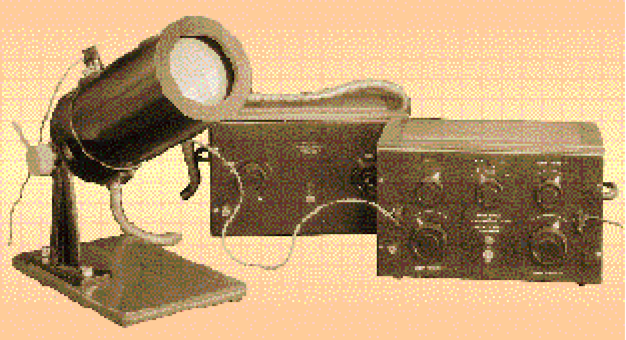
Evolution of the Cathode – Ray Oscilloscope 1931 – 2000



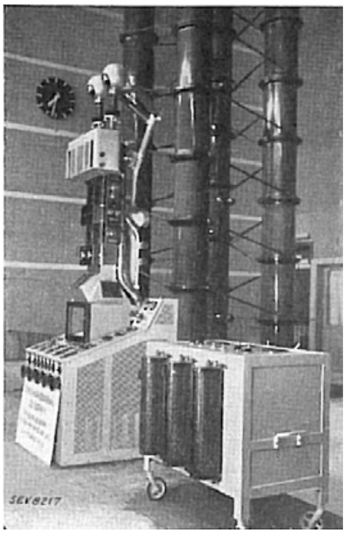
The first commercially built Cathode-Ray Oscilloscope was the type 535 built by the General Radio Co. of Cambridge, MA, in 1931. The instrument came in three parts, the CRT was mounted on a stand, the power supply and the type 506-A sweep generator in a separate cabinet. The 535 used a cathode-ray tube made by Manfred von Ardenne in Germany. The sweep generator had been developed by Professor Frederick Bedell of Cornell University. General Radio had a license later for the Bedell sweep generator.

General Radio's big move came in 1934, when it announced the type 687-A Electron Oscillograph, a complete scope, it included CRT, power supply and sweep generator, all in one housing. Deflection sensitivity ranged from 1 to 5 Volt, a linear function of anode voltage, which could be adjusted from 500 to 2,500 V. By today's standards, the instrument was far from sensitive, since signals were applied directly to the deflection plates. Plate capacitance was specified as less than 1.5 pf.

The first commercially built European Cathode - Ray Oscilloscope was developed in the German Manfred von Ardenne Laboratory at Berlin - Lichterfelde and manufactured from early 1932 at the small Swiss company Dipol AG, Arbon (Lake Konstanz), The power supply, the sweep generator as well as an optional vertical deflection amplifier were housed in the movable compartment. The Cathode Ray Tube built by Leybold und von Ardenne, Köln was mounted on a stand at the top of the compartment.

Allen Dumont started his company in late 1931 after leaving De Forest Radio Co. in Passaic, N. J. where he had been chief engineer and where he developed technology for manufacturing vacuum tubes and pursued television technology. Dumont's new company, in the basement of his home in Upper Montclair, N. J., began manufacturing cathode-ray tubes and later also made cathode-ray oscilloscopes. Dumont invented a form of self contained cathode ray oscilloscope with the power supply and an internal oscillator which repeatedly sweeps a beam of electrons across the screen at constant speed. The Dumont type 304, as shown on the photography, was announced early in 1934.

However with increasing interest in studies of steep-front voltage surges, the early cathode-ray oscilloscopes hadn't the ability to faithfully record such transients. Even a more advanced oscilloscope technique was necessary.



In the second half of the 30's the Swiss Trüb Täuber company invented a cold cathode oscilloscope to record transients in the microseconds and millimicroseconds region. The actual electron beam device wasn't a sealed cathode ray tube, but rather a continuously evacuated device by a high-vacuum pump. The high writing speed was attained by the use of high accelerating voltages for the electron beam, in the order of 50 kilovolts. The vertical deflection system of the oscilloscope was electrostatic and the sweep deflection system was electromagnetic. The oscilloscope hadn't a vertical amplifier. Y - Sensitivity was not an important factor, as ample signal voltage is available on transient investigations. A resolution of time intervals of the order of 10 millimicroseconds was typically for the current and voltage records. Two sources of error are of concern when very short transients are to be recorded. One is the error due to the transit time of the electrons in passing from one end to the other of the deflecting plates. The other error is caused by impedance mismatch in connecting the deflecting-plate circuit to the signal source. The Trüb Täuber cold cathode oscilloscope was highly advanced for the pre WWII epoch and had been in use in many European as well as American laboratories.

WWII U.S. Coast Guard veterans and an electronics expert from the U.S. Army Signal Corps founded on February 1946 the Tektronix Inc. Beaverton OR. Because of their experience in WWII electronics they knew about the shortcoming of the Cathode – Ray Oscilloscopes at that time. So they realized the idea for a new type of oscilloscopes with calibrated and triggered time sweep, calibrated vertical deflection system with a wider bandwidth, better pulse signal response and a higher sensitivity. The Tektronix type 511 portable wide band oscilloscope, as shown on the photography, came in 1947 on the market. It was more sensitive, more compact as any oscilloscope before and had a wideband circuitry. The 511 used a delay line to permit watching the "leading edge" of the pulses and a new distributed amplifier technique to obtain the bandwidth of 10 MHz.. The screen had a precise grid (graticule) to perform accurate measurement. The demand for the new type of oscilloscopes increased rapidly.

Tektronix began manufacturing own cathode-ray tubes when they could not get the quality they wanted for their oscilloscopes. They also conceived the idea of a basic oscilloscope that could be adapted with "plug-in" devices, rather than special oscilloscopes for different applications. The plug-in oscilloscopes, introduced with the series 530 in 1954, were an instant success. By 1957, the 545 oscilloscope as shown on the photo was introduced with a distributed 14 tube vertical amplifier of 30 MHz bandwidth. The 545 was also the first Tektronix oscilloscope with two time bases. The sweep delay was continuously variable from 1 microsecond to 10 seconds by a jitter not more than 1:20'000. The 545 became an important tool for the beginning digital and computer developments in the early 60's.

In the 90's digital technology began to offer a less expensive alternative. An A/D converter on each vertical channel digitizes the input; the microprocessor can then paint the trace as often as needed to keep even fleeting events displayed for as long as the user needs. The Tektronix TPS2014 oscilloscope, as shown on the photo, is a graph - displaying multicolour device, it has a bandwidth of 100 MHz, a sample rate of 1GS/s and 4 fully isolated vertical channels. In the FFT mode the frequency components of a signal are processed. A sampled signal (N samples) is transformed to the frequency domain. After the FFT process the main frequencies in the signal (N frequencies) are shown.