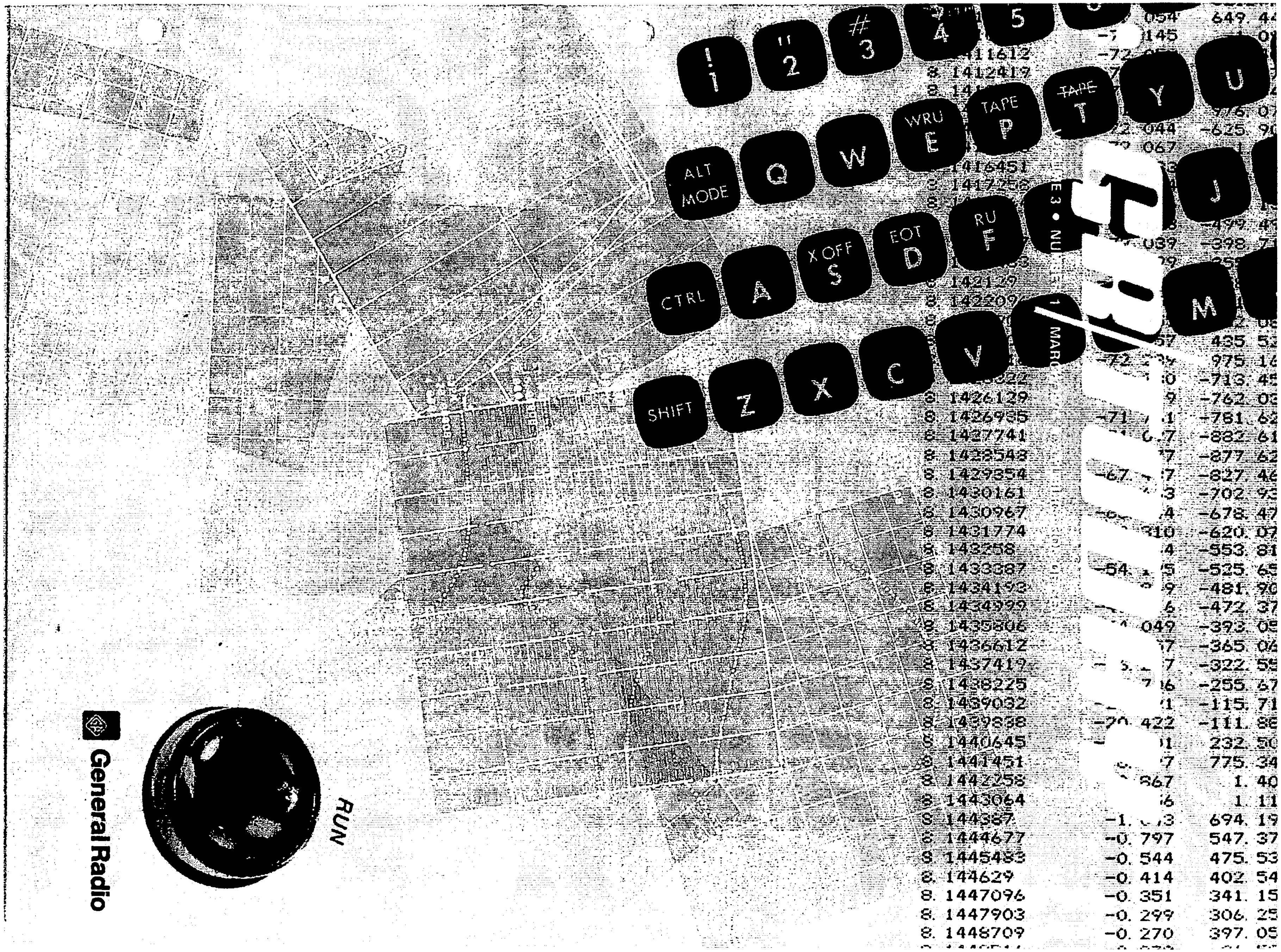
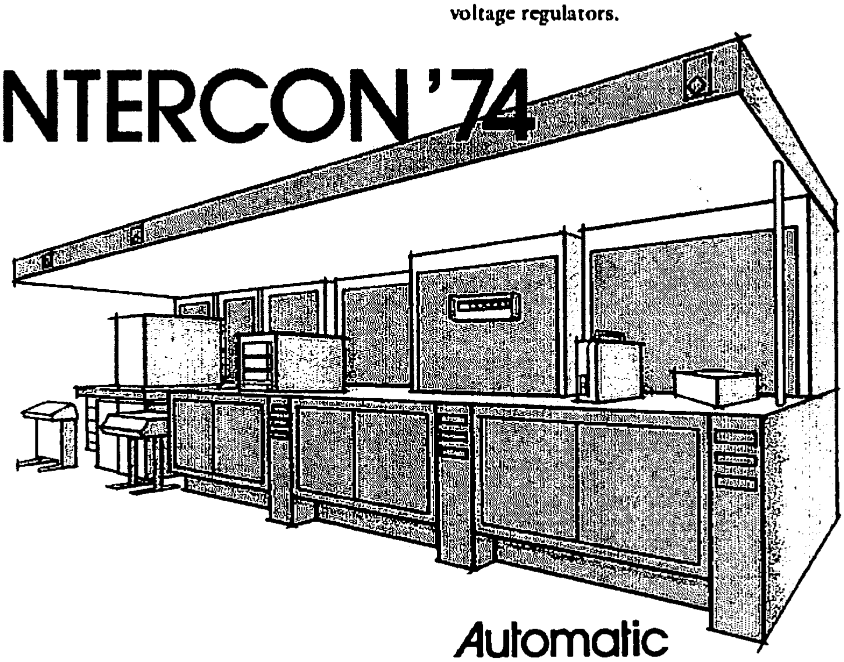

General Radio
RUN

There is always plenty of action at the IEEE show in New York and this year much of it will center around General Radio's booth 2318. The major attraction will be the GR 2260 Automatic Network Analyzer which will be on display for the first time. This new analyzer provides rf measurements to 500 MHz, quickly, precisely, and at the push of a button. Also on display will be the popular 1710 RF Network Analyzer, an automatic linear-circuit tester, a high-performance frequency synthesizer, and two representative models of a broad line of brown-out protecting voltage regulators.

