The GENERAL RADIO EXPERIMENTER

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ELECTRICAL COMMUNICATIONS TECHNIQUE AND ITS APPLICATIONS IN ALLIED FIELDS

MONITORING OF BROADCASTING STATIONS

IN running a broadcasting station, it is essential to get the maximum signal strength with the minimum of interference and distortion. A transmitter differs from ordinary circuits in that, once the amplitude exceeds a certain value, the signal is very badly distorted. In well-designed transmitters which are properly maintained, very little distortion exists below this definite overload point. The more nearly the overload point can be approached, the greater will be the coverage of the station and the smaller will be the percentage interference with neighboring stations. On the other hand, if the modulation capability is exceeded, very serious distortion will occur and, even worse, there will be serious interference known as "monkey chatter" in neighboring channels. Thus the problem of monitoring a broadcasting station consists, on the one side, in getting the largest percentage modulation possible without distortion and, on the other side, in keeping the modulation down to a sufficiently low level to avoid overloading.

Most modern transmitters when new are surprisingly linear. Modulation of 90% can usually be obtained without objectionable distortion. On the other hand, when tubes age and push-pull stages of

AND NOW FIDELITY

ONE of the greatest contributions to better broadcasting in recent years was the clearing up of the conditions resulting from off-frequency operation of broadcasting stations. The General Radio Company's contribution to this improvement was the visual continuous indicating frequency monitor.

The present most pressing problem in broadcasting is that of maintenance of high fidelity without loss of station efficiency. This involves careful maintenance of modulation at all times. To this end we have developed a continuous indicating modulation meter. A companion piece is a distortion and noise-level measuring instrument, whose simplicity of operation encourages frequent checks on these quantities.

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amplification become unbalanced, the transmitter is likely to become very badly non-linear.

At present, it is the practice with most stations to monitor the programs at the studio, maintaining a certain input level to the line leading to the remote transmitter, the level being determined by a power-level indicator. Another power-level indicator is used at the transmitter to make certain that the transmission line has not changed sufficiently to make serious overloading possible. Except under abnormal conditions, no control is permitted at the transmitter itself. In the best present practice the input power level permissible for a given type of program is determined by tests on the transmitter which correlate percentage modulation and distortion with input level.

This whole system is very badly at fault in several small but important details. In the first place the volume-level indicators are not at all instantaneous in their action and the overmodulation peaks which are responsible for all of the trouble are seldom of sufficient duration to register on the monitoring meters. In addition to the fact that the meters are not instantaneous, it so happens that most of those at present in use are subject to resonance troubles so that they fail to give a proper idea of the mean power in a syllable as well as not following peaks. A pulse of given intensity may transiently give an indication 3 or 4 decibels higher than the true value. Such a condition can result in radically wrong monitoring; a change of 3 decibels in adjustment would result in halving efficiency. The full significance of these meter faults has not been generally realized.

There is a further difficulty in that at present the program is monitored at the input to the transmitter rather than at the output. This means that changes in the gain of any of the audio-frequency amplifiers or in the modulator efficiency are not taken into account except by comparatively infrequent periodic checks. This practice has resulted from the lack of equipment designed for continuous monitoring.

Previous equipment was fairly satisfactory so far as it went but did not lend itself readily to rapid experimental checks, and as a result it was sparingly used by the operating staffs, tests being made every week or so. For this reason it was necessary to provide too large a safety factor and to use an unnecessarily low peak modulation to be sure of satisfactory transmission. Conversely, stations which have not been allowing such safety factors have had unnecessarily high distortion.

With these conditions in mind, the General Radio Company has designed a group of instruments to reduce the monitoring of broadcasting stations to a very simple procedure which can be carried on continuously and accurately.

