9 Fundamentals of Ram EDM

Ram EDM Machining

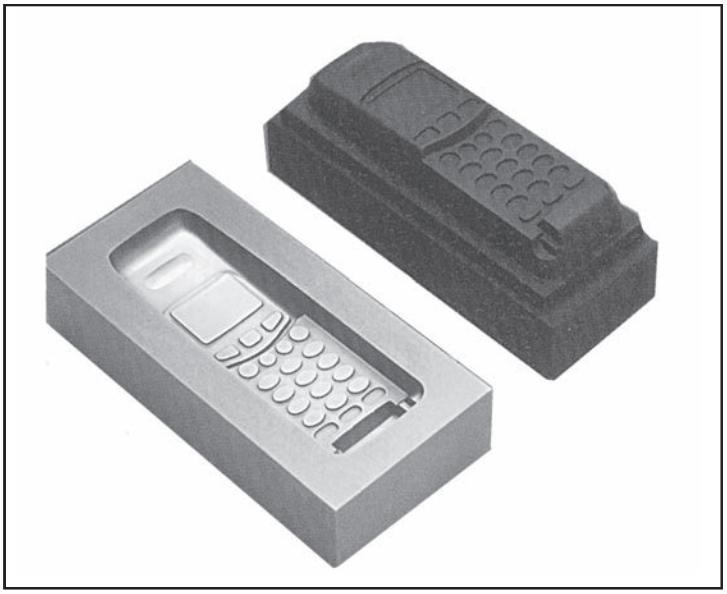
Ram electrical discharge machining (EDM)—also known as conventional EDM, sinker EDM, die sinker, vertical EDM, and plunge EDM, is generally used to produce blind cavities. See various machines in Figures 9:1.

Courtesy Mitsubishi

Figure 9:1

Ram Electrical Discharge Machines

When a blind cavity is required, a formed electrode is machined to the desired shape. Then, by means of electrical current, the formed electrode that is surrounded by dielectric oil reproduces its shape in the workpiece. See Figure 9:2.



Courtesy Mitsubishi

Figure 9:2

Ram EDM process uses a formed electrode to remove material.

Ram EDM Beginnings

Lightning is a form of electrical discharge machining. Its effect can be seen when it strikes the earth. Also, when a screwdriver shorts between a car body and battery, one witnesses how electricity can remove metal.

In 1889, Benjamin Chew Tilghman, of Philadelphia, PA, received a U.S. patent (patent No. 416,873) entitled, “Cutting Metal By Electricity." This is a portion of the patent:

> My object is to provide a method by which metal objects can not only be severed, but also planed, turned, or shaped in any ordinary way; and I avoid as far as possible heating the metal under treatment except at the point where the cutting action is taking place. This I accomplish by concentrating the electric current upon a path or continuous series of small spots or points adjoining each other, and successively brought under the influence of the current, so that the metal is always heated to the desired degree at the point where it is being operated upon and not elsewhere.

Although Tilghman had developed the concept of electrical discharge machining, spark erosion devices between World War I and World War II were used primarily to remove broken drills and taps. These early machines were very inefficient and difficult to use.

Then, two Russian scientists, Boris R. and Natalie I. Lazarenko (husband and wife) made two important improvements. First, they developed the R-C relaxation circuit which provided a consistent pulse control. Second, they developed a servo control unit which maintained a consistent gap allowing efficient electrical discharges.

These two developments made ram EDM a more dependable means of machining. However, the process still had its limitations. For instance, the vacuum tubes used for the direct current circuit could not carry enough current or allow quick switches between “on” and “off” times.

Current and switching problems faded with the introduction of the transistor. Better accuracy and finishes resulted because the solid state device permitted the use of the proper current and switching for “on” and “off."

Today's ram EDM machines have enhanced servo systems, CNC-controls with fuzzy logic, automatic tool changers (Figure 9:3), and capabilities of simultaneous six-axes machining. Ram EDM, along with wire EDM, has revolutionized machining.