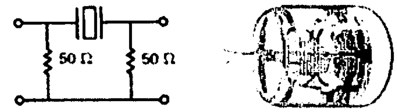
INTERCON '74

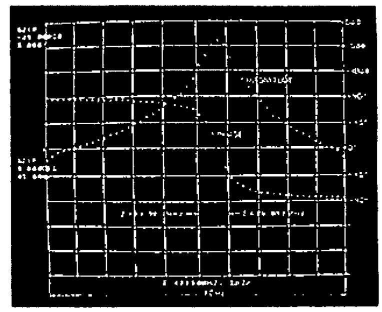


Automatic RF Network Analysis

One of the best ways to appreciate the power of the new GR 2260 Automatic Network Analyzer is to tally the amount of equipment and time you need to test and document completely your latest and most sophisticated linear rf device. Then bring the device to the show and test it again, this time on the 2260. If you're not attending the show, simply mail your device to us and we'll return it with a complete set of measurement data on any parameters you specify: General Radio
Dept. RLM
Bolton, MA. 01740

High-Q crystal





2.499[illegible]	[illegible]	44.[illegible]
2.4999[illegible]	-4.[illegible]	[illegible]
2.4999814	-4.112	[illegible]
2.4999[illegible]15	-4.[illegible]	-31.[illegible]
2.499[illegible]22	[illegible]	[illegible]

Typical of the resolution possible with the 2260 is this display of the measurement of the magnitude and phase response of an ultra-precise high-Q crystal. From the display you see immediately that the magnitude peaks and the phase shift minimizes at about 2.5 MHz. Considerably more precise, however, is the printout that, with the aid of a little mental arithmetic, defines the crystal center frequency as 2.4999814 MHz and the bandwidth as 1.5 Hz! Such resolution stems from the system's precision frequency synthesizer which is used as the source. You can also calculate series resistance from these data, which, for this crystal, is 58.7 ohms.

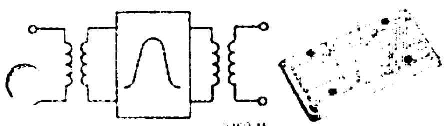
A must for many measurements is the necessity to specify dwell time at the measurement frequencies. In this case, for example, a dwell time of 500 ms was necessary in order to allow the crystal, which has an unloaded Q of over 5 million, to settle between frequency changes – dwell time of from 1 ms to 1 minute can be specified. Another important factor is the ability to set specified input levels in order not to overload the device. For this measurement, −30 dBm was specified. The system provides any level from −56 dBm to 0 dBm in 1-dB increments.

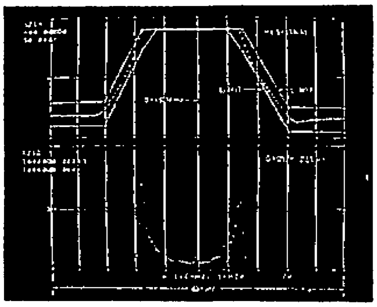
If the purpose of the tests were to check these crystals in production for the proper center frequency and bandwidth, the arithmetic would all be handled in the processor. The operator would only have to observe a "pass" or "fail" lamp.

GR/TODAY is mailed without charge to all interested in the products, services, developments and worldwide activities of General Radio Company. Address correspondence to: Editor, GR/TODAY, General Radio, 300 Baker Ave., Concord, Mass. 01742

Volume 3, Number 1 — March 1974

Narrow-band filter





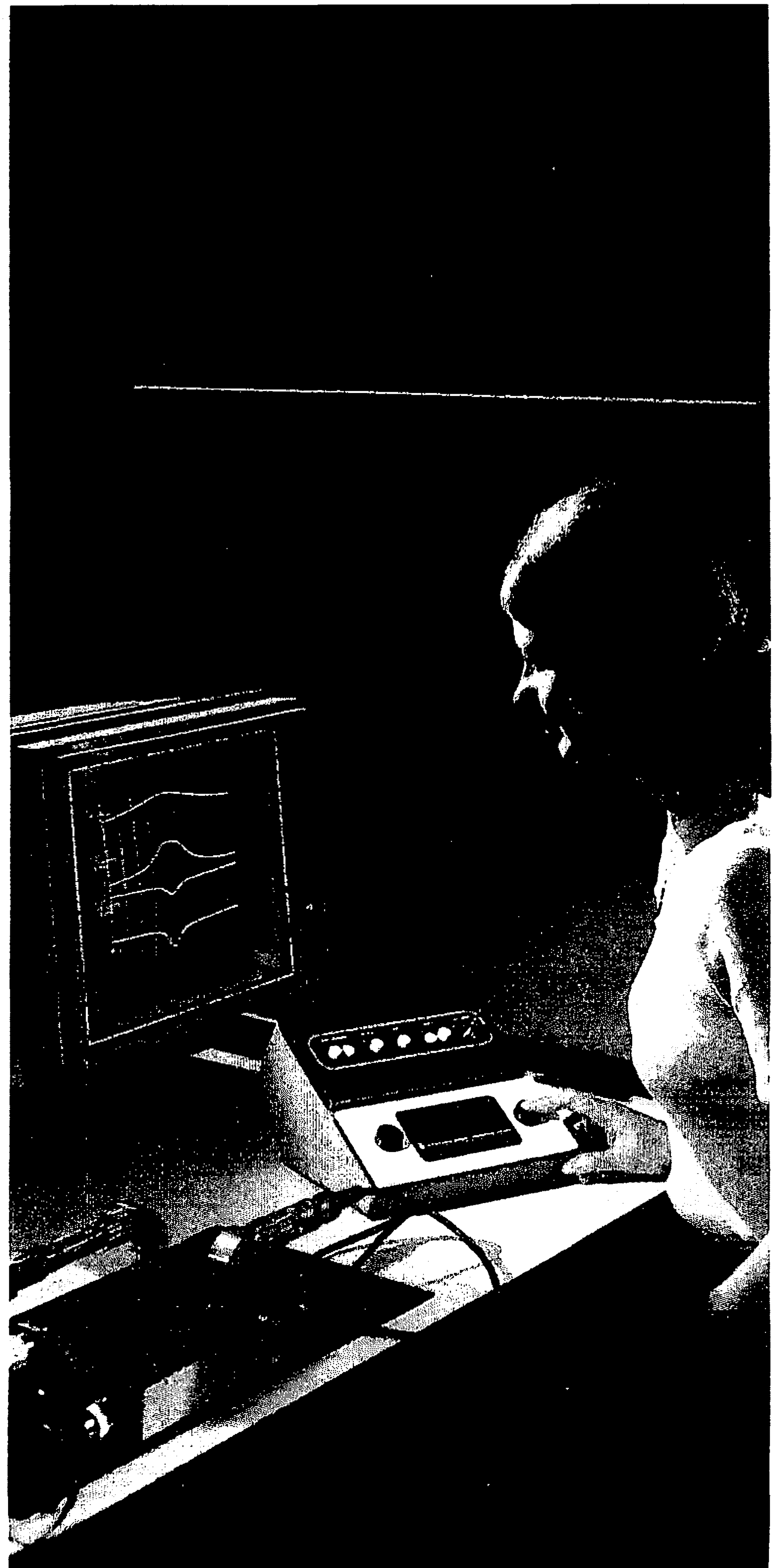
[illegible]	14[illegible]	[illegible]
[illegible]	14[illegible]	[illegible]
[illegible]	14[illegible]	[illegible]
[illegible]	1471[illegible]	[illegible] 49[illegible]
[illegible]	1472[illegible]	[illegible]