The Type 731-A Modulation Monitor is designed so that it can be coupled directly to the radio-frequency output of the transmitter. An automatic biasing arrangement used in conjunction with a thyratron flashes a light whenever the modulation instantaneously exceeds the value which is considered permissible with the particular transmitter. In addition, meters are provided to indicate carrier shift and percentage modulation. The per cent meter is direct reading on positive or negative peaks and is of the rapid movement type recently developed. While not instantaneous, it is free from resonance effects

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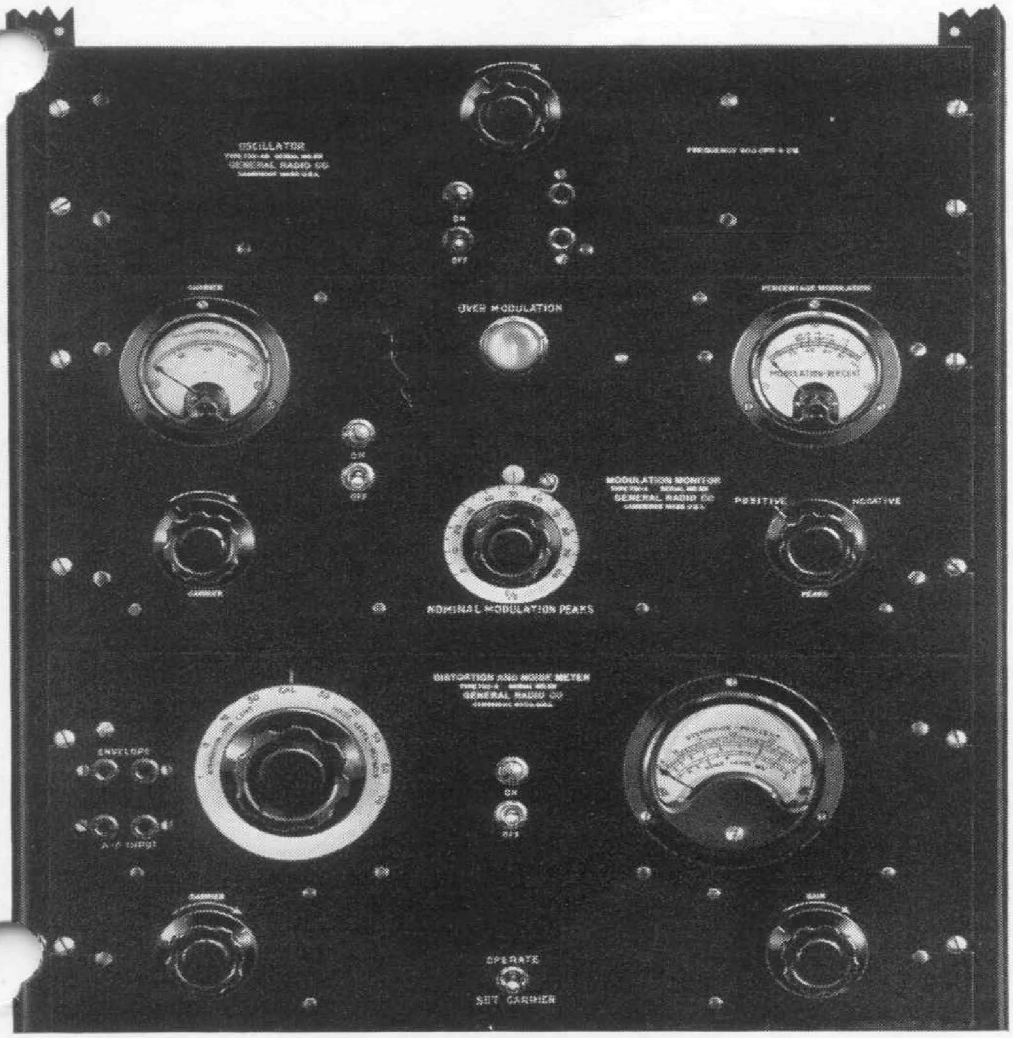

Class 730-A Transmission-Monitoring Assembly. The assembly consists of three rack-mounting units. From bottom to top they are the Type 731-A Modulation Monitor, the Type 732-A Distortion and Noise Meter, and the Type 733-A Oscillator. The entire assembly occupies 22¾ inches of rack space

(Licensed under patents of the American Telephone and Telegraph Company.)

and follows a signal much more faithfully and rapidly than the previous instruments.

