ond type, which is larger, is suited for regions of wind speeds under 12 km per hour, but above 6 km per hour. It has a 4.88 meter rotor with 12 blades and can resist wind speeds as high as 120 km per hour.

While most conventional windmills have a horizontal rotor on which the blades rotate in a vertical plane, a strikingly new and economical design has been recently evolved at the Indian Institute of Technology, Kharagpur, and full scale units are being developed at the Punjab Agricultural University. In this design the rotating shaft is placed in a vertical direction as an upright post, instead of being horizontal. This shaft carries cross arms to which are fixed sails which catch the wind.

S. K. Ghaswala

FROM LONDON

Anglo-French technological rapport

Diplomatically, Anglo-French relations look dismal, but on the technology scene there is fast-growing respect for the talents and achievements of each other. The Concorde supersonic airliner, whether or not the collaboration runs the full course, has shown convincingly that a joint program in very advanced technology can be pursued. Meanwhile Britain manages to sell other advanced technology—from computers to cryogenics—to the French. This has the full approval of the French government, provided the imports have a clear technological advantage over those available domestically.

In this context the French are showing flattering interest in Britain's nuclear technology. In statements recently, France's Minister of Scientific Research, Maurice Schuman, made it plain that his government is keen on closer ties between the two countries in advanced nuclear schemes.

In fact, for a year or so there have been strong if informal ties between the state nuclear research authorities and between the state generating utilities of the two countries, begun on the initiative of the French. Both countries have pursued the gas-cooled, graphite-moderated approach to nuclear power, leading toward the plutonium-burning breeder. But Britain is far ahead, both in gas-cooling developments and in her pursuit of the breeder.

French interest now focuses on a highly developed version of Britain's advanced gas-cooled (AGR) concept, for which Britain is already installing 3,700 megawatts of generating capacity and is likely to order the same amount again.

Stretched versions to come later will run at temperatures far beyond the gas outlet temperature of 565 degrees C., the limit of the AGR and also of present-day steam turbines. They would contain key ideas culled from Dragon, the helium-cooled high-temperature reactor experiment run by the European Nuclear Energy Agency in England.

Two stretched AGRs are emerging, one to be cooled by carbon dioxide and the other by helium. The carbon-dioxide-cooled core would probably use an unclad uranium fuel of low enrichment, but the helium-cooled core could well take advantage of a ceramic fuel developed by the British Atomic Energy Authority. This fuel, of uranium carbide dispersed in silicon carbide, has run at a surface temperature well beyond 1,000 degrees C., with burnups around 40,000 megawatt-day/ton.

As Dr. Hans Kronberger, scientist-in-chief on the AEA's Reactor Group pointed out recently, Britain's reactor research has now reached the stage the AEA always predicted: that designs of high-temperature reactors would converge towards a common concept.

The next question is how best to use the very hot gas from these advanced AGR's, for manifestly there now emerges the prospect of driving a gas turbine directly from the outlet gas. Either gas could be used in this way. At first sight helium appears to have the edge. The gas will be hotter, perhaps 850 degrees C., and helium turbines can be run at very high speeds. A very compact turbine is envisaged by Rolls-Royce, whose studies appear to favor the direct-cycle helium machine.

But temperatures in prospect for carbon dioxide have risen rapidly in the past year or two, and the French CEA has proposed a new thermodynamic cycle for this gas that promises "almost within known technology," according to Kronberger, to push the thermal efficiency beyond the 42 percent of the AGR. The gas when compressed is not unlike steam but the turbine should still be a great deal smaller.

For a year past the CEA has collaborated with the AEA's reactor group to bring this carbon dioxide concept to an advanced stage of development. There are hopes for a more formal agreement very soon between the two countries, covering exchanges of know-how and patents from research right through to utility operations. It could lead to a British design for a high-temperature gas-cooled nuclear station for the French grid.

George Saxby