Production testing of crystal filters presents some formidable problems. Accurate, high-resolution measurements must be made rapidly and the resultant data must be compared to preset limits just as rapidly for use as a go/no-go indication to the operator. In most cases, these data must be stored as hard-copy records to accompany the filter or to be used in statistical analyses of trends in the production process.

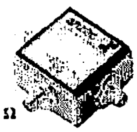
The 2260 not only provides the accuracy and precision required, it performs the measurements in seconds. It also provides a pass/fail indication, plus a graphic display of the limits, plus hard-copy records of all the measured data, or of just the fail data, whenever required – all at the push of a button.

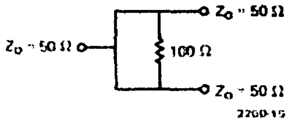
From the upper curve on the display, center frequency for the monolithic crystal filter is seen to be about 8.146 MHz. Upper and lower limits of 0 dB and −.6 dB were applied between 8.1447 MHz and 8.1470 MHz (passband). From the tabular data, the filter response is within thousandths of a dB of the lower limit at 8.1470 MHz. Effects of the transformerized test fixture were automatically subtracted from all measurements performed.

Of increasing importance these days in the characterization of many devices is group delay. Not only does the low noise of the synthesizer source in the 2260 allow precise group delay measurements but the system architecture permits such measurements well into the millisecond region – an impossibility with conventional sweep-frequency analysis.

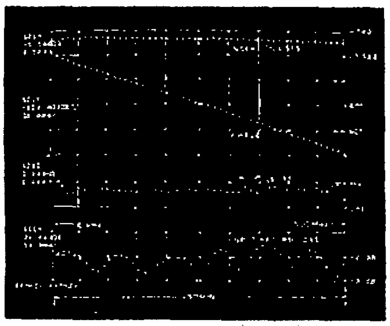


Broadband power divider

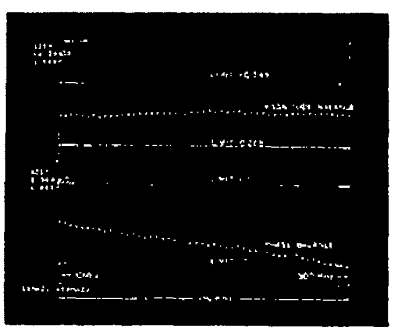




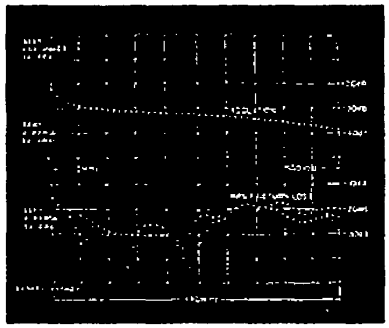
Small devices are not necessarily simple devices and many often require measurements of several parameters for complete characterization. One such device, a broadband isolated power splitter from Anzac, requires 9 measurements – an expensive, laborious task even with the most sophisticated sweep-frequency techniques. The 2260 manages the task in seconds, however, because all test instructions are stored in memory and called up automatically as needed.



The first measurements are those of insertion loss, phase and group delay between the input and one output, and the input return loss of the power splitter. Similar measurements could also be made on the second output. The versatility of the displays allow all four measurements to appear on a single grid, as shown, on four separate grids, as single displays of each parameter, as a group of two or three curves on a single grid or on separate grids. Limits could also be added for go/no-go testing as is done in the following display.

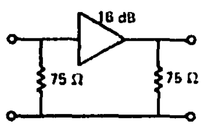


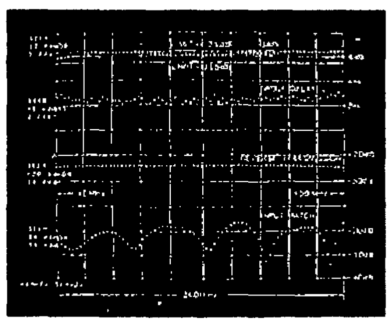
More important than characteristics of the individual outputs are balance characteristics between the outputs. In this measurement, limits are specified for both the magnitude and phase balance so that the operator need only watch pass/fail lamps.



Finally, the isolation between output ports and the input return loss of each output is checked.

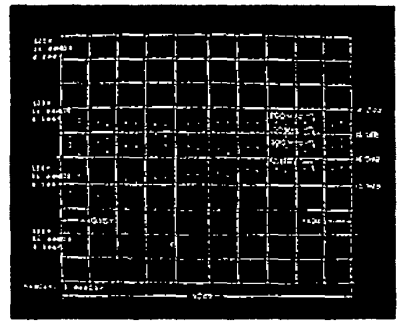
Low-distortion amplifier





Long-distance communications systems involve the use of repeater amplifiers. These amplifiers must maintain extreme faithfulness of the output to the input, especially if they are to be used with color-TV signals. One of the more important parameters in this regard is a flat gain characteristic in the passband, shown within the ±0.25-dB limits established.

