# IPE 381
# Chapter: 13
# Measurement of Screw Thread

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# Outline

- Common terms
- Common Errors
- Effective Dia Measurement

# Screw Thread

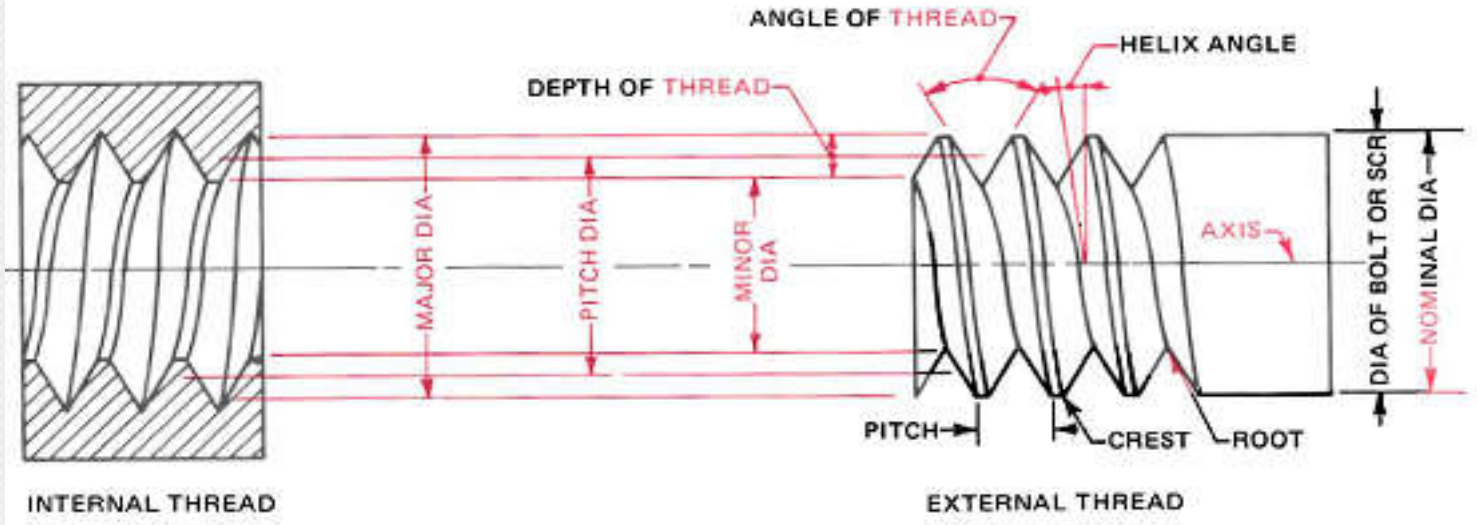
- • A SCREW THREAD is a ridge of uniform section in the form of a helix on the external or internal surface of a cylinder.
- • the PITCH of a thread P is the distance from a point on the thread form to the corresponding point on the next form, measured parallel to the axis

** TPI = 1/ Pitch (inch)

# Elements of a Vee-form Thread

A vee-from thread is composed basically of the following elements.

- • Major or outside diameter
- • Minor or root diameter
- • Form, particularly flank angles
- • Pitch
- • Simple effective diameter



# Terminology

**External Thread:** Thread formed outside of a work piece (bolts)

**Internal Thread:** Thread formed inside of a work piece (nut)

**Axis of thread:** Imaginary line running through the center of the screw.

**Crest and Root:** One is prominent part of the thread and another is bottom of the groove between two flanks whether external or internal.





# Terminology

**Flank:** straight edge which connect the crest with the root.

**Thread Angle:** Angle between the flanks.

**Flank Angle:** Individual flank and the perpendicular to the axis of the thread. Half angle of thread angle.

**Pitch:** Distance of the corresponding points on adjacent thread forms in the same axial points and it is parallel to the axis

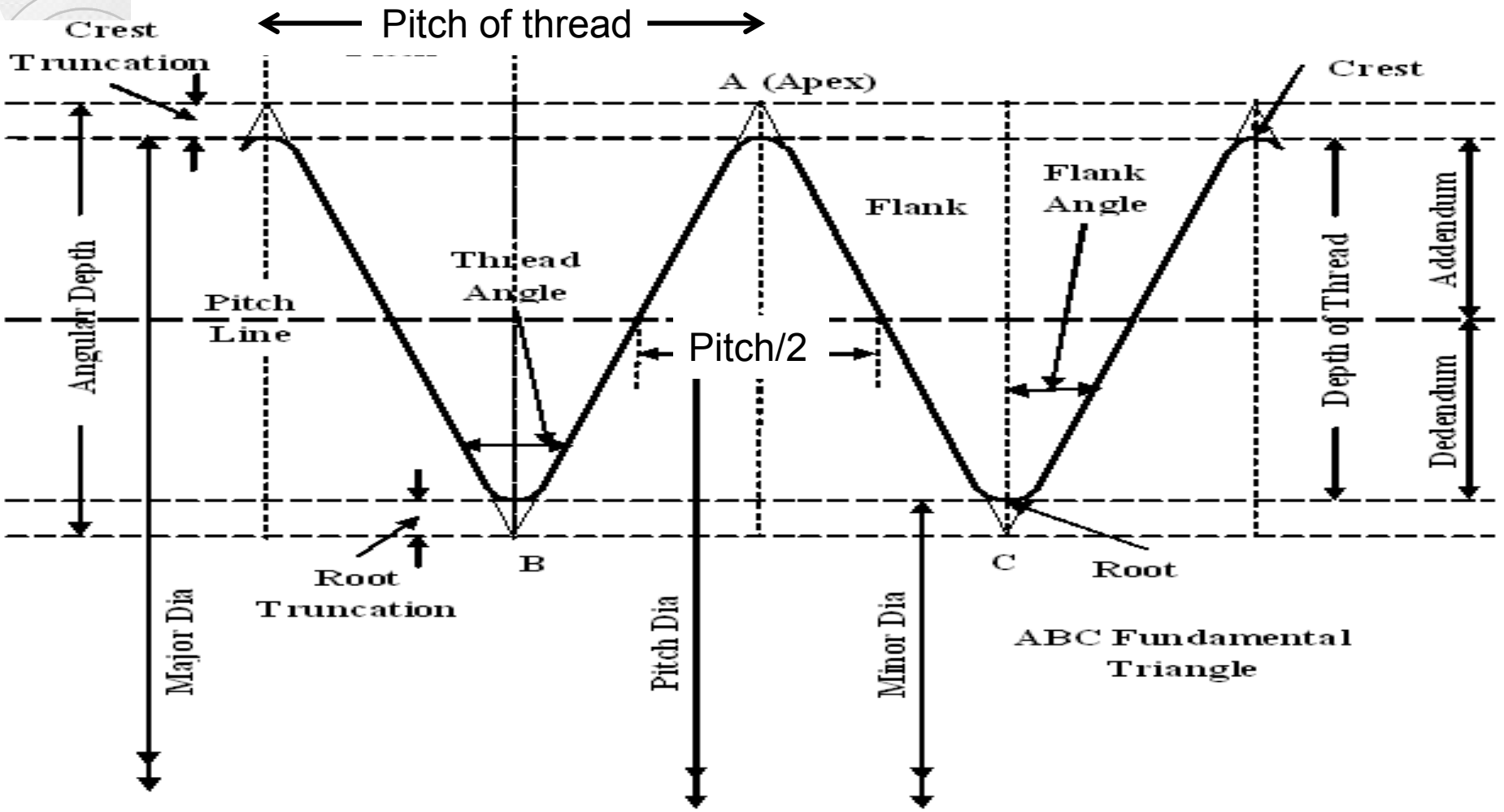
**Lead:** For one revolution about its axis, the axial distance travel by the threaded part.

