

Laboratory and Shop Notes

BRIEF contributions in any field of instrumentation or technique within the scope of the Journal can be accorded earlier publication if submitted for this section. Contributions should in general not exceed 500 words.

Low Noise Modifications of the Tektronix Type 122 Preamplifier

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BECAUSE of the flexibility, simplicity, and small size of the Tektronix Type 122 preamplifier, it is currently used in many laboratories for general amplifier applications. We have found that by several minor modifications of the input stages of the amplifier the internally generated noise level may be appreciably reduced. These changes increase the usefulness of the unit, making it more suitable for low-level applications.

The following alterations were made: 1. Plate and cathode resistors in the first two stages were replaced with noninductive wire-wound units. 2. The second stage 12AU7 was replaced with a 12AX7. This requires that the cathode resistor in this stage be increased from 100 k to 200 k. 3. Both the first and second stages were run at one-half heater potential. This is simply accomplished by connecting the heaters in each tube in series rather than parallel. These changes serve to reduce the noise components due to excess noise generated by deposited film resistors, and to drop the noise level due to flicker and shot noise in the first tube. Increased gain in the second stage resulting from the use of the 12AX7 makes noise in the first stage dominant.

The noise spectrum of the amplifier, before and after these modifications, is shown in Fig. 1. For these measurements, both input grids are shorted to ground and the noise is expressed as equivalent noise at the input. The original noise spectrum shows the typical $1/f$ spectrum characteristic of flicker and excess noise with some indication of change to "white" noise at high frequencies. Similar characteristics are present in the noise spectrum after modification, except that the over-all level is reduced and the transition to white noise occurs at about 100 cps. It is believed that this residual noise level represents flicker and shot noise in

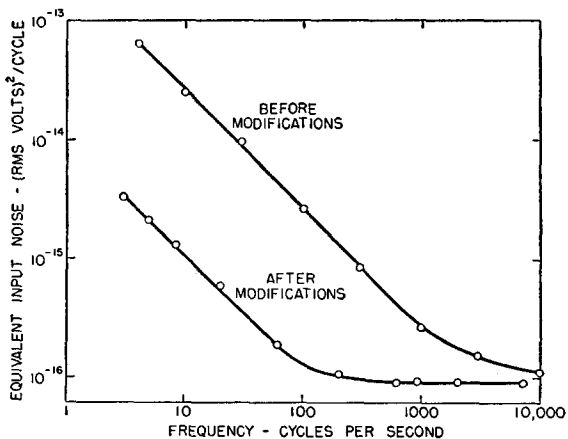


FIG. 1. Noise spectrum of the Tektronix Type 122 preamplifier before and after modifications described in the text. The noise level is expressed as equivalent input noise with both input grids shorted to ground.

the input stage. On the basis of the data in Fig. 1, the equivalent input noise level for wide-band operation is two microvolts before modification and one-half microvolt after.

It is found that the alterations cause minor changes in the other characteristics of the amplifier. The gain is increased from 1000 to 2800, the high-frequency cutoff is reduced from 40 kc to 20 kc, and the maximum undistorted input signal is 10 millivolts peak to peak rather than 20 millivolts. No attempt was made to regain the original characteristics since for the present application the amplifier is suitable as modified.

We believe that these simple changes in the Type 122 amplifier improve its usefulness for many applications and may be of interest to others using the unit for low-level amplification.

Improved Adjustable Lapping Mandrel

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THE tool herein described was designed to eliminate the objectionable problems and inconveniences encountered when lapping the inside of glass tubes. There are two general types of lapping mandrels¹ normally used for this type of work. One system employs the use of a mandrel with interchangeable ends, of assorted sizes. This is slow and inconvenient. Frequently the lap will work off the end of the mandrel and become stuck inside the glass tube. The other system makes use of expanding mandrels of various designs. The chief objection to them is that the mechanism to adjust the size of the mandrel is always in the part of the tool that is flooded with abrasive grit. Consequently, after short usage the grit has destroyed the adjustments.

