SPRING 80

SCIENCE & MECHANICS

"We don't grant patents on perpetual motion machines," said the examiners at the U.S. Patent Office. "It won't work because it violates the law of Conservation of Energy," said one physicist after another. But because inventor Howard Johnson is not the sort of man to be intimidated by such seemingly authoritative pronouncements, he now owns U.S. Patent No. 4,151,431 which describes how it is possible to generate motive power, as in a motor, using only the energy contained in the atoms of permanent magnets. That's right. Johnson has discovered how to build motors that run *without* an input of electricity or any other kind of *external* energy!

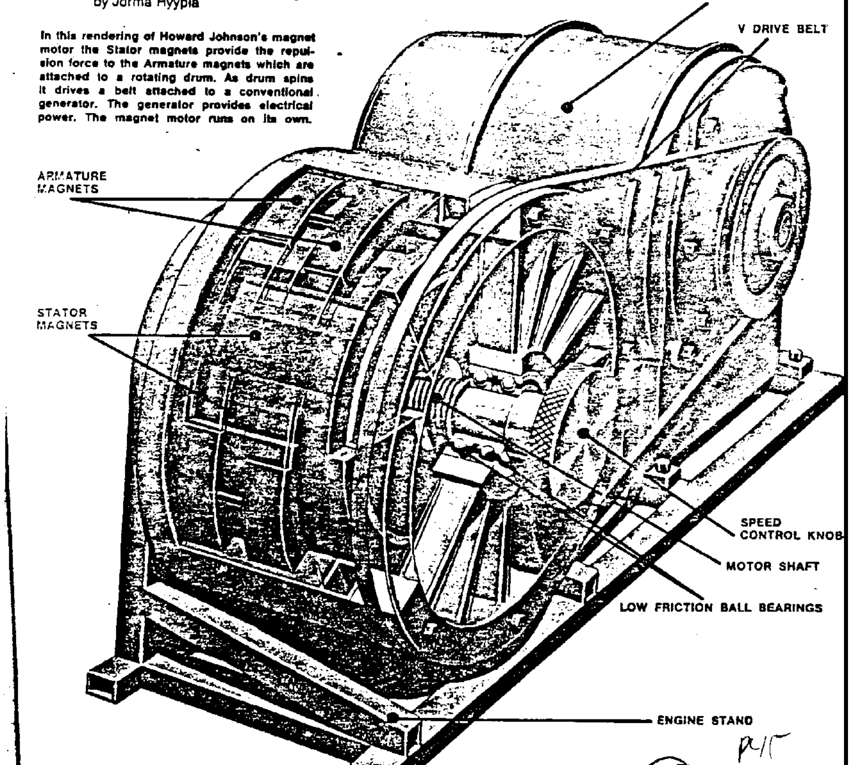
The monumental nature of this invention is obvious, especially in a world facing an alarming, escalating energy shortage. Yet inventor Johnson is not rushing to peddle his creation as the end-all solution to world-wide

AN S&M SPECIAL

Amazing Magnet-Powered Motor

by Jorma Hyypia

In this rendering of Howard Johnson's magnet motor the Stator magnets provide the repulsion force to the Armature magnets which are attached to a rotating drum. As drum spins it drives a belt attached to a conventional generator. The generator provides electrical power. The magnet motor runs on its own.



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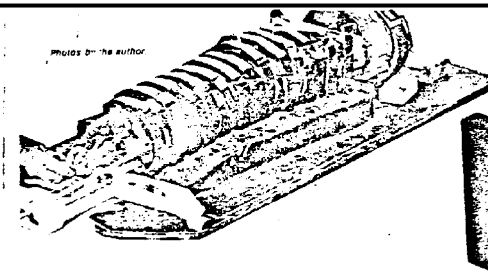
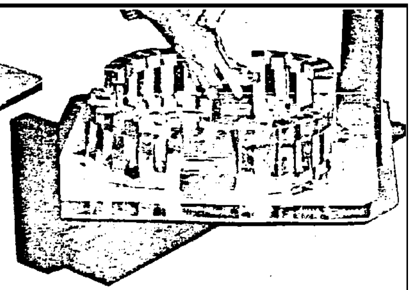
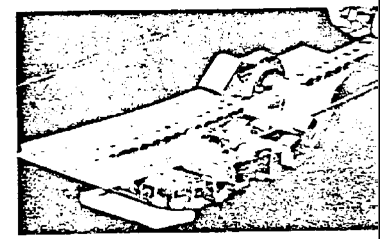
Photos by the author