Lead = No. of start × Pitch

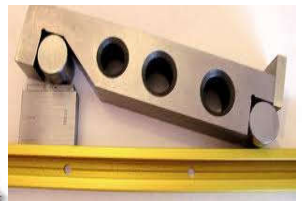




# Terminology







# Terminology

**Thread per Inch:** Reciprocal of pitch

**Depth of Thread:** Distance from the crest of the thread to the root of the thread.

**Fundamental Triangle:** Found by extending the flanks. ABC where BC = pitch, Vertical height = Angular depth

**Addendum:**

In external Thread it is radial distance between the major and pitch cylinder and in internal Thread it is radial distance between the minor and pitch cylinder

**Dedendum:**

In external thread it is radial distance between the minor and pitch cylinder and in internal Thread it is radial distance between the major and pitch cylinder





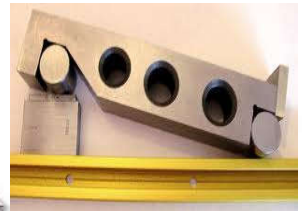
# Terminology

**Major Diameter:** Dia. of major cylinder, outside diameters (touches the crest- external thread, touches the root- internal thread)

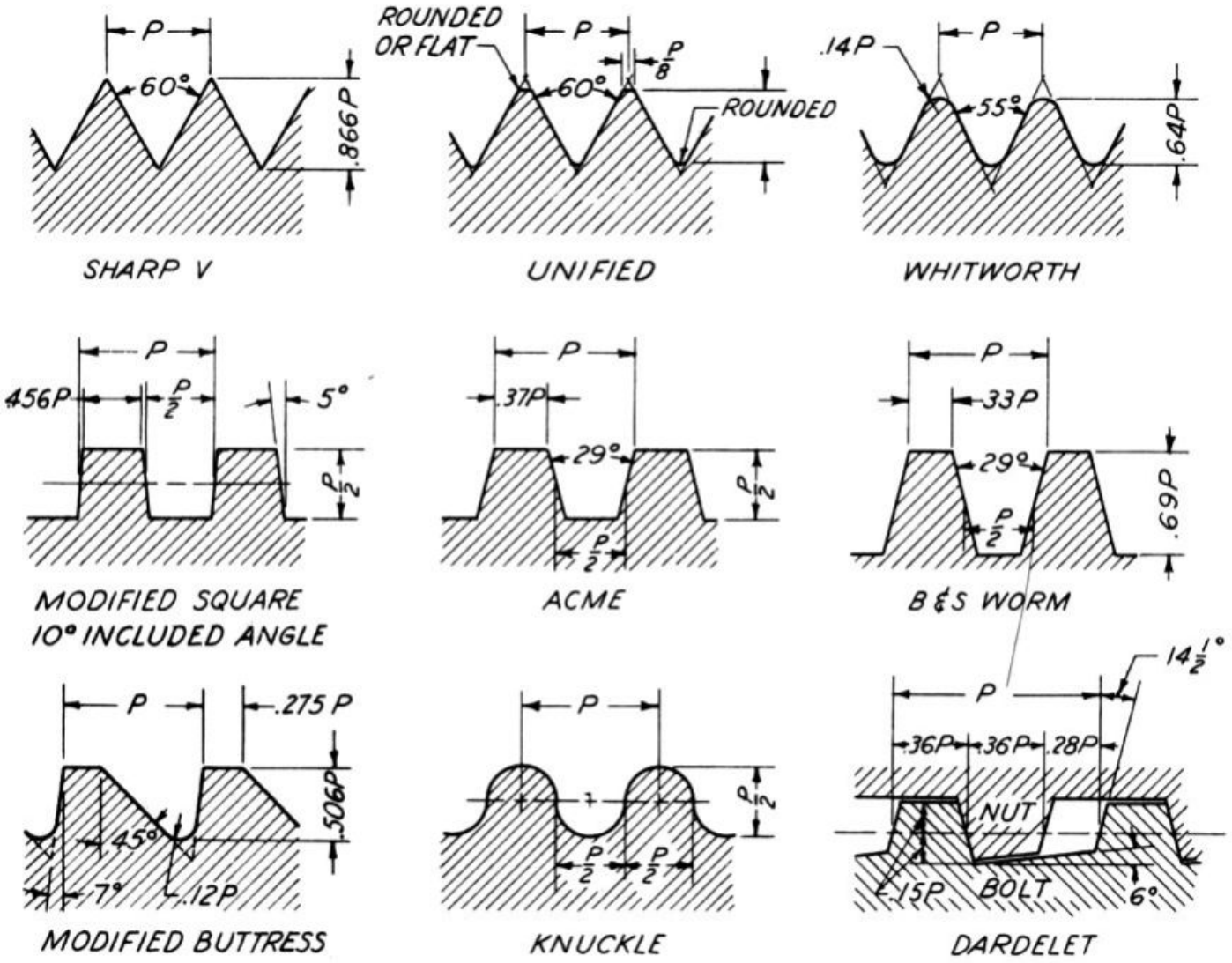
**Minor Diameter:** Dia. of minor cylinder, inside diameters (touches the root- external thread, touches the crest- internal thread)

**Effective Diameter (Pitch Diameter):** Diameter from pitch line where the width of the thread and the width of the space is equal, also called the diameter of the pitch cylinder. Pitch line is parallel to the axis of screw.