Courtesy Agie

Figure 9:3

A CNC Ram EDM with Tool Changer

How Ram EDM Works

Ram EDM uses spark erosion to remove metal. Its power supply generates electrical impulses between the workpiece and the electrode. A small gap between the electrode and the workpiece allows a flow of dielectric oil. When sufficient voltage is applied, the dielectric oil ionizes and controlled sparks melt and vaporize the workpiece.

The pressurized dielectric oil cools the vaporized metal and removes the eroded material from the gap. A filter system cleans the suspended particles from the dielectric oil. The oil goes through a chiller to remove the generated heat from the spark erosion process. This chiller keeps the oil at a constant temperature which aids in machining accuracy. See Figure 9:4

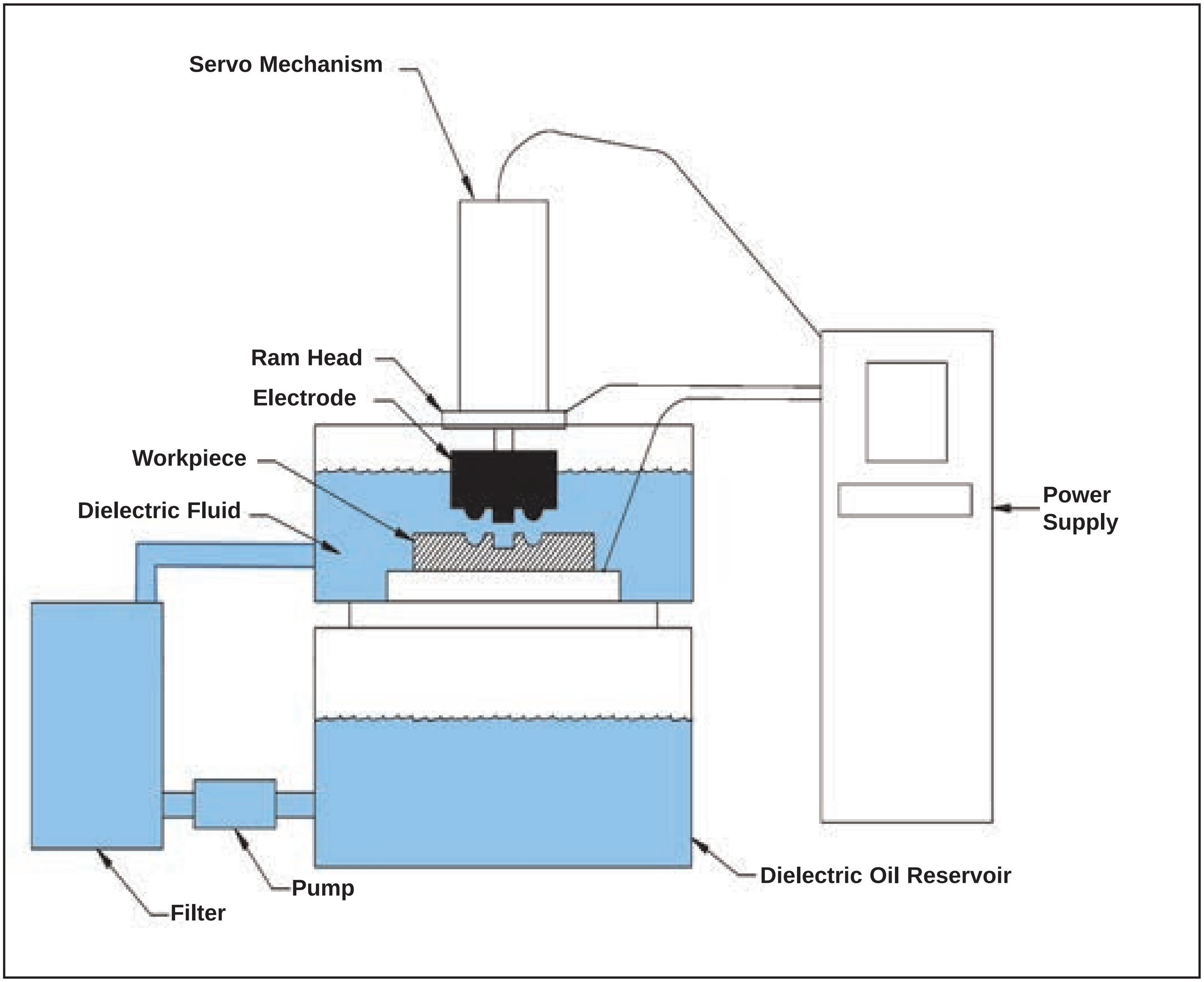


Figure 9:4

The Ram EDM Process

