Laboratory and Shop Notes

An Electromagnetic Focusing Device for the Electron Microscope

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THE use of electromagnetic rather than electrostatic alternating fields in a beam deflection focusing device was first demonstrated by Ir. LePoole of Delft.[1] The Delft instrument has a very narrow neck between the condenser lens and the specimen chamber; the electromagnetic coils are placed around this neck outside the instrument. Bishop[2] has also described such an adaptation to the RCA instrument.

In adapting the electromagnetic system to the RCA e.m.u. electron microscope, it was decided at this laboratory, that the size of the specimen chamber and the nature of the metal casting made it both practical and advisable to place the coils inside the chamber in close proximity to the electron beam. The coils were wound without cores to eliminate the possibility of hysteresis and induced or residual magnetism. A description of such an adaptation to the RCA e.m.u. microscope follows:

A one and one-half inch O.D. brass tube (Fig. 1) is rigidly attached at its top by flanges to the screws which support the stage motion springs on the roof of the specimen chamber casting. The tube extends downward to within one-fourth inch of the stage and has a one-inch wide slot in front to permit the insertion of the specimen holder. Four pins are placed at 90° intervals around the outside of the tube one-quarter inch from the bottom, this arrangement reproduced three-fourths inch higher. On each side, around the upper and lower pairs of pins, are wound coils consisting of 400 turns each of 36-gauge Format Insulated Magnet Wire, care being exercised to avoid short circuits within the coils or to the brass tubes. With opposite polarity in top and bottom pairs, one side of each pair may be brought to a single terminal in a special bushing (Fig. 2) inserted between the casting and the vacuum manifold at the rear of the specimen chamber. To this terminal is brought one output lead from a 6-volt, 60-cycle, a.c. transformer which is in turn connected to the ground lead of the microscope chassis. The two remaining coil leads, top and bottom, are brought through separate terminals in the bushing to either side of a 40-ohm potentiometer through the rotor of which is fed the other lead of the 6-volt transformer. A double pole, double throw switch is used, one position energizes the primary of the transformer, the other position grounds the ungrounded side of the coils to prevent pick-up within the microscope column.

The positioning of the coils is not highly critical, balancing is achieved by adjustment of the potentiometer until there is no

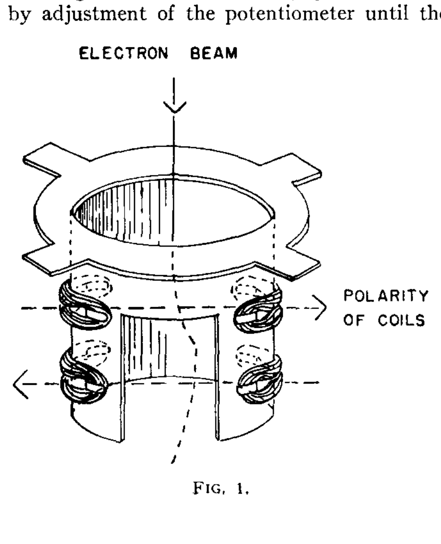

FIG. 1.

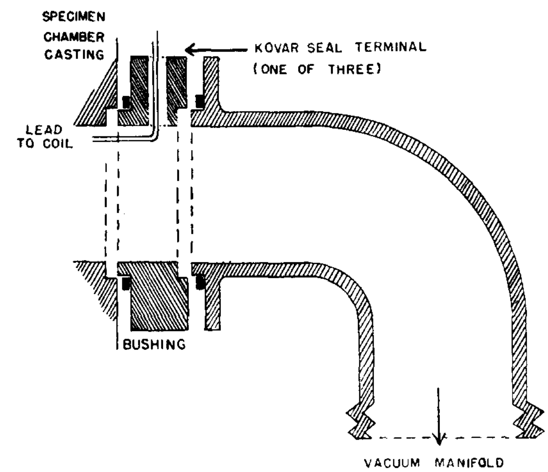

FIG. 2.

loss of illumination with the device energized. It is possible that square wave deflection may offer some advantages over sine wave at the expense of economy and simplicity.

This device, by increasing the angular aperture of illumination, decreases the depth of field and increases the sensitivity of focusing. At an instrument magnification of 8000×, a departure from correct focus of one unit on the vernier adjustment results, with the focusing device energized, in a blurring over half a millimeter wide at any well-defined point. Accuracy in focusing is, however, closely dependent on alignment, particularly image rotation, which must be scrupulously centered.