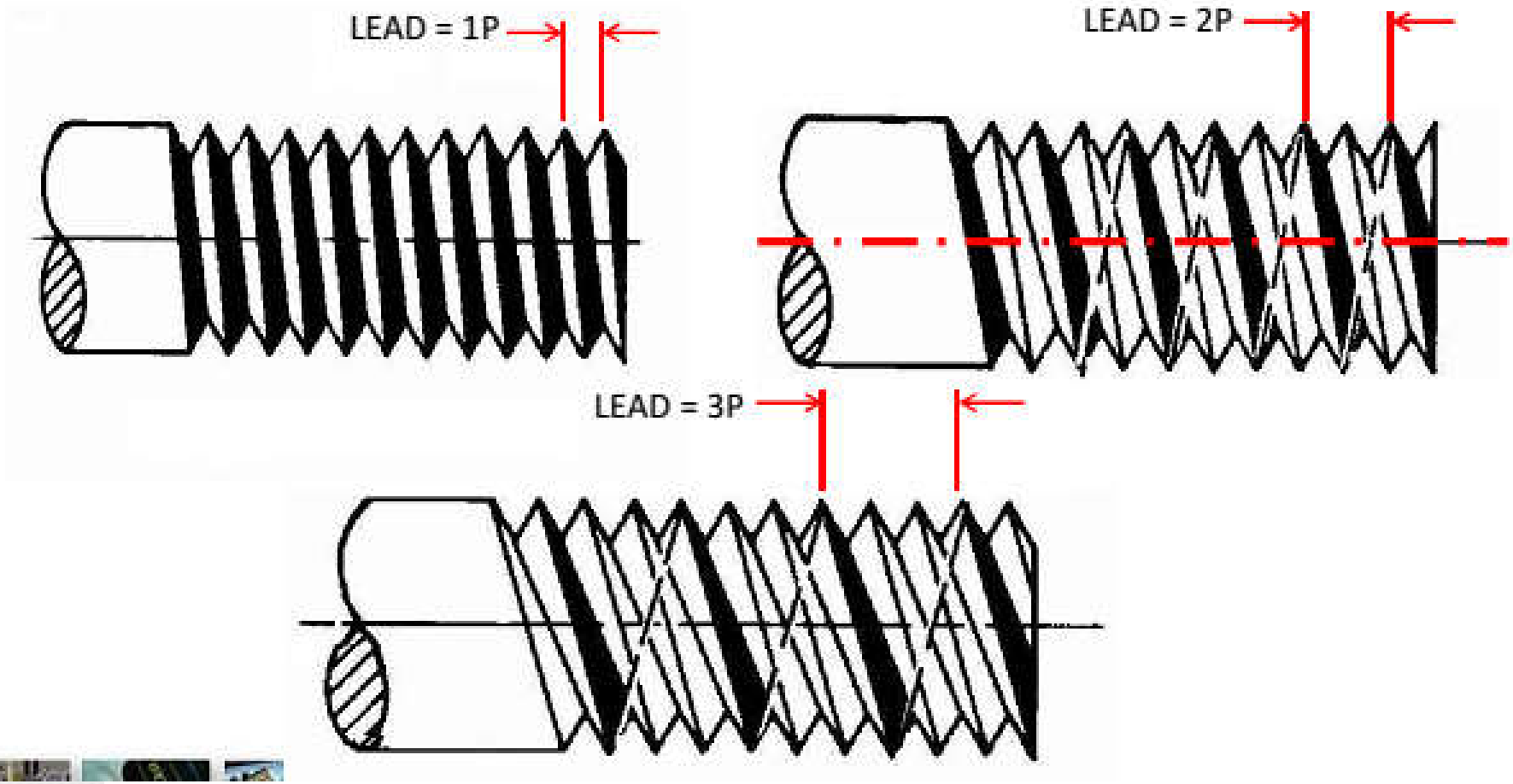




# Different Thread Standards

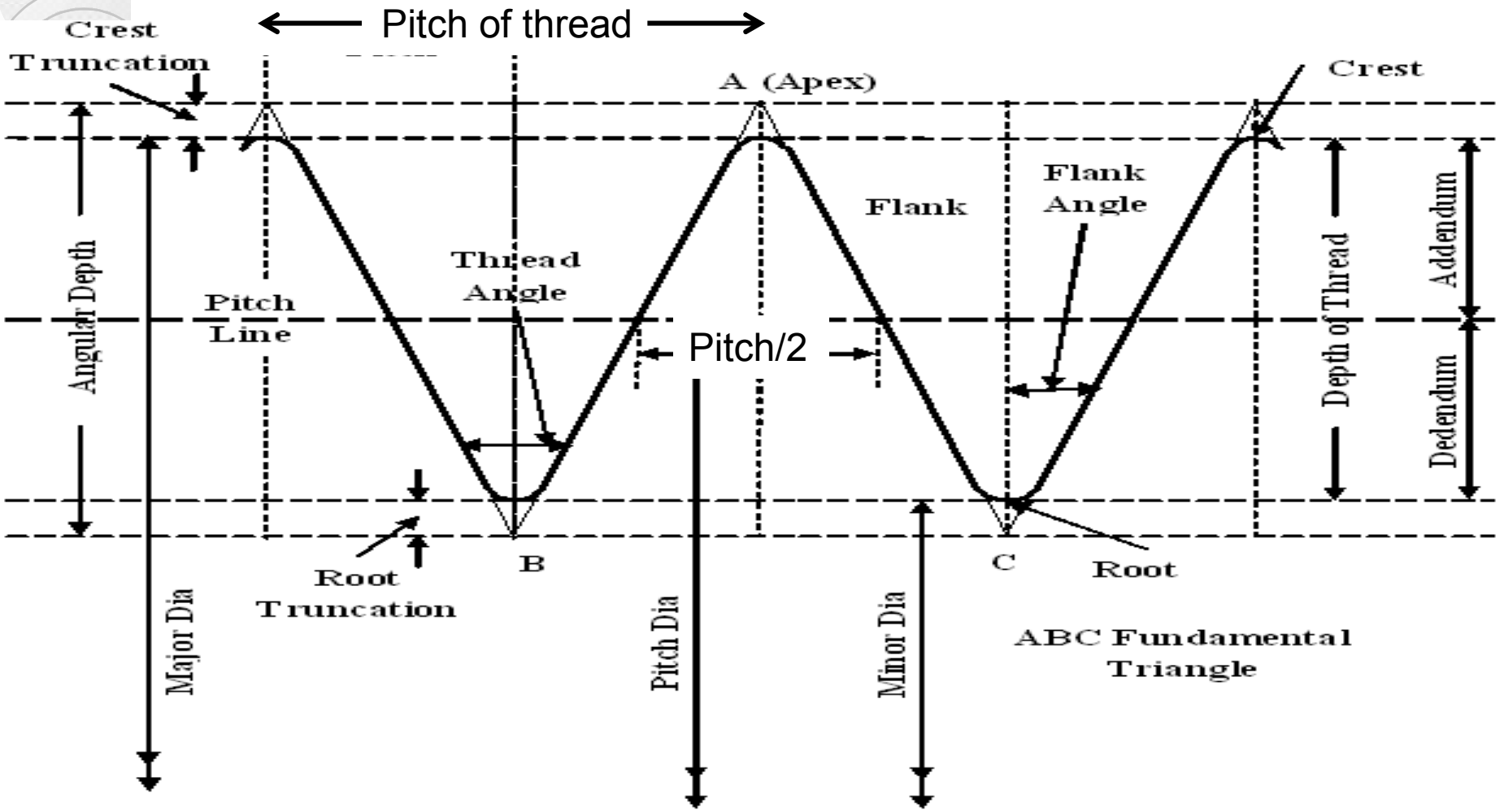



**Screw threads.**

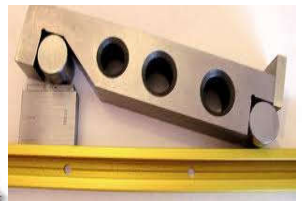
# Lead & Pitch



# Terminology

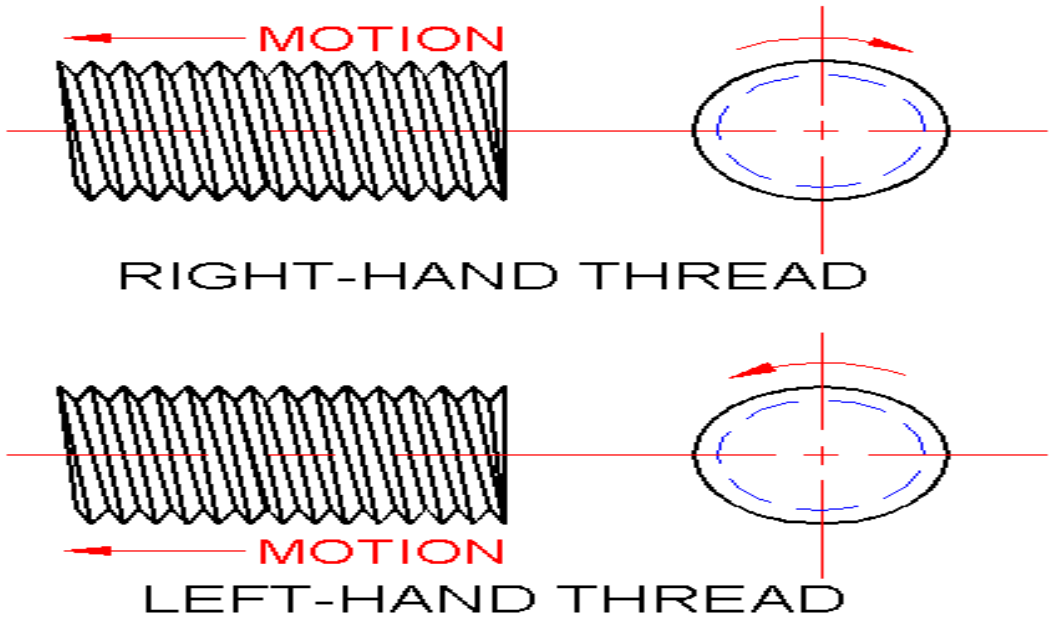






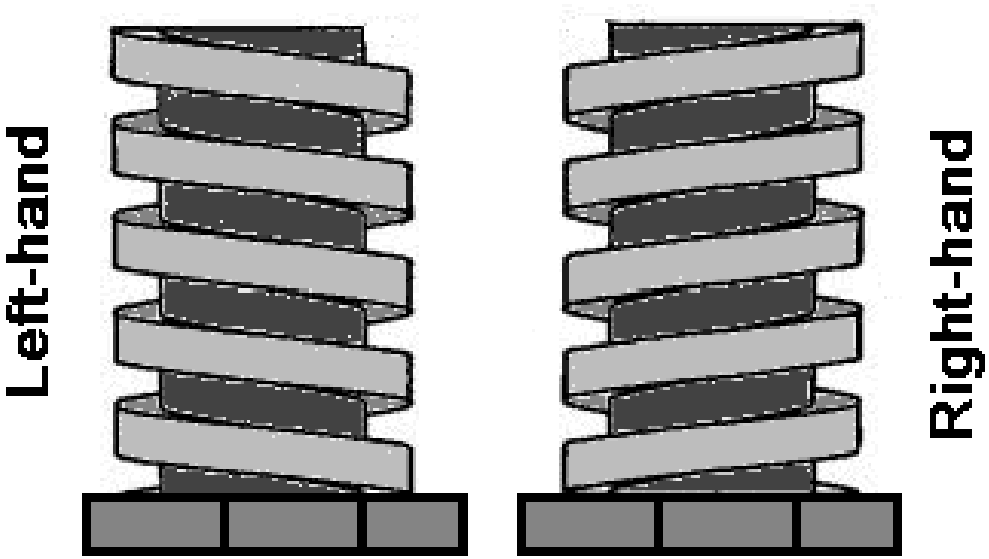
# Terminology

**Right or left hand Threads:** If a point moves along the thread in clockwise direction and thus moves away from observer- Right hand thread and if moves towards from observer- Left hand thread.