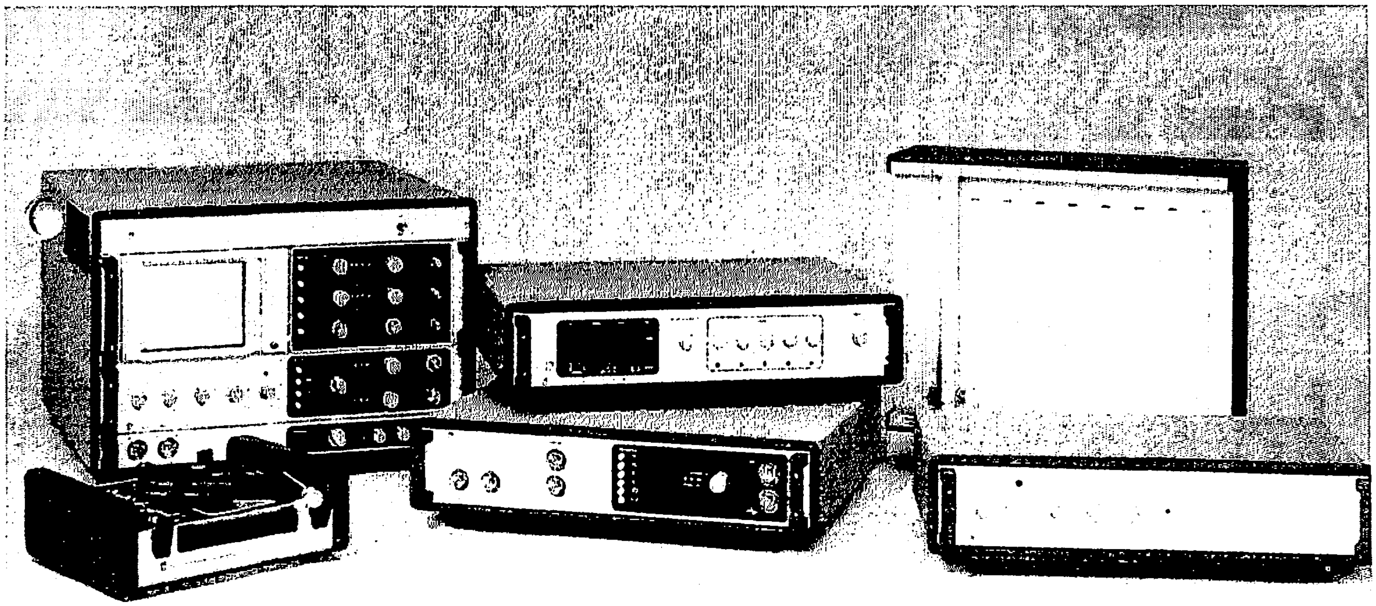
Another important parameter is group delay that also must remain constant with frequency and which, for this amplifier, does so at about 2.5 ns as shown in the second trace. Reverse transmission (isolation) and input match are also of importance and are shown in the lower two traces. Again, as with the display of the power-divider characteristics, the four traces could just as easily have been displayed separately and all could have included limits for rapid go/no-go tests.



	50 MHz	100 MHz	200 MHz	300 MHz
LEVEL (DBM)	S21M (DB)	S21M (DB)	S21M (DB)	S21M (DB)
-40	15.[illegible]	[illegible].064	16.[illegible]	16.[illegible]
-39	15.854	16.101	16.117	16.[illegible]
-38	15.939	16.120	16.162	16.[illegible]
-37	15.[illegible]	16.104	16.[illegible]	16.[illegible]
-36	15.[illegible]	16.151	16.104	16.[illegible]
-35	15.843	16.193	16.125	[illegible]
-34	15.878	16.[illegible]	16.[illegible]	16.[illegible]

One other factor often of interest in repeater amplifiers is gain vs input drive level. Since the 2260 allows the input level or dc bias, in addition to the frequency, to act as the independent variable, measurement of the gain vs input drive is simply a matter of a few keyboard commands. Here, gain is displayed and provided, as a hardcopy printout, as a function of input drives from –40 to –10 dBm at four different frequencies.

Manual and semi-automatic equipment has been used for years to test rf devices and will continue to be used for a good many years to come. But because devices are becoming more sophisticated and customers are becoming more demanding, automatic test equipment is playing an increasingly greater role. In fact, it is *now* possible to test devices much more economically and more completely with automatic systems, such as the GR 2260, whenever large amounts of well-defined data are to be collected on large volumes of units.



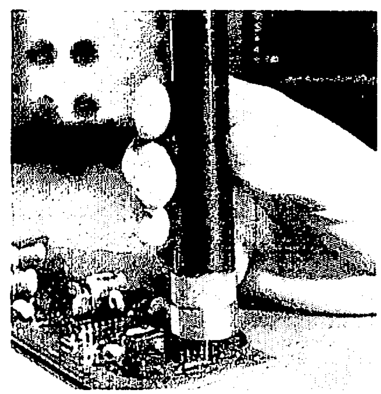
INTERCON '74

Popular RF Network Analysis

For over two years the GR 1710 RF Network Analyzer has been a popular choice for precise, yet fast rf measurements including magnitude, phase, group delay, and impedance. This sophisticated, simply operated system operates over a broad sweep-frequency range of 400 kHz to 500 MHz and a wide dynamic range of over 100 dB in either 50- or 75-ohm systems.

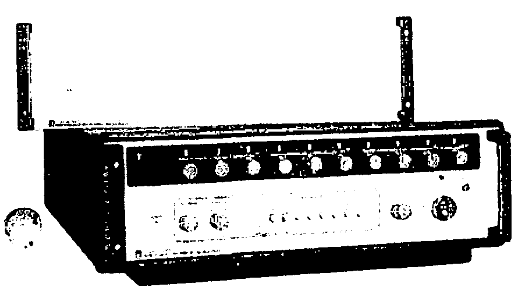
The transmission and reflection characteristics of both 50- and 75-Ω devices can be displayed in either rectangular or polar form. The sweep range is variable — as wide as 500 MHz or as narrow as 1 kHz, with a choice of log or linear sweep modes and a choice of sweep times from 10 ms to 100 s. A built-in variable-width marker adds to the operating ease.

A low-cost ($595) probe allows the basic analyzer to perform direct-reading sweep-frequency impedance measurements from 0.5 ohm to 1 megohm. Other accessories provide automatic frequency-response error updating, rapid X-Y recordings, and precise direct-reading frequency markers.



INTERCON '74

High-performance frequency synthesis



For high-performance frequency synthesis to 500 MHz, the GR 1062 Frequency Synthesizer is a natural choice. It provides the output purity of a high-grade frequency standard (multiplied up) and, with phase noise of greater than 60 dB down and nonharmonic spurious signals greater than 80 dB down, it makes an excellent source to up-convert or multiply into microwave frequency bands.