MAGNET-POWERED MOTOR

Pictured here are three of the inventor's early models. Top left is a linear motor which propels a magnetic vehicle at high speeds through a series of rings. Top right is rotary motor upon which the prototype will be built. The eight ounce magnet, hand held to the large ring weighing 40 pounds, provides enough force to spin the entire assembly. In the assembly at right the vehicle is propelled, in either direction, by the force of the large magnets arranged below tracks.



energy problems. He has more important work to do. First, there's the need to refine his laboratory prototypes into workable practical devices—in particular a 5,000-watt electric power generator already in the building. His second and perhaps more difficult major challenge: persuade a host of sceptics that his ideas are indeed practical.

Johnson, who has been coping with disbelievers for decades, can be very persuasive in a face-to-face encounter because he can now do more than merely theorize; he can demonstrate working models that unquestionably create motion using only permanent magnets. When this writer was urged by the editor of SCIENCE & MECHANICS to make a thousand mile pilgrimage to Blacksburg, Virginia, to meet with the inventor, he went there as an "open-minded skeptic" and as a former research scientist determined not to be fooled. Within two days, this former skeptic had become a believer. Here's why.

Doing the Unthinkable. Howard Johnson refuses to view the "laws" of science as somehow sacred, so doing the unthinkable and succeeding is second nature to him. If a particular law gets in the way, he sees no harm in going around it for a while to see if there's something on the other side. Johnson explains the persistent opposition he experiences from the established scientific community this way: "Physics is a measurement science and physicists are especially determined to protect the 'Law' of Conservation of Energy. Thus the physicists become game wardens who tell us what 'laws' we can't violate. In this case they don't even know what the game is. But they are so scared that I and my associates are going to violate some of these laws, that they have to get to the pass to head us off!"

The critics say Johnson offers a "free lunch" solution to energy problems, and that there can be no such thing. Johnson demurs, reminding repeatedly that he has never suggested that his invention provides something for nothing. He also points out that no one talks about a "free lunch" when discussing extraction of enormous amounts of atomic power by means of nuclear reactors and atom bombs. In his mind, it's much the same thing.

Johnson is the first to admit he doesn't actually know where the power he has tapped derives. But he postulates that the energy may be associated with spinning electrons, perhaps in the form of a "presently unnamed atomic particle." How do other physicists react to Johnson's suggestion that there may be an atomic particle so far overlooked by nuclear physicists? Says Johnson: "I guess it's fair to say that most of them are revolted." On the other hand, a few converted scientists, including some who are associated with large and prestigious research laboratories, are intrigued enough to suggest that there should be a hunt for the answer, be it a "particle" or some other as yet unsuspected characteristic of atomic structure.

This article is prefaced with the foregoing brief summary of the ongoing controversy so that, in fairness to the inventor, we might all view his claims with open minds, even if it means temporary setting aside of cherished scientific concepts until more complete explanations are forthcoming. The main question to be answered here and now is this: Does Johnson's permanent magnet motor work?

Before providing the answer, we need to face up to another question that undoubtedly nags in the minds of many readers: Is Johnson a bona fide researcher, or merely a "garage mechanic" mad inventor? As the following brief summary suggests, the inventor's credentials appear to be impeccable. Following seven years of college and university training, Johnson worked on atomic energy projects at Oak Ridge, did magnetics research for Burroughs company, and served as scientific consultant to Lukens Steel. He has participated in development of medical electrical products, including injection devices. For the military he invented a ceramic muffler that makes a portable motor generator silent at 50 feet; this has been in production for the past 18 years. His contributions to the motor industry include: a hysteresis brake; non-locking brake materials for anti-

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skid application, new methods of curing brake linings; and a method of dissolving asbestos fibers. He has also worked on silencers for small motors, a super charger, and has perfected a 92-pole no-brush generator to go in the wheel of Lincoln automobiles as a skid control; that last item reduced the cost to one-eighth of the cost of an earlier design by utilizing metal-filled plastics for the armature and field. In all, Johnson is connected with more than 30 patents in the fields of chemistry and physics.

