

Linear Variable Differential Transformer (LVDT)

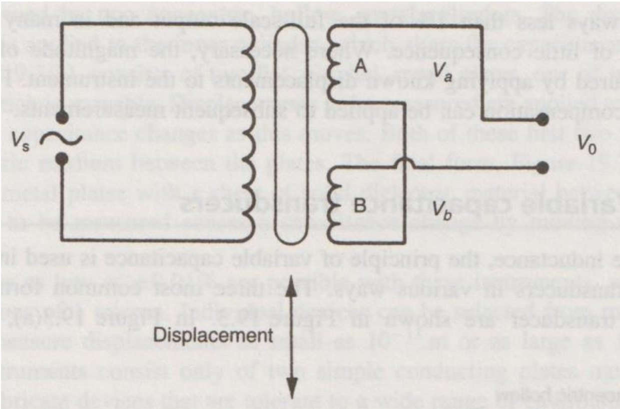

Fig-16: The Linear Variable Differential Transformer (LVDT)

The linear variable differential transformer, which is commonly known by the abbreviation LVDT, consists of a transformer with a single primary winding and two secondary windings connected in the series opposing manner shown in Fig-16. The object whose translational displacement is to be measured is physically attached to the central iron core of the transformer, so that all motions of the body are transferred to the core.

Variable Capacitance Transducers

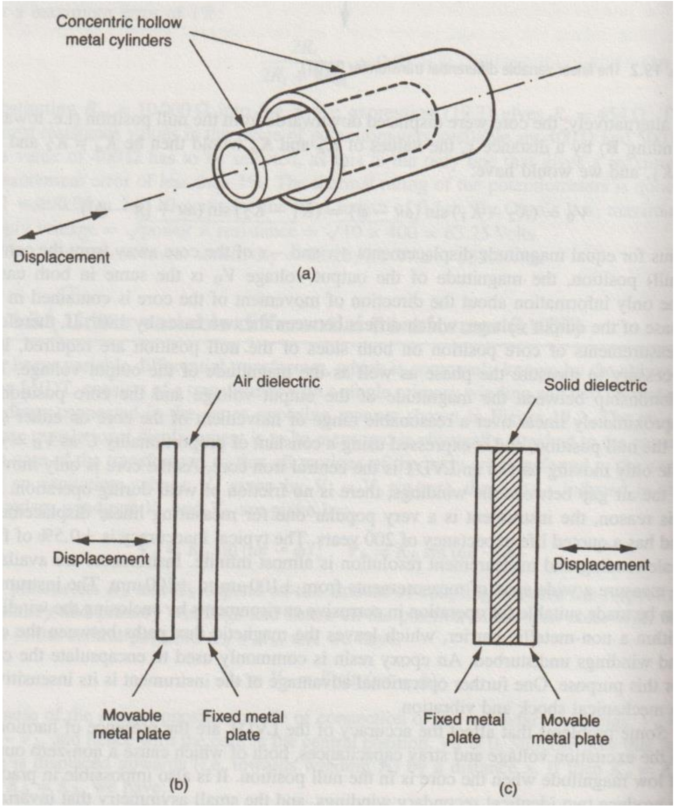

Fig-17: Variable capacitance transducer

Like variable inductance, the principle of variable capacitance is used in displacement measuring transducers in various ways. The three most common forms of variable capacitance transducer are shown in Fig-17. In Fig-17(a), the capacitor plates are formed by two concentric, hollow, metal cylinders. The displacement to be measured is applied to the inner cylinder, which alters the capacitance. The second form, Fig-17(b), consists of two flat, parallel, metal plates, one of which is fixed and one of which is movable. Displacements to be measured are applied to the movable plate, and the capacitance changes as this moves. Both of these first two forms use air as the dielectric medium between the plates. The final form, Fig-17 (c), has two flat, parallel, metal plates with a sheet of solid dielectric material between them. The displacement to be measured causes a capacitance change by moving the dielectric sheet.

