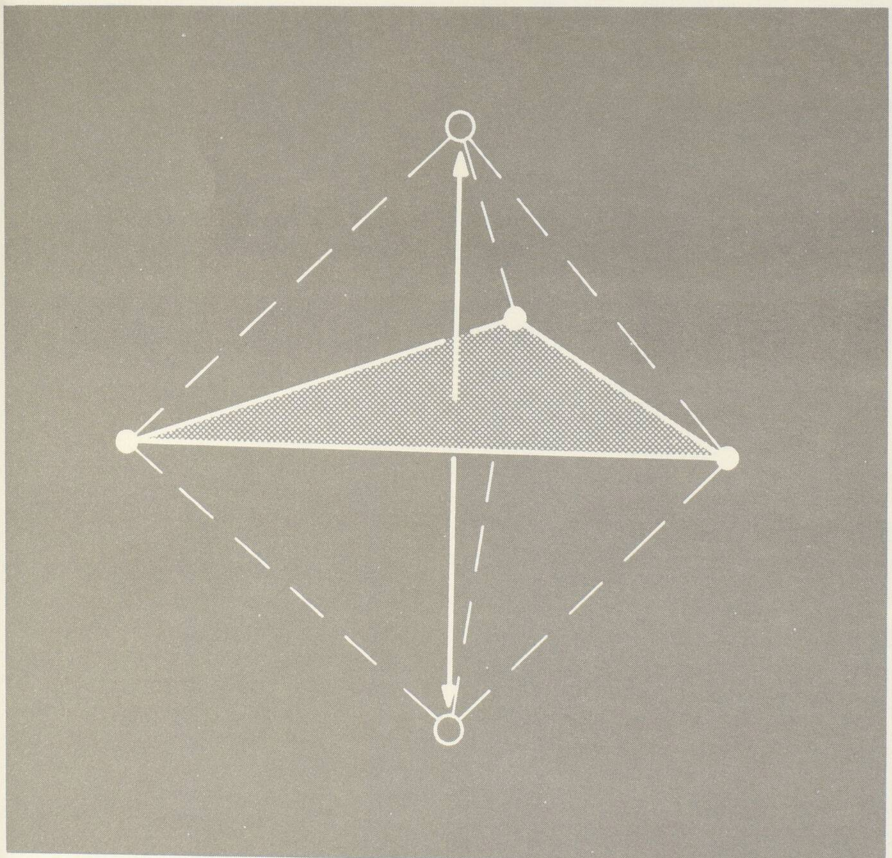
As part of its long-term program in the development of basic physical standards essential in today's highly technical world, the National Research Council of Canada is involved in continuing research to improve existing atomic time and frequency standards. This work, begun in 1956, produced one of the world's earliest caesium beam atomic clocks in 1958. Subsequent refinement of the experimental techniques in two later models resulted in appreciable improvements in accuracy. Simultaneous advances in other countries, coupled with the realization by the scientific community that such standards would provide a much more uniform unit of time than astronomic measurements, led in October, 1967, to the formal adoption by the International Bureau of Weights and Measures of the caesium hyperfine transition as the basis of the physical second.

As a result, at the present time, Canada's time signals, produced by standards maintained by the Dominion Observatory, are also directly related to the physical second maintained by the NRC primary caesium standard.

In addition to its work on caesium, NRC has been active in the development of other time and frequency standards, especially the hydrogen maser. The work at the Council has been carried on in the Electricity Section of the Division of Applied Physics by a group consisting of Dr. J. T. Henderson, Dr. Allan Mungall, Dr. Derek Morris, Herman Daams and Ralph Bailey.

As its name indicates, the hydrogen maser is a device which depends on radiation from excited atoms of hydrogen. In it, a beam of hydrogen atoms is first emitted from a source in which hydrogen molecules are dissociated into atoms by a radio frequency discharge. The beam then passes through a magnetic state selector which allows only the excited atoms to pass into a storage bulb enclosed by a resonant cavity tuned to the atomic hydrogen emission frequency. Thus, when the excited hydrogen atoms in the bulb start to radiate energy, the electro-magnetic field which is supported by the cavity resonance stimulates further emission from the other atoms. If the number of atoms entering the bulb per second is sufficient (about 10 million million per second are required for typical masers) then a steady oscillation is maintained, and all the atoms in the bulb radiate synchronously. This produces a very weak radio signal at a very constant frequency of 1,420,405,751 cycles per second. The walls of the storage bulb are coated with materials which maintain each atom radiating almost in synchronism



Mainspring of the first atomic clock, the ammonia (NH_3) clock (Classical picture): the periodic inversion of the nitrogen atom (circle, apex of the pyramid) through the base, formed by three hydrogen atoms (black dots).

Principe de la première horloge atomique, l'horloge d'ammoniac (représentation classique): l'inversion périodique de l'atome de nitrogène (cercle, au sommet de la pyramide) à travers la base formée par trois atomes d'hydrogène (points).