Sticky Tape Scientist. Despite his impressive credentials, this amiable and unpretentious inventor likes to characterize himself as a "sticky tape" scientist. He sees no virtue in wasting time building fancy, elaborate equipment when more simple assemblies serve as well to test new ideas. The prototype devices shown in the photographs in this article were assembled with sticky tape and aluminum foil, the later material being used mainly to keep individual permanent magnets packaged together so that they do not fly apart.

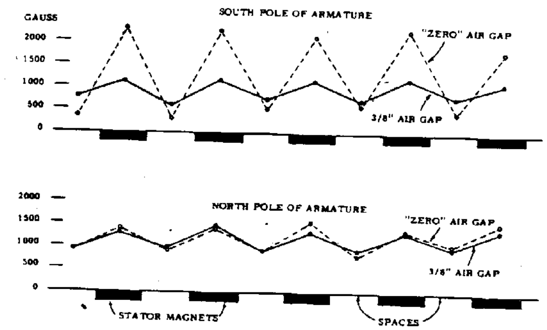
Perhaps the best way to describe what these three gadgets do is by reciting this writer's personal experiences during the interview demonstration. That way I will not merely be telling what the inventor says they do, but I will reveal what happened when I tried the experiments myself. When we start talking about how and why the things work as they do, we'll have to rely on the inventor's explanations.

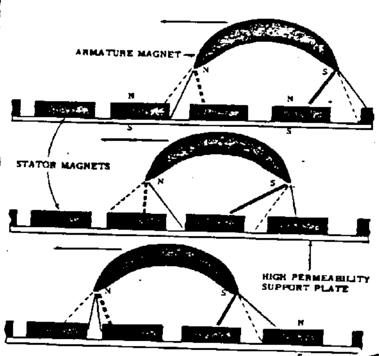
The first item consists of more than a dozen foil-wrapped magnets assembled to form a broad arc. Each magnet is extended upward slightly at each end to form a low U-shape, the better to concentrate magnetic fields where they are needed. The overall curvature of the mass of magnets apparently has no particular significance except to show that the distance between these stator magnets and the moving vehicle is not critical. A transparent plastic sheet atop this magnet assembly supports a length of plastic model railroad track. The vehicle, basically a model railroad flatcar, supports a foil-wrapped pair of curved magnets, plus some sort of weight, in some cases merely a rock. The weight is needed to keep the vehicle down on the track, against the powerful magnetic forces that would otherwise push it askew. That is all there is to the construction of this representation of a "linear motor."

I was prepared to develop eye strain in an effort to detect some sort of motion in the vehicle. I need not have been concerned. The moment the inventor let go of the vehicle he carefully placed at one end of the track, it accelerated and literally *zipped* from one end to the other and flew onto the floor! Wow!

I tried the experiment myself, and could feel the powerful magnetic forces at work as I placed the vehicle on the track. I gently eased the vehicle to the critical starting point, taking great care

Despite his credentials inventor Johnson has met with criticism. "I'm not offering a 'free lunch' solution to the energy problem," he says. "Magnetic particles act like atomic particles. And nobody, discredits the power of the atom."





Above are plots of experimental data showing the dramatically different magnetic effects at the north and south poles of armature magnet. These are "stepped" readings made over the stator magnets and spaces between them. If the magnetic flux patterns are plotted on a continuous basis as the armature moves along the stator track, the result is a "sinusoidal" graph. At right is diagram showing complex magnetic forces interacting to create off-balance effects that move the armature from right to left. Solid lines show magnetic attraction, dashed lines show repulsion. Double lines represent the more powerful forces at work.