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Variable Inductance Transducers

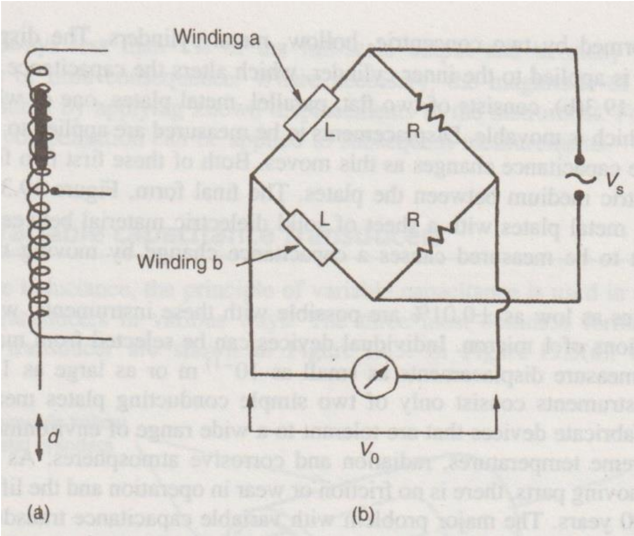

Fig-18: (a) Variable inductance transducers (b) Connection in bridge circuit

This has a typical measurement range of 0-10 mm. An alternative form of variable inductance transducer shown in Fig-18 (a) has a very similar size and physical appearance to the LVDT, but has a centre-tapped single winding. The two halves of the winding are connected, as shown in Fig-18 (b), to form two arms of a bridge circuit that is excited with an alternating voltage. With the core in the central position, the output from the bridge is zero. Displacements of the core either side of the null position cause a net output voltage that is approximately proportional to the displacement for small movements of the core. Instruments in this second form are available to cover a wide span of displacement measurements. At the lower end of this span, instruments with a range of 0-2 mm are available, whilst at the top end, instruments with a range of 0-5 m can be obtained.

Strain Gauges

Because of their very small range of measurement (typically 0-50 μm), strain gauges are normally only used to measure displacements within devices like diaphragm-based pressure sensors rather than as a primary sensor in their own right for direct displacement measurement. However, strain gauges can be used to measure larger displacements if the range of displacement measurement is extended by the scheme illustrated in Fig-19. In this, the displacement to be measured is applied to a wedge fixed between two beams carrying strain gauges. As the wedge is displaced downwards, the beams are forced apart and strained, causing an output reading on the strain gauges. Using this method, displacements up to about 50 mm can be measured.

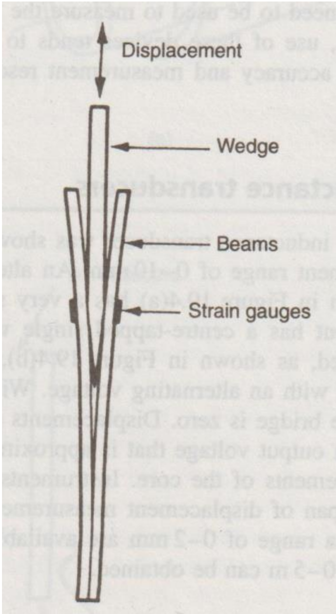

Fig-19: Strain gauges measuring large displacements

Piezoelectric transducers

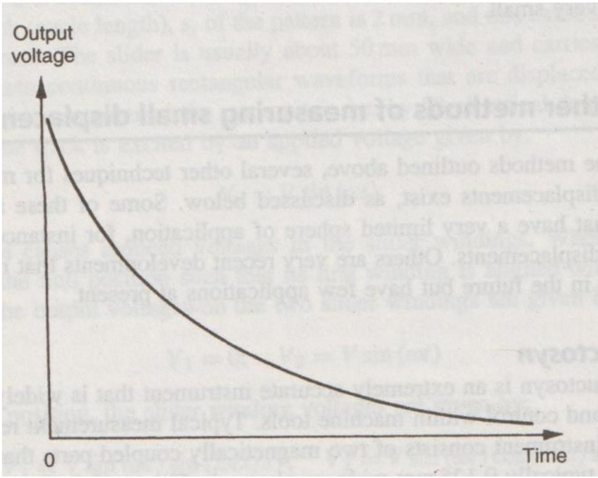

Fig-20: Voltage-time characteristic of piezoelectric transducer following step displacement

