Thapar Institute of Engineering & Technology – Patiala

# Manufacturing Processes
# UTA026

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# UTA026

## RESISTANCE WELDING
## Lecture - 27

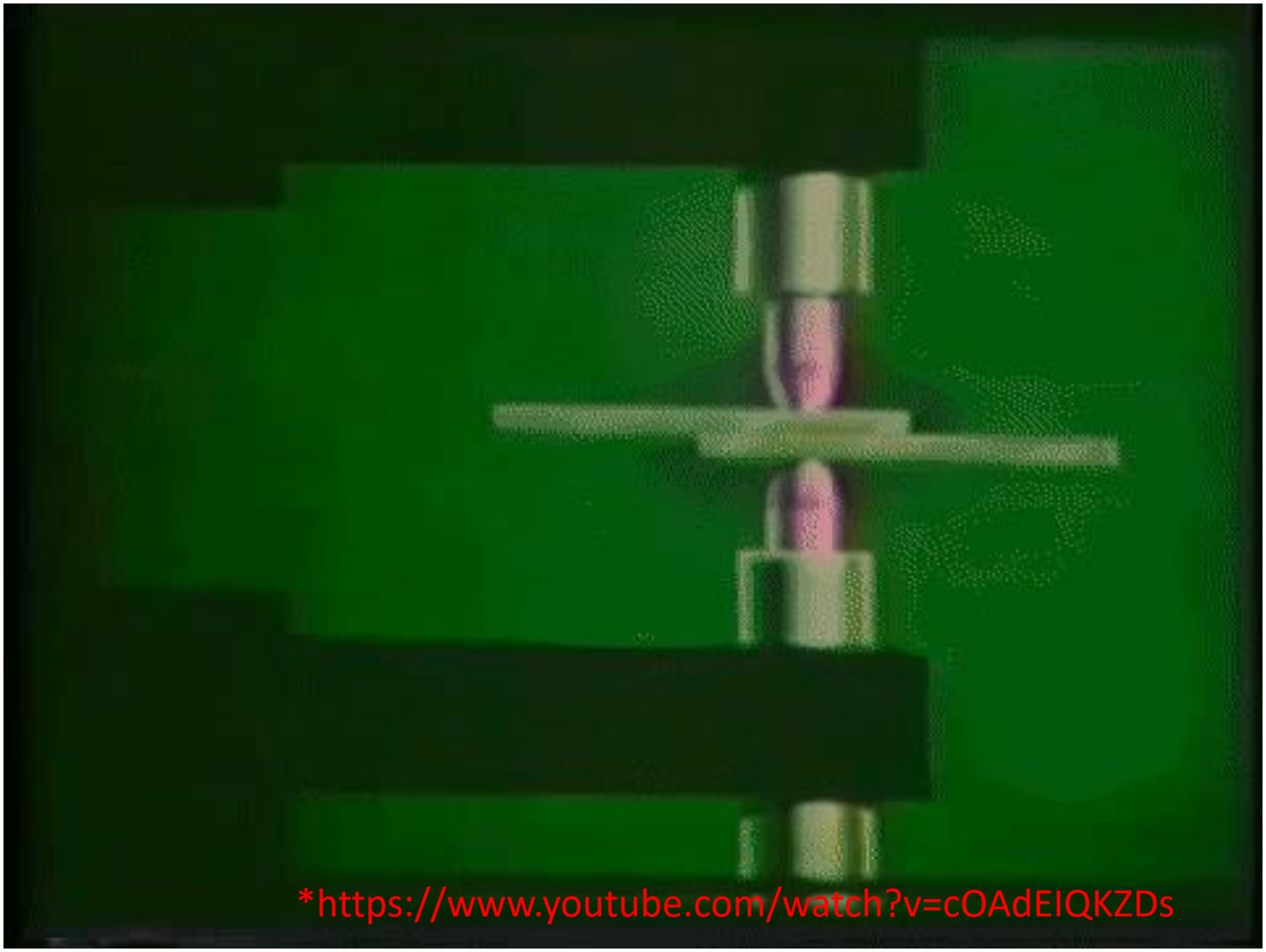
# Resistance Welding (RW)

- **Resistance Welding** is a welding process, in which work pieces are welded due to a **combination** of a **pressure** applied to them and a localized **heat** generated by a high electric **current** flowing through the contact area of the weld.

- The weld is made by a combination of ***HEAT***, ***PRESSURE***, and ***TIME***.

- ***Resistance*** of the material is used for welding by current flow which causes a ***localized heating*** in the part.

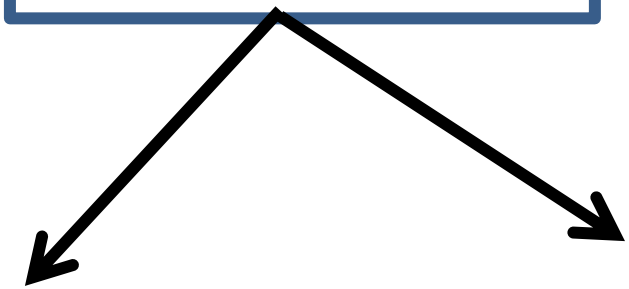
# Resistance Welding (RW)



# Resistance Welding (RW)

- The heat generated in resistance welding

$$H = I^2 R\, t \qquad (1)$$



$H_w$

***Heat used to form weld Nugget***

***say 60%***

$H_L$

***Heat lost into the work metal, electrodes, and surrounding air***

***say 40%***

# Resistance Welding (RW)

- Therefore the heat generated in resistance welding ***which is used to form the weld nugget*** can be expressed as

$$H = k I^2 R t \qquad (2)$$

  - ***H*** = the total heat generated in the work, J
  - ***I*** = electric current, A
  - ***t*** = time for which the electric current is passing through the joint
  - ***R*** = the resistance of the joint, ohms
  - ***k***= a constant to account for the heat losses from the welded joint. (if ***k=0.6***, that means ***40%*** of the heat is lost into the work metal, electrodes, and surrounding air. )