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not to exert any kind of forward push, even inadvertently. I let go. *Zip!* It was on the floor again, at the other end of the track. Knowing that I would be asked if the track might have had a slant, I reversed the vehicle and started it from the opposite end of the track. It worked just as effectively in the reverse direction. In fact, the vehicle can even navigate a respectable upgrade. In light of these tests, and considering the remarkable speed of the vehicle, you can discount any notion that this was a simple "coasting" effect.

Incidentally, the photograph shows the vehicle about half ways along the track. It was "frozen" there by the electronic flash used to make the picture; there is no way of "posing" the vehicle in that position short of tying it down.

The second device has the U-shaped magnets standing on end in a rough circular arrangement oddly reminiscent of England's Stonehenge. This assembly is mounted on a transparent plastic sheet supported on a plywood panel pivoted, underneath, on a free-turning wheel obtained from a skateboard. As instructed, I eased the 8-*ounce* "focusing" magnet into the ring of larger magnets, keeping it at least four inches away from the ring. The 40-*pound* magnet assembly immediately began to turn and accelerated to a very respectable rotating speed which it maintained for as long as the focusing magnet was held in the magnetic field. When the focusing magnet was reversed, the large assembly turned in the opposite direction.

Since this assembly is clearly a crude sort of motor, there's no doubt that it is indeed possible to construct a motor powered solely by permanent magnets.

The third assembly, which looks like the bones of some prehistoric sea creature, consists of a tunnel constructed of rubber magnet material that can be easily bent to form rings. This was one of the demonstration models Johnson took to the U.S. Patent Office during his appeal proceedings. Normally the patent examiners spend only a few minutes with each patent applicant, but played with Johnson's devices for the better part of an hour. As the inventor was leaving, he overheard one sideline observer remark: "How would you like to follow *that* act?!"

It took Johnson about six years of legal hassling to finally obtain his patent, and he has been congratulated for his ultimate victory over patent office bureaucracy as well as for his inventiveness. One sign that he left the patent office more than a little shaken by the experience was the inclusion of diagramatic material in the printed patent that does not belong there. So if you look up the patent, pay no attention to the "ferrite" graph on the first page; it belongs in some other patent!

The tunnel device of course worked very well in the inventor's office during my visit although Johnson observed that the rubber magnets are perhaps a thousand times weaker than the cobalt/samarium magnets used in the other assemblies. There's just one big problem with the more powerful magnets: they cost too much. According to the inventor, the magnets used to construct the Stonehenge rotating model are collectively worth more than one thousand dollars. But there's no need to depend solely on mass-production economies to bring the cost down to competitive levels. Johnson and U.S. Magnets and Alloy Co. are in the process of developing alternative, relatively low cost magnetic materials that perform very well.

How Do They Work? The drawing *(Continued on page 114)*

"Zero" Air Gap SOUTH POLE of Armature over: Spaces (Repulsion)	Stator Magnets (Attraction)	⅜" Air Gap SOUTH POLE of Armature over: Spaces (Repulsion)	Stator Magnets (Attraction)
825	1650	850	1250
675	2200	550	1175
600	2200	650	1150
500	2175	650	1150
375	2325	800	1150
300	2275	600	1175
525	2150	750	1150
600	2275	700	1200
450	1800	800	1100
550	1700	850	1150
575	1825	650	975
400	2050	850	1250
475	2150	675	1350
6,950 Gauss	26,775 Gauss	9,475 Gauss	15,225 Gauss
33,725 Gauss (Total)		24,700 Gauss (Total)	
9,025 Gauss (Difference)			

"Zero" Air Gap NORTH POLE of Armature over: Spaces (Attraction)	Stator Magnets (Repulsion)	⅜" Air Gap NORTH POLE of Armature over: Spaces (Attraction)	Stator Magnets (Repulsion)
750	1600	875	1100
700	1450	850	1450
850	1500	950	1400
1175	1600	925	1375
950	1400	825	1350
900	1400	950	1450
950	1575	925	1350
800	1350	925	1350
1050	1550	1000	1350
1000	950	925	1100
850	1700	875	1250
800	1900	775	1275
550	1400	600	1300
11,325 Gauss	19,375 Gauss	11,600 Gauss	17,100 Gauss
30,700 Gauss (Total)		28,700 Gauss (Total)	
2,000 Gauss (Difference)			

Readings taken at the north and south pole of the armature magnet indicate there is constant off balance situation. Note in one case the total difference is 2000 Gauss while in the other the total is 9,025 Gauss. The force conditions are far from identical.

