In the servo world, we are concerned only with DC motors, and have a choice of those equipped with an older style magnet-armature-brushes motor and the newer "coreless" motors. Basically, a DC motor is a magnetic device, consisting of permanent and electro-magnets - that is, those that produce magnetism only when current is applied. And we remember from our high school physics; all magnets have "north" and "south" poles. And, that like poles repel while unlike poles attract each other. In the DC motor, you have a moveable electro-magnet, the armature in which the polarity is reversed as it rotates, by a segmented part called a commutator and the brushes. Things are timed so that as an armature magnet pole approaches a permanent magnet pole, they differ and so attract each other. As the armature passes, the polarity is changed so that they now repel. The number of windings in the armature, thus the number of electro-magnets in it, is the number of "poles" in that particular motor.

Now, the "coreless" motor! In the motor just described, the armature is a heavy metal part around which the magnet wire is wound. In the coreless motor, this metal part is eliminated, the wire windings are self supported, and no doubt in some sort of encapsulation, but their effect is basically the same. The advantages is that, being much lighter, this assembly reaches its maximum speed faster, and when commanded to stop, will also do so faster due to its lack of weight and thus inertia.

In R/C, the coreless motor servo is considered superior; also being higher rated for speed and torque. Also more expensive, but those flyers skillful enough to tell the difference all seem to use them.

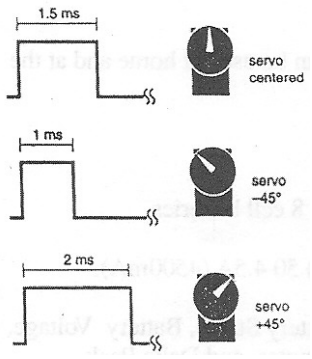
Some asides! In spite of what some of the ads might lead you to believe, the small, extremely high quality motors found in our servos are not produced primarily for our industry. They are actually made for the camera trade, which is much larger than that for radio control equipment. And, periodically you will read in the model press the "motor/engine" nomenclature controversy. Nobody is calling a motor an engine, except the youngsters into R/C cars, but some like to make the point that an engine is a motor, and that otherwise "General Motors" would be called "General Engines". Well, in my opinion, I think GM is wrong! My electronics text does not mention engines, but all describe a motor as a device that converts electrical into mechanical energy. Right? Right! Engines do not do that! The Auto Club agrees with me, in its Jan/Feb magazine, in a discussion about the recently introduced "hybrid" vehicles, it refers to them as having "both an electric motor and a gasoline engine".

I find it interesting also, that with my limited foreign language skills - my Swahili and Farsi are not too good! - English is the only language that has both words in common use. In Spanish and German, both are a "motor", with slightly different inflections of course; in French the word is "moteur"; in Italy that thing that powers your Ferrari is a "motore". Go figure!

Back to the subject at hand! Of course, in the R/C servo, that electrical energy now converted to mechanical energy (Ha!) is first harnessed to a high-ratio gear train, which actually determines the output wheel's speed and the available torque. For example, the Airtronics 94357 and -358 servos are 4.8 volts rated at 0.09 seconds, 100 ounce/inches of torque; and 0.13 seconds, 160 ounce/inches respectively. Notice that the 357, the faster one, has less torque, and vice versa. The only difference between the two is the ratio of the gear train. Airtronics publishes 6.0 volt ratings for these servos, also in the twenty percent increase range previously mentioned.

Now what turns the ordinary - or not so ordinary, as some replacement servo motors cost $30 to $40 - into one of our R/C wonders is the amplifier that controls it. They are amazing pieces of electronics; in that small package are precise timing circuits, comparators, and other components capable of handling the oft times high current demands of the motor.

Regardless of the motor type, or since we now have, in addition to the old type servos we've used for years, we now have "digital" servos, which will be discussed later, all servos are controlled by a Pulse Width Modulation signal. In effect, the transmitters emit a string of timed pulses, at around a fifty Hertz (times per second) rate, one pulse for each channel. The receiver separates these pulses, and directs them to the proper servo. In probably the only standard within the entire R/C industry, the length of each of these pulses is a nominal 1.0 to 2.0 milli-second (mS), with the average 1.5 mS signal resulting in servo neutral.



Similarly, regardless of the type of R/C system, AM, FM, PCM, or the erroneously named PPM, the receiver output signal to the servos is the same, even