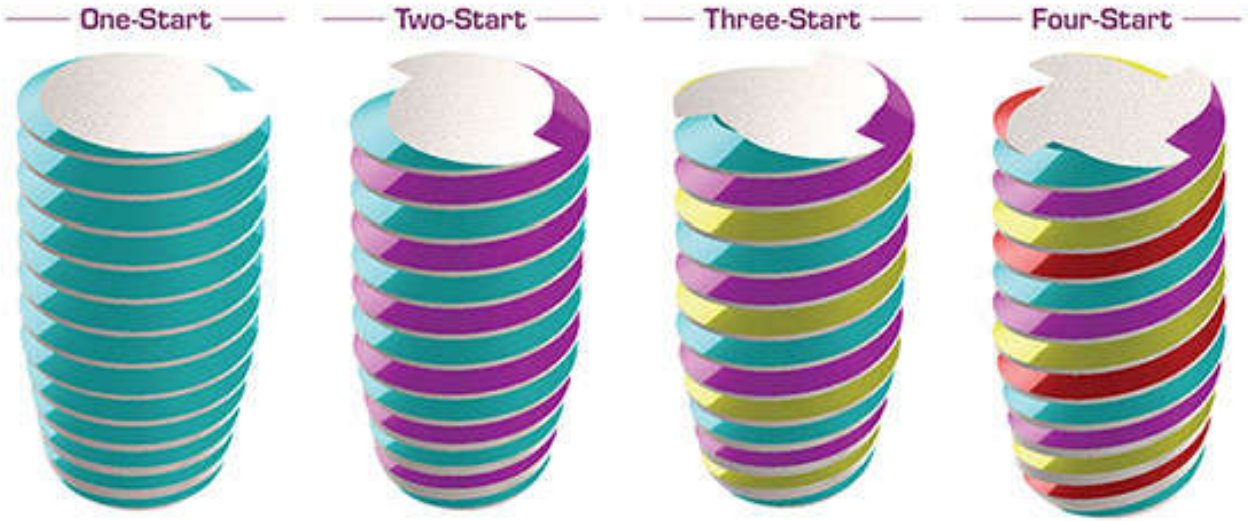
# Terminology





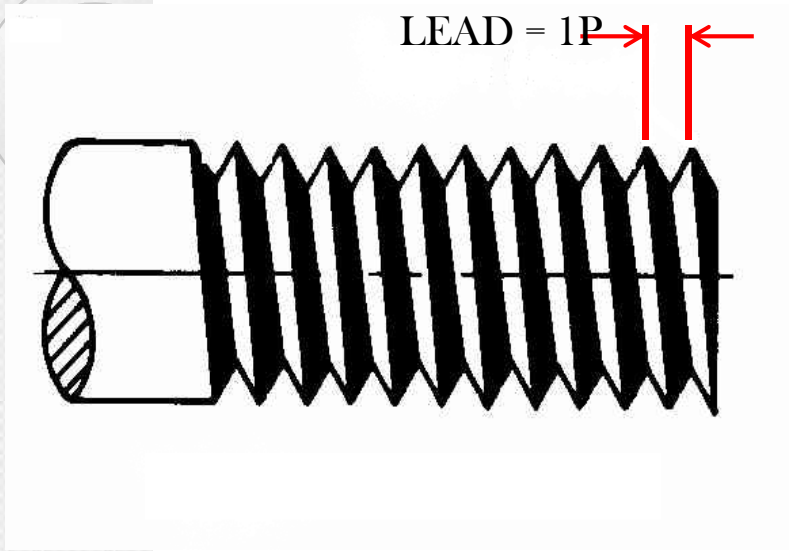
# Terminology

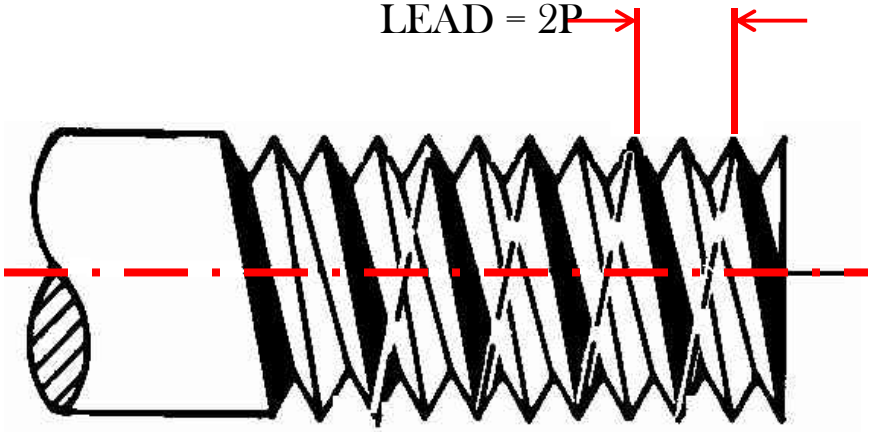
**Multiple Start Screw Thread:** Two or more helical groove, equally spaced. Gives a quick traverse without sacrificing core strength.

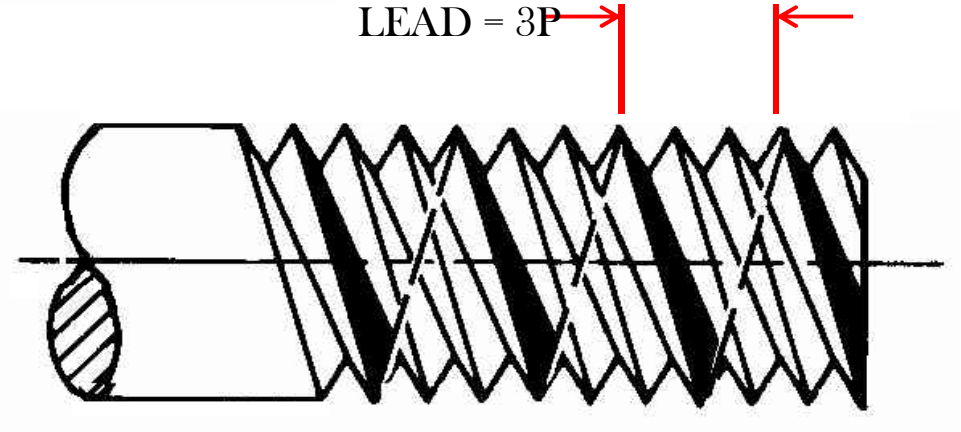




# Terminology





# Errors in Thread

There are at least five important elements of a thread:

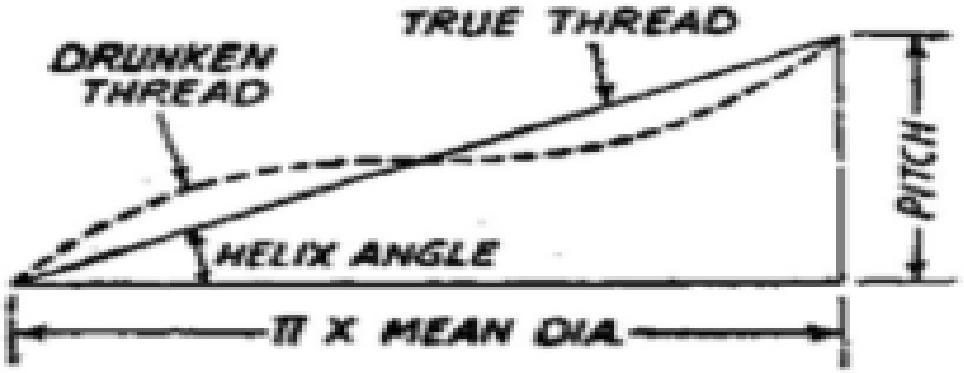
- **Major diameter**
- **Minor diameter**
- **Effective diameter**
- **Pitch and angle of the thread form**
- Errors on the major and minor diameters will cause **interference** with the mating thread
- Errors on the effective diameter will also result in **weakening** of the assembly
- Pitch and angle errors are also not desirable as they cause a **progressive tightening and interference** on assembly





