

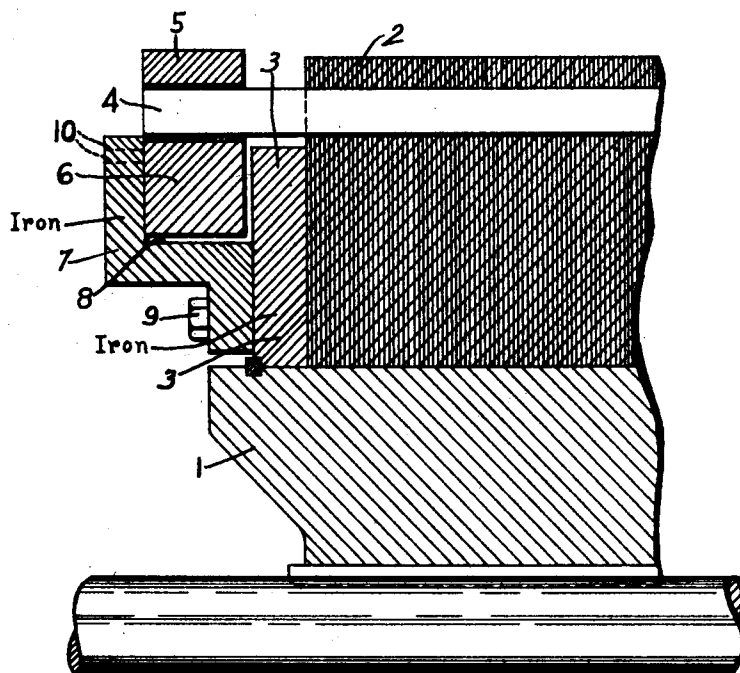
Sep. 15, 1931.

R. R. SHEELY

1,823,337

SQUIRREL CAGE MOTOR

Filed Dec. 14, 1928



INVENTOR
Robert R. Sheely

BY
Hester E. Carr
ATTORNEY

UNITED STATES PATENT OFFICE

ROBERT R. SHEELY, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

SQUIRREL-CAGE MOTOR

Application filed December 14, 1928. Serial No. 326,025.

My invention relates to means for providing an induction motor, which inherently operates without any moving switch-contacts or the like, that shall have a low starting-current, together with a high starting-torque and a low full-load slip; and it aims to attain the foregoing object in the most economical manner without resorting to a double-deck, squirrel-cage construction or to a special cross-section of squirrel-cage bars to approximate a double-deck construction and, as already indicated, without resorting to any parts which must change position between starting and full-speed or any parts which involve a material increase in the cost of manufacture.

The single figure of the drawing is a longitudinal cross-sectional view showing one end of an improved rotor member made in accordance with my invention.

As shown in the drawing, the rotor member comprises a spider 1 which supports punchings 2 held between steel end plates 3. The punchings 2 are perforated to receive standard squirrel-cage bars 4 of the usual shape common to squirrel-cage rotor members.

My invention relates to the end rings for short-circuiting the squirrel-cage bars. I provide an outer, high-resistance end ring 5 around the outside circumference of the bars 4, taken collectively, and connected thereto, said outer end ring 5 having a high resistance suitable for low-current, high-torque starting; and an inner, low-resistance end ring 6, located within the inner circumference of said bars, taken collectively, and connected thereto, said inner end ring 6 having a low resistance suitable for low-slip operation under running conditions.

The inner end ring 6 is disposed adjacent to the iron end plate 3 of the rotor core, the end plate being of such limited outer diameter that it does not come into the vicinity of the outer end ring 5. In order to increase the reactance of the inner, low-resistance end ring 6, according to my invention, I provide an angular iron ring 7 having a channel which receives the inner, low-resistance end ring 6, the channeled iron ring being perma-

nently clamped to the iron end plate 3 by means of lag bolts 9.

In a standard squirrel-cage induction motor designed for low-slip operation but with poor starting torque, the reactance of the end ring may be five or six times the resistance of the end ring at the moment of starting. By enclosing, or partially enclosing, the end ring in iron, as in my invention, this reactance may be increased to three or four times its former value.

From the foregoing description and explanation, it will be seen that, by the simple expedient of providing an outer, high-resistance end ring and an inner, low-resistance end ring, and increasing the reactance of the inner, low-resistance end ring, I have provided a very effective means whereby the larger portion of the starting current may be forced through the outer, high-resistance end ring at the time of starting.

When the motor operates from standstill to full-running speed, the frequency of the current in the squirrel-cage member decreases from the full line frequency, such as 60 cycles, to the slip frequency, such as 2 cycles, with a corresponding decrease of the reactance of the squirrel-cage circuits, so that, under running conditions, the reactance of the inner, low-resistance end ring is no longer sufficient to force the major portion of the current into the outer, high-resistance end ring.

If desired, in cases where it happens, by chance or design, that the low-resistance end ring has a higher reactance than is necessary to secure a certain guaranteed minimum starting current, the outer edge of the iron channel ring 7 may be turned down, as indicated at 10, to lower the reactance of the running winding.

In general, the resistance of the high-resistance end ring should be at least several times the resistance of the low-resistance end ring, and the low-resistance ring should have a reactance which, at starting, is higher than the total impedance of the high-resistance end ring, so as to force most of the starting current through the high-resistance ring, but the reactance of the low-resistance winding should

be so low, at full speed, and the resistance of the high-resistance winding should be so high, that the total impedance of the low-resistance end ring, under running conditions, is less
 5 than the resistance of the high-resistance end ring, so that most of the running current is forced into the low-resistance end ring.