The piezoelectric transducer is effectively a force-measuring device that is used in many instruments measuring force, or the force-related quantities of pressure and acceleration. It is included within this discussion of linear displacement transducers because its mode of operation is to generate an e.m.f. that is proportional to the distance by which it is compressed. The device is manufactured from a crystal, which can be either a natural material such as quartz or a synthetic material such as lithium sulphate. The crystal is mechanically stiff (i.e. a large force is required to compress it), and consequently piezoelectric transducers can only be used to measure the displacement of mechanical systems that are stiff enough themselves to be unaffected by the stiffness of the crystal.

When the crystal is compressed, a charge is generated on the surface that is measured as the output voltage. As is normal with any induced charge, the charge leaks away over a period of time. Consequently, the output voltage-time characteristic is as shown in Fig-20.

Nozzle flapper

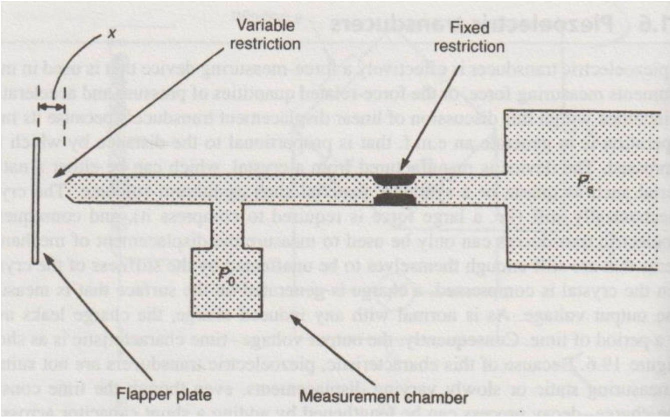

Fig-21: Nozzle flapper

The nozzle flapper is a displacement transducer that translates displacements into a pres- sure change. A secondary pressure-measuring device is therefore required within the instrument. The general form of a nozzle flapper is shown schematically in Fig-21. Fluid at a known supply pressure, P_s, flows through a fixed restriction and then through a variable restriction formed by the gap, x, between the end of the main vessel and the flapper plate. The body whose displacement is being measured is connected physically to the flapper plate. The output measurement of the instrument is the pressure P_0, in the chamber shown in Fig-21, and this is almost proportional to x over a limited range of movement of the flapper plate.

Linear inductosyn

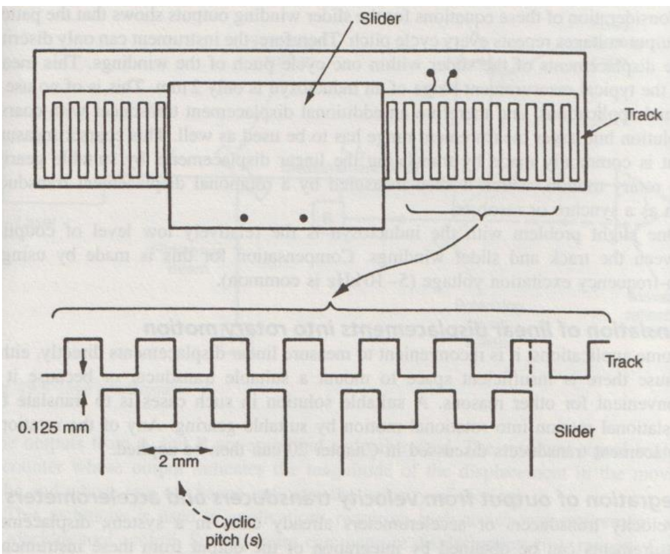

Fig-22: Linear Inductosyn

The linear inductosyn is an extremely accurate instrument that is widely used for at measurement and control within machine tools. Typical measurement resolution is 25 microns. The instrument consists of two magnetically coupled parts that are separated by an air gap, typically 0.125 mm wide, as shown in Fig-22. One part, the track is attached to the axis along which displacements are to be measured. This would generally be the bed of a machine tool. The other part, the slider, is attached to the body that is to be measured or positioned. This would usually be a cutting tool.