Such increase in focusing sensitivity becomes particularly valuable at low intensities and in low contrast biological specimens. Although the use of this device does not obviate the need for through-focus studies where exceptional resolution is demanded, it does eliminate such precautions in routine work and places efficient operation and good quality results within the scope of the most inexperienced operator.

[1] Seen at the Institute for Electron Microscopy, Delft, Holland (April, 1949).
[2] F. W. Bishop, Rev. Sci. Inst. 20, 532 (1949).

Automatic Stabilization of the Overvoltage on a Geiger Counter

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THE conventional Geiger counter circuit nearly always includes an electronic stabilizer which keeps the high voltage constant. However, this does not insure that the voltage will remain at the same value with respect to the plateau, because the latter may shift or change in length during an extended series of measurements. In many applications it is advantageous to eliminate the effect of drift in the characteristics of the counter tube by stabilizing the overvoltage rather than the absolute voltage. The purpose of this note is to describe a simple method by which this can be accomplished* and to suggest some specific applications.

As the voltage on a Geiger counter is increased from the lower to the upper limit of the plateau, the pulses can be seen to increase gradually in size. The pulse size is approximately proportional to the overvoltage, that is, to the excess of voltage over that corresponding to the lower limit of the plateau. Thus every time a count occurs, the size of the pulse gives information as to the value of the overvoltage. This fact is made use of in the circuit shown in Fig. 1, the high voltage being controlled automatically by the size of the pulse produced by the counter.

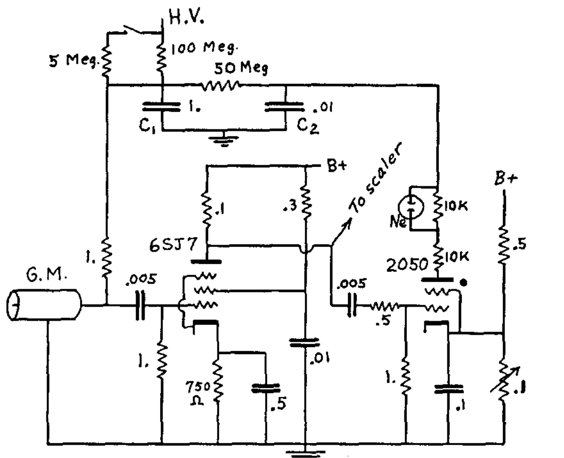

FIG. 1. All condenser and resistor values are in microfarads and megohms, respectively, except where otherwise specified. The circuit is designed for a B supply of 300 volts, and for a high voltage supply which gives up to about 400 volts in excess of the operating voltage of the counter tube.

The condensers C_1 and C_2 slowly charge from the high voltage supply. As the voltage on the counter tube rises above the threshold potential, the pulse height rises accordingly. The first pulse whose height exceeds a value determined by the bias on the thyratron, fires the thyratron, discharging C_2, which results in lowering the voltage on C_1 by about 10 volts. The thyratron will not fire again until after C_1 has recovered the 10 volts; the next pulse which comes along after that time will fire it. The circuit constants must be so chosen that the time required for C_1 to recover the 10 volts will be somewhat greater than the average time between counts, at the lowest counting rate to be expected. The component values given in Fig. 1 make the circuit suitable for use where the lowest counting rate to be expected is about 30 per minute. If the high voltage supplied to the circuit is 200 volts greater than the operating voltage of the counter tube, the thyratron will fire once every 5 seconds.

The "hunting" in the stabilizer appears as a saw-tooth oscillation of the high voltage, with a period of 5 seconds, and an amplitude of 10 volts. At high counting rates the upper and lower limits, which are 10 volts apart, are quite precisely defined. If the counting rate is reduced until it is not much greater than the hunting frequency, the voltage will make occasional excursions to values considerably above the upper limit just mentioned. If, in addition, the counter tube happens to be one whose plateau has considerable slope, an error in the number of counts will be introduced. There is, of course, nothing to prevent the voltage from making excursions clear to the region of continuous discharge, if the counting rate is low enough relative to the hunting frequency. A quantitative treatment of the hunting effects with proper regard for the shape of the plateau would be complicated. However, it may be remarked from the practical viewpoint that the difficulties just discussed can easily be avoided, since one is free to choose the hunting frequency sufficiently low to suit any application.

