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ELECTRICAL MEASUREMENTS AND THEIR INDUSTRIAL APPLICATIONS

DR. BERANEK BECOMES GENERAL RADIO CONSULTANT ON ACOUSTICS

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• **DR. LEO L. BERANEK,** Associate Professor of Communications Engineering and Technical Director of the Acoustics Laboratory at the Massachusetts Institute of Technology, is now associated with the General Radio Company as a consultant on acoustical problems and the design of acoustical measuring equipment. He will work with a development group in the General Radio Engineering Department, headed by Dr. A. P. G. Peterson.

Dr. Beranek is a native of Cedar Rapids, Iowa. He received his B.A. degree from Cornell College in 1936, his M.S. from Harvard in 1937, and his S.D. from Harvard in 1940. After teaching physics and communications engineering at Harvard, he became Director of the Electro-Acoustics Laboratory, an OSRD project, during the war. For his work in this laboratory, he received the Biennial Award of the Acoustical Society of America in 1944. In 1945, he became director of a second war laboratory, the Systems Research Laboratory, which dealt with psycho-physical problems encountered in the combined operation of radar, radio, telephone, and plotting instruments

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on board ships during combat. After the war he was granted a Guggenheim fellowship to study and do research in the field of acoustical materials and auditorium design.

Dr. Beranek is a member of the Editorial Board and a Fellow of the Acoustical Society of America, a Fellow of the American Physical Society, a Senior Member of the Institute of Radio Engineers, and a member of Sigma Xi. He is Chairman of the American Standards Association Sub Group Z-24B on Fundamental Acoustical Measurements, and is co-author of a book published by NDRC in 1944 entitled *"Principles of Sound Control in Airplanes."*

A FREQUENCY MONITOR FOR TELEVISION VIDEO TRANSMITTERS AND OTHER A-M SERVICES

The increasing demand for a frequency monitor for television video channels has resulted in a redesign of the TYPE 1175-A Frequency Monitor* to adapt it for use at frequencies up to 220 megacycles. Originally designed for a top frequency of 150 megacycles, this monitor could, with only minor changes, be made to operate satisfactorily on channels 7 to 12 of the television band, covering frequencies between 174 and 216 Mc.

For television, an increase in crystal oscillator stability to +0.001% is necessary, and this has been accomplished by changing the design of the oscillator circuit and controlling the temperature of some of the oscillator circuit elements. Provision has been made for harmonic tuning at higher frequencies, but otherwise the monitor is unchanged in its functional arrangement and operation.

The new model is now in production and will be available in two models: TYPE 1175-B for monitoring a maximum of four channels at frequencies between

*C. A. Cady, "A Versatile Monitor for Use from 1.6 to 150 Megacycles," *Experimenter*, XXI, 9, February, 1947.

Figure 1. Panel view of the Type 1175-B Frequency Monitor.

1.6 and 162 megacycles; and Type 1175-BT for monitoring a single channel at frequencies up to 220 Mc.

CIRCUIT CHANGES

Crystal Oscillator

The crystal oscillator circuit is one developed in the General Radio laboratories specifically for use in monitoring where a high degree of stability and reliability is required. It differs from older types in one important respect: no tuned elements are used in the circuit except the crystal itself. The crystal operates much nearer to its true series resonant frequency than is possible in conventional circuits, and the stability achieved is correspondingly higher. Figure 3 is an elementary circuit diagram of the oscillator.

The oscillator frequency remains well within the FCC specification of 0.001% for long periods. The results of several test runs are shown in Figure 4.

Any one of the four individual crystals can be selected by means of a panel switch. Each crystal position is provided with an independent frequency-adjustment capacitor located within the crystal oven. These are accessible from within the instrument by removing the rear dust cover. The frequency of each crystal may be shifted a maximum of ±7 ppm (±0.0007%) by means of these adjustments.

The temperature control system has been improved to meet the increased stability requirements, and the operating temperature has been raised from 50° to 60°C.

Crystal Buffer Amplifier

Improvements have been made in the crystal buffer-amplifier stage to increase the production of harmonics, which in turn provides for more reliable operation in the high frequency ranges. Reduced coupling to the oscillator increases the frequency stability. The external Crystal Output terminals are no longer directly coupled to the crystal oscillator itself, but are now fed from the cathode of the buffer amplifier. External load impedances placed across the Crystal Output terminals do not react upon the oscillator frequency.

