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In This Issue

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WESTON MODEL 1461 INDUCTRONIC® SENSITIZING AMPLIFIER

THE Model 1461 Inductronic Sensitizing Amplifier is a newly developed accessory unit for the Model 1411 D-C Amplifier to increase sensitivity and response speed, particularly for very low input ranges. It is a design companion to the Model 1411, as shown in Figure 1. The combination Model 1411-1461 is capable of operation on ranges where thermal noise becomes very apparent in the indicating instrument, but in general it must be considered as limited to laboratory service where environmental disturbances such as temperature changes and vibration are minimized.

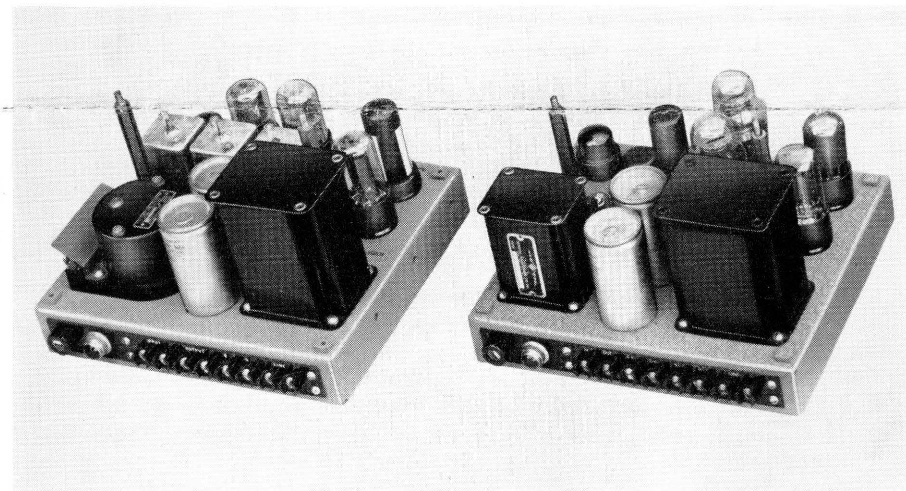
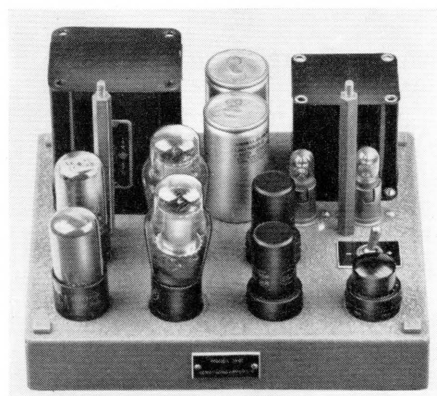


Figure 1—View above illustrates Model 1411 D-C Amplifier (left) and Model 1461 Sensitizing Amplifier (right). View below shows reverse side of Sensitizing Amplifier.

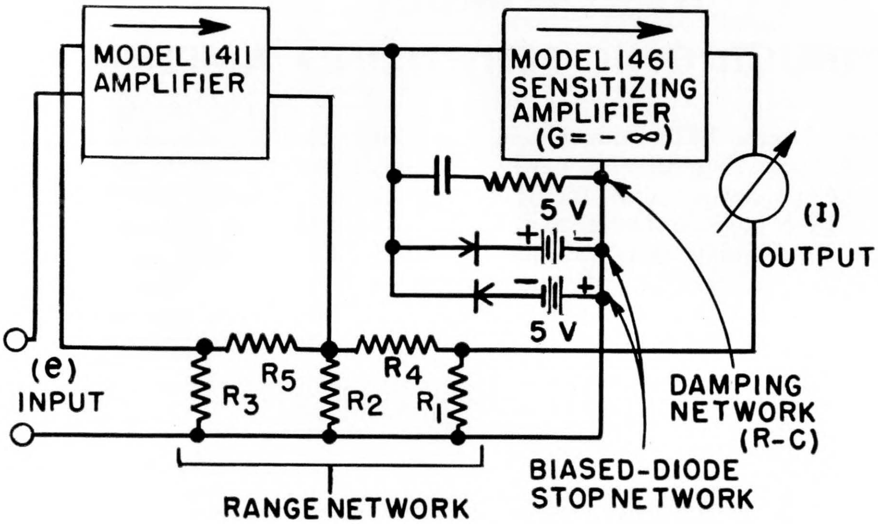


The Model 1461 is a conductively coupled, compound-feedback amplifier having a critical degree of internal regeneration to develop a substantially infinite internal gain. It is operated in cascade to the Model 1411 Amplifier but within the feedback loop, so that the compound feedback action supplies the output current demand in response to the system input without steady-state output demand upon the

Model 1411 Amplifier. The Model 1411 then only has to respond in a transient sense to input changes and the Model 1461 supplies the output demand.

Additionally the Sensitizing Amplifier is equipped with a biased diode circuit to effect a second feedback component with input overload. This overload feedback component is large, and prevents excessive excursion of the converter (Model 1401 Induction Galvanometer) in the Model 1411. This assures instantaneous recovery of the system from input overloads as large as 1,000 times full scale.