The track, which may be several metres long, consists of a fine metal wire formed into the pattern of a continuous rectangular waveform and deposited onto a glass base. The typical pitch (cycle length), s, of the pattern is 2 mm, and this extends over the full length of the track. The slider is usually about 50 mm wide and carries two separate wires formed into continuous rectangular waveforms that are displaced with respect to each other by one-quarter of the cycle pitch, i.e. by 90 electrical degrees.

Laser interferometer

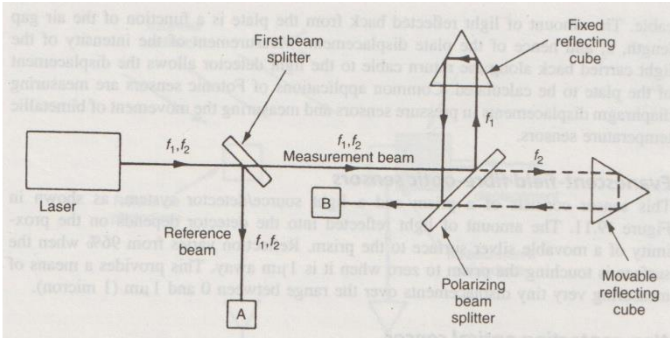

Fig-23: Laser Interferometer

This recently developed instrument is shown in Fig-23. In this particular design, a dual-frequency helium-neon (He-Ne) laser is used that gives an output pair of light waves at a nominal frequency of 5 x 1014 Hz. The two waves differ in frequency by 2 x 106 Hz and have opposite polarization. This dual-frequency output waveform is split into a measurement beam and a reference beam by the first beam splitter.

The reference beam is sensed by the polarizer and photo detector, A, which converts both waves in the light to the same polarization. The two waves interfere constructively and destructively alternately, producing light-dark flicker at a frequency of 2 x 10 Hz. This excites a 2 MHz electrical signal in the photo detector.

Fotonic sensor

The Fotonic sensor is one of many instruments developed recently that make use of fibre-optic techniques. It consists of a light source, a light detector, a fibre-optic light transmission system and a plate that moves with the body whose displacement is being measured, as shown in Fig-24. Light from the outward fibre-optic cable travels across the air gap to the plate and some of it is reflected back into the return fibre-optic cable. The amount of light reflected back from the plate is a function of the air gap length, x, and hence of the plate displacement.

