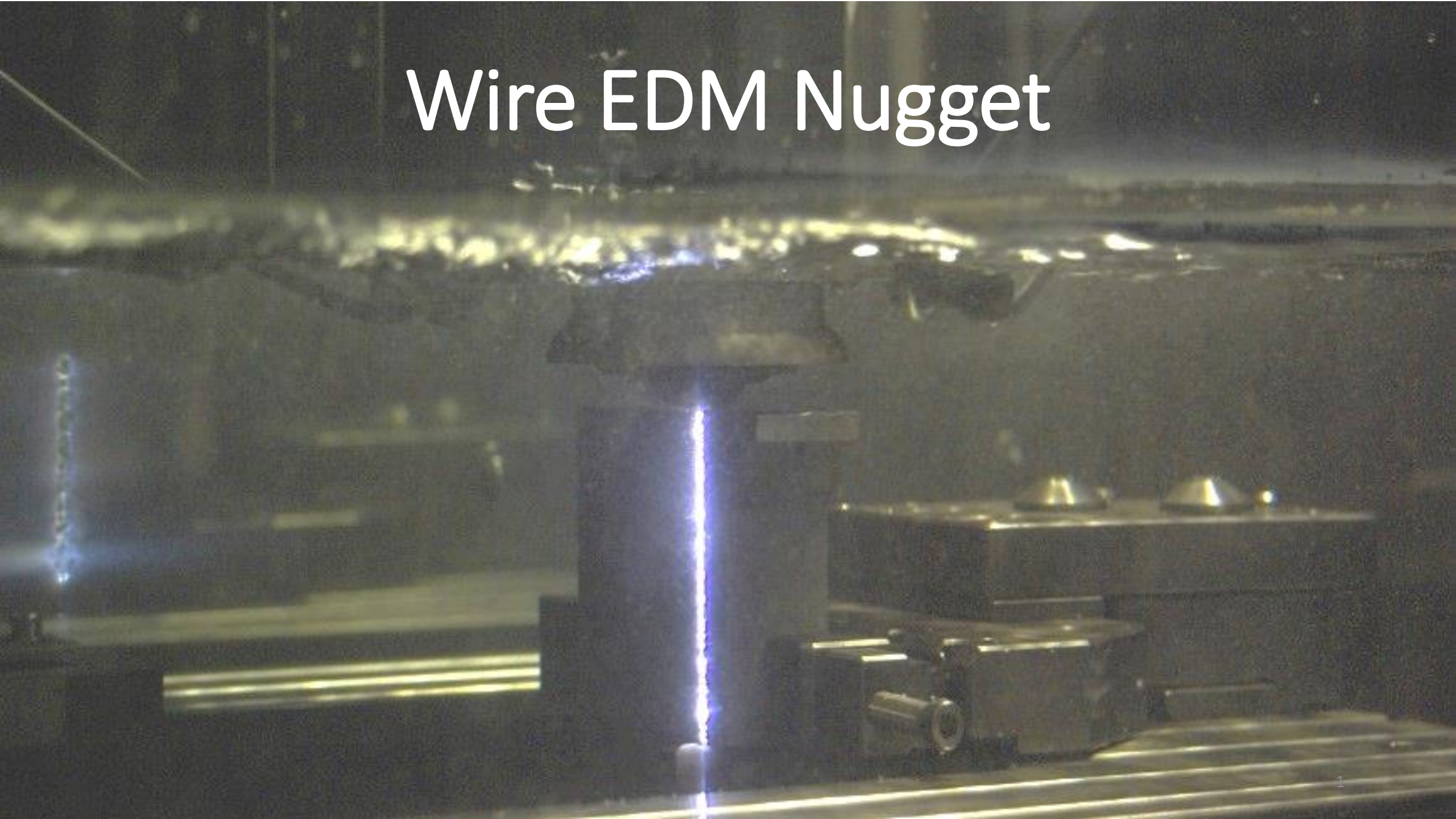
Wire EDM Nugget

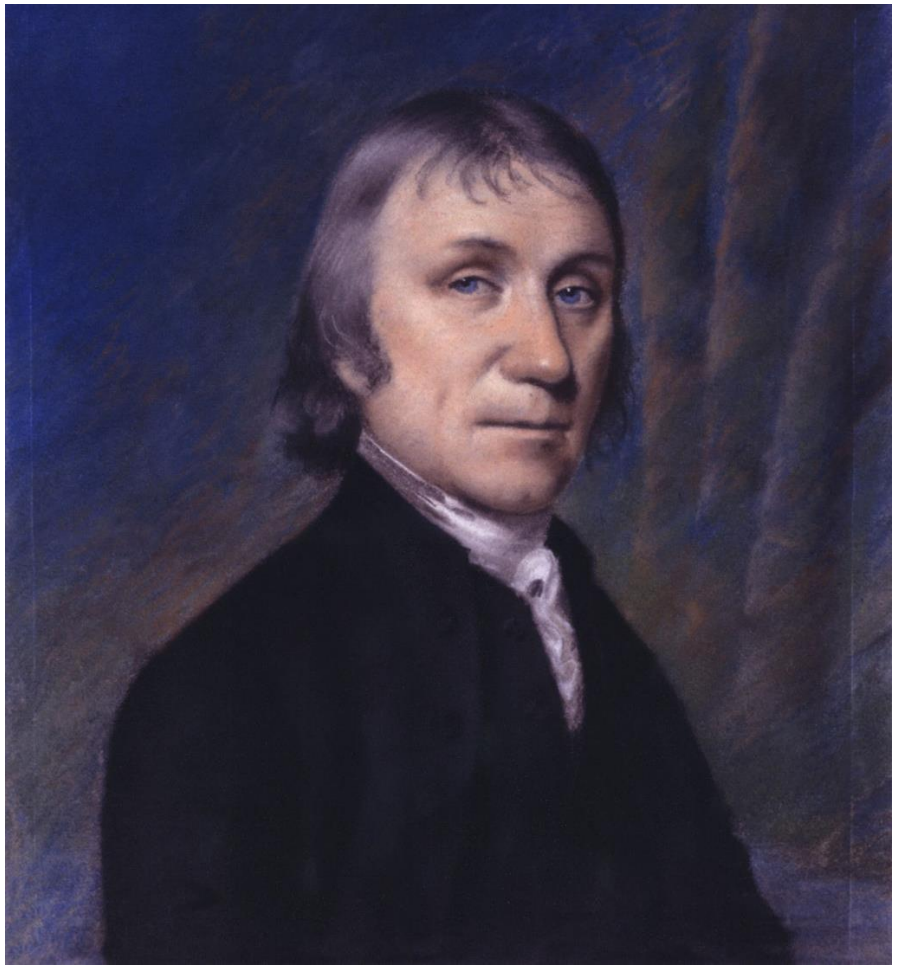


Agenda

- EDM History
- Wire EDM capabilities & overview
- Material removal mechanism

History

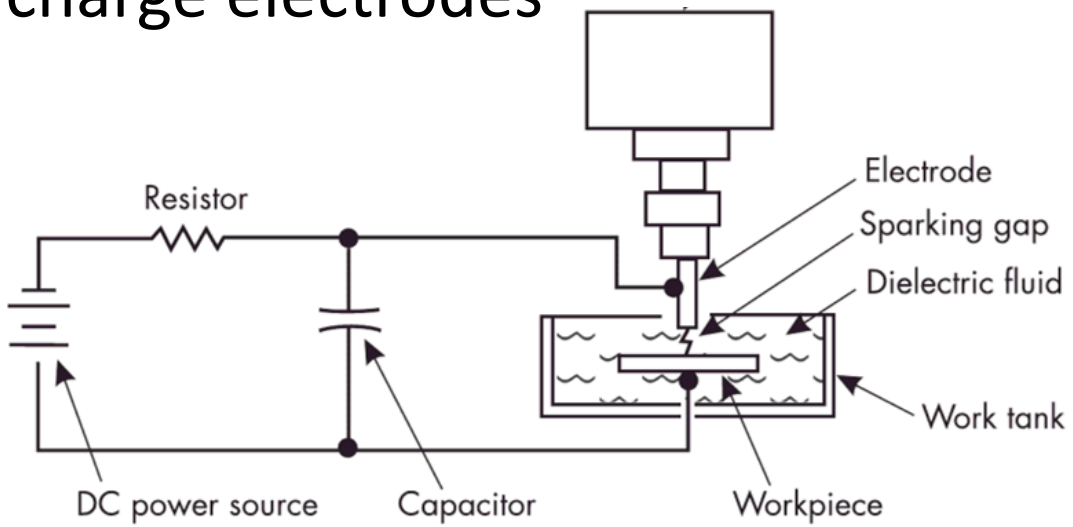
- 1770: English physicist Joseph Priestly notes the erosive effect of electrical discharges



WWII: First Sink EDMs

- In USSR, scientists learn to control erosion by immersing electrodes in a dielectric
- Invented a sink EDM to machine tungsten and other hard materials
- RC circuit to charge electrodes

- American team independently develops machine to remove broken drills and taps from castings
- Many machines built and used in USA during WWII



Post WWII

- EDM quickly accepted in Europe and Japan
- US slow to accept new process
- **1954**: First commercial die-sink EDM released by Charmilles (Swiss)
- Most EDMs manufactured in Europe

1960’s & 1970’s: Development of Wire EDM

- Dies for sink EDMs were labor-intensive & expensive
- Logical to use wire as electrode
  - Necessary for wire to continuously travel past surface during machining
- Many technological developments made wire EDM practical:
  - Computer Numerical Control
  - Ball screws & anti-friction ways
  - Servo motors with encoder & tachometer feedback
- **1967**: first commercial wire EDM produced in Soviet Union

In a nutshell: like a super-precision band saw

- Accuracies up to ~1 µm
- Cuts any conductive workpiece
- Material hardness not a factor
- Burr free
- Perfectly straight machining
- Non-contact, force-free
  - Except for forces from flushing jets
- Eliminates mechanical distortion
  - Can produce large aspect ratios

