S. R. BERGMAN.

INDUCTION MOTOR.

APPLICATION FILED OCT. 21, 1905.

919,527. Patented Apr. 27, 1909.

Fig. 1.

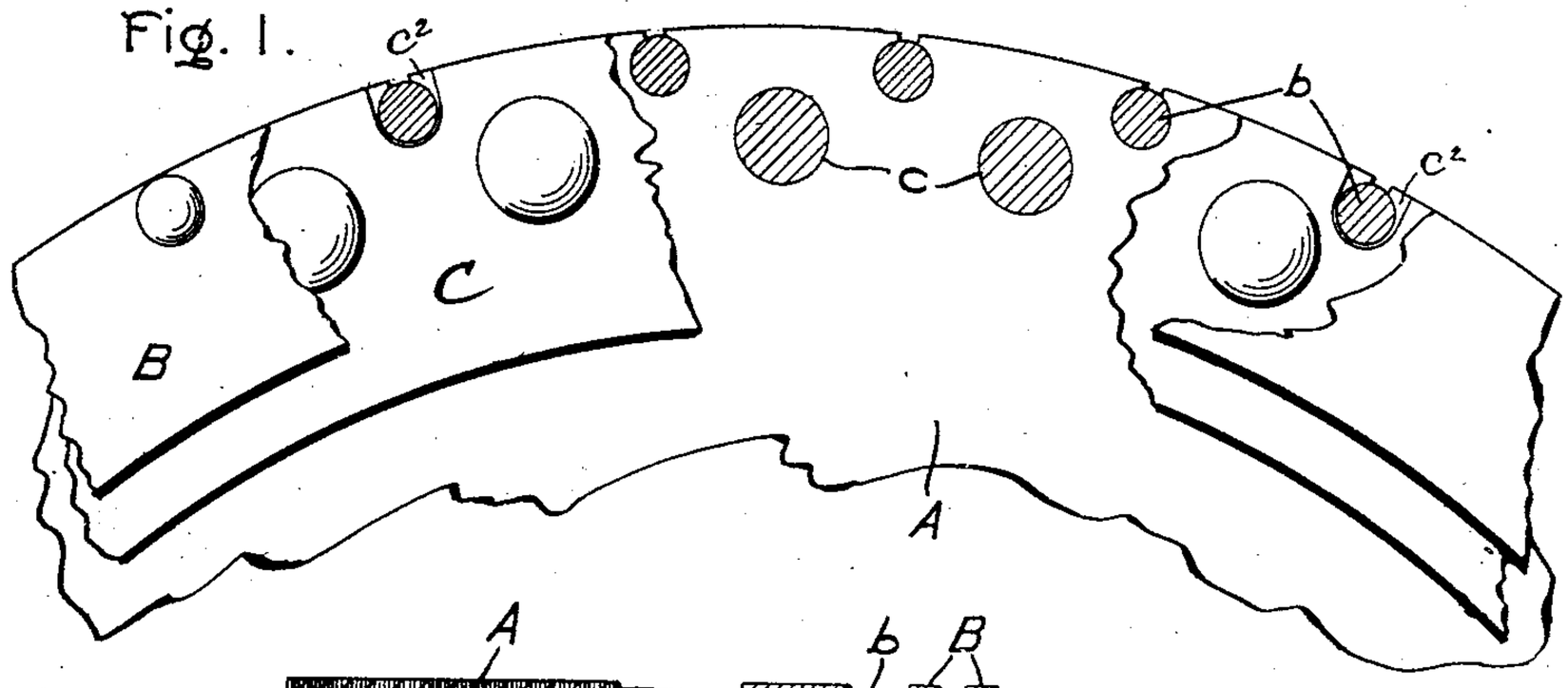


Fig. 2.

