tally, since the lamp glows each time an impulse is conducted, chatter of the key and other defects in the electrical system are easily detected. It may be, also, that making the electrical impulse "visible" will prove to have advantages for teaching purposes.

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USE OF THE LUNDEGARDH SPECTROGRAPHIC METHOD

A SURVEY of the spectrographic methods used in this country for the quantitative determination of small quantities of mineral substances reveals the fact that the Lundegårdh[1] method is not employed here. In this method the emission spectrum is excited by means of the flame of a special air-acetylene burner, for which the acetylene and the air are supplied at constant pressure. The air is forced through a few milliliters of the solution of the substance under analysis, thus spraying the solution into the flame uniformly. In this way the spectra of 32 elements at different concentrations have been photographed and, from the intensity of a certain line in each, it has been found possible to make fairly rapid, quantitative determinations of great accuracy and dependability. This is especially true when the Lundegårdh system of constructing both a plate correction curve and a concentration curve for each plate is followed.

The problem of the determination of the mineral constituents of citrus fruits and of some vegetables has been in progress in this laboratory for some time. The material has been dried and ashed quantitatively and then the per cent. of calcium, copper, iron, magnesium, manganese and phosphate in the ash has been determined by micro-photometric or micro-volumetric methods. It has been necessary to use large quantities of the materials in order to obtain sufficient ash to carry through the above analyses. For instance, in the case of orange juice, a liter would be required. This process is long, subject to many sources of error, and dependent upon complicated technique, all of which are in great contrast to the Lundegårdh spectrographic method.

Professor Lundegårdh very kindly gave me the opportunity of working in his laboratory at the Agricultural College of Sweden this summer, and I was able to do some preliminary work on the determination of the mineral constituents of orange juice. By concentrating 100 ml of the juice nearly ten times and oxidizing the organic matter by one of several methods, for instance, by nitric acid and perhydrol, it was possible to obtain results for copper, iron and manganese which were of the same order as our photometric methods. (See Table I.)

[1] H. Lundegårdh, "Die quantitative Spektralanalyse der Elemente II." Jena, 1934; *Lantbrukshögsk:s Annaler*, Vol. 3, s. 49.

TABLE I
MILLEMOLS PER LITER JUICE

Oranges	Copper	Iron	Manganese	Method
Blue Goose	0.0061	0.042	0.0039	Lundegårdh
Sunkist	0.0072	0.030	0.0039	"
Valencia	0.0065	0.030	0.0043	"
South Africa	0.0068	0.043	0.0033	"
Average[2] for California and Florida oranges	0.0069	0.025	0.0044	Micro-photometric

[2] Honors paper of Annette Florence, Wellesley College, 1936.

It was also possible to determine such metals as potassium and calcium which are present in much larger quantities without concentrating the juice, but by refluxing with hydrochloric acid, filtering out the solid material—really a form of wet ashing—and then spraying into the flame.

In this laboratory at the present time we are continuing the study of the various ways of preparing these solutions, as well as the spectrographic and photometric procedures. It is especially important to carry out careful blank determinations because of the possible contamination from chemicals and apparatus when such small quantities of some elements are to be determined. We also expect to use this method for the determination of mineral constituents in various biological materials, for which it is particularly well adapted.

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