# 4 Major Points of Resistance

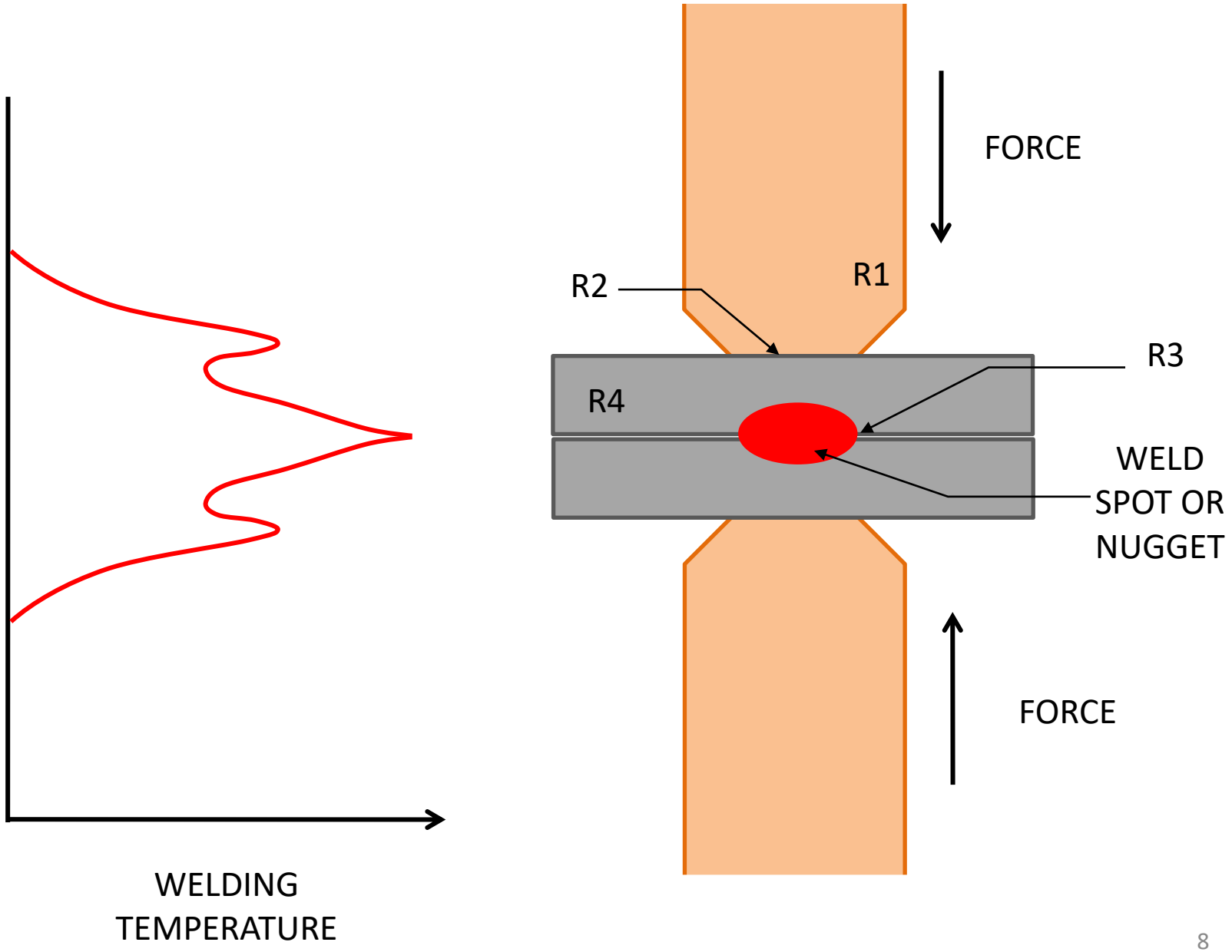
- There are 4 major points of resistance in the work area. They are as follows:

***(R1)*** Resistance of the electrodes.

***(R2)*** The contact resistance between the electrode and the workpiece.

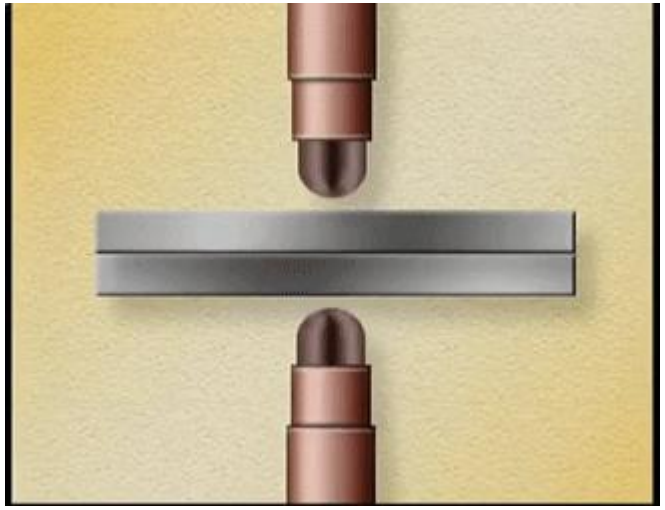
***(R3)*** The contact resistance between the two workpiece plates.