# Errors in Thread

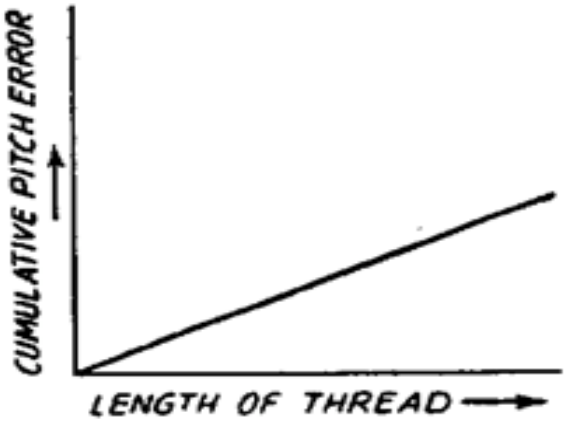
**Drunken Thread:** Advance of helix is irregular in one complete revolution of the thread, thread is not cut to a true helix.



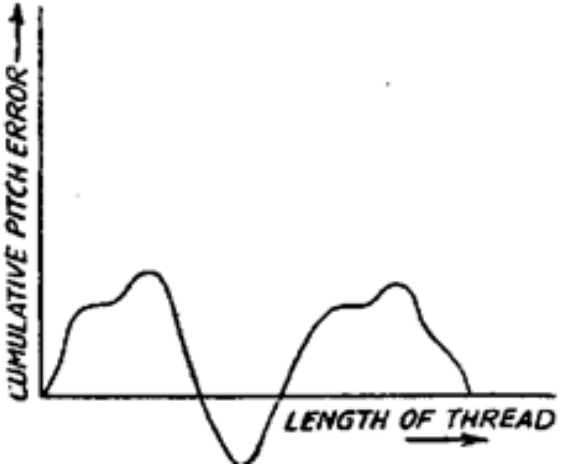


# Errors in Thread

- **Progressive Pitch Error:** Tool work velocity ratio constant but incorrect. Results due to pitch error in lead screw of the lathe or other generating machine.




- **Periodic Pitch Error:** Tool work velocity ratio incorrect and not constant. Error due to these are cyclic and pitch increases to maximum then reduce up to minimum. Results when lead screw lack of squareness, move backward or forward in one revolution.





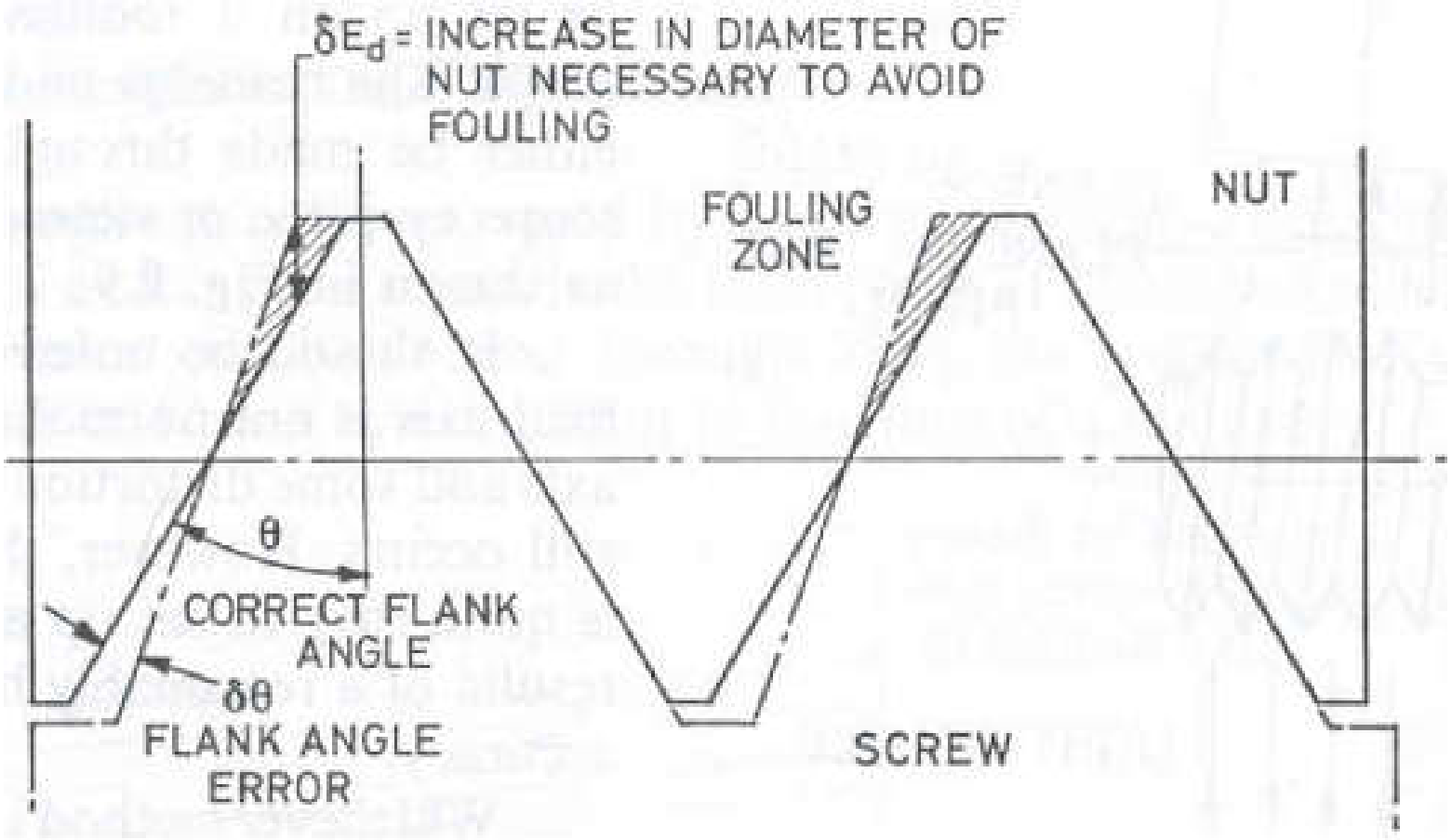
# Errors in Thread

**Irregular errors:** Arise from disturbances in the machining set-up, variations in the cutting properties of material etc. This is the irregular error in pitch and varies irregularly in magnitude over different lengths of thread.





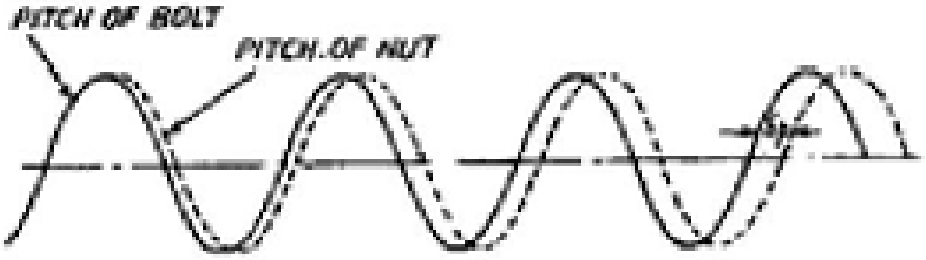
# Effect of Flank Angle Errors




Nut of perfect form mating with a screw having a flank angle error $\delta\theta$ on one flank only.

# Effect of Pitch Errors

-An error in pitch virtually increases the effective diameter of a bolt or screw and decreases the effective diameter of a nut.