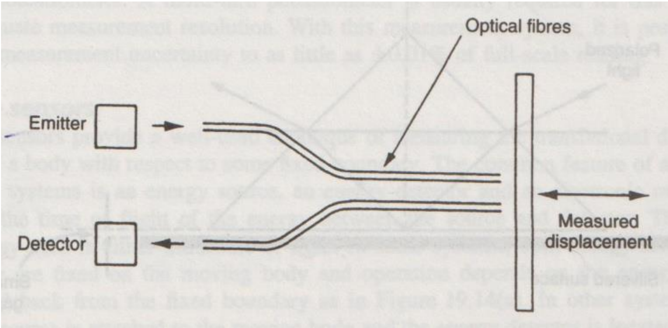

Fig-24: Fotonic sensor

Range sensor

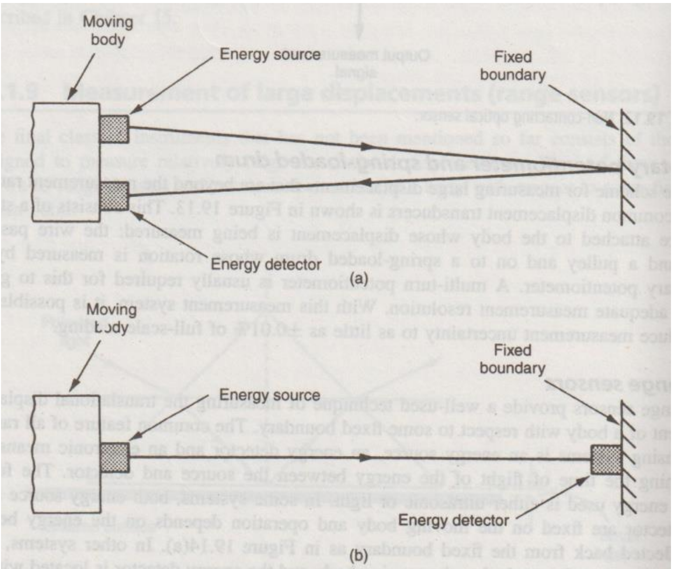

Fig-25: Range Sensors

Range sensors provide a well-used technique of measuring the translational displacement of a body with respect to some fixed boundary. The common feature of all range sensing systems is an energy source, an energy detector and an electronic means of timing the time of flight of the energy between the source and detector. The form of energy used is either ultrasonic or light. In some systems, both energy source and detector are fixed on the moving body and operation depends on the energy being reflected back from the fixed boundary as in Fig-25 (a). In other systems, the energy source is attached to the moving body and the energy detector is located within the fixed boundary, as shown in Fig-25 (b)

Proximity sensors

For the sake of completeness, it is proper to conclude this chapter on translational displacement transducers with consideration of proximity sensors. Proximity detectors provide information on the displacement of a body with respect to some boundary, but only insofar as to say whether the body is less than or greater than a certain distance away from the boundary. The output of a proximity sensor is thus binary in nature: the body is or is not close to the boundary.

9. Pill Box

ICI pilling box tester is used for testing pilling in fabrics. Now digital pilling tester is available. The number of rotations are done in the machine. The pills developed is sensed with sensor and automatic grading is done with sensors. Directly the pilling grade is digitally displayed.

10. Drape Tester

The drape of the fabric is determined using drape meter. But now fabric drape tester with digital camera is used. Drape co-efficient and drape wave number and amplitude are obtained through computer image processing technology. So there is no waste of time and laborious work. The sample can also be rotated and (D_s) static and dynamic draping co-efficient (D_m) is also obtained. Overcharging morphological change rate is also obtained. (L-((D_s-D_m) /D_s).

The working of various imaging techniques are given below.

Ultrasonic Imaging

The main applications of ultrasound in imaging are found in medical diagnosis and in industrial testing procedures. In both of these applications, a short burst of ultrasonic energy is transmitted from the ultrasonic element into the medium being investigated and the energy that is reflected back into the element is analysed. Ultrasonic elements in the frequency range 1 MHz to 15 MHz are used.

Ultrasound is reflected back at all interfaces between different materials, with the proportion of energy reflected being a function of the materials either side of the interface.

Nuclear Sensors

The principle of operation of nuclear sensors is very similar to optical sensors in that radiation is transmitted between a source and a detector through some medium in which the magnitude of transmission is attenuated according to the value of the measured variable. Caesium-137 is commonly used as a gamma-ray source and a sodium iodide device is commonly used as a gamma-ray detector. The latter gives a voltage output that is proportional to the radiation incident upon it.

Microsensors

Mechanical microsensors transform measured variables such as force, pressure and acceleration into a displacement. The displacement is usually measured by capacitive or piezoresistive techniques, although some devices use other technologies such as resonant frequency variation, resistance change, inductance change, the piezoelectric effect and changes in magnetic or optical coupling. The design of a cantilever silicon micro accelerometer is shown in Fig-26. The proof mass within this is about 100 µm across and the typical deflection measured is of the order of 1 micron (10^{-3} mm).