In order to provide for multichannel operation, with the resultant wide range in crystal frequencies, the coupling between oscillator and amplifier is aperiodic.

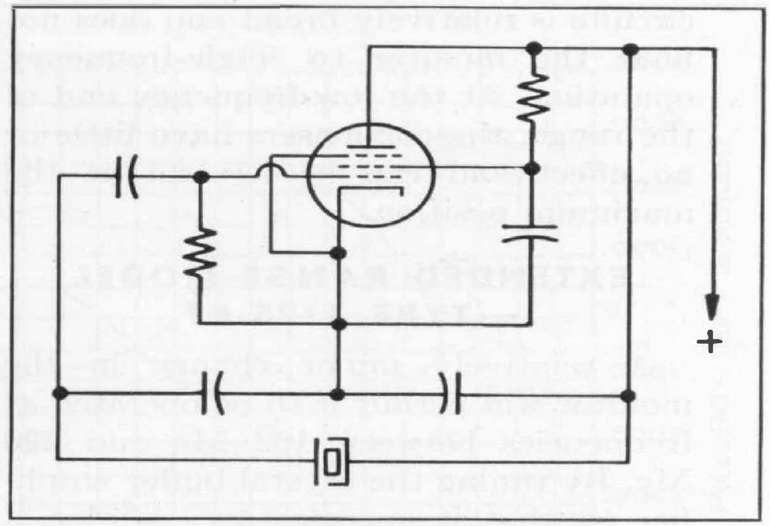


Figure 2. Elementary schematic circuit of the crystal oscillator. The crystal operates only slightly off resonance, at a frequency where its inductive reactance is equal to the reactance of the two capacitors.

Mixer

The use of a miniature-type mixer tube has resulted in improved operation at frequencies above 100 Mc. With reduced lead inductances, it is possible to provide series-tuning adjustments which are effective at the higher frequencies. The coupling capacitors, which are variable silver-mica units, can be tuned to resonance and thus provide greater sensitivity. The tuning of these circuits is relatively broad and does not limit the monitor to single-frequency operation. At the low-frequency end of the range, the condensers have little or no effect and can be left set at the maximum position.

EXTENDED RANGE MODEL —TYPE 1175-BT

A relatively minor change in the monitor will permit it to be operated at frequencies between 162 Mc and 220 Mc. By tuning the crystal buffer amplifier so that it operates as a tripler, a considerable increase in over-all sensitivity results and adequate crystal-harmonics are provided for operation up to 220 Mc.

Because the tuning of the crystal buffer-amplifier can be set for only one frequency at a time, the monitor becomes essentially a single-channel device when so operated. While there is a considerable range of adjustment on the buffer-amplifier tuning, the tuning capacitor is accessible only from within the instrument.