Some variations in the circuit may be mentioned: As a substitute for the thyratron a one shot multivibrator, a blocking oscillator, or a diode in a peak voltmeter circuit together with a triode regulator tube can be used. We chose the thyratron only because it seemed to be the simplest. The circuit is also adaptable to use with non-self-quenched counters. In that case the quench tube replaces the amplifier. If the quench circuit happens to be one which gives a negative signal, an inverter must be used between it and the thyratron.

The length of the warm-up period for the circuit presents a problem. Due to the small charging rate of C_1 the time required for it to rise from zero to the operating voltage when the power is first turned on is inconveniently long. Several easy solutions are possible. In the circuit shown a push button switch is provided, which increases the rate of charging by a factor 20. This is merely held down until the thyratron fires the first time, as indicated by flash of the neon bulb. Another solution is the use of the usual manual voltage control (unstabilized) at the start, with a switch to convert to the automatic control.

Several applications and advantages of the circuit are listed below:

1. Measurement of long duration, in which the characteristics of the counter are subject to drift due to changes in gas pressure, temperature, etc. The circuit will follow shifts of several hundred volts in the plateau.
2. Use of counters having narrow and sloping plateaus. Since the voltage is maintained at the same value with respect to the plateau, the counter efficiency remains essentially constant.
3. Coincidence and anticoincidence. Since the output pulse size is bracketed between close limits, the pulses from two or more such circuits can be combined directly to form coincidences without the use of auxiliary pulse shaping circuits to bring the pulses to uniform size.
4. Use with vibrator, multivibrator or radiofrequency high voltage supplies. Since the drain on the high voltage supply is of little importance, the circuit is well adapted to use with these types of high voltage supply.
5. Radiation monitors for safeguarding health, where it may be desirable to have the counter run for weeks or months without attention.
6. Measurements where attention is not possible, such as those in balloons or rockets.

The author is indebted to Mr. Earl McDaniel for assistance in developing the circuit described.

* Since writing this note it has come to my attention that a circuit which accomplishes the same result has been developed, independently, by the Radioactive Products Corporation of Detroit, Michigan.

Long-Lived Self-Quenching Counter Filling

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IT has been found that counters filled with a suitably proportioned mixture of the four gases argon-xenon-oxygen-nitrogen are self-quenching when operated with the same counter circuits ordinarily used with conventional self-quenching counters (Fig. 1). Such counters may, furthermore, have long and flat plateaus and operate at reasonable voltages even up to near atmospheric filling pressures. Most important, these counters have shown no apparent deterioration in plateau characteristics after prolonged operation at rather high counting rates. Similarly, holding them at extreme overvoltages in "continuous" discharge for extended periods also has had no apparent adverse effect on subsequent performance.

Figure 2 indicates how the counter performance is affected by variations in the composition of the mixture. These data were taken with glass counters having 0.002-in. tungsten center wire, $\frac{3}{4}$-in. diameter silver cathode and 3-in. active length. The data given for "threshold" represent the triggering voltage for the scaling circuit at the usual 0.25 volt sensitivity. The data given for "approximate length of counting region" represent the approximate length in volts of that region above threshold wherein the counter was responsive to a radioactive (gamma) source and exhibited self-quenching behavior. This counting region does not represent, in every instance, a satisfactory counting plateau since in those cases where the filling parameters were far removed from optimum the oscilloscope pattern frequently showed erratic

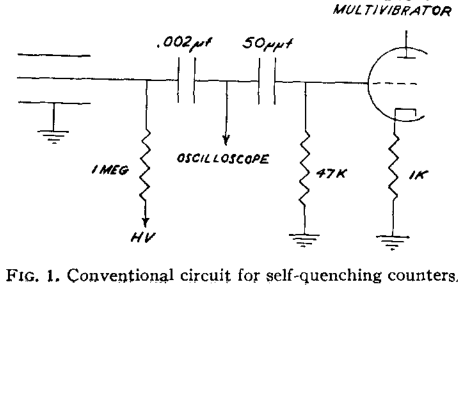

FIG. 1. Conventional circuit for self-quenching counters.