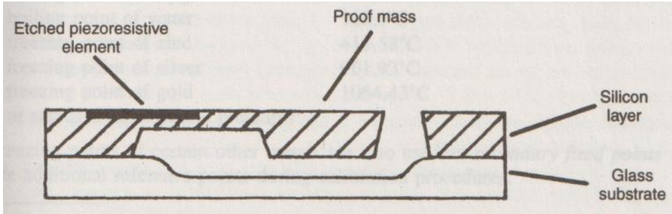

Fig-26: Silicon Microaccelerometer

Thermography (Thermal Imaging)

Thermography, or thermal imaging, involves scanning an infrared radiation detector across an object. The information gathered is then processed and an output in the form of the temperature distribution across the object is produced. Temperature measurement over the range from -20°C up to +-1500°C is possible. Elements of the system are shown in Fig-27.

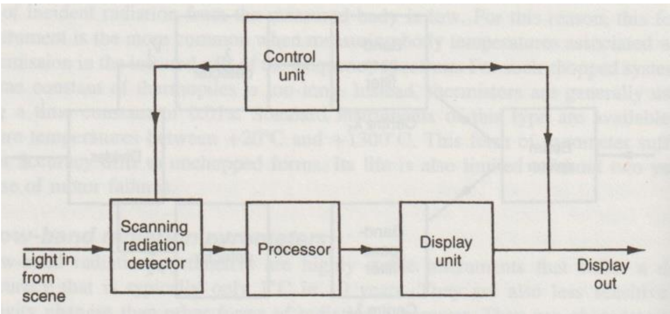

Fig-27: Thermography (Thermal Imaging) system

The radiation detector uses the same principles of operation as a radiation pyro-meter in inferring the temperature of the point that the instrument is focused on from a measurement of the incoming infrared radiation. However, instead of providing a measurement of the temperature of a single point at the focal point of the instrument, the detector is scanned across a body or scene, and thus provides information about temperature distributions. Because of the scanning mode of operation of the instrument, radiation detectors with a very fast response are required, and only photoconductive or photovoltaic sensors are suitable. These are sensitive to the portion of the infrared spectrum between wavelengths of 2 µm and 14 µm.

Simpler versions of thermal imaging instruments consist of hand-held viewers that are pointed at the object of interest. The output from an array of infrared detectors is directed onto a matrix of red light-emitting diodes assembled behind a glass screen, and the output display thus consists of different intensities of red on a black background, with the different intensities corresponding to different temperatures. Measurement resolution is high, with temperature differences as small as 0.1°C being detectable.

Using the image sensors and image processing technology drape of the fabric is automatically obtained.

11. Fabric Stiffness

Fabric stiffness test is obtained using Shirley stiffness tester. But pneumatic stiffness tester is also available. Bending moment Vs curvature curve is obatained from the tester.

The stiffness of fabric is automatically determined using pneumatic transmission sensors.

Pneumatic transmission

In recent years, pneumatic transmission tends to have been replaced by other alternatives in most new implementations of instrumentation systems, although many examples can still be found in operation in the process industries. Pneumatic transmission consists of transmitting analogue signals as a varying pneumatic pressure level that is usually in the range of 3-15 p.s.i. (Imperial units are still commonly used in process industries, though the equivalent range in SI units is 207-1034 mbar, which is often rounded to 200-1000 mbar in metric systems). A few systems also use alternative ranges of 3-27 p.s.i. or 6-48 p.s.i. Frequently, the initial signal is in the form of a varying voltage level that is converted into a corresponding pneumatic pressure.

However, in some examples of pneumatic transmission, the signal is in varying current form to start with, and a current to pressure converter is used to convert the 4-20 mA current signals into pneumatic signals prior to transmission.

The fabric bends with its own weight and the pneumatic control detects the bend level and convert it into signals & thereby connecting to digital output. So fabric stiffness is determined. Heart loop method of fabric stiffness tester is available in the FYI tester machine.

