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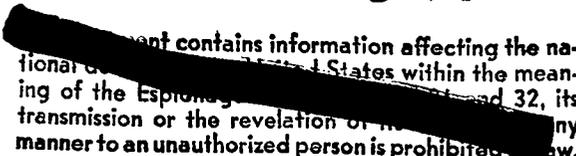# THE MULTIPLE-WIRE PROPORTIONAL COUNTER

(THE M. W. COUNTER)

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ABSTRACT

A multiple-wire counter, consisting of a grid of fine wires mounted between plane screens, has been operated as a shallow plane proportional counter. Preliminary results on the characteristics of this detector with argon - CO_2 fillings are given.

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THE MULTIPLE-WIRE PROPORTIONAL COUNTER

(THE M. W. COUNTER)

I. Introduction

A shallow multiple-wire (M. W.) proportional counter has been
constructed and briefly investigated, with the end in view of using such a
detector for counting recoil protons in certain fast neutron experiments.

An element of a M. W. counter is shown schematically in Fig. 1.
A grid of fine wires (Fig. 1, w) is mounted rigidly between two screens
(Fig. 1, s_1 and s_2) of high transparency. The wires are connected to the
grid of the first tube and the screens are connected to a negative voltage
supply. An ionizing particle (Fig. 1, p) entering the counter element
creates a number of ion pairs between the two screens. The electrons are
swept to the wires, and gas multiplication occurs as in the conventional
cylindrical proportional counter [1] [2].

The uniformity of response to ionization in different parts of
the counter will be influenced by the same factors which determine the
uniformity of response of the conventional cylindrical proportional counter:

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1) Rose, M. E. and Korff, S. A.   Phys. Rev., 59, 850 (1941).

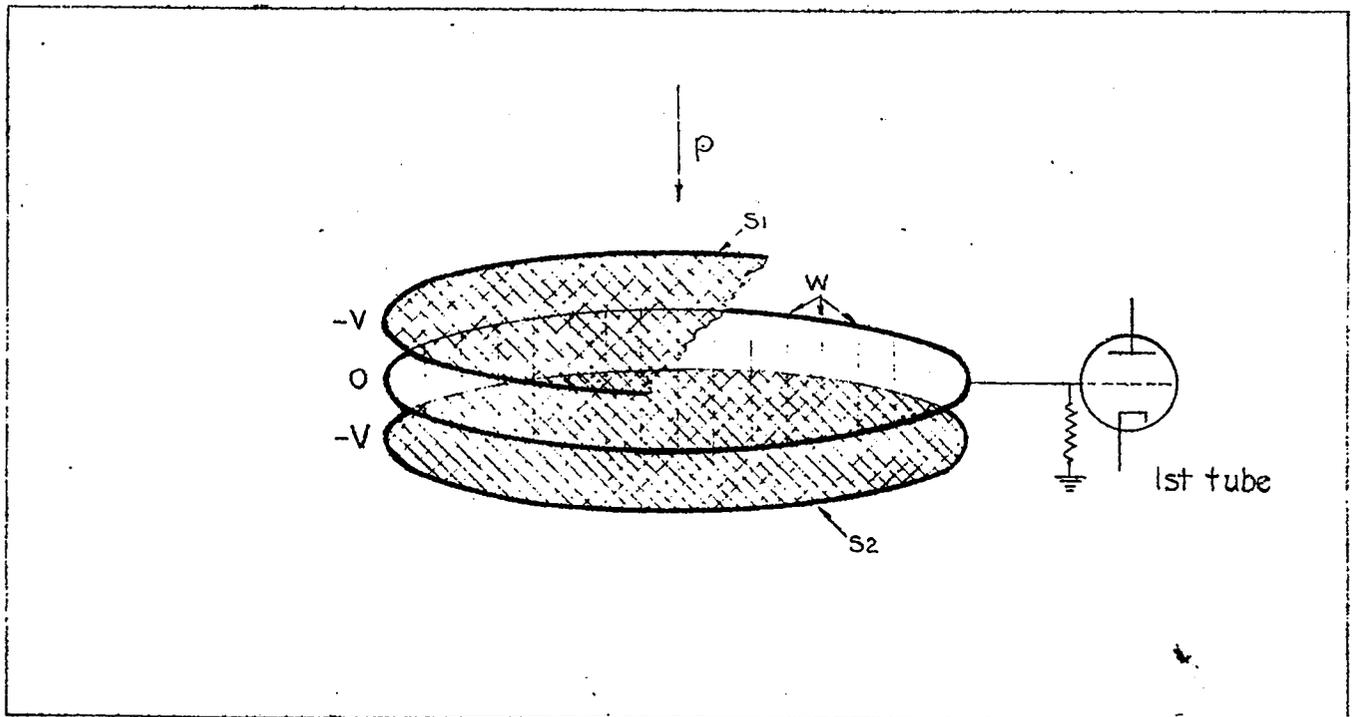2) Korff, S. A.   Rev. Mod. Phys., 14, 1 (1942).

