The jointing key

MARIAUD CONSULTING

OUR PROGRAM

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The Jointing Key

The Jointing Key

01 Presentation

The gauge, or jointing key, is a wooden or metal template used in coopering.

It is used to determine the exact proportions of the staves in order to obtain the desired shape of the cask and to ensure a precise jointing between them.

This template contains several essential pieces of information:

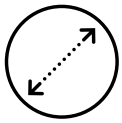
- The hollowed curve of the doling, at the bilge and/or at the head.
- The jointing angle, at the bilge and/or at the head.
- The reduction proportion between the bilge and the head.

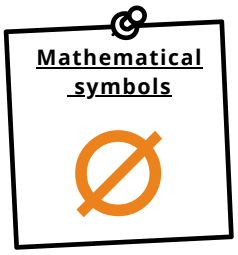
There are two types of jointing keys:

- The simple key, which is used to check:
  - The doling at the head,
  - The jointing angle at the head,
  - The proportions between the head and the bilge.
- The double key, which offers more complete control by allowing you to check:
  - The doling at the head and at the bilge,
  - The jointing angle at the head and at the bilge,
  - The proportions between the head and the bilge.

Each gauge is unique and must be specifically designed for each type of cask to ensure an optimal fit for the staves and guarantee the barrel's shape and tightness.

1. Diameter of a Circle





Definition :

The diameter of a circle is the distance between two opposite points on the circle, passing through its center. It is twice the radius.

Formula : **D=2R Diameter = 2 x the radius**

Where :

D represents the diameter
R represents the radius

Example :

If a circle's radius is 10 cm, its diameter is:

D=2×10=20 cm

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2. Radius of a Circle

Definition :

The radius of a circle is the distance between its center and any point on its circumference. It's half of the diameter.

Formula : **R=D/2**

Example :

If a circle's diameter is 50 cm, its radius is:

R=50/2=25 cm

3. Circumference of a Circle

Definition :

The perimeter of a circle, also called the circumference, is the length of the circle's outline.

Formula : $P = \pi D$ ou $P = 2\pi R$

Where :

- P is the perimeter (circumference).
- D is the diameter.
- R is the radius.
- $\pi \approx 3.1416$ is the mathematical constant Pi.

Example :

If a circle has a radius of 7 cm, its perimeter is:

$$P = 2\pi \times 7 \approx 2 \times 3.1416 \times 7 \approx 43.98 \text{ cm}$$

Summary or formulas

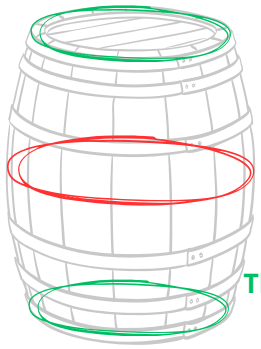
Concept	Formula	Variables
Diameter	$D=2R$	R : radius
Radius	$R=2D$	D : diameter
Perimeter (Circumference)	$P=\pi D$ or $P=2\pi R$	D : diameter R : radius π: 3.1416

4. Calculating the Reduction Coefficient

The reduction coefficient in cooperage is a key parameter that expresses the ratio between the barrel's maximum diameter, called **the bilge diameter,** and the diameter at its ends, called **the head diameter.**

This coefficient directly influences the barrel's shape, affecting its volume and interaction with the contents.

The reduction coefficient is calculated by dividing the head diameter by the bilge diameter:



$$\text{The reduction coefficient} = \frac{\text{The head diameter}}{\text{The bilge diameter}}$$

For example, consider a **225-liter** Bordeaux barrel with a head diameter of **57 cm** and a bilge diameter of **69 cm.**

The reduction coefficient would be: **57/69 = 0,826**
This means the head diameter represents approximately **82.6%** of the bilge diameter.

