June 28, 1949. W. R. BAKER 2,474,773

RADIATION DETECTOR

Filed Nov. 6, 1947

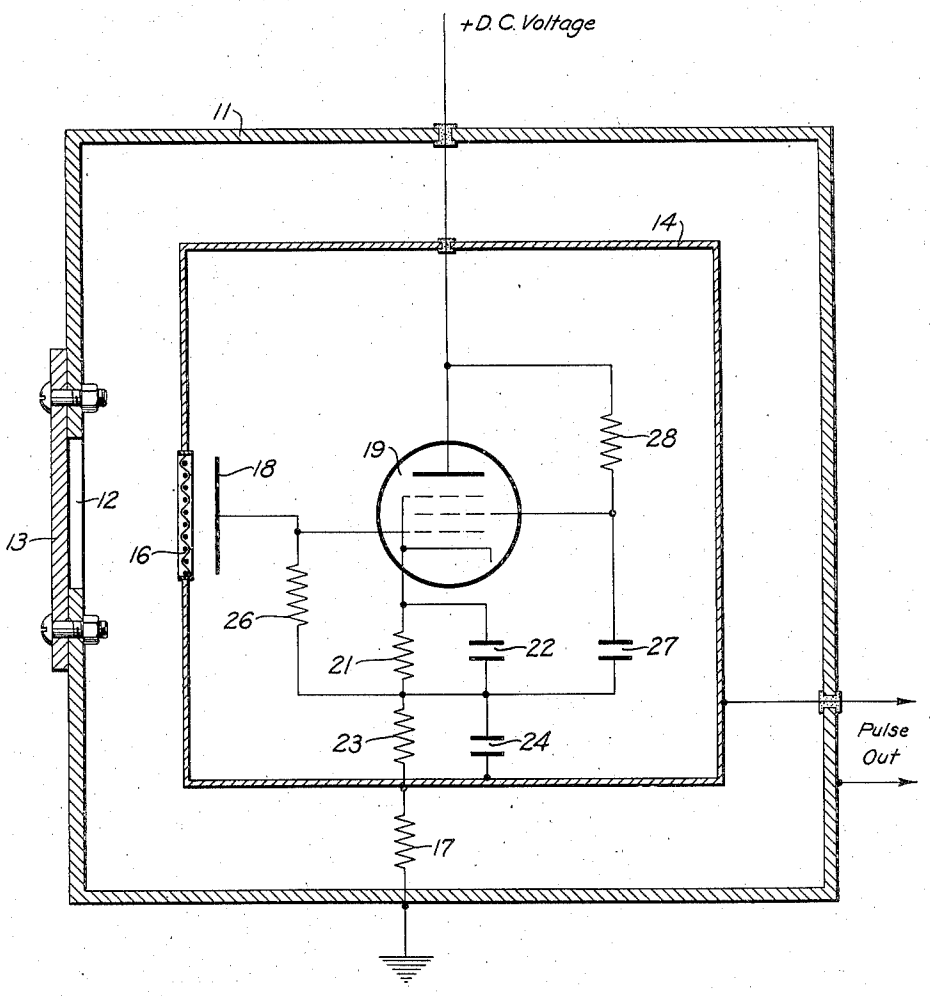

Fig. 1

INVENTOR.
WILLIAM R. BAKER
BY
Robert A. Lavender
ATTORNEY

Patented June 28, 1949

2,474,773

UNITED STATES PATENT OFFICE

2,474,773

RADIATION DETECTOR

William R. Baker, Berkeley, Calif., assignor to the United States of America as represented by the United States Atomic Energy Commission

Application November 6, 1947, Serial No. 784,356

3 Claims. (Cl. 250—83.6)

1

This invention relates to a circuit network and more particularly to an amplifier circuit network.

It is proposed by this invention to provide a cathode follower type preamplifier tube with a very high effective input impedance and a relatively low time constant. It has been found that this type circuit is extremely useful in combination with an ionization chamber for the detection of radiation.

Therefore, an object of this invention is to provide a new and improved amplifier network.

Another object of this invention is to provide an amplifier network having a very high effective input impedance and a relatively low time constant.

A further object is to provide an ionization chamber in combination with an amplifier network for radiation detection.

Other objects and advantages of the invention will be apparent in the following description and claims considered together with the accompanying drawing in which:

Figure 1 is a schematic wiring diagram embodying the invention and is the sole figure thereof.