Ram EDM, like wire EDM, is a spark erosion process. However, ram EDM produces the sparks along the surface of a formed electrode, as in Figure 9:5.

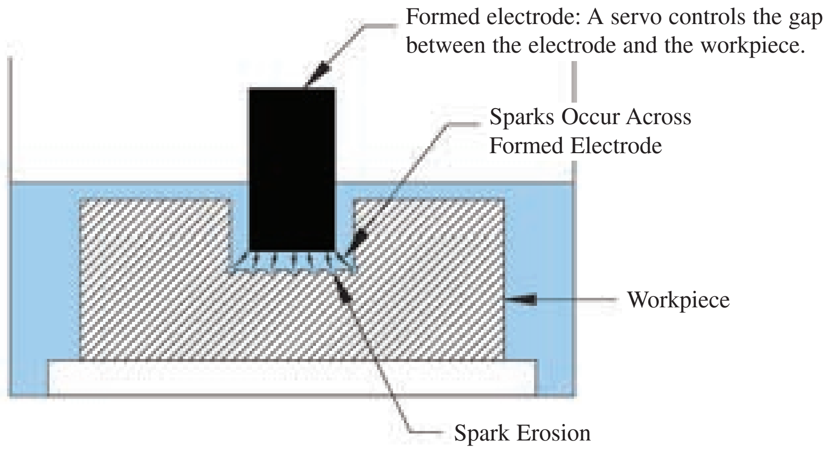


Figure 9:5

Spark Erosion Across the Formed Electrode

A servo mechanism maintains the gap between the electrode and the workpiece. The servo system prevents the electrode from touching the workpiece. If the electrode were to touch the workpiece, it would create a short circuit and no cutting would occur.

The Step-by-Step Ram EDM Process

The power supply provides electric current to the electrode and the workpiece. (A positive or negative charge is applied depending upon the desired cutting conditions.) The gap between the electrode and the workpiece is surrounded with dielectric oil. The oil acts as an insulator which allows sufficient current to develop. See Figure 9:6.

