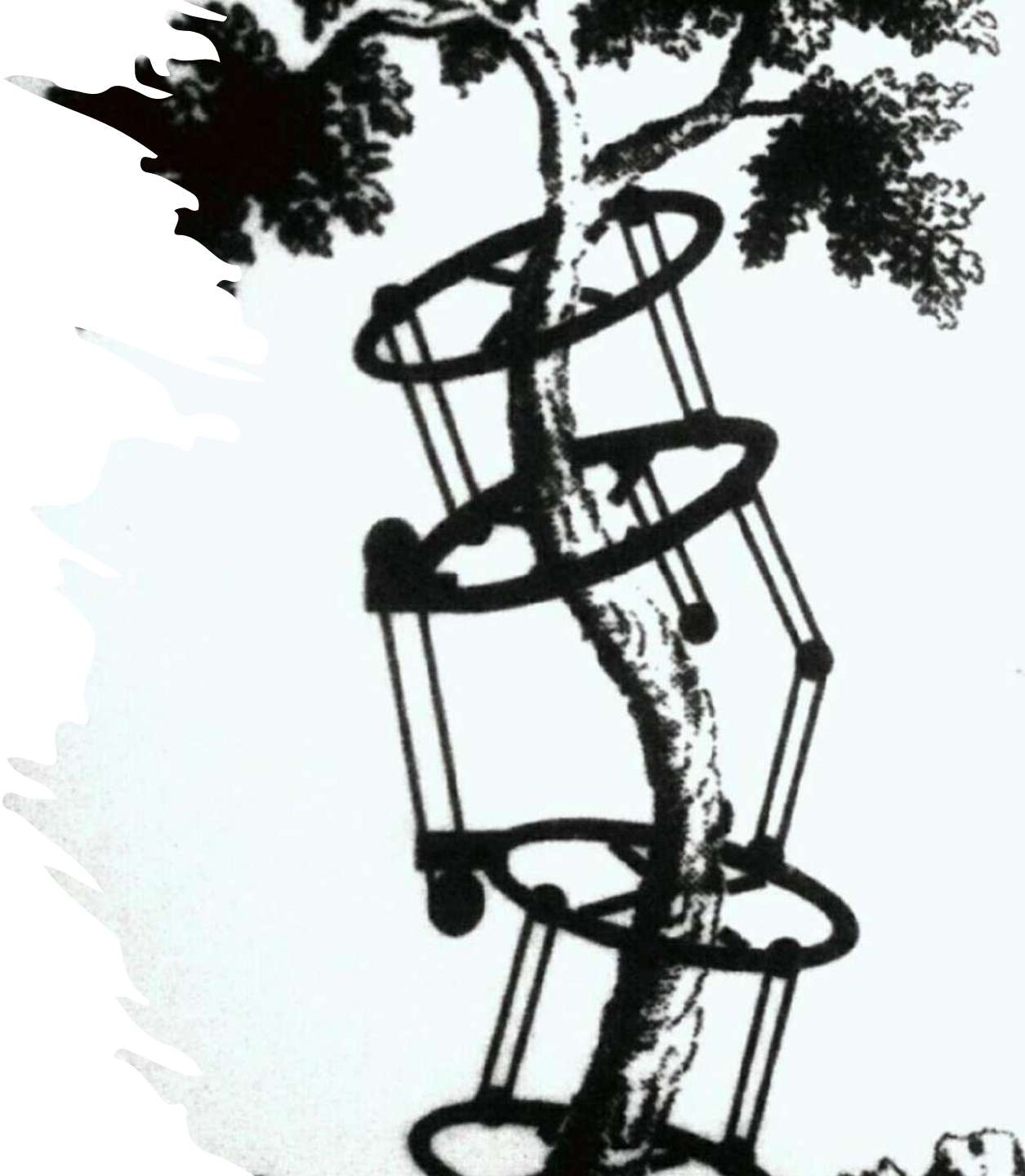
Basics of Ilizarov Part -1 Know your instruments!



Dr Daivik T Shetty

Consultant Orthopedic Surgeon

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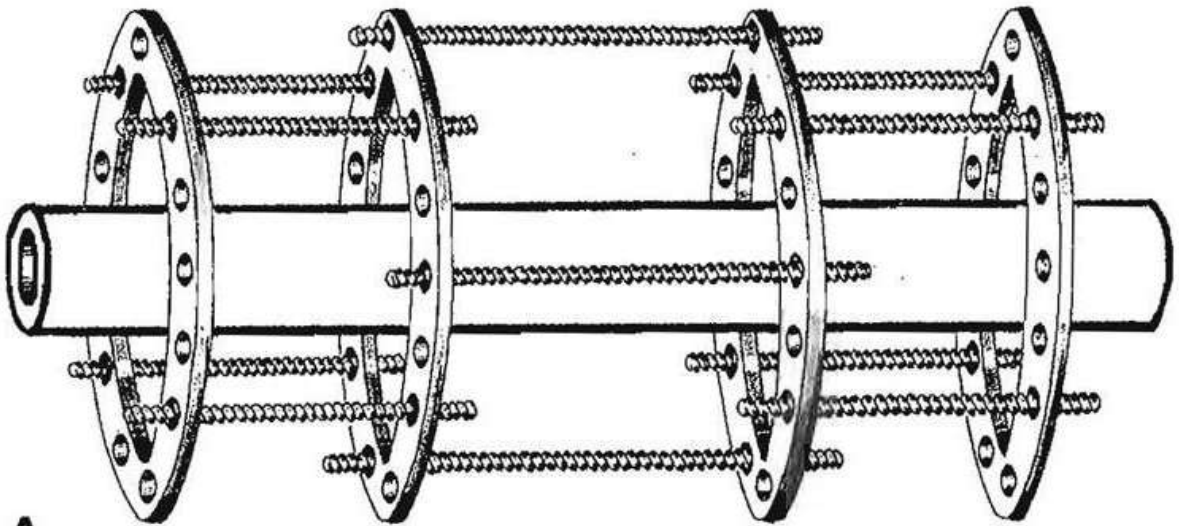

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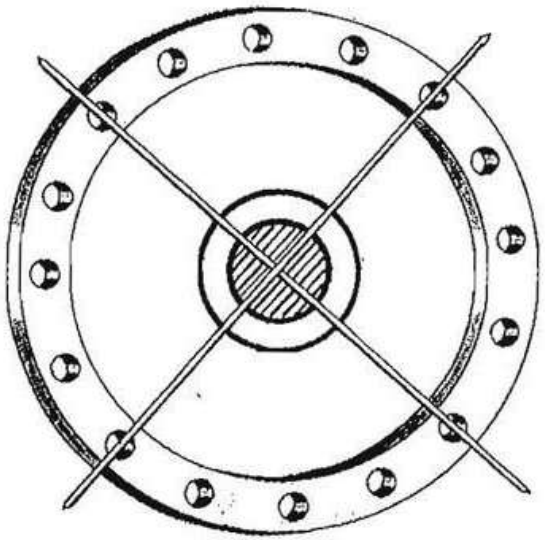

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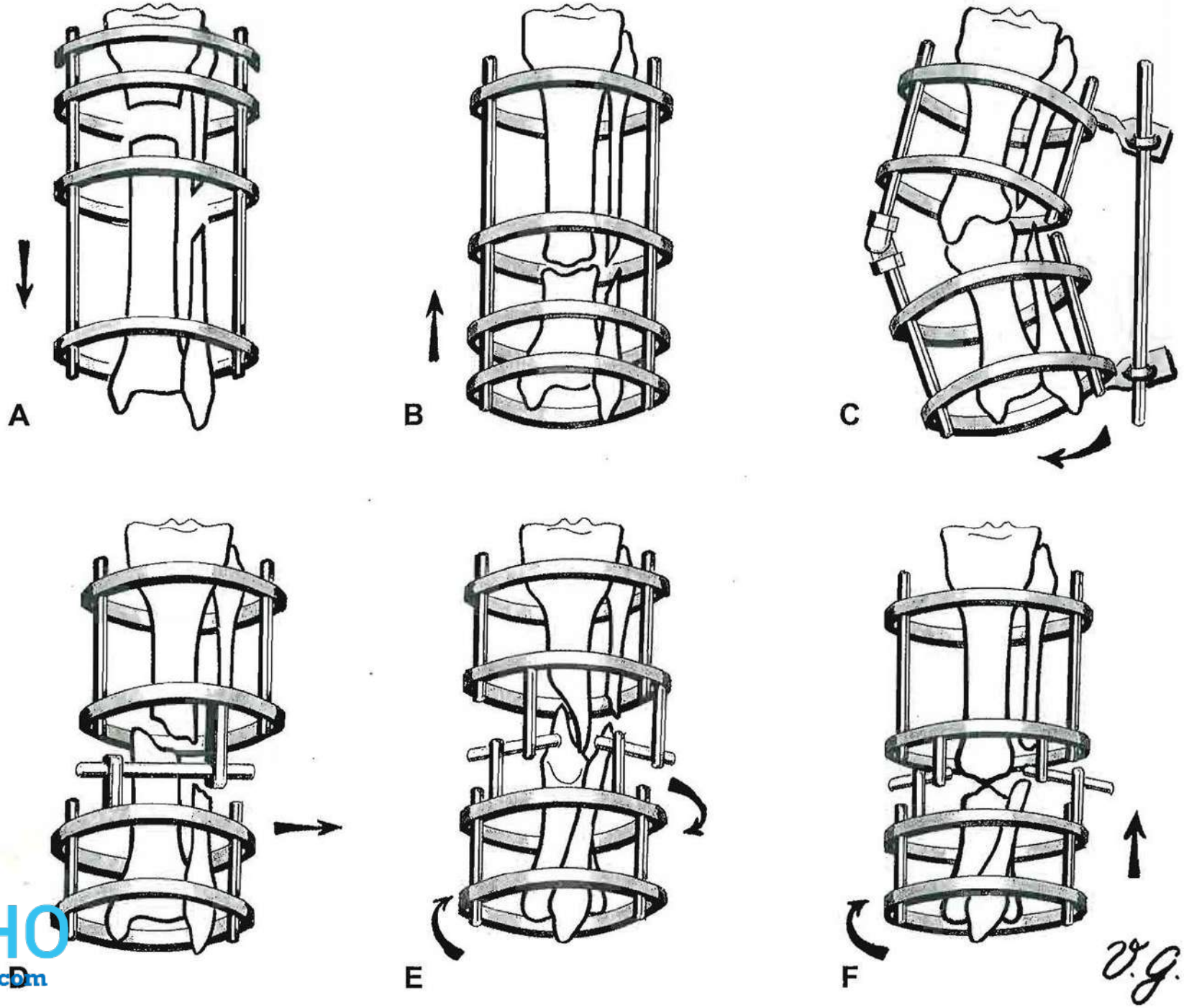
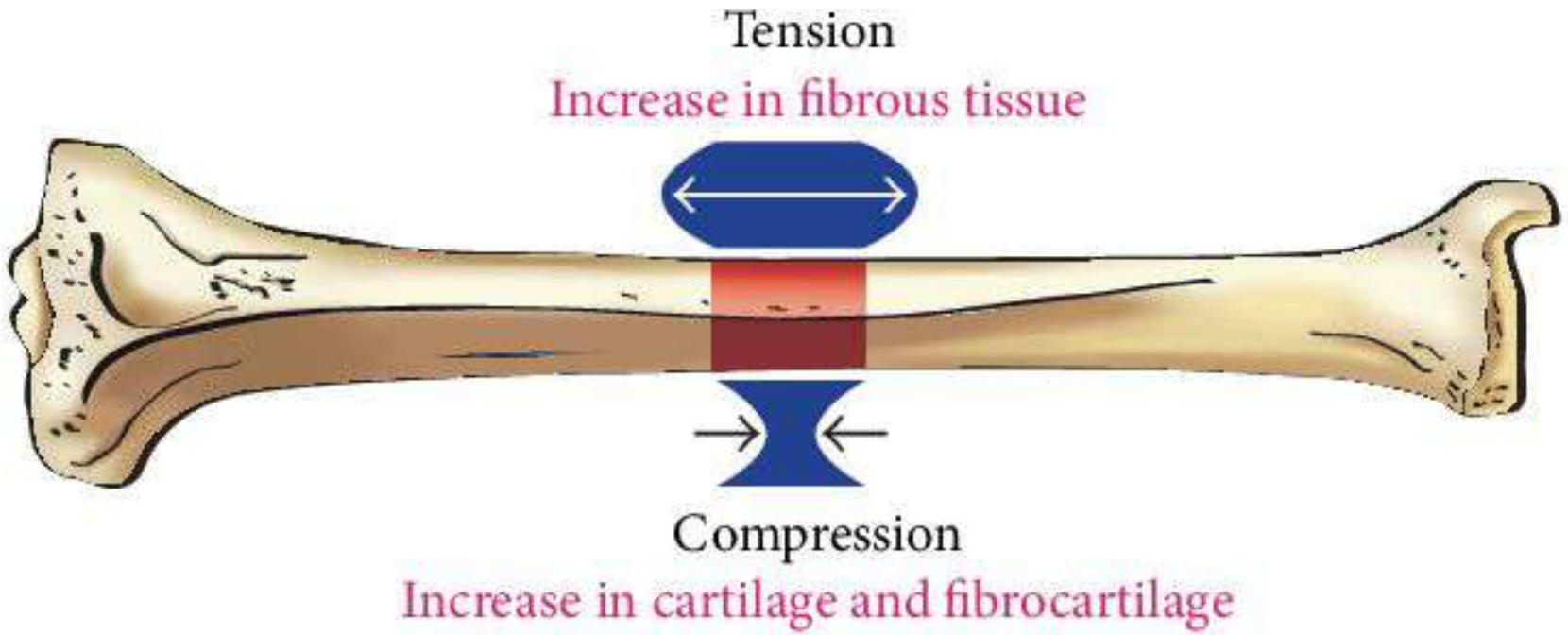


Accordion Technique Compression-Distraction technique



Ilizarov Apparatus

- Devised by **Dr Gavriil Abramovich Ilizarov**
- Called as "***Magician of Kurugan***"

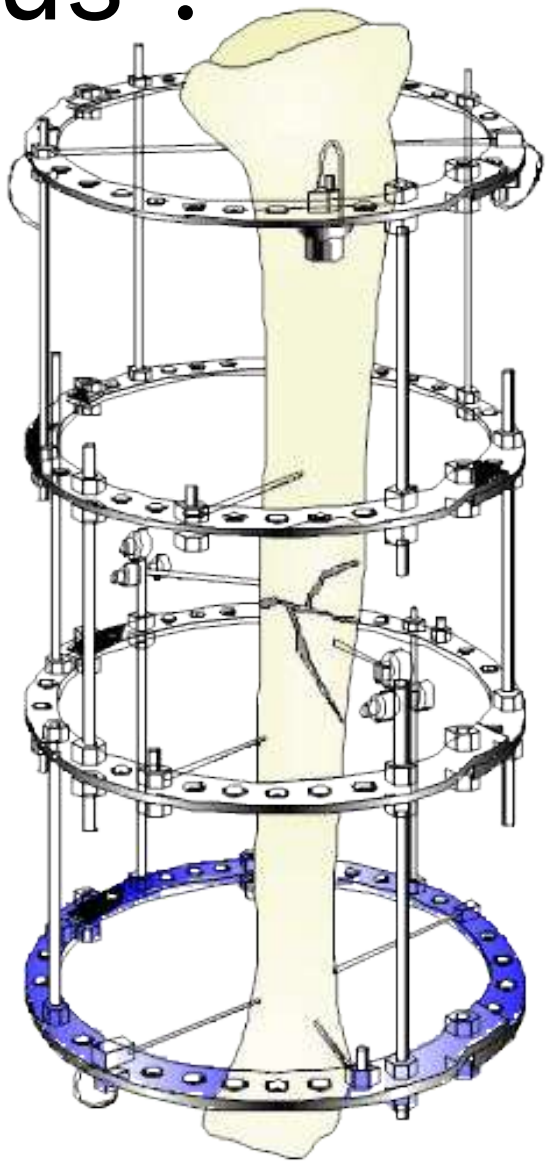
Which of the following is a Primary component of the Ilizarov apparatus ?

a) Spanner

b) Hinges

c) Rings

d) Washer



Know your instruments

Instrumentation

- Primary components
- Secondary components

Primary Components

- Standard parts

- Join the skeleton to the finished frame

1. Rings
2. Wires
3. Wire fixation bolts and buckles
4. Schanz / Orthofix pins
5. Pin clamps

Secondary Components

- Secondary components are special parts used to construct the frame of the apparatus

1. Spanners
2. Wrenches
3. Rods
4. Posts
5. Hinges
6. Plates
7. Supports
8. Washers
9. Nuts
10. Sockets
11. Bolts
12. Bushings

RINGS

GOOD WIRE INCLINATION AND PLANE ORIENTATION

RING BEARS STRESS OF TENSIONED WIRES (AS MUCH AS 150 KGS EACH)

PROVIDES RIGID SUPPORT FOR ENTIRE FRAME

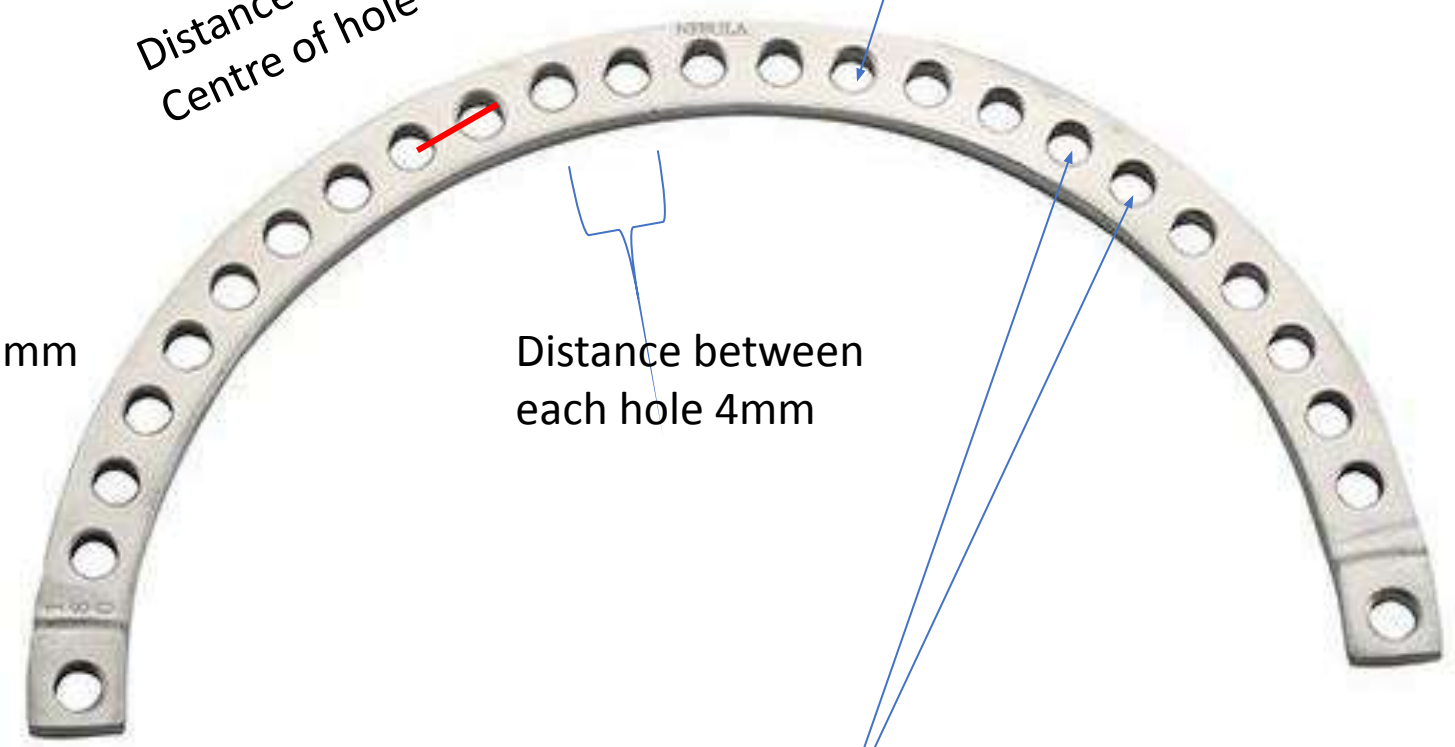
Rings

- Component on which the trans fixation K-Wires or half pins are connected
- Different rings at different areas joined together will form the FRAME
- Necessary for integrity of the apparatus and bone transport

Function

- Support trans fixation of ilizarov, olive wires and half pins
- Builds a fixator frame connecting two or more rings.
- Props up frame's supplementary parts

Half Rings



Rings are placed perpendicular to long axis of the bone

Made up of Stainless steel or Carbon fiber

Perforated holes on the half rings
Equidistant to one another
Helps in creating equal frames

What is the diameter of rod and bolt used in Ilizarov rings ?

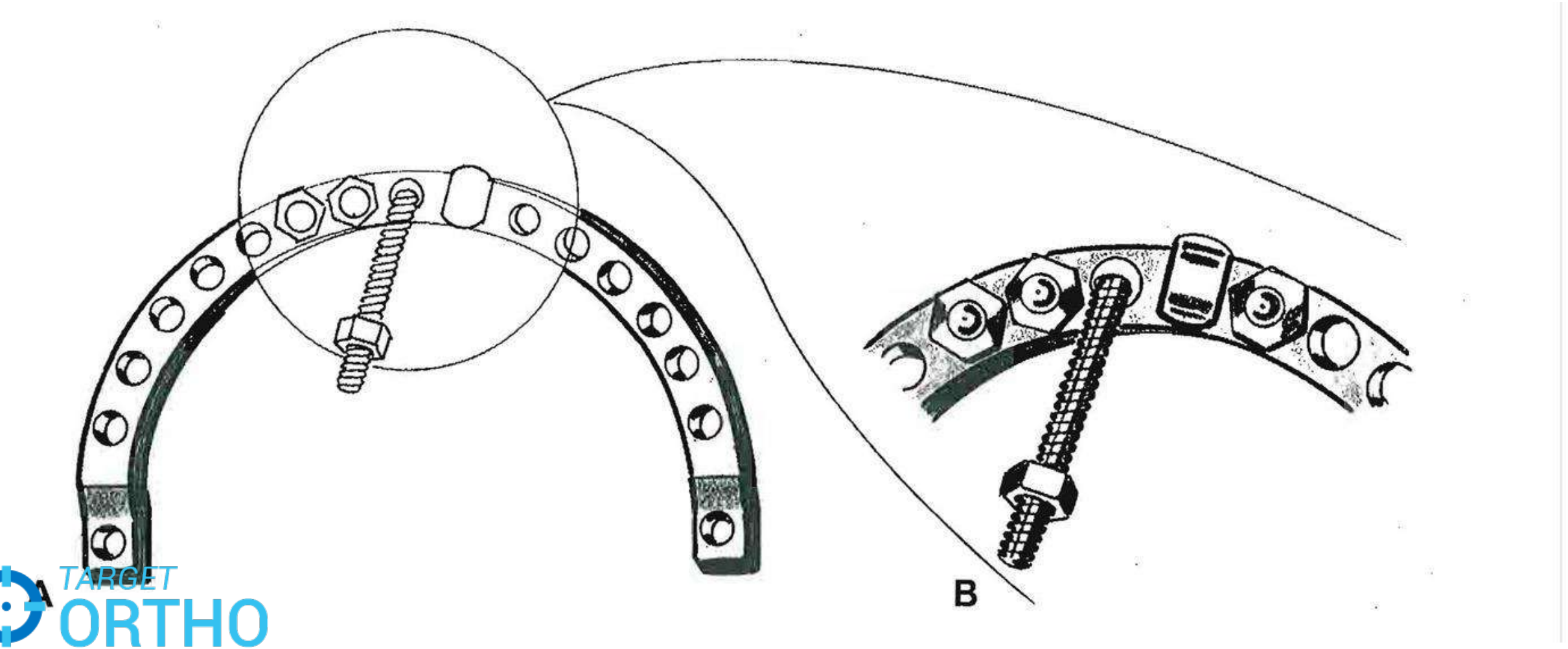
a) 8mm

b) 10mm

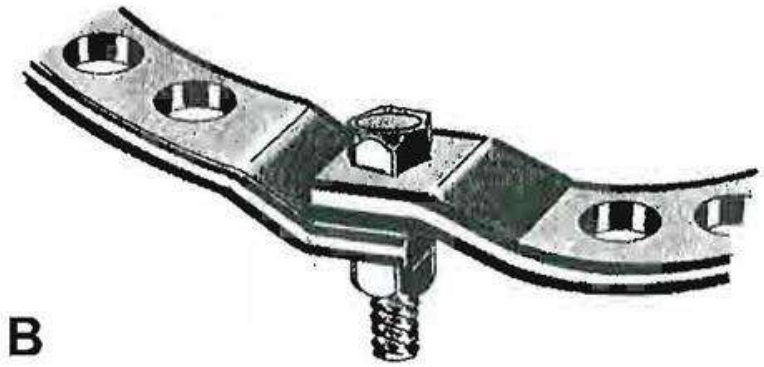
c) 6mm

d) 4mm

The diameter of the hole is 2mm greater than that of the rod or bolt, allowing the surgeon flexibility of angulation and introduction of a bolt



Connecting Half Rings

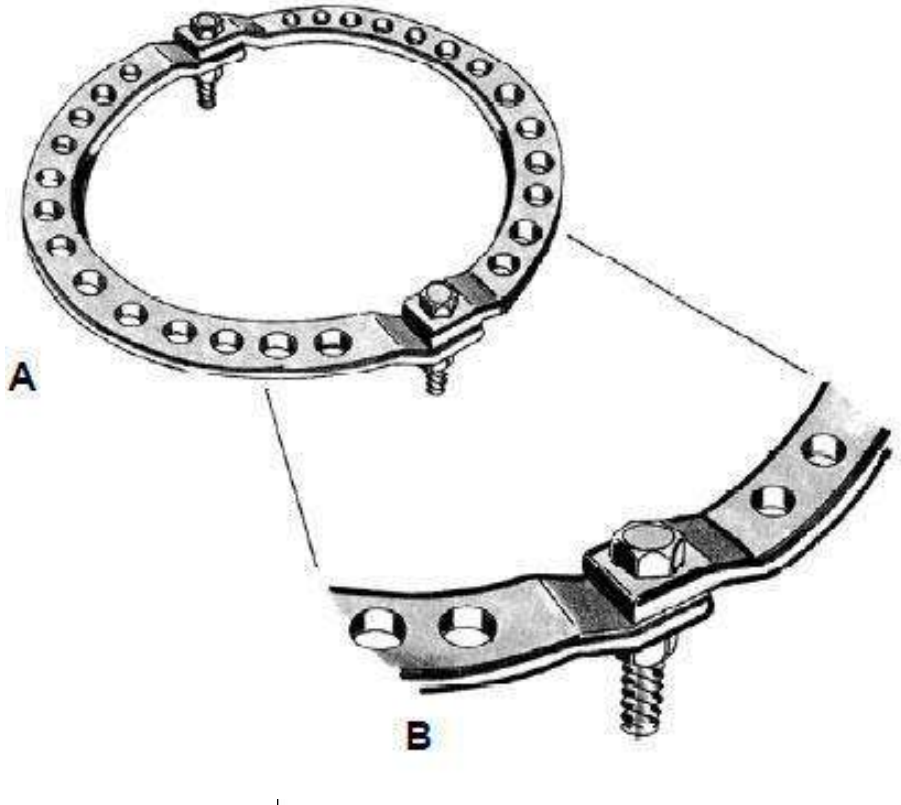


Ring Dimensions

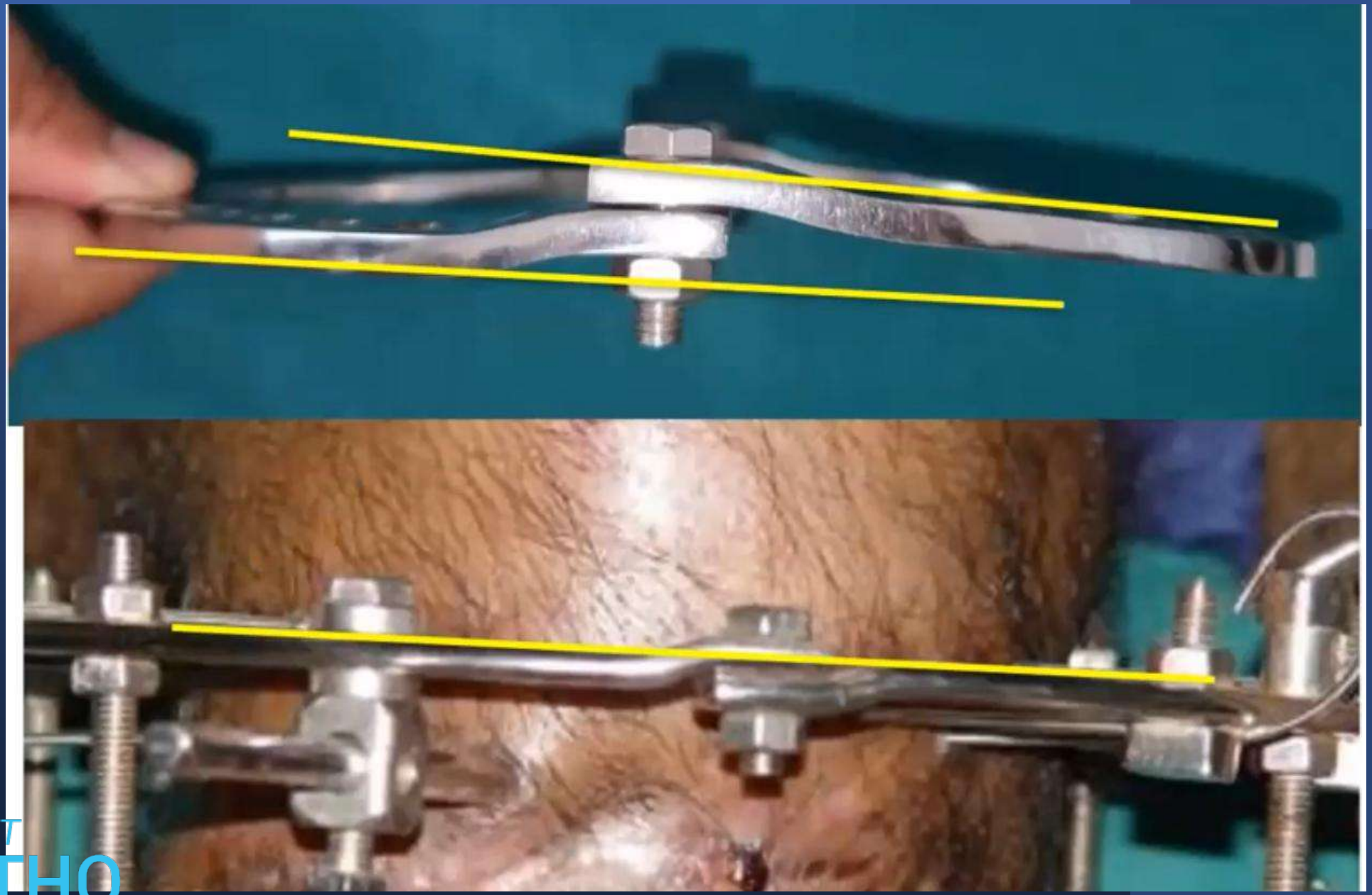
18-28 holes in Ring
Internal diameter of ring ranges from 80mm – 240mm