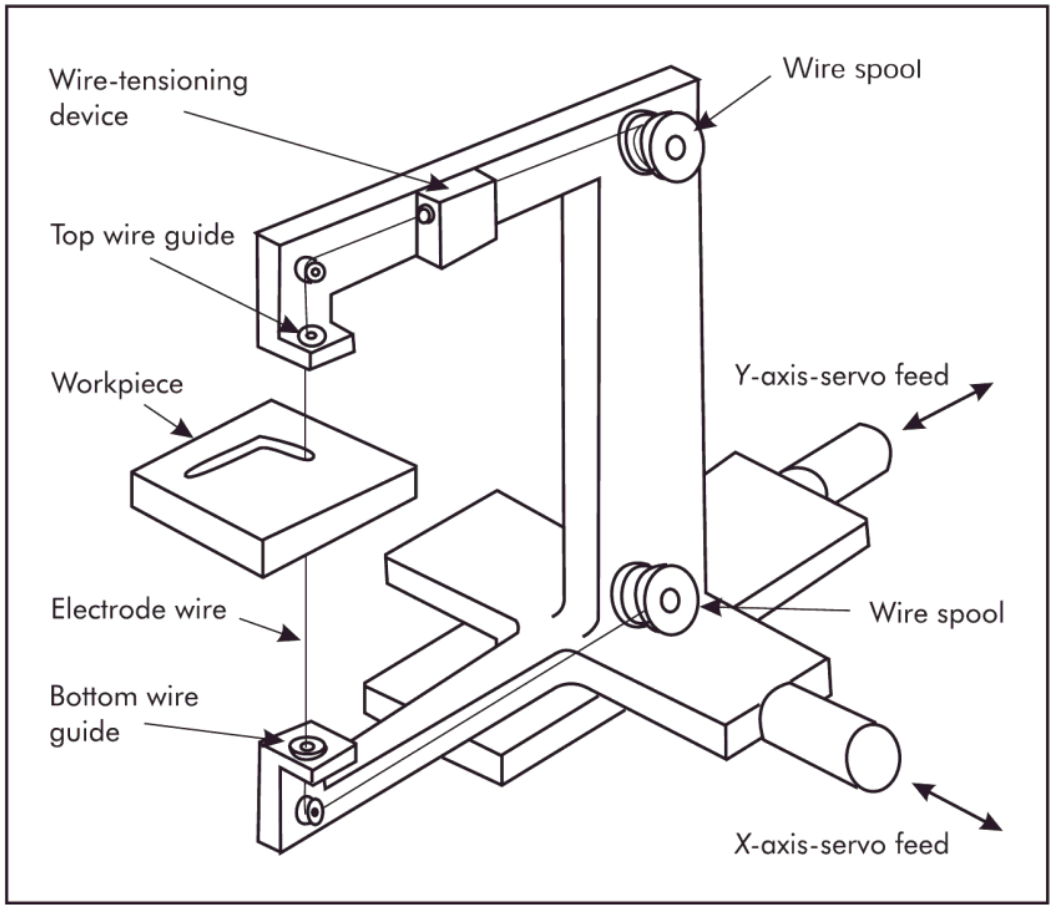


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Four Axis: independent top & bottom profiles

