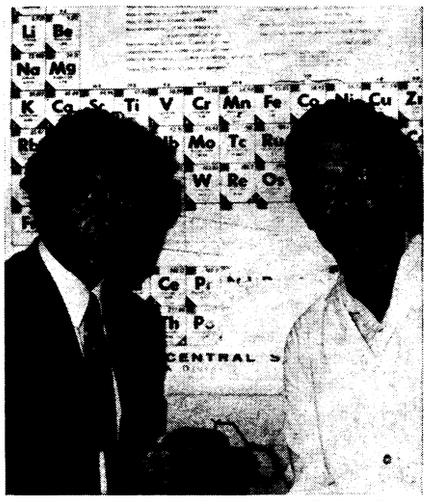
the laboratory: They have produced a compound which will fix nitrogen from the air—although at a miniscule fraction of the rate at which nitrogenase will fix it. The new compound will also reduce acetylene to ethylene, a capability of nitrogenase manifested in all nitrogen-fixing organisms (SN: 8/29, p. 161). This fraction occurs with the synthetic compound at about two percent the rate produced by natural nitrogenase. Other reactions attributed to nitrogenase also occurred with the model.

Nitrogenase itself was isolated in the early 1960's, but scientists did not know exactly how it converted nitrogen to ammonia. By producing their simple inorganic catalyst, the two chemists have proven what had been suspected, that the element molybdenum is a key to the process.

Working with a National Science Foundation grant, the researchers combined two of the simplest components of nitrogenase, one consisting of molybdenum salts, the other a sulfur-containing ligand. The inclusion of the molybdenum salts proved to be the key step; with them, the compound would produce ammonia from nitrogen dissolved in water under high pressure. Without molybdenum, the reaction did not take place.

The two researchers are now working to make the model progressively more complex in the hope of increasing its efficiency. Although Dr. Schrauzer says he is not primarily interested in the industrial possibilities, nitrogen-fixation is an important industrial process carried on under high temperatures and pressures. With an efficient catalyst these conditions might no longer be necessary.

The work also explains why the addition of molybdenum salts to soils with a low molybdenum content markedly enhances growth and nitrogen-fixing in leguminous plants. □



U. of C. San Diego

Schrauzer (left) and Schlesinger.

SUPER FLYWHEEL

Another auto entry

The recent week-long clean air car race from Massachusetts to California (SN: 8/29, p. 166) provided a shotgun approach to development of low-emission or nonpolluting vehicle engines. Yet despite more than 40 entries employing five engine classes, the winner was a modified standard internal-combustion engine fueled with nonleaded gasoline.

Auto manufacturers supported the contestants while pressing their own research. There is little doubt, however, that they would prefer to stay with present engine types. General Motors, for example, has just completed an evaluation of two advance-design steam-powered cars. The results were neither encouraging nor unexpected: few advantages except low cost; disadvantages included high emissions of nitrogen oxides and hydrocarbons, low performance, and poor fuel economy, serviceability and reliability.

There is a consensus among some engineers that the answer will lie with some form of electrically powered vehicle if such problems as limited operating time and poor acceleration can be solved. Using a novel concept for a hybrid electric system, researchers at the Johns Hopkins University Applied Physics Laboratory (APL), Silver Spring, Md., may replace the battery power supply with a flywheel for energy.

Invented by APL aeronautical engineer David W. Rabenhorst, the mechanical storage device uses a tapered bar, rather than a wheel, that could turn at speeds of 30,000 revolutions a minute or higher. The rotor, constructed of either bonded or unbonded anisotropic wires or filaments for maximum strength, would be housed in a moderate vacuum of 10^{-3} or 10^{-4} torr to reduce friction losses.

Once charged up and turning without air drag, a 220-pound super flywheel could power a 1,300-pound electric car indirectly through a generator, Rabenhorst says. He estimates the rotor would provide a 6.7 kilowatt-hour energy equivalent. At a speed of 55 miles per hour, 110 miles could be covered before the flywheel ran down. Using ordinary house current and a motor to charge the flywheel initially, cost of operation would be about 0.1 cent a mile, the inventor declares.

Concept feasibility is now being studied by an APL team under a one-year, $200,000 grant from the National Air Pollution Control Administration. If laboratory tests are successful, a follow-on grant will be sought to build a demonstration model in 1972.

Maintenance of the vacuum seal around the rotor shaft is critical to optimum performance, and Rabenhorst has designed one employing a new concept for which a patent application has recently been made. He claims it will provide a "near-infinite operating life," but he will not proffer any design details at this time.

Meanwhile, APL researchers will use a magnetic-fluid seal, one held in place electrically by a magnetic field, that is commercially available from Ferrofluidics Corp., Burlington, Mass. These devices have been tested about shafts turning at up to 50,000 revolutions a minute, he asserts, with leakage rates of less than 10^{-11} cubic centimeter of air a second.

Possible vehicular configurations with the flywheel are numerous. In one, both driving torque and acceleration torque would be supplied by the rotor. It in turn would be recharged by a small heat engine, a turbine. For an electrically powered suburban runabout, a smaller flywheel could be used to recharge the battery supply, and it could also provide direct mechanical power for rapid acceleration. Further, whenever maximum battery power is not required, that energy could be applied for flywheel recharge, Rabenhorst says.

Johns Hopkins

Rabenhorst and his auto flywheel.

Another scheme, he suggests, is recharging the flywheel by regenerative braking—energy normally dissipated in the form of heat energy might be transferred back into the flywheel.

A flywheel also could power cordless hand tools or a home generator.

As a propulsion (or even braking) power source, Rabenhorst cites many advantages: The flywheel can be run up or run down repeatedly without loss of performance, it can be charged at any reasonable rate and it can be discharged at any rate within the design limits of its supporting structures.

"In all these respects," he declares, "the flywheel outperforms any present or proposed battery." □