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MASS TRANSIT
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In a sense, as urban transportation demands grow and as additional funding becomes available, new transit sections can be easily "plugged into" those already operating. The use of modular systems also ensures that equipment malfunction in one section will not affect normal operation in other parts of the network.

How Soon? AGRT boosters say there is no time to waste and the development of AGRT should be given top priority if the nation is to escape a major transportation calamity. We are assured that, given continuing and adequate financial support, an initial AGRT system can be operational by mid 1985, and full urban network capability by the late 1980s.

Cities earmarked for special consideration in the development of AGRT systems include Los Angeles, St. Paul, Detroit, Miami, Houston, St. Louis, Norfolk, Baltimore, Jacksonville and Indianapolis. ■■■

TURNTABLES, CARTRIDGES
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But fixed-coil magnetic cartridges are the most popular by far. They are available at a wide number of price points and usually have user-replaceable styli. The better ones track at very low force and are of quite high compliance. When terminated properly, the better fixed-coil cartridges yield excellent frequency response on the test bench. And typically, they are highly sensitive and afford a good signal-to-noise ratio.

Splitting the Budget. It's tempting to give a glib answer to the perennial question: how should I split my record-player budget between turntable, arm, and cartridge? Indeed, simplistic answers are often proffered. In my opinion, there is no simple answer. I've used relatively inexpensive turntables that, in practice, performed as well as more expensive ones. And, I've not found a one-to-one relationship between cartridge cost and performance either.

I don't mean to imply that the more expensive cartridge in a manufacturer's line is no better than the least expensive one. Almost invariably, it is. But, if you don't like the sound characteristics of a certain manufacturer's cartridges, simply buying a more expensive cartridge in that same family is not likely to satisfy your taste. You may find a less expensive cartridge from a different manufacturer that suits you better. When it comes to turntables, the first bucks buy you the most performance. Additional money frequently goes into additional features. You may want them and find the investment well worthwhile. Or you may not. It's up to you.

Regardless of how much money you spend, you'll get the most for it by assuring that your turntable, arm, and cartridge mate as a system. Neither arm nor cartridge will provide the performance of which it's capable if the two are grossly mismatched. Nor will you be pleased with the sound if a specific system is so skittish that the stylus loses contact with the groove when you walk across the floor. So compatibility is important, and that's what this article has been about. ■■■

MAGNET-POWERED MOTOR
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that shows a curved "arcuate" armature magnet in three successive positions over a line of fixed stator magnets provides at least highly simplified insights into the theory of permanent magnet motive power generation. Johnson says curved magnets with sharp leading and trailing edges are important because they focus and concentrate the magnetic energy much more effectively than do blunt-end magnets. These arcuate magnets are made slightly longer than the lengths of two stator magnets plus the intervening space, in Johnson's setups about 3⅛ inches long.

Note that the stator magnets all have their North faces upward, and that they are resting on a high magnetic permeability support plate that helps concentrate the force fields. The best gap between the end poles of the armature magnet and the stator magnets appears to be about ⅛ inch.

As the armature north pole passes over a magnet, it is repelled by the stator north pole; and there's an attraction when the north pole is passing over a space between the stator magnets. The exact opposite is of course true with respect to the armature South pole. It is attracted when passing over a stator magnet, repelled when passing over a space.

The various magnetic forces that come into play are extremely complex, but the drawing shows some of the fundamental relationships. Solid lines represent attraction forces, dashed lines represent repulsion forces, and double lines in each case indicate the more dominant forces.

As the top drawing indicates, the leading (N) pole of the armature is repelled by the north poles of the two adjacent magnets. But, at the indicated position of the armature magnet, these two repulsive forces (which obviously work against each other) are not identical; the stronger of the two forces (double dashed line) overpowers the other force and tends to move the armature to the left. This left movement is enhanced by the attraction force between the armature north pole and the stator south pole at the bottom of the space between the stator magnets.