Importance of the Reduction Coefficient

This coefficient is crucial for several reasons:

- **Barrel Design:** It determines the curvature of the staves and the overall shape of the barrel, influencing its capacity and stability.
- **Manufacturing Process:** Coopers use this coefficient to adjust tools and techniques during stave assembly, ensuring a consistent shape and optimal sealing.
- **Interaction with Contents:** The barrel's shape, dictated by this coefficient, affects the contact surface area between the wood and the liquid, which influences the maturation process for wines and spirits.

Examples of Reduction Coefficients

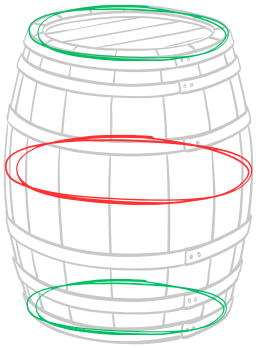
Different types of barrels have varied reduction coefficients depending on their design:

- **228-liter Burgundy barrel:** Has a head diameter of 60 cm and a bilge diameter of 72 cm, for a coefficient of approximately 0.833.
- **500-liter barrel:** Has a head diameter of 78 cm and a bilge diameter of 90 cm, for a coefficient of approximately 0.867.

These variations show how the reduction coefficient is adjusted based on the specific characteristics of each barrel to meet the needs of producers and the desired qualities of the final product.

The Jointing Key

02 Necessary Calculations



The head diameter

The bilge diameter

The head diameter

The reduction coefficient $\frac{\text{The head diameter}}{\text{The bilge diameter}}$

Capacity in liters	Ø HEAD	Ø BILGE	THE REDUCTION COEFFICIENT
1	11	15	0,73
5	18	22,2	0,81
10	21	26,1	0,80
15	23	29,6	0,78
20	27,5	34,3	0,80
25	29	36,6	0,79
28	30	37	0,81
30	30	38,2	0,79
35	31,5	38,5	0,82
40	31	40,1	0,77
50	34,5	44,2	0,78
57	39	47	0,83
60	35	45,5	0,77
70	36	46,1	0,78
75	37	47,7	0,78
105	43,5	55	0,79
114	49	58	0,84
140	46	59,2	0,78
150	47	60,8	0,77
200	54	68,1	0,79
210	57,5	68,1	0,84
225	56	69	0,81
228	60	73	0,82
250	61	74,8	0,82
265	60	73	0,82
300	62	73	0,85
350	66,5	81	0,82
400	70	86,5	0,81
500	76,5	94,7	0,81
600	86,5	102,5	0,84

03 Making a Gauge

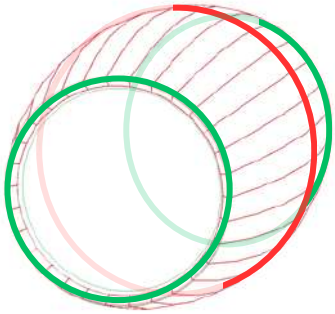
- **1. Plank prepar**

  Materials and Dimensions

  - Take a rectangular board approximately 25 cm x 10 cm with a thickness of between 5 and 7 mm.
  - Plane both faces to obtain a smooth and regular surface.
  - Plywood or other regular, solid, and easy-to-work material.

Example with a 225 L barrel

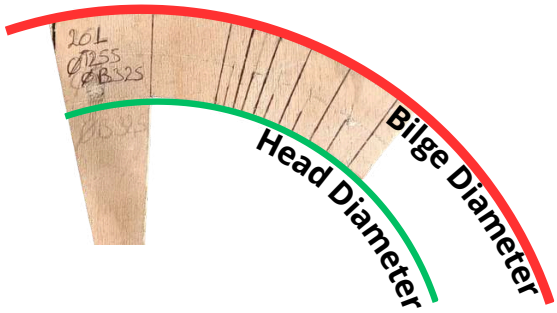
The head diameter (green) : **57 cm**
The bilge diameter (red) : **69 cm**

