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M. H. Mueller and R. B. Bilinski

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Silicone grease has been found to be very satisfactory with neoprene rings.

A one-inch valve for manual operation against full pressure and a three-inch diffusion pump valve which is the largest built at this writing are shown in Fig. 2. Some measurements on the large valve will illustrate permissible deviations from manufacturer's recommendations on "O" ring design. The tube was selected only as to nominal diameter. The bore was found to vary from 2.70 to 2.75. In addition, the glass blowing operations introduced an intrusion of 0.025 in. at the top of the large seal. This intrusion did not interfere with operation of the valve and was turned to advantage to eliminate the need for a stop to hold the valve in the open position against atmospheric pressure on the piston rod.

The valves would seem to lend themselves to properly designed automatic control and there appears to be no reason why similar construction would not be successful in metal systems.

* National Bureau of Standards, Washington, 25, D. C.

Sensitive Leak Control

M. H. Mueller and R. B. Bilinski
Argonne National Laboratory, Chicago, Illinois
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A SIMPLE device has been designed for controlling the leak into a gas x-ray tube and for many other such applications. This leak control is a modification of the one used on the Wyland gas tube,[1] in which the control is accomplished by varying the pressure applied to a series of alternate rubber and metal washers (Fig. 1, H). There are approximately six of each type of washer. Each washer has a central hole which permits gas to leak between the washers into the evacuated chamber.

A very sensitive control of the size of the leak is obtained by a gear reduction (Fig. 1, C and D) which permits relatively large movement of the control knob (Fig. 1, B) for a small change in the vacuum. The size of the leak is very constant for a given setting; this results in a stable operation of the gas x-ray tube. For use with the x-ray tube a pressure of 15–50 microns has been used; however, in order to check the practicability of other applications, the pressure in the vacuum chamber was varied from five hundred to several microns with good indications that the range can be extended in both directions.

This device also provides a means for the introduction of a controlled atmosphere into a system. The gas is allowed to flow from the intake tube through a milled out slot in the threads and may then pass around the slotted sleeve, which serves as a holder for the washers. Gas is prevented from escaping around the movable shaft by an "O" ring seal (Fig. 1, E).

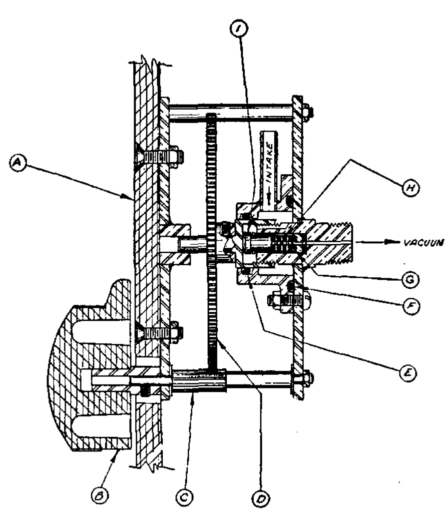

Fig. 1. Sensitive leak control. (A, Control panel; B, knob; C, pinion; D, gear; E, "O" ring; F, "O" ring; G, slotted sleeve; H. rubber and metal washers; and I, button.)

[1] George C. Wyland Laboratories, Rowe, Massachusetts.

Pulse Inverter Circuit*

Leonard Reiffel
Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago, Illinois
(Received February 19, 1951)

IT is often necessary to change the polarity of the signal from a source of electrical pulses. In many such instances, when the pulses need no amplification, it is possible to obtain the phase inversion without tubes or the limitations and inconvenience of a pulse transformer. The inverting circuit is shown in Fig. 1.

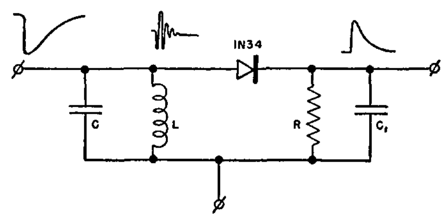

Fig. 1. Pulse inverting circuit.