***(R4)*** The workpiece resistance.


FORCE
R1
R2
R3
R4
WELD
SPOT OR
NUGGET
FORCE
WELDING
TEMPERATURE

# Current Voltage

- AC low volt (typically 1 to 30 V ) electric current (1000–100,000 A) is supplied through **copper electrodes** connected to the secondary coil of a welding transformer.



https://gfycat.com/tattereddownrightbutterfly

# APPLICATIONS

- Resistance Welding (RW) is used for joining
  - **vehicle body parts,**
  - **fuel tanks,**
  - **domestic radiators,**
  - **pipes of gas oil and water pipelines,**
  - **wire ends,**
  - **turbine blades etc.**

*SHEET METAL PRODUCTS*

# Metals Welded

- The following metals may be welded by Resistance Welding:
  - ***Low carbon steels*** - the widest application of Resistance Welding
  - ***Aluminum alloys***
  - ***Medium carbon steels, high carbon steels and Alloy steels***

# ADVANTAGES

- High welding rates
- Low fumes
- Cost effectiveness
- Easy automation
- No filler materials are required
- Low distortions
- Good repeatability and reliability

# Types of Resistance Welding (RW)

The most popular methods of Resistance Welding are:

1. Spot Welding (RSW)
2. Seam Welding (RSEW)
3. Resistance Projection Welding (RPW)

# 1. Spot Welding (RSW)

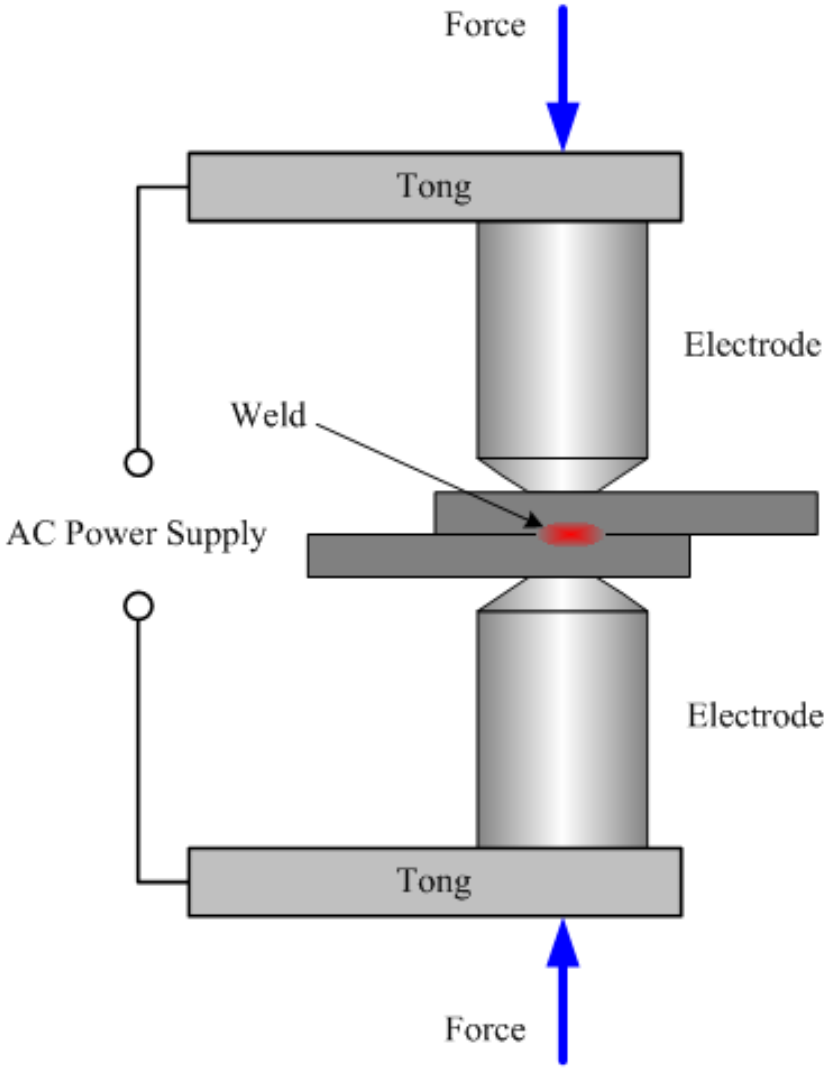
- **Spot Welding** is a Resistance Welding (RW) process, in which two or more overlapped metal sheets are joined by spot welds.

- The method uses pointed copper electrodes providing passage of electric current. The electrodes also transmit pressure required for formation of strong weld.

- ***Diameter*** of the weld spot is in the range - ***(3 - 12 mm).***

- Spot welding is widely used in ***automotive industry*** for joining vehicle body parts.

# 1. Spot Welding (RSW)



# 1. Spot Welding (RSW) - STEPS

- The sequence is as follows:

1. ***parts inserted*** between open electrodes,

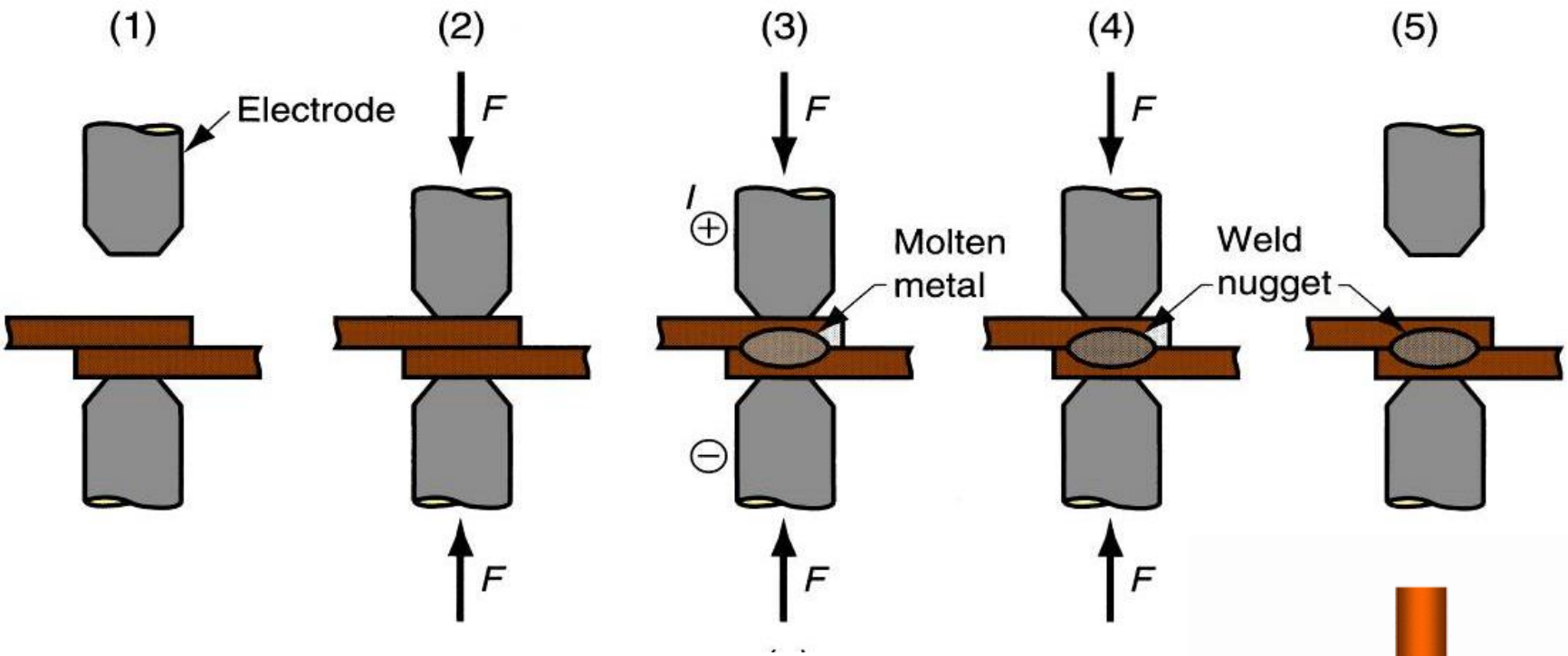
2. ***electrodes close*** and force is applied,