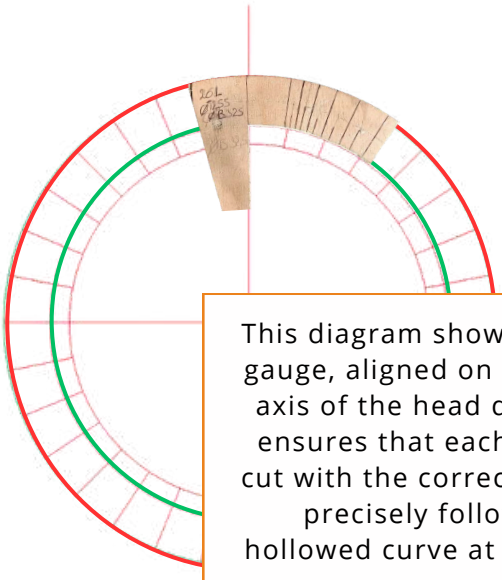


The necessary calculations:

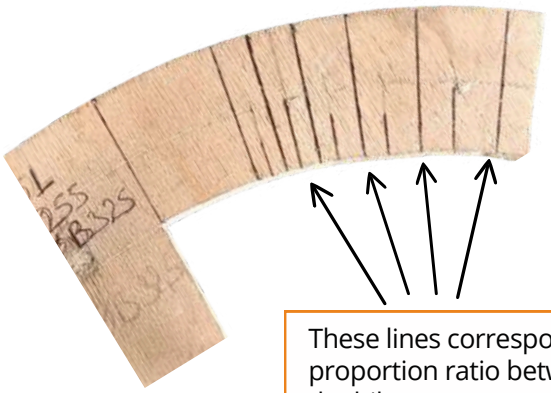
Diameter at the head (green) : **57 cm**
Diameter at the head = 57 / 2 = 28,5 cm

Diameter at the bilge (red) : **69 cm**
Radius at the bilge = 69 / 2 = 34,5 cm





This diagram shows that the gauge, aligned on the radial axis of the head diameter, ensures that each stave is cut with the correct angle to precisely follow the hollowed curve at the head.



These lines correspond to the proportion ratio between the head and the bilge.

Necessary Materials to Make a Jointing Key

1. Base Materials (Key Body)

✅ Hardwood (oak, beech, ash, maple) – Resistant to wear and stable over time.
✅ Quality plywood – An easier-to-work option for a first template.
✅ Metal (steel or aluminum) – For a more durable and rigid key.

2. Marking and Measuring Tools

📏 Graduated ruler – To draw precise lines.
🧭 Compass – To draw the arcs corresponding to the head and bilge diameters.
✍️ Grease pencil or fine marker – For visible lines on the wood.

3. Cutting and Adjusting Tools

🔪 Scroll saw or jigsaw – To cut the general shape.
🛠️ File and sandpaper (fine grit) – For a clean and smooth finish.

4. Fastening and Adjustment Elements

🔩 Screws or nails – To fasten the key to the workbench.







The Jointing Key

03 Making a Gauge

1

Place the plank on a stable support (workbench or table).
Position 4 points at the corners of the plank, making sure not to interfere with the future marking area.
Tap the points in lightly with a hammer, just enough to immobilize the plank without damaging it.
Check that the plank doesn't move by applying slight pressure on the edges.

📌 **Tip:** If the plank is too thin, use double-sided tape to hold it in place without causing damage.

Verification before proceeding to the next step
✅ The plank is well-secured and does not move.
✅ The points do not obstruct the marking of the arcs and jointing angles.
✅ The work surface is flat and stable to avoid measurement errors.

2

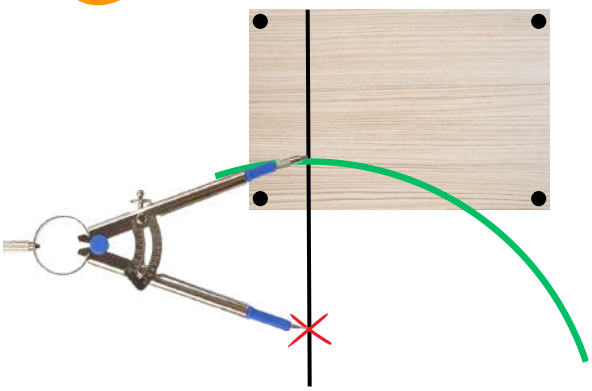
Position the ruler on the plank to draw a clean, continuous straight line.
Draw a straight line, ensuring it's longer than the bilge radius. (Here, 34.5 cm).