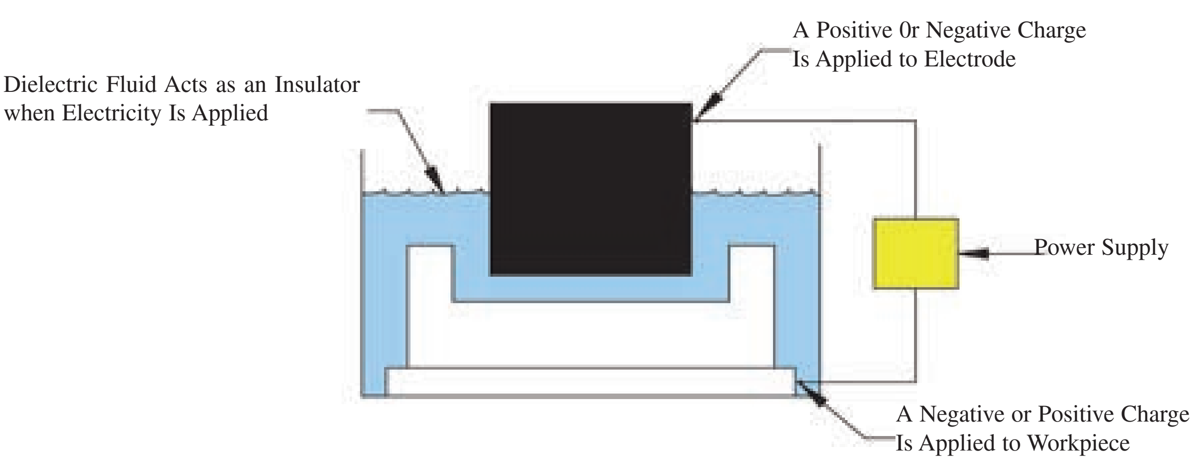


Figure 9:6

Power Supply Provides Volts and Amps

Once sufficient electricity is applied to the electrode and the workpiece, the insulating properties of the dielectric oil break down, as shown in Figure 9:7. A plasma zone is quickly formed which reaches temperatures up to 14,500° to 22,000° F (8,000° to 12,000° C). The heat causes the fluid to ionize and allows sparks of sufficient intensity to melt and vaporize the material. This takes place during the controlled "on time" phase of the power supply.

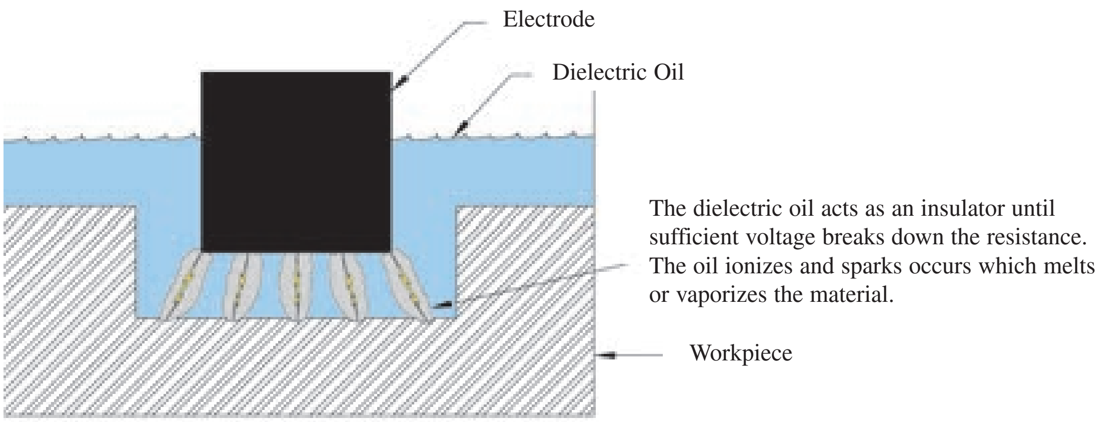


Figure 9:7

Sparks Causes the Material to Melt and Vaporize

During the "off times," the dielectric oil cools the vaporized material while the pressurized oil removes the EDM chips, as shown in Figure 9:8. The amount of electricity during the "on time" determines the depth of the workpiece erosion.