A block diagram of the system is shown in Figure 2 with a typical feedback network. The main feedback path is from the output of the Sensitizing Amplifier to the input of the Model 1411 Amplifier, and has a mutual resistance determining the range upon a 1-milliampere output current base. The network is a cascade pi to obtain a low mutual resistance using reasonably high value resistors. The stop diodes are reverse biased at about 5 volts so that when the Model 1411 Amplifier saturates the Sensitizing Amplifier the diodes will conduct, and an output current from the Model 1411 will be applied directly to the feedback network at a point of relatively high feedback resistance. The Model 1411 is capable of delivering about 40 volts at saturation, so the diode-stopped feedback takes effect far below saturation of the system at the input end. An *R-C* damping network is included as shown to stabilize the stop feedback component.



$$\text{Range}: \frac{e}{I} = \frac{R_1R_2R_3}{\Sigma R}$$

$$\text{Stop} = \frac{e}{i} = \frac{R_1R_2R_3+R_2R_3R_4}{\Sigma R}$$

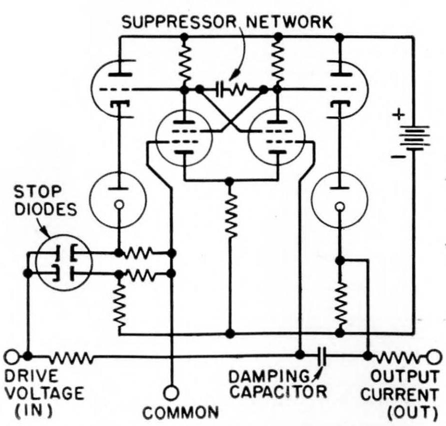
$$\Sigma R = R_1R_2+R_1R_3+R_1R_5+R_2R_3+R_2R_4+R_2R_5+R_3R_4+R_4R_5$$

Figure 2—Block diagram of Sensitizing Amplifier applied to the Model 1411, potential input.

A typical low range would be 1 microvolt for a full-scale output current of 1 milliampere. The feedback network would then have an over-all mutual resistance of .001 ohm. The system can then be stopped to an input level of 1 millivolt or 1,000 times full scale input, for which the diode current is fed into the feedback network at a point where the mutual resistance to the input circuit is 1 ohm. In operation, as the input level is raised from zero, the diode stop circuit will be inoperative until the Sensitizing Amplifier saturates at about 2 milliamperes, or 2 microvolts of input. The output drive potential of the Model 1411 Amplifier will then swing until it exceeds the diode bias potential. One diode will then conduct feedback current and keep the system in balance up to an input potential of something over 1 millivolt. When the input is again dropped below 1 microvolt, the system will recover rapidly because the Model 1411 Amplifier has not been allowed to saturate.

Figure 2 includes the expressions for the cascade pi network shown, but actually the network is peculiar to each application. For example, it may include range switching, or it may be designed for current rather than potential input. Also, in very low-range applications, it is generally found desirable to associate the range-determining feedback network with the input source device to avoid spurious influences. For this reason, the network is not included in the Model 1461 Sensitizing Amplifier, and is considered specific in design to each application.

Figure 3 is a simplified schematic diagram of the Sensitizing Amplifier illustrating the compound feedback system. Regeneration is obtained by cross-connecting the plates and screen grids of a balanced pentode amplifier. Cathode followers and gas tubes are used to conductively couple the pentode plates back to the input-output circuits. The stop diodes are biased by a resistor network carrying the coupling current of one of the cathode followers. A suppression network is included in the pentode plate circuit to reduce gain at high frequen-



Note: Plate resistors proportioned to critically regenerate plate/screen network so that the transfer conductance is design centered at − ∞.

Figure 3—Model 1461 Sensitizing Amplifier, compound-feedback section with diode stop network.

cies and avoid closed-loop oscillation within the amplifier network.

A conventional filtered d-c power supply is included in the Model 1461 Sensitizing Amplifier but is not shown in Figure 3.

Normally the Sensitizing Amplifier is applied in a fashion requiring a negative transfer conductance. However, in anticipation of applications where a positive transfer conductance is required, it includes an internal changeover switch marked "+" and "−" for selection of the desired conductance sign. In the normal negative (−) position, a signal applied to the drive terminal will develop an output current of opposite sign at the output terminal, both with respect to a common terminal.

The operating terminals are isolated internally from ground, with the actual chassis ground brought to a separate terminal. The circuit ground may then be made externally as required.

The Sensitizing Amplifier also includes two small regulator tubes (not shown in Figure 3) and associated circuits supplying small currents of opposite polarity to individual terminals. These are sometimes useful for exciting a zero adjusting network for convenient external correction of thermal drift. In usual Model 1411 Amplifier practice, zero is adjusted at the Model 1401 Converter. But on very low ranges, this adjustment is likely to be too coarse, and electrical correction is more convenient.

