the industry were $41 million, a 6.9 percent increase over the 1968 figure of $38.4 million. In the same period, utility advertising expenditures went from $290 million to $324 million, an increase of about 12 percent. This compares with total utility revenues in 1969 of $3.2 billion.

"They [the utilities] are trying to meet massive technological problems by massive advertising and sales promotion—this despite the energy shortage—rather than by the needed massive research and development programs," charges Metcalf.

If the automobile industry is doing the same, the facts may be public knowledge soon. Under the 1970 amendments to the Clean Air Act, the auto companies must report to APCO—and, presumably, to a National Academy of Sciences committee set up under the amendments—on their R&D expenditures.

Where the solution to the R&D problem lies is still a matter of conjecture. APCO frankly acknowledges it probably never will have the funds necessary to carry on the needed programs for pollution control R&D for automobiles, and it is relying on the 1970 amendments to force the auto companies into compliance with the new emission standards. But a Metcalf staffer suggests that the utility industry may never be innovative enough to do the R&D job. "Maybe the government has to do it," he says. □

Scyllac in operation at Los Alamos

Attempts to achieve controlled thermonuclear fusion, to gain energy for power production from the fusion of atomic nuclei, are proceeding in a variety of devices with a variety of names.

The basic problem is that a plasma of ions and electrons has to be held, usually by confinement in a magnetic field, for a sufficient time at a high enough temperature and density for enough fusions to take place so that the energy coming out of the process is greater than the energy it takes to maintain it.

One sort of device attempts to hold a relatively thin plasma for a long time. Since confining the plasma in a magnetic field is probably the most difficult of the three criteria to achieve, another sort of device attempts to trade off a short confinement time against high density and temperature. These devices are pulsed rather than steady, since the densities and temperatures desired can best be achieved by short compressing pulsations. If energy ever comes out of them it will come in bursts like a reciprocating steam engine.

This week the largest of the pulsed devices yet built, the Scyllac (SN: 10/17/70, p. 321) at the Los Alamos Scientific Laboratory in Los Alamos, N.M., began operation. Preliminary tests leave its designers and builders well satisfied.

Scyllac is what is called a theta pinch. It will ultimately be a toroidal, or doughnut-shaped chamber, 15 meters in circumference. At the moment it is a curved section, about a third or so of that.

When plasma has been placed in Scyllac, it will be subjected to a pinch. That is, the strength of the confining magnetic field will be suddenly increased. This will cause both implosion and shock, driving the plasma to the center of the tube and heating it.

Experience with smaller theta pinches at Los Alamos and elsewhere shows that temperatures and densities in the range appropriate to controlled fusion can be approached by this method.

Scyllac is designed to approach controlled fusion more closely than previous devices. The present section of it was tested this week by making within it a pre-ionized plasma. This is a preliminary step to the application of the magnetic implosion, the theta pinch itself. Scyllac repeatedly made pre-ionized plasmas to the satisfaction of the physicists working with it. Contrary to reports elsewhere, though gratifying, this is not a breakthrough on the way to controlled fusion. The real test of whether Scyllac can do what it is designed to do, the turning on of the theta pinch, will be tried sometime in the next few months.

If that test is satisfactory, the remainder of the circle will be built. Still later, the Los Alamos physicists plan to build a seven-meter straight Scyllac, and with this they hope to approach nearer to an actual controlled fusion reactor than anything on earth.

If controlled fusion experiments continue to go as well as they have for the last few years, the best guesses as to when fusion power can be expected to be commercially available are sometime in the 1990's.

HEAVY-ION ACCELERATORS

American physicists worry

Studies of atomic nuclei have made frequent use of single particles as probes. Beams of accelerated protons, electrons, neutrons, pi mesons and other particles are struck against nuclei, and the results are studied for information on the behavior and structure of nuclei.

Now physicists wish to use whole nuclei of heavy elements, or more correctly, heavy ions, as the impinging particles. Striking heavy nuclei against other heavy nuclei, they believe, will enable them to manufacture superheavy nuclei with atomic numbers beyond the currently known 105 and to study what happens when two objects containing many neutrons and protons come together. This could throw light on complexities of nuclear structure not decipherable by other means.

In various parts of the world heavy-ion accelerators are being built to enable this sort of work to be carried out. Only one such machine is under construction in the United States, the Superhilac at the Lawrence Radiation Laboratory in Berkeley, Calif. The paucity of the American effort dismays many specialists in the field.

"We are entering a period of planned deficiency of heavy-ion equipment in the U.S.," says Dr. Robert Beringer of Yale University in summing up the discontent. The single new American machine, the Superhilac, is somewhat old fashioned, he told the 1971 Particle Accelerator Conference at Chicago last week (see p. 183). It is a reconstruction of the existing Hilac (Heavy Ion Linear Accelerator), "a redesigned 1950's linac," says Dr. Beringer, "a foursquare state-of-the-art machine at modest cost." He would like to see completely new designs tried, but given the Government's financial priorities, he finds it difficult to disagree that under current conditions Superhilac is the best available.

Nevertheless, he worries that the United States will fall behind Western Europe and the Soviet Union, where newer designs are being pursued with more vigor.

Heavy ions can be accelerated in either linear accelerators or cyclotrons. Both sorts have their partisans, and some people see advantages in both. The first of the new generation of heavy-ion accelerators, the machine called Alice at the Orsay Laboratory in France, combines a linear accelerator and a cyclotron. Alice can accelerate ions of carbon or neon to energies of about 20 million electron-volts per nuclear particle (nucleon). Its heaviest ions are xenon, to which it can give about 3 million electron-volts per nucleon.