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A Method Producing Metal Globules

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Abstract

A simple method producing metal globules from wire molten by an electric current is described.

The magnitude distribution of produced globules was measured and some explanations on the causes of the produced globules having diameters much smaller than that of original wire were also given.

I. Principle and Remarks

A metal wire immersed in water is heated by an electric current. If the current is strong enough to heat it above its melting point, it breakes up in small pieces. In any way these pieces have no regular form at the first instant, but they must change their forms by surface tension, so long as they are in a molten state, and become spherical and solidify finally as metal globules. This is the leading principle of the present investigation. The reason why a wire was molten in water, is simply to avoide its burning, which often occurs in the air, If necessary, water can be replaced with proper oil. It is not unnecessary to remark about the heating energy. It appears that the heating of a wire in water, inevitably accompanies some excess loss of heat than in air, but it is not so serious as it may be thought, for the excess loss of heat only occurs so long as the surface temperature of the wire remains below 100°C, above this, the wire is covered with thin film of vapour and the convection loss of heat in such a thin film must be rather smaller than that in free air. In the case when a wire, which has a high melting point and very large heating rate is used, this excess loss of heat is rather negligible.

II. Apparatus

According to the above principle, an apparatus was constructed to produce metal globules automatically. The essential parts of this apparatus consist of two pars of graphite roller R_1,R_2 and a graphite plate E. (Fig. 1). Roller R_2 and plate E are immersed in water

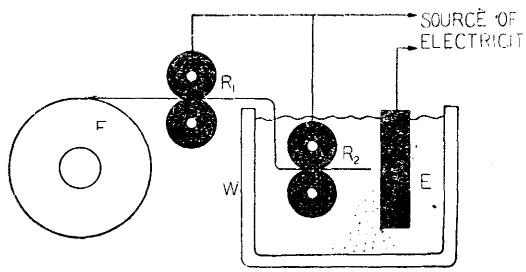

Fig. 1 Schematic diagram of the apparatus

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tank *W*. *R* and *E* are used as electrodes and kept at a constant potential difference; say 100 Volts. A wire is wounded on a frame *F*.

One end of this wire was driven out by roller R_1, R_2 through the water toward *E*. As soon as it touches *E*, an electric circuit is closed and a heavy current flows in the wire. Instantly, the bridged wire melts down with tremendous noise, and metal globules are collected on the bottom of the tank. So long as these rollers are driven by a motor, the feeding and melting of wire goes on continuously and automatically.

Present method can be applied for metals of high melting point as well as for those of low melting point, provided that they only could be drawn in wire. Metals actually globulized in this experiment are silver, copper, steel and brass.