PEDIATRIC – 80mm-140mm
ADULT – 150mm-240mm

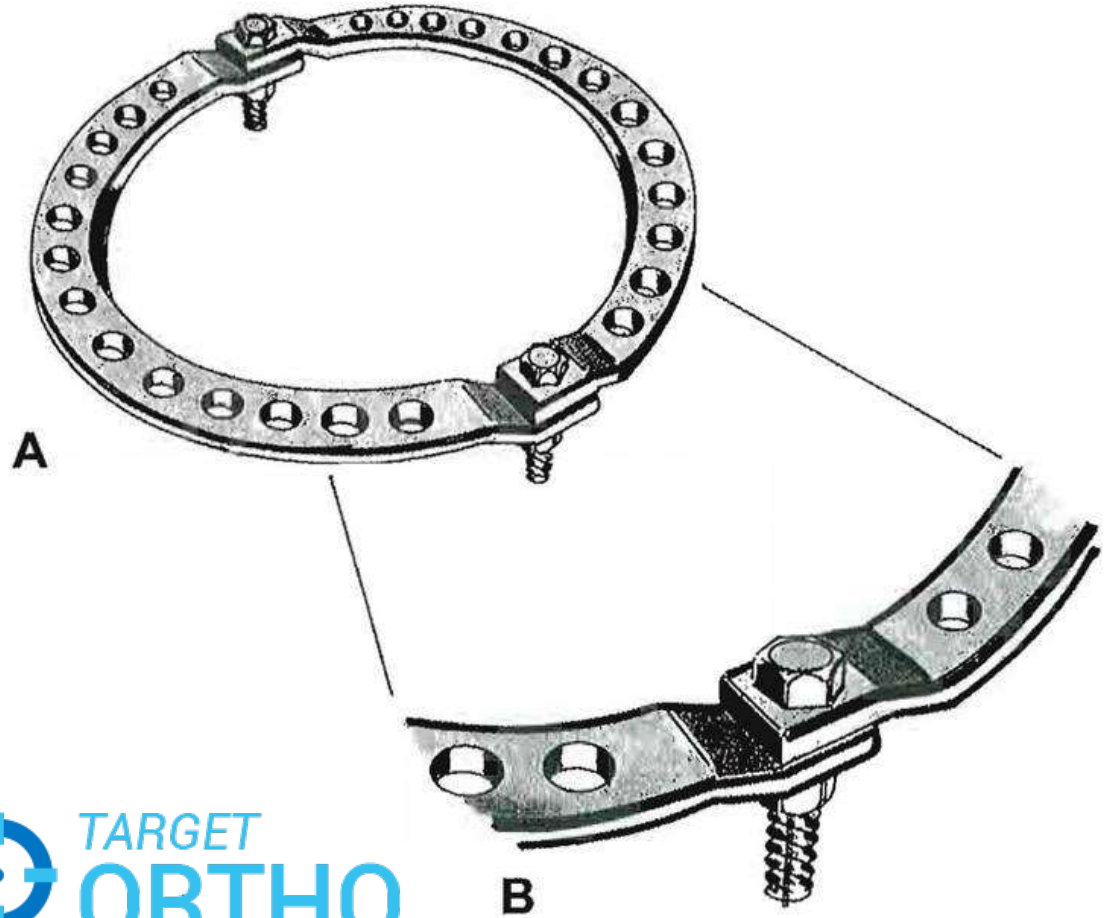
Thickness of rings – 5mm
End of half ring has an **Offset – coplanar rings**

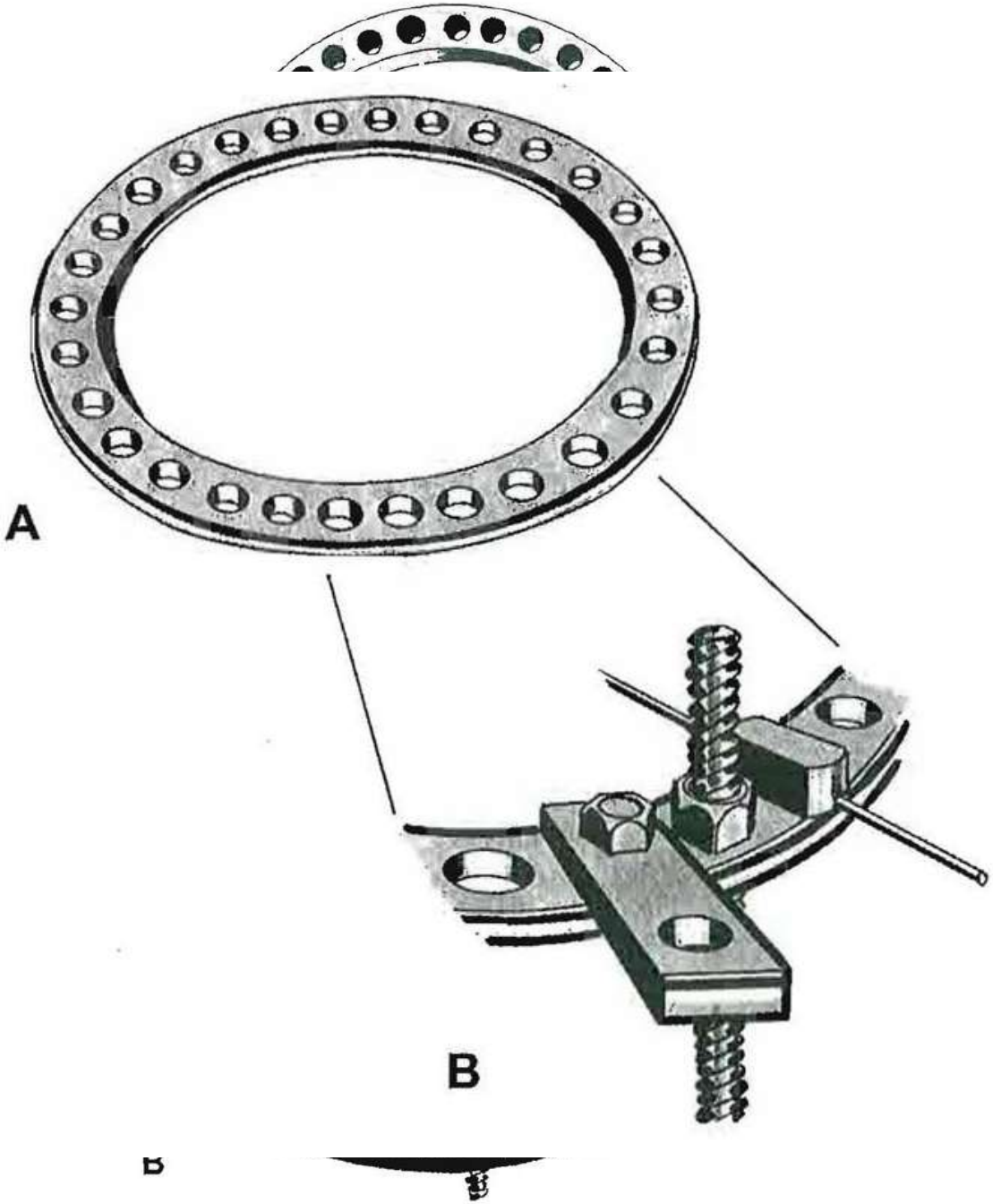


"Shake hand position"



Full Ring vs Half Ring Construction





Full Rings

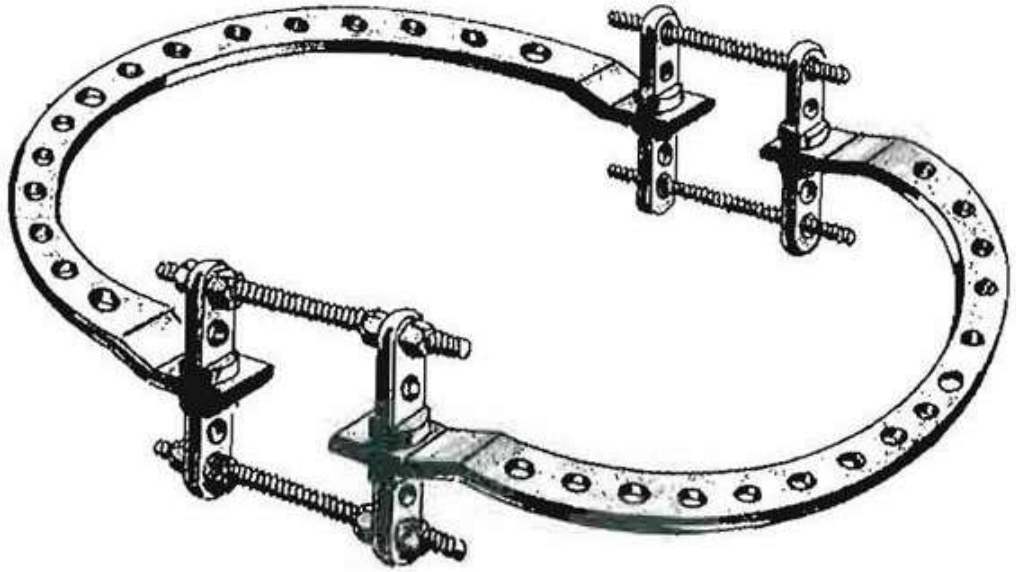
More perforations as there is no offset

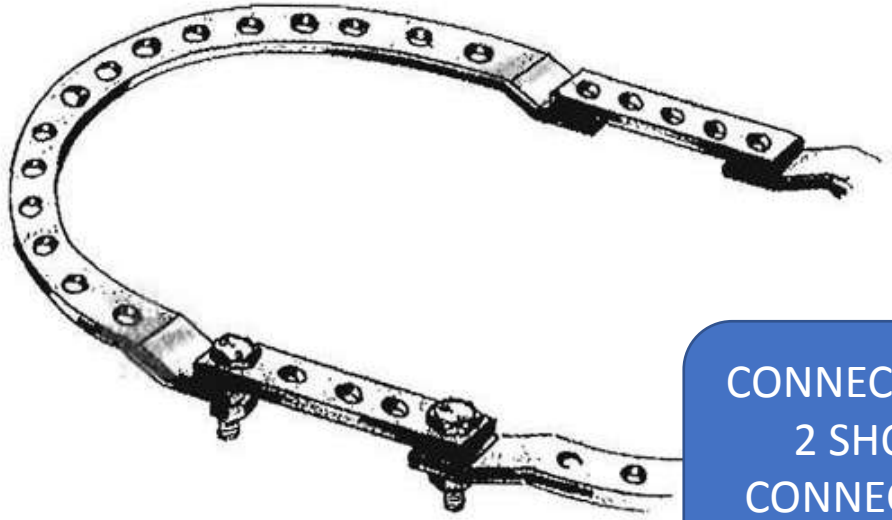
3 EXTRA HOLES

These extra holes can be used for secondary components

Full rings cannot be detached intraoperatively
They cannot be used with flexibility

Mostly used in foot end or Caudal end of the apparatus



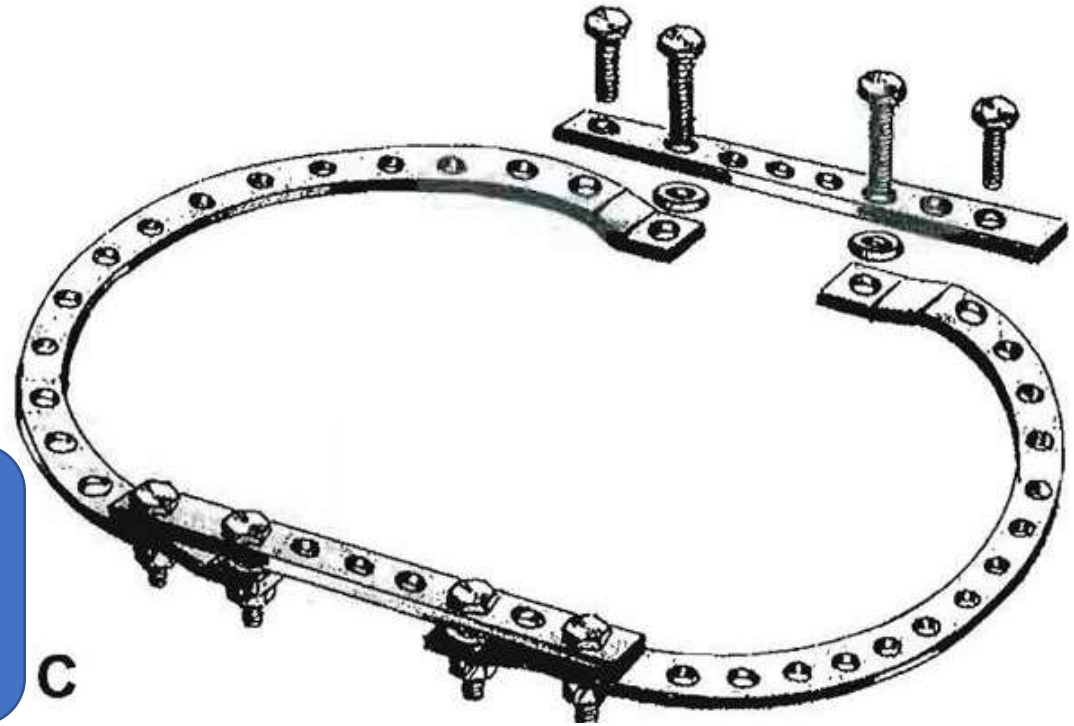


B

CONNECTED BY 2 SHORT CONNECTION PLATES

Connected by 4 threaded rods

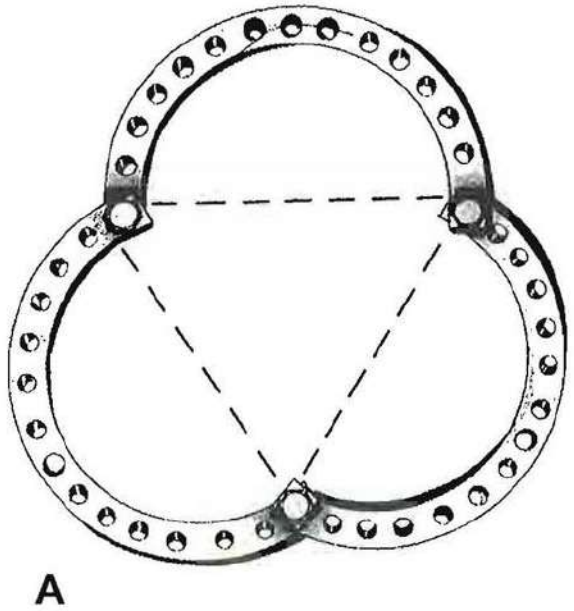
Distance between half rings regulated by turning the nut



C

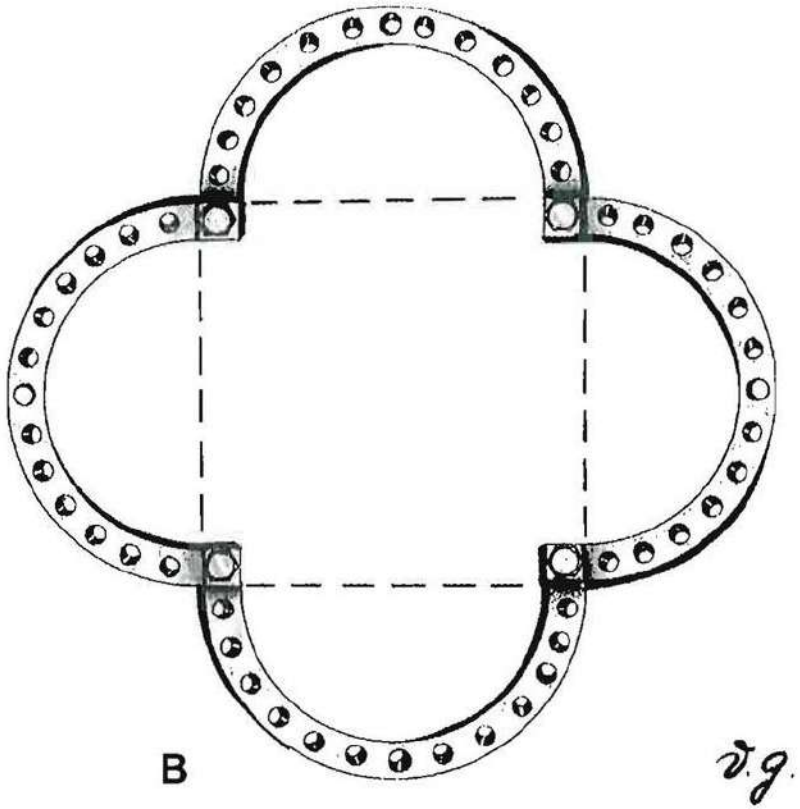
REINFORCED BY TWO LONG CONNECTING PLATES – WASHER USED AT OFFSET

FOOT COMPONENT

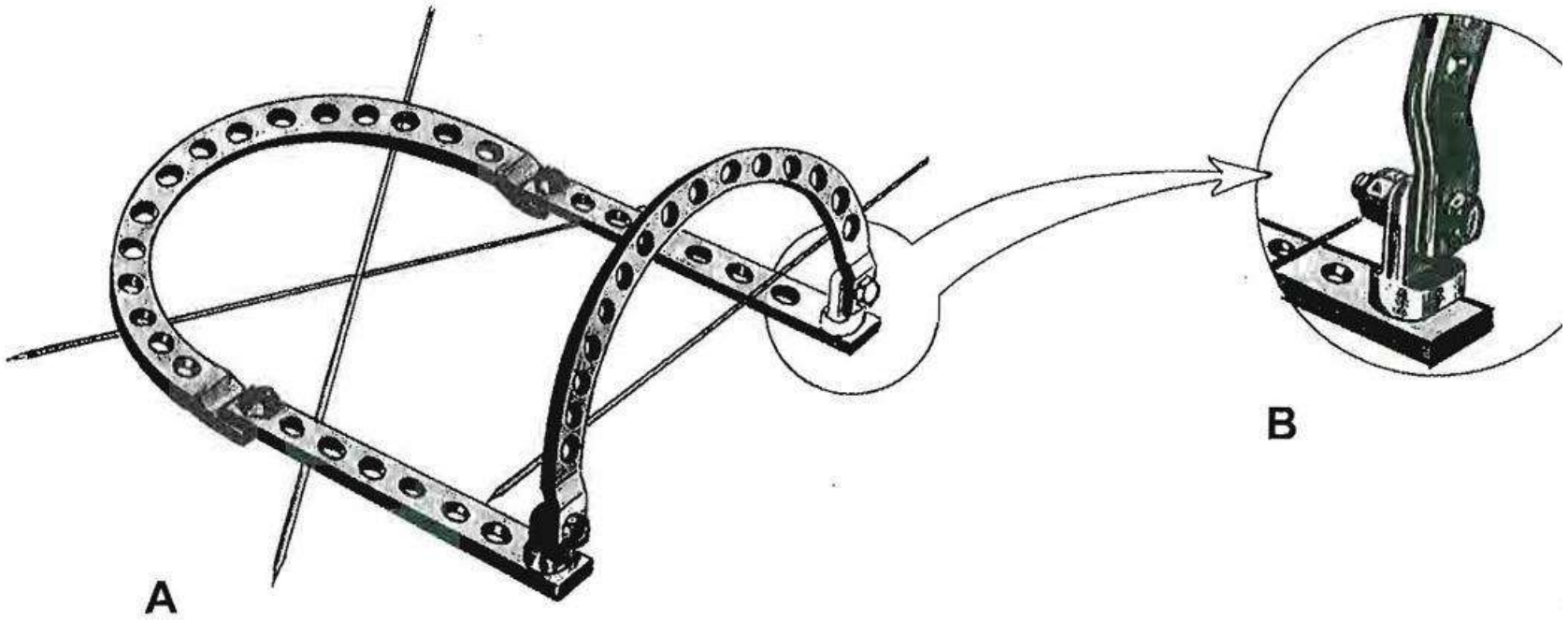


Small Rings –
Forearm, hand, child's foot

Larger interior space



Cloverleaf configuration



Use of two half rings for foot component of the leg frame

Used for Foot stabilization and Prevention of Equinus deformity

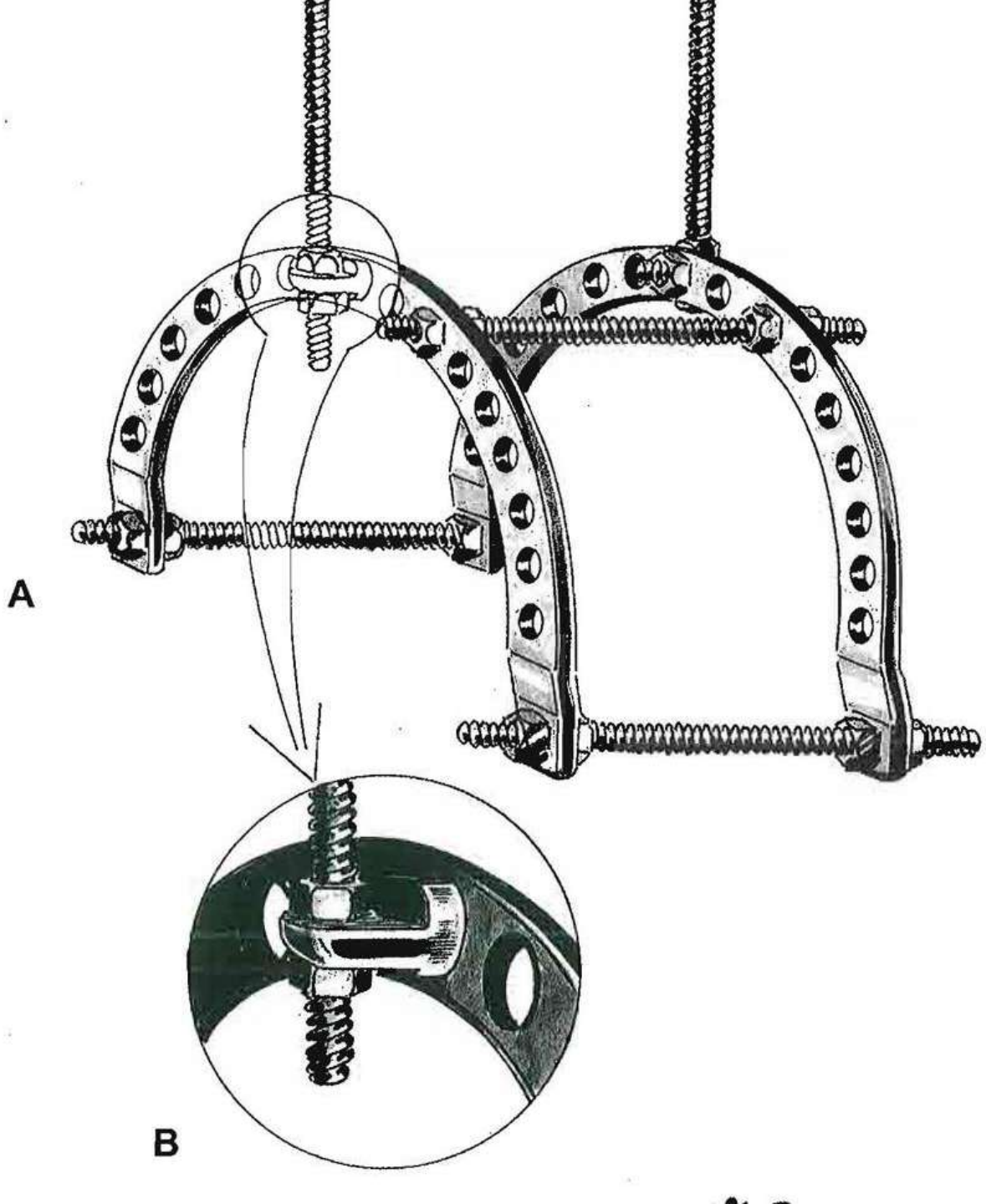
Calcaneal half ring (Horizontal) – 2 long plates – Forefoot half ring (Vertical)

Effective space for obliquely introduced K-Wires and greater flexibility of frame

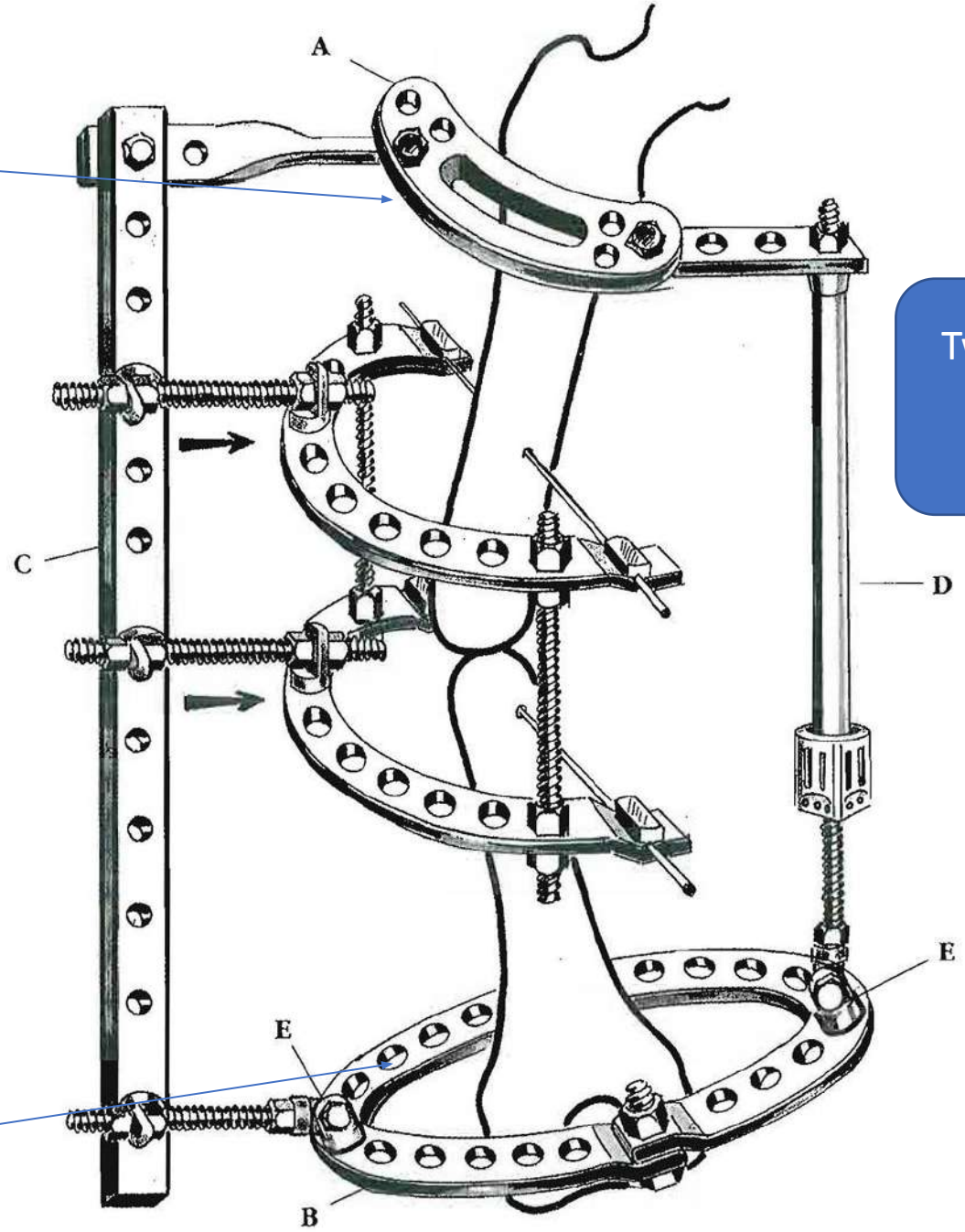
Puller-Pusher device

- Correction of angular deformity

- Pseudoarthrosis
- Nonunion with angulation



Proximal arc



Two half rings – Pusher Puller device

Shift bone fragment Perpendicular to Long axis of bone

Connected to fixed Part of frame

Connected by long plate

Connected by Graduated telescopic rod

Distal ring

What type of Ring is this?

1) Half ring

2) Arch Ring

3) Omega Ring

4) 5/8th Ring

What type of Ring is this?