- This line can extend past the workbench.

Verification before proceeding to the next step
✅ The line is clearly visible and continuous across the entire plank.
✅ It is longer than the bilge radius.
✅ It is perfectly straight, with no deviation or wavering.

ATTENTION: The thickness of the plank has a direct impact on precision.

3



Mark a point on the reference line.

- This point will be the center of your circle
- This is represented by a red cross in the diagram.

Set your compass to the head radius.

- For a 225 L barrel, this is 28.5 cm
- Double-check the measurement with a ruler for accuracy.

Place the point of the compass on the red cross.

- Hold the compass firmly to prevent any deviation.

Draw the arc

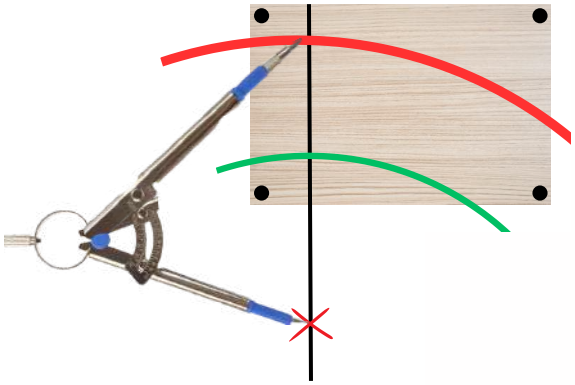
- The arc should be clean and well-defined, representing the doling radius at the head.

Verifications Before Proceeding to the Next Step
✅ The red cross is clearly visible and properly positioned on the line.
✅ The green arc is correctly drawn with a precise radius of 28.5 cm.
✅ The line is clean and shows no shifting.

The Jointing Key

03 Making a Gauge

4



Use the same red cross (the reference point defined in the previous step).

- This point remains the center of your marking, as the jointing key rests on the same axis.

Set your compass to the bilge radius.

- For a 225 L barrel, this is 34.5 cm.
- Double-check the measurement with a ruler.

Place the point of the compass on the red cross.

- Make sure it's stable before you start drawing.

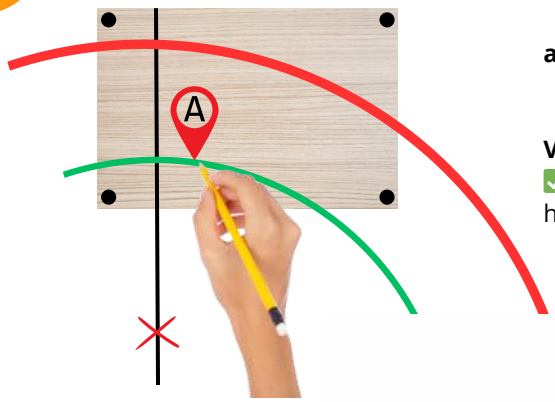
Draw a second arc.

- This arc should be wider than the first, respecting the difference in diameters.

Verifications Before Proceeding to the Next Step

✅ The red cross is correctly used as the central point.
✅ The bilge arc (shown in red in the example) is correctly drawn with a precise radius of 34.5 cm.
✅ The two arcs (head and bilge) are aligned and do not cross.