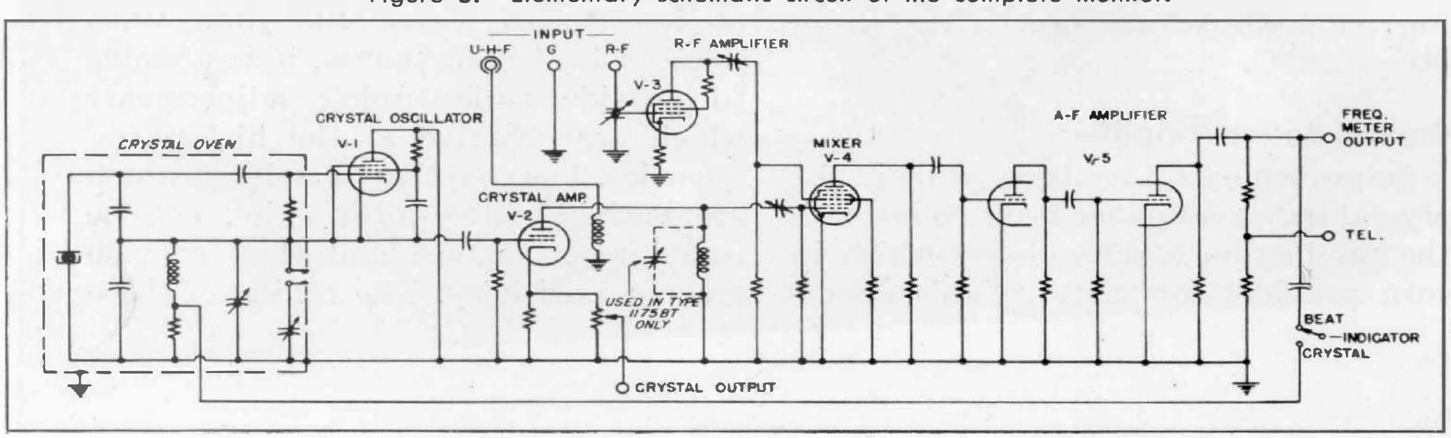
TELEVISION VIDEO TRANSMITTER MONITORING

The Type 1175-BT Frequency Monitor, used in conjunction with the Type 1176-A Frequency Meter, will provide a simple and convenient means of checking the carrier frequency of any television transmitter operating in channels No. 1 to 13 inclusive. For this use, an external plug-in filter unit is provided which eliminates the picture line-frequency of 15,750 cycles. This component of the video modulation signal must be attenuated in order to permit proper operation of the frequency meter. A low-pass filter with a 12-kc cut-off frequency accomplishes the desired result.

The monitor has a maximum operating range of ±12 kc from the assigned carrier frequency when the crystal frequency is selected for zero-beat operation and the filter unit is inserted. This is equivalent to about ±0.006% tolerance at the highest carrier frequency range and thus provides sufficient range beyond the FCC requirements of ±0.002% for television transmitters for all normal conditions. The Type 1176-A Frequency Meter should be operated on the 6-kc or 20-kc ranges (12 kc max. frequency) for television transmitters operating in the range of channels No. 7 to 13 inclusive. For television channels No. 1 to 6 inclusive, the 2-kc range of the frequency meter can be used in order to provide a more precise indication of the frequency error.

The crystal buffer-amplifier is usually tuned to a harmonic of the crystal oscillator. This is not an absolute requirement for applications in channels No. 1 to 6 inclusive, and hence the

Figure 3. Elementary schematic circuit of the complete monitor.