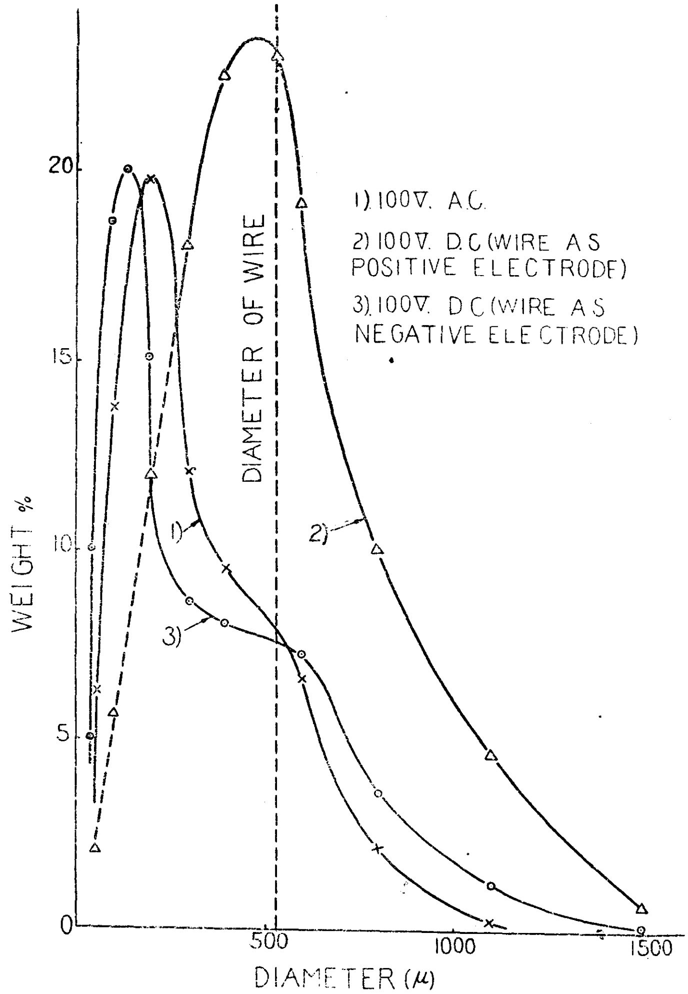
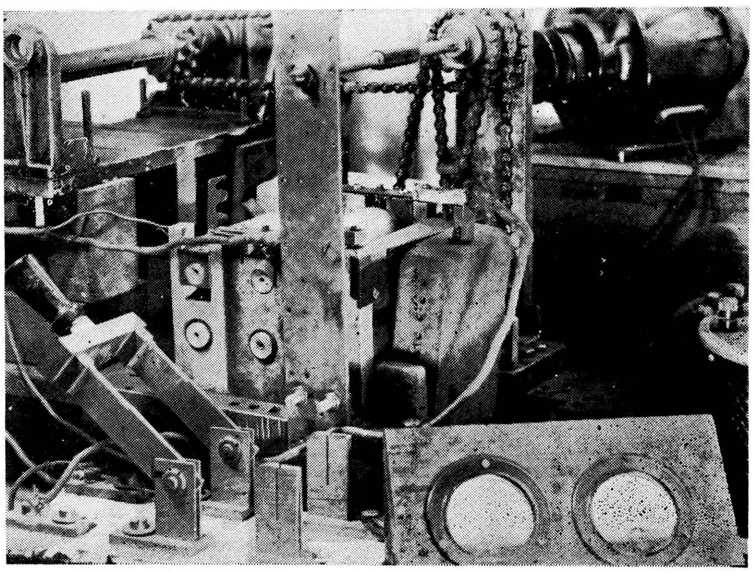
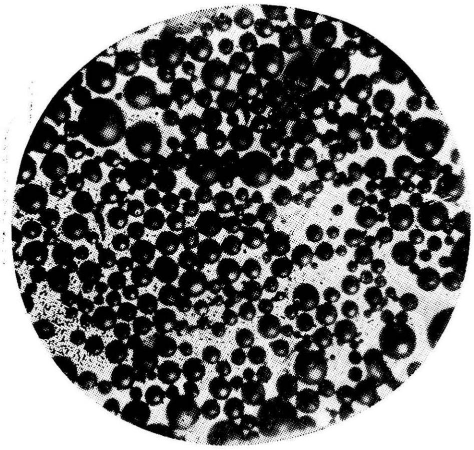


Fig. 2. Relation between partial mass and diameter of globules

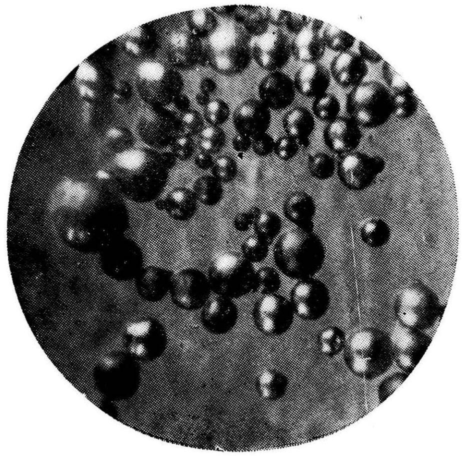
III. Distribution of the size of globules