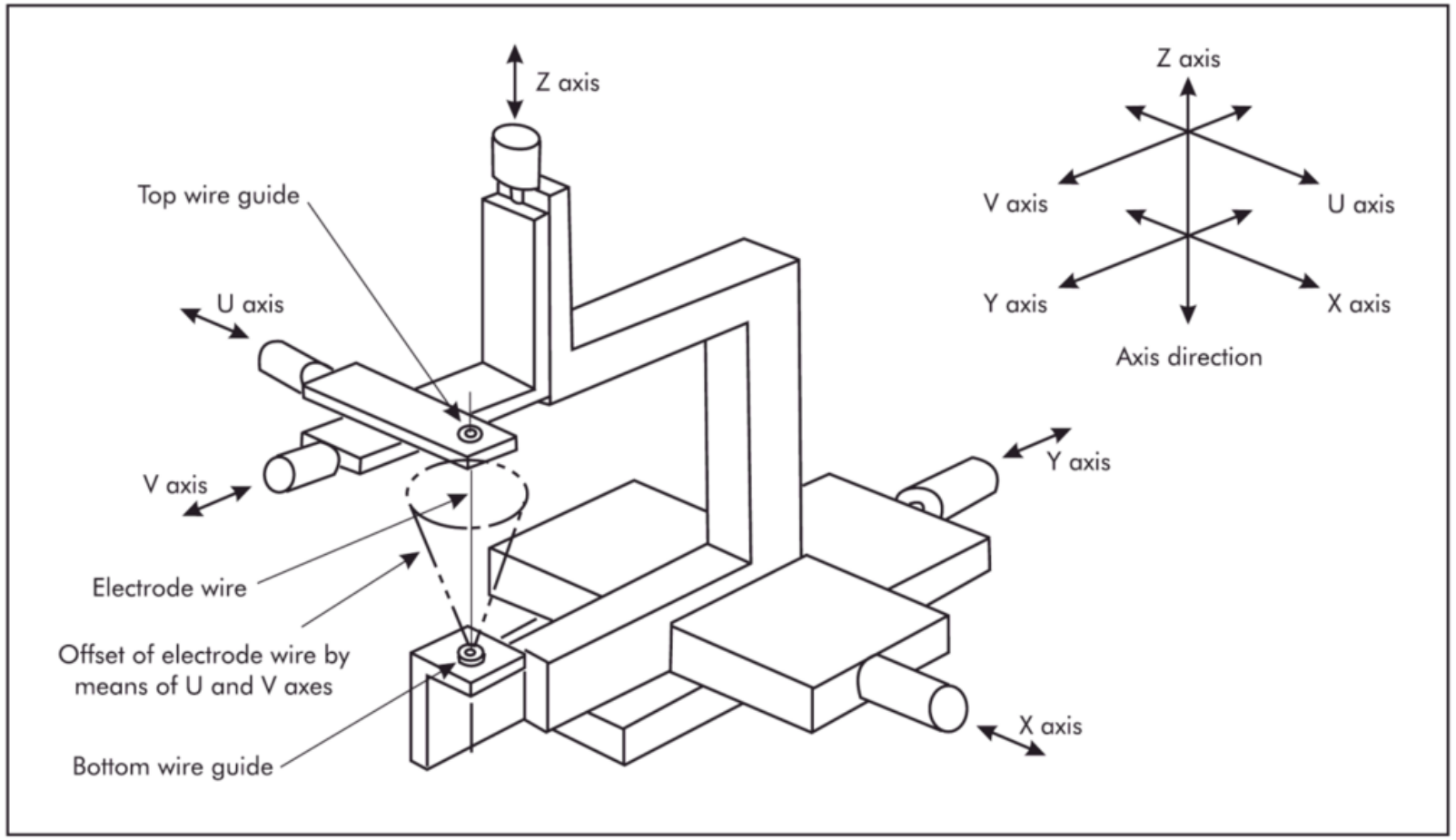
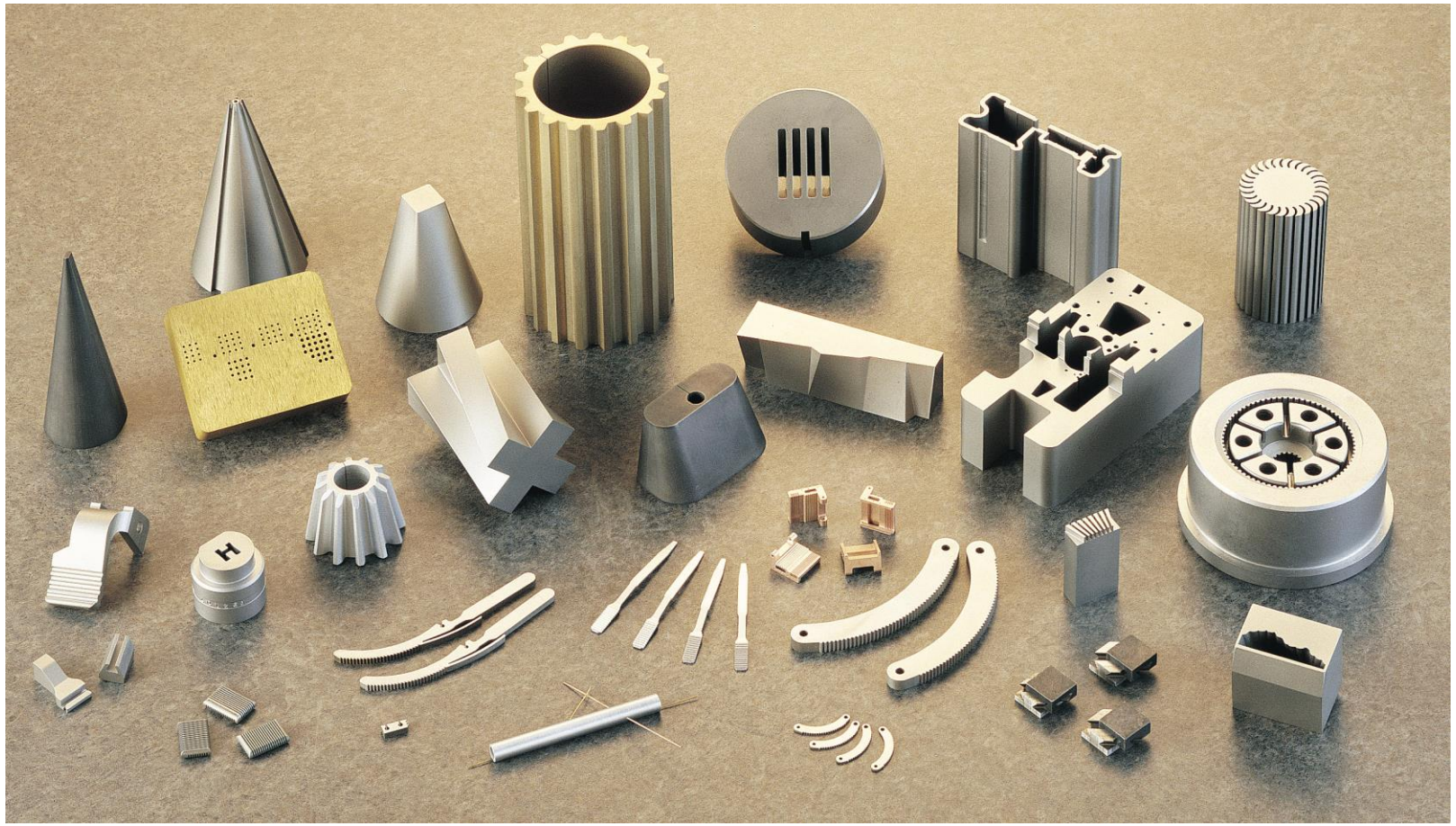


