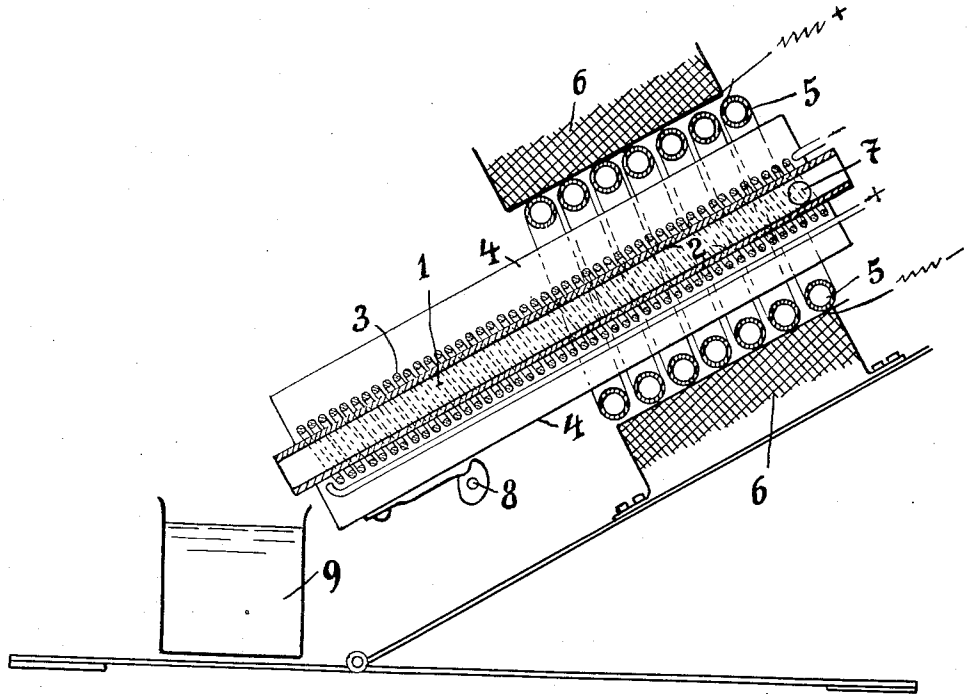
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APPARATUS FOR HARDENING PRODUCTS OF IRON, STEEL, AND OTHER FERROMAGNETIC MATERIALS

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APPARATUS FOR HARDENING PRODUCTS OF IRON, STEEL, AND OTHER FERRO-MAGNETIC MATERIALS

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The hardening temperature of all ferro-magnetic materials nearly coincides with the temperature of the magnetic transformation and this property has already been utilized for automatic hardening purposes in such a way that the object to be treated is held in the hardening furnace solely through the magnetic influence, so that the product falls out of the furnace as soon as the weight of the treated product exceeds the attractive magnetic force which decreases in consequence of the magnetic transformation.

It has been found through many tests that the hardening heretofore effected by said method, is very faulty for the reason that, during the rising of the temperature, the demagnetization of the products to be hardened does not take place suddenly, but according to a gradually sloping curve. In consequence thereof, the demagnetization occurring during rising temperatures occurs a long time before the necessary hardening temperature is reached and at such a low rate that, if even powerful electro-magnets are used, the weight of the product to be hardened exceeds the magnetic attractive force and consequently the product leaves the furnace before the proper time.

According to the present invention the said drawback is overcome by feeding the product to be hardened along a slanting or inclined track through the furnace, so that the time of retention of the product inside of the furnace is increased in consequence of the frictional resistance. In this way the product is held against movement in the furnace until the temperature of the magnetic transformation is approximated, then the product begins to travel along the inclined track, the speed of the travel being very slow in consequence of the frictional resistance, so that the product is subjected to the proper hardening temperature before it leaves the furnace. To avoid any stoppage or halting of the product while on the track the product is agitated by any suitable means.

The accompanying drawing is a sectional elevation of an apparatus for carrying out the new method according to the present invention.

Referring to the drawing, the interior 1 of the furnace is formed by one or several tubes 2 composed of a heat resistant material. The tubes are surrounded with an electric heating-spiral 3, and an isolating or insulating mantle 4 is provided to prevent radiation of the heat outwardly. The interior of the furnace is slanting or inclined. Outside of the isolating mantle, the upper part of the furnace is surrounded by cooling coils 5 which are arranged in such a way that a space exists between the exterior surface of the isolating mantle 4 and said cooling coils 5. Around the cooling coils 5 an electromagnetic coil 6 is arranged and is protected by said cooling coils against the heat radiating from the furnace 1. The furnace 1 is pivoted at its upper end to the shaft 7. At the lower end of the furnace a cam shaft 8 is provided and when rotated engages the lower free end of the mantle 4 to impart oscillation to the furnace in a vertical plane. Below the lower end of the tube 2 of the furnace is a trough 9 which contains the hardening liquid.

The operation of the furnace is as follows:

The furnace is heated up to the hardening temperature by connecting the heating spiral 3 with the usual current supply, and at the same time the cooling water is circulated through the cooling coils 5. Before charging the furnace the coil 6 is energized by the current supply, and the cam shaft 8 is rotated so that the lower end of the tube 2 is oscillated upon the shaft 7. After the products to be hardened have been introduced into the interior of the furnace through the upper end of the tube 2, they are first held against movement in the upper part of the furnace through the effect thereon of the magnetic field produced by the coil 6. The product is held against movement until the temperature of the product is equal to the temperature of the magnetic transformation. As soon as this temperature is reached, the product, being unaffected by the influence of the magnetic field, begins to travel by gravity downward along the inclined tube. The speed of the product is decreased through the friction between the product and the furnace wall, and an adherence of the product to the fur-

nace wall is prevented by the oscillatory movement imparted by the cam shaft 8 to the tube 2. During this downward travel of the product along the inclined tube 2 the temperature of the product reaches the degree necessary for hardening, said degree being obtained by a slight increase of temperature, the difference between the temperature of the magnetic transformation and the hardening temperature being relatively small. Finally the product arrives at the lower end of the tube 2 and falls into the trough 9 to be subjected to treatment by the hardening liquid.

I claim:

1. A furnace for hardening iron magnetic products, including a tubular inclined member having its upper end pivoted, means for oscillating the lower end thereof, an electrical heating unit surrounding the member the full length thereof, an electromagnet surrounding said tubular member adjacent the upper inlet end thereof, and a tempering bath adjacent the lower outlet end of the tubular member.

2. A furnace for hardening iron magnetic products, including a tubular inclined member having its upper end pivoted, means for oscillating the lower end thereof, an electrical heating unit surrounding the member the full length thereof, an electromagnet surrounding said tubular member adjacent the upper inlet end thereof, a tempering bath adjacent the lower outlet end of the tubular member, and a cooling means interposed between the electromagnet and the tubular member to produce a heat shield for the electromagnet.

In testimony whereof I have hereunto set my hand.

WILLY HEIDENHAIN.