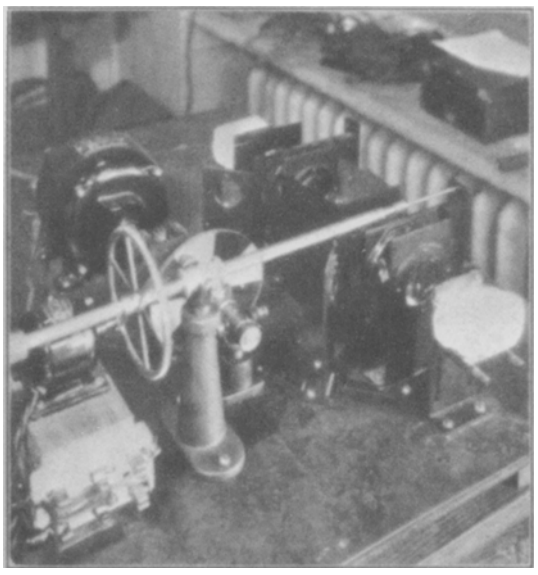
The Hardy Recording Spectrophotometer

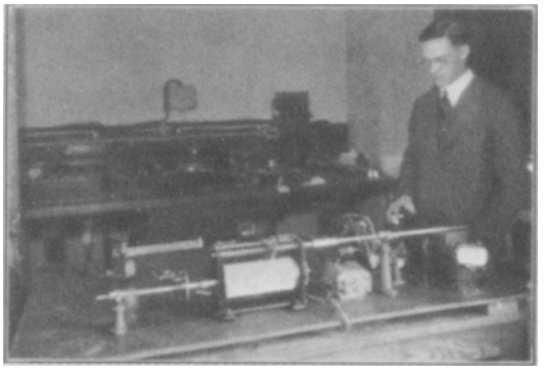
New Electrically Controlled Instrument Eliminates Visual Errors in Colorimetry

A MACHINE, known as the recording spectrophotometer, is now being developed for practical commercial applications at the research laboratories of the General Electric Company at Schenectady, N. Y. The instrument is primarily an analyzer of color for use in measuring and matching colors without the human eye playing any part. It makes a definite and permanent record in the form of a curve of every color and shade and does not depend on standard colors which might not retain their original shade over a period of time because of fading or some other deterioration. The idea of the spectrophotometer was conceived and developed by Professor Arthur C. Hardy of the Department of Physics of the Massachusetts Institute of Technology, who is also connected with the research staff of the General Electric Company.

The instrument measures the color by reflected light. A sample of the desired color is placed before a window in the machine and



Photograph of the spectrophotometer showing color specimen, magnesium carbonate standard, light source and analyzing disk. Photos by General Electric Co. as published in Executives' Service Bulletin.



Dr. Arthur C. Hardy, originator of the spectrophotometer, in the laboratory of the General Electric Co.

the power is turned on. The registration of the color value curve requires only 30 seconds. The curve as drawn by the instrument is taken out and compared with the curve of the color which is being matched or with the one which seems most like the one in question. Where the curves agree, the colors must be the same irrespective of their appearance to the human eye or of lighting conditions. If the curves do not coincide, then, the elements of the colors are different no matter how closely they may appear to match.

The spectrophotometer consists of an apparatus for breaking up the light reflected from a sample of color and measuring the intensity of each portion of the spectrum as compared with a standard. The record is made in the form of a continuous line on a chart. The sample is compared with carbonate of magnesia which is a very *white* white. The sample of color and standard are illuminated by a special ribbon-filament incandescent lamp. Shutters admit alternate beams from the sample and standard to the slit of a spectrograph. Another movable slit is automatically adjusted so that each portion of the spectrum, or color band of light, is admitted in turn to a photoelectric, or light sensitive, tube. As the light of single wave-length is reflected alternately from the sample and standard, and as the intensities differ, a pulsating current is set up in the photoelectric tube. This pulsating current is fed through a vacuum tube amplifier that in-

