



## *Making Small Change... Quarter Shrinking*

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The Quarter Shrinker uses extremely powerful pulsed magnetic fields to "shrink" coins in a process called high-velocity metal forming. There is no direct contact with the coin. All of the reshaping is done by invisible, but incredibly strong, magnetic fields! The coin is first centered within a 10-turn coil of insulated copper wire. The Quarter Shrinker then forces a huge pulse of electrical current (up to 100,000 amperes!) into the coil. Through transformer action, a current of up to *one million* amperes is created inside the coin. Another phenomenon, called "skin effect", forces this immense current to flow within a circular ring that's only 1/20" thick along the outer edge of the coin. During shrinking, the instantaneous power applied to the coil is comparable to the total electrical power consumed by a medium-sized city!

The circulating current created within the coin also creates a powerful magnetic field around the coin. The magnetic fields from the coil and the coin oppose each other - an effect called "Lenz's Law". This creates tremendous repulsion forces between the work coil and the coin. Intense compressive forces squeeze the coin inward, reducing its diameter while simultaneously making it thicker. The entire shrinking process takes less than the blink of an eye (~25 millionths of a second). The combination of rapid plastic deformation and high current raise the temperature of the coin by several hundred degrees. Although the diameter of a quarter becomes smaller than a dime, the coin retains all of its surface features, and is still easily recognized as being a quarter! However, there's no, "Honey, I shrunk the kids" magic involved. As the coin shrinks in diameter, it becomes thicker, so a shrunken coin still has the same mass, volume, and density as the original coin. The amount of "shrinkage" depends on the amount of energy we apply to the coil - higher energy shots create smaller diameter coins.

There are equal (and opposite) reaction forces on the coil. Intense magnetic pressure pushes the inside of the copper coil outward, rapidly expanding its diameter, ultimately causing it to explode in a shower of potentially deadly copper fragments. As the coil expands, the wire stretches to less than half its original diameter. The wire's insulation can't stretch to the same degree, so it gets blown off, leaving fragments of mostly bare wire. As the coil explodes, the copper fragments are ejected with the force of a small bomb, and small fragments can reach a velocity of over 5,000 feet/second. To protect nearby objects (and people!), coin shrinking must be done inside a bulletproof chamber. After the coil disintegrates, any residual electrical energy is dissipated in a bright ball of blue-white plasma and a shock wave (an extremely loud BANG). We only shrink one coin at a time. ***Each coin requires its own carefully wound coil which is explosively destroyed during the shrinking process.***

The Quarter Shrinker works quite well on most circulating US coins and many foreign coins and tokens. It is particularly effective on US "clad" coins, since these are constructed with a highly conductive pure copper core sandwiched between thin outer layers of a nickel-copper alloy that has a higher melting temperature. Golden Sacagawea or other small Presidential Dollars also shrink well since these coins also use a pure copper core sandwiched between layers of a gold-colored manganese/brass alloy. Bronze pennies made before 1982 also shrink well. However, newer pennies are made using a thin layer of copper plated over a zinc core. If we try to shrink one of these, the copper layer vaporizes, and the zinc core explodes in a shower of molten zinc droplets. US nickels and other nickel-copper alloy coins don't shrink as well since this alloy is significantly harder and is a much poorer electrical conductor. Pure nickel coins (such as older Canadian nickels and quarters) shrink quite nicely, as do most gold bullion coins and larger silver coins such as silver half-dollars and dollars. Unfortunately, silver dimes and quarters tend to melt and fragment, and the coins often turn an unsightly greenish-brass color as copper begins to separate out of the copper-silver alloy.

Bimetal coins, with outer rings and disc-shaped centers made from different metal alloys, often show different degrees of shrinkage based upon the electrical conductivity and hardness of the individual alloys. In many coins, the center shrinks more than the outer ring, causing the coin to separate into two pieces. Shrinking coins or tokens that have a hole in the center often causes the hole to shrink or even close up entirely. More information, references, plenty of images, and links to other "interesting" stuff, such as our "Captured Lightning" sculptures, can be found on our web site: <https://capturedlightning.com>

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