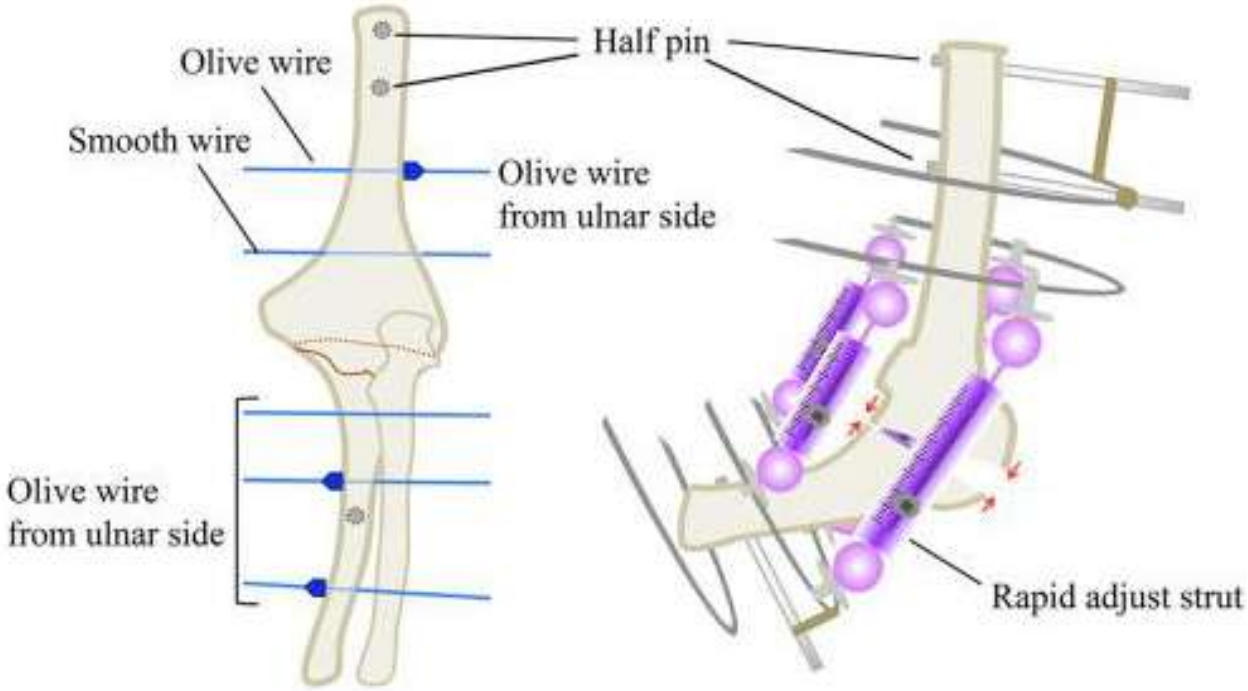
1) Half ring

2) Arch Ring

3) Omega Ring

4) 5/8th Ring

5/8th Ring



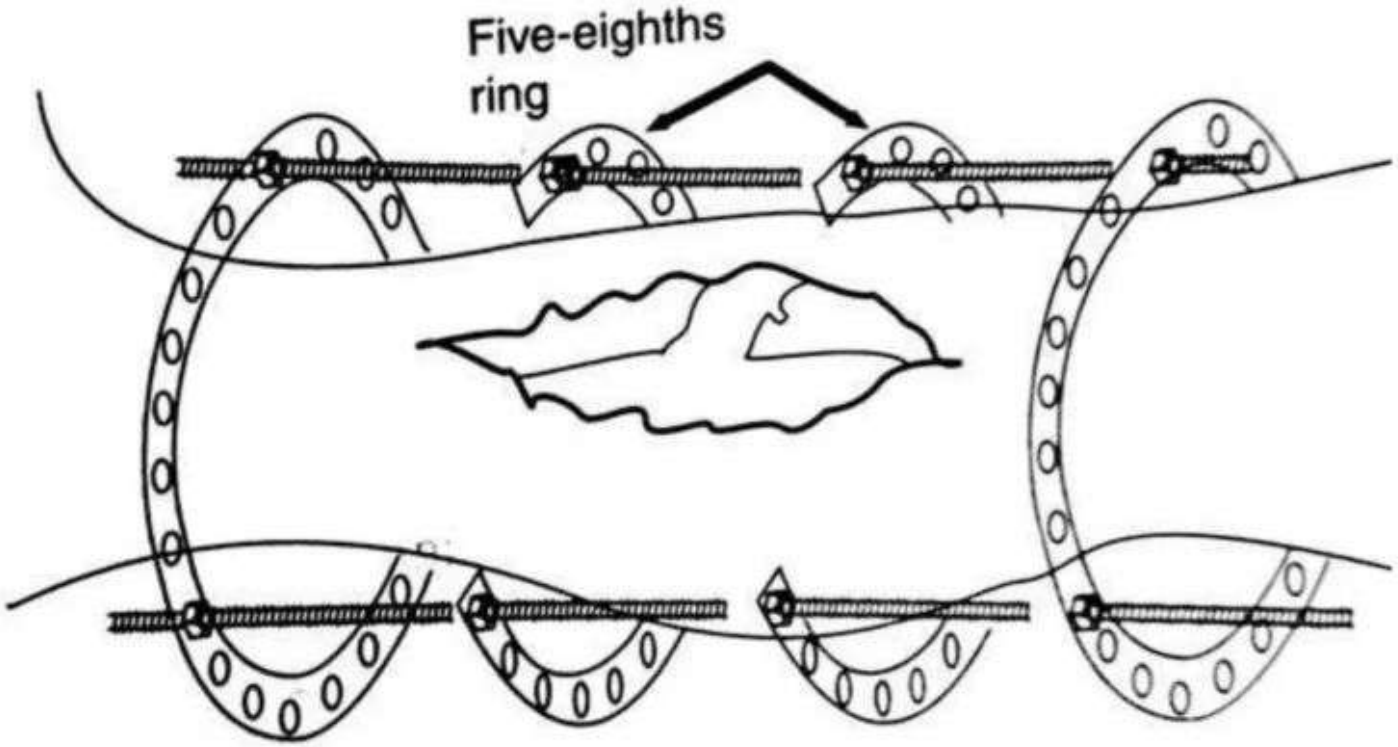
Used around joints where motion of joints are desirable

Example :
Proximal tibia
Distal femur
Around the Elbow Joint

5/8th ring can be used as a Primary Ring in
Proximal Humerus fixation
Distal Humerus Fixation

5/8TH Ring

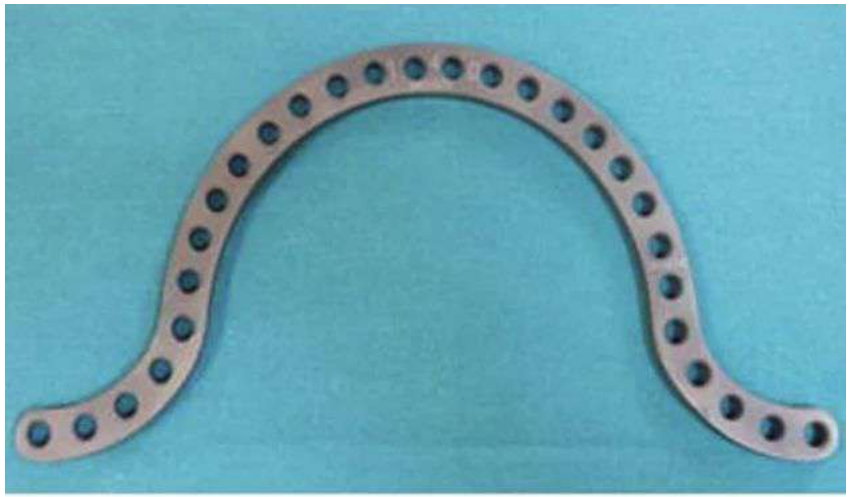
- Not strong enough for the load of tensioned K –Wires – used in combination with a full rings
- Made in 3 sizes – 130,150, 160mm Internal diameter
- 130mm – Near elbow , Pediatric knee



Special care of soft tissue:

- Existence of myocutaneous flaps
- Large open wound with skin and soft tissue defect
- Large deep incision – compartment syndrome

What type of Ring is this ?



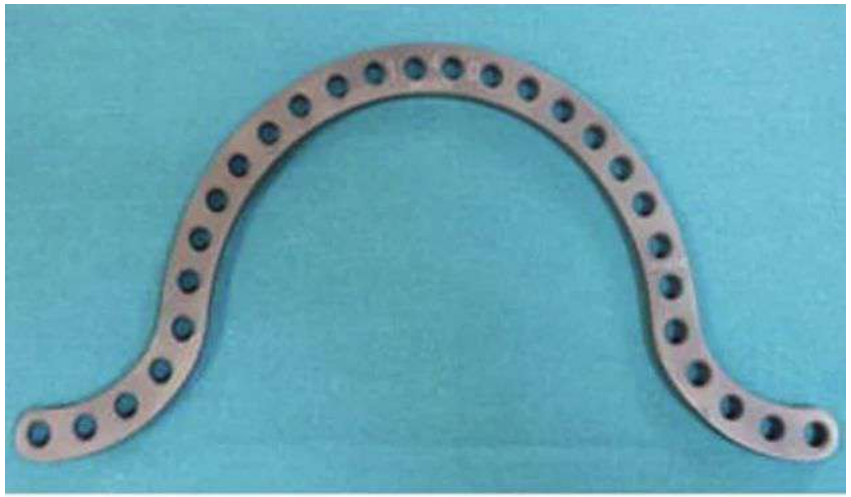
1) Half ring

2) Arch Ring

3) Omega Ring

4) 5/8th Ring

What type of Ring is this ?



1) Half ring

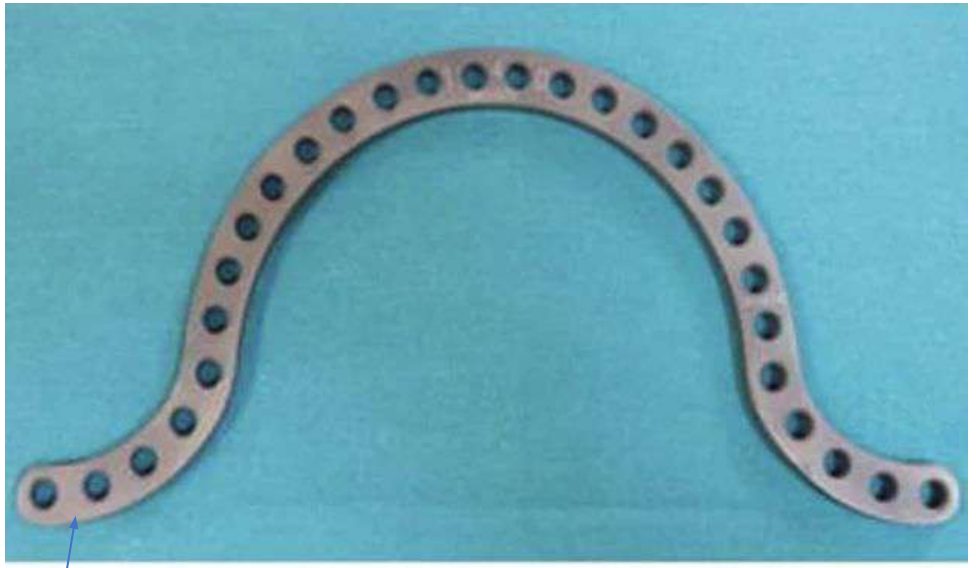
2) Arch Ring

3) Omega Ring

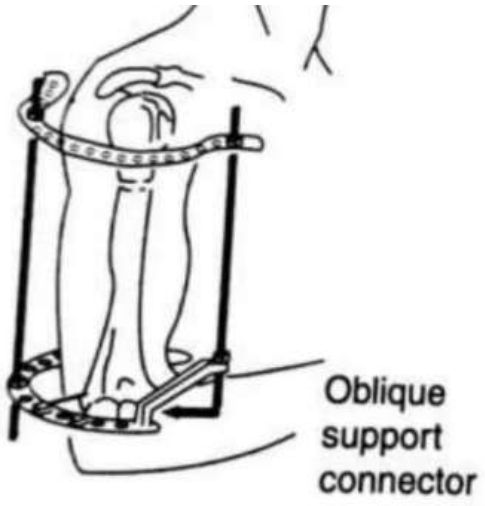
4) 5/8th Ring

Omega Rings

- Used around the shoulder joint
- Modified to fit over the deltoid area of shoulder



Phalanges going Outwards



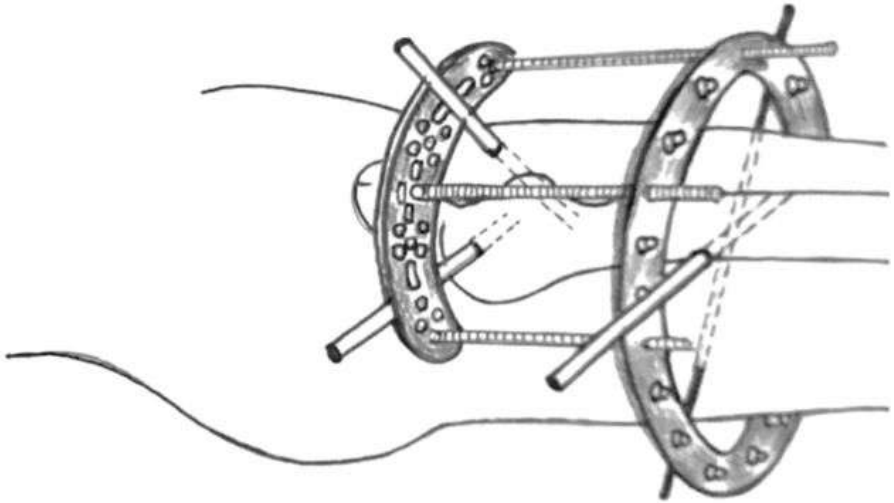
OMEGA RINGS

$5/8^{TH}$ RING

WEAKER RINGS

IDEALLY REQUIRE MULTIPLE LEVEL FIXATION

What type of Ring is this ?



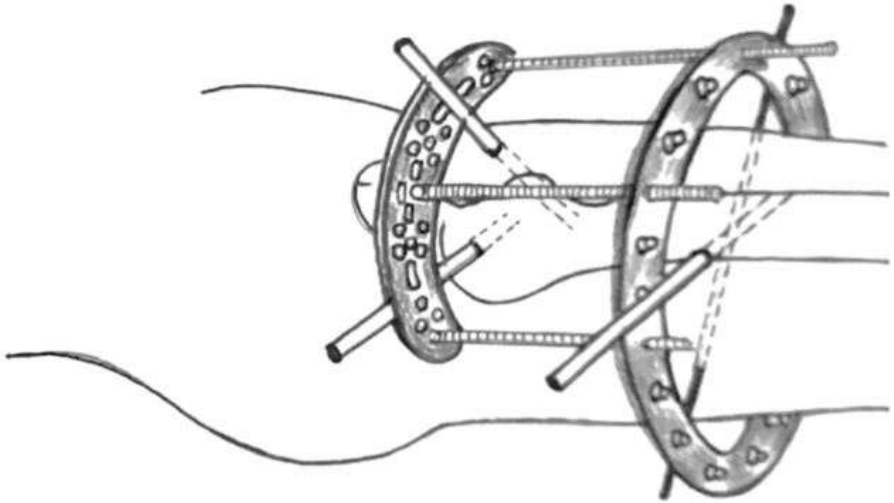
a) Omega Rings

b) Russian Arch

c) 5/8 Ring

d) Italian Arch

What type of Ring is this ?



a) Omega Rings

b) Russian Arch

c) 5/8 Ring

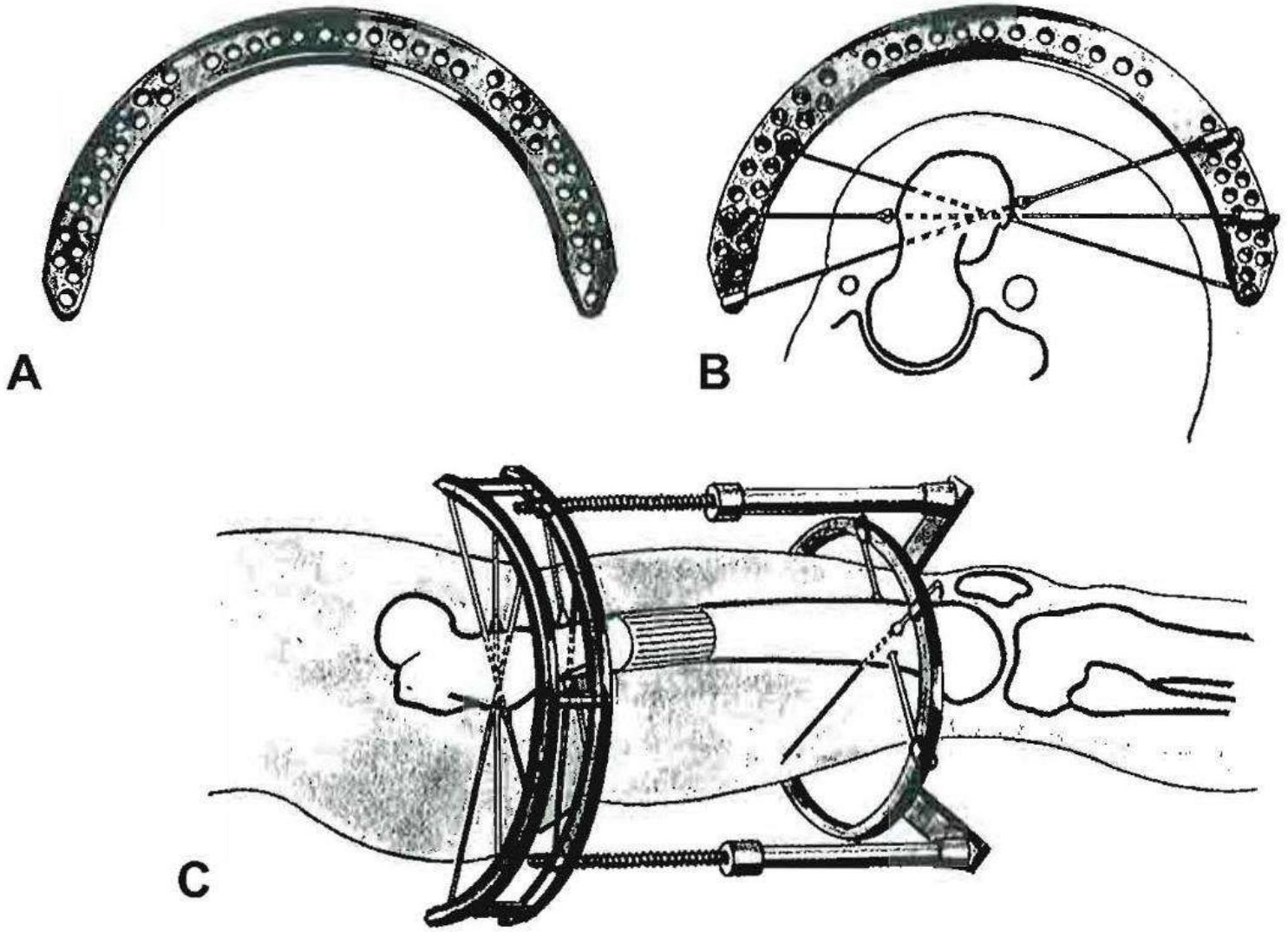
d) Italian Arch

Dr Ilizarov and assistants

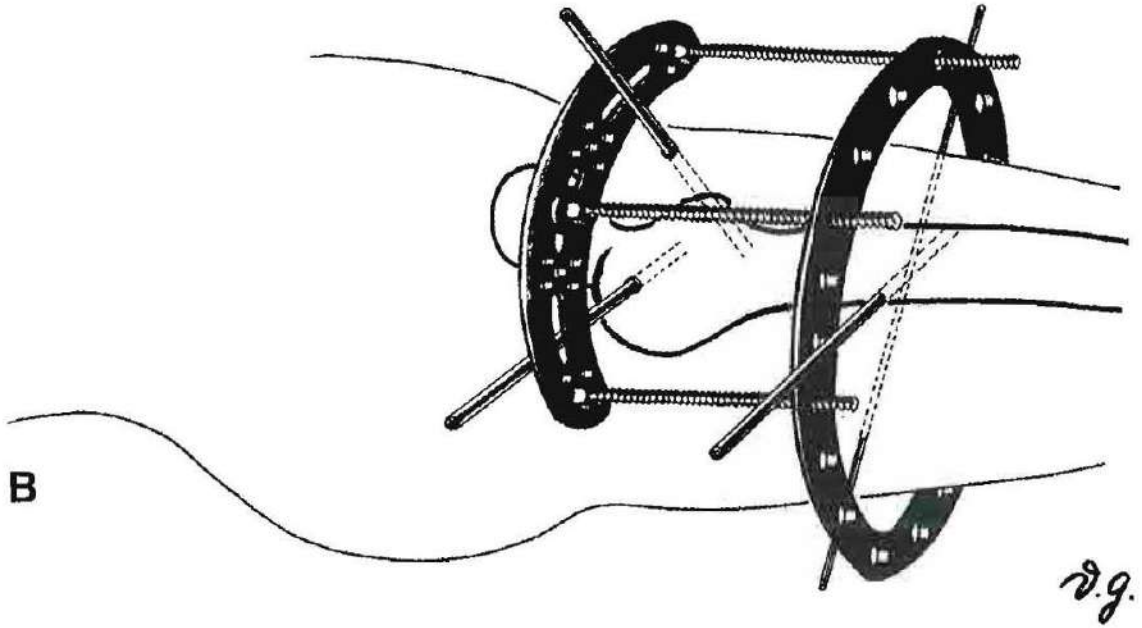
Upper femoral arches

Fan like – large semicircular 30-degree angles

Some wires lie very close to sciatic nerve



Dr Cattagni Italy



90- and 120-degree arches with slots

Half pins instead of wire

Do not come close to sciatic nerve

ARCHES

Larger diameter than half rings

Extra holes for use at level of proximal humerus and
Proximal femur

Does not limit joint motion

RUSSIAN ARCH

ITALIAN ARCH

SLOTTED
HOLES

Ring Size

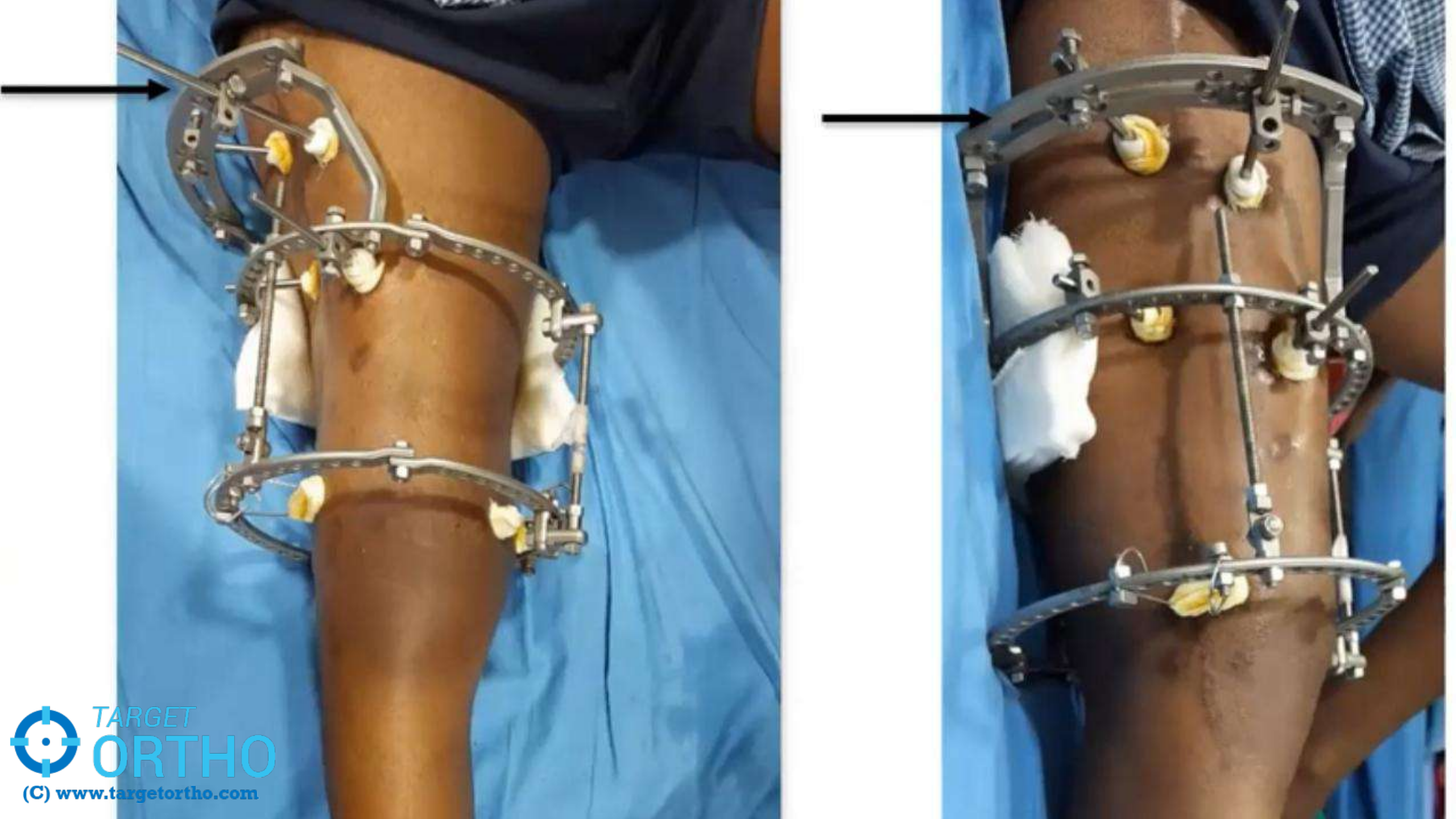
- Circumference = $2\pi r$
- $2r = D$
- $D = \text{Circumference} / \pi$
- 2 finger breadths above and 3 finger breadths below
- D + 60 = inner diameter (mm)

Ring Connections :

1. Threaded rods
2. Partially threaded rods
3. Telescopic rods
4. Connection plates
5. Graduated telescopic rods
6. Threaded sockets
7. Oblique support connectors

Original set

Italian



Oblique Support

J – Support

Arch to ring

Diagonal connection

What is the pitch and diameter of a Connecting rod ?

1) P=2mm,D=8mm

2) P=1mm,D=6mm

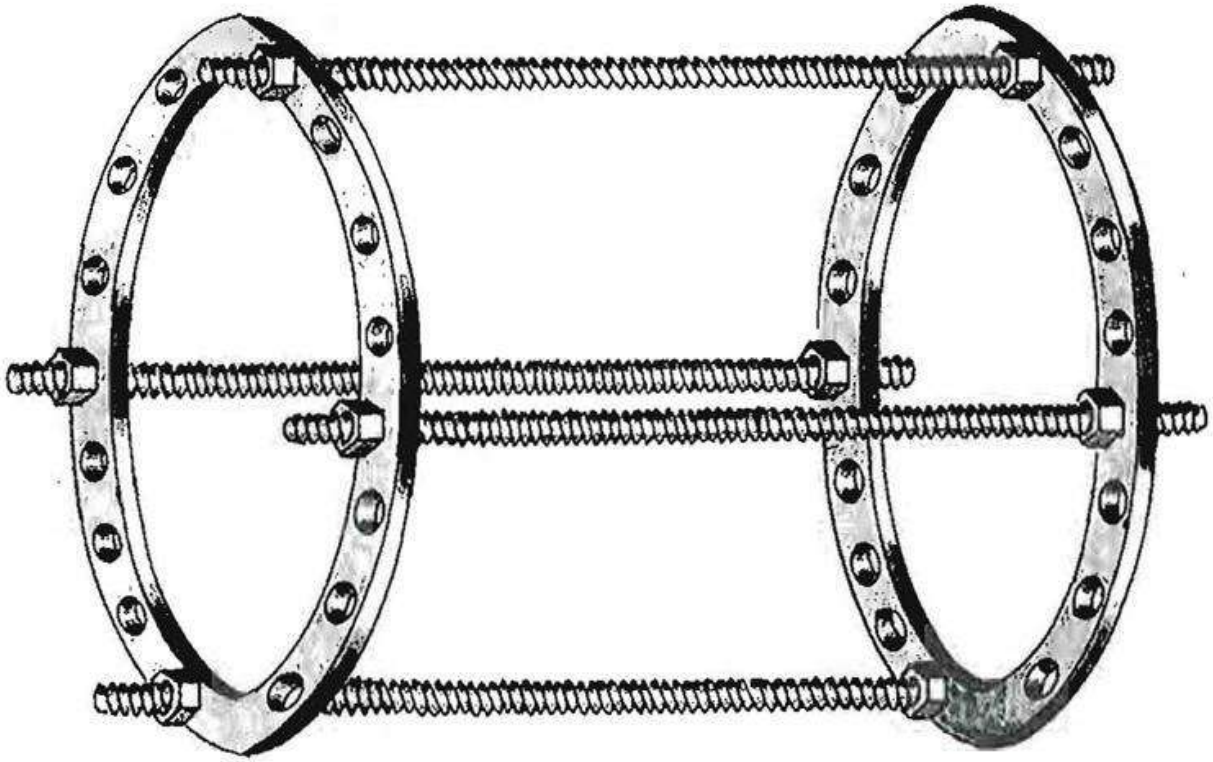
3) P=1mm,D=6mm

4) P=2mm,D=6mm

Connecting Rods

- Used to connect two rings to each other
- 6mm Diameter
- Generally, 4 rings are used to connect two rings together
- Length 60-400mm

- Movement of nuts on the rod produce desired Compression – Distraction = 1mm pitch



Distance between two neighboring rings must be not greater than that of diameter of the ring

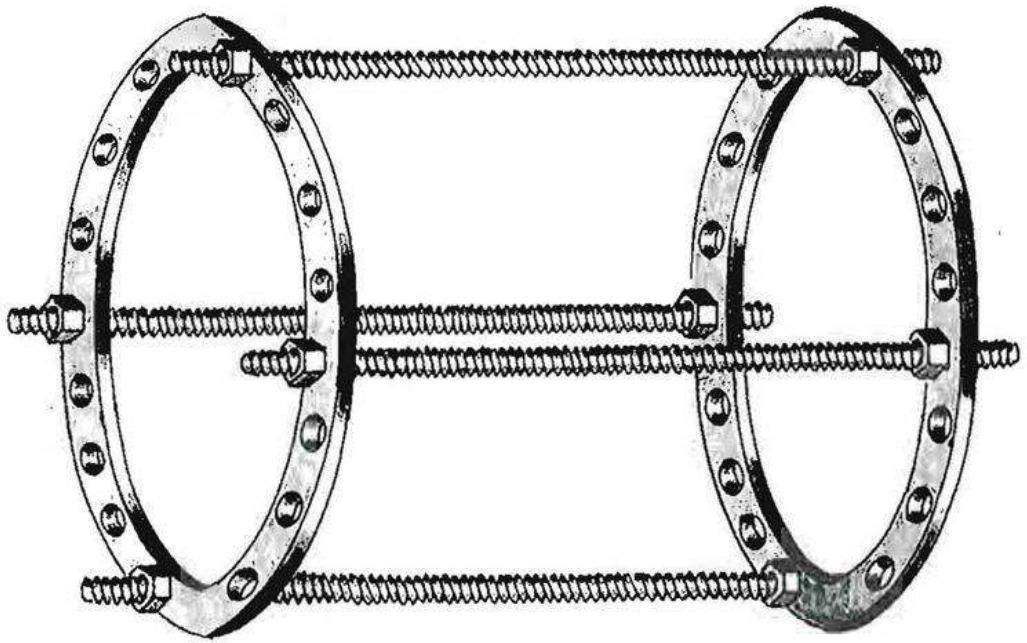
All rods share the same pitch which equals 1mm