But that's not all! Let's see what is happening simultaneously at the other end (S) of the armature magnet. The length of this magnet (about 3⅛ inches) is chosen, in relation to the pairs of stator magnets plus the space between them, so that once again the attraction/repulsion forces work to move the armature magnet to the left. In this case the armature pole (S) is attracted by the north surfaces of adjacent stator magnets but, because of the critical armature dimensioning, more strongly by the magnet (double solid line) that tends to "pull" the armature to the left. It overpowers the lesser "drag" effect of the stator magnet to the right. Here also there is the added advantage of, in this case, repulsion force between the south pole of the armature and the south pole in the space between the stator magnets.

The importance of correct dimensioning of the armature magnet cannot be over-emphasized. If it is either too long or too short, it could achieve an undesirable equilibrium condition that would stall movement. The objective is to optimize all force conditions to develop the greatest possible *off-balance* condition, but always in the same direction as the armature magnet moves along the row of stator magnets. However, if the armature is rotated 180 degrees and started at the opposite end of the track, it would behave in exactly the same manner except that it would, in this example, move from left to right. Also note that once the armature is in motion, it has *momentum* that helps carry it into the sphere of influence of the next pair of magnets where it gets another push and pull, and additional momentum.

Complex Forces. Some very complex magnetic forces are obviously at play in this deceptively simple magnetic system, and at this time it is impossible to develop a mathematical model of what actually occurs. However, computer analysis of the system, conducted by Professor William Harrison and his associates at Virginia Polytechnic Institute (Blacksburg, Va.), provide vital feedback information that greatly helps in the effort to optimize these complex forces to achieve the most efficient possible operating design.

As Professor Harrison points out, in addition to the obvious interaction between the two poles of the armature magnet and the stator magnets, many other interactions are in play. The stator magnets affect each other and the support plate. Magnet distances and their strengths vary despite best efforts of manufacturers to exercise quality controls. In the assembly of the working model, there are inevitable differences between horizontal and vertical air spaces. All these interrelated factors must be optimized, which is why computer analysis in this refinement stage is vital. It's a kind of information feedback system. As changes are made in the physical design, fast dynamic measurements are made to see whether the expected results have actually been achieved. The new computer data is then used to develop new changes in the design of the experimental model. And so on, and on.

That very different magnetic conditions exist at the two ends of the armature is shown by the actual experimental data displayed in the table and associated graph. To obtain this information, the researchers first passed the probe of an instrument used to measure magnetic field strengths over the stator magnets and the intervening spaces. We shall call this the "Zero" level although there is a very tiny gap between the probe and the tops of the stator magnets. These measurements in effect indicate what each pole of the armature magnet "sees" below as it passes over the stator magnets.

Next the probe is moved to a position just beneath one of the armature poles, at the top of the ⅛-inch armature-to-stator air gap. Another set of magnetic flux measurements is made. The procedure is repeated with the probe positioned just beneath the other armature pole.

Now "instinct" might suggest, and correctly so, that the flux measurements at the top and bottom of the air gap will differ. But if "instinct" also suggests that these differences are pretty much the same at the two armature pole positions, you would be very much in error!

First study the two tables that show actual flux density measurements. Note that in this particular experiment the total magnetic flux amounted to 30,700 Gauss (the unit of magnetic strength) when the probe was held at the "Zero"
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level under the north pole of the magnet, and a total of 28,700 Gauss when the probe was moved to the top of the ⅝-inch air gap. The difference between these total measurements is 2,000 Gauss.

Similar readings made at the air gap between the south pole of the armature and the stator magnets indicates a total flux at "Zero" level of 33,725 Gauss, and 24,700 Gauss at the top of the air gap. This time the difference is a much larger 9,025 Gauss, or four and one half times greater than for the north pole! Clearly, the magnetic force conditions are far from identical at the two ends of the armature magnet.