3. ***weld time—*** current is switched on,

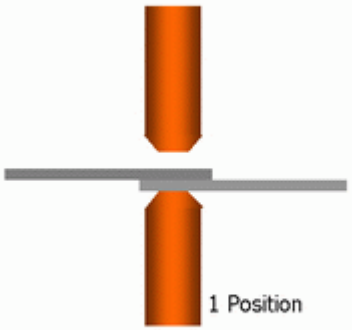
4. ***current is turned off*** but force is maintained or increased (a reduced current is sometimes applied near the end of this step for stress relief in the weld region), and

5. ***electrodes are opened***, and the welded assembly is removed.

# 1. Spot Welding (RSW) - STEPS

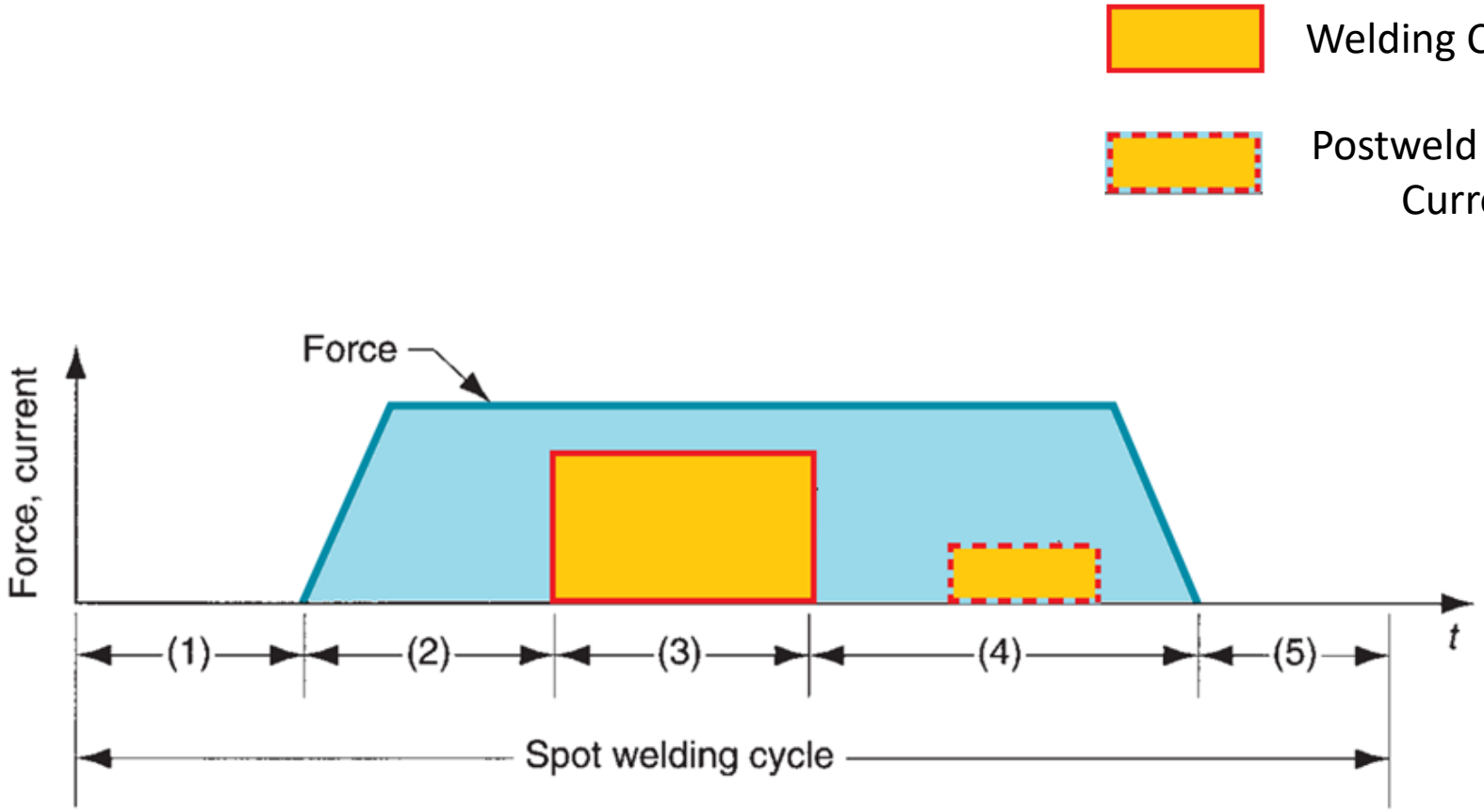



(1) parts inserted between electrodes, (2) electrodes close, force applied, (3) current on, (4) current off, (5) electrodes opened.




http://www.davidpageassociates.co.uk/spotweld.htm

# 1. Force, Current vs Time




(1) parts inserted between electrodes, (2) electrodes close, force applied, (3) current on, (4) current off, (5) electrodes opened.