Important in distraction or compression

Have strength for axial loading, ability to withstand bending decreases with increased length

Connecting Rods

- Rods are machined so that thread causes 1mm translational along its longitudinal axis with each complete 360* revolution of nut

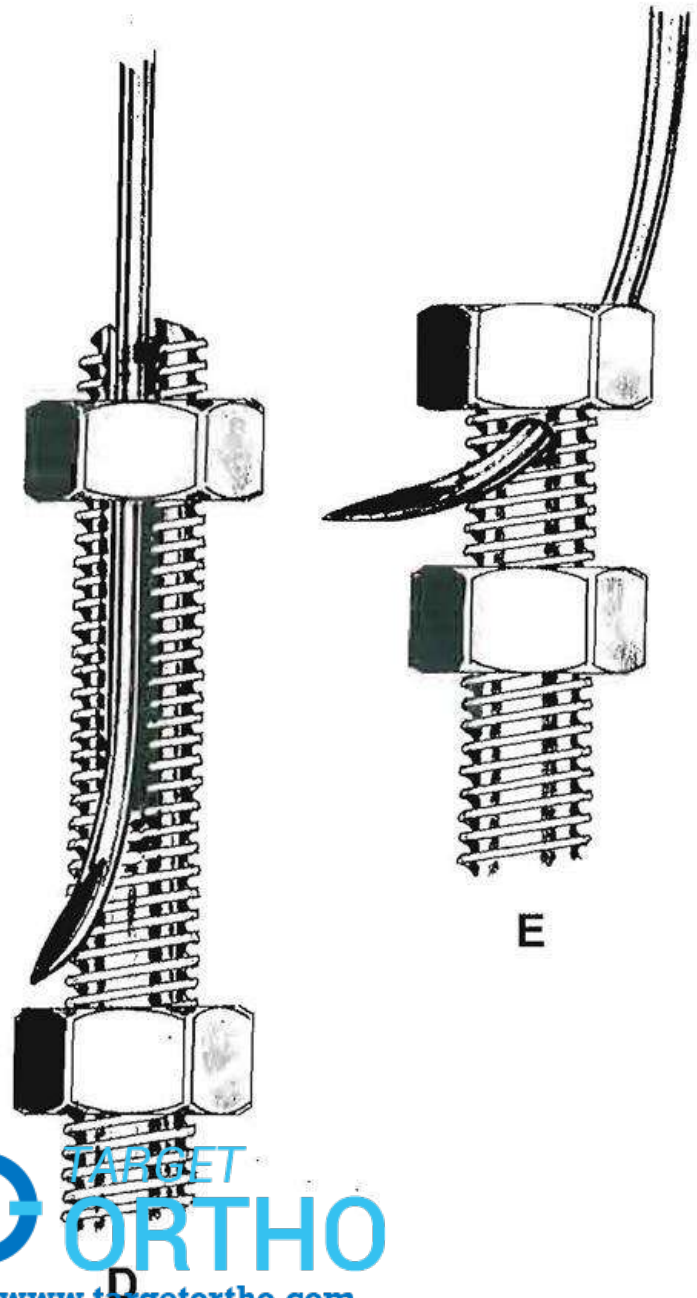


- Types of Rod

1. Regular Rod
2. Slotted rod
3. Cannulated rod

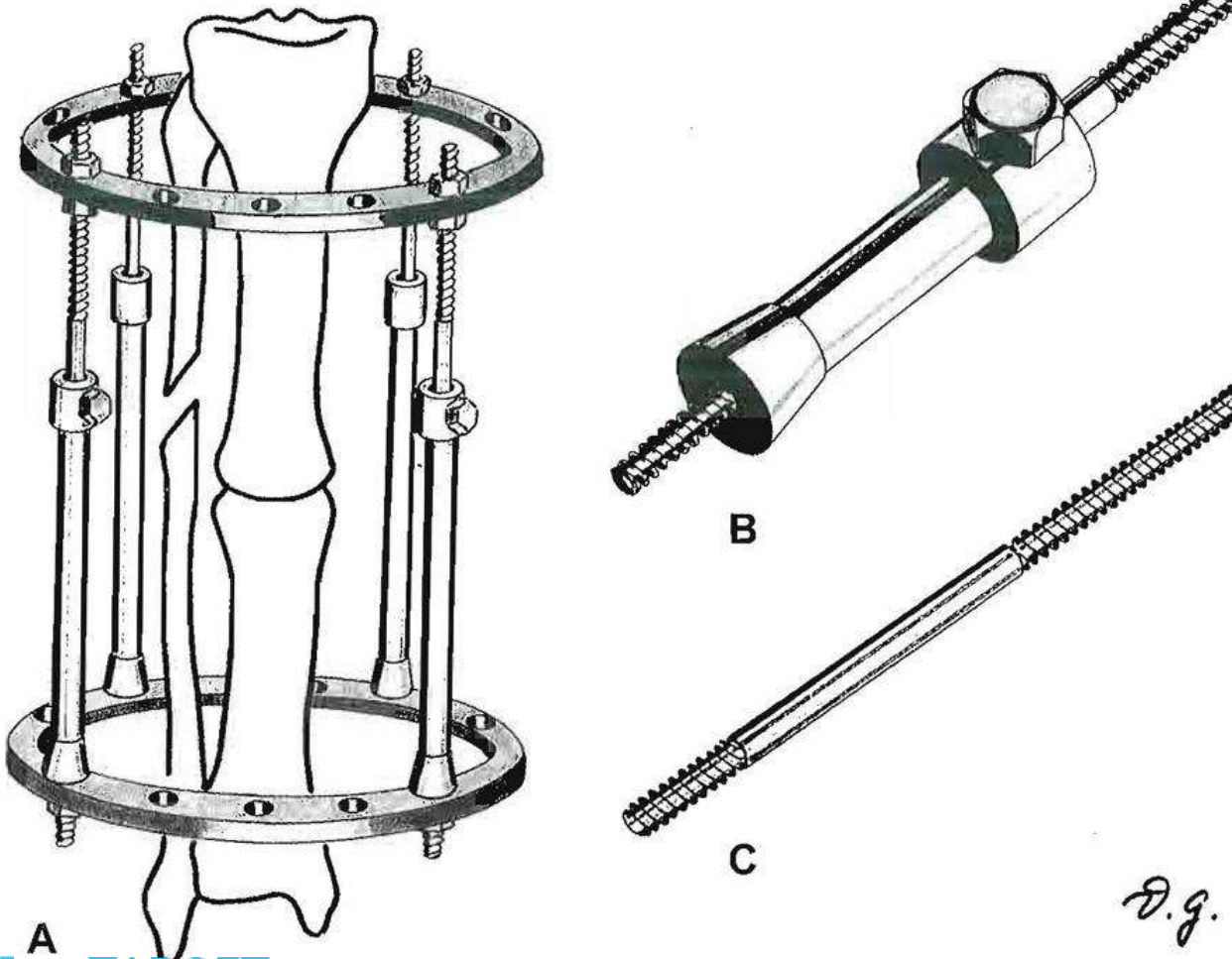
To pass K-wire through it

A B C



Slotted Cannulated Rod

This rod may serve as a connector rod at the same time may be used as pulling device



Telescopic Rod with Partially threaded shaft

Stiffer than threaded rods

100,150,200,250mm long

Partially threaded rod

More stable than Fully threaded

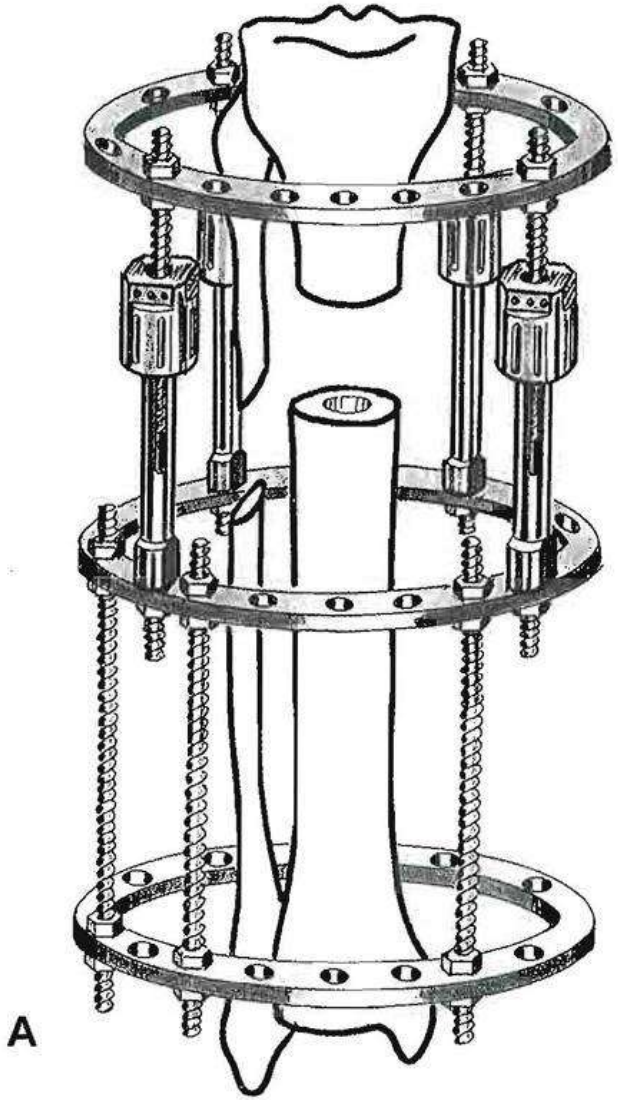
Same as threaded, 6mm diameter

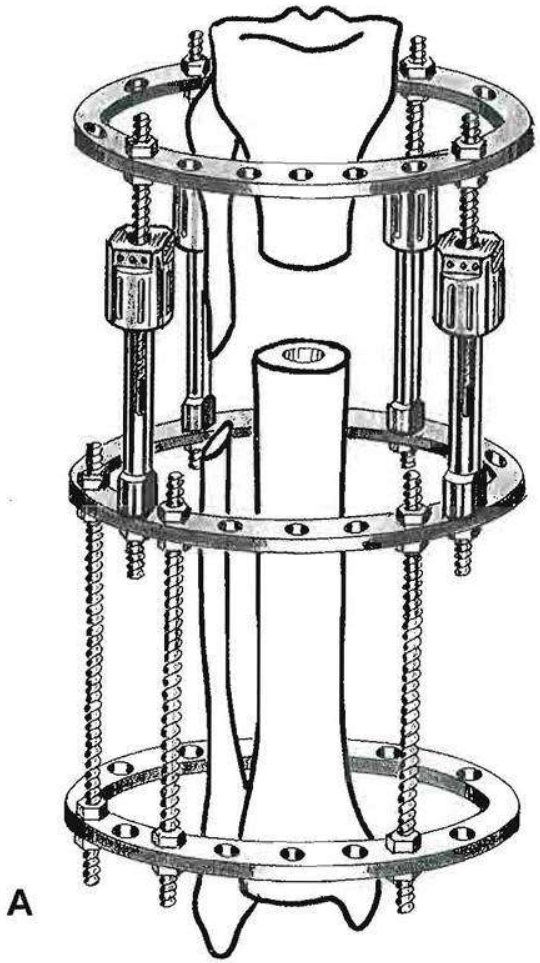
Smooth surface provides greater stiffness

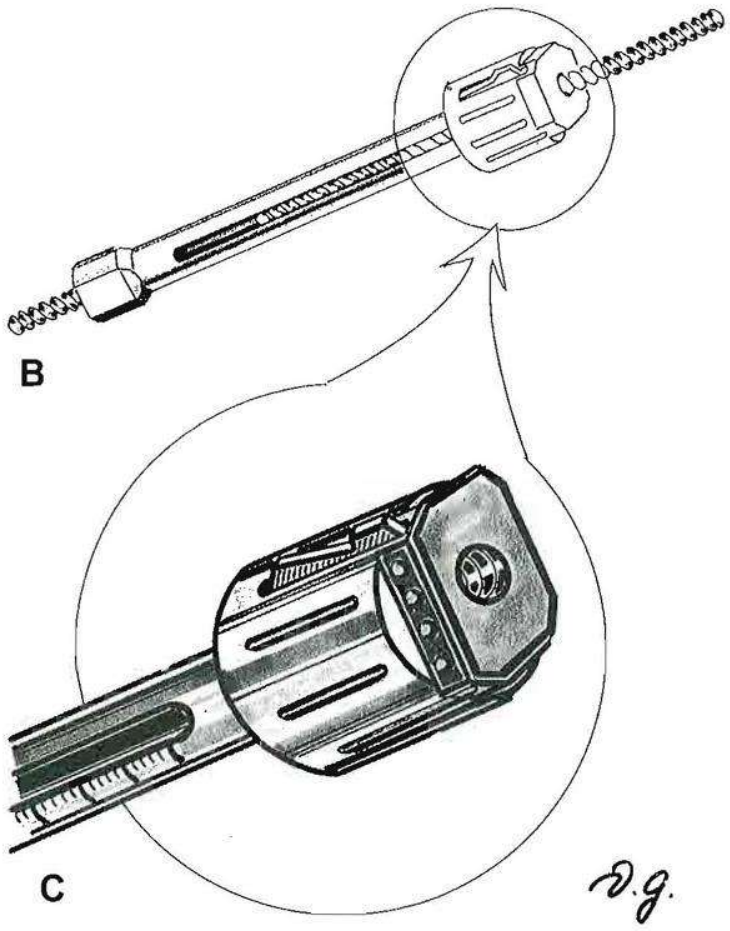
130,170 and 210mm

Graduated Telescopic Rod

- Invention of ASAMI, Italy







Cylinder with one end coupled to a ring via a tightened bolt

Inside of cylinder is fully threaded

Square head that is adjustable by hand
Automatic locking system with lever

Wires

- Stainless steel of critical hardness and elasticity
- Types – Beaded and Non beaded

- Connects bone with frame using supporting elements

- Kirshner wires
  - 1.5mm (Pediatric)
  - 1.8mm (Adult)

Minimum 2-3 wires to each ring

Wires =

Stable fixation

Which type of wire is used preferably in Cancellous bone?

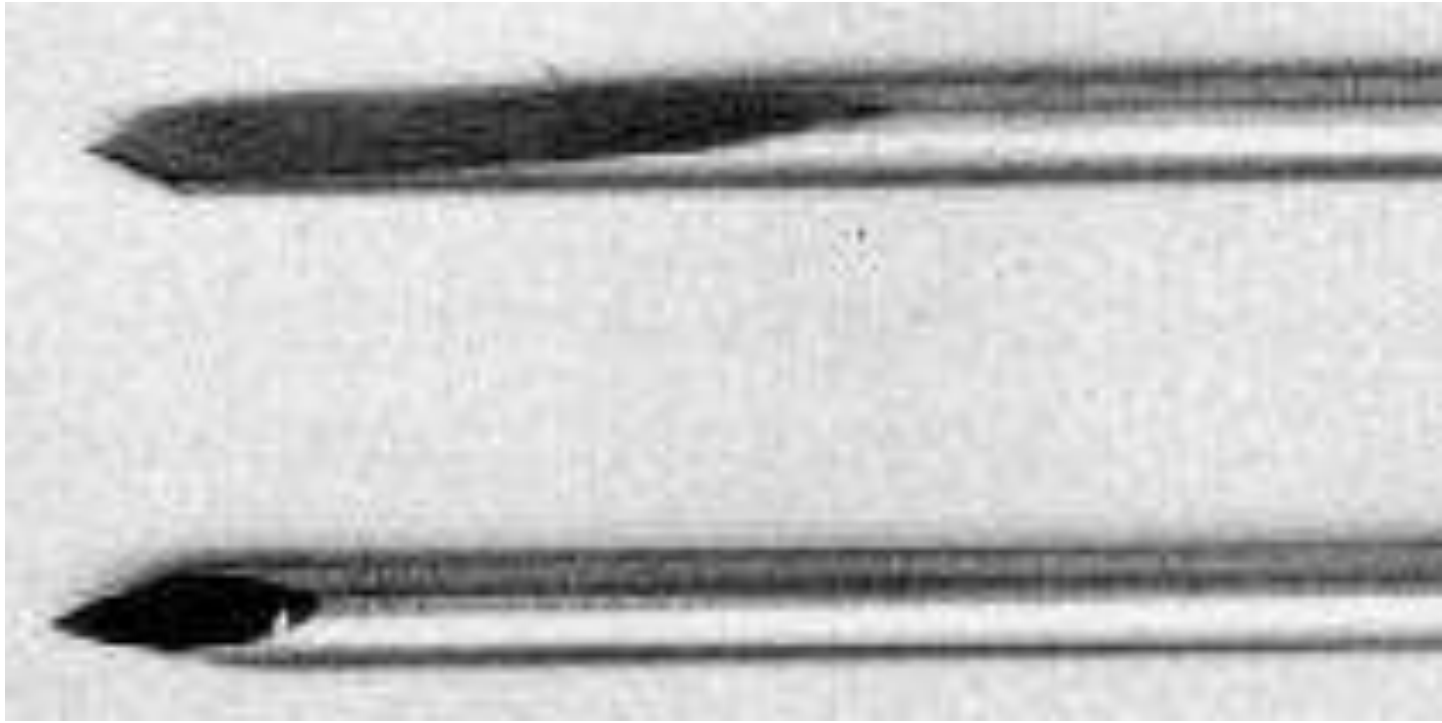
a)Trochar Tip

b)Bayonet Tip

Two Types of Tip

BAYONET TIP
Better directional hold when drilling cancellous bone such as Metaphysis and Epiphysis

TROCHAR TIP
Better directional hold when drilling Hard cortical bone such as Diaphysis

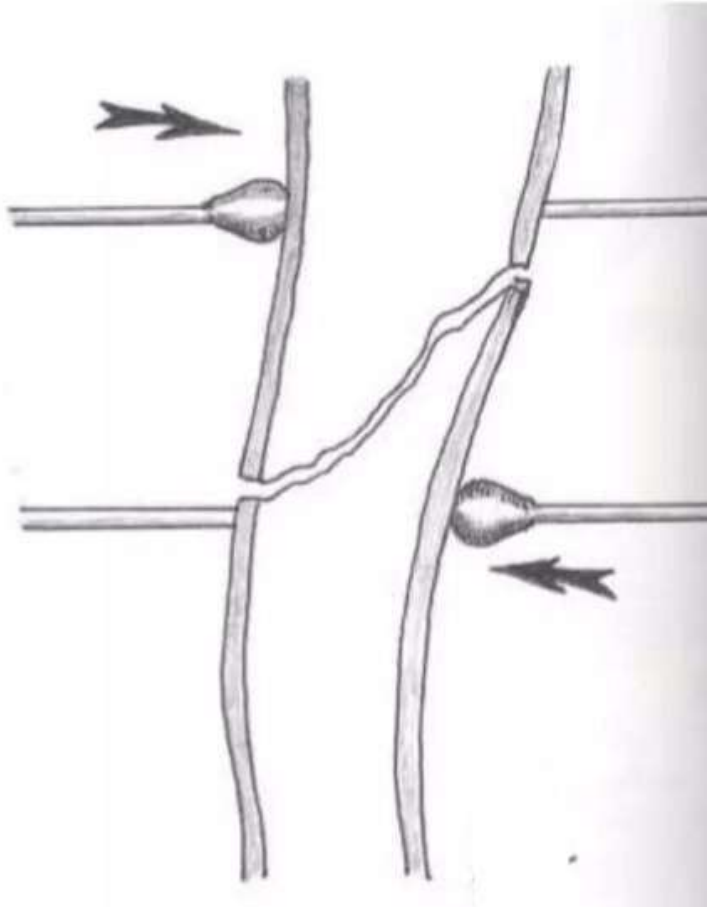


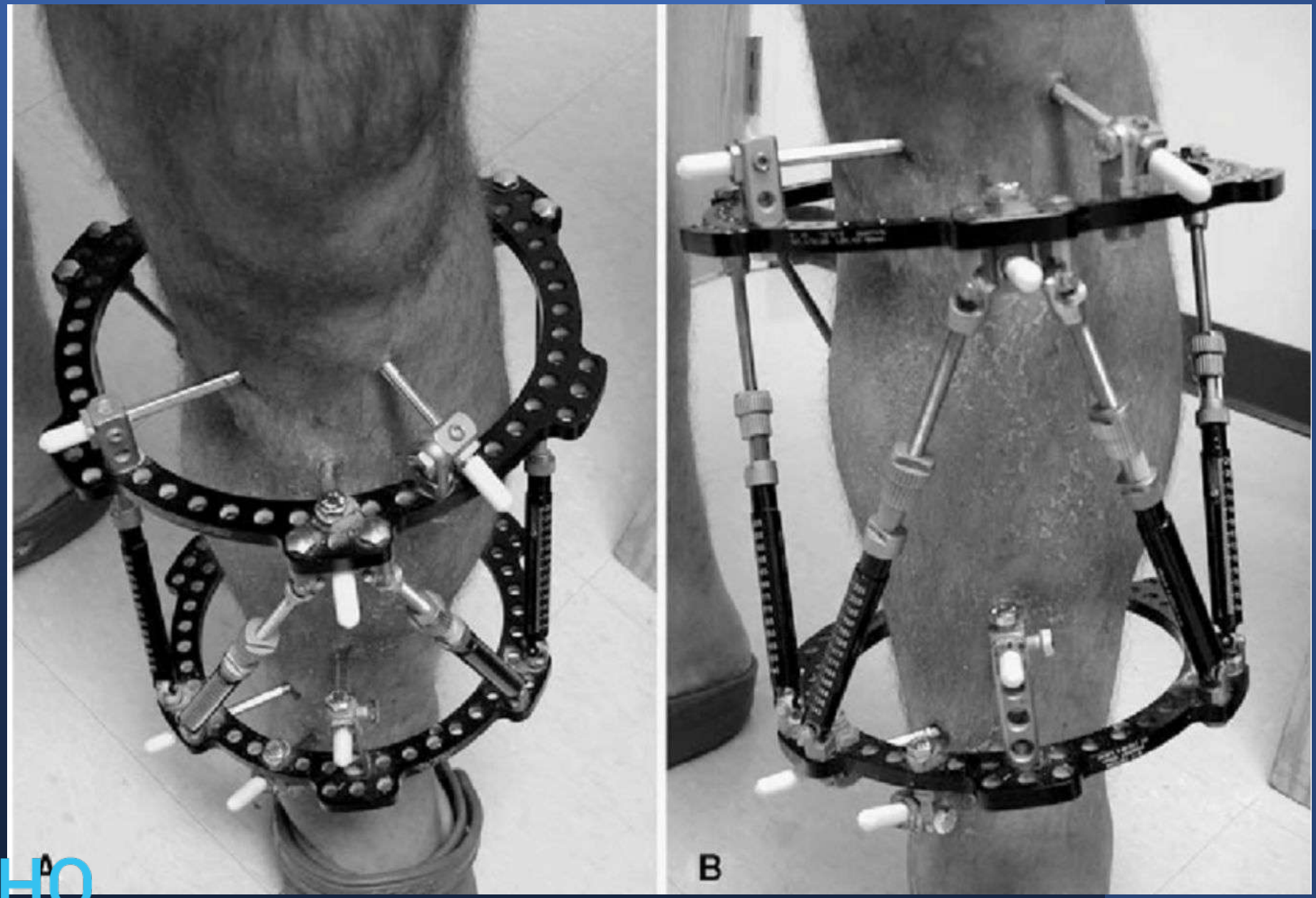
Olive Wires

Metallic bead present in the wire

Function

- Interfragmentary compression
- Increasing stability of the construct
- Gradual distraction
- Translation of fragments





Half Pins / Pins

Present in different sizes
Can be seen with threaded tips
Ilizarov half pins are 4.5 mm, 5.0 mm, and 6.0 mm in size

E.g.-
6mm Femoral Cortical pin
6mm femoral cancellous pin
6mm Cortical tibial pin
4.5mm Half Pins – Standard Schanz Pin

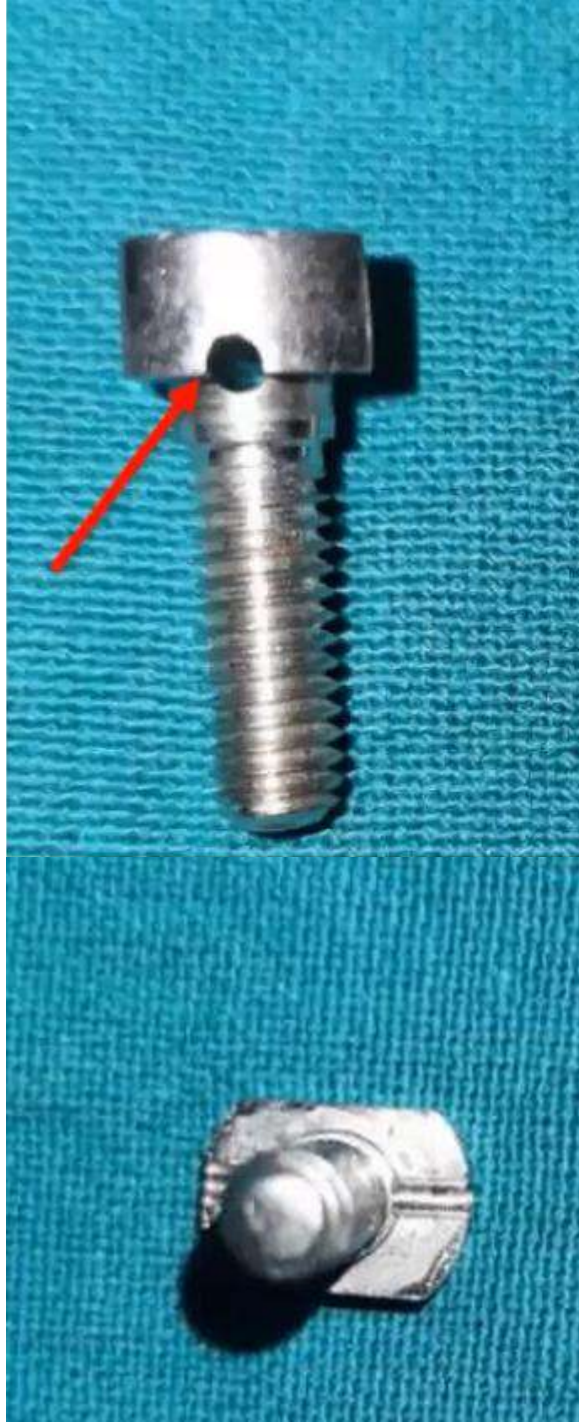
Identify this device?

a) Wrenchocube

b) Nuts

c) Bolts

d) Supporting post



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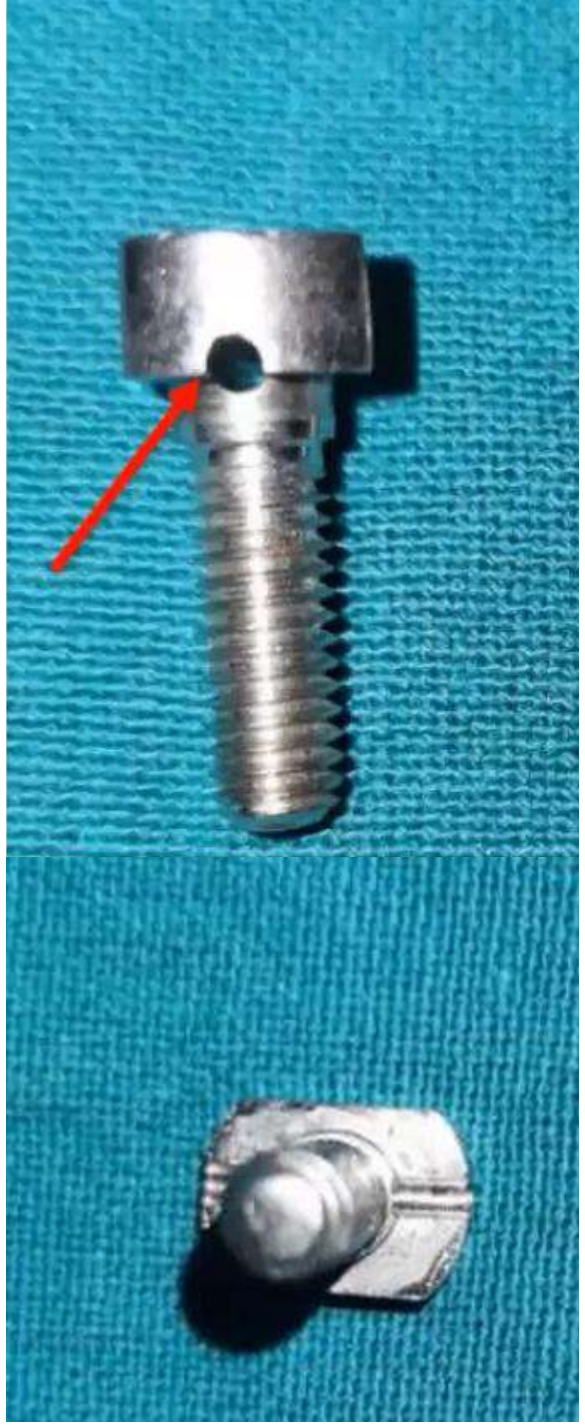
c) Bolts

d) Supporting post

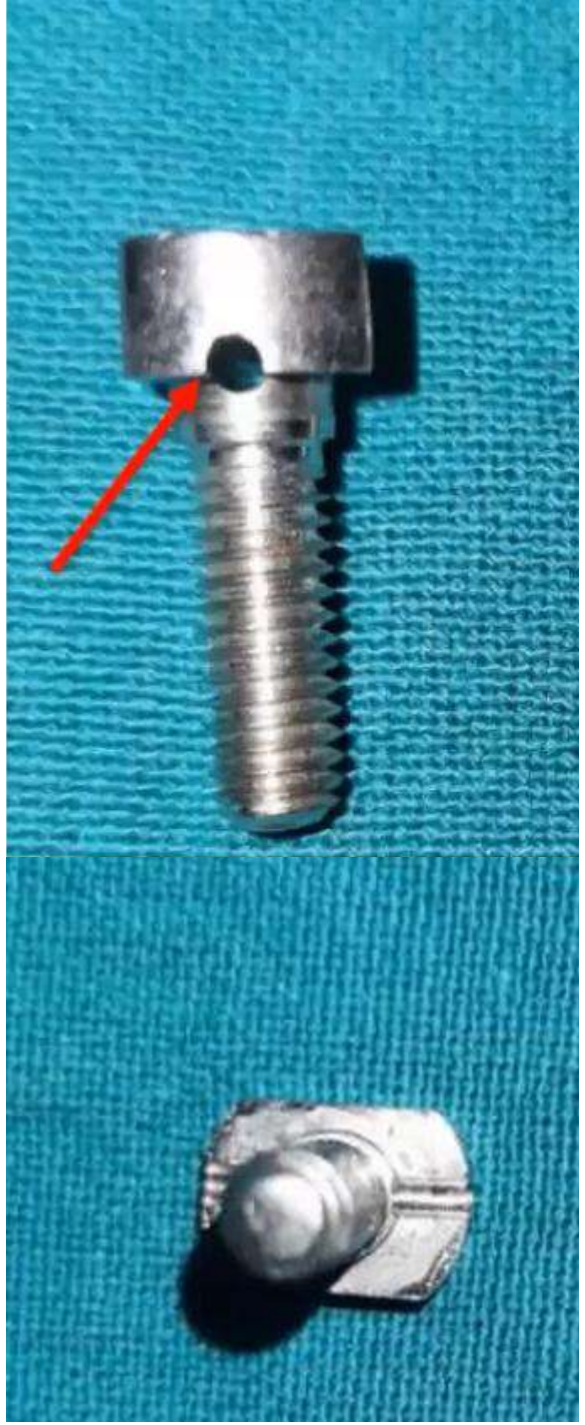


Identify this device?