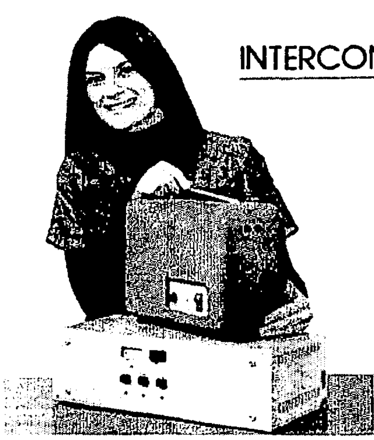
The 1062 is ten times faster than most synthesizers (switching speed is less than 100 μs or, for example, less than a second for 10,000 steps), more compact (only 5¼ inches panel height), and one of the most economical (from $8900). The basic unit provides a leveled output of −7 to +13 dBm from 10 kHz to 500 MHz with 10-kHz (5-digit) resolution (optional to 0.1 Hz, 10-digit). A search-sweep mode provides continuous resolution and both frequency and output level can be remotely programmed.

INTERCON '74

Automatic linear-circuit tester

The GR 1730 Linear Circuit Tester handles with equal ease such diverse applications as circuit evaluation, production testing, and incoming inspection. It tests all common linear circuits including single and dual operational amplifiers, voltage followers, single and dual comparators, voltage regulators, and other low-voltage operational amplifiers. It provides as much information as desired, from a simple go/no-go indication of a series of up to 18 tests to a detailed account, and does so at speeds of from 50 to 200 ms per test.

Also impressive is the variety of parameters tested: Current, power-supply rejection ratio, maximum output, slew rate, common-mode limit, offset voltage and current, bias current, voltage gain with and without load, common-mode-rejection ratio, output impedance, and gain-bandwidth product -- all at the push of a button! Test parameters are easily changed by simple slide-switch settings, a host of devices can be accommodated by versatile device-adaptor boards, and a low-cost option provides data-output and input-programming capabilities. This bench-top system starts at only $5,950.



INTERCON '74

Line-voltage regulation

Brownouts are a way of life these days but they needn't shut down an entire operation just because one or two critical pieces of equipment are affected. GR regulators accept input line variations of up to ±20% (most brownouts are less than 8%), provide outputs constant to better than ±0.5%, and power the fussiest of loads including precision instrumentation, computers, and on-line process-control equipment.

Models are available for inputs of 50 to 60 Hz, single or three phase, and outputs from 8.7 amperes to 85 amperes. All are insensitive to load type, introduce no distortion or noise, respond quickly to input changes, and withstand 1000% transient overloads. Portable, bench-top, rack-mount, and wall-mount units are offered, starting at $460.

QUIET is the law

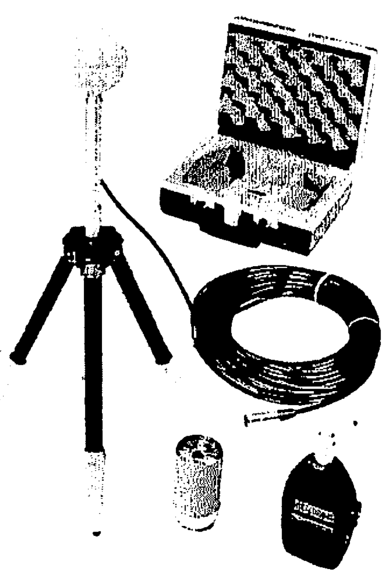
Vehicle Noise

Quiet - you're on candid microphone

Motor vehicles are everywhere, so is the noise they make and so are the regulations to control the noise. Vehicle noise ordinances are currently second in number to zoning noise ordinances and state highway patrols may one day be using sound-level meters as handily as they do radar.

To help communities measure vehicle noise and enforce related ordinances, General Radio has designed the 1565-9906 Vehicle-Noise Measurement Set. This new set features simplicity of operation and calibration so that reliable measurements can be made by law-enforcement officers who've had no prior experience in acoustic measurements.

The set includes a 1565-9015 Sound-Level Meter that measures directly from 50 to 140 dB and a windscreen to prevent erroneous readings due to wind noise. Also, to preserve accuracy, a 1567 Sound-Level Calibrator is furnished with which calibrations can be performed in seconds. Both the meter and the calibrator are protected during storage and transportation by an impact-resistant, padded carrying case.



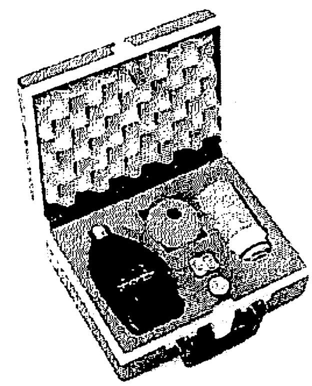
Since most vehicle-noise measurement regulations specify microphone location during measurement, with the observer out of the sound field, the set includes a remote microphone, extension cable, and tripod. Measurements are direct reading when the extension cable is used. General-purpose measurements are possible by simply attaching the microphone directly to the meter and subtracting 20 dB from the meter reading (the sound-level-meter range becomes 30 to 120 dB, the range necessary, for example, in community-noise programs.)

Community Noise

The problems Until recently, noise pollution in our cities and towns has taken a back seat to air and water pollution. Noise doesn't irritate our eyes or kill our fish. But noise annoys -- it annoys to such an extent that 80 million people in the U.S. lose their efficiency because of it, 60 million lose their ability to understand normal speech, and 10 million suffer temporary hearing impairment. Over $5 billion in damages are currently estimated in noise lawsuits, and the courts are granting more and more awards every day.

The laws The Federal Government has attacked the problem in industry through the Occupational Safety and Health Act and municipalities have begun to address the problem through passage of ordinances. Many of the existing laws involve noise in and around airports because airport noise is an obvious nuisance. Now, however, more ordinances are being aimed at community and traffic noise and zoning laws are being modified to incorporate maximum allowable noise levels for residential as well as commercial and industrial districts.

The measurements The start of any noise-control program, and its eventual success, almost invariably begins with measurements to determine present levels, then evaluates the effectiveness of corrective measures. To ease the problem of instrument selection, General Radio has recently developed a complete



set specifically designed for use in community-noise-control programs.

The set consists of a 1565-C Sound-Level Meter for making noise measurements from 30 to 130 dB, a 1567 Sound-Level Calibrator for routine calibration of the meter, a windscreen, and a rugged carrying case. The 1565-C meets all ANSI Type 2 specifications, is easy to operate, and is extremely durable even under the severe operating conditions encountered in the field.

In communities where noise laws are yet to be enacted, the 1565-C enables authorities to make noise-level surveys throughout their municipality to determine the areas that pose a current or potential noise nuisance. Compilation of these data also aids in determining what types of ordinances may be needed.

Where laws exist, the 1565-C is an excellent instrument for making measurements to determine compliance.