The Model 1461 is particularly effective in developing a fast response speed on low ranges. The speed is normally greater than that of the fastest indicating instrument. It is possible to make indicating instruments down to ranges as low as 1 microvolt or 0.02 microampere full scale. With a fast instrument on these ranges, thermal noise is apparent as a random fluctuation of about 2 per cent. This is the ultimate limit of any system. However, thermal drift, as distinguished from noise, is still limiting, and such low ranges are only feasible under quite ideal conditions and after careful installation and adjustment.

Specifications

Size:
$9\frac{1}{4}''$ wide x $8\frac{1}{2}''$ deep x $6\frac{1}{8}''$ high, overall (Same as Model 1411).

Weight:
12 lbs.

Output Range:
(In Combination with Model 1411): 1 milliampere, any zero position, into 5,000 ohms maximum load resistance.

Transfer Conductance:
∞ to 20,000 micromhos (0-50 millivolts input drive), d-c, positive or negative by switch selection.

Tube Complement:
2—Type 6SJ7 pentodes, amplifiers.
1—Type 6SN7 dual triode, cathode followers.
2—Type 0A3/VR75 regulators, coupling tubes.
2—Type 991 regulators, zero adjustable supply.
1—Type 6H6 dual diode, stop diodes.
1—Type 5Y3 power rectifier, power supply.

Power:
105-125 volts a-c, 50-1,600 cps, 35 watts demand.

E. N.—No. 101 —*R. W. Gilbert.*

A NEW WESTON MEDIUM-RANGE FREQUENCY RECORDER

FREQUENCY measuring instruments, including recorders, are logically divided into three types—wide-range, medium-range, and narrow-range. A wide-range type would have an on-scale zero, or nearly so. A medium-range type would have a spread of $\frac{1}{2}$ to $\frac{1}{10}$ of the center-scale frequency, whereas a narrow-range type would have a spread of less than $\frac{1}{10}$ of the center-scale frequency. Division into these types is natural because of the differences in appropriate operating networks. Usually wide-range instruments employ simple reactance; medium-range types use reactance-resistance resonant combinations, capacitive or inductive; and narrow-range types use full-resonant capacitive-inductive-resistive networks.

The new Weston recorder herein described is a medium-range instrument. A typical range of 350-450 cps, which is a spread of $\frac{1}{4}$ of the center-scale frequency, 100 cps over

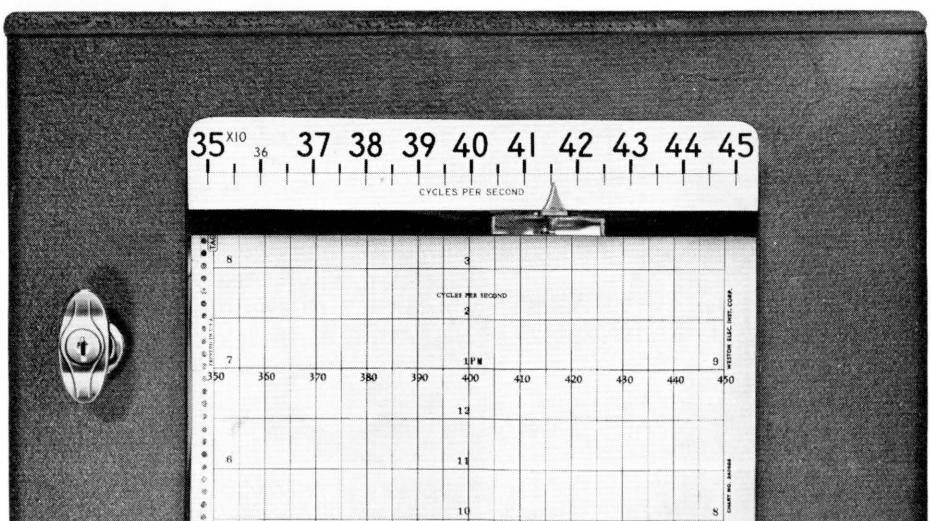


Figure 1—Weston Medium-Range Frequency Recorder.

400 cps, is shown in Figure 1. Likewise a range of, for example, 50-70 cps for power frequency would be suited to this method.

A most desirable characteristic in a recorder is a linear response to track on linear chart paper. Conventionally, resistance-capacitance (*R-C*) networks such as the Wien bridge or the parallel-T are used, but these tune with frequency as the reciprocal of the resistive elements, or, in general:

$$f = \frac{1}{2\pi RC} \qquad (1)$$

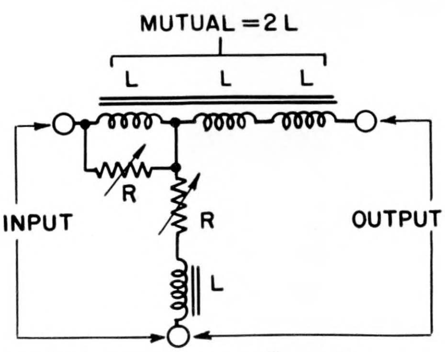
When applied to a servo-balanced recorder with a linear slidewire, the *R-C* network thereby develops a scale proportional to the reciprocal of frequency, resulting in a nonlinear scale distribution.