In addition to the modulation monitor, a new direct-reading distortion factor and noise meter (Type 732-A) has been provided for getting very rapid checks on noise and distortion. A filtered 400-cycle oscillator (Type 733-A) of good waveform has been provided for use in conjunction with the distortion meter. The distortion meter reads the noise level of the "unmodulated" signals directly in decibels with respect to the standard modulated signal. The operation of the instrument is so simple that it is possible to make checks on noise between announcements, if it is thought desirable to do so.

This frequent monitoring of noise makes it possible to keep constant checks on the balance of the rectifier equipment, assuring a minimum hum at all times. It also makes possible frequent checks on transmission lines to make certain that excessive interference is not present. The meter will give an accurate indication of noises down to 65 db below the completely modulated signal. This same instrument gives direct reading indication of distortion on a 400-cycle signal. A check of distortion at any one level should certainly take less than one minute and there is no reason why such a check should not be made immediately before and after the station is on the air so that it should always be possible to keep the station working at its optimum efficiency.

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A technical discussion of all of these instruments will be given in next month's issue of the EXPERIMENTER. It is our belief that this group of instruments will prove a very definite economy to broadcasting stations in enabling them to operate at the highest possible level consistent with fidelity.

—L. B. ARGUIMBAU

The CLASS 730-A Transmission-Monitoring Assembly was designed by L. B. Arguimbau. We were fortunate in having the close co-operation of the engineers of the Columbia Broadcasting System in the development and testing of the apparatus.

Every effort has been made to design the equipment to meet the actual conditions of present installations and methods of operation. The monitoring assembly consists of three units: Modulation meter with over-modulation indicator (TYPE 731-A), distortion and noise meter (TYPE 732-A), 400-cycle oscillator (TYPE 733-A). The equipment is capable of measuring:

1. Percentage modulation on both positive and negative peaks.
2. Program monitoring with high-speed volume indicator meter.
3. Carrier shift upon the application of modulation.
4. Carrier noise and hum level.
5. Combined audio-frequency harmonic distortion of modulation envelope.
6. Modulation peaks exceeding a predetermined, desired degree of modulation (*i.e.*, over-modulation indicator).
7. Combined audio-frequency harmonic distortion present in speech-input amplifier and other station equipment.
8. Noise and *hum* level of audio amplifiers and other station equipment, including wire lines to remote pickup points and to transmitter.

With the addition of a variable-frequency audio oscillator it is also possible to measure:

9. Transmitter audio-frequency response.
10. Audio amplifier and equipment frequency response.
11. Wire line frequency response.

No critical adjustments or balances are required. The quantities measured are read directly from the instrument and no calculations are involved. In the course of operating tests the equipment has been used to measure the characteristics of radio transmitters ranging from 50-watt portable remote pickup equipment to 50-kilowatt broadcast transmitters, as well as high-frequency transmitters operating at frequencies up to 15 megacycles. Checks on audio equipment have been made on everything from portable field amplifiers to program amplifiers and public-address equipment.

It has been found possible to make complete runs on a transmitter determining positive and negative modulation peaks, per cent distortion, hum and noise level throughout the range of audio input of the transmitter in less than ten minutes.

The entire monitoring assembly, CLASS 730-A, is priced at $462.00 (Code Word, EXILE). Delivery will start about February 28.

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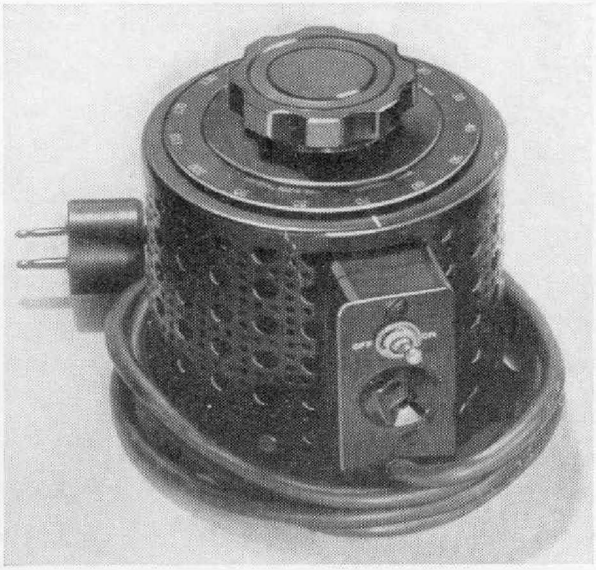
VARIAC APPLICATIONS IN PHOTOGRAPHY