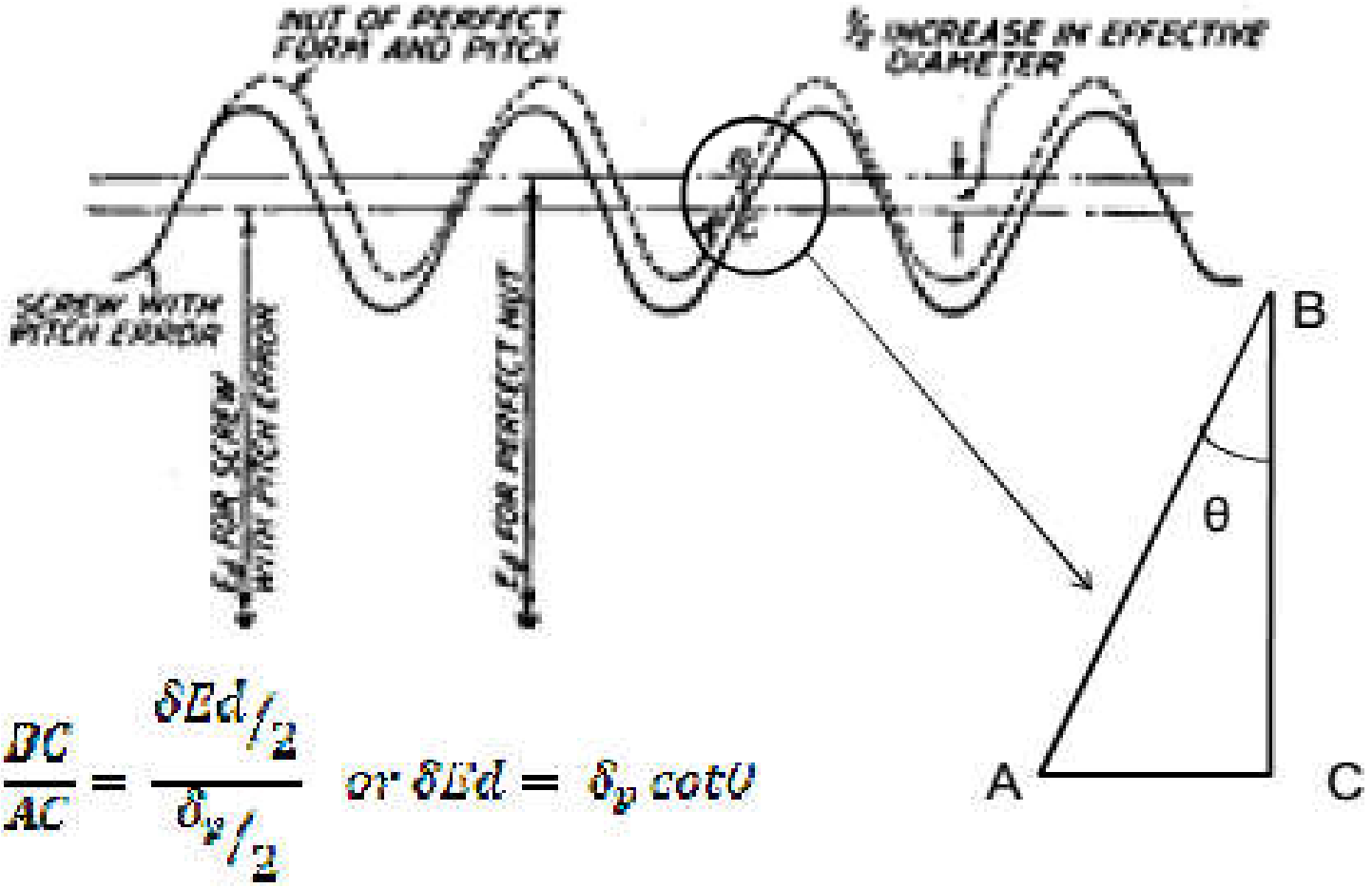



-Error in Flank angle also increases the effective diameter of Screw.

-Let us consider, $\delta p$ as the error in pitch and $\delta\theta 1$ **and** $\delta\theta 2$ are error in flank angle .

# Virtual Effective Diameter Calculation

**δp = pitch error**
**δEd = effective dia error**




$$\cot U = \frac{DC}{AC} = \frac{\delta Ed/2}{\delta_p/2} \quad or \quad \delta Ed = \delta_p \cot U$$

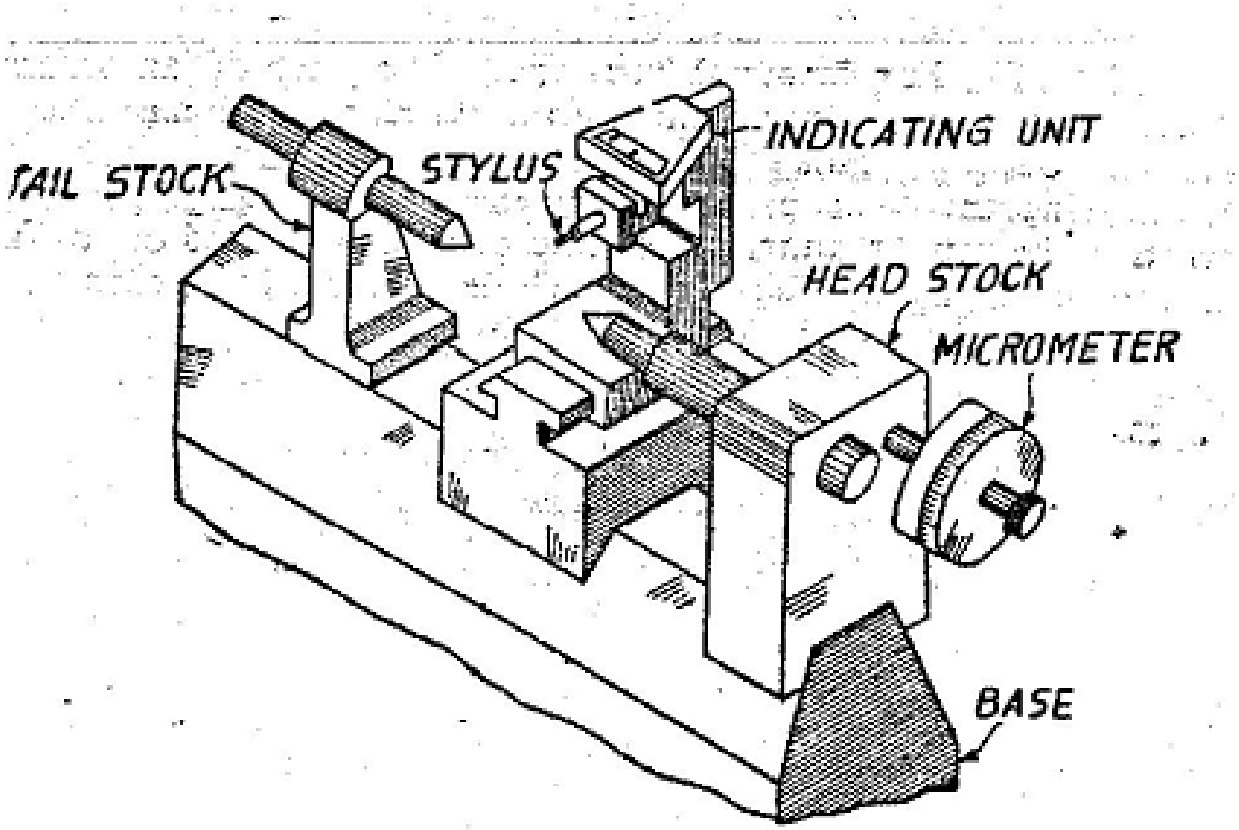
# Virtual Effective Diameter Calculation

- So ,for Pitch error, the Correction factor in effective dia = $\cot(\theta/2)\ \delta P$
- And for Flank Error $\delta\theta 1$ and $\delta\theta 2$ , the Correction factor in effective dia = $CP(\delta\theta 1 + \delta\theta 2)$

-For **Whithworth** Thread, C=0.0105 and $\theta=55$ so, $\cot(55/2)=1.921$ . Hence in this case ,

Virtual Effective Diameter = Simple Effective Diameter + $1.921\delta P + 0.0105P\ (\delta\theta 1 + \delta\theta 2)$

# Matrix Pitch Measuring Machine



# Effective Dia Measurement

I) Thread micrometer method.