The negative input pulse shock excites the resonant circuit consisting of L and C, commencing a train of damped oscillations. The positive half-cycles of oscillation are rectified and integrated by the peak detector consisting of the IN34, R, and C_I. A positive output pulse, therefore, appears across C_I, decaying as the envelope of the oscillations and delayed by a constant interval (one half-cycle) with respect to the input pulse. (A very simple variable delay circuit may be made in this way—changing C will change the delay time. When only inversion is desirable, short delays; i.e., $\sim$0.1 microsecond are used.)

The circuit will work equally well for positive to negative inversion (by reversing the diode) and will handle up to 50 volts peak with a single IN34. The rise time of the output is determined by the resonant frequency and can be made quite fast. The fact that the output pulse polarity is independent of input polarity for a given diode arrangement, is also sometimes usable. For example, a square univibrator pulse of variable width may be differentiated and passed through the circuit illustrated to provide two positive pulses with variable spacing quite suitable for resolving time tests. The amplitudes of the two pulses produced in this manner will be slightly different because of the change in loading on the oscillatory circuit.

* This work was done as one aspect of a project carried on under contract with the United States Department of the Air Force.

The Temperature Coefficient of Scintillation Phosphors

W. L. Minarik and H. G. Drickamer
Department of Chemistry, University of Illinois, Urbana, Illinois
(Received December 9, 1950)

THE following material constitutes an addition to the quantitative material now available[1–6] on the temperature coefficient of scintillation phosphors. The curves of Fig. 1 show the temperature coefficients for anthracene, calcium tungstate, and thallium activated sodium iodide calculated to a common base at room temperature. These results were obtained with a 1P28 photomultiplier tube cooled to dry ice temperature. The scintilla-

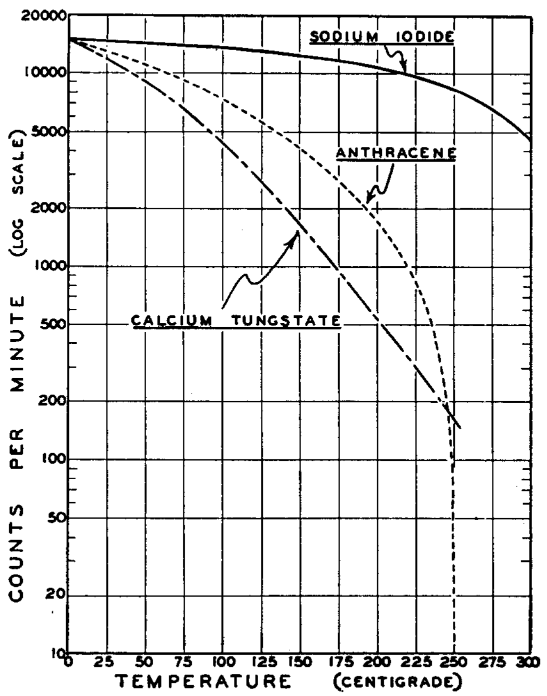

FIG. 1. Comparison of the counting rates as functions of temperature of typical sodium, iodide, anthracene, and calcium tungstate crystals.

tion crystal was fastened on the end of a nine-inch amorphous quartz rod which served as a light conducting medium. The crystal was heated with wires wound in magnesia, and the temperature was measured with a thermocouple adjacent to the crystal. A 0.1-millicurie radium source was used. The source was placed directly below and about $1\frac{1}{2}$ inches from the crystal. The circuit was used as a modification of that published by Sherr.[6] An atomic instrument amplifier (204-B) and preamp. (205-B) were used, with an amplifier setting of 8. By using dual sources at various conditions it was found that there was no appreciable coincidence loss at either room or elevated temperature. The curves were run several times at different rates to insure that