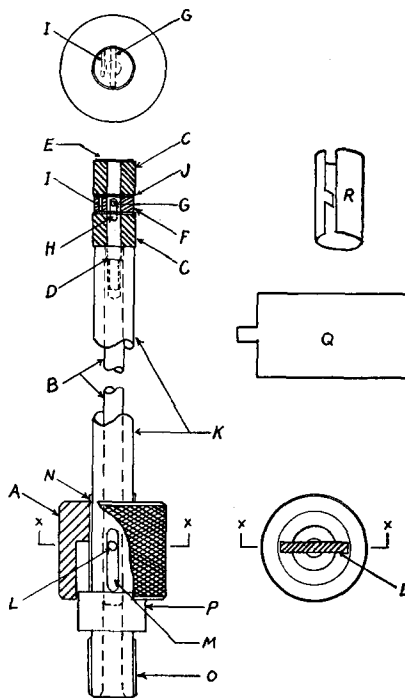


FIG. 1. Adjustable lapping mandrel: A, knurled adjusting collar; B, draw bar, $\frac{1}{4}$ -in. diam; C, expansion rubbers; D, 8-32 threaded coupling sections of draw bar; E, end plate; F, brass driving ring; G, 0.093 \times 0.5-in. brass pin; H, 0.095 \times 0.25-in. slot in end of draw bar; I, 0.020-in. slot for tongue of copper lap; J, 0.020-in. brass washer on both sides of F; K, shank of tool; L, draw bar pin, 0.125-in. diam. \times 0.870 in. long; M, draw bar pin slot in shank; N, $\frac{1}{8}$ -18 adjustment thread; O, thread to fit spindle of lapping machine; P, thread shoulder extended within bore of adjusting collar; Q, 0.020-in. flat sheet copper for lap; R, formed lap ready to place on mandrel.

This tool was designed so that the diameter of the lap is increased by compressing the ends of a rubber cylinder. The adjusting mechanism is also designed in such a manner that it is kept free from abrasive grit. Referring to Fig. 1, the rubber cylinders (C) are compressed by turning the knurled adjusting collar (A) in a clockwise direction on the thread (N). The internal shoulder of (A) presses against the draw bar pin (L). This is linked with the end plate (E) by the draw bar (B). To reduce the diameter of the lap, the adjusting collar is merely turned in the opposite direction. To assure a positive drive for the copper lap (R), it was necessary to have a floating brass driving ring (F) with a slot (I) in which the tongue of the lap is inserted. This ring (F) is linked with the draw bar by a brass pin that rides in the slot (H). There is a 0.020-in. thick brass washer (J) on each side of driving ring (F) to prevent the tongue of the lap from moving out of the slot (I) and cutting the expansion rubbers. The extending end of the draw bar is 0.187 in. in diameter and is coupled to the 1/4-in. section of the bar at (D) with an 8-32 thread. This simplifies the assemblage and is convenient if one desires to use a larger lap. It should be pointed out that the adjusting collar (A) extends over the shoulder (P), thus preventing grit from coming in contact with the adjustment thread (N).

Over a period of weeks it was found that this tool cuts the lapping time in half, as compared with other types of mandrels. When using a lap to grind a 12-mm i.d. tube, it is possible to expand it to a full 15 mm. This range of adjustment was sufficient to grind the entire side walls of a tube. If it should be desired to use a lap of a larger size, the range of adjustment would be proportionately greater.

* National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare.
 † A good example of the type of laps referred to is given in the Eisler Engineering Company Catalog, Bulletin No. 11-43, p. 23 (1942).

Simple Device for Converting an Automatic Recorder into a Flexible Program Controller

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ESSENTIALLY the system consists of a line drawn on the recorder chart representing the desired program and, attached to the recorder pen carriage, a device which will detect the presence or absence of the line and control the process in such manner as to return the carriage to the line.