To obtain linearity, the Weston recorder employs a newly developed resistance-inductance (*R-L*) network, which, in general, responds as:

$$f = \frac{R}{2\pi L} \qquad (2)$$

Such a network tunes linearly with frequency by resistance, and a linear slidewire provides a linear frequency scale.

The basic resonant *R-L* network is shown in Figure 2. It is a three-terminal configuration having a zero transfer function at resonance. It includes a mutual inductor and a self inductor, and tunes with two



[For output/input null transfer—

$$f\,(cps) = \frac{R\,(ohms)}{2\pi L\,(Henries)}$$

Figure 2—Basic R-L frequency network.

resistive elements. With the limitation that the resistances (R, R) be equal, the mutual inductor has a turns ratio of 2, a primary self-inductance of L, and a secondary self-inductance of $4L$. The coupling is essentially complete so the mutual inductance is $2L$. The resonant frequency then follows expression (2).

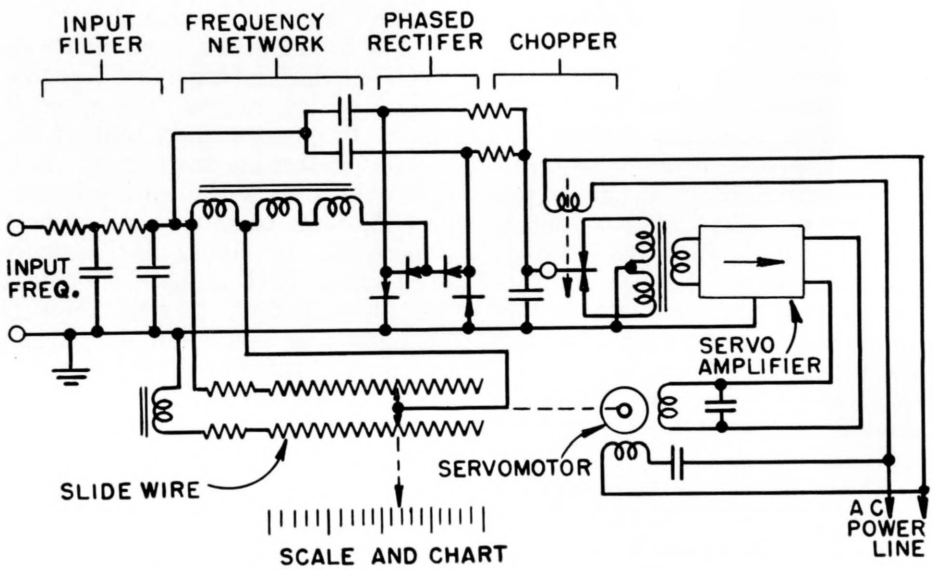


Figure 3—Frequency recorder system using servo-tuned R-L network.

Operation of the resonant *R-L* transfer network of Figure 2 as a servo-balanced recorder is illustrated by Figure 3. Portions of the tuning resistance are elements of a double slidewire driven by the servomotor and carrying the pen carriage. Mistuning of the network develops a phased error signal, which is phase rectified to produce a d-c error signal having a sign and magnitude proportional to the tuning error. The d-c error signal operates a chopper type servo amplifier to drive the motor in a corrective direction. The system is thereby autotuned to the impressed frequency, and follows frequency changes by re-resonating the network automatically.

The input is preconditioned by a low-pass *R-C* filter circuit to remove harmonics that otherwise might project through the network and saturate the rectifier, spoiling the null resolution. This is a precaution against badly distorted wave form in the input source.

A practical necessity is to carry a common ground straight through the system, as shown. This avoids transient interferences that otherwise would require expensive and questionable isolating devices such as shielded and balanced transformers. This also dictates the form of the phased rectifier, particularly the output dividing resistors, which current balance the d-c output against the common ground connection.

The chopper, servo amplifier, slidewire drive, and the general mechanical design are the same as those in the standard Weston recorder, and the components therein are interchangeable with, for example, temperature recorders. The slidewire, however, is dual, with a pigtail connection to the slider. The components special to the frequency version are almost all within a network chassis.

The frequency network chassis has two inductors, which are a Weston design used for many years in indicating frequency meters. These are the critical components, and they are fully balanced as to copper resistance and distribution, air gap location and leakage fields, etc. They are adjustable by means of rigid locking screws, and have an adjusted permanence sufficient for much narrower frequency spans than are contemplated for this type of recorder.

E. N.—No. 102 —*R. W. Gilbert.*

MAINTAINING THE VALUE OF THE OHM AT THE WESTON PLANT

The story about George Simon Ohm entitled "125 Years of Ohm's Law," printed in the July, 1952, issue of ENGINEERING NOTES, *stimulated considerable discussion among our engineers, and many letters were received from our readers. A review of the resistance standards at the Weston Plant has resulted in the discussion below.*—THE EDITOR.