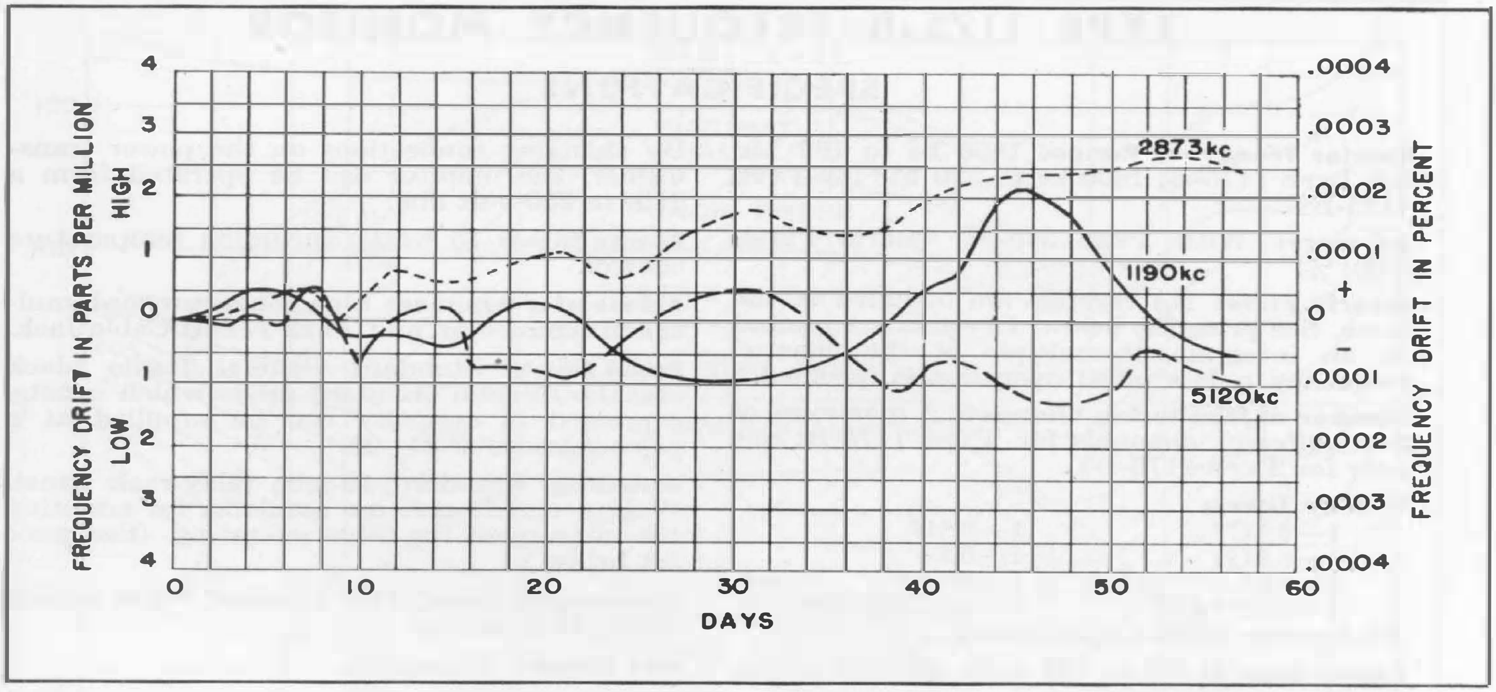


Figure 4. Actual records of crystal oscillator stability over a period of several weeks. The frequencies indicated on the plot are fundamentals. Harmonics are used for monitoring.

tuning may be omitted in order to provide multichannel monitoring, if desired. However, for operation in channels No. 7 to 13, this tuning is a definite requirement and thus limits the monitor to single-channel applications when operating in this range.

Since the crystal is normally adjusted for "zero-beat" operation, the "sign" of the frequency error from the assigned channel is determined by means of a pushbutton on the panel. Depressing this button shifts the monitor crystal oscillator by a discrete amount. The magnitude of this frequency shift is independently adjustable for each crystal position and can be set to a value commensurate with the transmitter tolerance in each case.

Offset Frequency Operation

There are certain applications that may require offset operation rather than the usual zero-beat method. For example, it may be desirable to avoid coincidence of the transmitter frequency error with that of certain modulation products present in the transmitted signal. There is also a very narrow region, within ±20 cycles of zero beat, where stable operation is not obtained because the frequency-indicating device does not have a d-c response. Most transmitters, however, never operate within this accuracy at the carrier frequencies considered, nor does the instantaneous stability approach this value.

The Type 1175-BT Frequency Monitor can be operated with an offset frequency crystal, if desired. Correct transmitter frequency would then be at center scale on the appropriate range of the Type 1176-A Frequency Meter. C. A. Cady

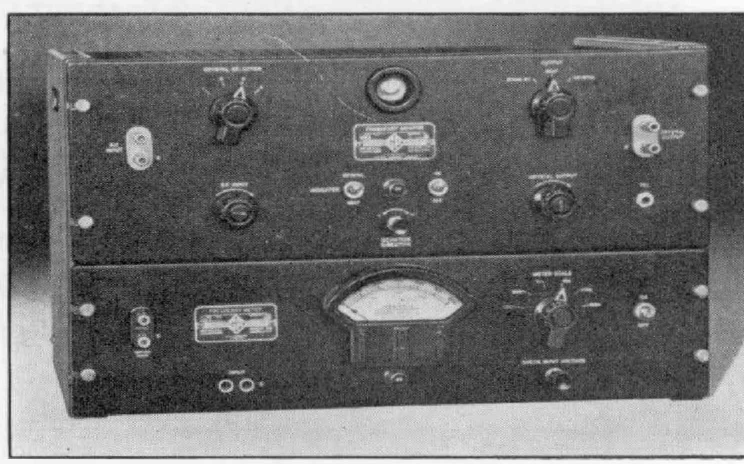


Figure 5. View of a Type 1175-B Frequency Monitor and a Type 1176-A Frequency Meter assembled in end frames.

TYPE 1175-B FREQUENCY MONITOR

SPECIFICATIONS

Carrier Frequency Range: 1600 kc to 162 Mc for TYPE 1175-B; 1600 kc to 220 Mc for TYPE 1175-BT.

Accuracy: With TYPE 376-M Quartz Plate, 0.001%.

Quartz Plate: No crystals are included in the price. See price list below. Crystals are ground to an integral sub-multiple of the channel frequency unless offset operation is specified.

Number of Monitoring Channels: A maximum of four different channels for TYPE 1175-B; one only for TYPE 1175-BT.

Vacuum Tubes:

1—6AC7	1—6SJ7
1—6AG7	1—6X5
1—6E5	1—6BE6
1—6SN7-GT	1—0D3/VR150

All vacuum tubes are supplied.

