Letters to the Editor

Further Confirmation of the Montgomery Theory of Counter Discharge

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THE Montgomery theory[1] of counter discharge makes it possible to predict the dependence of pulse size (maximum negative potential change of the counter wire) upon wire capacity and counter length under conditions where it is safe to assume that the discharge starts simultaneously at all points in the tube. The picture is particularly interesting if, as we vary counter length and wire capacity, the discharge passes from what has been termed a "slow" breakdown to a "fast" breakdown (for non-self-quenching gas mixtures). It follows from the discharge mechanism that for a given cylinder potential and wire capacity there is a length l_e such that for all $l \leqslant l_e$ the pulse size is constant and equal to the over-voltage on the counter. For values of $l > l_e$, $V = l\alpha/C$, where α is the charge per unit length in the positive ion sheath necessary to quench the discharge at the assigned cylinder potential. For $l < l_e$ the counter is breaking multiply in each discharge and the succession of these multiple breaks produces what has been called a slow breakdown. For $l > l_e$ the counter is "overshooting." Here there is only one break in the discharge and the counter has been referred to as having a fast breakdown.

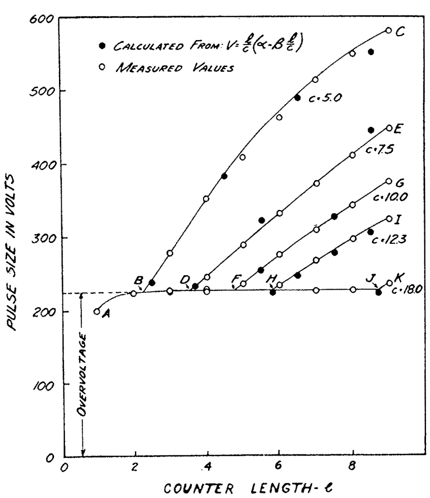

FIG. 1.

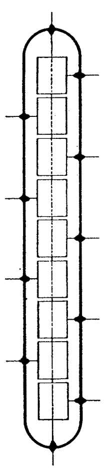

FIG. 2.

FIG. 1. Maximum potential change of counter wire and its variation with counter length for a series of wire capacities. C expressed in farads in the empirical expression, $\alpha = 5.2 \times 10^{-10}$, $\beta = 1.2 \times 10^{-22}$. Low value of A due to end effect in short counter.

FIG. 2. Counter cylinder composed of nine separately insulated segments. The number of segments above (here 225 volts above) starting potential defines the effective counter length, other segments being at a value below the starting potential. Thus by changing the potential of the segments the effective counter length may be changed *without altering capacity of the wire system.* Capacity changes were made by adding condensers between wire and ground. Voltage swing measured using a weakly coupled electrometer tube and grounding counter wire with key after each discharge. Counter filled with 9 cm argon-oxygen mixture.

If the discharge does not start at all points in the tube within a short time interval (10^{-7} second) after it has started at one point, the linear charge density will not be constant over the counter length and the picture, although unaltered in form, is modified somewhat in detail to allow for the finite time required for the discharge to propagate itself from one point to another. Simple considerations combined with direct observations on the time variation of counter wire potential[2] indicate that this time of propagation is only important in modifying the picture for small C and large l.

Figure 1 is a family of curves showing the variation of pulse size with l for a series of values of C. Here great care was taken in the experimental procedure to obtain low values of C, *variation of l without altering C*, and a true value of the maximum negative voltage when no charge is allowed to leak from the counter wire. Refer to Fig. 2 and its caption for a description of the procedure.

In Fig. 1, ABC is the characteristic for $C = 5.0\mu\mu$f, ADE for the wire capacity C equal to $7.5\mu\mu$f, AFG for $C = 10.0\mu\mu$f, and so on. Examination of this family reveals that the lengths AB, AD, AF, AH, AJ (values of l_e) are proportional to C. The family may be represented satisfactorily by the relation $V = \text{Constant} = \text{over-voltage}$ for values of $l \leqslant l_e$ and $V = (l/C)[\alpha - \beta(l/C)]$ for values of $l \geqslant l_e$. Here α is the constant charge per unit length referred to above and experimentally obtained for small l and large C. Thus to a first approximation propagation time reduces the average charge per unit length by an amount proportional to l/C.

The experimental picture obtained agrees with the picture presented by the theory, altered only to allow for propagation times of the order of 10^{-7} second. The authors have been unable to reconcile the results obtained with any picture of the discharge differing materially from that presented by this theory.

[1] C. G. Montgomery and D. D. Montgomery, Phys. Rev. **57**, 1030 (1940).
[2] W. E. Ramsey, Phys. Rev. **57**, 1022 (1940).

New Reactions in Nickel

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KONOPINSKI has shown[1] that the half-lives of many radioactive nuclei show certain regularities when expressed as functions of their atomic numbers. These regularities occur in families of nuclei that differ only in the number of alpha-particle units that they contain. If the logarithm of the period is plotted against the atomic number for a given family, the resulting curves may be interpolated to make predictions about unknown and uncertain members of the family.

Curves of the families containing radioactive isotopes of nickel are drawn in Fig. 1. According to the predictions of these curves, Ni^{57} should have a half-life of about 2 minutes and Ni^{59} a half-life of about 36 hours. A period of 36 hours