5

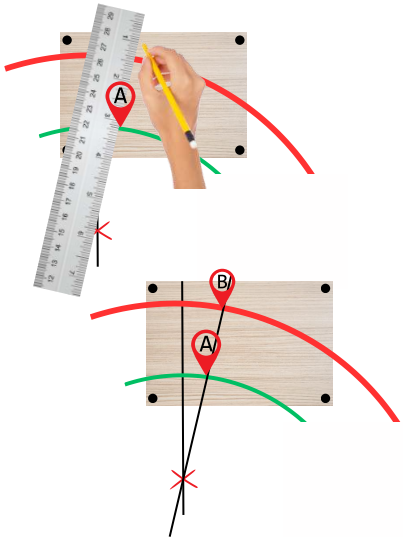


Mark point A at a distance of 3 cm from the central axis on the head arc.

Verifications Before Proceeding to the Next Step

✅ Point A is correctly marked 3 cm from the axis on the head arc.

6



Position the ruler from the center to the bilge arc.

- Align the ruler starting from the red cross (center), passing through point A, and extending to the bilge arc.

Draw a continuous straight line.

- This line must intersect the bilge arc at a specific spot, thus forming point B.

Mark point B on the bilge arc.

- This point B represents the exact alignment of the stave between the head arc and the bilge arc.

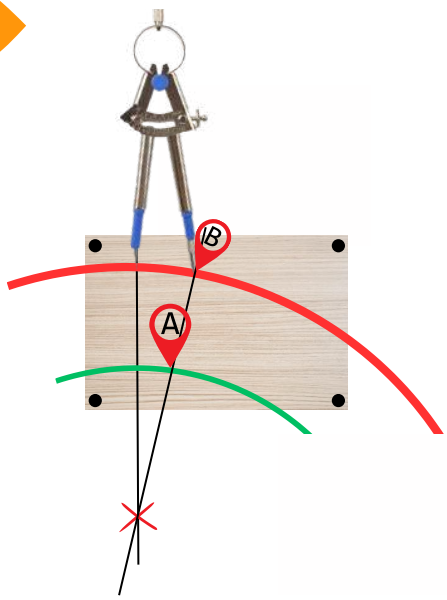
Verifications Before Proceeding to the Next Step

✅ The line correctly passes through the center, point A, and reaches the bilge arc.

The Jointing Key

03 Making a Gauge

7



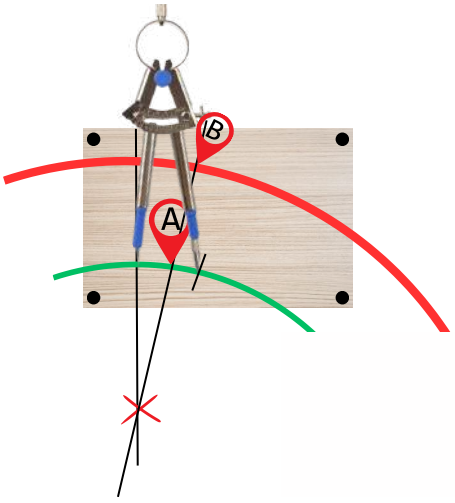
Open the compass to the distance between the axis and point B.

- Place the compass point on the central axis at **the bilge arc**.
- Open the compass until the pencil reaches point B on the bilge arc.
- Ouvrir le compas jusqu'au point B sur l'arc de bouge.
  Transfer this distance to the head arc.
- Without changing the compass's opening
- Place the compass point on the central axis, this time at **the head arc**.
- Draw a light arc to mark the new point on the head arc.

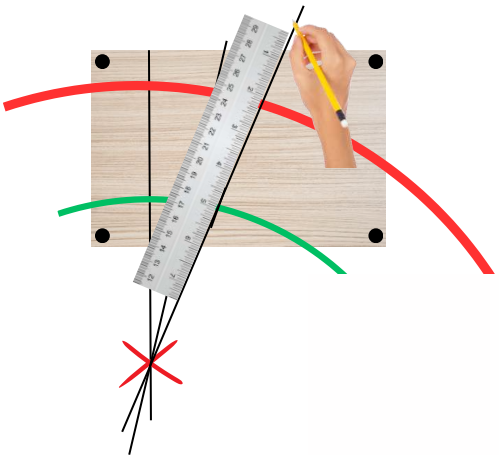
Clearly mark the resulting point and draw a straight line through the center.