PHOTOGRAPHY enthusiasts have been finding a variety of applications for the Variac auto-transformer described in previous issues of the EXPERIMENTER. This unit, which combines the ease of control of a rheostat with the high efficiency of a transformer, is being substituted for resistance controls in all of the photographic processes where control of light intensity is required. Heretofore full advantage has not been taken of the possibilities of light control at the source of illumination as the equipment generally available has a number of limitations.

PHOTOFLOOD LAMPS

Photoflood Lamps are being used by thousands of photographers, professional and amateur. The life of the No. 1 Photoflood Lamp is approximately two hours when operated on a 115-volt circuit. During the major portion of its life, however, the lamps could be operated at reduced voltage, while arranging subjects, getting correct light angles, focusing, and all the other operations preliminary to actual exposure. The Variac makes it possible to reduce the voltage on the Photoflood Lamp to any desired value, and then to "flash" the lamp at normal voltage during the comparatively brief exposure period, thereby prolonging the life of the lamps greatly.

The curve of Figure 1 shows the relation between lamp voltage and average lamp life, and lamp voltage and illumination of the No. 1 Photoflood Lamp. A voltage reduction of only 11 volts, on the average, increases the lamp life by a factor of four, and the illumination from the lamp is still sufficient for most preliminary operations. When the lamp voltage is reduced by some 50%, the life of the Photoflood Lamps is comparable to that of a standard lamp operating at normal voltage.

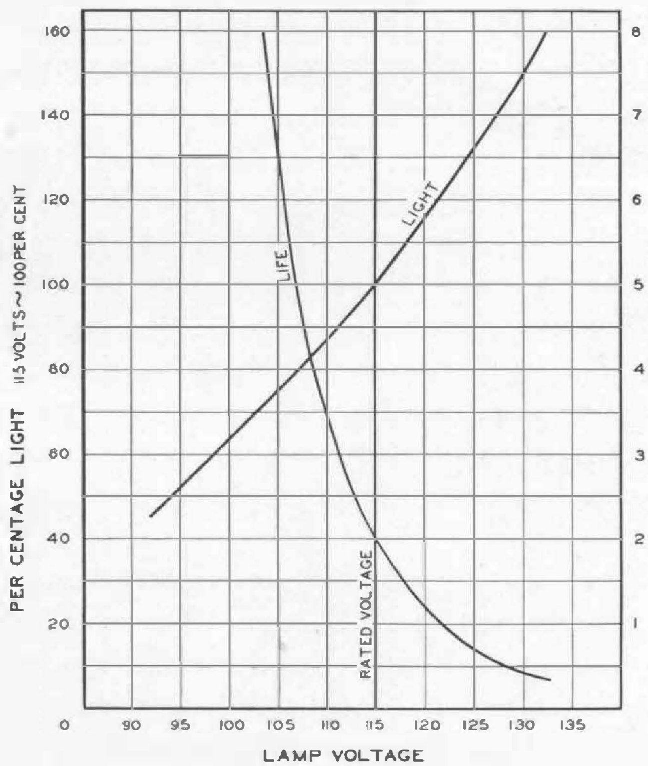


Figure 1. No. 1 Photoflood Lamp showing lamp voltage as a function of (a) probable life in hours and (b) percentage of light

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Some photographers are operating Photoflood Lamps in groups of two, connecting them in series to secure half normal voltage during the preliminary adjustments, and in parallel for full illumination during the time of exposure. At half voltage the illumination is so low, comparatively, that it is difficult to predict the results when the lamps are operated at normal voltage. The Variac permits setting the voltage on the lamps at any value.