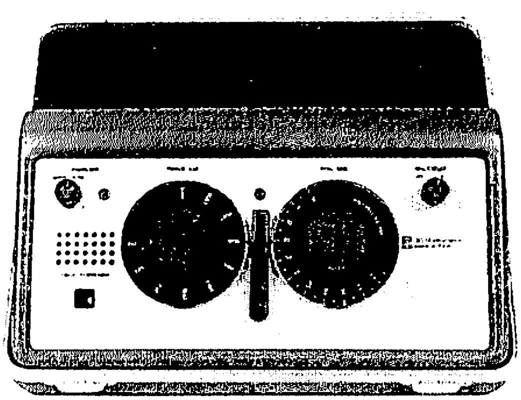
QUIET is the law

Those new audiometric tests

Audiometric testing has been implied by the OSHA regulations for some time, but only rather vaguely. Under the proposed regulations, however, the requirements would be much more specific. Tests of employee hearing would be required when their daily noise exposure exceeds 50% of the maximum allowed per day, or when their exposure is controlled by personal protective equipment such as ear muffs or ear plugs.

For several years, General Radio has been producing the 1703 Recording Audiometer, a moderately priced automatic unit primarily for use in larger hearing-conservation programs. Recently, we have introduced a much more economical unit intended for the smaller programs, especially those that must include audiometric testing under the proposed legislation.

This new audiometer, the GR 1937 at $395, is an exceptionally sound investment where the number of employees to be tested each year is small. Unlike most low-cost audiometers, the 1937 features a built-in intercom system, with microphone, for communications between the employee and the technician administering the test. Those who've experienced the frustrations of trying to communicate to an employee taking a test in a soundproof booth can readily appreciate this simple, but highly effective, addition. Technicans will also be impressed with the operating ease carefully incorporated in the unit – the tone presentation bar is easily accessible to the hand that manipulates the hearing threshold level, and controls are carefully arranged for minimum operator motion.

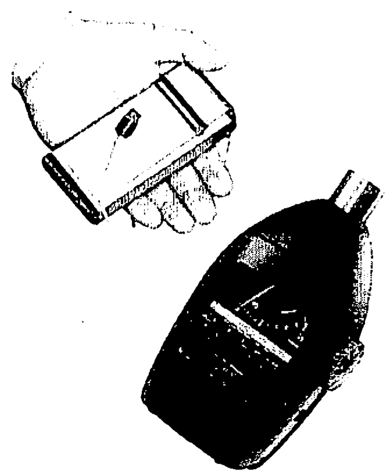


All ten preferred frequencies are included, the HTL range is a full -10 to +90dB at all frequencies, and calibration is in full accordance with ANSI-1969 and ISO-1964. The HTL control uses a unique, continuously variable, thick-film attenuator with detents at 5-dB intervals, which permits more precise definition of threshold levels than is possible with conventional stepped attenuators. Reliability is ensured by state-of-the-art integrated circuits and the unit is packaged in an attractive and rugged plastic carrying case with ample space for the earphone and accessories.

OSHA tightens up

This May or June the Department of Labor is expected to issue new and stricter OSHA noise regulations based on a draft (1910.95 Occupational Noise Exposure) submitted by the OSHA Standards Advisory Committee. Highlights of this proposal include:

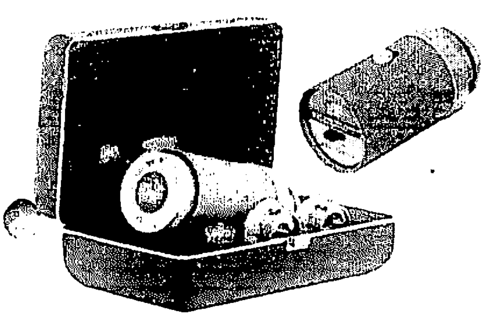
More restricted exposure As proposed, unlimited exposure would be restricted to levels below 85 dBA, rather than 90 dBA as previously stipulated, and exposure would be limited to 16 hours at 85 dBA. Both GR's 1565-B Sound-Level Meter and 1944 Noise Dosimeter will measure in accordance with the proposed change when it becomes effective.



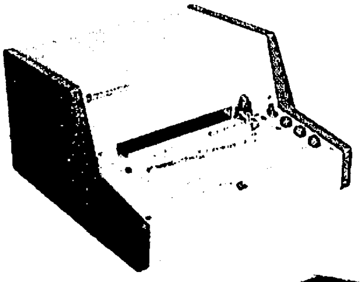
More accurate measurements Of the three types of sound-level meters previously allowed, only the Types 1 and 2 would be authorized under the proposed regulations – the lower-accuracy Type 3 would no longer be acceptable. Measurements must

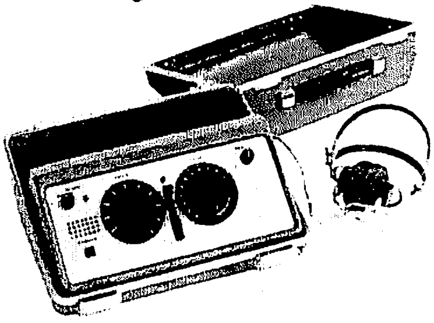
also "be made with the microphone of the sound measuring instrument at a position at which the noise most closely approximates the noise levels at the head position of the employee during normal operation." Both requirements are met by the GR 1565-B Sound-Level Meter and 1944 Noise Dosimeter (with remote microphone).

Dosimeter measurements, according to the proposal, must be made with an "OSHA approved audio dosimeter." No dosimeters are currently "OSHA approved" but, when a formal testing program is inaugurated, we expect the GR 1944 Noise Dosimeter will meet the criteria handily. Measurement accuracy must also be verified, under the proposed changes, by an acoustical calibrator before and after each day's measurements. Either the five-frequency GR 1562-A or single frequency 1567 Sound-Level Calibrator can be used to assure compliance for the 1565-B Sound-Level Meter. The 1944 Noise Dosimeter includes a built-in acoustical calibrator.



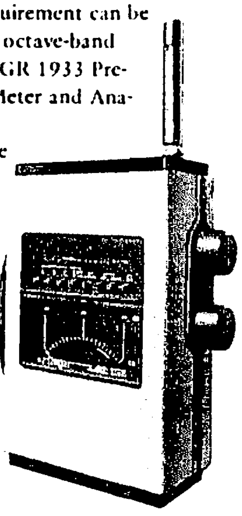
Required audiometric testing The new proposal more clearly defines the requirement for audiometric tests of employee hearing: When daily noise exposure exceeds 0.5 (i.e., 50% of the maximum allowed) or for all employees whose exposure is controlled by personal protective equipment such as ear muffs or ear plugs. The new GR 1937 Manual Audiometer (see "Those New Audiometric Tests", opposite page) is excellent for use in small companies while the popular GR 1703 Automatic Audiometer is a better choice for larger companies.