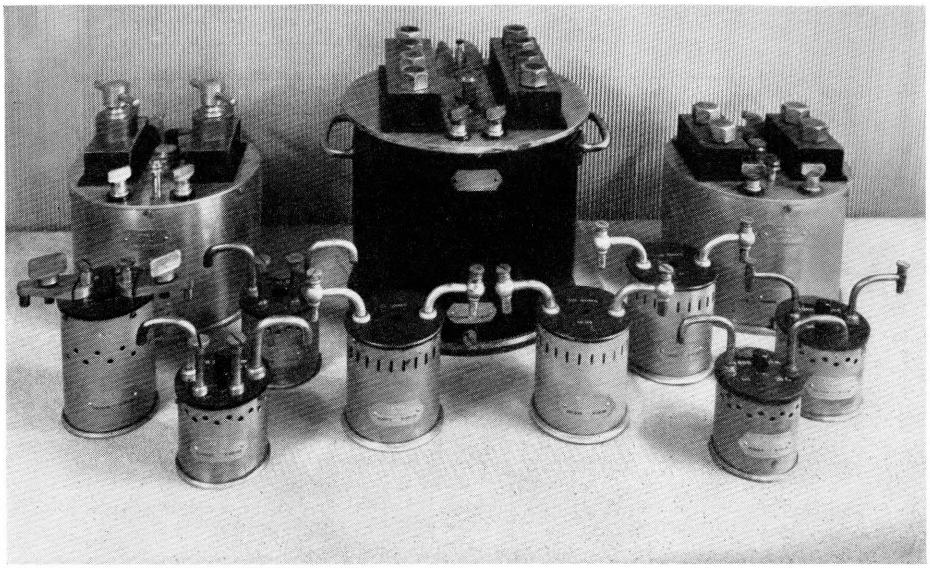


Figure 1—A group of standard resistors as described. Values are as indicated below.
0.001 ohm Wolff — 0.00001 ohm Wolff — 0.0001 ohm Wolff
1.0 ohm Wolff — 1,000 ohm Weston
0.01 ohm Wolff — 10 ohm Weston — 100 ohm Weston — 100,000 ohm Wolff
0.1 ohm Wolff — 10,000 ohm Wolff

CURRENT measurements are almost universally made today by measuring the potential drop of that current through a known resistance. In fact, it is doubtful if any current balances, as designed by Kelvin or others, are found outside the national laboratories, where they are occasionally used as a cross check against other current measuring methods. In view of this use of a resistor to measure current, it is obviously most important to be able to measure the value of that resistance to a high degree of accuracy.

Fortunately, the ohm is readily maintained. It is not a fugitive quantity like the ampere, which can be standardized, but ceases to exist when we store our apparatus or leave it over the week-end. Nor does it depend on electrochemistry, as does our standard of the volt, the Weston Standard Cell, which has been previously discussed.[1] In fact, resistance is merely a dimension and a quality; a measured cross section and a length; and resistivity per centimeter cube. Although the resistivity is subject to change with temperature, we can hold the temperature constant or compensate for values at other temperatures. But everything being relative, to what degree can we maintain a resistance standard? And to what degree can it be held over long periods of time?

Shunts are adjusted for $\frac{1}{2}$ or $\frac{1}{4}$ of 1 per cent quite readily, as are series resistances for voltmeters, and they will hold within these limits for long periods of time. Adjustments to $^{1}/_{10}$ and $^{1}/_{20}$ of 1 per cent for use with accurate portable instruments begin to be quite difficult in the manipulation, and these fine adjustments will hold only if the resistance material has been stabilized by temperature cycling after it has been bent or wound or otherwise placed in final position. Temperature corrections will not be needed in these brackets if used within 15 to 35 degrees C, provided a suitable grade of manganin resistance material has been used.

But when we start to consider the stability of resistors used as standards for a calibrating laboratory—essentially to maintain a standard resistance value between periodic cross checking visits to the National Bureau of Standards—we find *all* our standards are drifting up and down in terms of a few parts per million per year. Even the most stable metals and alloys seem to change with time, in their basic quality of resistivity, probably due to minor changes in crystal structure; surface conditions modify the initial dimensions, and soldered or brazed joints appear to flow. The quality of a purported standard in these hair-line brackets seems almost a random result; certainly it is best proven by experience over long periods of time.

The Weston Company is perhaps fortunate that in the early days Dr. Weston saw fit to purchase a large number of resistance standards from the outstanding maker of the time, Otto Wolff of Berlin. Using manganin wire and sheet—the alloy invented by Dr. Weston as made by Isabellenhuette, the German rolling mill—Wolff was apparently able to produce resistance standards which have long outlived his own business organization.

We are told that Otto Wolff had a small shop which was a short distance from the center of Berlin, where, with approximately ten workmen, he fabricated and personally adjusted the resistance standards, bridges, and potentiometers which made his name famous in scientific circles around the turn of the century. He had a very considerable store of manganin wire and sheet, fabricated and aged through the seasons to reach a stable condition; and he was able to solder this material into terminals and adjust it in a manner that kept it from being under strain, whereby its performance through the years changed but little.