Crease recovery tester is easy to use & hence not much change is done with machine. Original Shirley crease recovery tester can be used.

12. Air Permeability Tester

In old method air permeability is obtained using the height of float in the tube. But now air permeability tester is available in digital model. Many models of air permeability tester are available. Computerized air permeability tester is available.

The flow of air is determined using differential pressure (obstruction type) meters, orifice plate, venturis, pitot static tube, rotameters, positive displacement flowmeters, Turbine meters, electromagnetic flowmeters, vortex shedding flowmeter, ultrasonic flowmeters, Doppler shift ultrasonic flowmeter, transit time ultrasonic flowmeter are available. Suitable measurement is made with devices and electrical

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signal output is obtained from that digital air permeability of fabric is obtained.

Variable area flowmeters (Rotameters)

In the variable area flowmeter (which is also sometimes known as a Rotameter), the differential pressure across a variable aperture is used to adjust the area of the aperture. The aperture area is then a measure of the flow rate. The instrument is reliable and cheap and used extensively throughout industry, accounting for about 20% of all flowmeters sold. Normally, this type of instrument only gives a visual indication of flow rate, and so it is of no use in automatic control schemes. However, special versions of variable area flowmeters are now available that incorporate fibre optics. In these, a row of fibres detects the position of the float by sensing the reflection of light from it, and an electrical signal output can be derived from this.

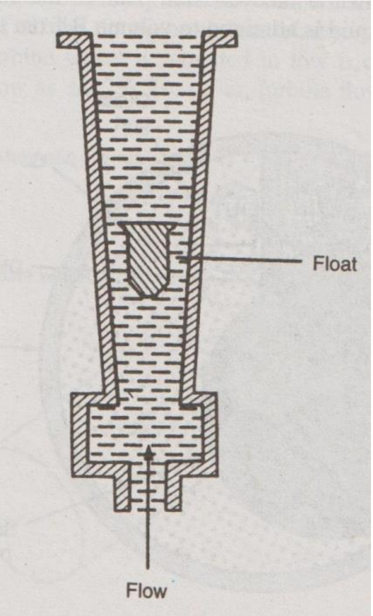

Fig-28: Variable area flowmeter

In its simplest form, shown in Fig-28, the instrument consists of a tapered glass tube containing a float which takes up a stable position where its submerged weight is balanced by the upthrust due to the differential pressure across it. The position of the float is a measure of the effective annular area of the flow passage and hence of the flow rate. The inaccuracy of the cheapest instruments is typically 5%, but more expensive versions offer measurement inaccuracies as low as ±0.5%.

The computerized air permeability tester works on the same principle but the output is presented to computer.

13. Water Repellency Tester

Bundersmann water repellency tester is available with various features. Varied water flow, automatic timer for switch off, drip tray, mechanical filter, optional centrifuge to remove surface water from samples are available. Other water penetration tests can be carried out in chemical labs.

Many flowmeters are available and suitable flowmeters are used & digital output of water repellency is given.

Positive displacement flowmeters can be used for water consumption. It is explained below.

Positive displacement flowmeters

Positive displacement flowmeters account for nearly 10% of the total number of flowmeters used in industry and are used in large numbers for metering domestic gas and water consumption. The cheapest instruments have a typical inaccuracy of about ±2%, but the inaccuracy in more expensive ones can be as low as ±0.5% These higher quality instruments are used extensively within the oil industry, as such applications can justify the high cost of such instruments.