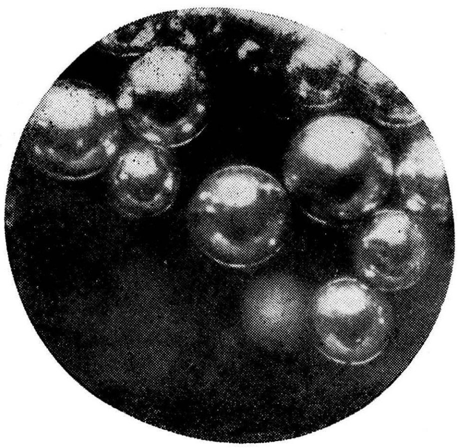
PL. 1. General view of the **Apparatus**



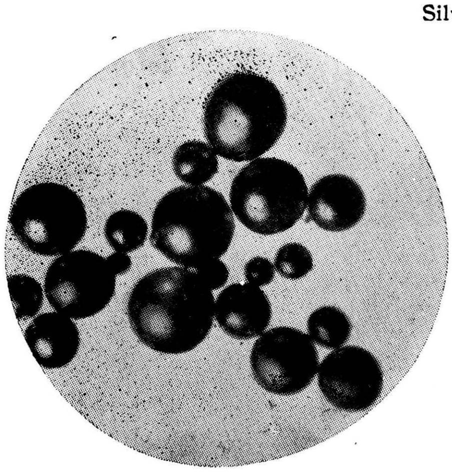
Steel ×20



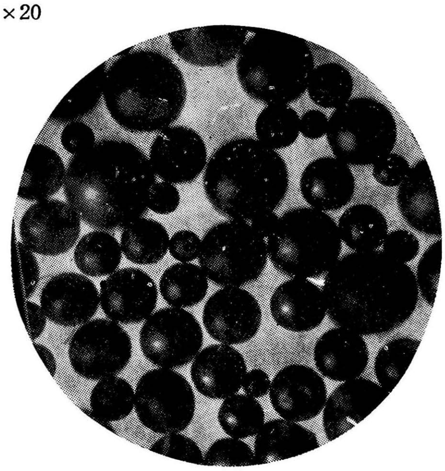
Iron ×20



Silver ×20



Nickel ×20



Brass ×20

PL. 2. Micro-photographs of globules

Using wire of given diameter d, the size of globules obtaind was not even, but distributed in wide range, for example some had a diameter larger than 3d while some smaller than 0.1 d.

Globules obtained were sieved with sieves of different meshes and we got a distribution curve.

Let the total mass of globules obtaind be M, and the partial mass of globules having diameter lying between d and $d+\Delta d$ be ΔM, then $\Delta M/M \times 100$ denotes the percentage of partial mass. Taking this percentage as an ordinate and d as an abscissa, we got a curve shown in Fig. 2.

Again let N be the number of globules with diameters lying between d and $d+\Delta d$, the relation between N and d can approximately be expressed by following simple eqation

$$Nd^3 = C$$

where C is a constant. (Of course its value depends on the length of wire consumed. For example using iron wire of 0.5mm in diameter, $C = 1500$ per one meter of wire consumed.)

An explanation must be given on the cause of the formation of globules with diameter differing in a wide range.

A long thin wire once melted, it can no longer keep its original form, but due to its surface tension, some beads are produced along the molten thread and the thread between beads becomes slender. On that slender part again some smaller " secondary " beads are produced resulting smaller globules.

When once the breaking occurs at any point of the molten thread an arc starts there and accompanies vaporization of the metal. This vapour rapidly condenses to smallest globules.

Some globules, especially of larger diameter, were hollow instead to be full. This fact gives another cause of obtaining smaller globules. At the beginning of cooling of a larger molten globule, the outer shell solidifies and shrinks rapidly, while the inner contents is yet in molten state and receives a large pressure due to the shrinkage of the outer shell. If this pressure be large enough to burst some week point of the shell, the molten metal gushes out through this split and solidifies as " secondary " smaller globules.

By microscopic observation, it was found that, most globules were quite spherical and their surfaces smooth. Some microphotographs are reproduced in Plate 2.

Steel globules produced by this method are hardend, as it can readily be understood from their producing process.

Acknowlegement

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