March 7, 1950 H. M. JOY 2,499,390

ROTOR FOR ALTERNATING CURRENT MACHINES

Filed July 10, 1944

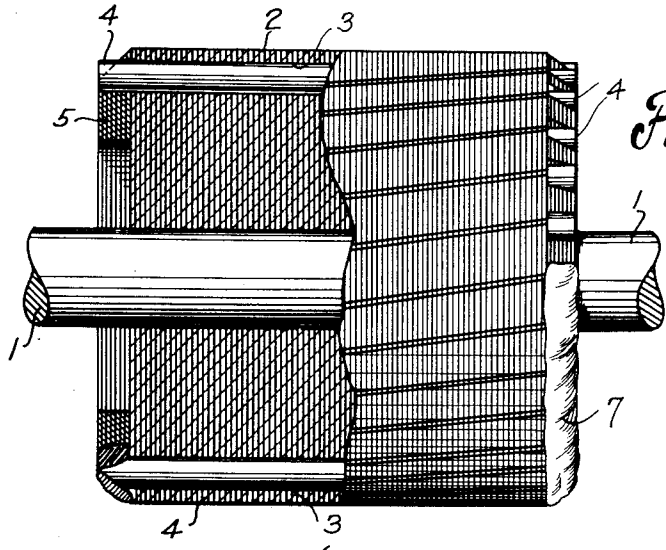


Fig.-1

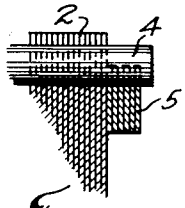
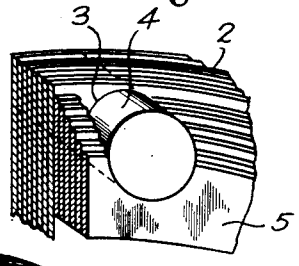