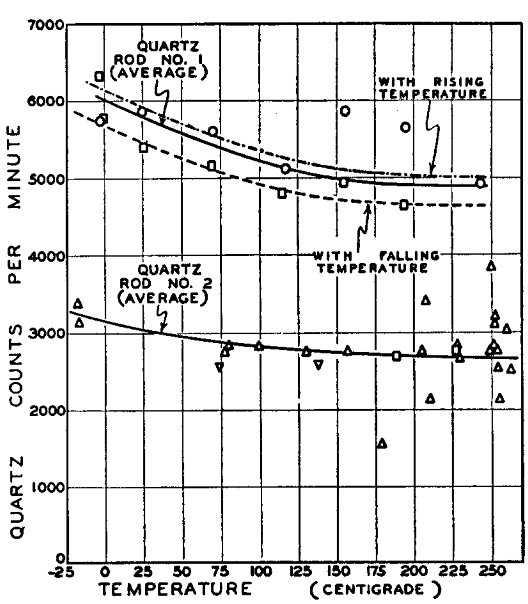

FIG. 2. Counting rates of two quartz rods as a function of the temperature at end of rod.

thermal equilibrium had been obtained. In the case of the sodium iodide and calcium tungstate, and for the anthracene when not heated above the melting point, the curves obtained on heating and on cooling were identical. Of course, after melting, the anthracene crystals were entirely changed.

It can be seen that the sodium iodide has, by far, the flattest temperature profile. This is an important consideration for tracer work at high temperatures.

It was necessary to obtain and zero out the counts from the quartz rod. Typical curves are shown in Fig. 2. The quartz showed a noticeable hysteresis effect. An x-ray photograph of the quartz proved that it was definitely amorphous. It should be kept in mind that the rod was subjected to a temperature gradient at all times, and that at the high temperatures the gradient was largest. This may account for the flat temperature profile.

A further investigation indicated that amorphous or crystalline quartz will count energetic beta-particles such as P^{32}, but is totally ineffective for C^{14}. The time constant of the quartz is also very poor.

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Energy Doubling in dc Accelerators

LUIS W. ALVAREZ
Department of Physics, Radiation Laboratory, University of California, Berkeley, California
(Received May 4, 1951)

It is generally believed that charged particles cannot be accelerated from ground potential to ground potential unless they pass through a system which has associated with it a time varying magnetic field. Dc electric fields must satisfy the equation $\oint E ds=0$, while the time varying fields used in radiofrequency accelerators and betatrons are freed from this restriction of scalar potential theory. In 1932, A. J. Dempster[1] produced protons with an energy of 45 kev, by passing them from an electrode at +22.5 kv dc to ground. The protons were first accelerated to ground potential, with an energy gain of 22.5 kev. A small fraction of the protons then picked up an electron from a residual gas molecule, and "coasted" to a second electrode at +22.5 kv. Then a small fraction of these neutral hydrogen atoms lost their electrons, and were accelerated to ground with a second gain in energy equal to 22.5 kev. An accelerator of this type is obviously impractical for several reasons. The probability of neutralizing a proton varies inversely with a high power of the particle velocity, so the scheme would not work at energies of interest to nuclear physicists. Even at the low energies where neutralization is not negligible, the energy spread of the beam would be wide because charge exchange could take place at all points along the beam trajectory.

It does appear, however, that charge variation can be utilized in a practical manner to circumvent the apparent restrictions of potential theory. If one accelerates negative hydrogen ions (H^- or D^-) to an electrode at $+V$ volts, strips off the two electrons by a thin foil at that point, and accelerates the protons or deuterons to ground potential, he will have doubled the effective voltage of the accelerator. The stripping foil can be of thin collodion, for example, so the energy loss and scattering would be negligible. The stripping cross sections are of order 10^{-16} cm^2, so a foil with 10^{16} atoms per cm^2 will strip more than one-half of the beam. Such a foil weighs less than 1 microgram per cm^2. Therefore any physically realizable foil will give good stripping; its thickness can be so small as to give no appreciable straggling or scattering. (The energy loss can be a few hundred electron volts.)

An accelerator of this type is now being designed to give 4-Mev protons. It is to be constructed by L. C. Marshall and J. Woodyard