Verifications Before Proceeding to the Next Step

✅ The distance between the axis and point B on the bilge arc has been correctly measured.
✅ This distance has been accurately transferred to the head arc with the compass.
✅ The new point on the head arc is clearly identified.

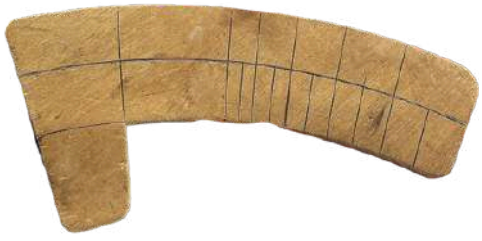


Clearly Marking the New Point



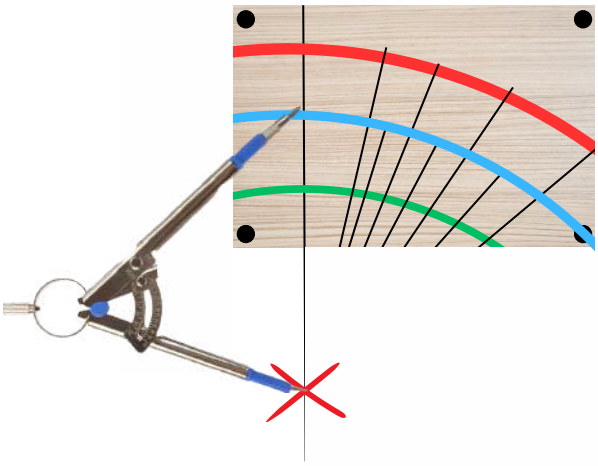
Draw a Continuous Line

Repeat Steps 6 and 7 as many times as necessary to obtain a sufficient number of graduations.



The Jointing Key

03 Making a Gauge



Method for Drawing this Supplementary Arc

Position the compass at the center of the axis.

- Open the compass to a distance halfway between the bilge arc and the head arc

Draw a new arc.

- This new arc will serve as a visual guide to organize the marking of the lines.
- It must be perfectly concentric to the other arcs.

Regulate the visibility of the markings.

- When you draw the lines from the center, stop every other line on this supplementary arc.
- This avoids an over-concentration of lines at the beginning of the key and improves the readability of the diagram.

📌 **Tip:** For a clean finish, use a different color for this arc to distinguish it well.

Expected Result

✅ A clearer and more readable diagram.
✅ Less confusion in the closely spaced lines at the beginning of the key.
✅ Better organization of the markers for cutting.

Information to Inscribe on the Jointing Key

- Cask Volume → Example: 225L, 500L, etc.
- Head Diameter → Example: ∅T = 57 cm
- Bilge Diameter → Example : ∅B = 69 cm
- Head Radius → Example : RT = 28,5 cm
- Bilge Radius → Example : RB = 34,5 cm
- Bilge development → Example : dvB≈ 216,7 cm for a 225L cask.

Expected Result

✅ A clear and well-identified key.
✅ Time saving during use.
✅ An assurance that the dimensions are respected before assembly.

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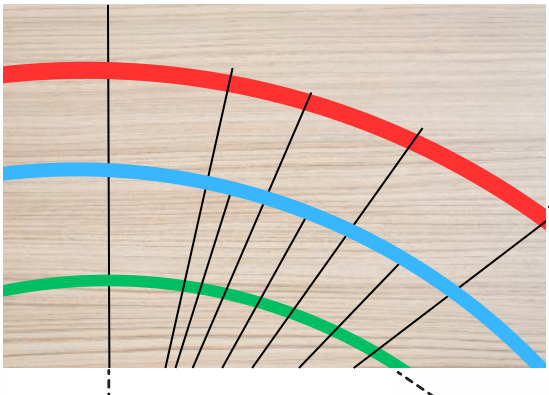
03 Making a Gauge



Cut Along the Bilge Diameter

- Follow the bilge arc exactly to the intersection with the central axis.
- Use a fine saw or a scroll saw to respect the curvature.
- Check that the cut remains clean and regular.