Weston purchased a variety of standard resistors from Wolff. Records indicate that the first one obtained carried Wolff's serial No. 487, made in 1893. Miscellaneous resistors were added, with a large number having been purchased in 1907, so that there was a standard resistor of every decimal value from 0.00001 ohm to 100,000 ohms. Each one shipped into this country carried the seal of the Reichsanstalt, at that time probably the top technical bureau of the world, and a hand-written certificate giving its value in terms of the then standard mercury column. Later work indicated that the German interpretation of the standard mercury ohm was 15 parts per million higher than the value later known as the International Ohm.

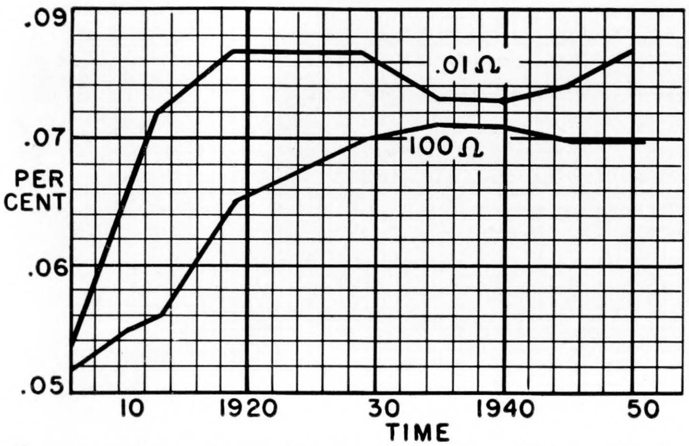


Figure 2—Variations in the 0.01-ohm Wolff unit and in the 100-ohm Weston unit over the last half century.

And in the same period—1905-1910—Dr. Weston manufactured his own version of standard resistors embodying certain features of novelty which he considered important and which had been passed over in the Wolff design.

Today, half a century later, we have a rich summary of data on these old units, effectively proving that some of them have become extremely stable, changing only a few parts per million per year according to the very best checks which can be obtained at the Bureau of Standards. Records are kept by converting to absolute ohms the original German values and the values measured prior to 1950, and there is plotted in the chart (Figure 2) the variations over the last half century in the 0.01-ohm Wolff unit and in the 100-ohm Weston unit. All of these checks are by the Bureau of Standards, except for the original Reichsanstalt values.

Figure 1 shows the complete set of basic standard resistors; each of these is supplemented by an auxiliary standard of similar type and several sets of working standards on which records are also kept. Thus, if some accident should overtake the basic standard, the auxiliary standard could take over.

Weston no longer makes standard resistors as such, but the history of the Weston-made standards shows that the art is well understood in the organization. In the last analysis, the resistors are simply shunts of rather high caliber and rather conservatively rated. It might be of interest to point out that 1,000 amperes through the 0.00001-ohm standard resistance will give only 10 millivolts drop!

Reference:
[1] F. X. Lamb, "*Weston's Cadmium Cells,*" WESTON ENGINEERING NOTES, Vol. 1, No. 3, June, 1946.

E. N.—No. 103 —*J. H. Miller.*

A HIGH TORQUE D-C MECHANISM

IN VIEW of numerous requests for High Torque D-C Mechanisms to drive such items as sensitive potentiometers, synchro-repeaters, and the like, the Weston Model 399 Type 3 mechanism has been made generally available.

Actually developed as a high torque mechanism with an external magnet for use in driving direct writing recorders, the mechanism has been redesigned and made available in core magnet form.

Part of the original study of the mechanism was the problem of dirt getting into the air gap when the recording instrument was opened to replace the chart paper. The problem posed was to design a mechanism which, with no auxiliary housing around it, would be immune to the metal particles floating in the air, for example, in a steel mill. This problem was effectively solved by mounting the bridges on the core and enclosing the ends of the magnet system with transparent plastic caps, including a dust seal of resilient material adjacent to the ends of the pole pieces. Figure 1 shows the mechanism with the top cap removed.

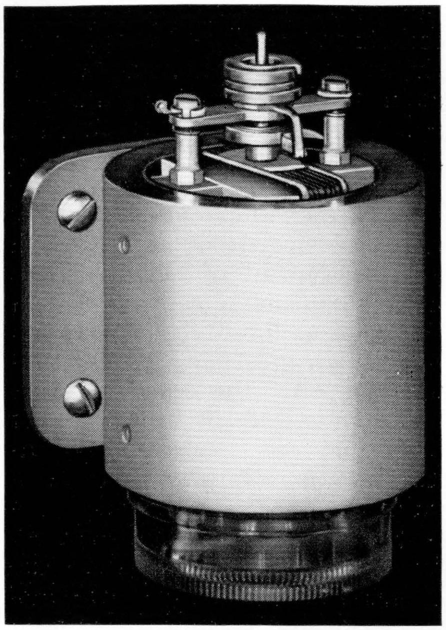


Figure 1—Illustration of the High Torque D-C Mechanism with top cap removed.