a) Slotted Wire fixation bolts

b) Cannulated Wire fixation Bolts

c) Connecting bolts



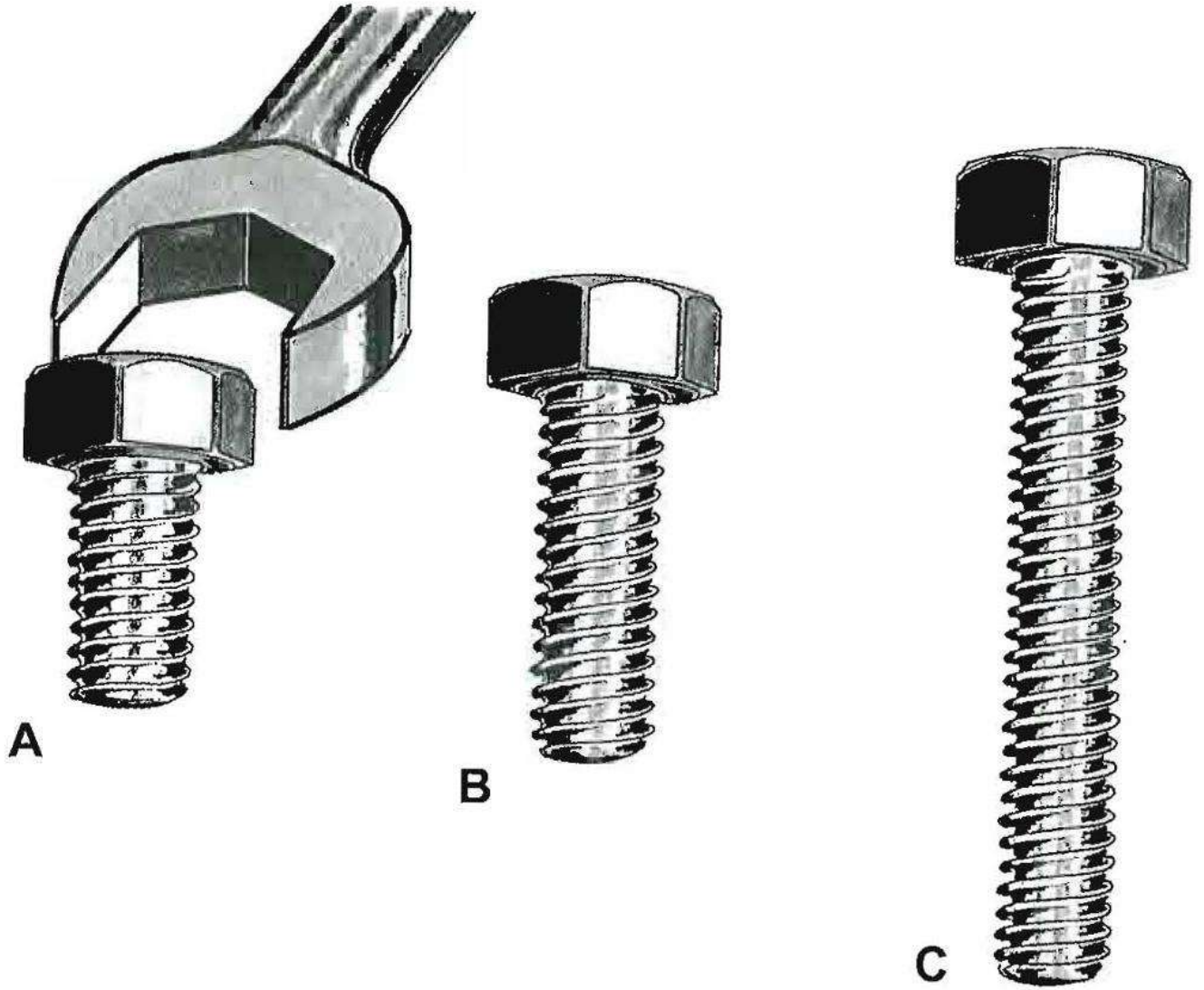
Bolts

Role in Ilizarov assembly is that all parts must be tightened with a bolt or nuts

Immediate firm tightening achieves stability required for frame assemblage

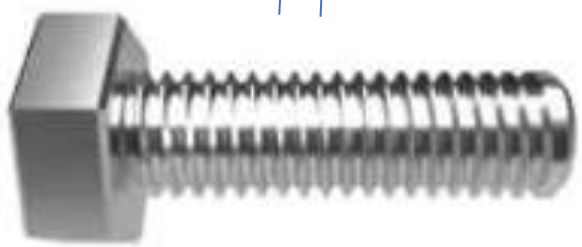
2 types of Bolts in set

1. **Connecting Bolts**
2. **Wire Fixation Bolts**



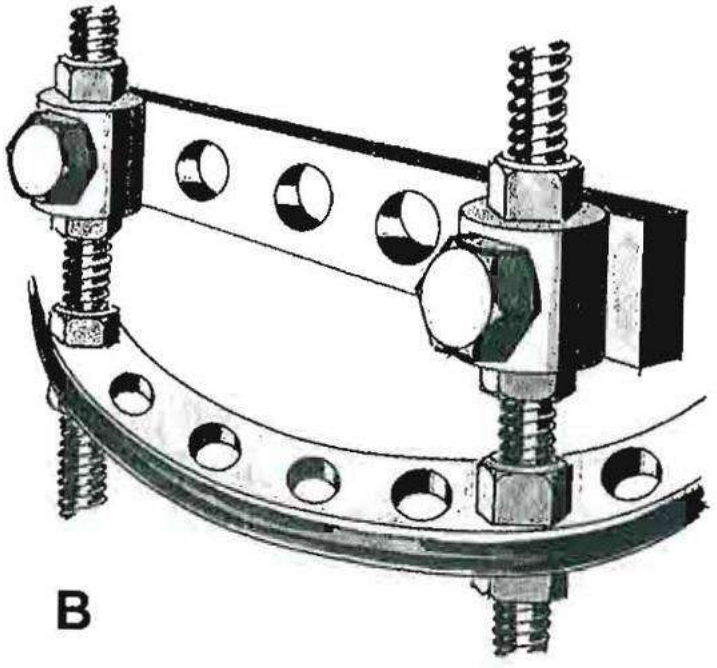
Connecting Bolts

Different length bolts are seen
10mm
16mm
25mm (Modification)
30mm



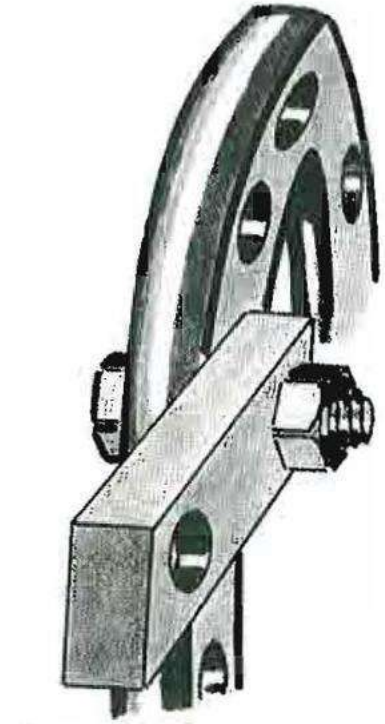
10 mm connecting bolts

Used to tighten threaded sockets to ring

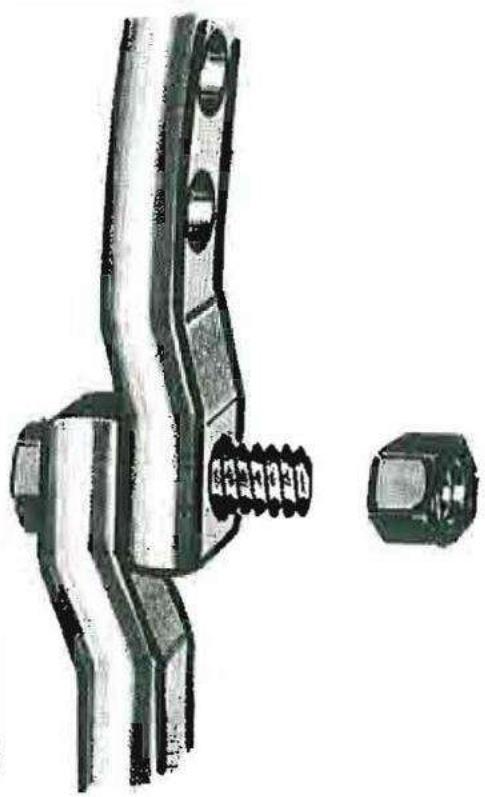


Connecting two bushings to threaded rods

16 mm connecting bolts

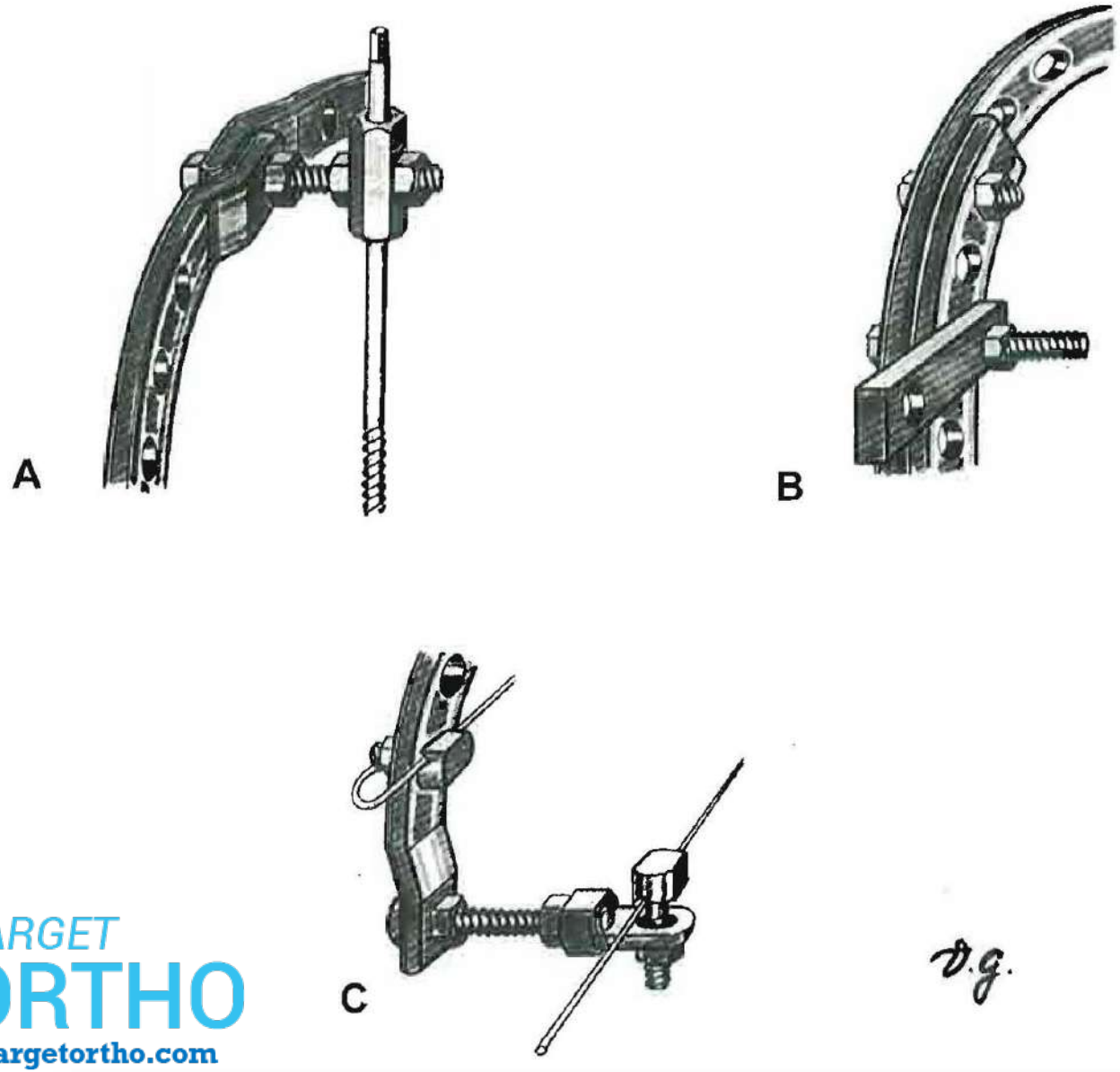


16mm bolt used with short connection plate to a ring



Offset end of half ring connected by 16mm bolt

30mm connecting bolts



Connecting 3 or more parts

Useful in cases in which gap must be left between 2 parts

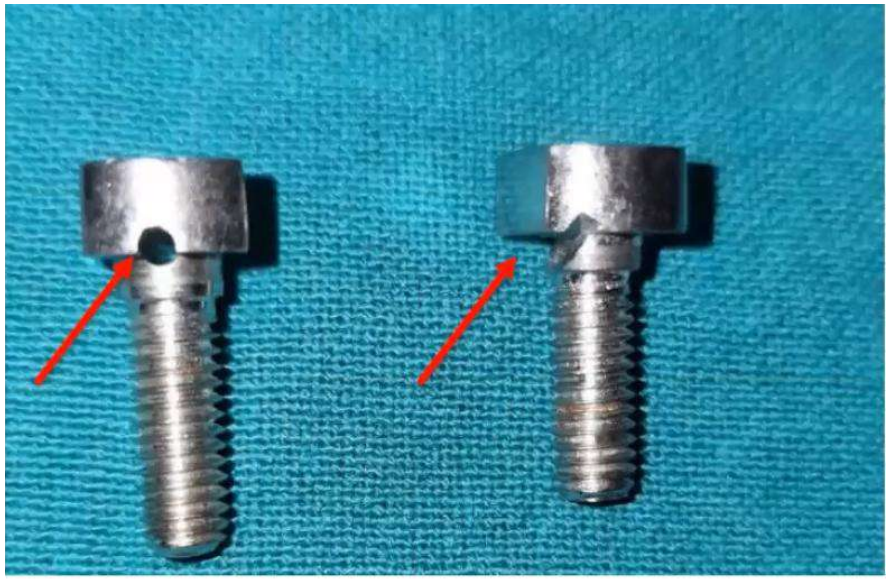
Wire Fixation Bolts

Specially designed for Wire fixation, K-Wire fastening

To tighten the K-Wire to flat surface of the ring

The strength of this tightening determines the stability of
bone fragment to which the wire is introduced

Range of wire stiffness = 200-300kgs



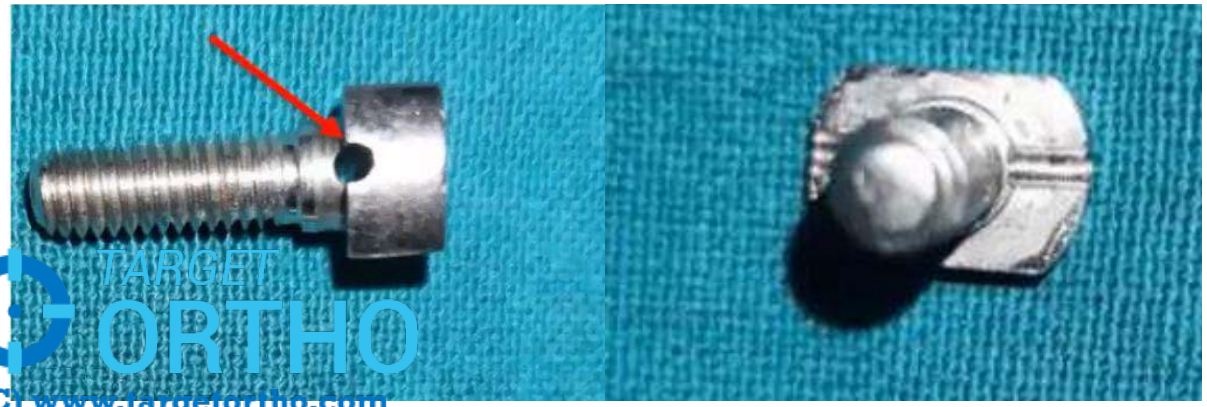
To tighten the wire stiffness, 2 special wire fixation bolts used:

- **CANNULATED WIRE FIXATION BOLTS**

✔ 2mm hole which is through the head

✔ Holds 1.8mm,1.5mm K-wire

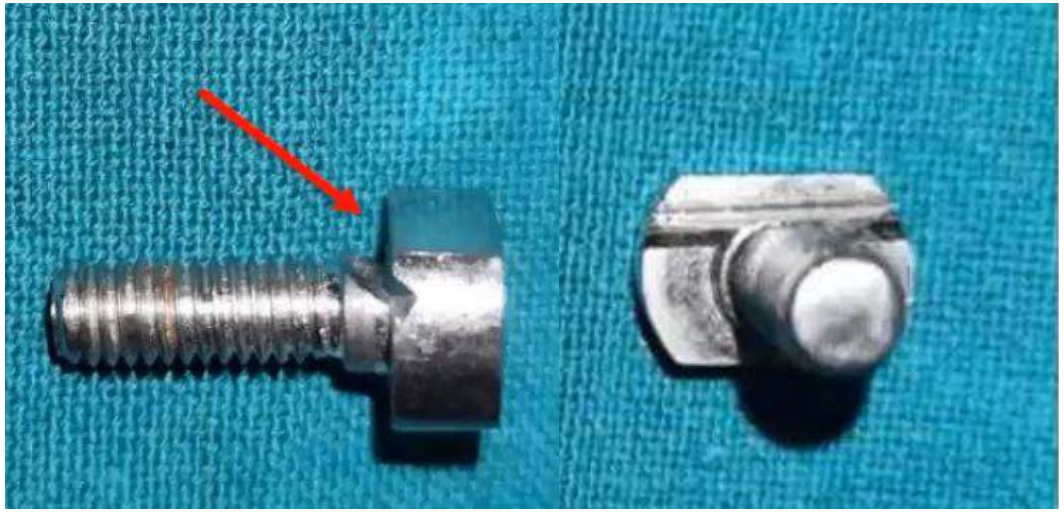
✔ Centrally passing wire

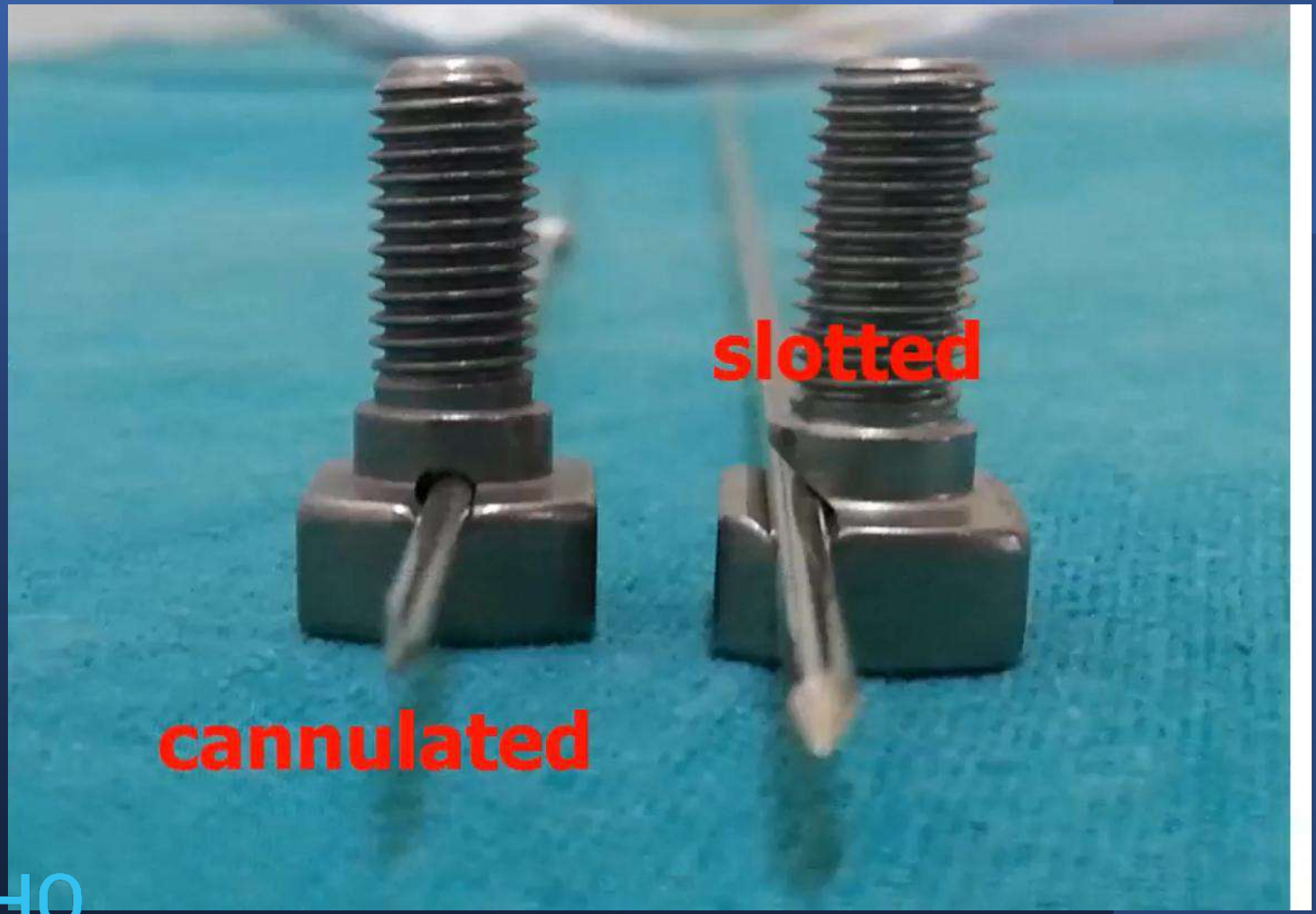


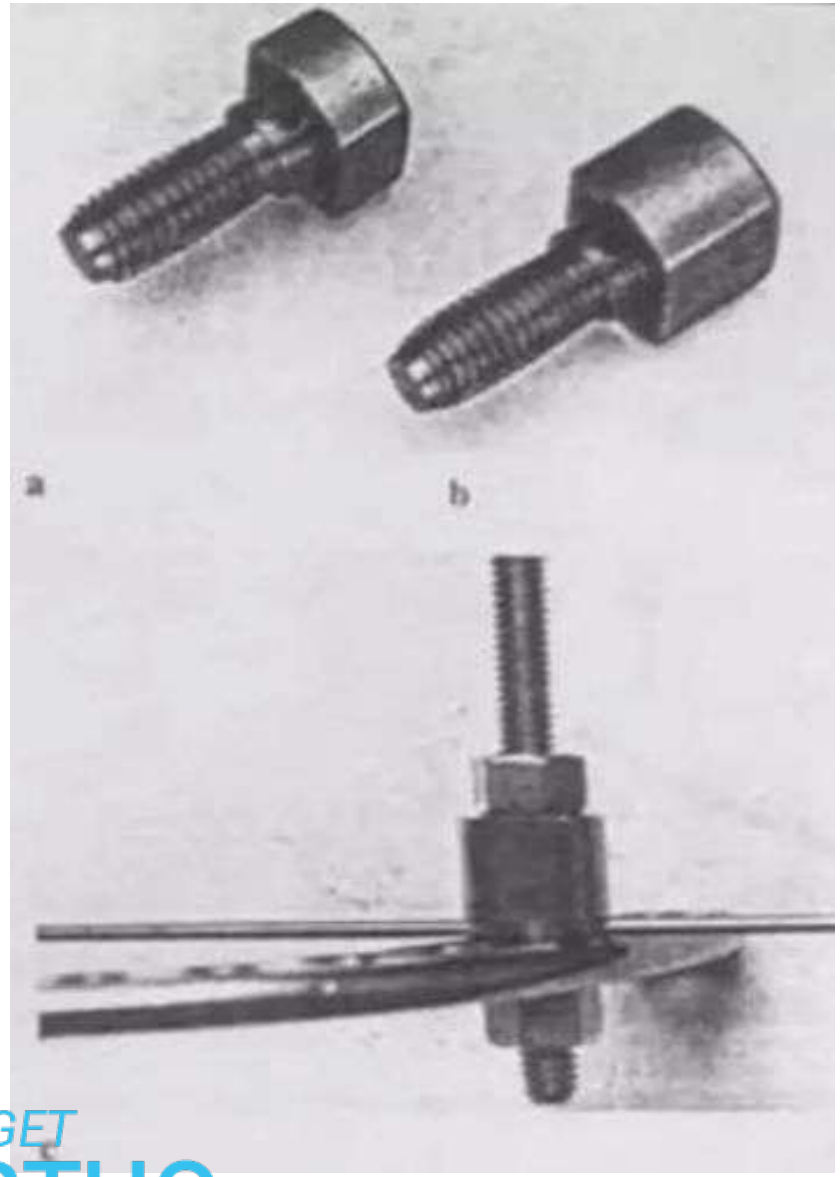
- **SLOTTED WIRE FIXATION BOLTS**

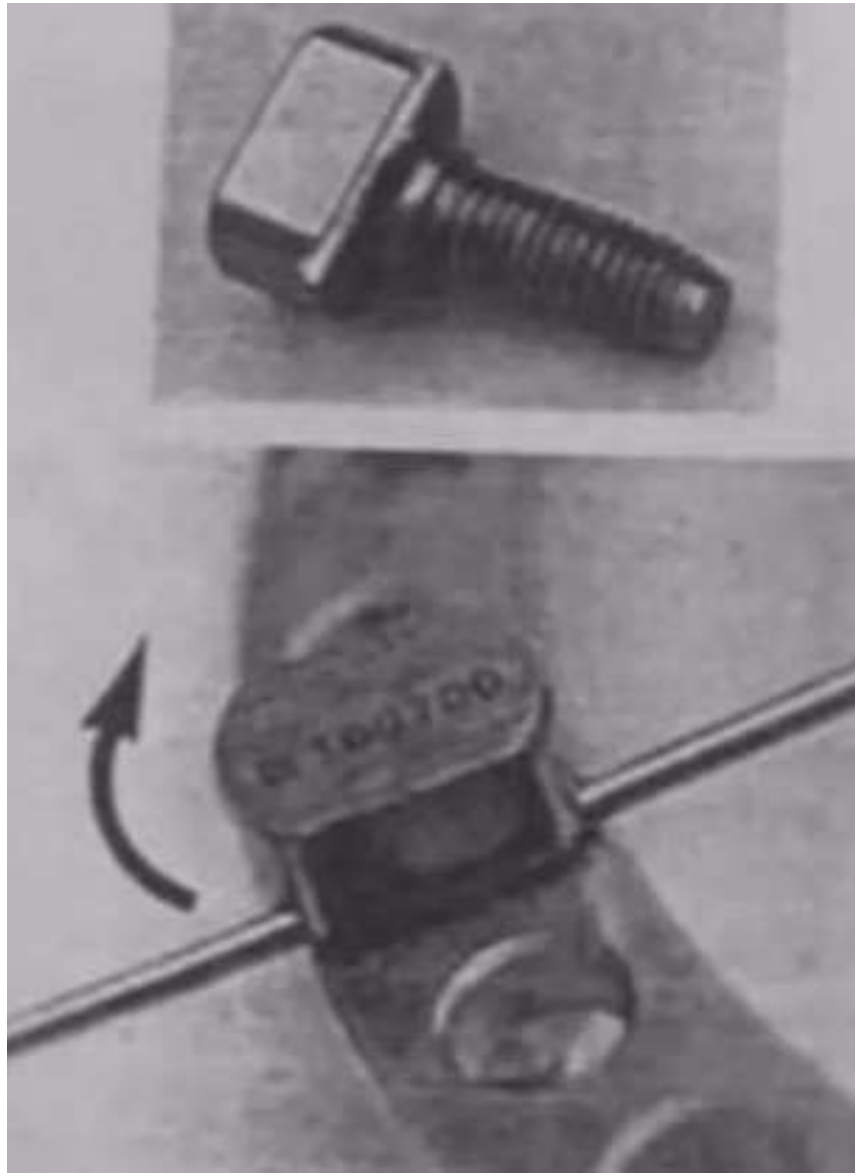
✔ Oblique slot just below the head

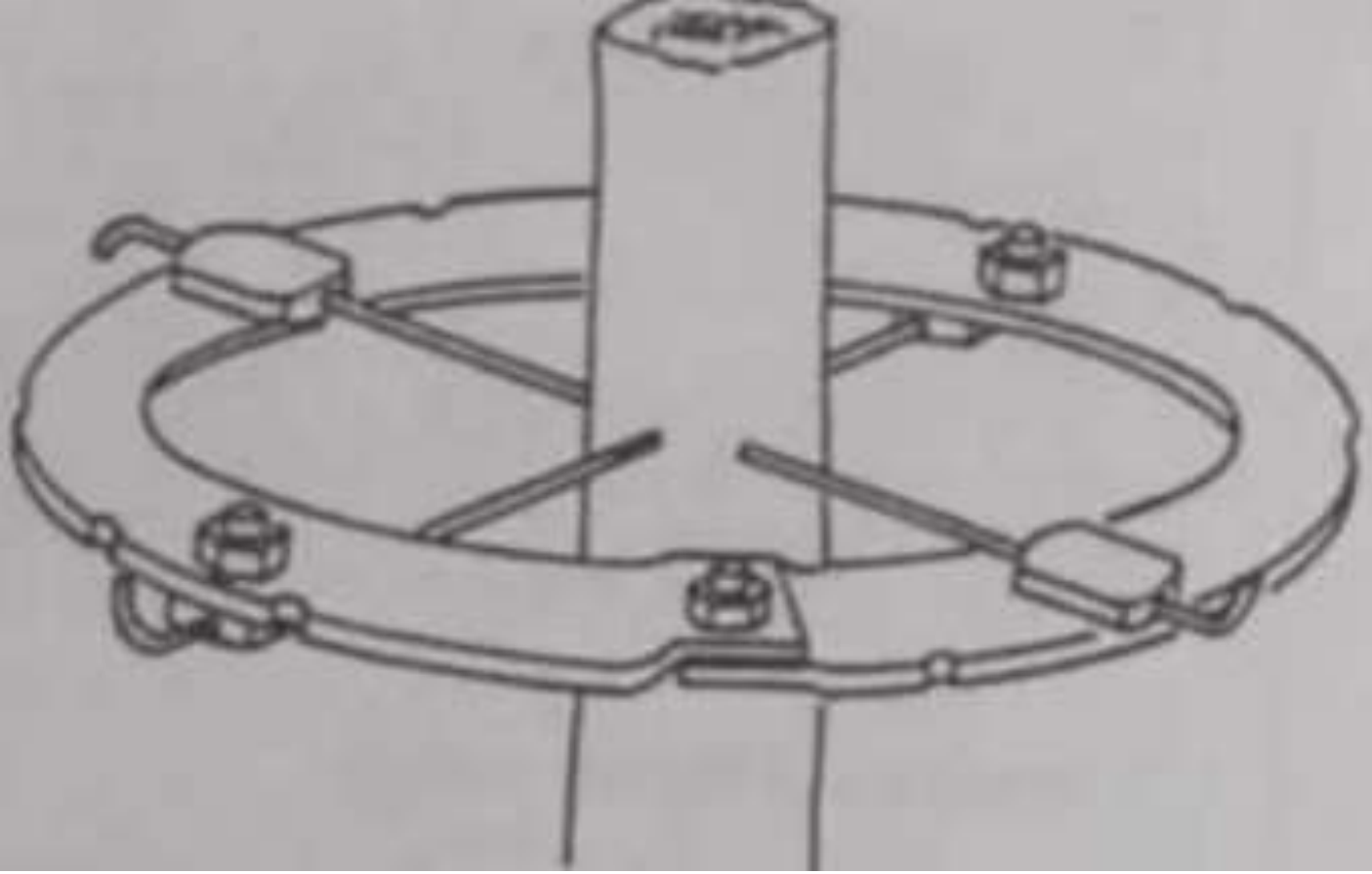
✔ Eccentric passing wire

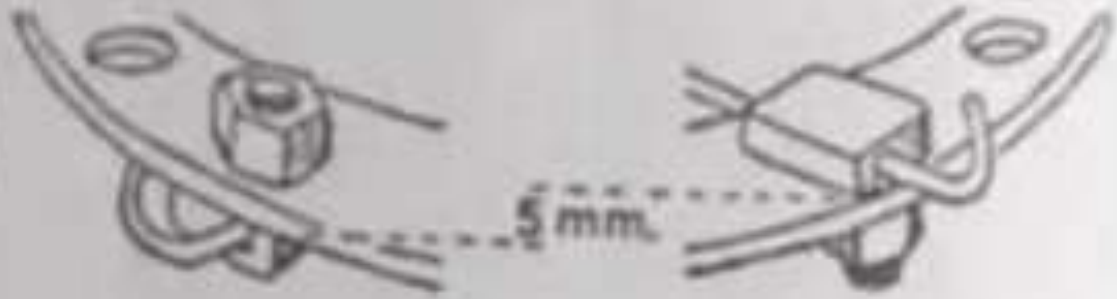












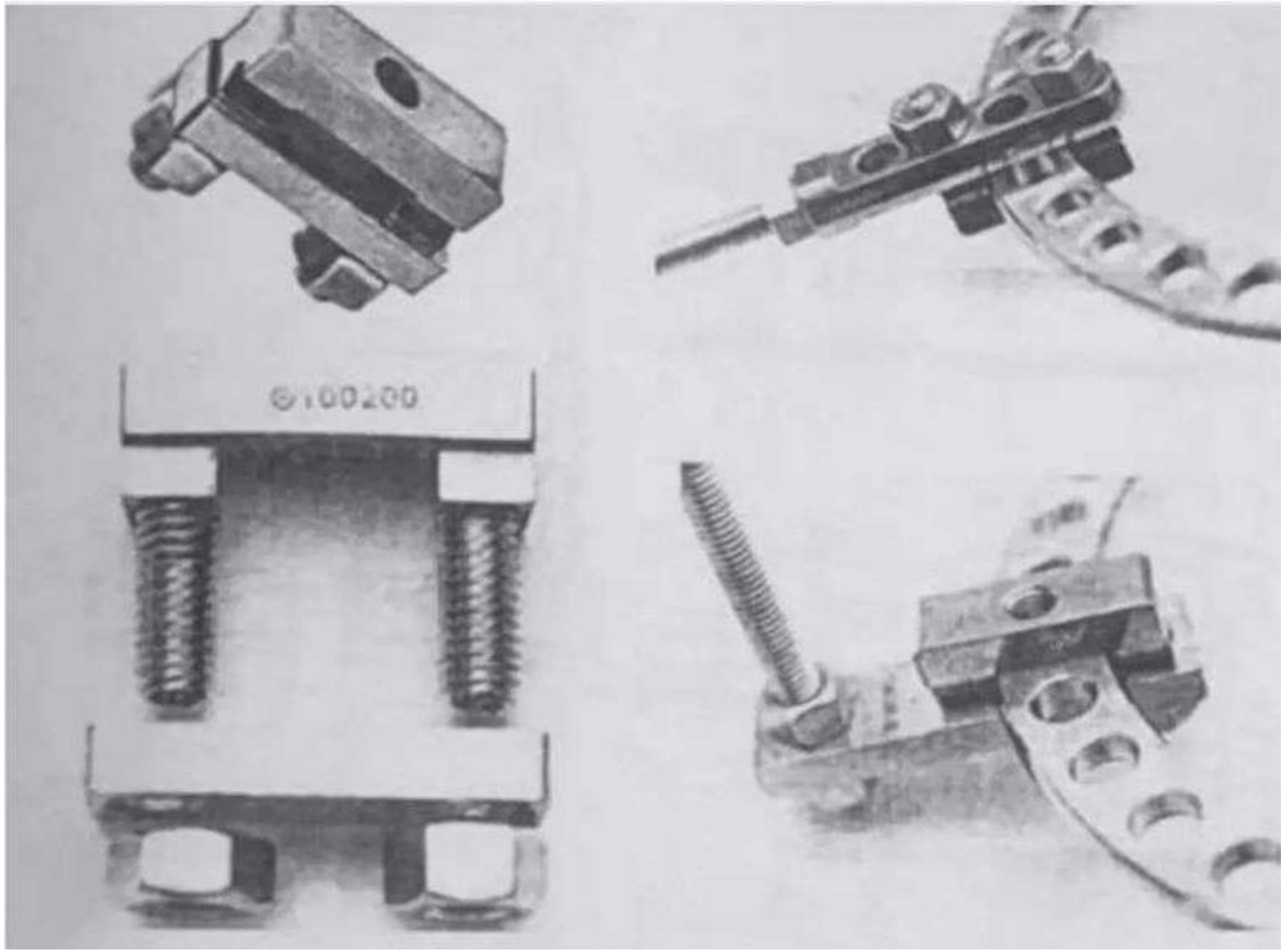
- **COUPLED EFFECT** = Placing one wire above at both ends and another wire below at both ends

Avoids Torsional effect on the bone

Identify this device ?

- Wire fixation bolt
- Wire fixation buckles
- Plate
- Wrenches

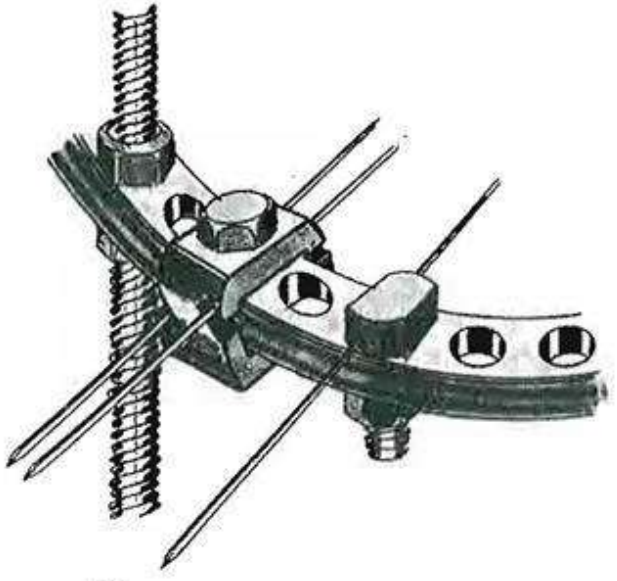
Wire Fixation Buckles

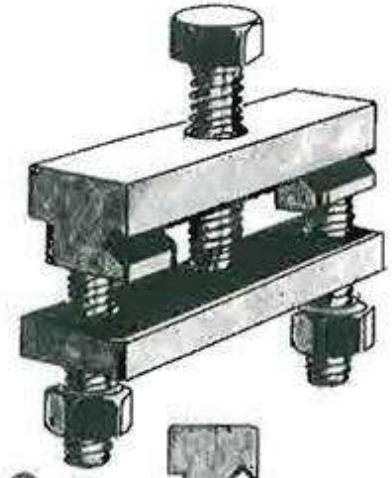


Wire Fixation Buckle

- Used to fix k-wires to the rings

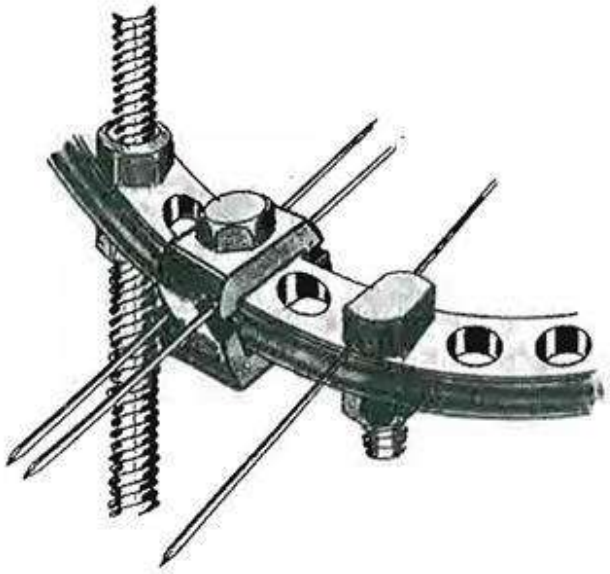
- Can be used in ring locations where there are no accessible holes , fixed to flat surface of ring with nuts and bolts

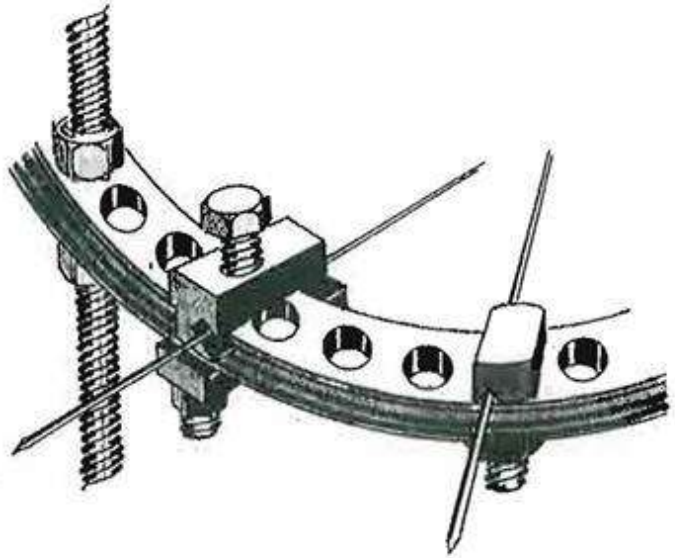




Dual sided wire fixation buckle

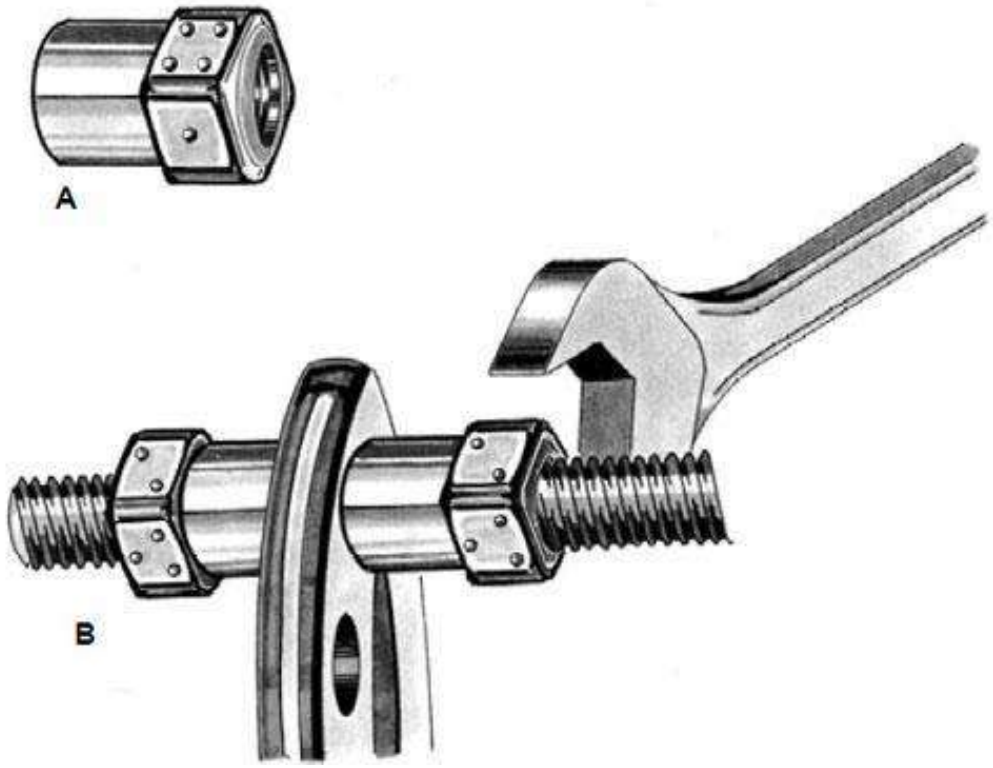
Detachable wire fixation buckle





Nuts

- 10mm in size



- Serves multiple purposes

1. Tighten connecting belts
2. Stabilize connecting rods
3. Tighten wire fixation bolts
4. Used in distraction, compression forces
5. Lock the socket on the threaded rod
6. Fix pulling wire of distraction device
7. Fix the male support
8. Secure hinge component
9. Secure gap on threaded rod

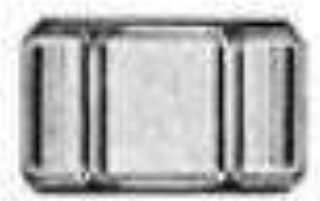
How many threads does a Full nut have ?

a) 10 threads

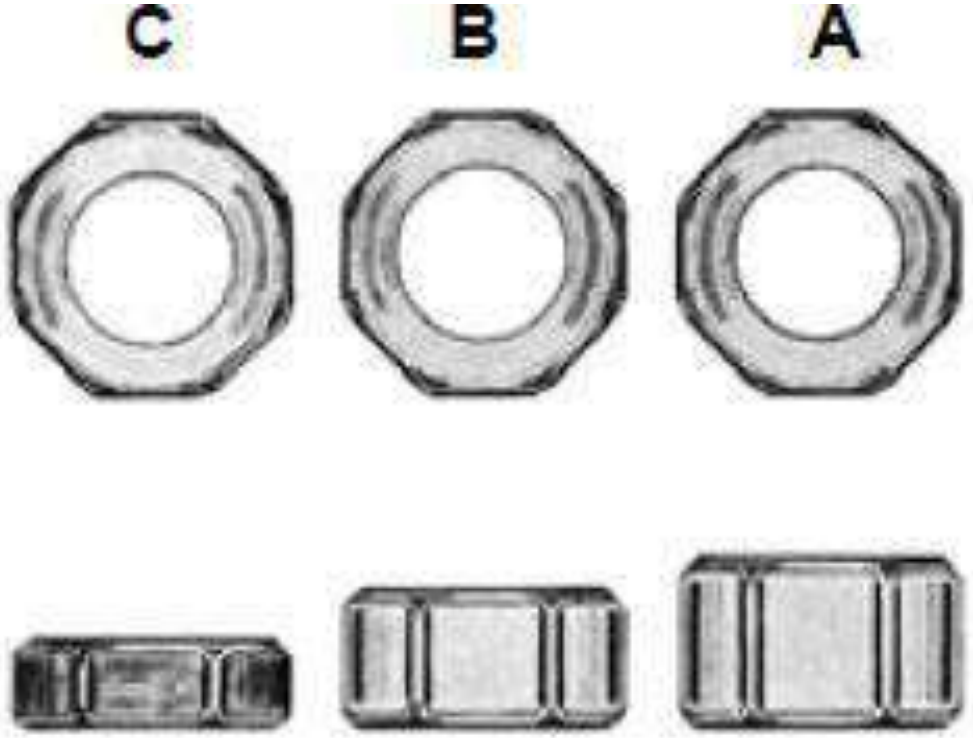
b) 6 threads

c) 5 threads

d) 3 threads



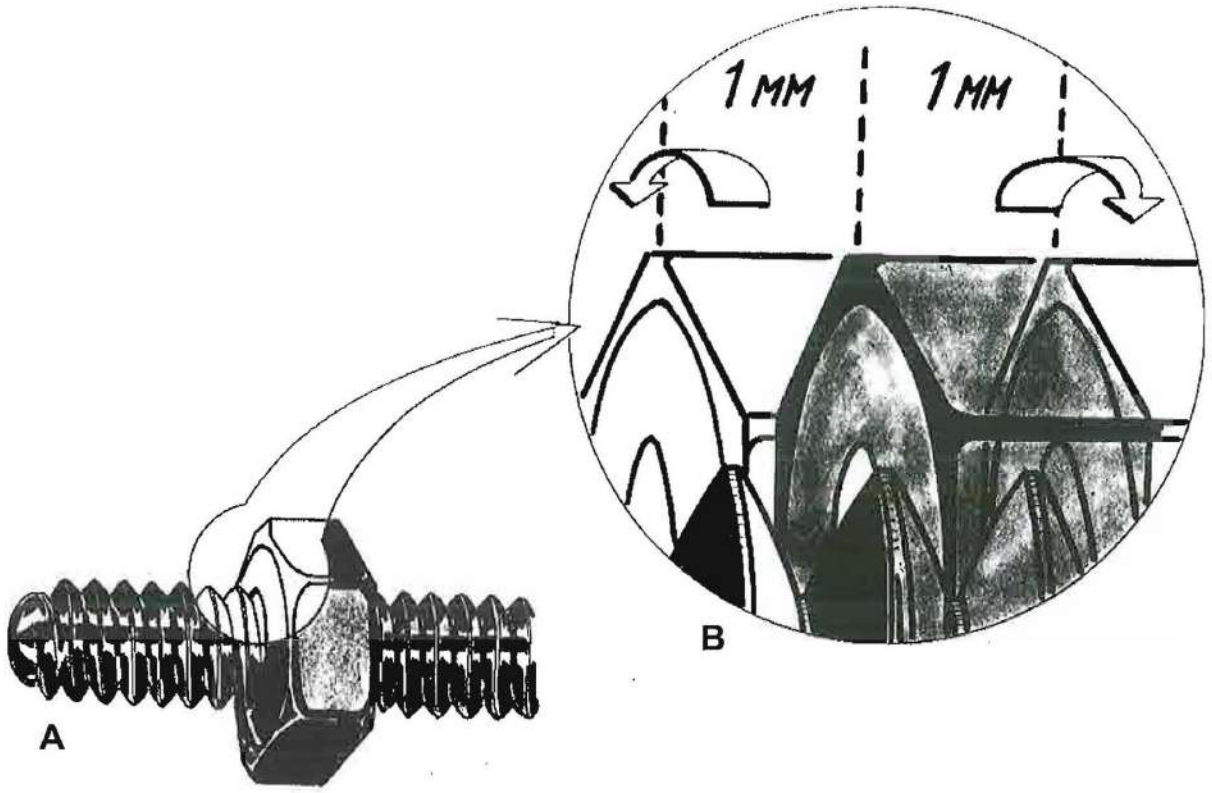
3 TYPES OF NUTS



3mm Nut
Half Nut

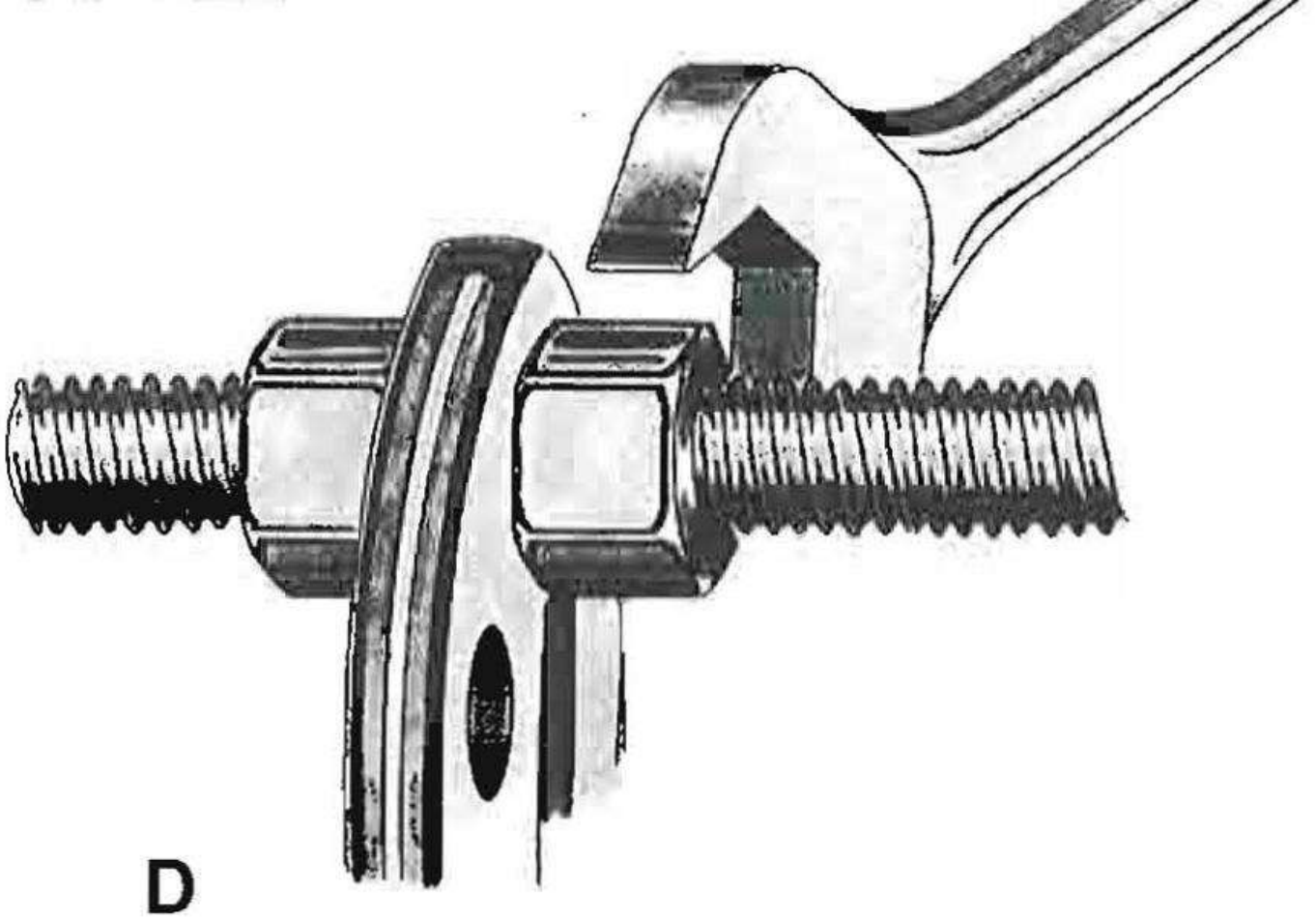
5mm Nut
Three quarter
Most commonly used

6mm Nut
Full Nut



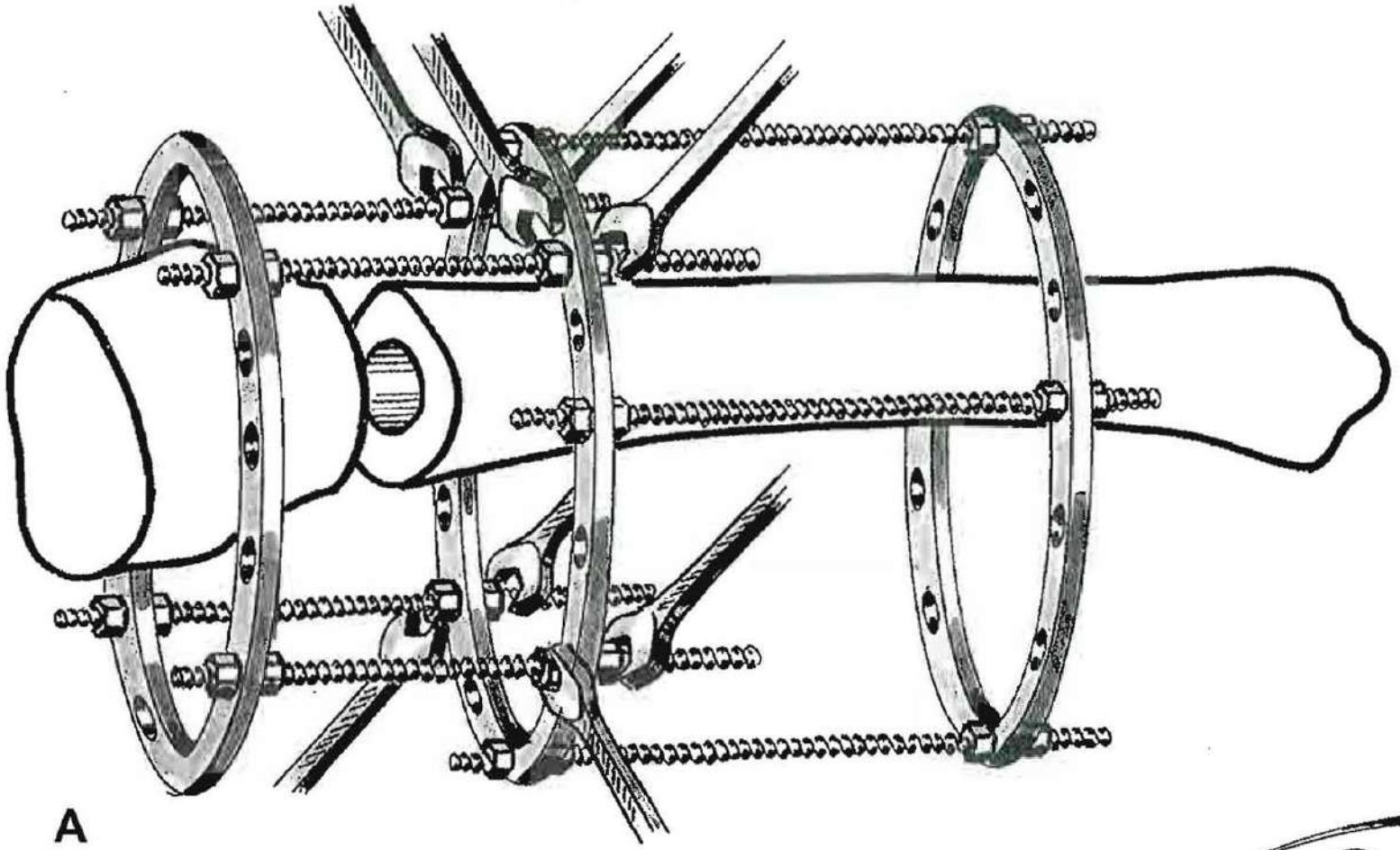
INNER THREADS HAVE 1mm PITCH
HENCE 1 ROTATION GIVES 1MM OF DISTRACTION
WHICH IS RECOMMENDED

Thickness of nut = number of threads
One threads pitch equals 1mm

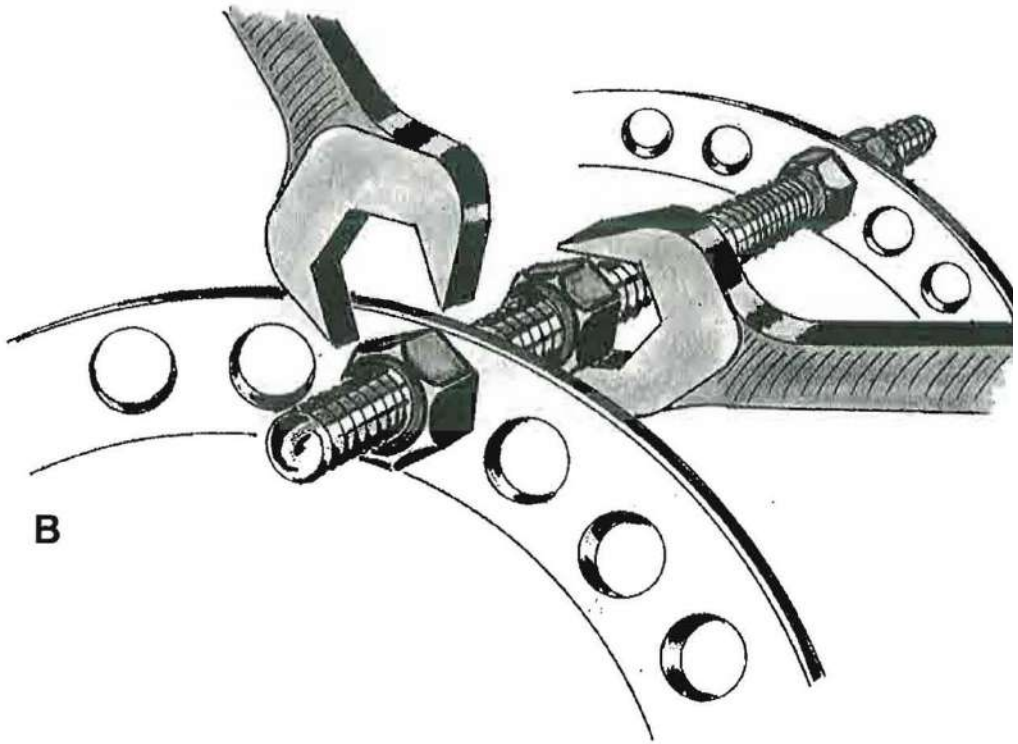


Turn of nut is driving force of Ilizarov technique

Usually **one-fourth turn four times a day** is recommended distraction-compression rate for 1 day



A

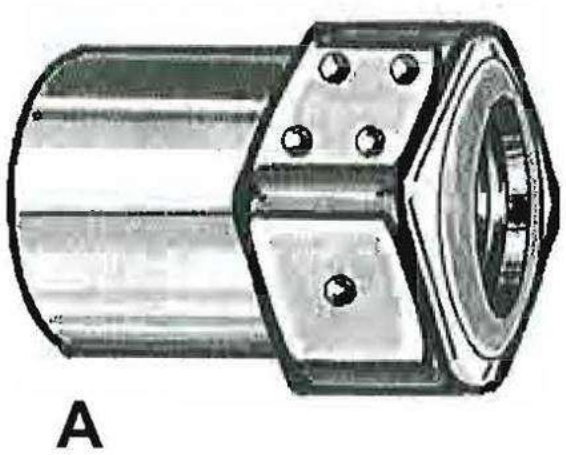


B

- Nuts and bolts should never be reused again
- Fine threads break during compression

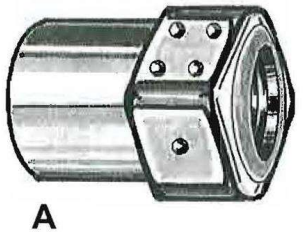
If reused – leads to a weak frame

What is this ?