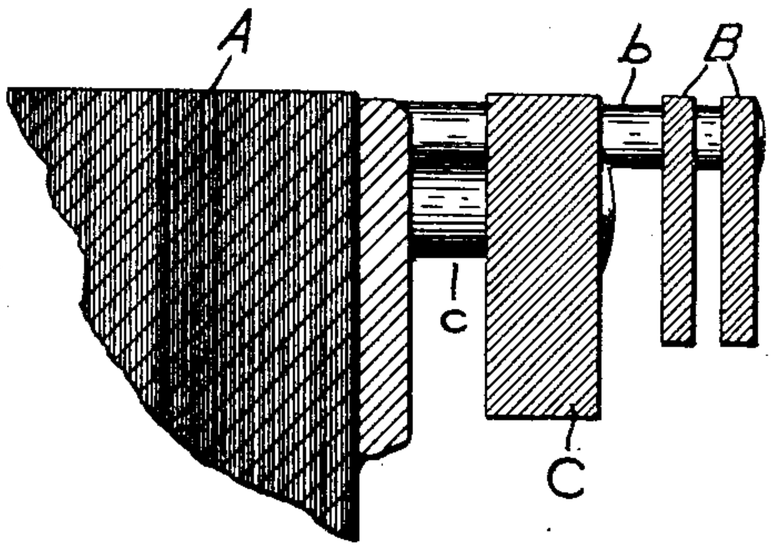


Fig. 3.

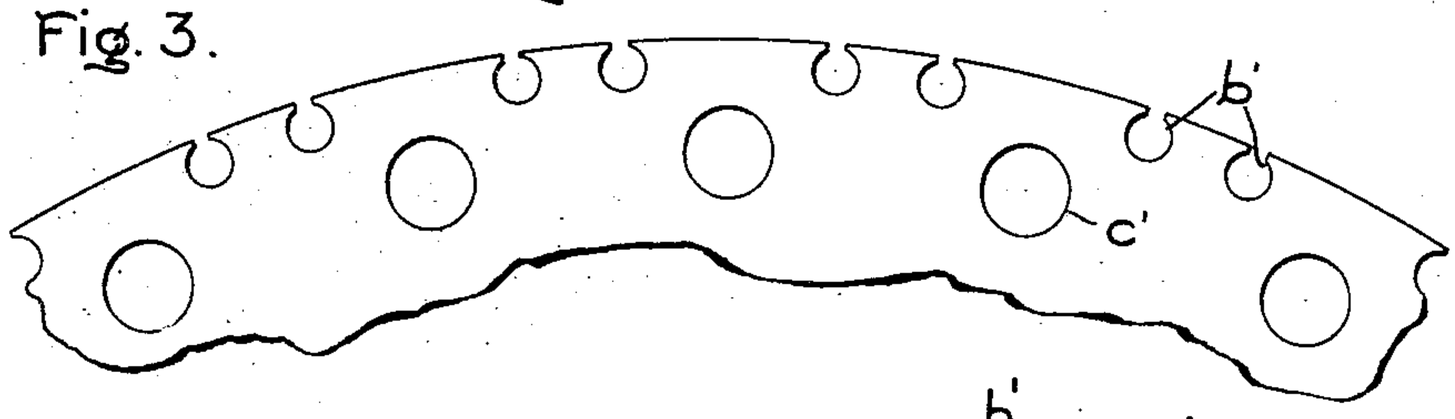
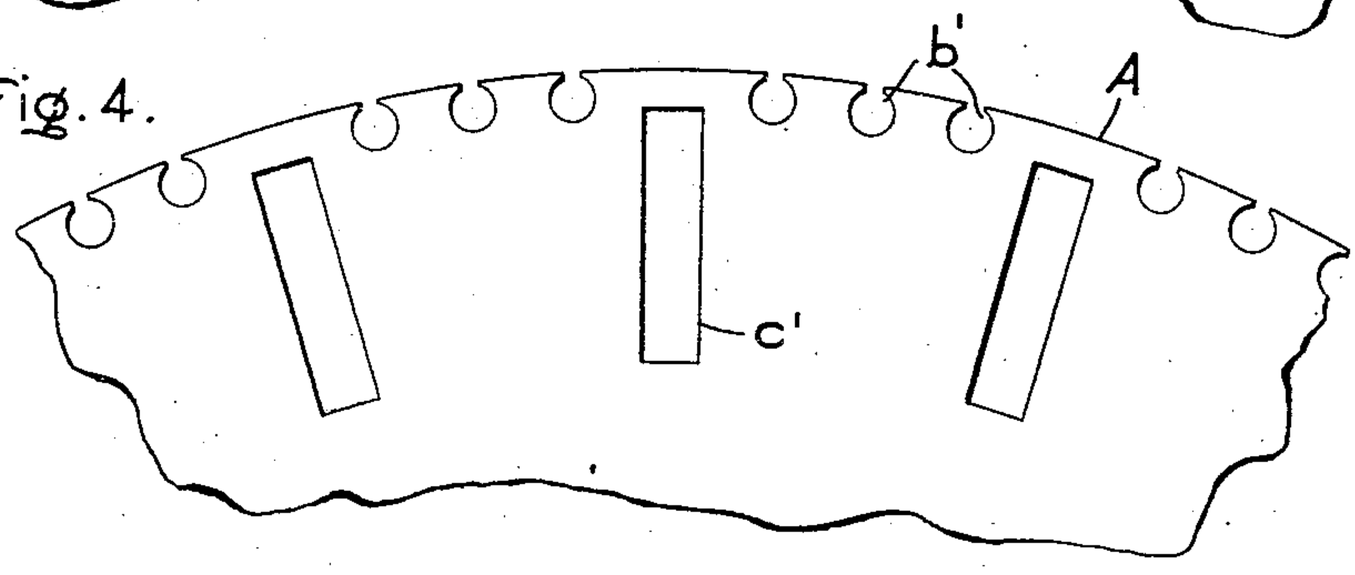