II) One wire method

III) Two wire method.

IV) Three wire method

V) Best size wire method

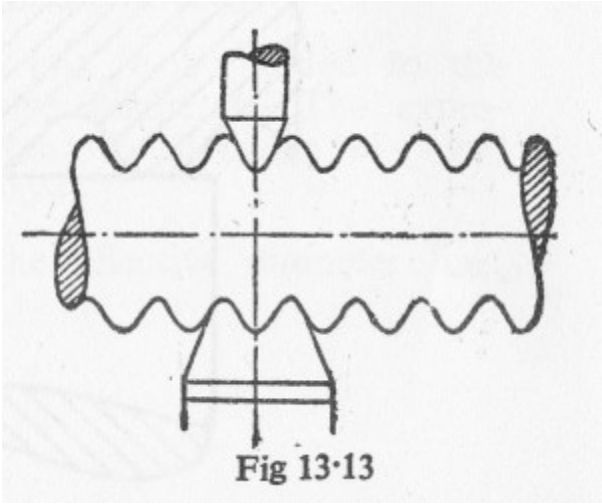


Fig 13·13

Pitch dia =
D- 0.6403 p
(Whitworth)

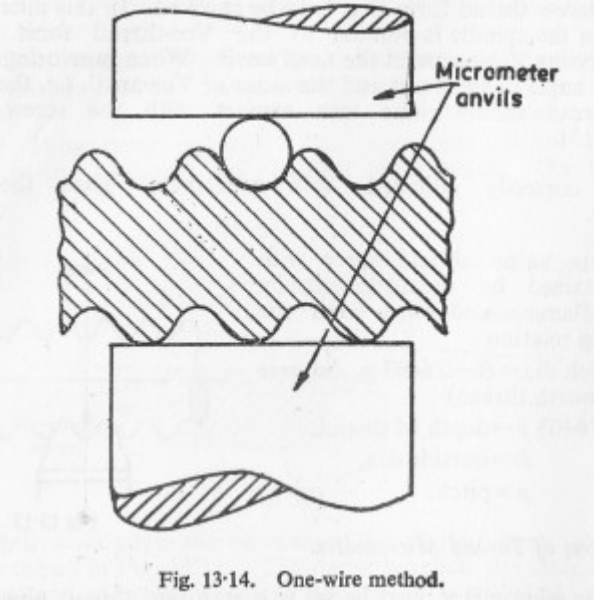



Fig. 13·14. One-wire method.

# Self Study

I) Thread micrometer method.

II) One wire method

# Two wire method

$E = T + P$

Where $T$ = Dimension under the wires

$= M - 2d$

$M$ = dimension over the wires, $d$ = diameter of each wire

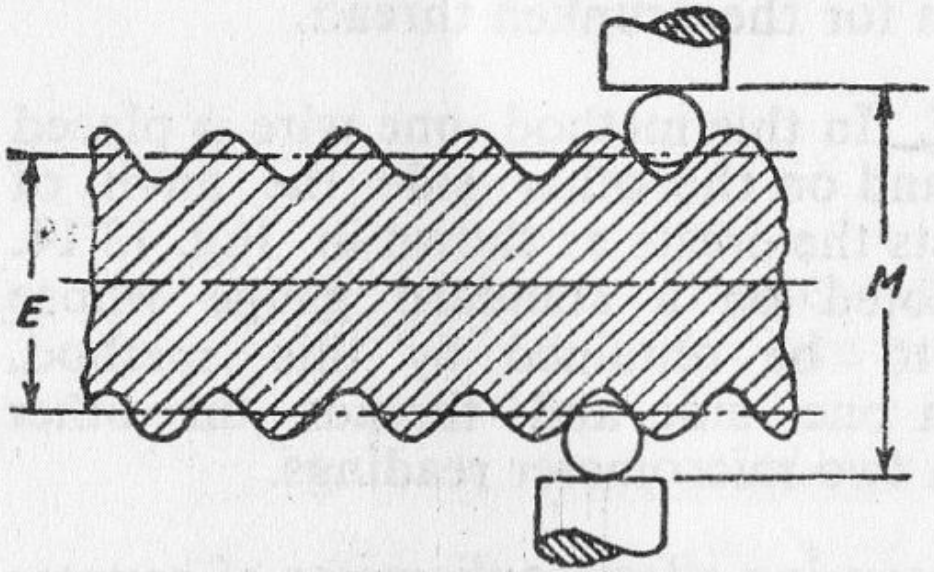



Fig. 13·15 (*a*)

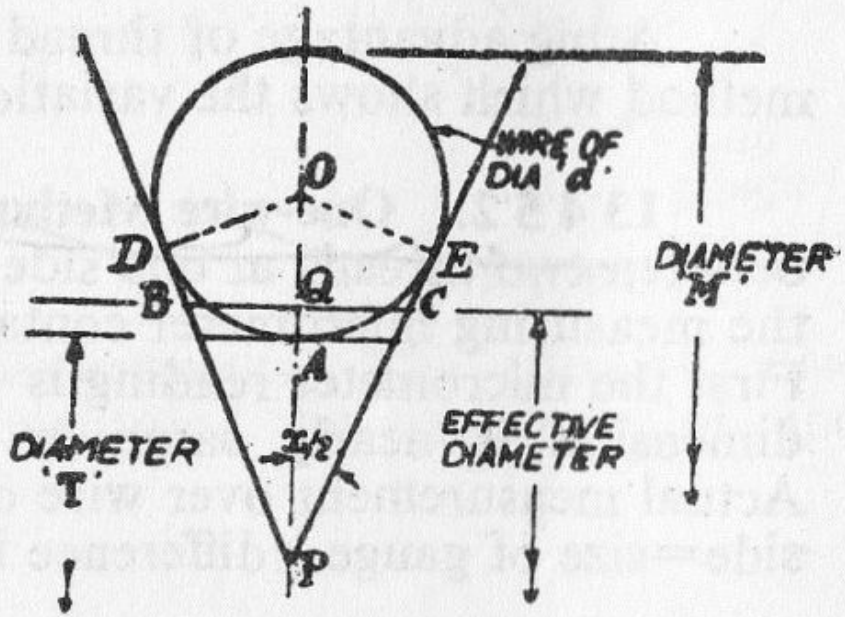



Fig. 13·15 (*b*)