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Widely used to make dies and prototypes



Anatomy of a wire EDM

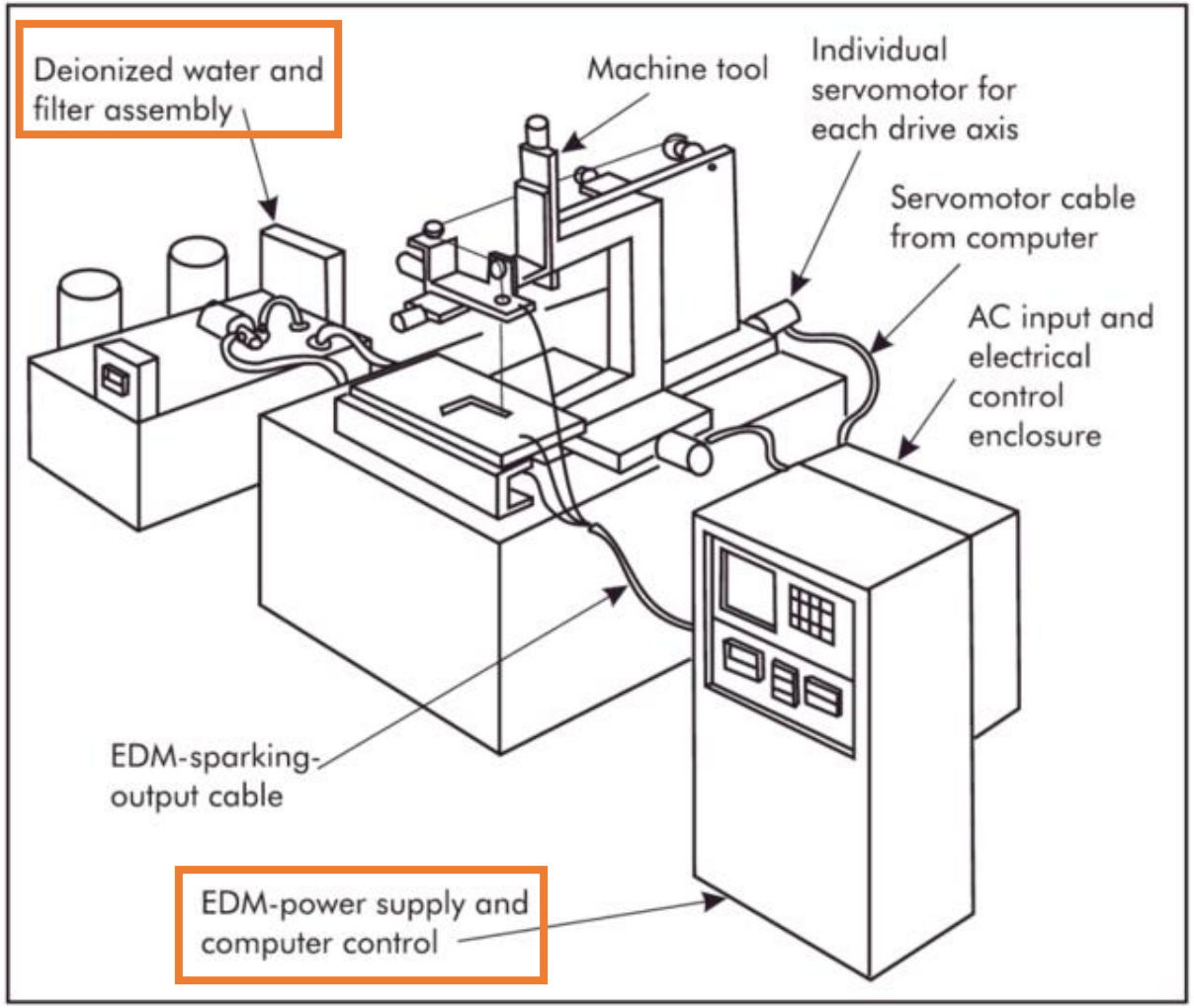


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Dielectric fluid acts as an insulator

