steps that the adjustment is, for practical purposes, continuous. The first unit, the Type 200-C, had a current rating of 5 amperes. Later other sizes were manufactured, beginning with a smaller one rated at 2 amperes and a larger one at 20. Tuttle coined its name, "Variac" for "variable ac." It was expected that the Variac autotransformer would first find its greatest use in laboratories, and it did. Later it found its way into many industrial applications, and in this expanded market, many millions are in use today. Not all have been made by GR, as several other companies were licensed to manufacture under the basic Karplus patent.

A second instrument was the Type 535-A Electron Oscillograph. The history of the cathode-ray tube starts with the work of Karl Braun in Germany in 1897. In its modern form, it is, of course, most familiar as "the tube" of the TV set. Following Braun's basic work, many scientists worked upon improving it, with notable advances being made by J. B. Johnson of the Bell Telephone Laboratories. About 1929, reasonably good commercial tubes were available, but aside from the idea that they might someday have application for television if many other technical problems could be solved, they were regarded as being rather more interesting than useful.

One major difficulty was that since no way had been devised to sweep the electron beam across the tube's screen at a constant speed and to hold a repetitive pattern in place, it was impossible to display electric waves in their familiar form. Another was that the spot did not focus well at all parts of the screen. However, with all the drawbacks, cathode-ray tubes did have some useful applications, and, in 1931, GR marketed the first commercial instrument with tubes first obtained from Manfred von Ardenne in Germany, and later from Westinghouse. It was in two parts. The tube was mounted separately on a stand, and the power supply, in a separate cabinet, was connected to it by a cable. By this time Professor Frederick Bedell of Cornell University had invented the so-called linear sweep circuit, which did, at last, provide a means to traverse the spot across the screen at a constant speed and with a steady display. This invention, after the tube itself, was the most important advance up to that time in cathode-ray oscillography. Based upon this invention, GR produced the first commercial linear sweep circuit, called the Type 506-A

Bedell Sweep Circuit. It was housed in a separate cabinet so that a complete oscilloscope consisted of three parts: the tube, the power supply, and the sweep circuit. At first the latter was made under license from Bedell, but later GR purchased the patent, selling the entertainment rights to RCA, who hoped to, and eventually did, apply it to television. GR retained the instrument rights. The Type 535-A Electron Oscillograph combined the tube and its mounting with the power supply, and finally in 1934 GR announced the Type 687-A Electron Oscillograph, which, in addition to the power supply, incorporated the sweep circuit all in one housing. This was the first complete oscilloscope ever marketed. Its design was a joint development of Karplus and Scott. It was followed by the Type 770-A by Dr. Donald B. Sinclair (M. I. T. '31, ScD. '35), an advanced design which included most of the features found in oscilloscopes today. It was never marketed, however, because it was judged to be difficult to manufacture and probably too expensive for the market.

This history would be incomplete without noting that a few years after its introduction of the first cathode-ray oscilloscopes and its development of them up to the Type 770-A, the Company dropped their production. The reason was that the tubes had not been highly developed, and the instrument, unless excessively expensive, was not too suitable for most accurate laboratory work. For that reason it was thought that it would be principally a tool for the radio service technician. This was a field in which the Company did not happen to be interested. Under the impetus of radar development during World War II, the cathode-ray tube was developed to a degree that seemed impossible in the thirties and was then capable of performing excellent work as a laboratory instrument. By this time the Company had been out of the business for several years and had so many other projects afoot that it never re-engineered a new oscilloscope. This was a considerable error in product judgment, as the oscilloscope eventually became one of the most widely used of all laboratory instruments.

The third pioneer instrument of major significance described in that issue of the *Experimenter* was the wave analyzer. This was a development of L. B. Arguimbau. It was a very advanced instrument for its time and provided the means for making accurate, harmonic analyses