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FIGURE   1

THE MULTIPLE WIRE PROPORTIONAL COUNTER

namely: 1) Electron attachment; 2) Cylindrical symmetry of field about
wires; 3) Collection time of initial electrons; and, 4) End effects.
Proliminary tests of the overall effect of these factors have been conducted
with a particular amplifier.

II. Apparatus

A. The Counter

A working drawing of the counter used is given in Fig. 2. The
wires and screens are mounted on invar rings and stretched tight by
differential thermal contraction. There are two counter elements, with a
common screen, so that the reaction of one element on another can be in-
vestigated.

A collimated beam of α-particles (from polonium) can be directed
into the counter through either of two sets of collimating holes (Fig. 2, A
and B) of 0.026 inch diameter, 0.5 inch length, and of 2mm separation. The
holes normal to the plane of the counter are drilled on a line making an
angle of 31.5° with the direction of the wires, so that five positions of
the beam may be obtained between two wires.

B. The Amplifier

An RC coupled linear amplifier of conventional design was used to
amplify the α-pulses. The shortest time constant was 100 microseconds.

III. Experimental Results

As the M. W. counter was intended to count proton recoils from a
paraffin radiator, the gas used throughout the investigation was argon.
It is well known that it is difficult or impossible to operate a propor-
tional counter at high gas amplification with very pure argon. It has

Gun-B.

Revolve this plate so
that line of holes is 58°-30'
from vertical

⅛"-Hoke stainless
steel valve-pumpout

.0055"-Nickel wire - 5.5mm. apart.

5 mm

kovar seals

Lucite insulation

Gun-A.

TWO GRIDS-INVAR RING

.003"-Wire - 32 mesh sreen

THREE SCREENS-INVAR RING

2 ¼"

5/100"

1/32"

FIG.-2.

MULTIPLE WIRE COUNTER
SCALE — FULL SIZE
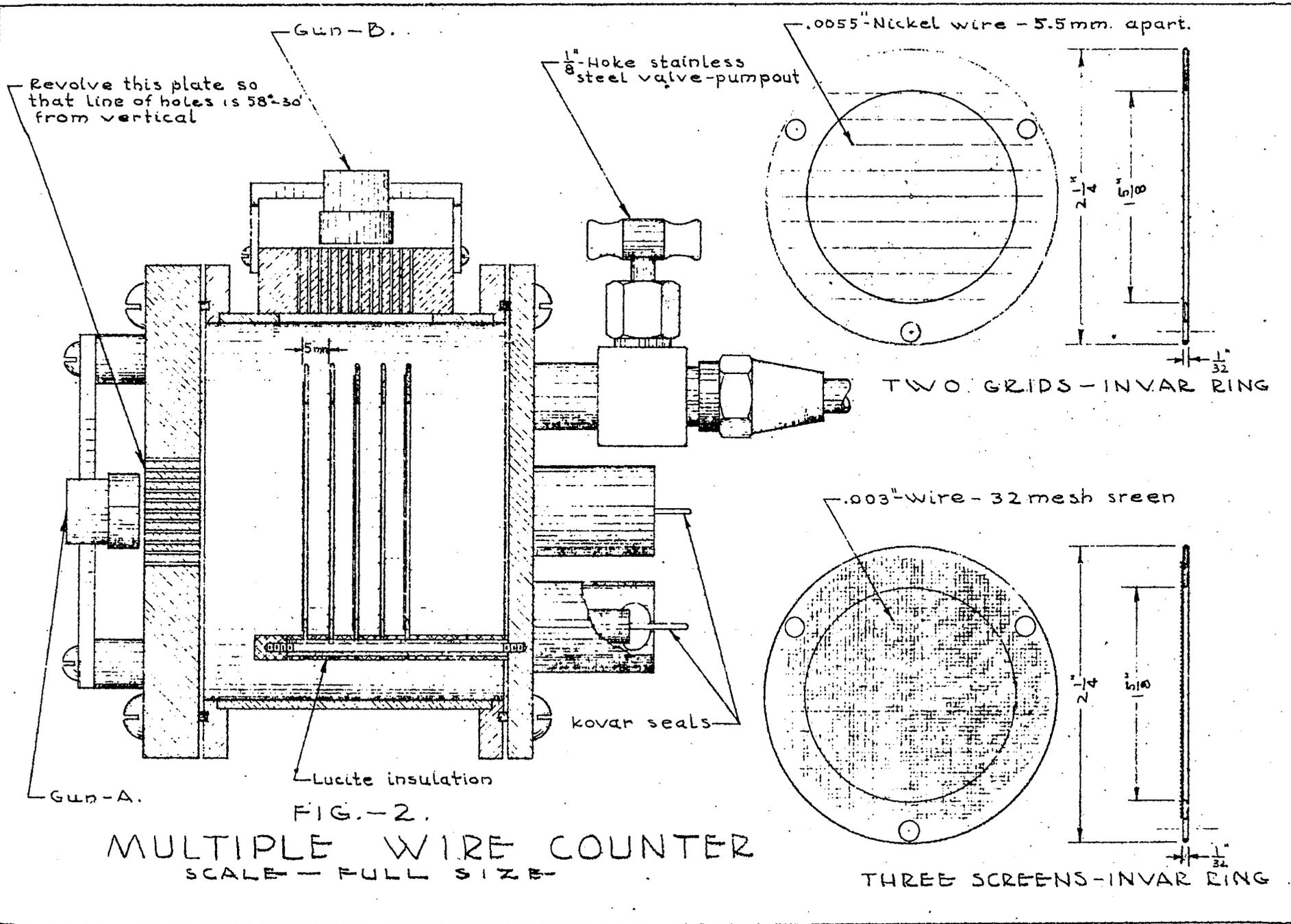
been found in this laboratory that the addition of a few per cent of CO_2 to ordinary tank argon (99.6% purity) makes the operation of an argon-filled counter quite practical. CO_2 is used since it is a good quenching gas, does not attach electrons[3], and neither carbon nor oxygen have known neutron-induced reactions up to several Mev. Argon 97% - CO_2 3% mixtures were used throughout the present investigation.