Fig.-7

Fig.-5



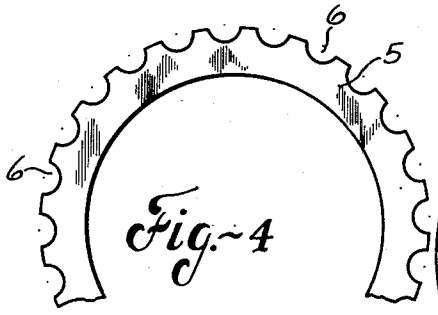


Fig.-4

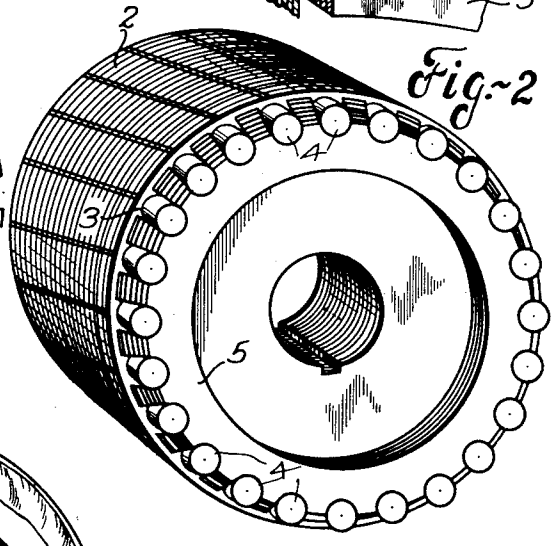


Fig.-2

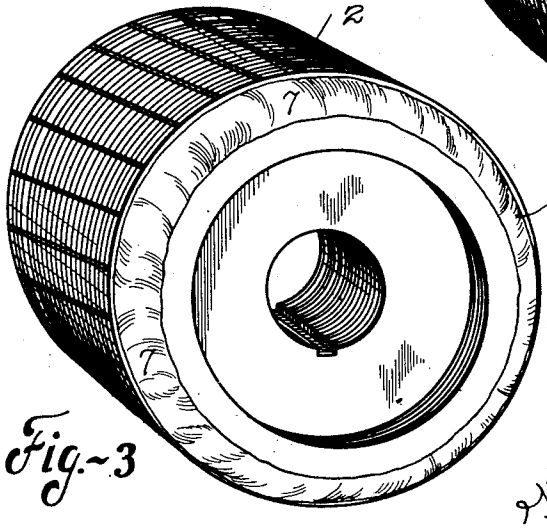


Fig.-3

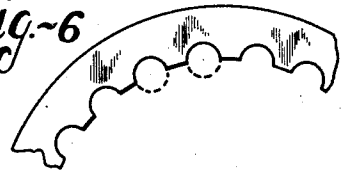


Fig.-6

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ROTOR FOR ALTERNATING CURRENT MACHINES

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10 Claims. (Cl. 172—120)

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This invention pertains to electric motors, and more particularly to a rotor of the squirrel cage type for an induction motor and the mode of manufacture thereof. Rotors of the present type ordinarily consist of a stack of steel laminae, having therein registering marginal notches or spaced holes forming passages through which extend electrical conductor bars interconnected by like conductor rings at the opposite ends of the laminae assembly.

Numerous forms of construction and methods of manufacture of such rotors have been proposed and many are now used, each having its attendant advantages and disadvantages. One such method which has proven highly advantageous and has hence been extensively used, is by casting in situ the bars and rings as an integral structure in combination with the laminae assembly. This method, however, is not applicable with equal facility to all metals. Copper is highly desirable for the particular purpose, but cannot be advantageously cast in relation with the laminae assembly on a commercial production basis due to difficulty of producing a homogenous mass of uniform density, and the further fact that the melting point of the steel rotor laminations is so close to that of copper that a mixing of the respective metals occurs during casting of the copper, unless the operation is very closely controlled.

To overcome this difficulty of casting the bars and rings, it has been common practice to employ preformed bars and end rings and interconnect them by welding. However, unitary end rings of sufficient cross sectional area necessitate use of large and expensive equipment, and cannot be efficiently punched from necessarily thick plate stock.

To reduce the cost of such method of manufacture, it has been proposed to employ end rings of laminated construction to which the ends of the conductor bars extending through the laminated assembly are welded. Again difficulties of manufacture have been encountered due to inaccessibility of the joint and impossibility of effecting perfect welds. The results have not only been unsatisfactory, but unsightly, impractical and insecure. It has frequently been found that only a portion of the end ring laminations effected union with the conductor bars, and that many times the inner laminae remained loose without effective electrical union.

To overcome these difficulties the present construction and method of operation forming the subject matter hereof includes the formation of

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marginal notches in the end ring laminae, in which the ends of the conductor bars are exposed, and by a fusing operation the exposed ends of the rods and the end ring laminae are merged into each other as a continuous weld, which also integrally unites the ring laminae, instead of a series of separate welds.

The object of the invention is to improve the construction as well as the means and mode of operation of producing squirrel cage type rotors, whereby they may not only be economically manufactured, but will be more efficient in use, uniform in performance, possess a unitary winding of increased conductivity, and be unlikely to get out of repair.

A further object of the invention is to provide an integrally welded winding for a laminated rotor, wherein the conductor bars and end ring laminae are positively and integrally fused one into the other.

A further object of the invention is to provide in a laminated rotor an assembly of conductor bars and end rings, wherein the ends of the bars and contiguous portions of the end rings are exposed for easy access for subsequent fusing and welding operations.

A further object of the invention is to provide a series of conductor bar and laminated end ring unions or joints of uniform density and equal bond.

A further object of the invention is to provide an assembly of rotor conductor bars and end rings having welded joints of uniform density and equal electrical bonding united in a single continuous operation.

A further object of the invention is to provide an induction rotor, including integrally united conductor bars and end rings having the advantageous structural features and inherent meritorious characteristics and mode of operation as herein set forth.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation, or their equivalents, as hereinafter described or illustrated in the accompanying drawings.