The middle five pairs of figures from each table have been plotted in graphic form to make these differences more obvious. In the top "South Pole" graph the dashed line connects the "Zero" level readings made over the stator magnets and over the intervening air spaces. Points along the solid line indicate comparable readings made with the probe just beneath the armature south pole. It is easy to see that there is an average 43 percent *reduction* of the *attraction* between the armature and stator magnets created by the air gap. Equally true, but perhaps not so obvious, is the fact that there is an average 38 percent *increase* of *repulsion* when the south pole of the armature pases over the spaces between the stator magnets. The percentage increase only seems smaller because it applies to a much smaller "Zero" level value.

The second graph shows that the changes are much less dramatic at the north pole of the armature. In this case there's an average 11.7 percent *decrease* of *attraction* over the spaces, and a 2.4 percent *increase* of *repulsion* when the armature north pole passes over the stator magnets.

As you study the data, be sure to note that the columns are labeled differently. In the case of the north pole data, the stator *magnet* areas *repulse* the armature north pole while the *spaces* between the stator magnets *attract*. The conditions are exactly the opposite for the south pole of the armature magnet. When the south pole passes over a magnet, there is strong attraction; when it passes over a space, there is repulsion.

The Ultimate Motor. A motor based on Johnson's findings would be of extremely simple design compared to conventional motors. As shown in the diagrams developed from Johnson's patent literature, the stator/base unit would contain a ring of spaced magnets backed by a high magnetic per-

meability sleeve. Three arcuate armature magnets would be mounted in the armature which has a belt groove for power transmission. The armature is supported on ball bearings on a shaft that either screws or slides into the stator unit. Speed control and start/stop action would be achieved by the simple means of moving the armature toward and away from the stator section.

There is a noticeable pulsing action in the simple prototype units that may be undesirable in a practical motor. The movement can be smoothed, the inventor believes, by simply using two or more staggered armature magnets as shown in another drawing.

What's Ahead? For inventor Howard Johnson and his permanent magnet power source there's bound to be plenty of controversy, certainly, but also progress. A 5000-watt electric generator powered by a permanent magnet motor is already on the way, and Johnson has firm licensing agreements with at least four companies at this writing.

Will we see permanent magnet motors in automobiles in the near future? Johnson wants nothing to do with Detroit at this time because, as he puts it: "It's too emotional—we'd get smashed into the earth!" The inventor is equally reluctant to make predictions about other applications as well, mainly because he just wants time to perfect his ideas and, hopefully, get the scientific establishment to at least consider his unorthodox ideas with a more open mind.

For example, Johnson argues that the magnetic forces in a permanent magnet represent superconductance that is akin to phenomena normally associated only with extremely cold superconducting systems. He argues that a magnet is a room temperature superconducting system because the electron flow does not cease, and because this electron flow can be made to do work. And for those who pooh-pooh the idea that permanent magnets do work, Johnson has an answer: "You come along with a magnet and pick up a piece of iron, then some physicist says you didn't do any work because you used that magnet. But you moved a mass through a distance. Right? That's work that requires energy. Or you can hold one magnet in the air indefinitely by positioning it over another magnet with like poles facing. The physicists will argue that because it involves magnetic repulsion, no work is done. Yet if you support the same object with a jet of water or a stream of air, they will agree in a minute that work is done!"

There's no doubt in Johnson's mind that he has succeeded in extracting usable energy from the atoms of permanent magnets. But does that imply that the electron spins and associated phenomena that he thinks provide this power will eventually be used up? Johnson makes no pretense of knowing the answer: "I didn't start the electron spins, and I don't know any way to stop them—do you? They may eventually stop, but that is not my problem."

Johnson still has many practical problems to solve to perfect his invention. But his greater challenge may be to win general acceptance of his ideas by an obviously nervous scientific community in which many physicists remain compulsive about defending the law of Conservation of Energy without ever wondering whether that "law" really needs defending.

The dilemma facing Johnson is not really his dilemma but rather that of other scientists who have observed his prototypes. The devices obviously *do* work. But the textbooks say it shouldn't work. And all that Johnson is really saying to the scientific community is this: here is a phenomenon which seems to contradict some of our traditional beliefs. For all our sakes let's not dismiss it outright but take the time to really understand the complex forces at work here. ■ ■ ■