PROJECTION PRINTERS

Photoflood Lamps are being used in projection printers so that enlargements may be made on chloride or chloro-bromide contact paper. Some control of the brilliancy of the light is essential as the heat generated by the Photoflood Lamp is sufficient, in many cases, to cause the negative to buckle before an exposure may be made. If used over prolonged periods at standard voltage, the Photoflood Lamp may damage the enlarging system, the reflector, or condensing lens, or the projection lens.

The Variac allows continuous adjustment of the brilliance of the lamp, to reduce it during the time the negative is being adjusted and masked, the picture "framed," and the paper adjusted. It also permits operating the Photoflood Lamps at reduced voltages when bromide papers are being enlarged upon.

In enlarging machines using standard electric lights, the several models of the Variac giving output voltages higher than line voltage are very useful in that the standard lamp may be flashed at voltages higher than normal when printing on extra dense negatives or making very large enlargements. The Variac, when used with an enlarger, also makes it possible to use a constant iris diaphragm setting, varying the degree of illumination to suit the density of the negative.

CONTACT PRINTERS

In printing machines, particularly when used in commercial photo-finishing establishments, the use of a standard printing time on all negatives, varying the illumination from the lamps according to the negative density, is conducive to uniformity of results. Where it is desired to work to a standard illumination and control the printing by varying the time of exposure, the Variac models affording "above line" output voltages are used to compensate for changes in line voltages unfortunately met with in many localities.

SAFELIGHTS

A control of the illumination from the safelamp is an exceedingly useful adjunct to the developing and printing room in that, when very sensitive emulsions or papers are being used, the safelamp may be operated at a voltage just great enough to allow the photographer to see his way around, yet it can be brought up to full brilliance momentarily to observe development progress. As the speed of emulsions varies, the amount of "safe" illumination varies also and hence the usefulness of a varying light source.

STUDIO LIGHTING

In the photographic studio, amateur, portrait, or commercial, the lighting problem involves, in general, the control of both the intensity and the *direction* of the various light sources. Heretofore the intensity of illumination has been controlled by varying the distance between the subject and the light sources. This method is not en-

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tirely satisfactory; any change in the position of the lamp stands, to vary the *amount* of light, also affects the *angle* between the light source and the subject, requiring a readjustment of the light angles each time the stands are moved.

Many photographers work with well-defined and known light angles, merely varying the degree of illumination of the general, flood, and spot lights to secure the desired tone values and modeling. The Variac control offers an extremely flexible, simple, and economically operated method of controlling the illumination by varying the intensity of the light itself. When the Variac is used in the studio, the lamp stands are placed to secure the desired light angles and all modeling is accomplished electrically by adjusting the Variacs to change the intensity of each main light source.

ADVANTAGES OF USING VARIAC CONTROL

The Variac has many advantages over the resistive control method. In the first place, up to the full load rating, the output of the Variac is essentially independent of load. One Variac can be used to control one or more lamps, replacing a number of resistive units. The power saving from use of the Variac is quite appreciable. Figure 2 shows the actual *saving* in watts when a Variac is used in place of a resistive control to vary the voltage on four No. 1 Photoflood Lamps.

VARIAC RATINGS

The Type 200-B Variac (price $10.00) will control any lamp combination drawing not over 170 watts at 115 volts. It is ideal for controlling a single Photoflood Lamp. It supplies output voltages from zero to line.