Ear-protector evaluation One of the proposals means additional instrumentation for some manufacturers – the requirement for the measurement of the noise-reduction factor of ear protection. This requirement can be met with a precision octave-band analyzer such as the GR 1933 Precision Sound-Level Meter and Analyzer.

The fact that these proposals have been made speaks for a growing maturity of the OSHA regulations. The fact that GR's engineering foresight provides instrumentation currently available to meet the proposals speaks for itself.



In print

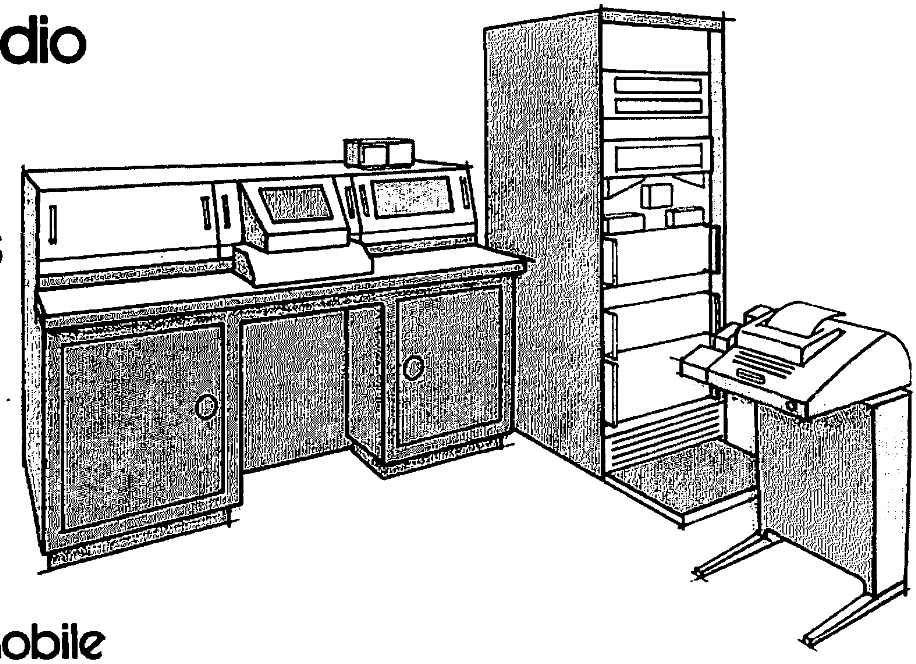
FITTING THE RLC BRIDGE TO YOUR APPLICATION:

An eight-page detailed discussion on manual and automatic resistance-capacitance inductance bridges, their selection and use for laboratory, incoming-inspection, production-testing and automatic-systems applications, as well as for several unusual applications. The ranges, accuracy, speed, and prices of different types of bridges and meters are compared to simplify the choice for a particular measurement. Henry Hall, GR engineering staff consultant, wrote this article which appeared in the October 15, 1973 issue of *Electronic Products Magazine*.

STOPPING MOTION WHERE YOU WANT IT:

An eight-page, liberally illustrated article on the principles and practical aspects of delay triggering for stroboscopes. This article was written by Bill Reich, GR product specialist, and originally appeared in the November 15, 1973 issue of *Machine Design*.

General Radio and their electric whiz-bangs

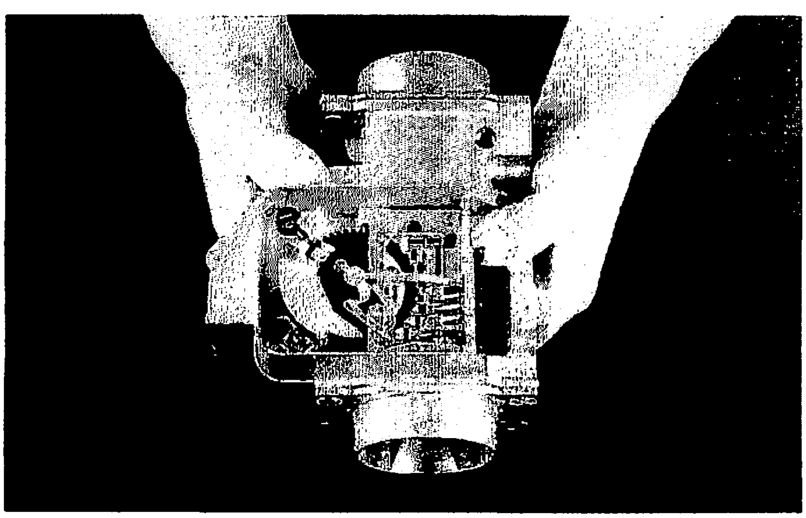


for *your* automobile

Not only are manual chokes nearly extinct but the carburetors that use them may be rapidly following suit. Latest development is the air-flow meter, introduced as an essential element in fuel-injected engines. An air-flow meter uses a flap to control the air flow to the cylinders in relation to the air temperature, engine temperature, exhaust emissions, and throttle opening set by the driver. All this reduces fuel consumption and exhaust pollutants but increases control complexity because of the sophisticated system used to position the flap.

Heart of the system is a thick-film feedback potentiometer. The arm of the potentiometer is connected to, and moves with, the flap in the air-flow meter. A dc voltage is applied across the potentiometer so that the arm produces voltage in a carefully controlled relationship to the flap opening.

This relationship is determined by the model of air-flow meter, by the characteristics of each individual air-flow meter, and by the type of engine on which it will be used. In order to tailor the meter to these requirements, the potentiometer is divided into ten sections, each with an individually trimmed resistor in parallel with it. The major problem, of course, is how to trim thousands upon thousands of these units with the speed, precision, and economy demanded in a high-volume production situation, such as the automotive industry.



The answer, naturally enough, is a GR system – in particular, the 2250 Functional Laser Trim System which has been selected for the job. Data on the meter type and engine type are stored in the system's processor before the test run. Then data on the flap setting for the individual meter, as measured elsewhere, are loaded into the processor. The meter is inserted into a special carrier on the 2250, a button is pushed and, less than 25 seconds later, the meter is ready – all ten padding resistors have been automatically trimmed. While one meter is being trimmed, data for the next are loaded into the processor so that production rates exceed 120 units per hour!