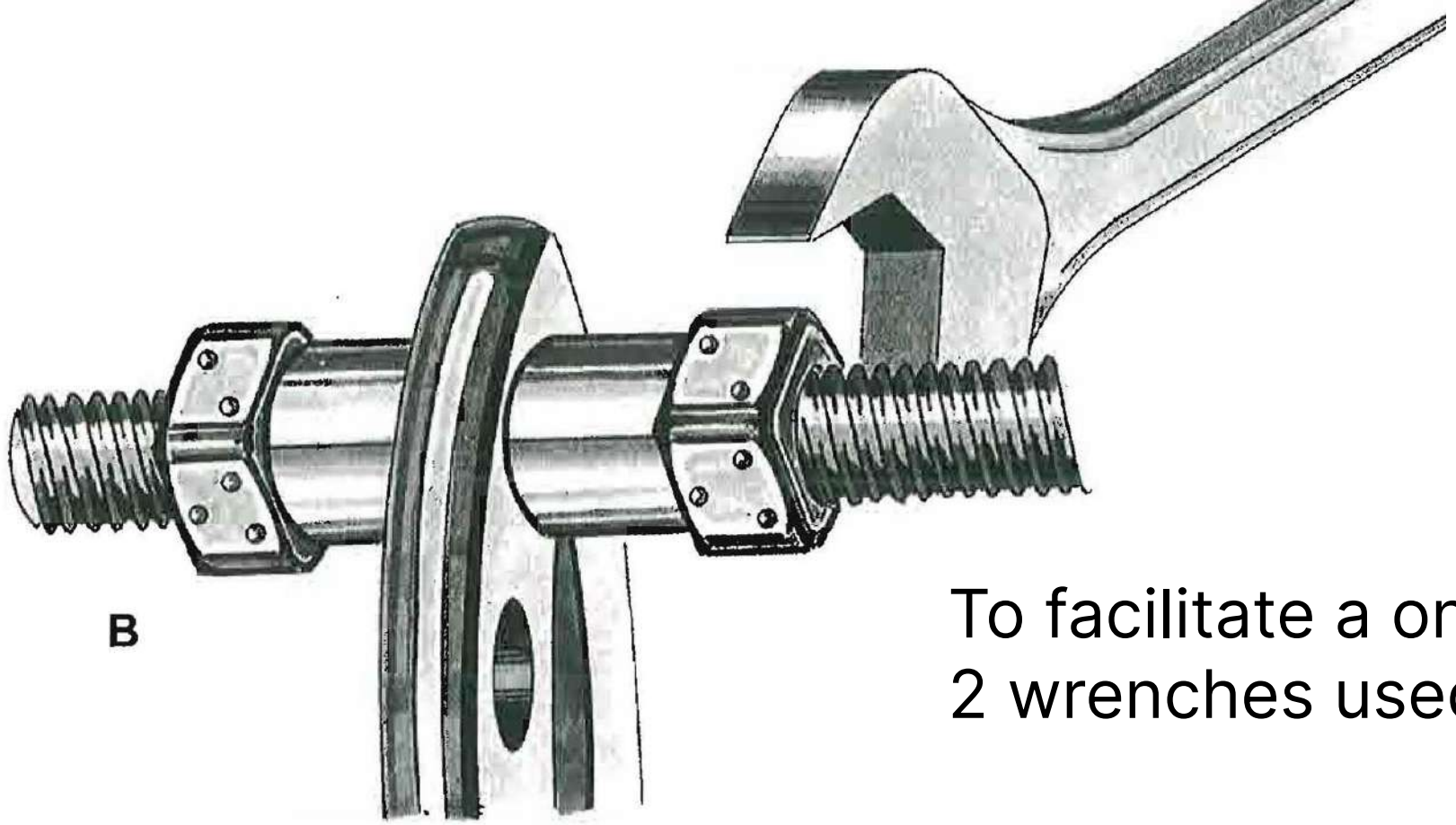
Special Nuts

Quadrangular Special Nut



Not a hexagonal head , but
Quadrangular head

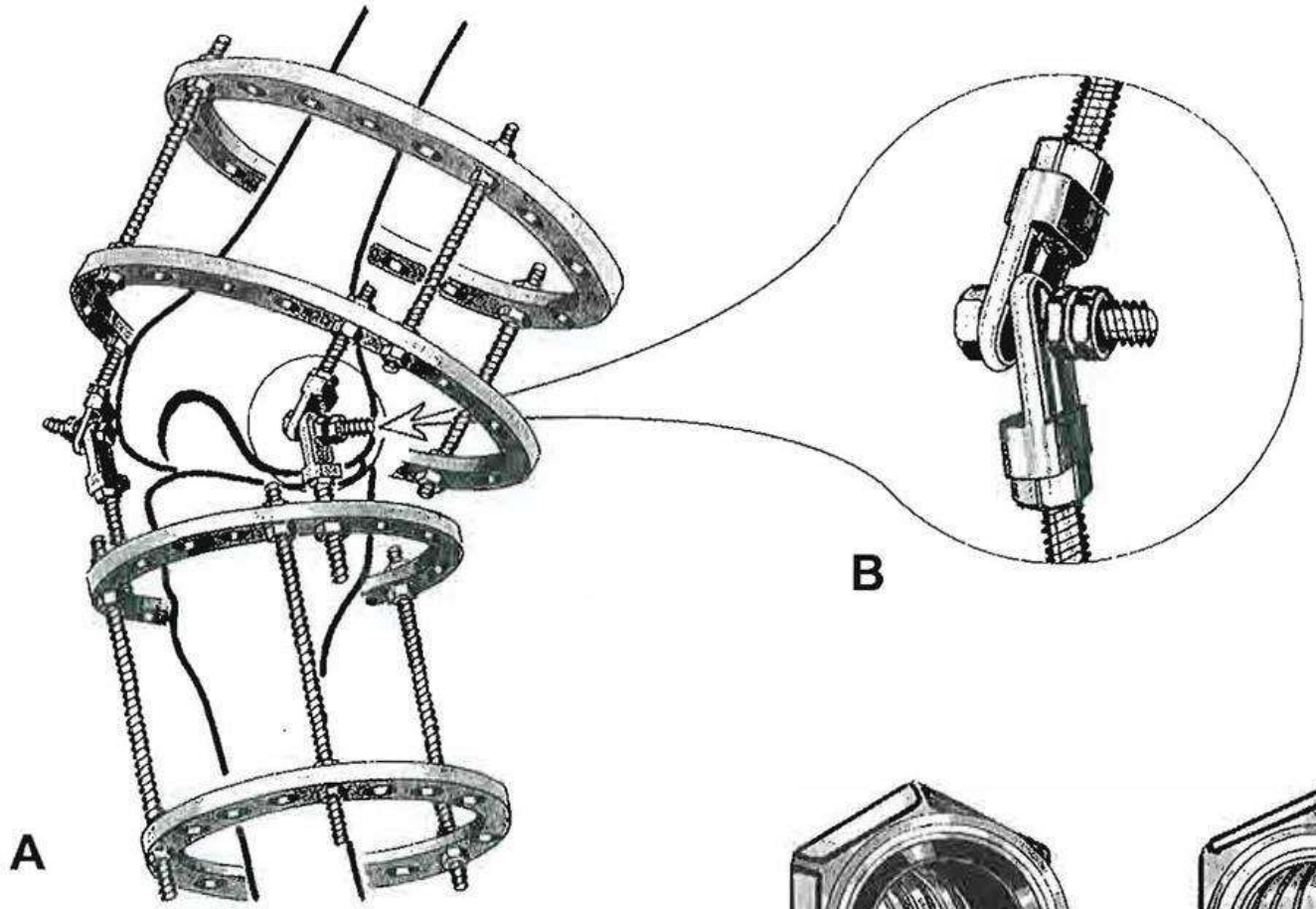
Has turn markings
Easy for distraction

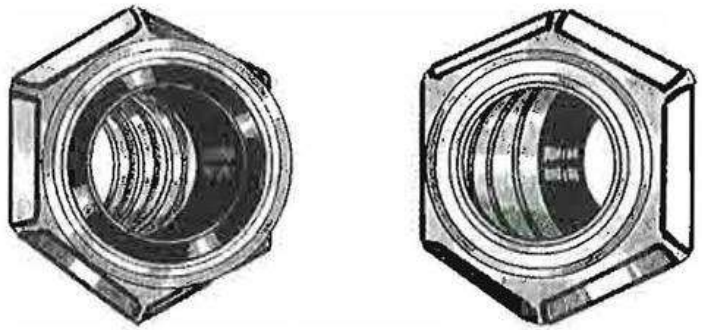


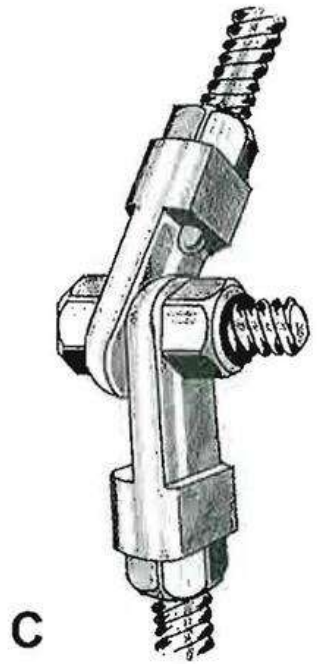
To facilitate a one-fourth turn
2 wrenches used for 0.25mm turn

10mm long
10mm quadrangular head
Marked with dots – 1 to 4

Very stable with 15 threads







Nylon Nut / Stopper Nut

Stopper Nut

Nylon bushing inside it

Stopper nut allows it to remain locked at a position
Doesn’t loosen

ONLY USED TO MAKE HINGES

Identify this device

- a) Washer
- b) Wrench
- c) Wrenchocube
- d) Female Post

Identify this device

- a) Washer
- b) Wrench
- c) Wrenchocube
- d) Female Post

Which washer is used with Femoral/ Italian Arches ?

a) 1.5mm washer

b) 2mm washer

c) 2mm wide body washer

d) Slotted 3mm washer

Washer

3 types of Washer

1. Plain washers
2. Grooved washers
3. Paired Spheric washers

Plain washers:

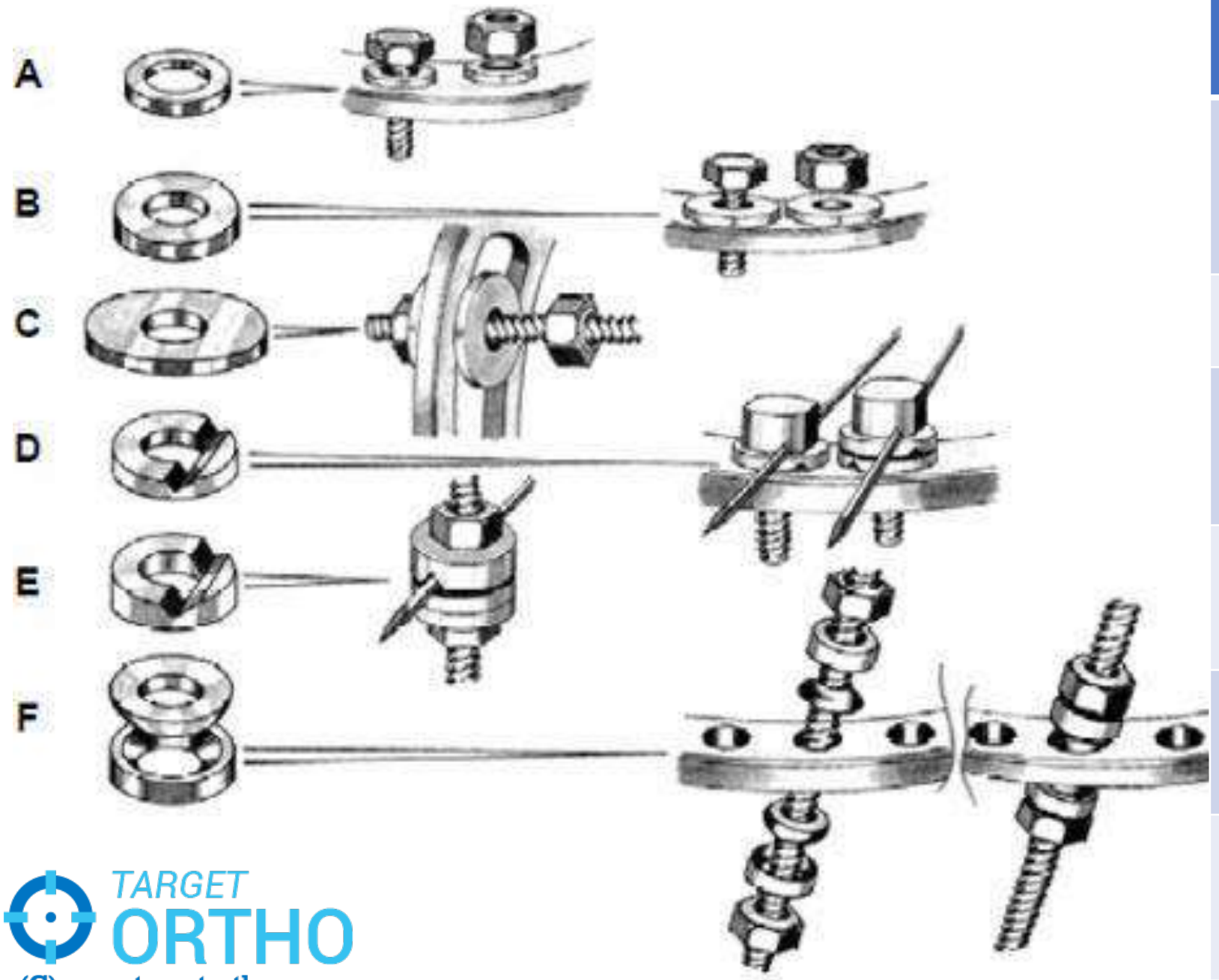
- Two thickness 1.5 & 2.0 mm
- Used to separate a piece of hardware from another
- Used with grooved washers for wire fixation

Grooved washers:

- Used for wire fixation anywhere in the configuration
- The groove should rest against a flat piece of hardware
- If the wire is far from the plane of the ring a multiple washers are stacked on a long bolt to secure the wire

Paired spheric washers:

- Used to compensate for angulation between ring and threaded rod
- They allow for the threaded rod a 7.5 degree of angulation in a hole



Washer Sizes

a) 1.5mm thick washer , 12mm diameter , not recommended in wire fixation bolts (2mm used)

b) 2mm washer , 14mm diameter

c) 2mm wide body washer (20mm diameter)
Used in Italian Arches

d) 3mm thick, 14mm diameter
Slotted washer

e) 4mm thick, 14mm diameter
Slotted washer

f) 3mm thick Conical washer couple 7.5-degree movement in all direction (upto 15 deg)

Identify the instrument

a) Combination wrench

b) Wrenchocube

c) Box Wrench

d) Telescopic Rod

Wrenches

BOX WRENCH

- "Spanner"

- Tightening always performed simultaneously with 2 wrenches

One wrench – motionless part

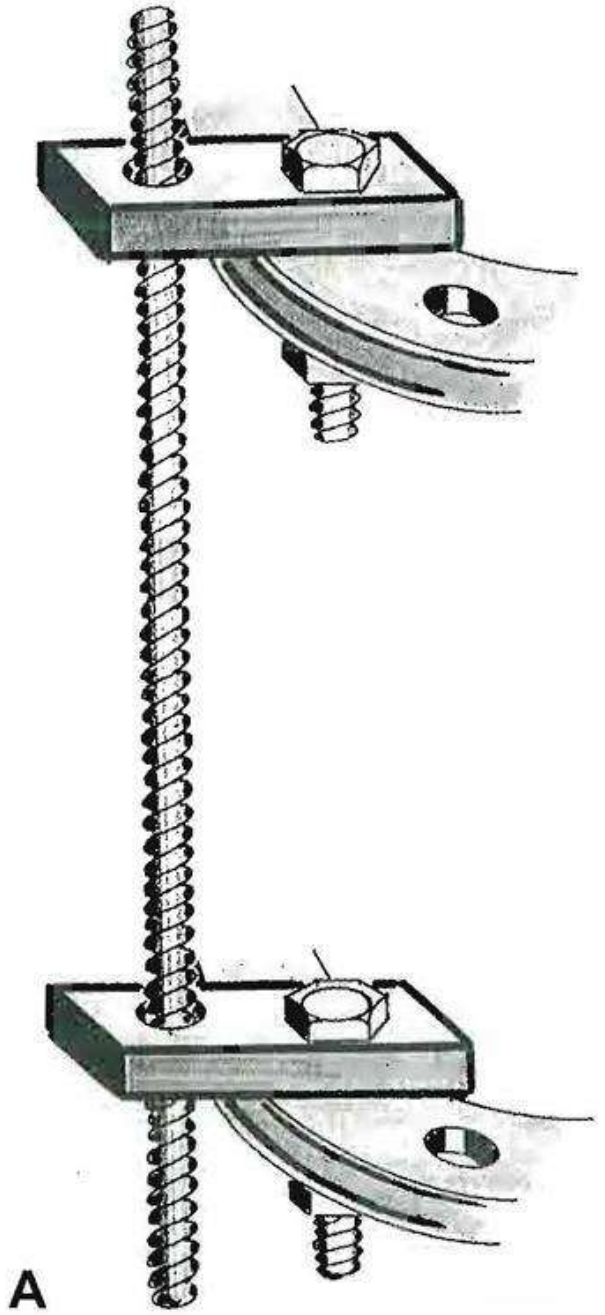
One wrench – part being tightened

COMBINATION WRENCH

- Tightening force – as much as 200kgs

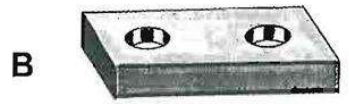
Plates

- Reinforce Ring Fixators
- Used as Extension to rings



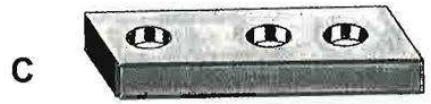
- **Short Connecting Plates**

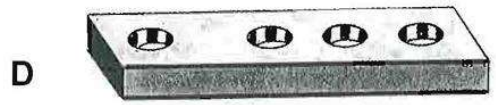
Used as extension of rings



- **Long Connecting Plates**

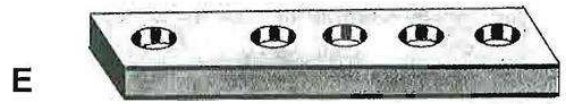
Used to reinforce large frames during bone fragment transport





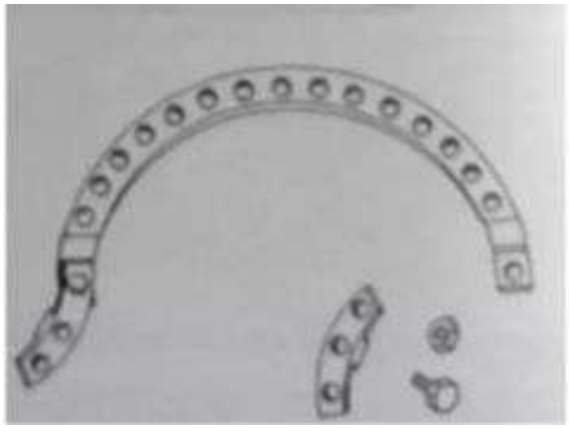
- **Plates with threaded rod**

used to support a hinge as well as a frame



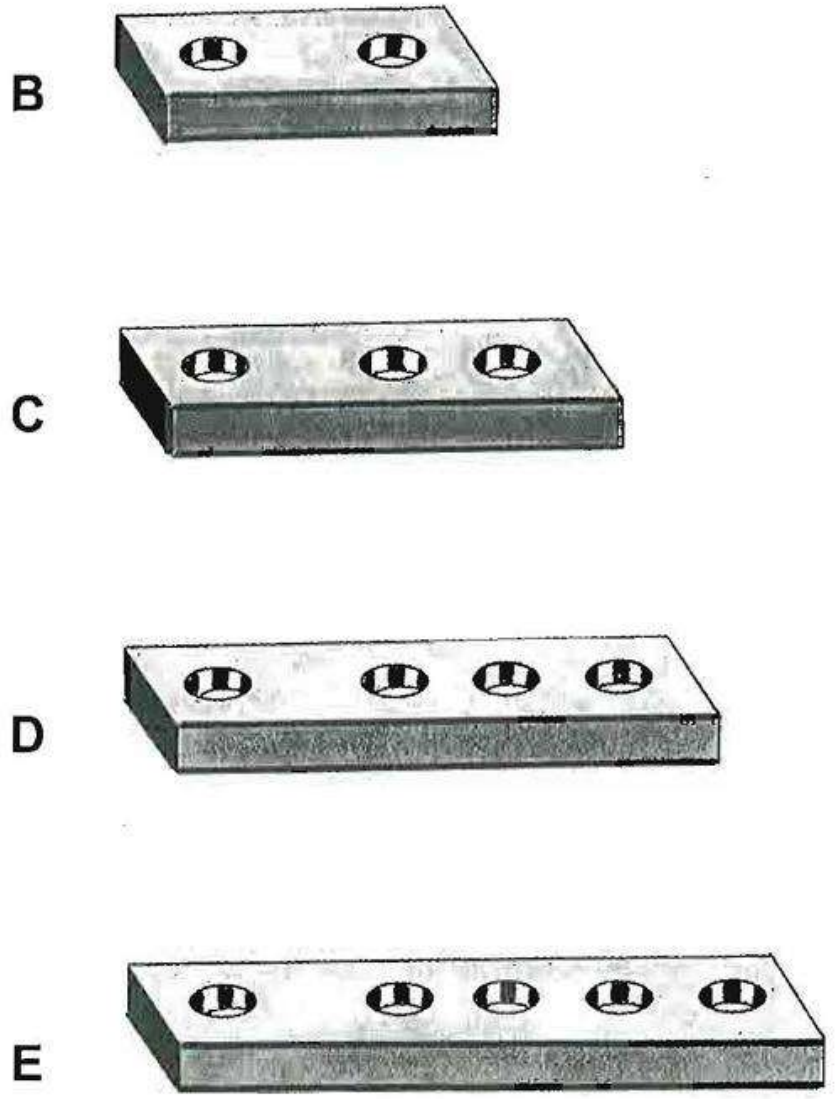
- **Twisted plates**

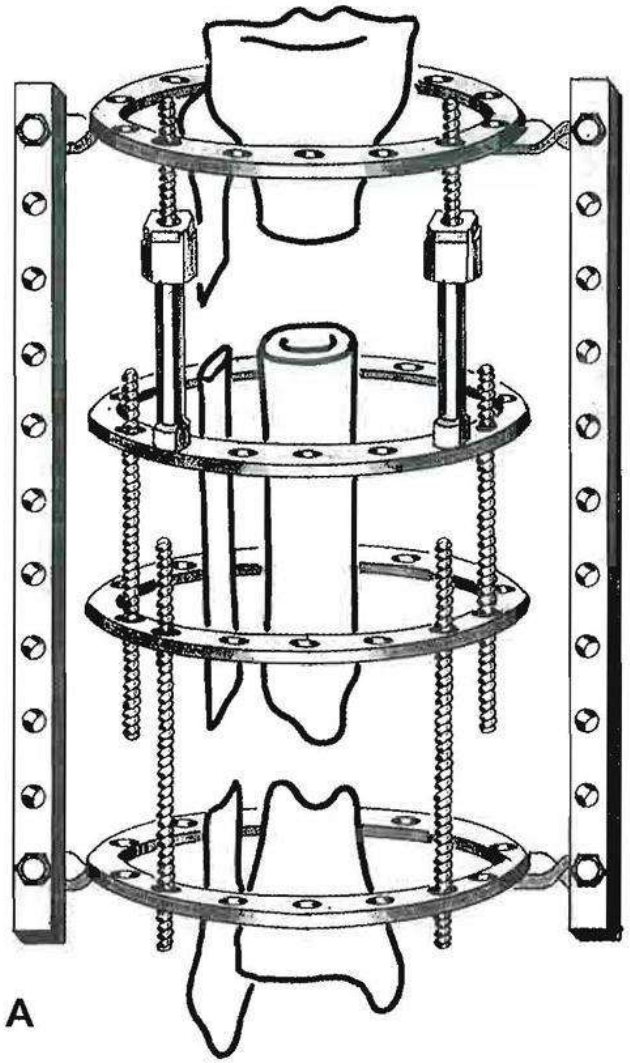
- **Curved plates**

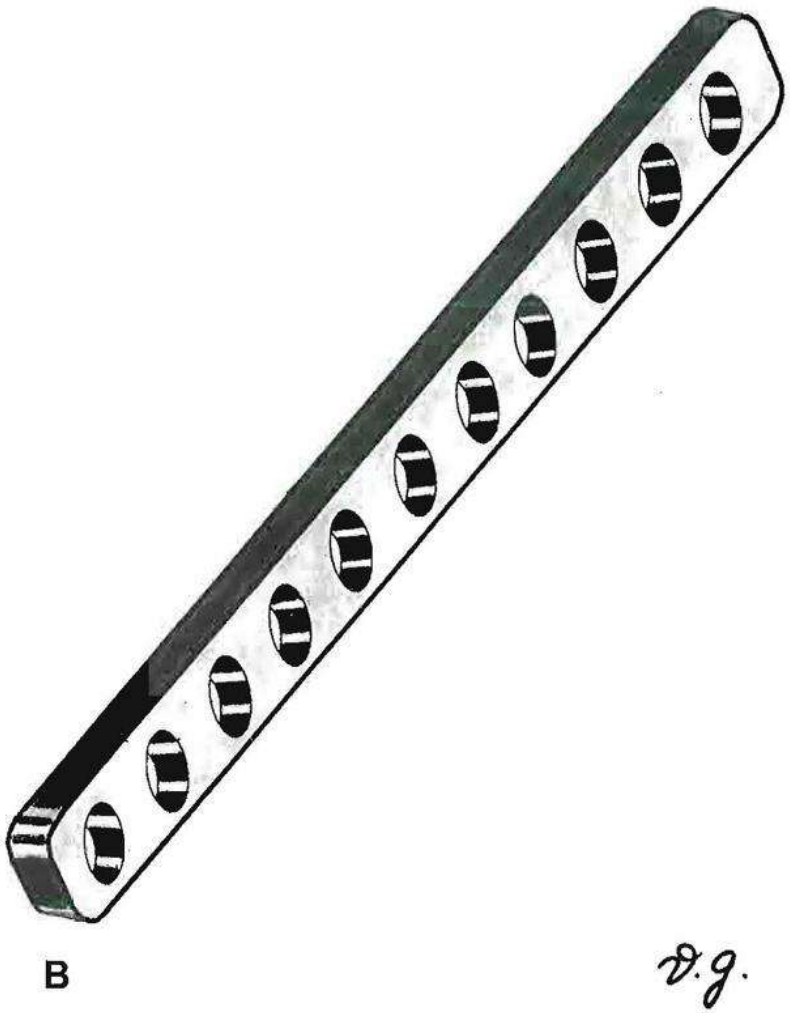


Dimensions

- 5 mm thick
- 14 mm wide
- 7mm diameter perforated holes



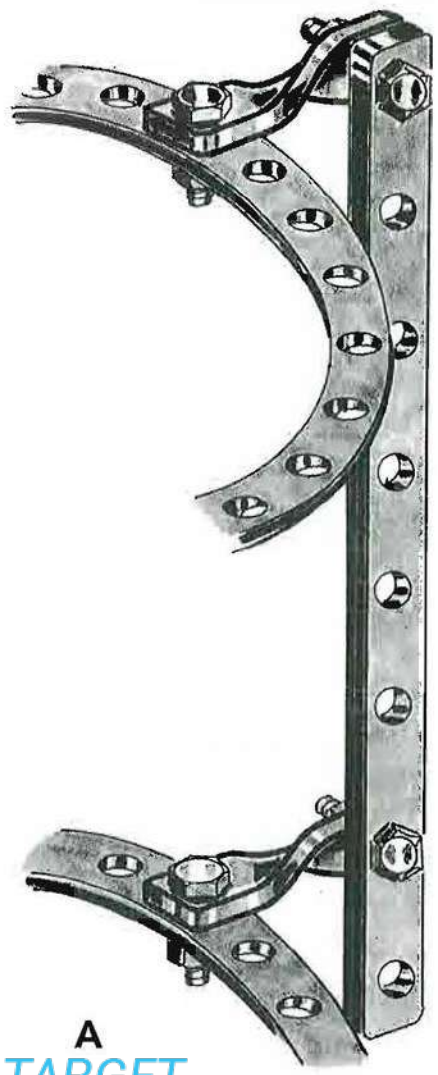


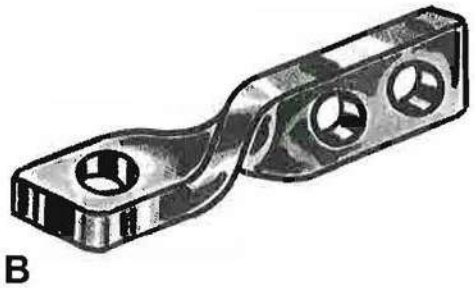


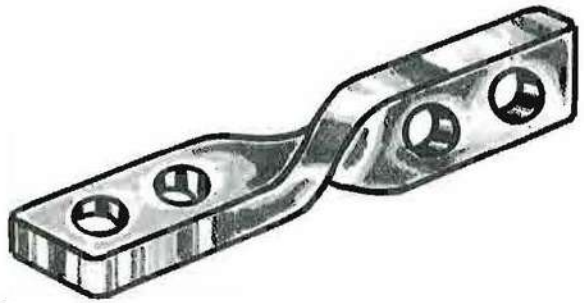
Used as a stiff supporting component for ilizarov apparatus.