In the drawings, wherein is shown the preferred but obviously not necessarily the only form of embodiment of the invention and steps of procedure,

Fig. 1 is a side elevation partly in section of an

assembled rotor illustrating successive stages in the method of production thereof.

Fig. 2 is a perspective view of an assembled rotor, including conductor bars and laminated end rings preparatory to fusing.

Fig. 3 is a similar view of the assembled rotor after completion of the fusing operation.

Fig. 4 is a detail view of one of the end ring laminations.

Fig. 5 is a detail perspective view of the end of a bar and adjacent portions of the end ring laminae before fusing.

Fig. 6 is a detail view of a modified end ring.

Fig. 7 is a detail view of a further modification of the joint preparatory to fusing.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawings, 1 indicates a rotor shaft, on which is mounted a body of steel laminae 2, having therein registering holes or slots which intersect the periphery of the laminated body at 3. Extending through the registering laminae and projecting therebeyond at opposite sides of the assembly are a plurality of relatively spaced, electrically conductive bars 4 of low resistance, preferably, but not necessarily, of copper. Disposed at each end of the body of laminations 2 is a series of conductor ring laminae 5 which have therein successions of peripheral notches 6 which fit about the protruding ends of the conductor bars 4. The plurality of ring laminae 5 may be of progressively decreasing diameters to form a substantially beveled end ring assembly as illustrated, or they may be of uniform size. In Fig. 1 there are shown both sectional and exterior views of the rotor in different stages of manufacture. At the upper left of Fig. 1 there is shown a sectional view of the assembly of the rotor laminae, the end ring laminae and a conductor bar before welding. At the upper right is an exterior view of the same assembly, showing the ends of the conductor bars exposed in recesses or pockets formed by the registering notches 6 of the end ring laminae, as are also shown in perspective in Fig. 2 and on somewhat larger scale in Fig. 5. After assembly as shown, while the ring and rotor laminae are being held under pressure, the exposed ends of the conductor bars 4 and adjacent portions of the end ring laminae 5 are subjected to fusing heat, by which the conductor bar ends and the end ring laminae are thoroughly melted and merged into a homogenous winding or "cage" interlacing the rotor laminae 2. In Fig. 1 at the lower left is shown in section the effect of such fusing and welding of the bars 4 and ring laminae 5, while at the lower right of Fig. 1, and in Fig. 3, is illustrated the exterior appearance of the welded ring laminae and conductor bars.

While for simplicity of illustration the bars 4 have been shown as round or cylindrical, such shape is not essential but the bars may be of other cross sectional form. Due to the fact that at least a part of the ring laminae are of less diameter than that of the rotor, the protruding ends of the conductor bars 4 are exposed within the peripheral notches 6 of the ring laminae, which form pockets within which the bars and ring laminae are in contact, and these elements are readily accessible for welding of the component parts of the winding into a unitary assembly. During assembly the rotor and ring laminae may be stacked in a slightly askew relation, whereby the conductor bars will be angularly disposed in inclined relation to the axis of the rotor.

During the preferred mode of performing the welding operation the rotor and ring laminae are clamped in assembled relation and subjected to the action of an automatic rotary welding machine, wherein an electrode or a welding flame travels around the periphery of the assembled unit, or the latter is rotated relative to the electrode or flame, which produces a fillet-like continuous weld 7 coincident with the rotor laminae and the end ring laminae into which the protruding ends of the conductor bars 4 are integrally merged. Such continuous weld 7 securely bonds each of the end ring laminae to each other, and simultaneously to each of the conductor bars, into an integral homogenous winding assembly in interlaced relation with the rotor laminae.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise the preferred form of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. A squirrel cage rotor assembly, wherein low resistance conductor bars extend at spaced intervals through a stack of rotor laminae with their ends protruding therebeyond, a plurality of marginally notched end ring laminae of progressively decreasing diameter disposed beyond each end of the stack of rotor laminae, within the marginal notches of which the protruding ends of the conductor bars are seated in semi-exposed relation, and a continuous weld formed by simultaneously fusing the exposed portions of the conductor bars and end ring laminae wherein they are merged into each other into an integral cage-like winding for the rotor.