Power Supply: 105 to 125 volts, 50 to 60 cycles. By changing connections on the power transformer, the monitor can be operated from a 210- to 250-volt line.

Power Input: 75 watts, including temperature control.

Accessories Supplied: Line connector cord, multipoint connector, and TYPE 774-M Cable Jack.

Panel Finish: Standard General Radio black crackle. Certain standard grays which can be processed in quantity can be supplied at a price increase of $11.00.

Mounting: Standard 19-inch relay-rack panel. Walnut end frames are available for adapting the instrument for table mounting. (See price list below.)

Dimensions: Panel, 19 x 7 inches; depth behind panel, 11¼ inches.

Net Weight: 22 pounds.

Type		*Code Word*	*Price*
1175-B	**Frequency Monitor 1600 kc to 162 Mc**	TIPSY	**$325.00**
1175-BT	**Frequency Monitor 1600 kc to 220 Mc**	TONIC	**340.00**
376-M	**Quartz Plate**	LABOR	**70.00**
ZFRI-410P-1	**End Frames for Type 1175-B (or -BT)**	ENDFRAMDAY	**16.50 pair**
ZFRI-710P-5	**End Frames for Type 1175-A mounted with Type 1176-B (or -BT) as a single unit**	ENDFRAMGAS	**17.00 pair**

This instrument is manufactured and sold under the following U. S. Patents and license agreements:

1,967,185 **2,012,497**

Patents of the American Telephone and Telegraph Company.
Patents of G. W. Pierce pertaining to piezo-electric crystals and their applications.

TYPE 1176-A FREQUENCY METER

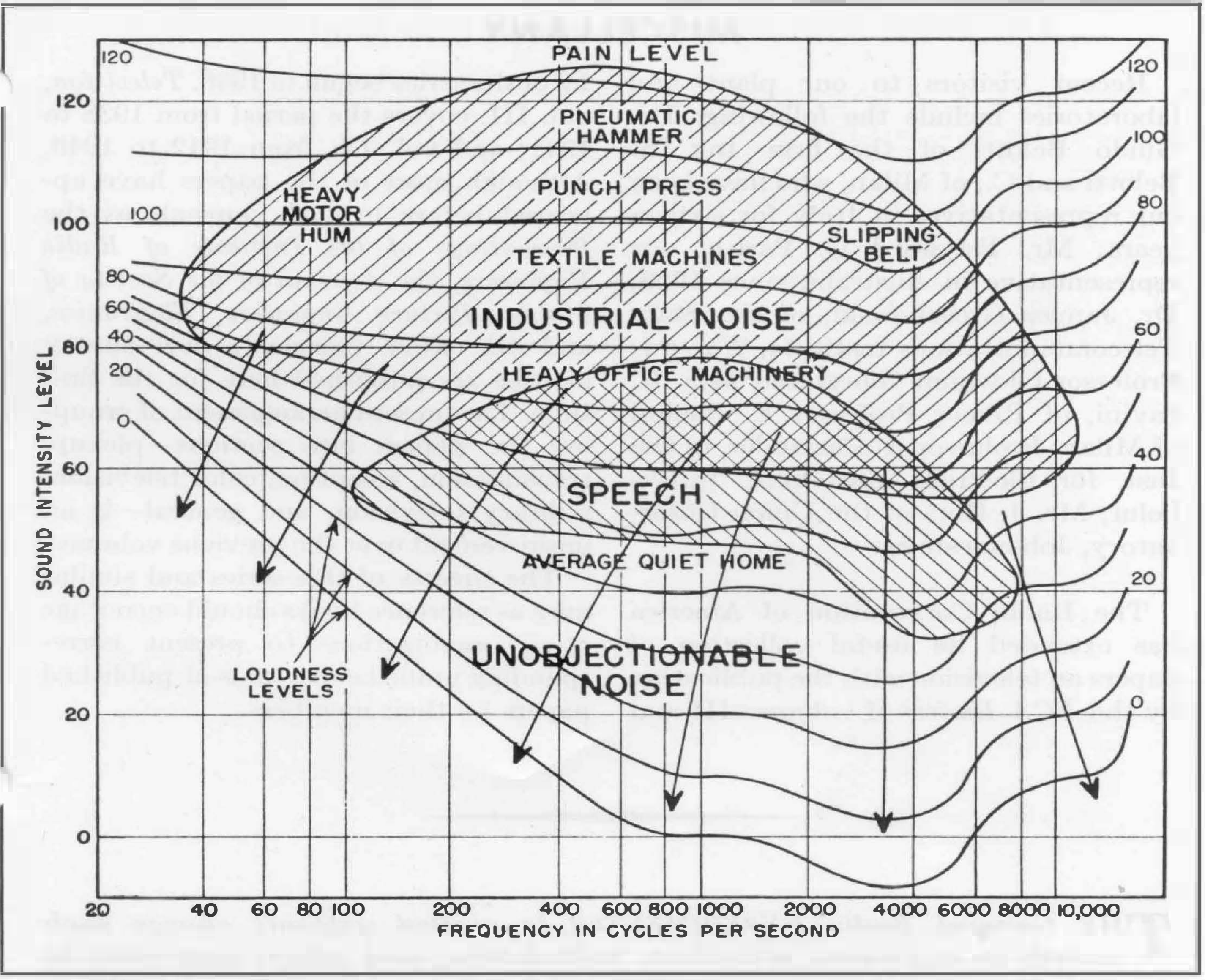
The TYPE 1176-A Frequency Meter is recommended for use with the TYPE 1175-B Frequency Monitor as an indicator of the deviation frequency. A complete description, with specifications, will be found in the *Experimenter* for February, 1946. Price and other necessary ordering information are listed below.