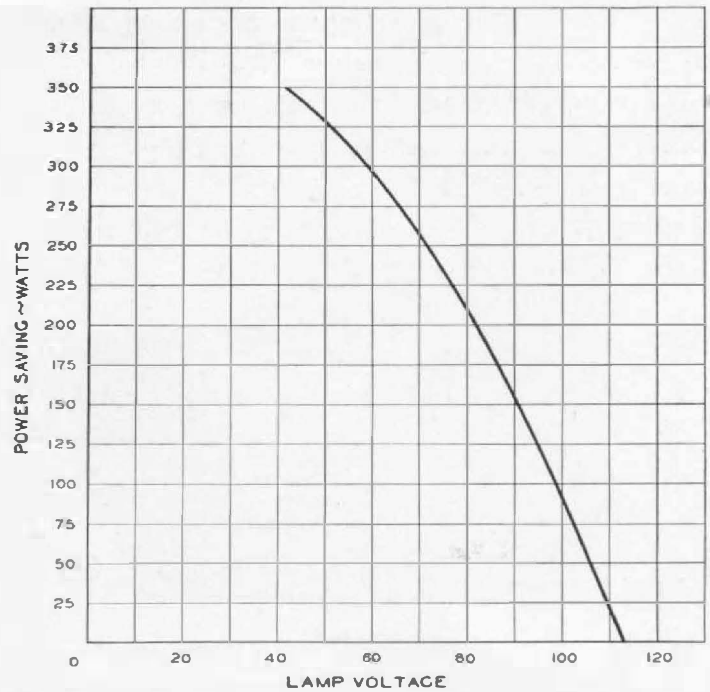

Figure 2. Actual power saved when using the Type 200-C Variac instead of a rheostat to control four No. 1 Photoflood Lamps

The Type 200-C Variac (Type 200-CM mounted and supplied with cord, plug, switch, and outlet, price $17.50) — Type 200-CU (unmounted and no wiring conveniences, price $14.00) will control 860 watts at 115 volts. It can be used to control from one to four No. 1 Photoflood Lamps. Its output voltages are continuously adjustable from zero to *135* volts, and is the model to use where voltages above line are required.

The Type 100 Variac (Type 100-K, for 115-volt circuits and Type 100-L, for 230-volt circuits, price $40.00) is rated at 2 kva at line voltage and will control any lamp combination consuming not over 2000 watts at line voltage. The Type 100-L Variac is supplied with a tap so that this unit may be operated on 115-volt circuits to give output voltages up to 230 volts. When so operated, the Type 100-L is rated at 1350 watts at output voltages from zero to 150, tapering to 900 watts at 230 volts.

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DIRECT-READING VARIABLE INDUCTORS

THE usefulness of any variable reactor or resistor is greatly increased if it is direct-reading. Reference to a calibration chart is always time-consuming and frequently leads to errors.

During recent years a number of direct-reading instruments have been announced by the General Radio Co. The five TYPE 107 Variable Inductors now join this continually lengthening list.

The general appearance of the calibrated dial is shown above. While the scale is not uniform, it is sufficiently linear to allow an accuracy of reading of 1% of the full scale reading.

The terminals of the rotor and stator coils are brought out separately to two pairs of posts on the upper left corner of the panel, which are distinct from the terminal posts on the upper right corner. The two coils may be placed either in series or in parallel by means of two links. The engraved plate at the top edge of the panel specifies the positions of these links. The scale marked on the dial is for the series connection of the coils, as indicated on the dial.

The inductance of the coils when connected in parallel is one-quarter that for the series connection to an accuracy of better than 0.1%. The existence of circulating currents in these coils for this connection has been minimized by making their separate inductances equal.

When the rotor and stator coils are at right angles, their mutual inductance is zero. The value of their self-inductance at which this occurs is given on the engraved plate in the lower left corner of the panel. For any other position of the coils their mutual inductance is one-half the difference between this zero mutual value and the scale reading. These formulae, together with the nominal d-c resistance and current-carrying capacity of the inductor, are also given on this plate.

There are five sizes of TYPE 107 Variable Inductors as shown in the following table.

Type	*Self-Inductance*		*Mutual*
	Series	*Parallel*	*Inductance*
107–J	6– 50 μh	1.5–12.5 μh	0–12.5 μh
107–K	50–500 μh	13–125 μh	0–125 μh
107–L	.5– 5 mh	.13–1.25 mh	0–1.25 mh
107–M	5– 50 mh	1.3–12.5 mh	0–12.5 mh
107–N	50–500 mh	13–125 mh	0–125 mh

The price of the three smallest inductors is $35.00, that of the two larger, $40.00.

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