Fig. 4.



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UNITED STATES PATENT OFFICE.

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INDUCTION-MOTOR.

No. 919,527. Specification of Letters Patent. Patented April 27, 1909.

Application filed October 21, 1905. Serial No. 283,756.

To all whom it may concern:

Be it known that I, SVEN R. BERGMAN, a subject of the King of Sweden and Norway, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Induction-Motors, of which the following is a specification.

My invention relates to induction motors, and its object is to provide a simple and efficient construction by means of which, without the employment of external resistances or switching devices of any kind, the motor will be enabled to start under load without an excessive current, and to operate efficiently when up to speed.

It is well understood in the art that in order that an induction motor should start under load without an excessive current-flow, it is necessary that the secondary circuit should possess a high resistance, and on the other hand, that when the motor is up to speed the resistance of the rotor circuit should be low in order to secure efficient operation. In order to secure these results many forms of switching devices, both manual and automatic, have been employed heretofore, and also certain special forms of windings have been devised for producing these results without the use of switching devices.

My invention relates to the latter type of motor and comprises a simple and efficient structure for obtaining the end desired. I take advantage of the difference in the frequencies of the induced rotor currents at starting and when running at full speed, by providing two windings, one of high resistance and low self-induction, and the other of low resistance and high self-induction,—the former carrying the greater part of the load at starting when the frequency of the rotor currents is high, and the latter carrying the load when the rotor is up to speed and the frequency of the induced currents is low.

My invention consists in providing the rotor core with a high-resistance squirrel-cage winding carried in open slots at the periphery of the core and a second low-resistance squirrel-cage winding carried in closed slots in the body of the core. By thus arranging the two windings the high-resistance winding is given a low self-induction, since the self-induction depends, among other things, upon the reluctance of the magnetic path surrounding each conductor. Since the high-resistance conductors are placed in open slots, this reluctance is high and the self-induction consequently low. On the other hand, since the conductors of the low-resistance winding are placed in closed slots and therefore completely surrounded by magnetic material, the reluctance for the flux surrounding each of these conductors is low and the self-induction consequently high. Thus, at starting, owing to the high self-induction of the low-resistance winding, the greater part of the high frequency rotor current flows through the high-resistance winding, while when the motor is up to speed the low-frequency currents then induced in the rotor find a low-resistance path through the low-resistance winding, which then carries the greater part of the load. This action is entirely automatic, and obviously requires no switching device of any kind.

