Maximum Voltage: 750 V.
Terminals: Two locking GR874 coaxial connectors; easily convertible to other types of connectors by attachment of locking adaptors. Outer shell of one connector is ungrounded to permit capacitor to be used with external resistor as a dissipation-factor standard.

Accessories Required: For connection to TYPE 1615-A Capacitance Bridge, 2 TYPE 874-R20A or TYPE 874-R22LA Patch Cords.
Dimensions: Width 6¾, height 6⅝, depth 8 in (175, 170, 205 mm), over-all.
Net Weight: 8½ lb (3.9 kg).
Shipping Weight: 14 lb (6.5 kg).

Catalog Number	*Description*	*Price in USA*
1404-9701	**Type 1404-A Reference Standard Capacitor,** 1000 pF	**$225.00**
1404-9702	**Type 1404-B Reference Standard Capacitor,** 100 pF	**225.00**
1404-9703	**Type 1404-C Reference Standard Capacitor,** 10 pF	**225.00**

U.S. Patent Number 2,548,457.

INCREASED FREQUENCY RESOLUTION FOR WAVE-ANALYZER RECORDINGS OF VIBRATION, ACOUSTIC, AND ELECTRICAL SIGNALS

The TYPE 1900-A Wave Analyzer[1] is widely used for low-frequency spectrum analysis, because it has three bandwidths, 3, 10, and 50 Hz, and an 80-dB dynamic range for recording. The 3-Hz bandwidth is particularly popular, because of its excellent resolution. In order to take full advantage of that resolution, we are now making available a link unit that will permit recording with an expanded frequency scale on the TYPE 1521-B Graphic Level Recorder. This TYPE 1900-P3 Link Unit is shown in Figure 1 installed on the wave analyzer and recorder.

With this new link unit the frequency scale of a recording is spread out to 2 inches for 100 Hz, so that a frequency difference of 1 Hz can be noticed. An additional frequency scale of 2 inches for 1000 Hz, identical with that of the TYPE 1900-P1 Link Unit, is also provided. A neutral position simplifies the setting of the frequency control to the desired starting point.

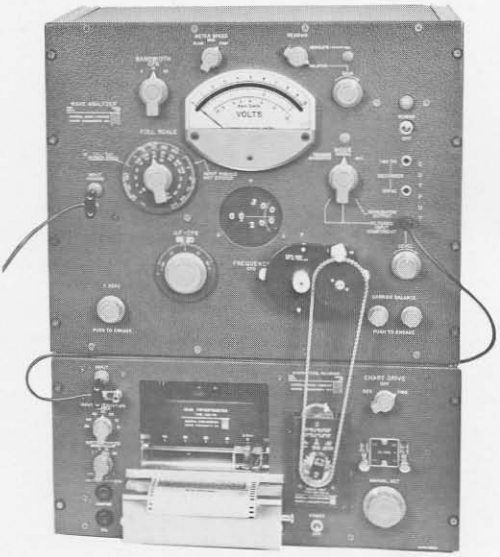

Figure 1. Type 1900-P3 Link Unit installed on the wave analyzer and graphic level recorder.

The same chart paper, TYPE 1521-9464, is used for both speeds.

The recording reproduced in Figure 2 shows evidence of the smoothness of the frequency-control drive with this link unit. The components displayed are spaced 10 Hz apart in the vicinity of 50,000 Hz, and the absence of significant jitter in this expanded display demon-

[1] A. Peterson, "New Wave Analyzer has 3 Bandwidths, 80-dB Dynamic Range," *General Radio Experimenter*, April, 1964.

strates that the new drive can be used to advantage over the full frequency range of the wave analyzer. Of course, the applied signal must also be sufficiently stable that the 3-Hz bandwidth can be used. For the pulse signal analyzed in Figure 2, the pulse repetition frequency of a TYPE 1217-C Unit Pulse Generator was controlled at 10 Hz by a highly stable, crystal-controlled, time-mark generator so that the harmonics up to and beyond the 5000th would not show any appreciable jitter.

The resolution of the 3-Hz bandwidth and the convenient display of the analyzed spectrum on the recorder make the system well suited to the analysis of certain types of electrical, acoustic, and vibration signals, including for example, the acoustic noise and vibration produced by such rotating machinery as gear trains, electrical motors, and turbines.

Arnold P. G. Peterson received his B. Eng degree from the University of Toledo in 1934 and his S.M. and Sc.D. degrees from M.I.T. in 1937 and 1941, respectively. He was a research assistant at M.I.T. from 1936 to 1940. He came to General Radio in 1940 as a Development Engineer and became Group Leader of the Audio Group in 1947. He is a Fellow of IEEE and of the Acoustical Society of America, of which he was Vice President in 1958–59. He is a member of AAAS, AAPT, and AGU, and of several standards committees in the general field of acoustics.