# Two wire method

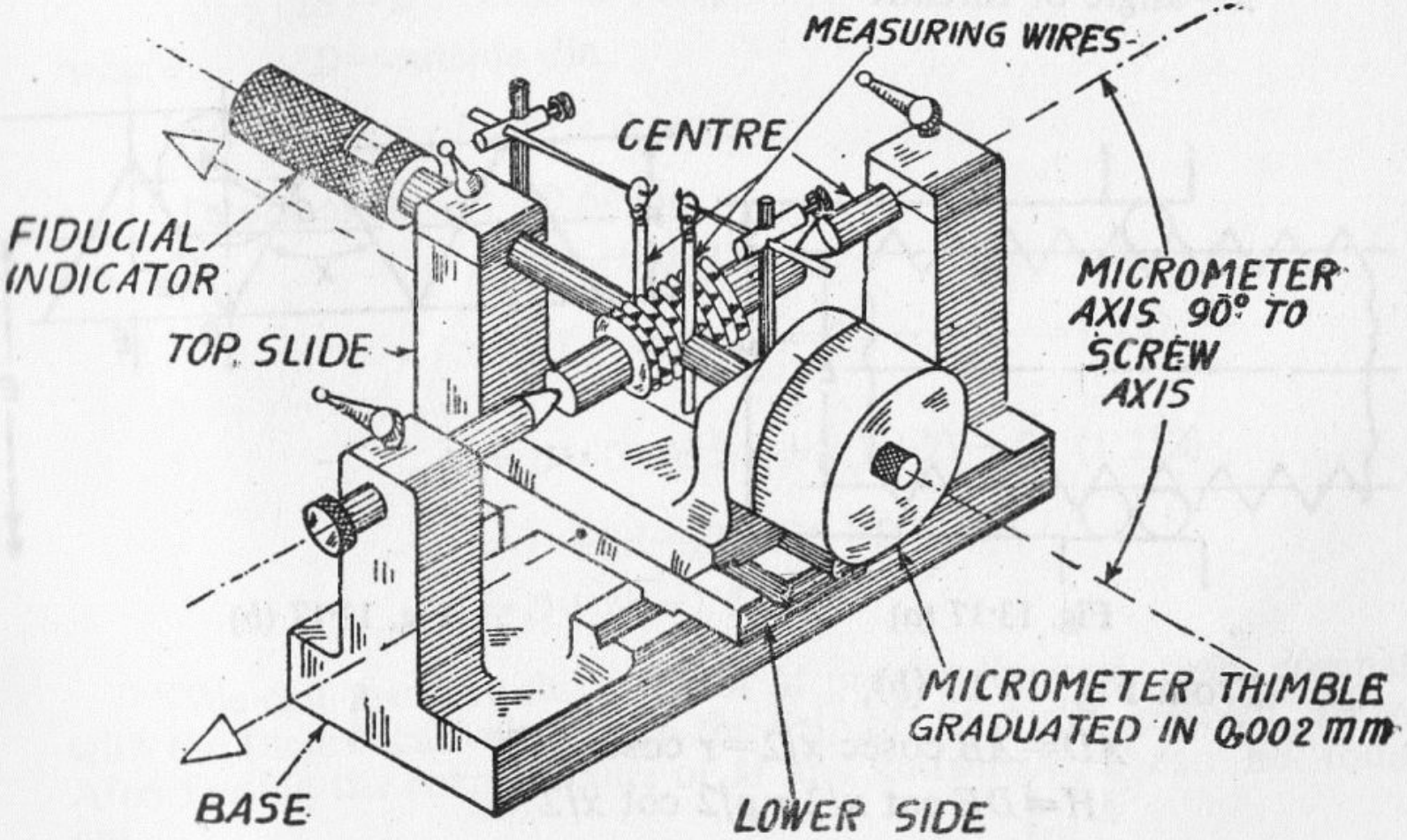



Fig. 13·16

# Two Wire Method

In Fig. 13.15 (*b*), since $BC$ lies on the effective diameter line, $BC = \frac{1}{2}$ pitch $= \frac{1}{2}p$

$$OP = \frac{d \operatorname{cosec} x/2}{2}$$

$$PA = \frac{d\,(\operatorname{cosec} x/2 - 1)}{2}$$

$$PQ = QC \cot x/2 = \frac{p}{4} \cot x/2$$

$$AQ = PQ - AP = \frac{p \cot x/2}{4} - \frac{d\,(\operatorname{cosec} x/2 - 1)}{2}$$

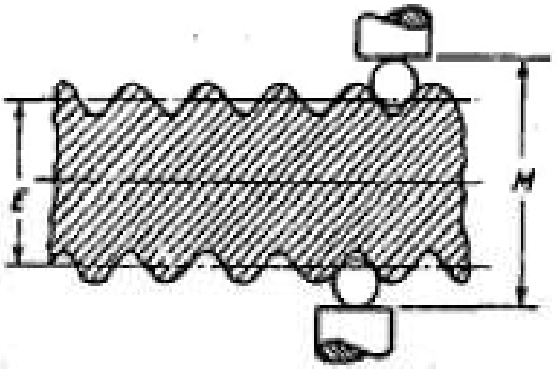
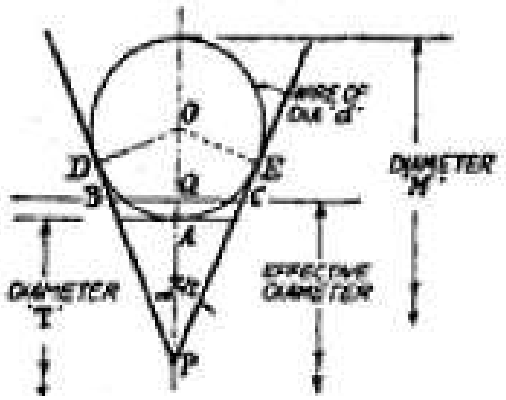



Fig. 13.15 (a)

$AQ$ is half the value of $P$

$$\therefore \qquad P \text{ value} = 2AQ = \frac{p}{2} \cot \frac{x}{2} - d\left(\operatorname{cosec} \frac{x}{2} - 1\right)$$




*Effective dia = T+2*p-value*

# Three wire method

- The wires may be either held in hand or hung from a stand so that the wires can adjust themselves under micrometer pressure.
- M=distance over wires
- E=effective diameter
- r=radius of the wires
- d=diameter of wires
- D=outside dia of the thread
- h =height of the centre or the wire or rod from the effective
- x=angle of thread.

# Three wire method

- AD=AB cosec x/2=r cosec x/2
- H=DE cot x/2=p/2 cot x/2
- CD=½H=p/4 cot x/2
- h=AD CD
- h = r cosec x/2 p/4 cot x/2

So, Distance over wires=M=E+2h+2r

=E+2(r cosec x/2 – p/4 cot x/2)+2r

=E+2r (l+cosec x/2 ) p/2 cot x/2

So , M=E+d (1+cosec x/2) p/2 cot x/2

$M$ = distance over wires  $E$ = effective diameter
$r$ = radius of the wires  $d$ = diameter of wires
$h$ = height of the centre or the wire or rod from the effective diameter
$x$ = angle of thread.

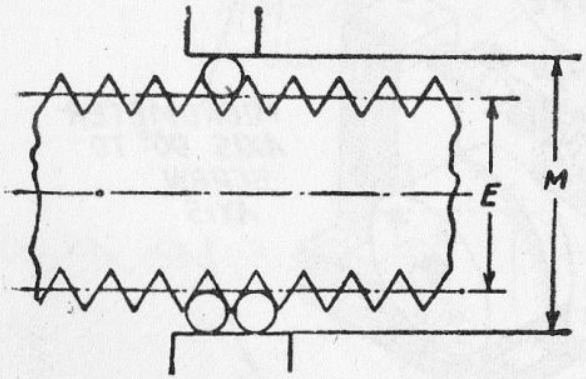



Fig. 13·17 (*a*)

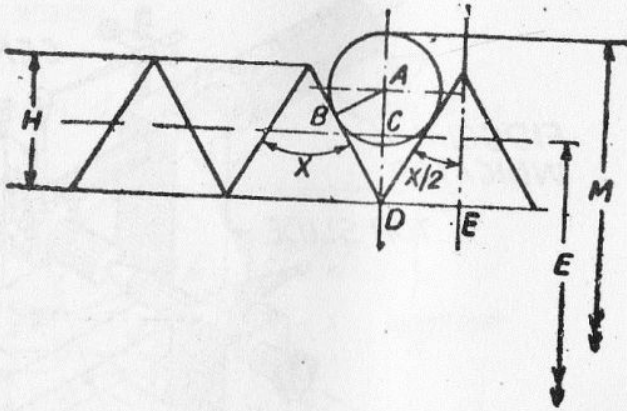



Fig. 13·17 (*b*)

# Three wire method

**In case of Whitworth thread:**

- x=55°, depth of thread =0.64 p, so that
- E=D—0.64 p and cosec x/2 =2.1657
- Cot x/2 = 1.921
- M=E + d(1+cosec x/2) — p/2 cot x/2

  =D 0.64p+d(1+2.1657) p/2(1.921)

  =D+3.1657d 1.6005p

# Three wire method

**In case of metric threads :**

- Depth of thread=0.6495p
- so, E=D-0.6495p.
- x=60°, cosec x/2=2 ; cot x/2 = 1.732
- M=E + d(1+cosec x/2) — p/2 cot x/2

  =D 0.6495 p + d(1+2)—p/2 (1.732)

  =D+3d (0.6495+0.866)p

  =D+3d—1.5155p.

# Best Size Wire Method

- It is recommended that for measuring the effective diameter, always the best size wire should be used and for this condition the wire touches the flank at mean diameter line within ±1/5 of flank length

.

- Workout Example: **Problem 13.1**

  **(Derive an expression for Best Size Wire)**

# That's all for now