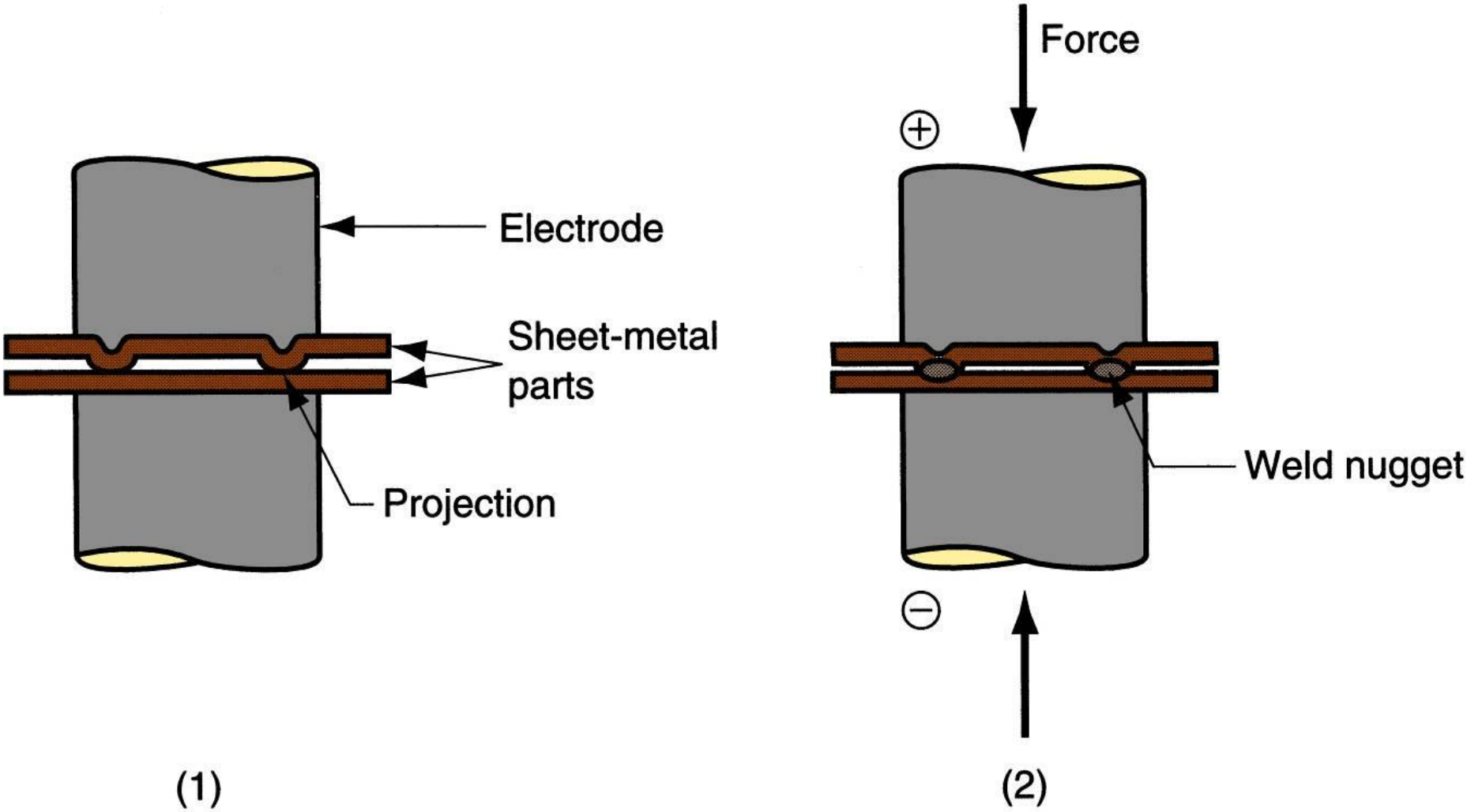
# 1. Spot Welding (RSW) - POSTWELD

- It has been observed that ***steels*** containing more than ***0.15% carbon*** may result into ***brittle weld joint*** during resistance welding.

- Therefore ***post-weld heating*** is sometimes applied to ***eliminate possible brittleness***.

# 2. Resistance Projection Welding (RPW)

- When **increased strength** is required, **multiple welds** are often needed, and this means multiple operations.
- Dimples are embossed into one of the workpieces at the location where a weld is desired.
- The two workpieces are then placed between large-area electrodes in a press machine, and pressure and current are applied as in spot welding.
- Since the current must flow through the points of contact (i.e., the dimples), the heating is concentrated where the weld is desired.