Through a sapphire ring jewel in the top bridge, and the upper cap, a staff emerges to which is clamped the pen in the original design. This cap also carries the upper spring abutment; rotation of the cap then adjusts the zero position. This particular combination is covered by Patent No. 2,312,990. The modification using the core magnet has been made reasonably simple inasmuch as the rather large size allows for the use of a very heavy core magnet of optimum magnet dimensions. As normally furnished, the cylindrical yoke is drilled and tapped for mounting on a suitable saddle. Since the bottom bearing is a pointed pivot in a V sapphire, the mechanism is for use only with a vertical axis.

Torque available depends, of course, on the energy supplied and the spring strength.

A torque of 36,000 milligram-centimeters for 60 degrees normal deflection is frequently furnished. In considering this value of torque, it should be noted that 1,000 milligram-centimeters, or 1 gram-centimeter, is equal to 0.0139 ounce-inch. Conversely, 1 ounce-inch is equal to 71.96 gram-centimeters or 71,960 milligram-centimeters. So the 60 degree torque of 36 gram-centimeters is practically equal to 0.50 ounce-inch.

A popular low torque potentiometer is stated to have a starting torque of 0.005 ounce-inch, which is 1 per cent of the torque mentioned above for 60 degrees deflection. Figure 2 shows such a potentiometer mounted on the mechanism and driven directly by a flexible coupling.

To obtain this amount of torque, there is required about 13.5 milliwatts. That is, with 5 ma for 60 degrees deflection, the moving coil resistance is approximately 540 ohms. For 2 ma, the resistance would be 3,375 ohms, while for 10 ma, the resistance is only 135 ohms. With this value of torque and using a normal coil frame for damping, the instrument is fairly well damped with only a few per cent overshoot. Using variations possible in winding, and heavy springs, the torque can be stepped up several times if the electrical power is available. About the only limit on the power that can be applied to the moving coil is that of self-heating.

With an exponential thermal time constant of 22 seconds, the final temperature rise is 6° C. per watt in the moving coil. Thus, for a temperature rise of 30° C., some 5 watts could be dissipated in the coil system, equal to a torque of 690 gram-centimeters or 9.6 ounce-inches for 60 degrees, and which might be obtained with 96 milliamperes in the 540-ohm coil mentioned above. Such very high torque values pose several problems. Using a heavy copper frame in place of the aluminum frame, good damping is possible up to values of around 100 gram-centimeters; higher torques, however, will be under damped. Springs for such very high values become a problem, but sometimes are not required in a torque balance system.

The mechanism is 2.5 inches in diameter and is 4.41 inches high over the end caps; it weighs 3 pounds, 6 ounces. The cylindrical staff emerging is stainless steel, 0.081 inch in diameter and is protected by a sleeve which is part of the transparent upper end housing. A hole through the side of this housing extension allows for a set screw in the coupling. The mechanism has also been used as a part of a servo-mechanism and in some arrangements carries heavy correcting surges of current serving to re-establish a basic torque balance against some other torque-producing mechanism; presumably in the linkage some auxiliary means of damping may also be supplied.

The torque values given above may seem low in terms of ounce-inches, but it might be pointed out that the average laboratory indicating instrument has a full scale torque of the order of a few hundred milligram-centimeters, and the average panel instrument has a torque of 15 to 30 milligram-centimeters.

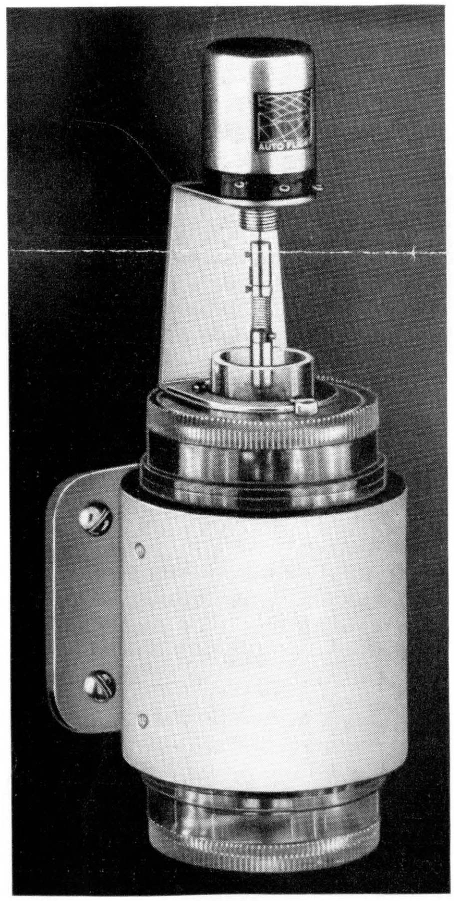


Figure 2—A low torque potentiometer mounted on the High Torque Mechanism and driven directly by a flexible coupling.

It is believed that the availability of this higher torque mechanism may be of some interest to those concerned with automatic control.