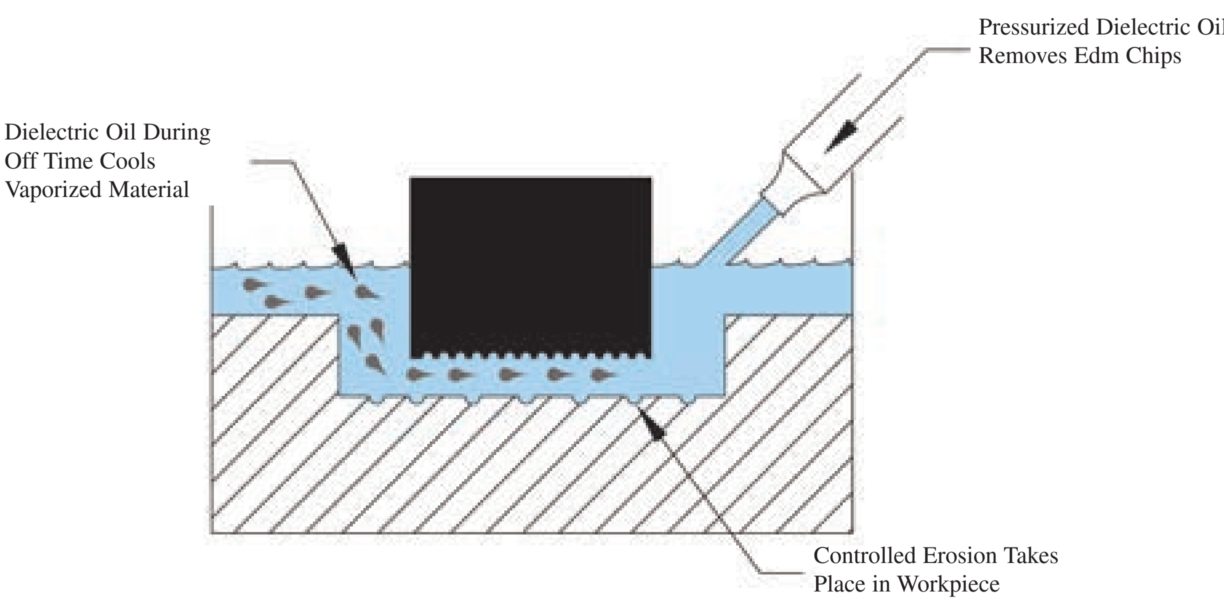


Figure 9:8

Pressurized Dielectric Oil Removes the EDM Chips

Polarity

Polarity refers to the direction of the current flow in relation to the electrode. The polarity can be either positive or negative. (Polarity changes are not used in wire EDM.)

Changing the polarity can have dramatic effects when ram EDMing. Generally, electrodes with positive polarity wear better, while electrodes with negative polarity cut faster. However, some metals do not respond this way. Carbide, titanium, and copper are generally cut with negative polarity.

No-Wear

An electrode that wears less than 1% is considered to be in the no-wear cycle. No-wear is achieved when the graphite electrode is in positive polarity and "on times" are long and "off times" are short. During the time of no-wear, the electrode will appear silvery, showing that the workpiece is actually plating the electrode. During the no-wear cycle, there is a danger that nodules will grow on the electrode, thereby changing its shape.

Fuzzy Logic

Some ram machines come equipped with fuzzy logic. Unlike bilevel logic, which recognizes a statement as either true or false, fuzzy logic allows a statement to be partially true or false. Fuzzy logic allows machines to think and react quickly to various machining conditions. These machines can lower or increase power settings to obtain the optimum combination of speed, precision, and finish. Fuzzy logic machines constantly monitor the cut and change power settings to maximize efficiency.

Fumes from Ram EDM

Fumes are emitted during the EDM process; therefore, a proper ventilation system should be installed. Boron carbide, titanium boride, and beryllium are three metals that give off toxic fumes when being EDMed; these metals need to be especially well-vented.

Danger from Explosion

One must be careful that the electrode is fully submersed in oil. If the electrode is not fully submersed, or sufficiently submersed in oil, the sparks jumping from the electrode to the workpiece can result in a fire that can severely damage the machine and even cause an explosion. An incident happened where an employee removed a suppressor nozzle from a fire extinguisher. The oil ignited, and the fire extinguisher went off. But without the suppressor, the force of the fire extinguisher caused the hot oil to explode. The explosion was so great that it tore off part of the roof.

Disadvantages of Ram/Sinker EDM

One of the great disadvantages of owning a ram EDM is that making the graphite electrodes can make your shop full of graphite dust. Graphite is easy to machine, but it gets into everything. We have a room devoted to machining our graphite. We have three CNC mills for making electrodes in the room with filtration systems attached.

Benefits of Understanding the Process

The better understanding manufacturers have of the EDM process, the better they can use it to reduce costs. The following section discusses how to profit with ram EDM.

Free Training Videos (ReliableEDM.com)

How Ram EDM Works: Part 1 (6:20)

How Ram EDM Works: Part 2 (7:14)