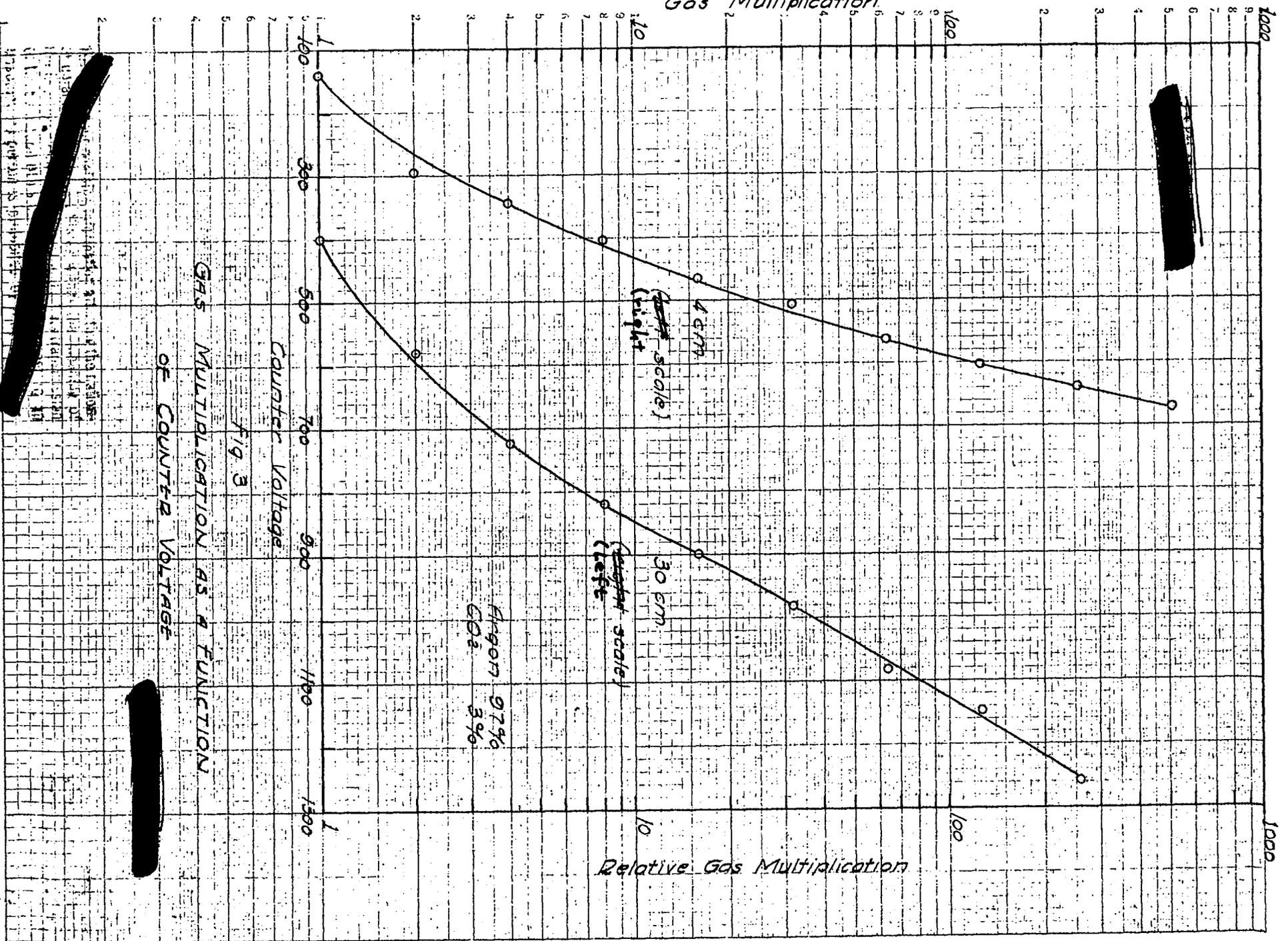A. Gas Multiplication as a Function of Counter Voltage