The 2250 is a near-perfect answer to production problems that involve large-quantity, high-precision, and unusual or complex resistor trimming. It trims not only to dc voltage, as with the air-flow meter, but to resistance, ac voltage, and frequency as well, and features versatile software and hardware to suit a wide variety of applications.

for your telephone

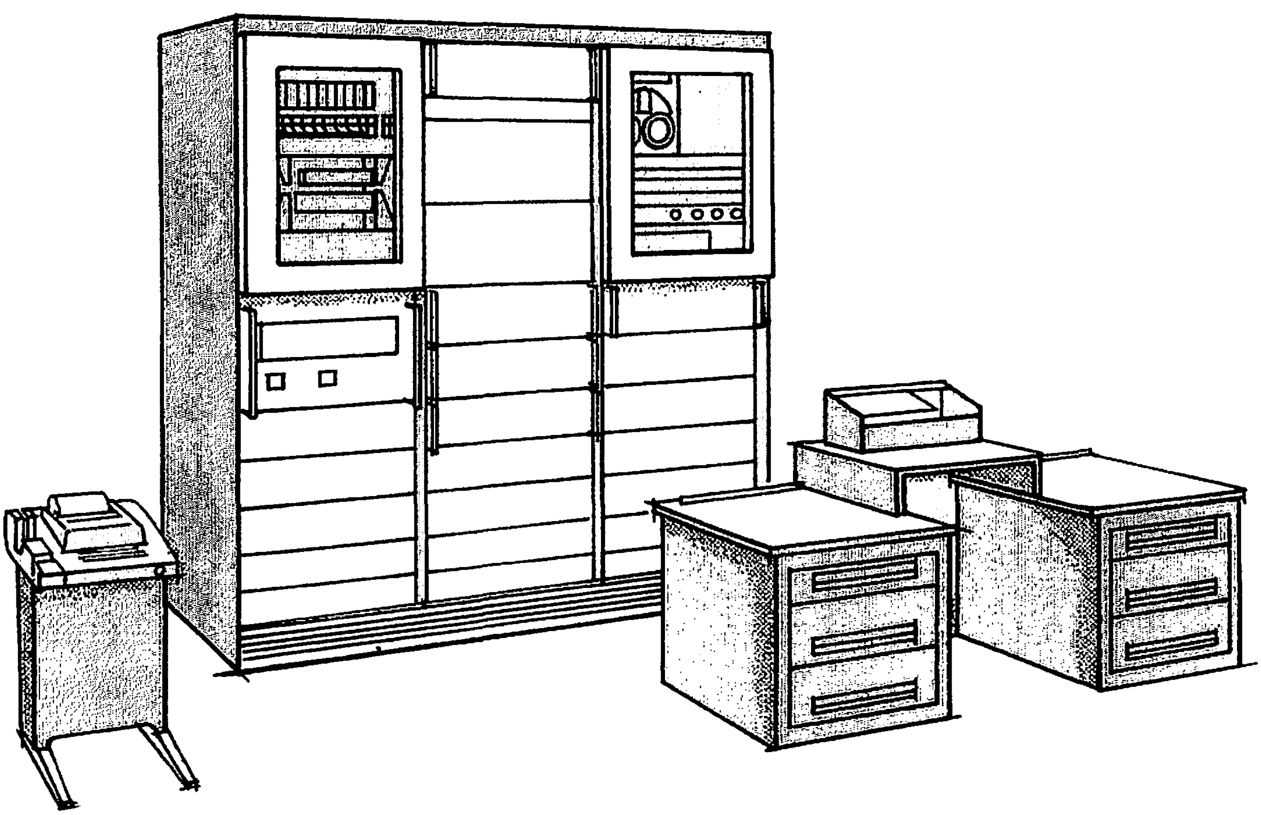
Phone systems may be getting more sophisticated every day but most still rely on some relatively mundane components – transformers, for example. Thousands of these things are used each year to update, expand, or repair the nation's phone systems and, while they may be mundane, they are far from simple.

A typical audio transformer used in a telephone system must meet rigid specifications on continuity, dc resistance, inductance with and without bias, turns ratio, and inductance unbalance. Just checking unbalance manually can take an operator 1 to 3 minutes; meanwhile he's turning six different knobs and watching a meter. Total time for the rest of the tests can take as long, or from 2 to 6 minutes to check each transformer completely – GR's newest Autotrans Test System takes 2 to 6 seconds!

With the Autotrans Test System, the operator need only specify the type of transformer to be tested, connect it, and push a button. The system does the rest and provides complete documentation of the test results, if necessary, in addition to a simple go/no-go indication. The entire system is a turn-key installation; you just turn it on and supply a test program, an operator and the transformers.

The actual testing is performed by an RLC bridge, a DVM, and a unique new unbalance and ratio test module, all interfaced to a built-in central processor. The transformers are inserted in a specially designed test fixture on the operator's console and connected to the test instrumentation by a high-performance scanner, also under processor control. Basic test results are available on a display panel and detailed measurement results are available from a teletype. Test programs are prepared on the teletype and automatically loaded into the processor and mag-tape storage unit.

Although the initial investment in an automatic system may seem high, buying one often costs much less than developing an in-house system from the ground up. Since an automatic system operates 60 times faster than any manual "equivalent", it can pay for itself in a very short time, often in as little as 6 months to a year.



IEEE honors GR engineer

The Board of Directors of the Institute of Electrical and Electronic Engineers has announced a singular honor for a member of General Radio's Engineering Department — our own Robert A. Soderman. Bob has been appointed to the position of Fellow of the Institute. With that appointment he joins a select group and takes his place among other past and present leaders in the art and science of electronic technology. Bob's citation reads:

"For contributions to the development of instrumentation and measurement methods, and for leadership in the establishment and acceptance of associated standards."

With this singular honor, Bob adds yet another milestone to his career. He came to GR in 1945 after earning an E.E. degree from Stanford University and participating in three years of high-frequency development work at Harvard's Radio Research Laboratory and some radar-countermeasures work in England for which he received a Certificate of Merit from the Office of Scientific Research and Development.

At GR, Bob has been involved in and directed our efforts in impedance standards and measurement equipment, high-frequency components, bridges and signal sources, quartz and atomic frequency standards, analyzers, and digital instruments. He is currently responsible for the administrative operation of the Engineering Department.

He has held positions of responsibility in many technical societies and activities — Professional Group on Instrumentation and Measurement of the IEEE, Chairman of the Conference on Precision Electromagnetic Measurements, Instrument Society of America, International Radio and Scientific Union, American National Standards Institute, and the Evaluation Panel of the National Bureau of Standards, and has authored many significant technical publications.

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