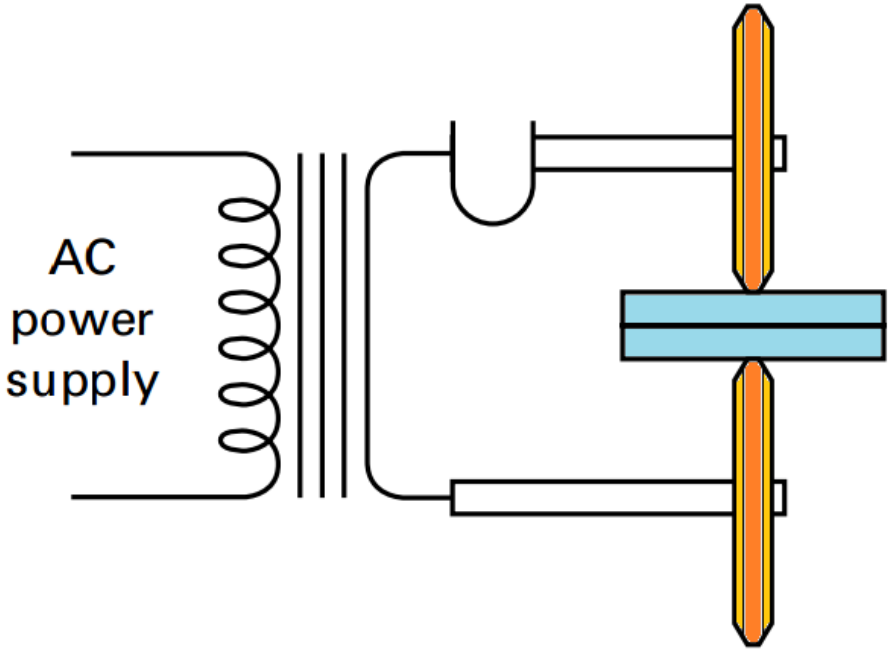


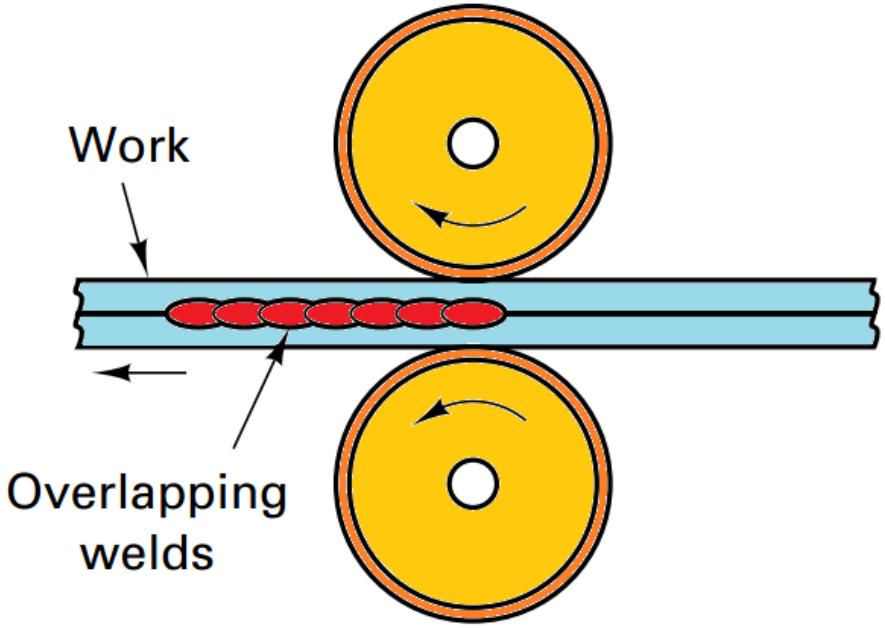

- Resistance projection welding (RPW): (1) start of operation, contact between parts is at projections; (2) when current is applied, weld nuggets similar to spot welding are formed at the projections.

# 3. Seam Welding (RSEW)

- **Seam Welding** is a Resistance Welding (RW) process of continuous joining of overlapping sheets by passing them between two rotating electrode wheels.
- Heat generated by the electric current flowing through the contact area and pressure provided by the wheels are sufficient to produce a **leak-tight weld**.
- Resistance seam welds (RSEW) can be made by ***two distinctly different processes***.