Figures 3, 4, and 5 illustrate the detail that can now be obtained in a practical case. These recordings are analyses of the vibration of the paper-drive frame of the TYPE 1520-A Sampling Recorder. A scan of the frequency range of the analyzer in the normal drive position shows (Figure 3)

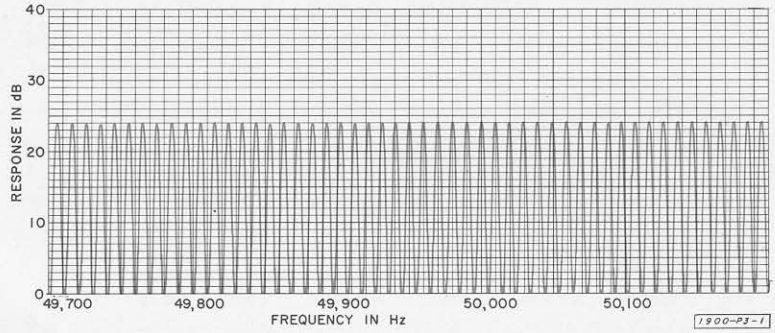

Figure 2. Section of a frequency spectrum in the vicinity of 50,000 Hz of a 30-μs pulse repeated every 0.1 s. The expanded frequency scale is used to show the individual components every 10 Hz.

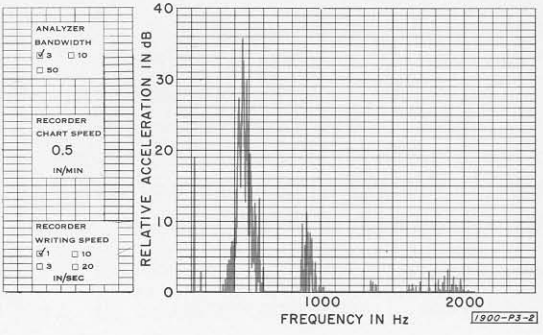

Figure 3. Analysis of the vibration of a frame holding a gear-belt drive. The frequency scale is sufficiently compressed to show the general character of the spectrum.

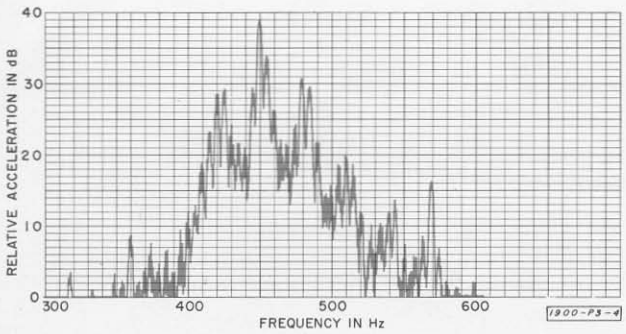

Figure 4. Analysis of the same vibration signal of Figure 3, but with the expanded frequency scale.

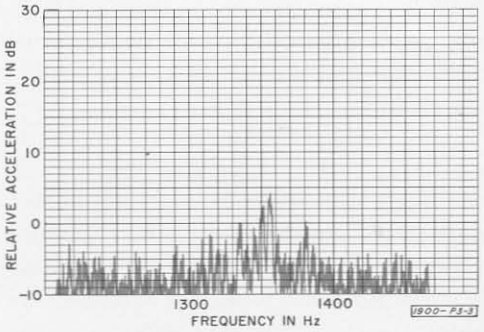

Figure 5. The expanded frequency scale is used here to show the components in the vicinity of 1350 Hz.

that the significant components of vibration are at 120 Hz, and in the vicinity of 450 Hz, 900 Hz, and 1350 Hz.

A detailed recording in the vicinity of 450 Hz with the expanded scale (Figure 4) shows that the belt-gear-drive tooth-contact rate of 450 impacts per second determines the frequency of the dominant component, and the gear belt with its speed of 5 r/s introduces a host of components spaced about the main component by multiples of 5 Hz. The torque pulsations from the 1800-rpm synchronous motor and the 120-Hz magnetically driven vibration in the motor also influence the spectrum.

The large number of components is a result of complex interactions of the various impacts and forces.[2] The 3-Hz bandwidth and the expanded scale make it possible to display these many components and to determine their actual frequencies.

A significant amount of random motion in the mechanism being measured obscures some of the weaker components. This effect is even more important at higher frequencies. As shown in Figure 5, a few components in the immediate vicinity of 1350 Hz are displayed clearly, but the existence of many others is obviously probable by reason of the spacing of fluctuating peaks at 5-Hz intervals.

This new accessory makes the recording wave analyzer an even more versatile tool than before for the analysis of stable, complex signals.

— Arnold Peterson

[2] L. S. Wirt, "An Amplitude Modulation Theory for Gear-Induced Vibrations," Chapter 17 of *Measurement Engineering* by P. K. Stein, Tempe, Arizona, 1962.

Catalog Number	*Description*	*Net Wt*	*Ship Wt*	*Price in USA*
1900-9603	**Type 1900-P3 Link Unit**	1 lb (0.5 kg)	4 lb (1.9 kg)	**$55.00**