2. A squirrel cage type rotor for an induction electrical motor, wherein conductor bars of low resistance extend at spaced intervals through a stack of rotor laminae and their protruding ends are electrically interconnected with each other, including a plurality of superposed marginally notched end ring laminae of varying diameter, a series of open side pockets of varying depth formed by registering notches thereof in which the protruding ends of the conductor bars are received, and a continuous weld formed by fusing contiguous exposed portions of the conductor bars and end ring laminae into an integral assembly.

3. The herein described method of integrally uniting relatively spaced conductor bars extending through an assembly of electric motor rotor laminae and end rings electrically connecting the ends of the bars, including the step of simultaneously fusing contiguous portions of the bars and end rings, and forming a continuous annular weld wherein the ends of the conductor bars and a portion of the end rings merge into each other and into the remaining portion of the end rings to form an integral homogenous assembly.

4. The herein described method of integrally uniting relatively spaced conductor bars interlacing an assembly of rotor laminae and electroconductive end rings interconnecting the ends of the bars, including the steps of providing relatively spaced open side pockets of less depth than the bars in the end rings in which the ends of the bars are seated in semi-exposed relation, and simultaneously fusing contiguous portions of the end rings and of the conductor bars seated in said pockets into a continuous weld wherein the exposed conductor bars and end rings integrally merge into each other.

5. The herein described method of integrally uniting conductor bars interlaced through a stack of rotor laminations of an induction type electric motor and electroconductive end rings interconnecting the bars, including the step of simultaneously fusing contiguous portions of the end ring and bars and forming a continuous weld wherein the bars and a part of the end ring merge each into the other, the remaining unfused part of the end ring being simultaneously fused thereto.

6. An end ring for interconnecting the ends of conductor bars interlaced through a stack of rotor laminae of an induction type electric motor rotor, comprising an annular body of electroconductive material having a progressively varying diameter and a series of relatively spaced peripheral indentations therein of less depth than the conductor bars to support the ends of said conductor bars with which they are subsequently united by a continuous weld.

7. An end ring for interconnecting the ends of relatively spaced conductor bars interlaced through a stack of rotor laminae of an induction type electric motor, comprising a plurality of superposed laminae, a succession of relatively spaced open side indentations therein disposed to receive the ends of said bars and so proportioned that at least a part of the sides of the said bars are exposed, the successive laminae being of progressively varying diameter and the indentations therein being of progressively varying depth in accordance with the change in diameter of the laminae.

8. The mode of integrally uniting a series of conductor bars interlaced at spaced intervals through a stack of rotor laminae of an induction type electric motor with a common electroconductive end ring overlapped by the ends of the bars, including the step of simultaneously fusing contiguous portions of the ring and bars and

forming a continuous weld wherein the fused portions of the ring and bars are integrally merged into each other, the remaining unfused portions of the bars and end ring being simultaneously fused thereto to form a homogenous mass.

9. The mode of integrally uniting a series of conductor bars interlaced at spaced intervals through a stack of rotor laminae of an induction type electric motor with a common electroconductive end ring, including the step of assembling the ring and bars in overlapping relation with side area portions of the bars exposed, and subjecting the exposed portions of the bars and contiguous portions of the ring to fusing heat by which said portions are melted and merged into each other.

10. A rotor assembly for an induction type electric motor, wherein a series of conductor bars are interlaced at spaced intervals through a stack of rotor laminations, beyond the terminals of which the ends of the bars extend, including an end ring having a succession of open side pockets therein into which the ends of the bars are assembled with a portion of their side areas exposed, and a continuous weld formed by fusing the exposed areas of the bars and contiguous portions of the ring uniting said parts into integral merging condition.

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