# 3. Seam Welding (RSEW)

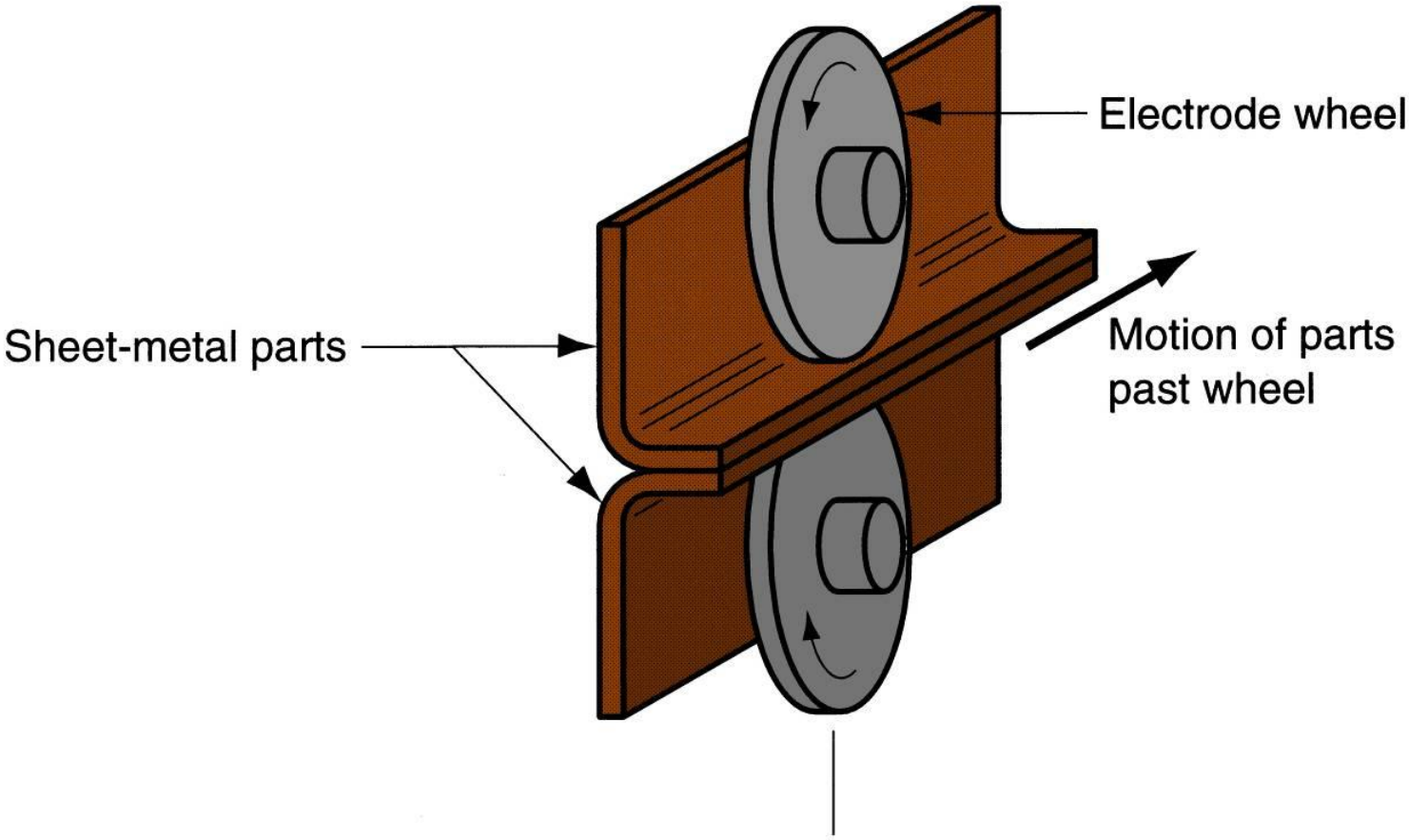




https://gfycat.com/gifs/search/resistance+welding

# 3. Seam Welding (RSEW)



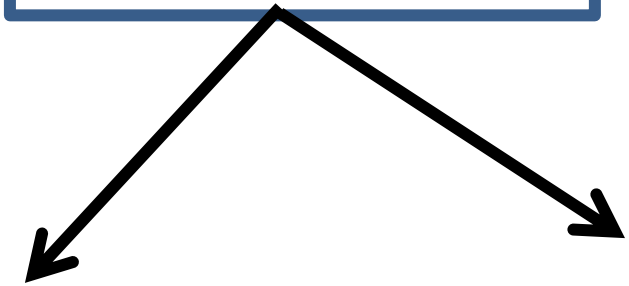
# 3. Seam Welding (RSEW)

- Seam Welding is high speed and clean process, which is used when continuous tight weld is required .
- Can produce air-tight joints
- ***Applications:***
  - ***Gasoline tanks***
  - ***Automobile mufflers***
  - ***Various other sheet metal containers***

# Resistance Welding Numerical (RW)

- The heat generated in resistance welding

$$H = I^2 R\, t \qquad (1)$$



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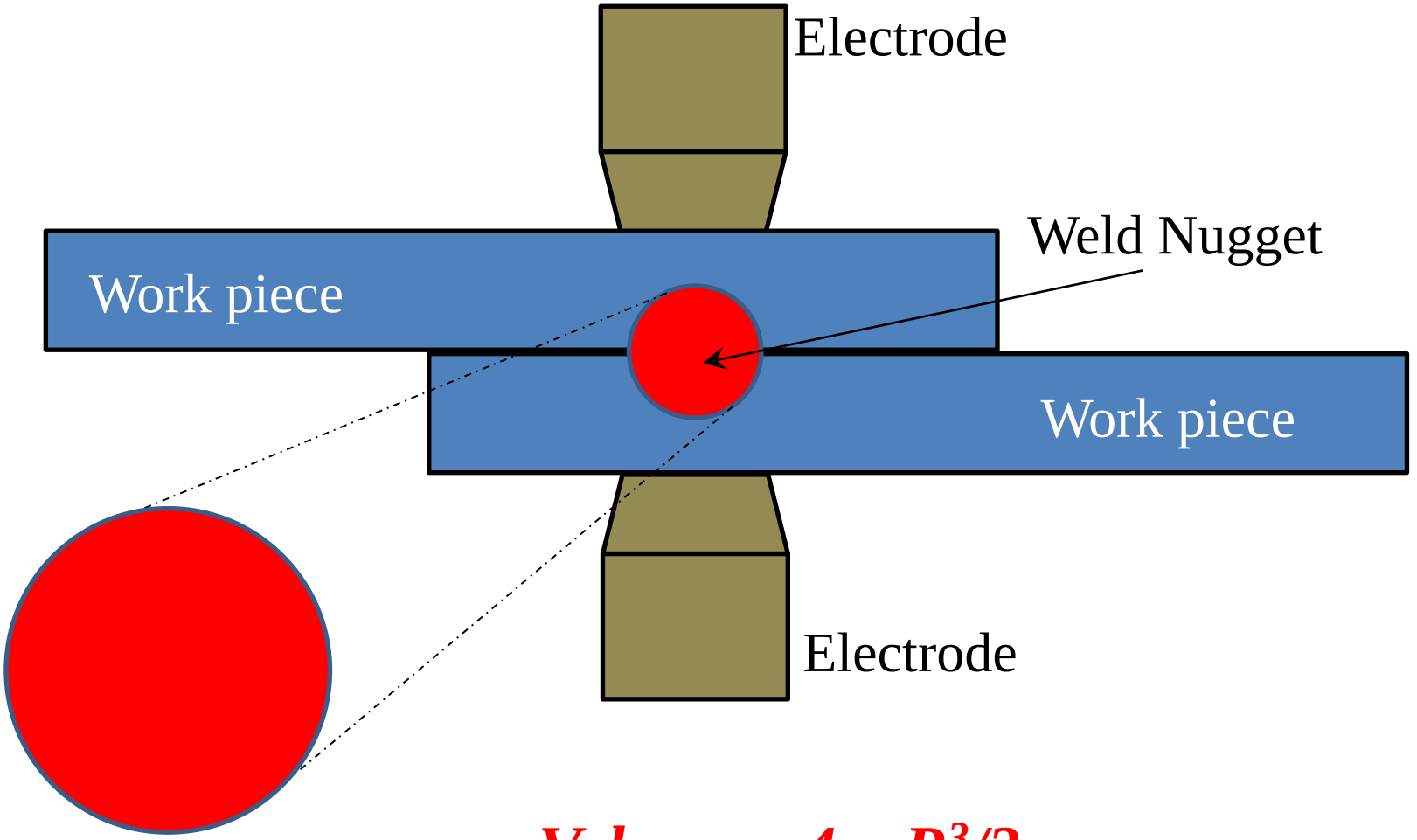
# NUMERICAL- Q