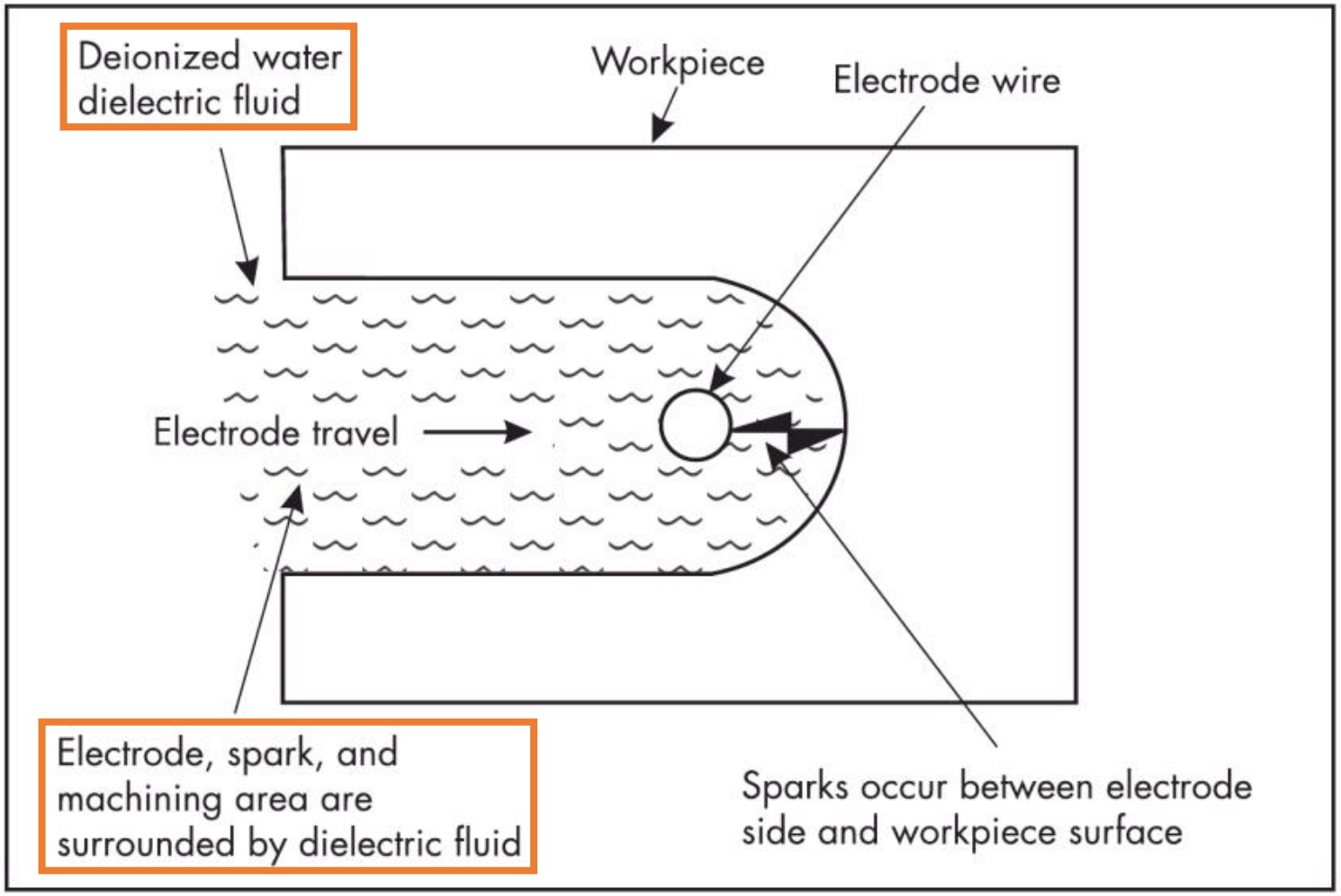


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

