seek to improve length standard

Measurements, such as length, are the indispensable foundation of science and industry. They must be continually improved to keep up with demands for increasing accuracy and precision. Work now is in progress to determine whether a laser can make the International Standard of Length more accurate

The rapid development of science and technological industry during recent decades has placed heavy demands on scientists to improve basic standards of physical measurement. Without continual improvement in the precision and accuracy of measurement, progress in science and industry would be at first critically handicapped and, in due course, stopped.

All the fundamental physical standards for Canada are housed and serviced in the Division of Applied Physics of the National Research Council of Canada. While these primary standards are equal to any in the world, science and technology marches on, and what is today up-to-date apparatus can very quickly become obsolete.

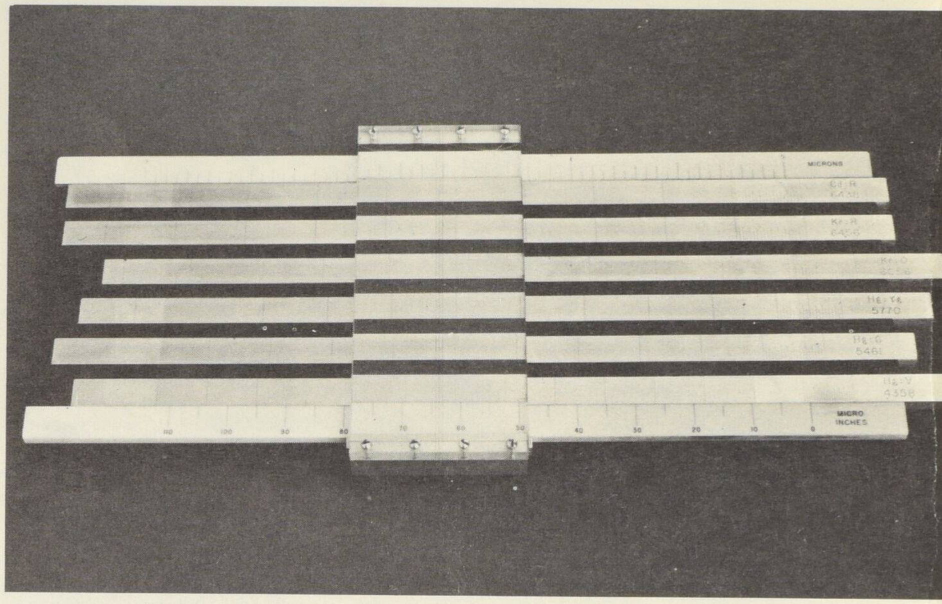
As a result, measurement scientists at NRC continually strive to improve Canada's basic standards of physical measurement. At the moment, these scientists are again playing a leading role in continuing international efforts to make the international standard of length more accurate.

Until 1960 the international standard of length was the "M" – the metre bar of platinum-iridium kept at Sèvres, France. The Canadian yard was defined as 0.9144 of the International Metre, which made the inch exactly equal to 25.4 millimetres.

In 1960, under pressure from the need for increased accuracy in the primary standard, the International Conference on Weights and Measures agreed that the international standard of length should be 1,650,763.73 times the wavelength of one of the orange lines emitted by isotopic krypton of atomic weight 86. This decision was based on research conducted in Canada, France, Germany, Australia, Japan, the United Kingdom, the United States and Russia.

The Canadian work, which played an important role in the decision to adopt the new international standard of length, was conducted in the laboratory of Dr. K. M. Baird, Head of the Optical Physics Section (then called the Interferometry Section) of NRC's Division of Applied Physics.

With this standard it is possible to specify lengths to better than one part in a hundred million, but beyond this point the low intensity and instability of the source and the line width limit the reproducibility of measurements.



Simple slide rule device, developed at NRC, for converting measurements using light into English or metric units.

Règle à calcul, mise au point au Conseil, qui permet de convertir les mesures interférométriques directement en unités du système métrique ou anglais.

After adoption of the new standard of length in 1960, scientists began experimenting with light from a helium-neon laser for measuring lengths. Since this light is intense, and the line width is extremely small, it is possible to make very precise measurements of length in terms of this wavelength. Unfortunately, the wavelength of the laser depends upon the construction and the operating conditions of the laser and, in spite of its many desirable characteristics, the wavelength of a laser emission line has not been sufficiently reproducible to be useful as a standard.

NEW WORK STARTED

However, a means has now been devised by the Optical Physics Section of NRC's Division of Applied Physics for stabilizing the wavelength of the red emission line of a helium-neon laser. Light from the laser is passed through iodine vapor and the wavelength of the laser emission is locked to that of a particular absorption line of iodine. In this way the wavelength of the very sharp laser line is determined by that of the iodine absorption line and the wavelength of this absorption is largely independent of the geometric arrangement and other physical conditions.

Dr. G. R. Hanes, who is conducting this work, says that although only preliminary experiments have been carried out, it now appears that the stabilized helium-neon laser can generate a line whose wavelength can be specified with a precision at least a hundred times better than that of the present krypton standard.

"This source has an excellent chance of becoming the new standard of length," Dr. Hanes says.

The Section's work with the helium-neon laser is an example of how the National Research Council promotes research for the continuous improvement of the precision and accuracy of fundamental standards for physical measurement, including length, mass, time, electricity, heat, light and ionizing radiations. Industrial and scientific progress both depend on accurate measurement, and modern mass production would be impossible without it.