known, though they too were first realized more than a half-century ago.

Both electron and ion beam accelerators have attained extremely high energies at which the charged particles are traveling at near the speed of light. But these high-energy accelerators have been limited to very low beam currents, and, therefore, low beam power.

New types of accelerators have had to be developed in order to achieve high-current, high-energy particle beams. And in the case of ions, which, because of their much greater mass, promise to have a much greater punch than electrons, Soviet beam scientists have pioneered the most important concepts.

All accelerators utilize an electric field to accelerate electrically charged particles. This electric field can be either oscillating or continuous, and, it can be combined with oscillating or continuous magnetic fields. But the chief problem is to damp motions of the ion perpendicular to the direction of acceleration. These "transverse" motions cause the ion beam to become defocused and hit the wall of the accelerating chamber.

The difficulty with high current ion beam accelerators is that the possible modes for coupling accelerating energy into unwanted transverse beam motions is greatly increased by the non-linear interaction of the beam particles which appear at higher beam currents. But these non-linear effects become beneficial once the ion beam has been accelerated to near the speed of light. (At this point these non-linear interactions produce a sort of beam self-focusing phenomenon.) Therefore, it is during the startup and first phase of beam acceleration that the greatest difficulties are encountered.

This resolves down to two distinct areas: 1) ion sources; 2) the first accelerator stage.

The Soviet Union has led the way in both areas in terms of the parameters needed for beam weapons. While the U.S. pursued positive ion sources, needed for neutral beam heaters on near-term magnetic fusion experiments, the Soviet program pursued negative ion sources which are applicable to either long-term fusion reactor requirements or near-term neutral particle beam weapons.

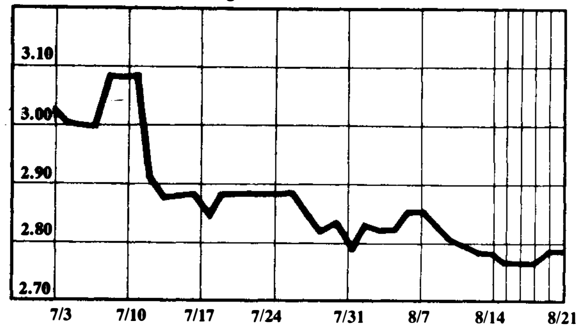
Neutral beams of high energy atoms have major applications to both magnetic fusion and space-based beam weapons. In both cases, ions are first extracted from a plasma source and accelerated to high energies. They are then passed through a gas cell in which they become neutral atoms once again without a loss of energy or direction. For higher energy and current beams, negative ions can be gas-cell neutralized more efficiently than positive ions.

In terms of accelerators, the leading technology for high current beams being concentrated on in the West is that of the Radio Frequency Quadropole (RFQ). This concept was pioneered by Soviet scientists. But despite the great success with the RFQ in the West, the Soviets apparently are concentrating on another concept, the alternating phase accelerator; a concept which is yet to be seriously pursued in the West.

Currency Rates

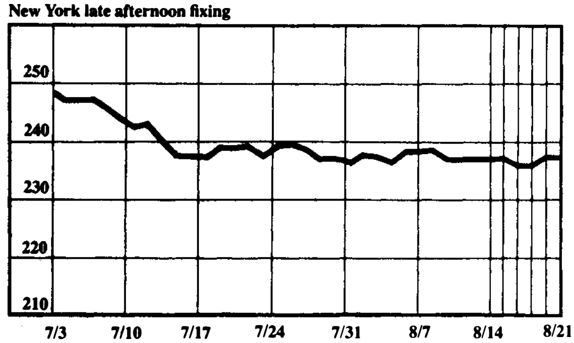
The dollar in deutschemarks

New York late afternoon fixing



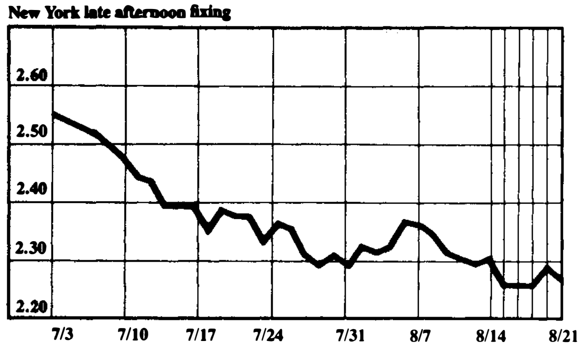
The dollar in yen

New York late afternoon fixing



The dollar in Swiss francs

New York late afternoon fixing



The British pound in dollars

New York late afternoon fixing