E. N.—No. 96 —*J. H. Miller*

A NEW ILLUMINATED VU METER

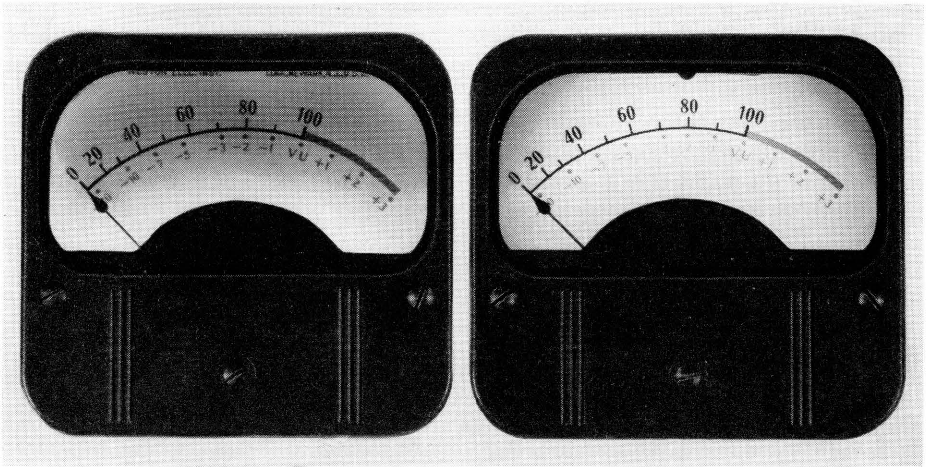


Figure 1—Unretouched photo of angle illumination (left) and rear illumination (right), showing increased uniformity of new method.

WITH the increased use of the VU meter[1] as a monitoring instrument for voice frequency in a broadcast studio, a critical analysis was made of the use of the instrument. As contrasted with the use of a conventional instrument where occasional readings are taken from time to time, the volume indicator is continuously watched by the monitoring operator during an entire program in order that the gain controls be adjusted. It is most desirable that the voice frequency amplitude be adequate to allow for full modulation of the transmitter power at the higher sound levels with appropriate lower power at lower levels. This frequently means compressing the louder passages of an orchestra downward and in raising the more subtle phrases.

Such continuous observation of an instrument for periods up to one hour inevitably results in fatigue and the very best, smoothest and softest illumination of the monitoring instrument that is most worth while.

VU instruments offered up to this time have generally been illuminated by small incandescent lamps below the scale whereby the light strikes the scale at a sharp angle. Such an arrangement has been used in the Weston Model 862 VU Meter. However, such sharp angle lighting at best is not as uniform as might be desirable, and the portion of the scale near the lamps is somewhat brighter than the outer edges.

Rear illumination appeared to be desirable, and with the advent of the core magnet mechanism[2] it appeared possible to use rear illumination of a translucent scale, since there was no longer necessity for a large and heavy magnet in the rear of the scale.

Although the moving coil system in the core magnet structure is somewhat larger than in the conventional VU meter, it was found possible through a proper choice of moving coil winding and pointer weight to establish adequate torque and damping to obtain the established characteristics of the standard for this instrument.[3] Such a mechanism was built and critically studied to the end that production of this type of mechanism seemed practicable.

Illumination from the rear then required a suitable choice of scale material, and a translucent, matte-finished plastic was obtained having the color tone established by the referenced standard.[3] Insertion of the lamps from the rear of the case posed a problem in that the aperture should necessarily be closed to eliminate dirt under all conditions, and this was worked out through the use of transparent plastic caps inside the structure. Special lamp sockets were designed allowing for the removal of the lamp and socket as a unit for lamp replacement and without any wires dangling from the socket.

Positioning of the lamps to secure smooth, even illumination was a bit of a problem. Eventually, through an arrangement of baffling inside the instrument, a very acceptable degree of uniformity was achieved. With the rear illumination, the contrast between the scale markings and pointer and the background is high, and the instrument indications are more rapidly valued at a quick glance than in the older type where the illumination of the scale arc was somewhat less than the higher brilliancy around the edges of the opening. Even with one lamp removed or burned out, the new type of illumination is quite adequate allowing for continuous monitoring.

The instrument has been used experimentally in a few studios and found to be a material improvement in easing the strain on the monitoring operator; those who have used it are enthusiastic about its use as a standard volume indicator.

The new instrument will be identified as Model 862, Type 30AX and 30BX, the A and B referring to the type of scales as explained in the literature. The A scale has the large VU designations above the scale, whereas the B scale, largely used for broadcast monitoring, has the figures 0-100 above the scale. The letter X indicates rear or external illumination.

References:

[1] WESTON ENGINEERING NOTES, Volume 2, Number 2, April, 1947, *A. G. Smith.*

[2] WESTON ENGINEERING NOTES, Volume 4, Number 1, February, 1949, *J. H. Miller.*

[3] American Recommended Practice for Volume Measurements of Electrical Speech and Progress Waves, Document C16.5-1942. American Standards Association, 70 E. 45th Street, New York 17, New York.

E. N.—No. 104 —*John H. Miller.*