Type		*Code Word*	*Price*
1176-A	**Frequency Meter**	TIMID	**$265.00**
ZFRI-310P-1	**End Frames for Type 1176-A**	ENDFRAMCAT	**16.50 pair**
ZFRI-710P-5	**End Frames for Type 1176-A mounted with Type 1175-B (or -BT) as a single unit**	ENDFRAMGAS	**17.00 pair**

This instrument is manufactured and sold under the following U. S. Patents and license agreements:

2,362,503

Patents of the American Telephone and Telegraph Company.



Prepared by Dr. Howard C. Hardy, Armour Research Foundation, reprinted from *Industry and Power*, May, 1947

FREQUENCY-LOUDNESS CHART FOR INDUSTRIAL NOISE

Users of General Radio sound- and vibration-measuring instruments will be interested in an article by Howard C. Hardy, entitled "Noise and Vibration Reduction Speaks for Itself," which appeared in the May, 1947, issue of *Industry and Power*. Dr. Hardy, who is Supervisor of the Acoustics and Vibrations Section, Physics Division, Armour Research Foundation of Illinois Institute of Technology, discusses in this article the psychological aspects of industrial noise and the steps necessary for its elimination or isolation.

In the accompanying chart, which is reproduced from this article, the frequency-loudness areas for various types of industrial noise are superposed on the equal-loudness contours of the average ear, thus showing the distribution of the noise according to intensity, frequency, and loudness level as heard by the ear. The objective of noise control, the author points out, is to move the sounds in intensity and frequency in the direction of the arrows.

MISCELLANY

Recent visitors to our plant and laboratories include the following: Dr. Guido Belotti of the firm Ing. S. Belotti and C., of Milan, who have been our representatives in Italy for sixteen years; Mr. Hayward C. Parish, our representative in Australia since 1926; Dr. Janusz Groszkowski, of the State Telecommunications Institute, Warsaw; Professor Giovanni Giorgi and Mrs. R. Savini, of Rome; Professor E. Paolini of Milan; Professor A. Carlander, of the Inst. för Electrisk Mätteknik, Stockholm; Mr. J. Hers of the Union Observatory, Johannesburg.

The Radio Corporation of America has extended its useful collection of papers on television with the publication by the *RCA Review* of volumes III and IV of the series begun in 1936. *Television*, vol. III, covers the period from 1938 to 1941; and vol. IV, from 1942 to 1946. Although most of the papers have appeared before in such journals as the *Proceedings of the Institute of Radio Engineers*, the *Journal of the Society of Motion Picture Engineers*, *Electronics*, and the *RCA Review*, a few survey articles are published here for the first time. The present arrangement of grouping the papers into sections—pickup, transmission, reception, color television, military television, and general—is an improvement over the previous volumes.

The success of this series and similar ones as reference books should encourage other organizations to present corresponding unified collections of published papers by their members.

THE General Radio EXPERIMENTER is mailed without charge each month to engineers, scientists, technicians, and others interested in communication-frequency measurement and control problems. When sending requests for subscriptions and address-change notices, please supply the following information: name, company address, type of business company is engaged in, and title or position of individual.

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