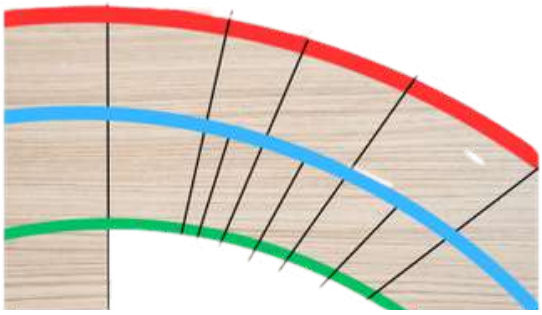
Cut Along the Head Diameter to the Intersection with the Axis

- Follow the head diameter arc precisely to its intersection with the axis.
- This cut must be made carefully to ensure a fluid and uninterrupted curvature.

Cut Along the Central Axis to the Intersection with the Head Diameter Arc

- Cut in a straight line starting from the center.
- Stop precisely at the intersection with the head diameter arc.
- Do not go past this point to avoid any proportion error.

Expected Result

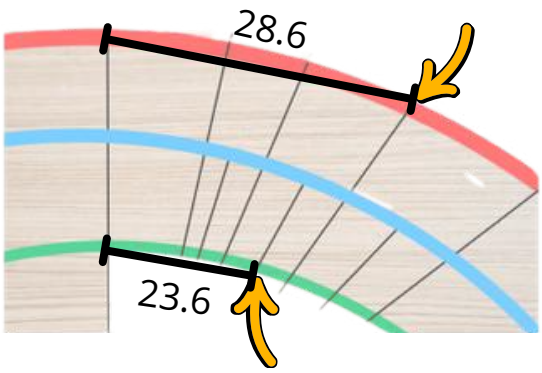


Verifications Before Proceeding to the Next Step

✅ The dimensions and angles are precise.
✅ The cuts are clean, precise, and conform to the markings.
✅ The bilge and head curves are accurately followed.

The Jointing Key

04 Checking the Gauge



Choosing Two Aligned Lines

- Select a line on the head arc..
- Select **the immediately following line** on the bilge arc (and not a more distant line).

Measure the Corresponding Distances

- 📏 Measure the distance between the central axis and the selected line on the head arc.
- 📏 Measure the distance between the central axis and the immediately following line on the bilge arc.

Calculate the Reduction Coefficient

$$K = \frac{\text{Distance measured on the head arc}}{\text{Distance measured on the bilge arc}}$$

Verify the Consistency of the Values

💡 **Simplified Summary:**

- ✅ **If Kmeasured ≈ Kinitial** → The trace is correct, the key is valid.
- ❌ **If Kmeasured ≠ Kinitial** → Error in trace, requires correction.

Exemple Concret de Vérification de la Clef de Jointage pour une Barrique de 225L

🔍 **Contexte :**

Nous avons une barrique de **225L** avec :

- **Diamètre en tête** : 57 cm
- **Diamètre en bouge** : 69 cm
- **Coefficient réducteur théorique** : $K = \frac{R_t}{R_b} = \frac{28.5}{34.5} \approx 0.826$

L'objectif est de **vérifier la précision de la clef de jointage** avant son utilisation.

1️⃣ Étape 1 : Mesurer la Distance Réelle sur la Clef

1. Placer la clef sur une surface plane et bien stabilisée.
2. Avec une **règle graduée ou un pied à coulisse**, mesurer la distance entre :
   - L'axe central et un trait sur l'arc de tête → ex. 23.6 cm
   - L'axe central et le trait correspondant sur l'arc de bouge → ex. 28.6 cm