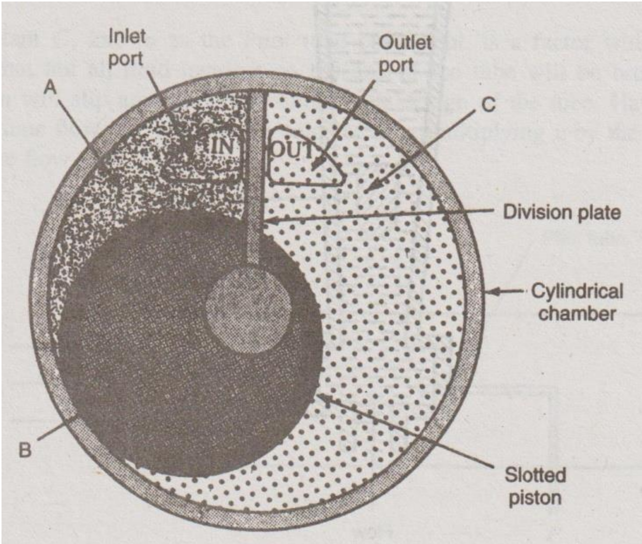

Fig-29: Rotary piston form of positive displacement flowmeter

All positive displacement meters operate by using mechanical divisions to displace discrete volumes of fluid successively. Whilst this principle of operation is common, many different mechanical arrangements exist for putting the principle into practice. However, all versions of positive displacement meter are low friction, low maintenance and long-life devices, although they do impose a small permanent pressure loss on the flowing fluid. Low friction is especially important when measuring gas flows, and meters with special mechanical arrangements to satisfy this requirement have been developed.

The rotary piston meter is a common type of positive displacement meter, and the principles of operation of this are shown in Fig-29. It consists of a slotted cylindrical piston moving inside a cylindrical working chamber that has an inlet port and an outlet port. The piston moves round the chamber such that its outer surface maintains contact with the inner surface of the chamber, and, as this happens, the piston slot slides up and down a fixed division plate in the chamber. At the start of each piston motion cycle, liquid is admitted to volume B from the inlet port. The fluid pressure causes the piston to start to rotate around the chamber, and, as this happens, liquid in volume C starts to flow out of the outlet port, and also liquid starts to flow from the inlet port into volume A. As the piston rotates further, volume B becomes shut off from the inlet port, whilst liquid continues to be admitted into A and pushed out of C. When the piston reaches the endpoint of its motion cycle, the outlet port is opened to volume B, and the liquid which has been transported round inside the piston is expelled. After this, the piston pivots about the contact point between the top of its slot and the division plate, and volume A effectively becomes volume C ready for the start of the next motion cycle. A peg on top of the piston causes a reciprocating motion of a lever attached to it. This is made to operate a counter, and the flow rate is therefore determined from the count in unit time multiplied by the quantity (fixed) of liquid transferred between the inlet and outlet ports for each motion cycle.

The other tests of water permeability wetting time test, spray test, drop penetration test, hydrostatic head test are done with digital output.

These working methods are given in reference (5).

14. Other Modern Textile Instruments

The high volume instrument gives details about cotton fibre properties. It is very costly (22 lakhs), but it can be used in industry. Advanced fibre information system was developed by Uster company. It is aeromechanical fibre processing method, electro optical sensing and processing by computer is done. This gives lesser value than HVI instrument. But it is costlier than HVI (1 crore). Autosorter with latest model, count of fibre, yarn and rovings can be tested in the instrument. It has also computer attachments. Uster tensorapid determines breaking load, elongation of simple yarns, plied yarns & fabrics.

The working of objective measurement using KES-F, FAST, Sensory Handmatry or Colorimetry are all modern electronic equipments and it is used as it is in olden methods.

15. Results & Discussions

Using electronics for instruments makes the testing accurate and large calculations are automatically done using PLC designs. The role of electronics to textiles is presented. The discussion on PLC is given & its understanding is done clearly. The various modern instruments for fabric properties are given. These are not in the present syllabus of curricula of textile students. But industries uses only these modern instruments. So necessary steps to introduce these techniques to curriculum of textile students should be taken to cater the need of textile industry.

16. Conclusion

Various new modern instruments uses electronic techniques and computers which gives accurate results with less time and less labour work. To have good quality of product modern techniques should be employed. Students should be taught with modern techniques in polytechnics & colleges.

17. References

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