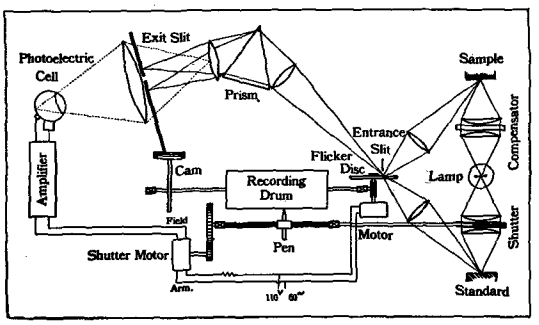


Diagram of the arrangement of the various parts of the Hardy Spectrophotometer

creases the power ten billion times, and is then fed to a motor which adjusts the shutter between the light source and the standard to that position where the current pulsation ceases. The opening of the shutter, then, is a measure of the intensity of a particular spectrum line in the specimen color. The device automatically compares minute portions of the specimen spectrum with the standard, and records the analysis on a revolving drum.

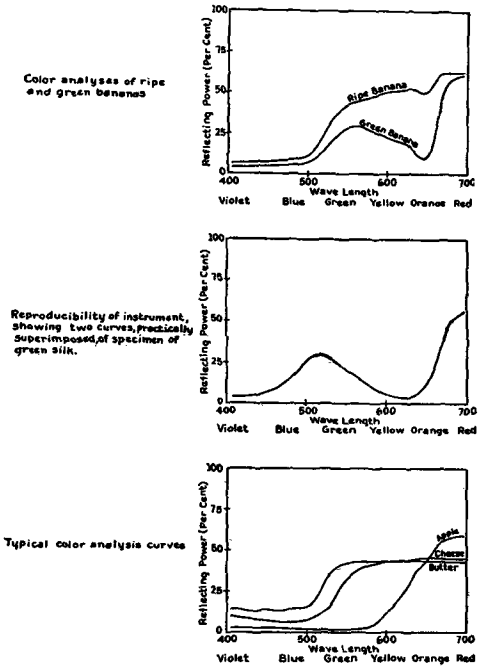
The importance of the new color analyzer lies in its value to industry, in nearly every branch of which control of the color of products is necessary. Accurate measurement of colors is the first concern of manufacturers of fabrics, particularly in the delicate shades which often deceive the eye. Color control and accuracy are, as is well known, also of basic importance in the making of printing inks, paints, dyes and paper. There is scarcely an industry without a color problem.

Lubricating oils are graded almost entirely on the basis of color. In the same way, small differences in color mean thousands of dollars in the sales of vegetable oils. It is quite possible that this machine may be developed to such a point that it will greatly simplify the color grading of oils.

The desirability of a product of uniform color applies equally well in manufacturing such things as soap, lard, flour, butter, oleomargarine, cheese, sugar, syrup, chocolate, glass, automobiles, tile, brick, roofing materials, carpets, rope, hardware, paper, leather, cement, linoleum, textiles, cosmetics, and many other products.

One of the most important fields of usefulness for the recording spectrophotometer is expected to be in the cataloging of the curves of different dyes, so that new colors with pre- it is expected to be of service; but a sufficient determined characteristics can be obtained at any time by the proper mixture of standard dyes already at hand.

Since the instrument has been developed, there has not been sufficent time to test its applicability to all of the industries in which



Color analyses of ripe and green bananas, showing more orange and yellow in the ripe fruit. Showing how two samples of one color give superimposed curves. Typical color analyses of apple, cheese, butter.

number of tests have been made to indicate that the instrument will be of use in many different kinds of work.

Research is being carried on at the laboratories of the General Electric Company. Neither the originator of the instrument nor the company is ready as yet for commercial use of the machine on a broad scale. Its commercial application has innumerable possibilities which have been appreciated by various industries. Inquiries from every conceivable source have actually swamped the General Electric Company so great is the interest in the device. In the oil industries, its possible uses are quite obvious in color matching and color measuring. As further data regarding the instrument becomes available, particularly regarding its application in oils and fats, Dr. Hardy has agreed to see to it that the facts shall be furnished promptly to the readers of *Oil & Fat Industries.*