2️⃣ Étape 2 : Calcul du Coefficient Réducteur Mesuré

🔍 📌 **Formule :**

$$K_{\text{mesuré}} = \frac{\text{Distance mesurée sur l'arc de tête}}{\text{Distance mesurée sur l'arc de bouge}}$$

$$K_{\text{mesuré}} = \frac{23.6}{28.6} = 0.825$$

3️⃣ Étape 3 : Comparaison avec le Coefficient Théorique

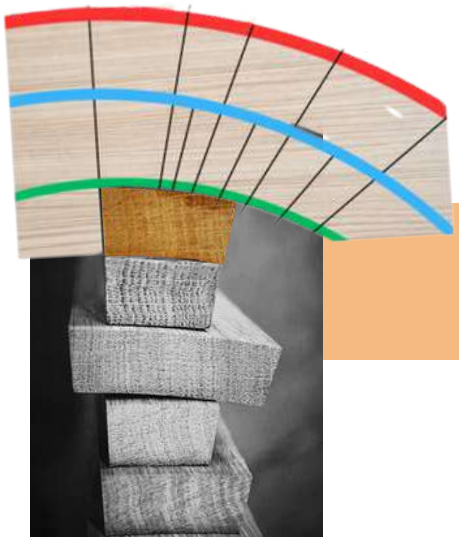
✅ Si $K_{\text{mesuré}} \approx K_{\text{théorique}}$ (ex. : 0.825 ≈ 0.826)
➡️ **Le tracé est correct, la clef est validée.**

❌ Si $K_{\text{mesuré}} \neq K_{\text{théorique}}$ (écart supérieur à 0.01)
➡️ **Erreur détectée, nécessite une correction** (ponçage léger, ajustement du tracé).

The Jointing Key

05

Using the Gauge

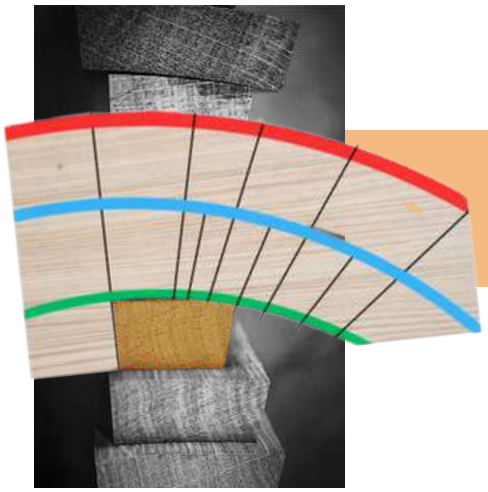


📌 **Verification of the Jointing Key's Use - Example 1**

In the adjacent example, the jointing key is placed on a stave to check its positioning.

✅ **We observe that the stave's width at the head is located between the 4th and 5th marks on the key.**
✅ **Applying the rule of proportion, the width at the bilge of the same stave must then be positioned between the 5th and 6th marks.**

The stave's angle is pressed firmly against the central axis of the key, ensuring correct alignment and a uniform distribution of the staves.



📌**Verification of the Jointing Key - Example 2**

In the adjacent example, the stave is positioned so that its width at the head corresponds exactly to the 4th mark of the jointing key.

✅ **According to the logic of proportionality, the width at the bilge of the same stave must then be located on the 5th mark of the key.**

The stave's angle is pressed against the central axis of the key, ensuring precise alignment and good positioning to ensure a regular distribution of the staves around the barrel.

📌 Advantages and Disadvantages of the Jointing Gauge

The use of **the jointing gauge** has both **advantages** and **disadvantages** that are important to know in order to optimize its use.

✅ Advantages of the Gauge

✔ **Quick marking** → Allows for the rapid marking of the necessary reference points for jointing the staves.
✔ **Ease of use** → Easy to handle, it does not require complex adjustments.
✔ **Accessible tool** → Does not require advanced calculations or precise settings to be used effectively.

❌ Disadvantages of the Gauge

⚠ **Limited precision** → The marking lacks finesse, which can lead to variations.

⚠ **Dependence on the heading** → The only reference taken into account is **the heading**, which can lead to deviations at the bilge.

It's now up to you to practice and perfect your craftsmanship!