— AC Motor —

Anatomy of a Motor

Any electrical motor, from an idealized viewpoint, consists of two sets of magnets—one set stationary, one set free to move—placed in special geometric relation to one another.

For most practical motors, electromagnets are employed: they don't weaken as permanent magnets do, but they must be energized with currents to have any magnetic force at all. These electromagnets are generally mounted in two rings, one set within the other, and connected up so that polarities will alternate north-south in each ring of pole projections. As to which set of magnets is to move (the *rotor*) and which to stand still (the *stator*), either will do. Though most familiar motors spin the inner array, some other designs rotate the entire outer circumference around a stationary center.

Magnets, even electromagnets, have no natural need to keep moving. A rotor with 12 sets of poles mounted on a shaft so as to nearly contact 12 sets of surrounding stator windings would move itself just enough to tug attracting north-south pairs into closest alignment. And there the arrangement would sit, humming quietly, wasting electricity, and going nowhere.

To become a motor, the useless device imagined above must constantly reverse the north-south polarity of its electromagnets. We'll suppose in a particular motor the rotor poles remain constant while the stator's switch constantly. Then, the rotor's unchanging poles cannot find a resting place. Each is pulled a little distance toward an opposite pole only to have it reverse just as the two poles reach alignment. The rotor pole is then repelled, sent in the direction of the next stator pole, which happens, moreover, to be rebuilding its field at the attractive polarity. It's an electrical con game, bait and switch, taking place many times each second that makes a motor turn.

AC and DC Motors

AC motors before Tesla were rare, laboratory devices—curiosities. They never ran smoothly, perhaps because a good design needed to anticipate and utilize the rather more complex, dynamic rules that govern currents and fields in AC circuits.

Direct current was the name of the game prior to Tesla. Yet direct current motors have one obvious drawback: reversing current direction through magnet windings can happen only with some sort of switching that swaps current direction end for end. In practice, this is normally done by applying power through a pair of stubby contacts, called "brushes," that ride against the spinning rotor shaft, against a ring of contacts (the "commutator"); the commutator, thus, is always rotating its connections with the brushes, sending current through the rotor windings first in one direction and then the other.

Tesla's Invention

What Tesla conceived is essentially this: an alternating current fed to stator windings would create poles that reversed themselves without any mechanical aid. Though the stator remains motionless its fields are, in effect, whirling around its interior from one pole face to the next.

Two-phase induction motor

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Learn more about the differences between alternating and direct current.

View AC motor patents 381,968, 390,414, 417,794, and 555,190.

Early Tesla induction motor

He understood, as well, no physical power connection need be applied to the rotor. Rotor poles might be made to generate their currents by induction from the stator fields —a tricky proposition in 1888, for the conditions of voltage, current, and field must be choreographed very closely.

AC motors proved both durable and adaptable. Within the space of two years Tesla had patented over twenty useful modifications of his new motors: to start up under heavy loads, to run at variable speed, or at constant speed, or with polyphase power supply, to mention a few. The great advantage of polyphase motors is, for a given number of poles, a smoother, more intense whirling field; such motors, in myriad forms, launched the electrical age of heavy industry. A somewhat more modest lineage of AC motors has powered most of the familiar appliances of twentieth-century life, from refrigerators to coffee grinders.

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