A further feature of my invention consists in so arranging the spacing of the slots as further to increase the difference in the self-inductions of the two windings. The reluctance for the flux surrounding each conductor is increased not only by using an open slot, but also by spacing the slots closely together. This reduces the cross-section of the magnetic material between adjacent conductors, and since adjacent conductors tend to produce opposing fluxes in this portion of the core, the reluctance for the flux surrounding each conductor is raised.

In this further aspect my invention accordingly consists in placing the high-resistance squirrel-cage winding in closely-spaced slots and placing the low-resistance winding in comparatively widely-spaced slots.

My invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 shows an end view of a portion of the rotor of an induction motor arranged in accordance with my invention; Fig. 2 shows a cross-sectional side elevation of a portion of the same; and Figs. 3 and 4 show modifications of the rotor punchings.

In the drawings A represents the rotor core which is built up of laminations in the usual manner. This core carries two squir-

rel-cage windings, one of these windings comprising conductors *b* and short-circuiting end-rings B, is of high resistance, and the conductors are placed in open slots at the periphery of the core, thereby obtaining a comparatively low self-induction, as has been heretofore explained. The other squirrel-cage is of low resistance and comprises the conductors *c* in closed slots in the body of the core and the short-circuiting end-rings C. It is evident that the flux surrounding each conductor *c* has a magnetic path of low reluctance, and consequently this winding has a high self-induction. The two windings are preferably independent, and consequently the end-rings C are cut away, as shown at c^2 in Fig. 1, to provide passages for the conductors *b* to the outer end-rings B. It is not essential to my invention in its broadest aspect, however, that independent end-rings should be employed for the two windings. But end-rings common to both windings do not give as good results electrically as the independent windings shown in the drawings.

As has been explained above, the self-induction of the windings may be increased or diminished by changing the distance between adjacent conductors. Thus, in Fig. 3, the slots *b'* at the periphery for the high-resistance conductors are placed closer together than the closed slots *c'* for the low-resistance conductors, thereby further increasing the difference between the self-inductions of the two windings. Fig. 4 shows another modification in which the high-resistance winding is still further distributed relatively to the low-resistance winding. The slots *c'* for the low-resistance winding are in this figure shown adapted to receive rectangular instead of circular bars.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an induction motor, a rotor core, a high-resistance squirrel-cage winding carried in open slots at the periphery of said core, and a low-resistance squirrel-cage winding carried in closed slots in the body of said core.

2. In an induction motor, a rotor core, a high-resistance squirrel-cage winding carried in closely-spaced open slots at the periphery of said core, and a low-resistance squirrel-cage winding carried in comparatively widely-spaced closed slots in the body of said core.

3. In an induction motor, a rotor core, high-resistance conductors carried in open slots at the periphery of said core, low-resistance conductors carried in closed slots in the body of said core, and independent end-rings separately short-circuiting each set of conductors.

4. In an induction motor, a rotor core, high-resistance conductors carried in open slots at the periphery of said core, low-resistance conductors carried in closed slots in the body of said core, and independent parallel end-rings separately short-circuiting each set of conductors, the inner end-ring being cut away to afford passage for one set of conductors to the other end-ring.

5. In an induction motor, a rotor core, high-resistance conductors carried in closely-spaced open slots at the periphery of said core, low-resistance conductors carried in comparatively widely-spaced closed slots in the body of said core, and independent end-rings separately short-circuiting each set of conductors.

6. In an induction motor, a rotor core, high-resistance conductors carried in closely spaced slots in said core, low-resistance conductors carried in comparatively widely spaced slots, and independent end-rings separately short-circuiting permanently each set of conductors.

In witness whereof, I have hereunto set my hand this nineteenth day of October, 1905.

SVEN R. BERGMAN.

Witnesses:

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