The gas amplification as a function of counter voltage has been measured at total pressures of 4 cm. and 29 cm. The results are presented in Fig. 3. At 29 cm. pressure, the measurements were made by comparison of pulse height with and without gas amplification. At 4 cm. pressure, the energy loss in the counter was too small to permit observation of ionization pulses, so that the gas amplification is plotted on an arbitrary scale.

B. Variation of Pulse Height with Position of Ionizing Particle

1. Transverse Experiment

When a collimated beam of α-particles was shot through the counter normal to the plane of the elements (i.e. through Fig. 2, A), the average pulse height was found to vary continuously from wire to wire, as the source was moved from hole to hole. The pulse height reached a maximum when the α-particles passed near a wire and a minimum when the α-particles passed midway between wires. The curves of Fig. 4 are preliminary bias
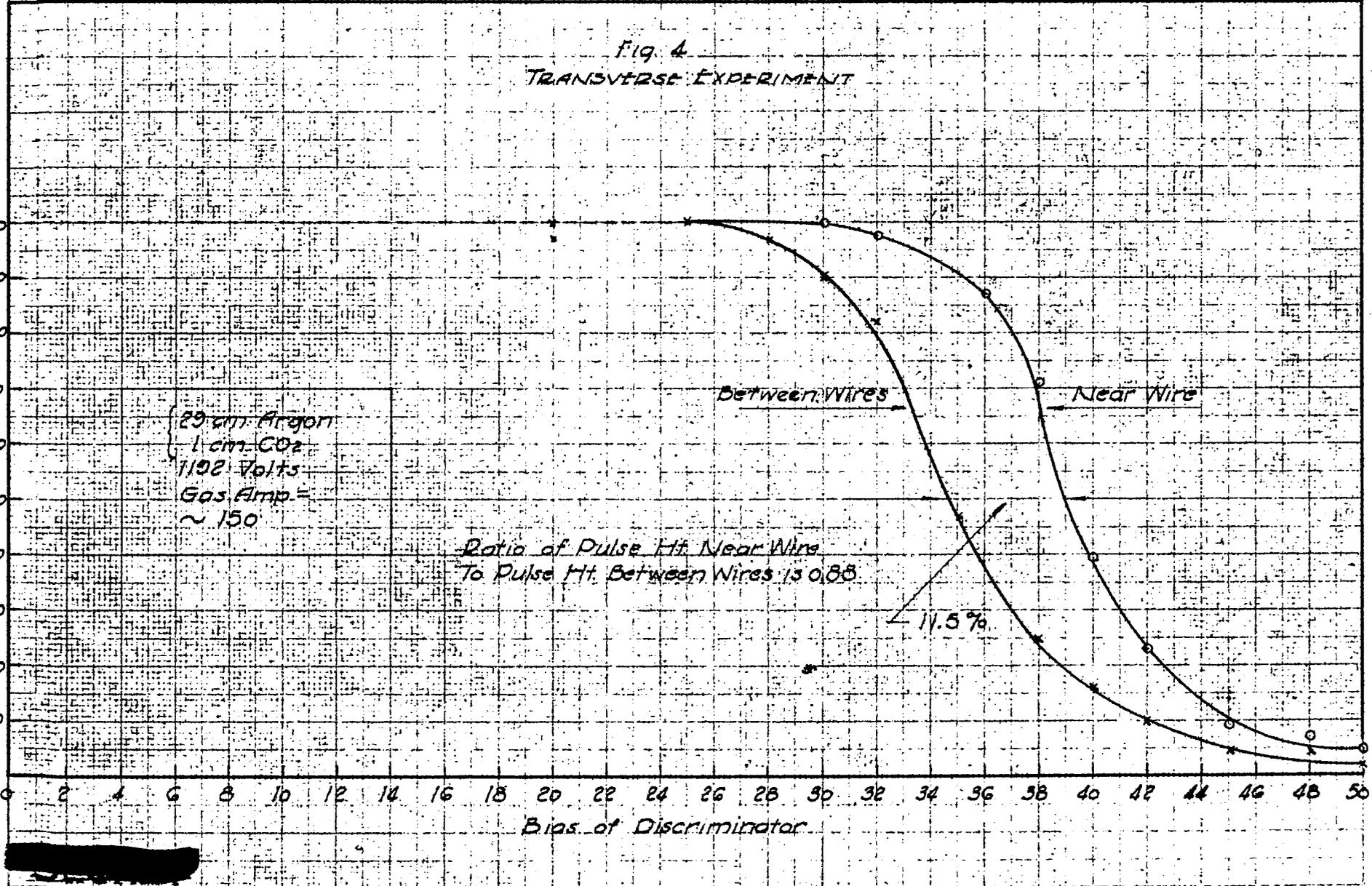
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3) Healey, R. H. and Reed, J. W. "The Behavior of Slow Electrons in Gases", (The Wireless Press for Amalgamated Wireless, Sydney. 1941) p. 85