- A resistance spot-welding operation is performed on two pieces of 3.5-mm-thick sheet steel using ***12,000A*** for a ***0.20 s*** duration. The electrodes are 7 mm in diameter at the contacting surfaces. Resistance is assumed to be ***0.0001 Ω*** , and the resulting weld nugget is a ***sphere*** of ***6 mm*** in diameter. The unit melting energy for the metal ***U=12.0 J/ mm$^3$***. What portion of the heat generated was used to form the weld nugget, and what portion was dissipated into the work metal, electrodes, and surrounding air?

# NUMERICAL- Ans




***Volume = 4 π $R^3$/3***

# NUMERICAL- Ans

- The heat generated in the operation ***(H)***

$$H = I^2 R\, t$$

$$H = (12000)^2 \times 0.0001 \times 0.20$$

$$H = 2880\ J$$

# NUMERICAL- Ans

- Volume of weld nugget = vol of sphere with a diameter of 6 mm

$$= \frac{4}{3} \pi R^3$$

$$= 4/3 \times 3.14 \times (3)^3$$

$$= 113.04\ mm^3$$

# NUMERICAL- Ans

- Heat required to weld the nugget $(H_W)$ = vol X U

$$= 113.04 \times 12$$

$$= 1356.48\ J$$

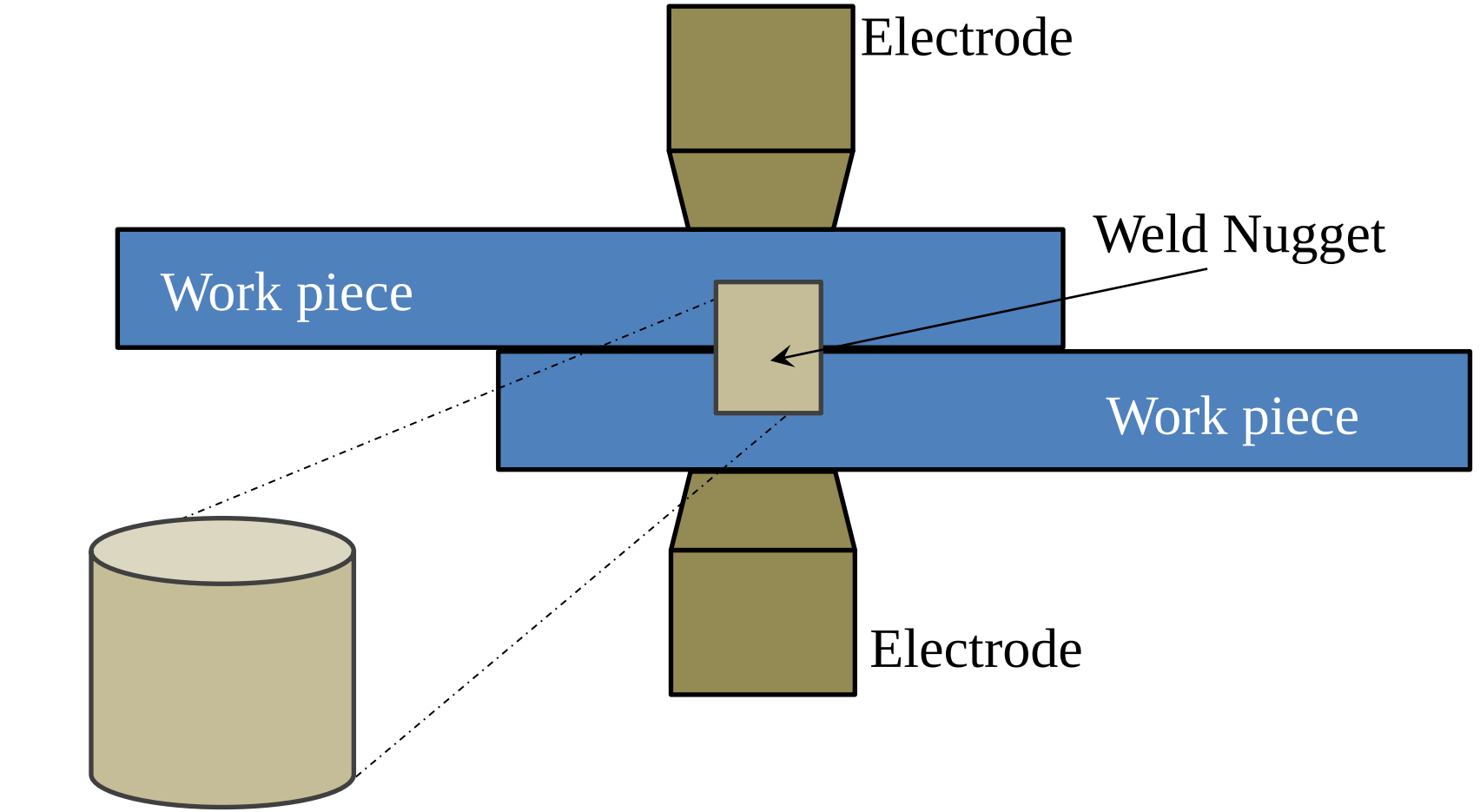
# NUMERICAL- Ans

- Heat Lost $(H_L) = (H) - (H_W)$

$$= 2880 - 1356.48$$

$$= 1523.52\ J$$

# NUMERICAL-




$$Volume = \pi R^2 h$$

# References: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- Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8th ed.
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- https://gfycat.com/gifs/search/resistance+welding

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# Thanks!!