With sufficient voltage, dielectric ionizes

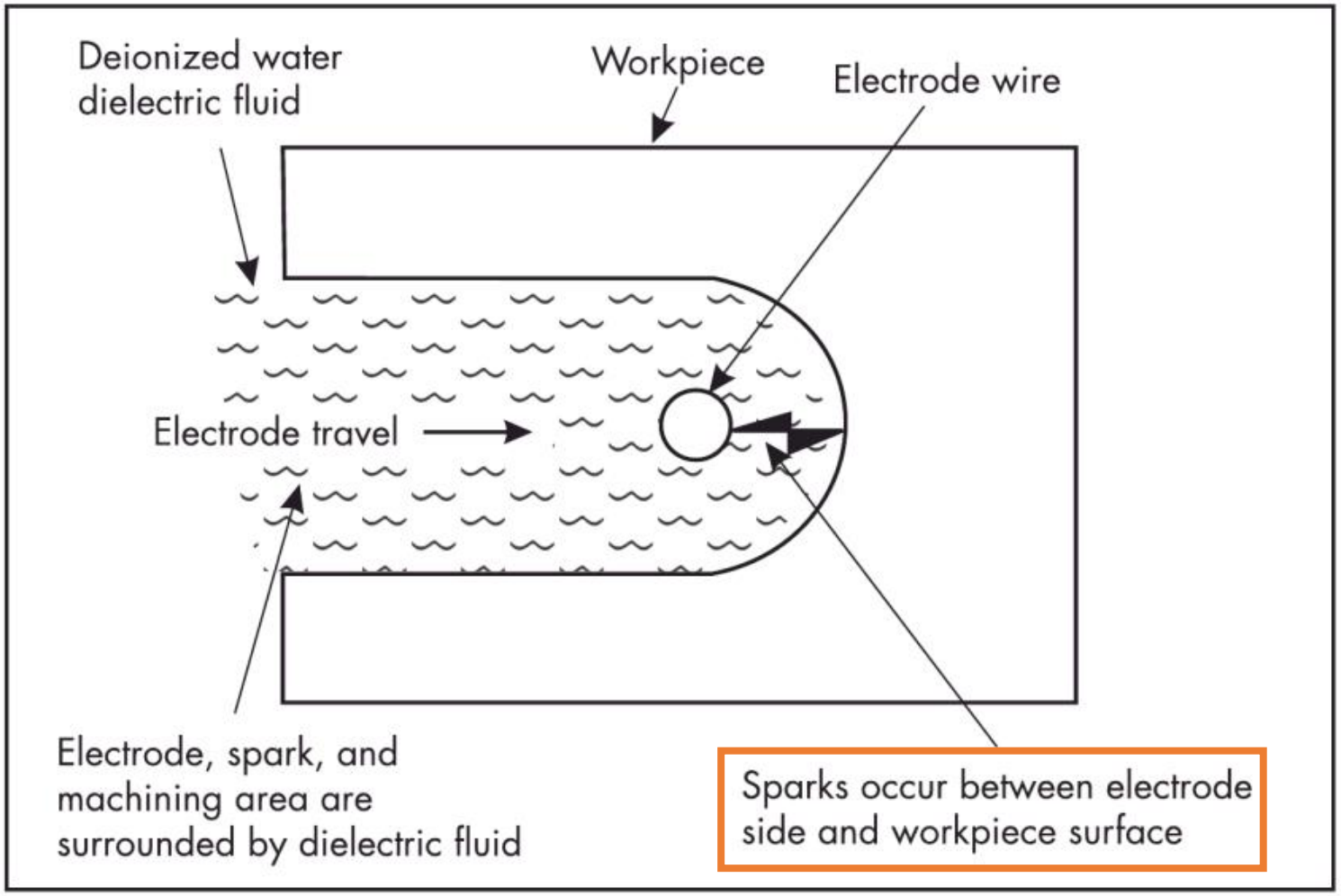
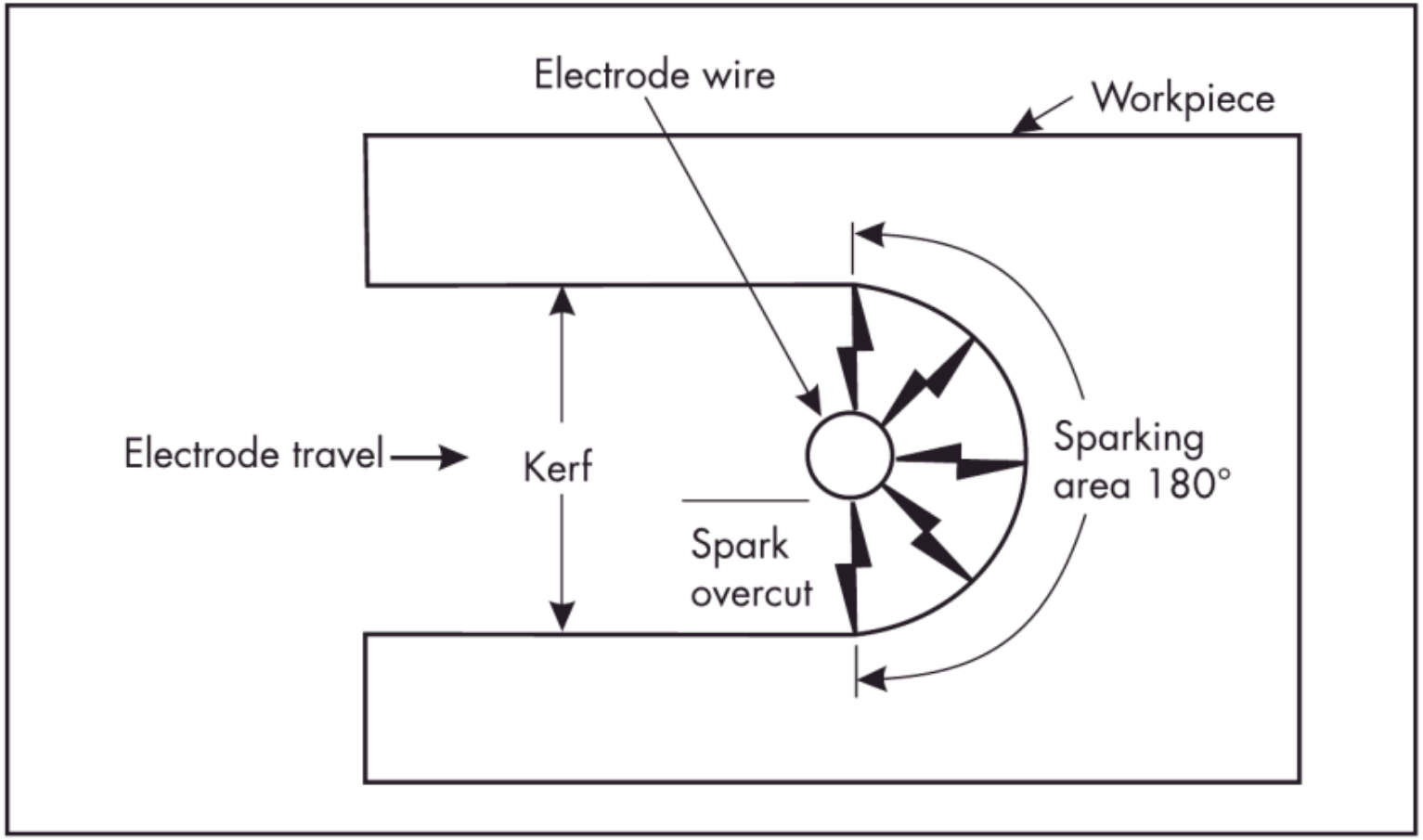