Gas Multiplication

1000

Gas Multiplication

Relative Gas Multiplication

4 cm
(upper scale)
(right)

30 cm
(lower scale)
(left)

Argon 97%
CO_2
3%

GAS MULTIPLICATION AS A FUNCTION OF COUNTER VOLTAGE

Counter Voltage

fig. 3

Fig. 4
TRANSVERSE EXPERIMENT

Relative Separation

Between Wires   Near Wire

29 cm Argon
1 cm CO₂
1192 Volts
Gas Amp =
~ 150

Ratio of Pulse Ht. Near Wire
To Pulse Ht. Between Wires is 0.88

11.5 %

Bias of Discriminator

curves corresponding to the maximum and minimum pulse height. The total
amplitude of the variation is seen to be about 11% of the average pulse
height. It should be emphasized that this is a preliminary result and that
the variation is undoubtedly a function of all the counter parameters.
The curves of Fig. 4 were taken under a very particular set of conditions.

2. Longitudinal Experiment

In connection with coincidence counting methods, it is of
interest to investigate whether a pulse in one element of the counter
produces a pulse in an adjoining element. This question was investigated
by shooting α-particles into the counter parallel to the plane of the
elements (i.e. through Fig. 2, B). With 30 cm. of argon, 0.9 cm. of CO_2,
and 1192 volts on the counter (giving a multiplication of about 150), it
was possible to set a lower limit of 500 for the ratio of a genuine pulse
to the corresponding induced pulse appearing simultaneously in the adja-
cent element. The boundary of the "active volume" was found to be sharply
defined by the screen (cf. ratio above) to the extent that it could be
investigated with collimating holes 2 mm apart. No investigation was made
of edge effects at the invar rings.

C. Statistical Spread in Pulse Heights

Differentiation of the curves of Fig. 4 gives a half-width
of 13% of the average pulse height. This is an upper limit for the width
of the statistical distribution in pulse height. No attempt at evaluation
of the true width will be made since 1) non-uniformity of the mica-windows;
2) dirt on the mica windows; and, 3) finite thickness of the polonium

source contribute an unknown fraction of the observed width.

IV. Conclusions

1) A M. W. counter can be used for counting the number of ionizing particles traversing it.

2) Since the counter can be made very shallow and since gas multiplication can be used, it is especially suitable for range measurements at low energies and for range measurements at high energies but low intensity.

3) The counter is suited to coincidence methods due to the absence of appreciable pickup from adjoining units.

4) Further investigation is required before it can be said that the M. W. counter is suitable for pulse height methods.
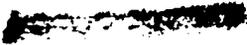
5) Although tests have not been carried out, it seems very likely that the M. W. counter can be used as a Geiger-Muller counter.

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