3 sizes

- 155 mm with 8 holes
- 235 mm with 12 holes
- 335 mm with seventeen holes





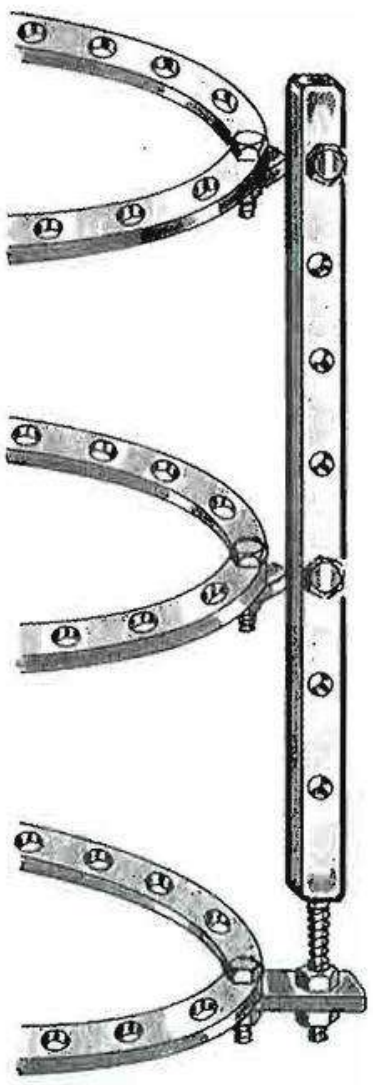


TWISTED PLATES

Connection from a horizontal to a vertical plane in the frame assembly

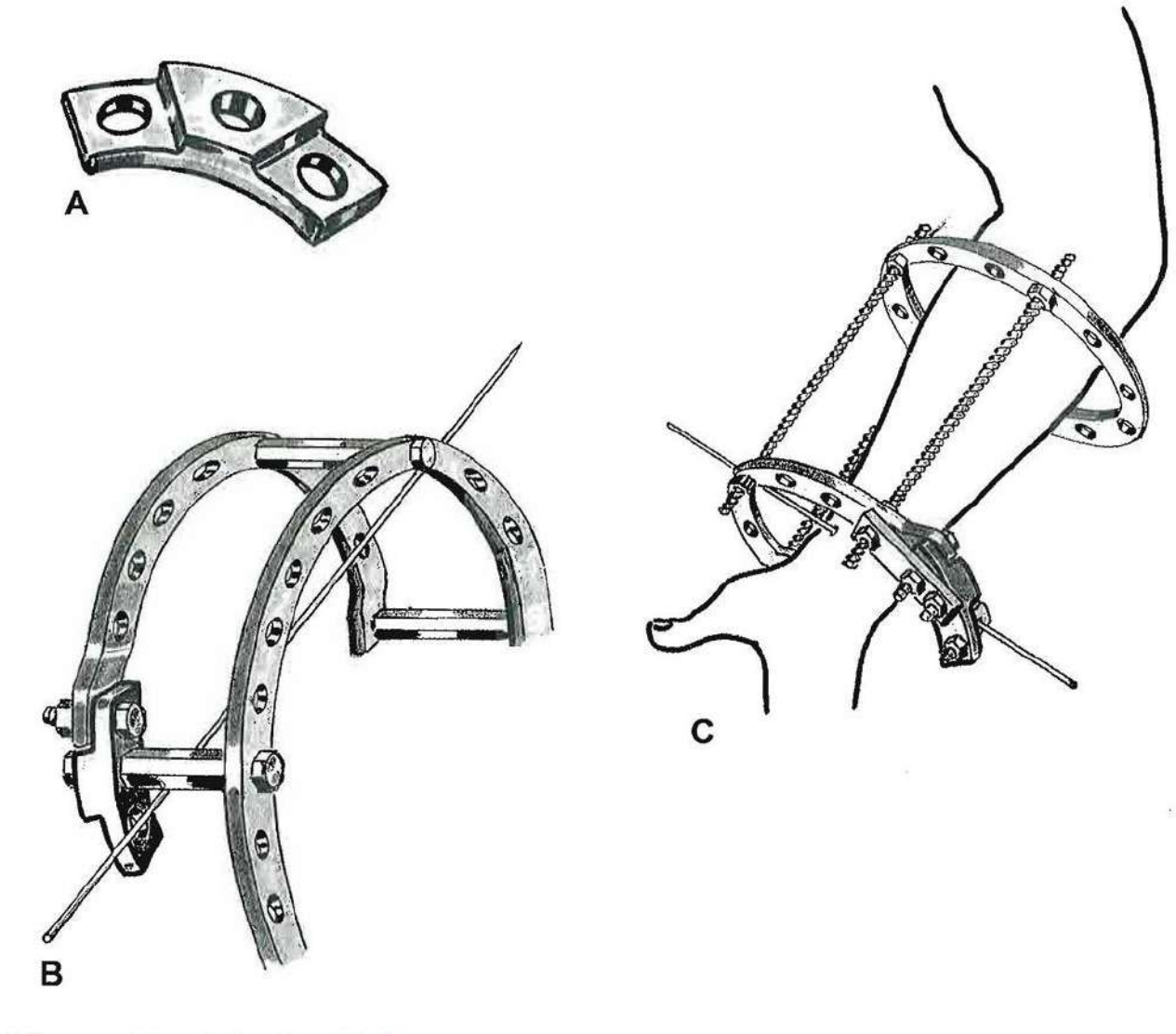
Available in 3 sizes

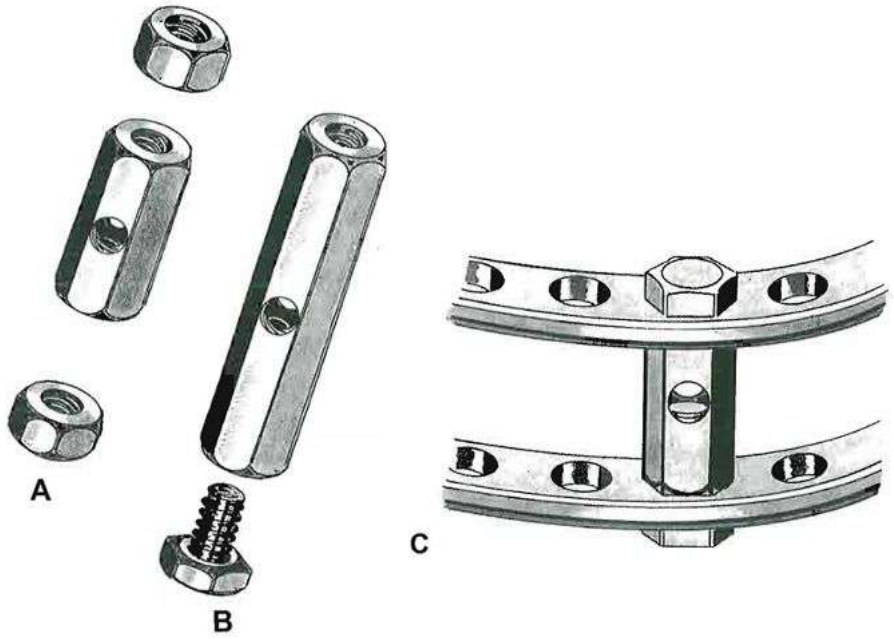
- 45mm with 2 holes
- 65mm with 3 holes
- 85mm with 4 holes



Connection plate with threaded end

Curved Plate





Identify the instruments ?

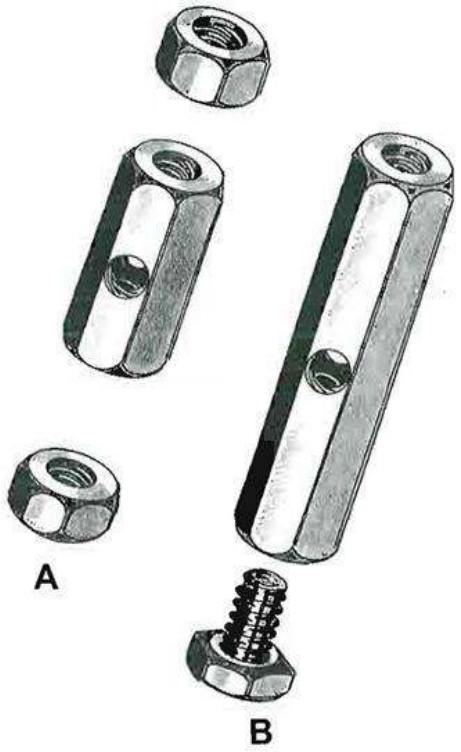
1) All Threaded sockets

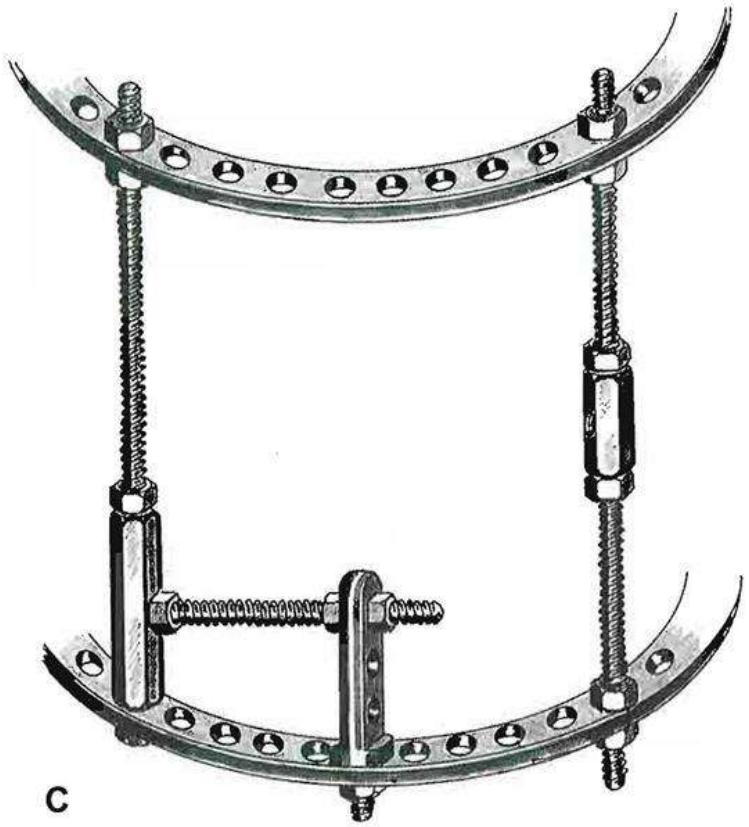
2) A is Threaded socket, B is bushing, and C is post

3) A and B are threaded socket and C is bushing

4) A is bushing and B, C are threaded socket

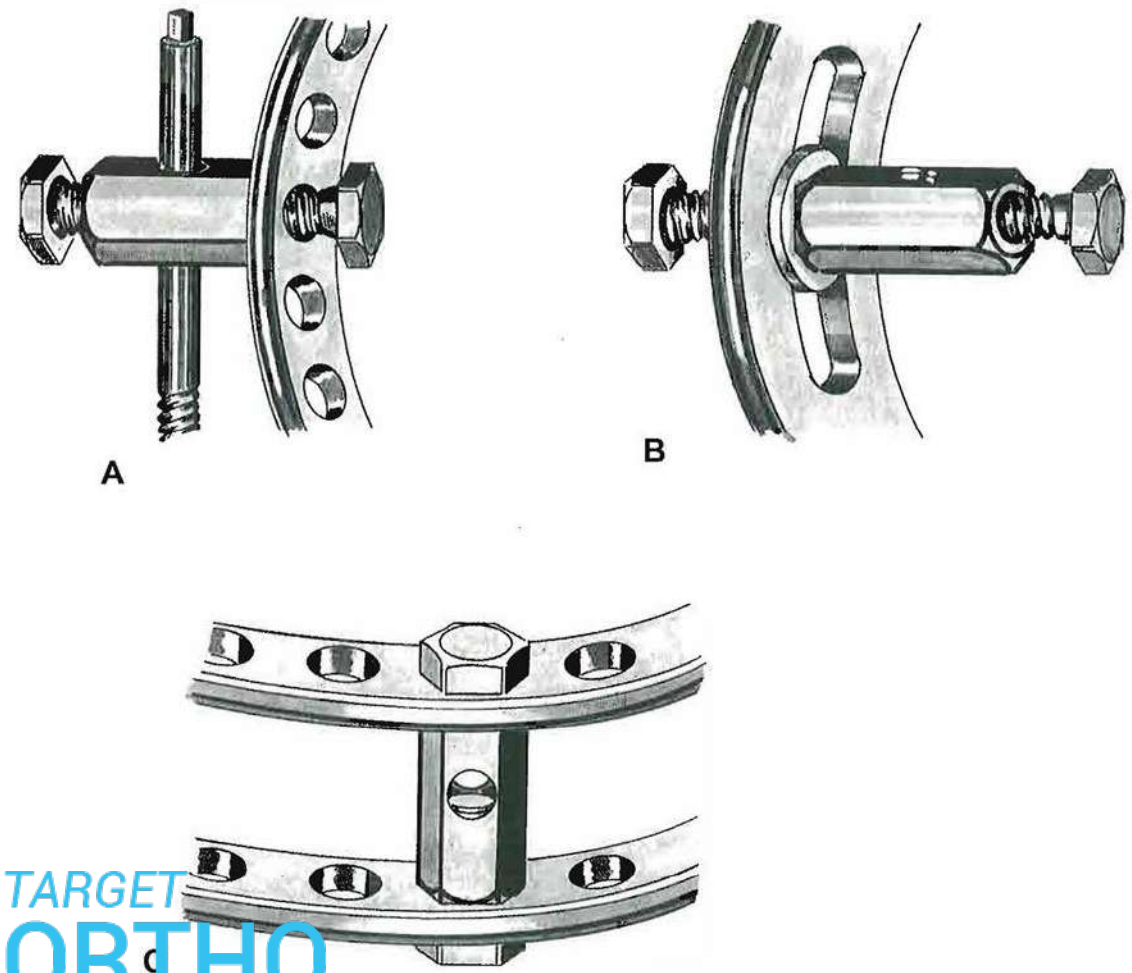
Threaded Sockets





1. Small, 20mm threaded socket with 2 nuts
2. Large, 40mm threaded socket with bolts

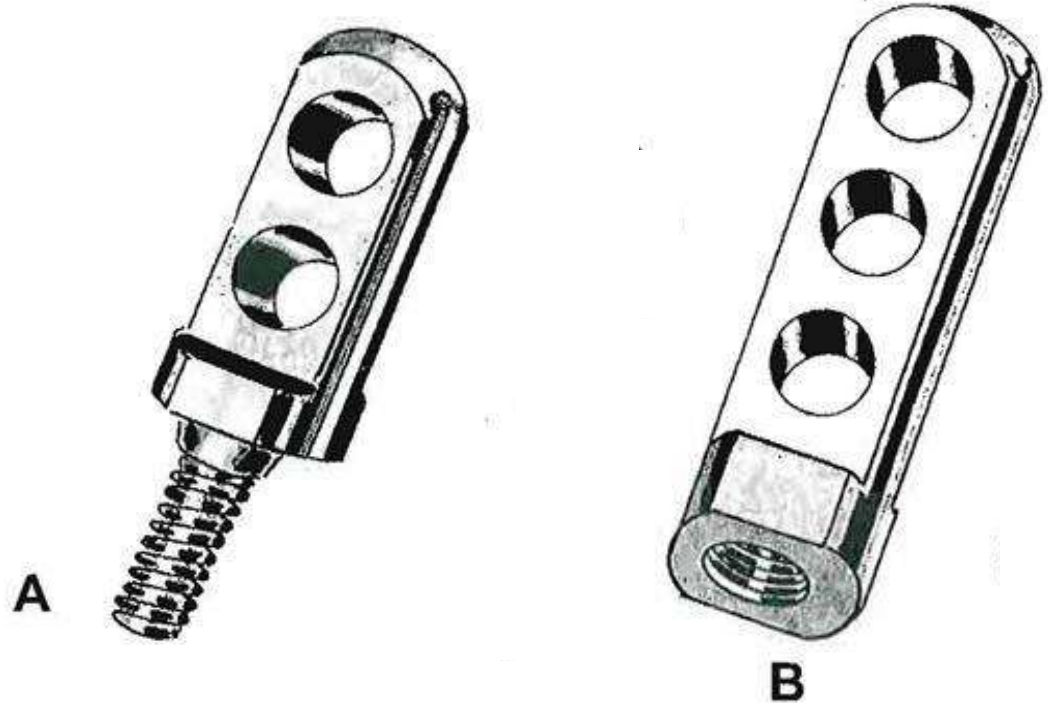
Bushing



Unthreaded aperture

1mm wider than threaded rods

Supports and Posts



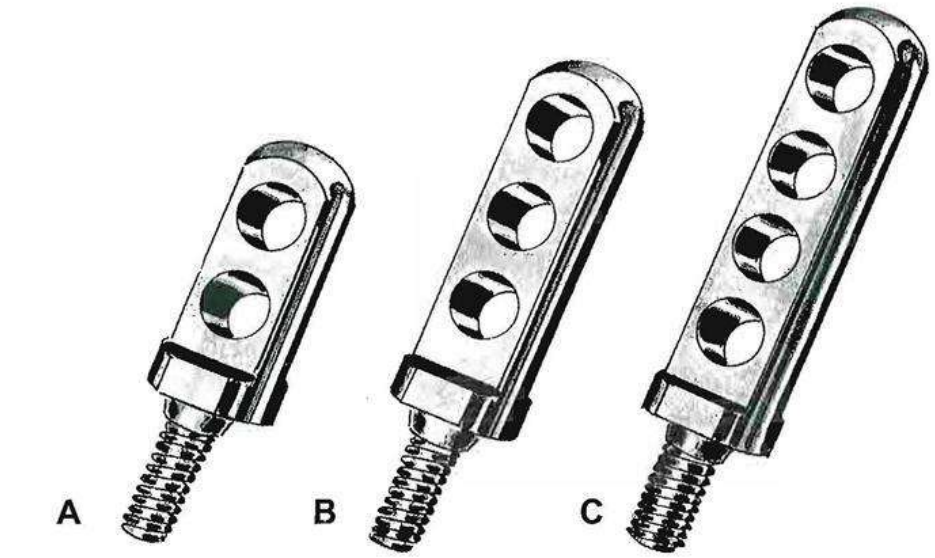
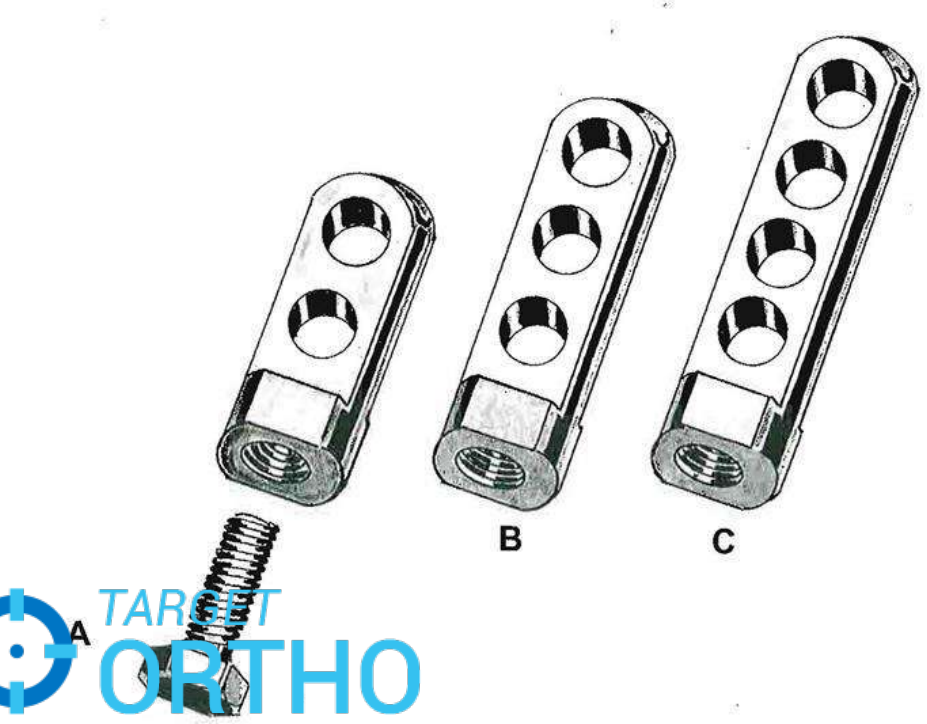


Figure 9.25: A, two-hole male support. B, three-hole male support. C, four-hole male support



Male Support

13mm long standard threaded leg protruding from the butt end
This leg serves as a connection to other components
4mm base

Female Post

No protruding rod
10mm deep threaded hole at butt end
This hole serves to connect bolts or rods
6mm base

Half Hinges

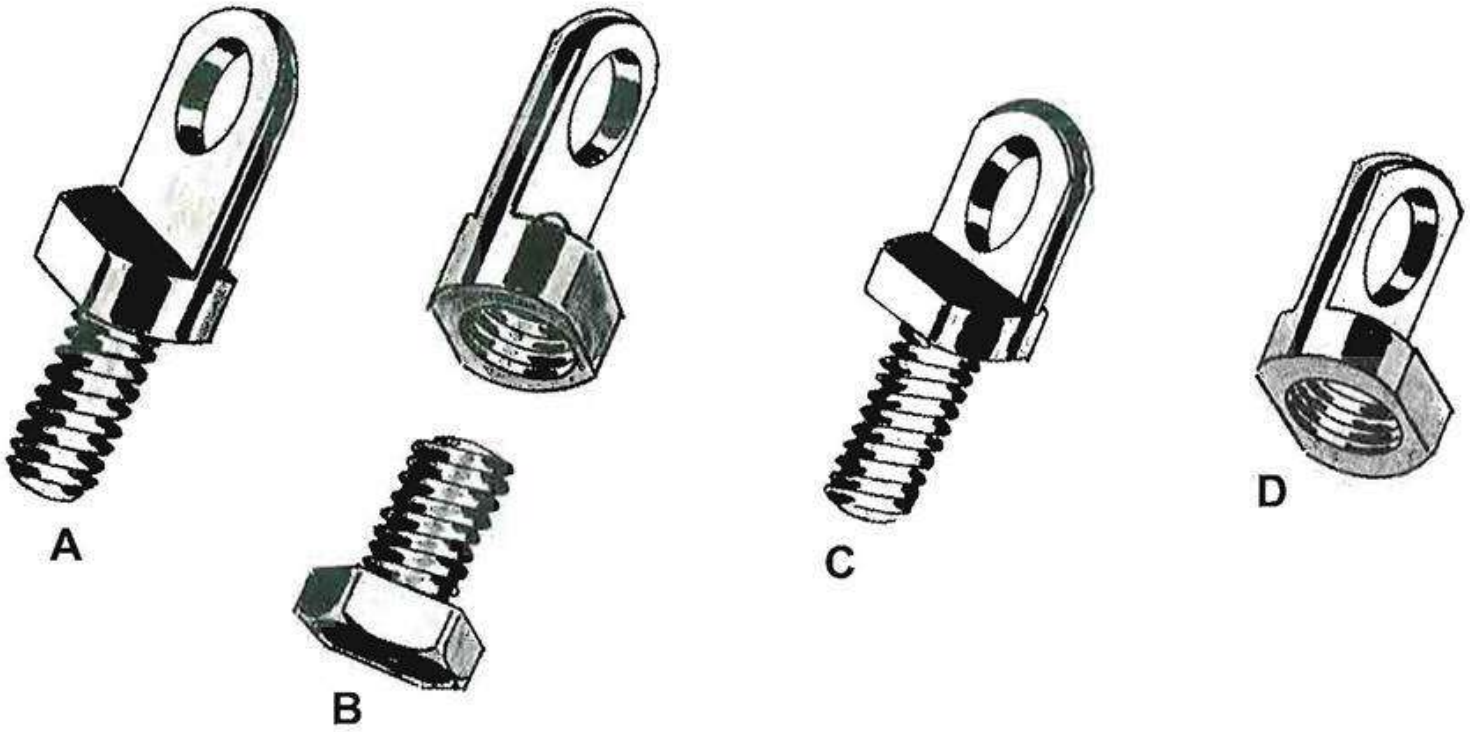


Figure 9.27: A, regular male half-hinge. B, regular female half-hinge. C, small male half-hinge. D, small female half-hinge. Note that the base of the small half-hinge is thinner and smaller than that on a regular hinge

Wrenchocube

Used to connect half pin / schanz pin to the half rings

Tensioners

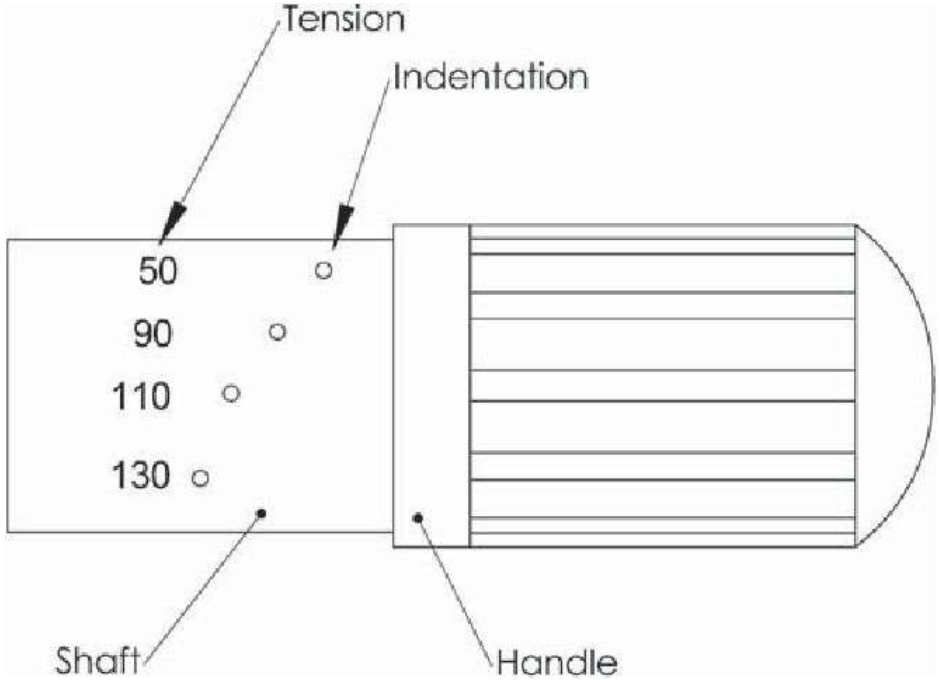
- Devices which are used to tension the wires to an exact force thus improving the entire bone frame construct

- Divided into

1. Standard
2. Dynamometric

Wires tensioned between 50-140 kgs

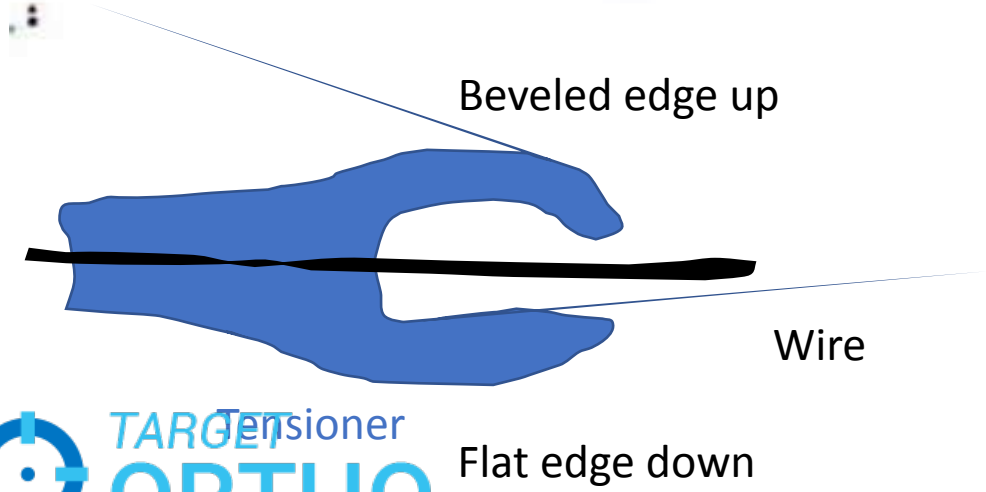
Tensioning



Depends on

- Weight of the patient
- Quality of the bone
- Treatment plan
- Local Frame Construct

K WIRE	TENSIONER
1.5MM	90-105 KGS
1.8MM	130-140 KGS



Rotate the device anti-clockwise until wire gets inside it

Engage clockwise so that tensioner engages to desire tension

Once tightening achieved, tightening nut at desired tension