Suppose, for example, it is desired to heat a furnace, whose temperature is detected by a thermocouple connected to an auto-

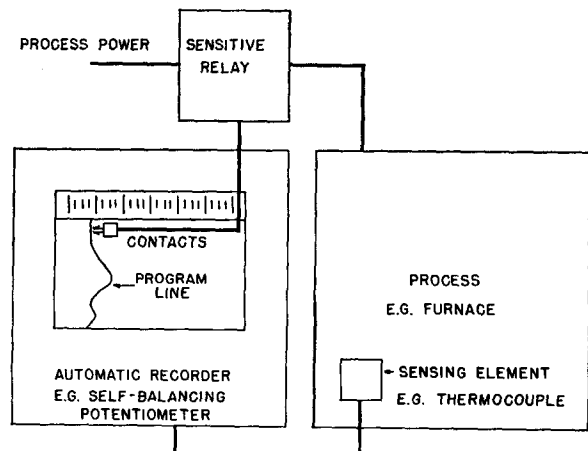


FIG. 1. Program control system (schematic).

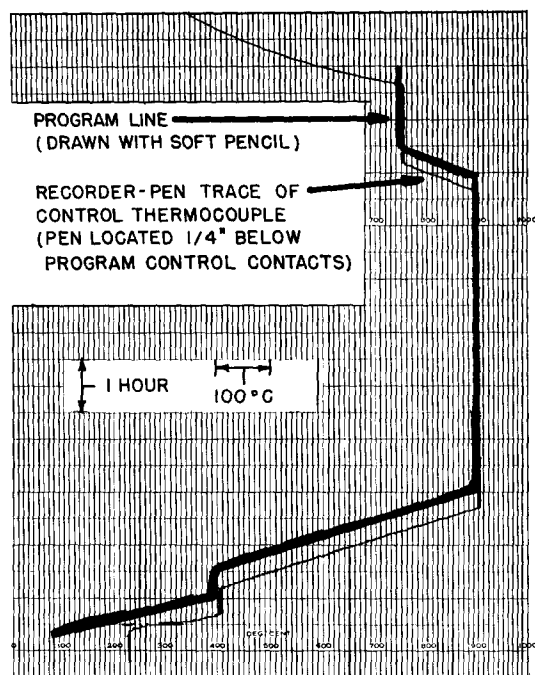


FIG. 2. Typical program control chart.

matic recording potentiometer, at the rate of 100° per hour. An electrically conducting line with a slope of 100° per hour is drawn on the recorder chart with a soft lead pencil. Two closely spaced contacts are attached to the potentiometer pen carriage and so arranged that when they rest on the electrical conductor they will energize a control circuit. The control cycle will be as follows. After the recorder chart has been manually advanced until the beginning of the program line touches the contacts, the circuit thus completed through the program line energizes the control circuit and starts the furnace heating. As the furnace temperature rises, the recorder (in response to the thermocouple signal) moves pen carriage and contacts away from the program line and opens the circuit to the furnace. The furnace temperature drops and the pen carriage returns toward the line which meanwhile has been moved by the continuous advance of the chart. Thus the contacts will encounter the program line at a higher temperature, and the cycle will be repeated at a higher temperature. The control thermocouple curve then is a cyclic one riding on the high side of the drawn program line.

The program line may be nonlinear as well as linear, and it may call for cooling as well as heating. The system can be used, of course, to control variables other than temperature (illumination or liquid level for example), and in conjunction with an x-y recorder it can be applied where the second variable is one other than time (fluid flow versus pH, for example).

The device has been used successfully at NRL on both strip and circular chart recorders, and for controlling both laboratory and industrial type heat-treating furnaces. The design is shown schematically in Fig. 1. Figure 2 shows a program line which has been used for laboratory annealing of malleable iron.

In practice several conditions must be met to operate the system successfully. The line must have sufficient conductivity to activate a sensitive relay (usually a thyatron circuit). A line drawn with an IBM electrographic sensing pencil and a brushed-on line of colloidal graphite suspended in alcohol have both been used at NRL. Allowance must be made for undershoot of the controlled system and can be made by drawing a wide line or by using sensing elements with a wide contact. Experience has shown that weight-loaded contacts are more successful than spring-loaded ones to achieve proper pressure on the chart paper.