Referring to Fig. 1 in detail, the numeral 11 indicates a grounded shield generally of cylindrical shape defining a chamber which is substantially free of electrostatic fields and which is provided with an aperture 12 and a cooperating cover plate 13 for the aperture 12. A second chamber 14 is centrally disposed within the chamber 11 and is provided with a grid faced aperture 16 which is in alignment with the aperture 12. The two chambers 11 and 14 are electrically connected by means of a high value resistor 17. A collector plate 18 is positioned within the chamber 14 parallel to the grid aperture 16 and in alignment therewith. The collector plate 18 is connected to the control grid of a pentode tube 19 which is disposed within the chamber 14 as is its associated network. The cathode of this tube 19 is electrically connected through a cathode bias resistor 21 which is shunted by a condenser 22 and a resistor 23 which is shunted by a condenser 24 to one wall of the chamber 14. The junction point of the resistors 21 and 23 is connected through a high value grid resistor 26 to the control grid of the tube 19. An internal connection is made between the suppressor grid and the cathode of the tube 19, whereas the screen grid is connected through a condenser 27 having a large capacitance to the junction point between the resistors 21 and 23. A further connection is made from the screen grid to the plate of the

2

tube 19 through a screen grid resistor 28. The plate of the tube 19 is connected to the positive terminal of a suitable voltage supply, the negative terminal of which is grounded. The output voltage is taken across the resistor 17 or between the two chambers 11 and 14.

By the arrangement of the circuit elements, the effective input impedance of the amplifier may be expressed as being equal to $R_g(1-R_kG_m)$, where R_g is the value of the resistor 26, R_k is the value of the resistor 17, and G_m is the value of the transconductance of the tube 19. Thus, if a tube is chosen which has a value of transconductance of about 5000 micromhos, if the resistor 26 has a value of about 100 megohms, and if the resistor 17 has a value of about 10 megohms, it is seen that an effective input impedance of about 5 million megohms is attained. Also, the input time constant of the amplifier circuit may be expressed in terms of the circuit elements; that is, the input time constant may be expressed as the product of the value of the resistance 26 and the input capacitance of the tube 19. The input capacitance of the tube 19 is reduced by the large capacitive coupling condenser 27 between the screen grid and the cathode which substantially follows the control grid. Likewise, the input capacitance of the tube 19 is reduced by connecting the aperture grid 16 to the cathode of the tube through the condensers 22 and 24.

In operation, a radioactive sample is placed on the cover plate 13 and exposed to the interior of the chamber 11. The charged particles accelerated through the grid aperture 16 to the collector plate 18, produce a voltage drop across the resistor 26 which results in an output voltage substantially equal to the product of the input current and the effective input impedance. The current as well as the duration of the pulse may be determined by the field between collector plate 18, the grid aperture 16 and the walls of the chamber 11, by the energy and the type of particle emitted by the radioactive sample, and by the type of gas filling the ionization chamber. The duration of the pulse may also be determined by the input time constant of the amplifier circuit.

While the salient features of this invention have been described in detail with respect to one embodiment, it will, of course, be apparent that numerous modifications may be made within the spirit and scope of this invention and therefore it is not desired to limit the invention to the exact details shown except in so far as they may be defined in the following claims.

What is claimed is:

1. In a radiation detector, the combination comprising a first chamber having a port formed therein, a cover for said port adapted to support radioactive material and to be sealed over said port, a second chamber disposed within said first chamber having a grid portion aligned with said port, a collector plate disposed within said second chamber and aligned with said grid and port, electrical means connected to said first and second chambers and said collector plate for maintaining said second chamber at a positive potential with respect to said first chamber and said collector plate at a positive potential with respect to said second chamber, and an amplifier disposed within said second chamber and connected between said second chamber and said collector plate for amplifying the charge collected by said collector plate.

2. In a radiation detector, the combination comprising a substantially cylindrical chamber having a port formed therein, a cover for said port adapted to support radioactive material on the inner surface thereof and to be sealed over said port, a second chamber centrally disposed within said cylindrical chamber having a grid portion aligned with said port, a collector plate disposed within said second chamber and aligned with said grid and port, an amplifier tube having at least anode, control grid, and cathode circuits disposed within said second chamber, said cathode circuit comprising a tapped first resistor and a second resistor, said first resistor being connected between said cathode and said second chamber and the tapped point connected to said control grid and said collector plate through a grid resistor, said second resistor connected between said cylindrical chamber and said second chamber, condenser means connected in parallel with said first resistor for by-passing varying voltages developed thereacross, and potential means connected between said anode circuit and said cylindrical chamber.

3. In a radiation detector of claim 1, said amplifier further characterized as a cathode follower having an input and an output circuit, said input circuit being connected to said collector plate, and said output circuit including the potential between said chambers.

WILLIAM R. BAKER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,200,055	Burnett	May 7, 1940
2,241,534	Blumlein et al.	May 13, 1941
2,275,747	Fearon	Mar. 10, 1942
2,288,718	Kallmann et al.	July 7, 1942