The provision of the iron channel member
 7 around the inner, low-resistance end ring does not materially lower the power factor
 10 of the motor, as a whole, because the end-ring reactance in a normal motor is not more than 2 or 3 per cent of the total reactance of the machine, so that a three-fold increase in the
 15 end ring reactance will not produce more than about a 10 per cent increase in the reactance of the machine, which is as good as can be done in any special winding or construction which aims to secure a low starting current
 20 with a high starting torque and without materially increasing the full load slip.

While I have shown my invention in what is believed now to be the most desirable construction, all things considered, it is to be understood that such showing is merely illustrative and that any means for permanently surrounding, or partially surrounding, the low-resistance end ring with iron may be
 25 utilized without departing from the broader spirit of my invention, whether the low-resistance end ring is inside or outside of the squirrel-cage bars, and also regardless of the position of the high-resistance end ring, so long as it is spaced somewhat from the iron
 30 that surrounds the low-resistance end ring.

I claim as my invention:

1. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring connected thereto, having a
 35 high resistance suitable for low-current, high-torque starting, a low-resistance end ring connected thereto having a low resistance suitable for low-slip operation under running conditions, and iron members fixedly disposed
 40 adjacent to said low-resistance end ring to greatly increase the reactance thereof without materially increasing the reactance of the high-resistance end ring, the resistances of the two end rings and the reactance of the low-resistance end ring being such that the high-resistance ring is effective at the moment
 45 of starting and largely ineffective during running conditions, characterized by the high-resistance end ring having at least several times the resistance of the low-resistance end ring, and the low-resistance end ring having a reactance which, at starting, is higher than the total impedance of the high-resistance end ring, and yet which, at full-speed, is so low
 50 that the total impedance of the low-resistance end ring is less than the resistance of the high-resistance end ring.

2. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring around the outside circumfer-

ence of said bars, taken collectively, and connected thereto, having a high resistance suitable for low-current, high-torque starting, a low-resistance end ring located within the inner circumference of said bars, taken collectively, and connected thereto, having a low resistance suitable for low-slip operation under running conditions, and iron members disposed adjacent to said low-resistance end ring to greatly increase the reactance thereof without materially increasing the reactance of the high-resistance end ring, the resistances of the two end rings and the reactance of the low-resistance end ring being such that the high-resistance ring is effective at the moment
 70 of starting and largely ineffective during running conditions, characterized by the high-resistance end ring having at least several times the resistance of the low-resistance end ring, and the low-resistance end ring having a reactance which, at starting, is higher than the total impedance of the high-resistance end ring, and yet which, at full-speed, is so low that the total impedance of the low-resistance end ring is less than the resistance
 80 of the high-resistance end ring.

3. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring connected thereto, a low-resistance end ring connected thereto at the same end
 85 of the rotor, an iron end plate disposed at that end of the rotor core, the low-resistance end ring being disposed adjacent to said iron end plate, and a channeled iron ring rigidly clamped to said iron end plate, with the low-resistance end ring disposed in its channel, the high-resistance end ring being spaced from said iron members.

4. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring around the outside circumference of said bars, taken collectively, and connected thereto, having a high resistance suitable for low-current, high-torque starting, a low-resistance end ring located within the inner circumference of said bars, taken collectively, and connected thereto, having a low resistance suitable for low-slip operation under running conditions, an iron end plate disposed adjacent to the inner side of the low-resistance end ring but not the high-resistance ring, and a channeled iron ring permanently clamped to said iron end plate, with the low-resistance end ring in its channel.

5. A squirrel-cage induction motor secondary winding adapted to have a high effective resistance at starting, and a low effective resistance at full-speed, the change in resistance being all in the end connections, characterized by having two end connections at each end of the squirrel-cage bars, one end connection being of the desired high resistance for starting, and the other being of at least several times lower resistance for running, the high-resistance end connection hav-

ing a relatively low reactance, as compared to its resistance, at starting, and the low-resistance end connection having a reactance which at starting is higher than the total impedance of the high-resistance end connection, and yet which, at full-speed, is so low that the total impedance of the low-resistance end connection is less than the resistance of the high-resistance end connection.

6. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring around the outside circumference of said bars, taken collectively, and connected thereto, having a high resistance suitable for low-current, high-torque starting, a low-resistance end ring located within the inner circumference of said bars, taken collectively, and connected thereto, having a low resistance suitable for low-slip operation under running conditions, and a thick iron channel member having an annular channel in which said low-resistance end ring is nested, the iron walls of said channel member being of sufficient thickness to produce substantial eddy-current effects at starting, characterized by the high-resistance end ring having at least several times the resistance of the low-resistance end ring, and the low-resistance end ring having a reactance which, at starting, is higher than the total impedance of the high-resistance end ring, and yet which, at full-speed, is so low that the total impedance of the low-resistance end ring is less than the resistance of the high-resistance end ring.

7. A squirrel-cage induction-motor rotor including squirrel-cage bars, a high-resistance end ring around the outside circumference of said bars, taken collectively, and connected thereto, having a high resistance suitable for low-current, high-torque starting, a low-resistance end ring located within the inner circumference of said bars, taken collectively, and connected thereto, having a low resistance suitable for low-slip operation under running conditions, and thick iron material disposed in close proximity to at least two sides of said low-resistance end ring, the thickness of said iron member or members being sufficient to produce substantial eddy-current effects at starting, characterized by the high-resistance end ring having at least several times the resistance of the low-resistance end ring, and the low-resistance end ring having a reactance which, at starting, is higher than the total impedance of the high-resistance end ring, and yet which, at full-speed, is so low that the total impedance of the low-resistance end ring is less than the resistance of the high-resistance end ring.

In testimony whereof, I have hereunto subscribed my name this seventh day of December 1928.

ROBERT R. SHEELY.