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Sparks cause erosion of wire & workpiece



- Between sparks, dielectric fluid cools workpiece & flushes debris
- Servo system maintains gap between wire electrode and workpiece

Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Sparks controlled to obtain predicable results

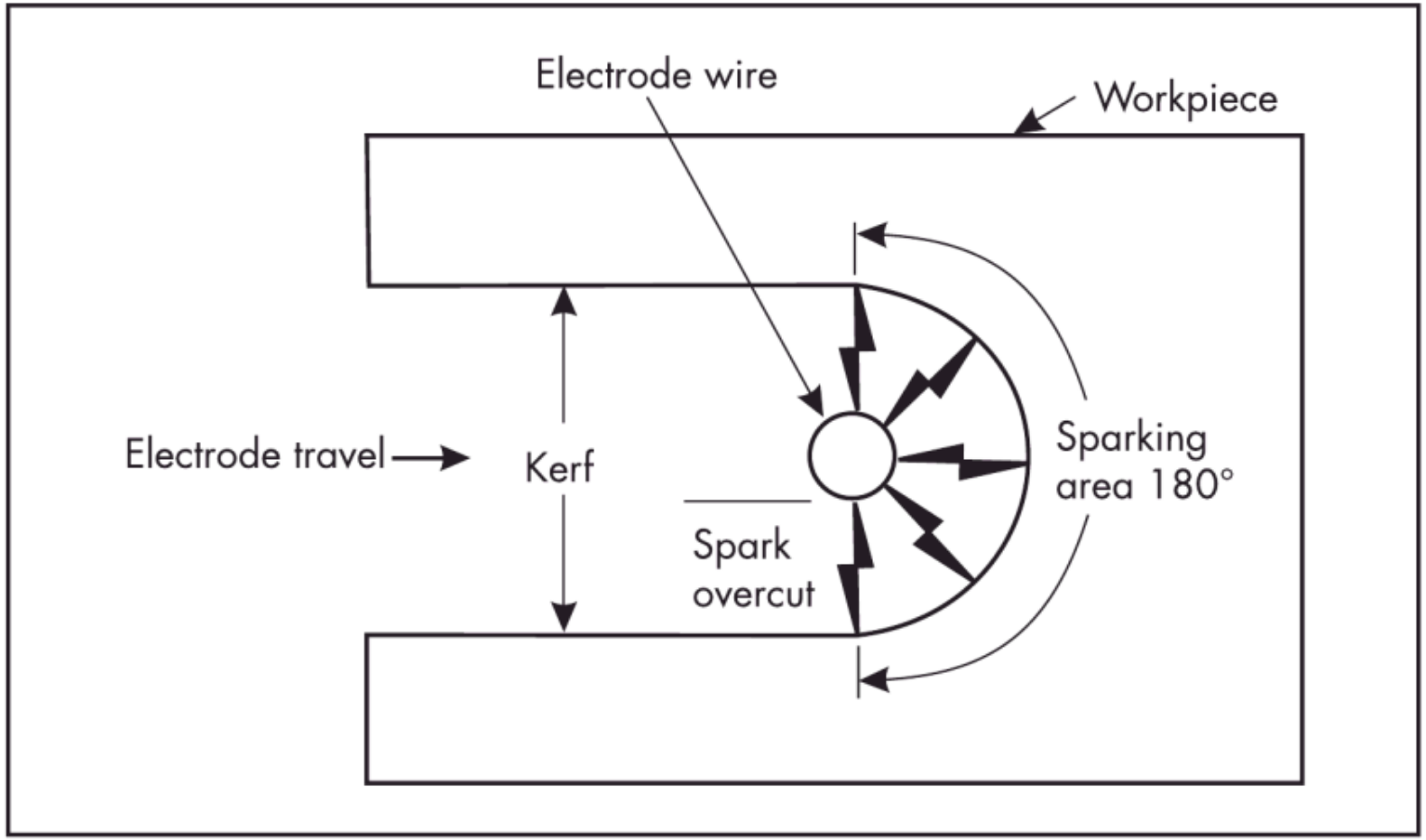


Figure adapted from E. C. Jameson, *Electrical Discharge Machining*. 2001.

Train of voltage pulses to electrodes, with controlled:

- Waveform shape
- Amplitude
- Frequency
- Max current

Material Removal Mechanism

- Insufficient experimental evidence to conclusively define mechanism

- **Thermal model**: spark melts and vaporizes material
  - Explains observations for large discharge energies

- **Electrical force model**: electrostatic force pulls away bits of material
  - Explains observations for small discharge energies

Assignment

- Attend small group session to learn to use machine (after lecture)
- Work in pairs to create star, using instructions provided

References

[1] C. Sommer and S. Sommer, *Wire EDM Handbook*, Second Edi. Houston: Technical Advance Publishing Company, 1994.

[2] E. C. Jameson, *Electrical Discharge Machining*. Society of Manufacturing Engineers, 2001.

[3] B. Fleming, *The EDM How-To Book*. Fleming Publications, 2005.