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HIGH-SPEED PRODUCTION OF MAGNET WIRE

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This invention relates to the production of magnet wire and more particularly to an improved method and apparatus for this purpose which enables such wire to be produced continuously at a substantially higher production rate than has been feasible heretofore.

Heretofore, magnet wire has been manufactured from bare wire wound on spools which are arranged in supply racks. Bare wire of the gauge desired in the final product is continuously unwound from the spool and pulled through a treating path where insulating enamel is coated in liquid form and then baked or cured on the wire, this procedure being repeated to provide the desired insulation "build" on the wire as it travels along the treating path. Generally, the baking or curing is effected in an oven through which the wire is pulled back and forth in multiple passes by a capstan, and idler rollers are provided at the opposite ends of the oven for guiding the wire in these passes and directing it through an enamel applicator at the beginning of each pass. From the final coating and baking pass, the coated wire is pulled continuously to a take-up device serving to wind the wire on a spool or spools on which it is sold for ultimate use.

From the viewpoint of efficiency, it is desirable to move the wire through these operations at the highest possible linear speed consistent with providing a final product of good quality. Through recent improvements in automatic spooling of the finished wire, and in the enamel applicators and the drying or curing rate of such enamels, it is possible to perform the enameling and take-up operations at much higher speeds than previously used. Despite these improvements, however, the operating speeds used commercially have not increased substantially, operating speeds in excess of about 200 feet per minute being rare and the speeds commonly used being much lower than this.

A major factor contributing to this speed limitation has been the difficulties arising from the supply spools for the bare wire, and which may be summarized as follows:

(1) The bare wire has previously been drawn down to the desired gauge from larger gauge wire and then reeled on the supply spools, these drawing and reeling operations being performed at high speed in the wire mill. As a result, flaws or imperfections occur in the reeling of the wire on the spools which eventually supply the bare wire to the enameling operations. While such flaws can be tolerated in the enameling operations at the present low speeds commercially used, they could not be tolerated in high-speed enameling operations, where they would cause excessive wire breakages, coating imperfections, etc.

(2) If the bare wire is dereeled from the supply spool by rotation of the spool as the wire is pulled off tangentially, there is a practical limit to the amount of wire which the spool can supply without creating excessive tensions in the wire. For example, a spool of 44-gauge wire weighing more than 10 pounds is impractical because too much tension would be required to rotate such a heavy spool. Thus, substantially higher enameling speeds would entail the disadvantage of much more frequent replacements of the supply spools. Of course, excessive tensions with much larger supply spools would be avoided by resort to the well-known "over-the-end" dereeling

wherein the spool is held stationary while the wire is payed-off over one end under the action of a spinner. However, the latter method of dereeling has been impracticable for supplying enameling operations because of the resulting twists in the wire, which would impair the desired application of a uniform coating and, particularly at high speeds and in fine wire sizes, would increase the risk of breaking the wire as it is pulled through the enameling operations.

Another factor which has limited the wire speed through the enameling operations is the need to maintain a close control of the wire tension. Normally, it is desirable to heat the wire to about its annealing temperature in the oven, and at this temperature copper wire has very low tensile strength. Even at their present low operating speeds the wire transport means commonly used for pulling the wire through the enameling operations will impose tensions near (and all too frequently exceeding) the breaking point of the wire, at least with fine gauge wire. For example, in a typical wire transport means one power-driven capstan, to which the finished wire travels, serves to pull the bare wire off the supply spool, around a guide post, over five idler guide rolls at opposite ends of the oven and through four enamel applicators. Such transport means are therefore unsuited for the much more demanding conditions required for high-speed operation.

An object of this invention is to provide a method for producing magnet wire at high speed, up to 1,000 feet per minute, without impairing the quality of the final product. A further object is to provide improved apparatus for carrying out the new method.

According to the invention, the bare wire to be processed is supplied from the supply spool at a relatively low linear speed but at a gauge or thickness considerably in excess of that desired in the finished magnet wire. The wire thus supplied is passed continuously through a wire-drawing zone where it is drawn down to substantially the finished wire gauge, with the result that it is considerably elongated, preferably to several times its starting length, incident to such drawing. From the drawing zone, the wire is pulled continuously through a treating path at a high linear speed which exceeds the starting speed by an amount commensurate with this elongation. Liquid enamel is continuously and repeatedly applied to the drawn wire and baked on it as it is pulled through the treating path, to form the desired build of multiple coatings; and the coated wire is withdrawn from the treating path at substantially the aforesaid high speed and passed to a high-speed spooling device.

With this method, the magnet wire can be produced at a linear speed which is much higher than the speed at which bare wire is dereeled from the supply spool, so that the dereeling can be effected in a safe and simple manner at relatively low speed. Moreover, the bare wire can be supplied by over-the-end dereeling from the spool, with its attendant advantages, because the resulting twists in the wire are removed by the action of drawing down the wire in the drawing zone as the wire passes to the enameling operations. This drawing action also removes flaws such as twists resulting from imperfect spooling of the bare wire in the wire mill. In addition, the surface of freshly drawn copper wire seems to have greater and more uniform wettability for the enamel application than bare wire which has aged even a day or two.

An apparatus made according to the invention comprises wire-drawing die means and power-driven means for continuously pulling the bare wire from the supply spool through the die means, the latter forming a drawing zone preferably having a series of die holes which progressively decrease in size in the direction of the wire travel, so that the drawing operation is effected in stages. The