coupling with the hydromagnetic motions. All these motions can generate enough disorder to destroy conservation of energy and conservation of the adiabatic invariants for the single particles which are supposed to be confined in the system. As a result both plasma and energy can be lost to the wall.

We see therefore that heating, plasma injection, and plasma compression do represent sizeable additional problems. These problems are, however, closely connected with the more general question of confinement. If the latter were solved completely, then we could take time with the other processes and probably execute them sufficiently carefully so that the plasma could be brought to the appropriate conditions. The actual fact is, however, that the problem of plasma confinement is solved only very partially and therefore this problem and that of the establishment of the right temperatures and densities have to be handled together.

EFFECTS OF IMPURITIES

Another difficulty that is quite generally encountered is connected with impurities. The presence of impurities leads to increased bremsstrahlung and consequent rapid loss of energy from the plasma. At temperatures low compared to the ignition point, these losses are often aggravated by radiation from incompletely ionized atoms. These partially ionized systems are usually not in Saha equilibrium, since of the four possible processes — collisional ionization, radiative electron capture, recombination by triple collisions, and ionization by photons — only the first two occur. This somewhat involved problem has been thoroughly investigated by Post and has led to the recognition that heating must be made to occur rapidly, particularly in the lower temperature regions.

If neutral atoms are knocked off the walls, these cause an energy loss by an additional mechanism: They can neutralize fast plasma ions by charge exchange and these fast neutral particles can cross the magnetic barrier and get to the wall. Here they can knock out more neutral particles and a loss mechanism can be built up.

EXPERIMENTAL DEVELOPMENT

The above enumeration of difficulties and problems is by no means complete. Neither does this theoretical discussion do justice to the experimental problems of machine design and to the diagnostic work which has been carried out. The development of extremely large pulsed condenser banks for creating the large volume, high magnetic fields required, and the operation of large "baked out" vacuum systems for high plasma purity at pressures as low as 10^{-10} mm Hg, are major achievements of the experimentalists. The observation of gross current and electric field behavior and the determination of magnetic field and plasma pressure by means of probes introduced into a system, have given valuable data. Plasma densities have been measured by experiments involving absorption and transmission of electromagnetic waves in the radar range. Spectroscopic observations have been carried out and the appearance and behavior of neutrons have led to additional knowledge about the state of the plasma. Thus our knowledge of plasma physics is increasing considerably with each passing year.