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PROCESS FOR PATENTING HOT-ROLLED STEEL WIRE IN A FLUIDIZED BED

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ABSTRACT OF THE DISCLOSURE

A fluidized bed used in the patenting of steel wire and comprising a unidirectional flow of gas entraining a mass of zirconium-silicate particles of substantially spherical shape and 0.1 mm. mean diameter in an elongated conduit is driven with a power density of 700 to 4000 m·kp./sec. per square meter of conduit cross-section.

Our present invention relates to a process for patenting rolled-steel wire and to a fluidized bed for carrying out the process.

In the patenting of rolled-steel wire it is known that the usual fused-lead bath may be replaced by a fluidized bed, e.g. as described in our prior U.S. Patent No. 3,492,740, with no substantial differences in the properties of the patented wire. Until now it was also thought that these properties were independent of the composition of the heat-carrying particles contained in the fluidized bed which heretofore consisted, typically, of clay, sand, magnesium oxide, silicon carbide, or ferrosilicon. Whereas the use of a fused-lead bath is expensive owing to the high cost of lead, conventional fluidized beds are not entirely free from drawbacks including easy oxidation in the fluidized bed (as in the case of ferrosilicon) and insufficient availability. Because there was never any evidence to indicate that the quality of the wire depended on the composition of the particles constituting the fluidized bed used to patent the wire, the composition of the bed was chosen strictly on an economic basis.

A simple criterion for the quality of wire is its tensile strength. For lead-patented wire the tensile strength σ_B varies with the carbon content roughly according to the formula

$$\sigma_B = 50 + 100\% \text{ C (kg./mm.}^2\text{)}$$

The tensile strength of wire patented in the usual fluidized beds containing clay, magnesium oxide or sand is generally 2% less than that of lead-patented wire.

Another important criterion for the quality of wire is the number of bends it can withstand. Tests show that lead-patented wire and wire patented in fluidized beds containing magnesium oxide, clay, sand or similar material withstand substantially the same number of bends for wires down to 1.8 mm. diameter drawn from rolled stock of 5.5 mm. diameter. These values are on the average 140% of those specified by the German standard DIN 2078.

The object of our present invention is to produce a steel wire of improved tensile and flexural strengths by a process retaining the economic advantages of the fluidized-bed technique. We accomplish this by patenting

rolled-steel wire in a fluidized bed containing substantially spherical particles of zirconium silicate, advantageously Australian zirconium sand, preferably having a mean diameter of about 0.1 mm. The use of such particles in a fluidized bed for patenting wire yields, surprisingly, a stronger and more durable wire in the aforestated diameter range as compared with wire patented in fluidized beds comprising ceramic particles of aluminum oxide and the like.

According to our tests, wires patented in a zirconium-silicate fluidized bed had tensile strengths approximately 3% higher than the reference wires, their performance in bending tests lying between 150% and 180% of the German standard 2078.

Best results were achieved when the wire, spread out in open turns on a conveyor belt, moved through a bed of 30 cm. height with a relative speed of 40 to 130 cm./sec., preferably 50 to 100 cm./sec., while the zirconium-silicate particles were impelled by the gas flow with a power density of 700 to 4000 m·kp./sec. per square meter of cross-section, preferably 800 to 2000 m·kp./sec. The optimal power density was found to vary proportionally with the cross-sectional height of the fluidized bed.

CONTROL TEST

A steel wire containing by weight 0.55% carbon, 0.2% silicon, 0.5% manganese, 0.017% phosphorus, 0.02% sulphur, and 0.004% nitrogen (all percentages by weight) was rolled to a diameter of 5.5 mm. on a continuous wire-rolling mill and patented in a fanned-out formation in a fluidized bed 30 cm. in height whose heat-exchanging constituents were clay particles of 0.08 to 0.15 mm. in diameter. The wire had a tensile strength of 104 kg./mm.^{2}. In ten successive draws the wire was reduced to 1.8 mm. diameter with a tensile strength of 195 kg./mm.^{2}. The bending test yielded values between 12 and 16 with an average of 14 bends. The minimum number of bends according to German standard DIN 2078 for wire of this diameter and tensile strength is 10. Its constriction on rupture was 0.53%.

EXAMPLE

A wire of identical composition was rolled and patented under the same conditions as the above-mentioned specimen except that the fluidized bed, driven with a power density of 1200 m·kp./sec. per square meter of cross-section and containing zirconium-silicate particles of mean diameter 0.1 mm., was used. The wire original stock of 55 mm. diameter had a tensile strength of 108 kg./mm.^{2}. After being drawn to a diameter of 1.8 mm., the wire attained a tensile strength of 199 kg./mm.^{2}. The wire samples withstood 14 to 18 bendings, with an average number of 16 bends.

One can see that the use of zirconium-silicate particles in the fluidized-bed patenting of steel wire as described above greatly improves the plastic and elastic qualities of wire. Additionally advantageous is the fact that zirconium silicate reacts neither with the wire nor with the oxygen in the air stream of the bed.

We claim:

1. A process for patenting hot-rolled steel wire emerging from a rolling mill, comprising the step of forcedly cooling said wire in a fluidized bed of unidirectionally flowing gas entraining a mass of zirconium-silicate particles of substantially spherical shape.

2. A process as defined in claim 1 wherein said particles have a mean diameter of substantially 0.1 mm.

3. A process as defined in claim 1 wherein said bed is driven with a power density ranging between substantially 700 and 4000 m·kp./sec. per square meter of its cross-section.

4. A process as defined in claim 3 wherein the cross-sectional height of said bed is substantially 30 cm.

5. A process as defined in claim 1 wherein said wire is advanced through said bed in open turns at a rate of substantially 40 to 130 cm./sec. relative to the gas flow.

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