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POSITION-INDICATING PROPORTIONAL COUNTER

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ABSTRACT

A type of detector is proposed in which a very fine mesh wire array (20 wires per mm) is used as a proportional counter plane. The wires are led into the interior of a vacuum tube, and the identification of which wires have counted is obtained by using the charge provided by the proportional counter pulse to deflect either a scanning beam, provided by an auxiliary electron gun, or a slow secondary electron beam produced by the scanning beam.

It is desirable to detect the position of a particle as accurately as possible because the size and cost of the magnets used for a determination of momentum will become smaller. It is also desirable to have the position indicated by means of an electric signal so that the device can be used "on-line." Spark chambers using sonic detectors or using magnetostrictive sensing devices are examples of such detectors. Another example is the Charpak proportional counter, in which the signal is measured from each of a grid of fine wires, and which promises to give high resolution--especially if the time delay of the electrons can be measured. However, this device implies rather complicated and expensive electronics even if we assume remarkable developments in "chip" circuits. The present suggestion is a proportional counter in which the resolution results from using many fine wires placed close together. The wires are then scanned to see which wires has sensed the nearby passage of a particle.

As one form that the counter might take let us imagine a long gas-filled cylindrical tube, one or two inches in diameter, which contains a grid of many fine wires, let's say 0.01 mm in diameter that are 0.05 mm apart (see Fig. 1). These wires will run parallel to the axis of the tube and will be in a plane midway between two long parallel electrodes that are about 1 mm apart. A positive voltage is placed on the grid to make a conventional proportional counter.

The wires are to pass through a semiconducting glass insulator at one end of the tube into a vacuum region where the scanning will take place. As a particle passes near a wire, the ionization electrons will be multiplied and a negative potential from several to several-hundred volts should appear on the wire, depending on the multiplication, and it is this potential that must be sensed before the signal decays away because of the conductivity of the insulator.

There is probably a clever method of scanning the wires by means of a gaseous discharge , which steps successively from wire to wire in the manner of a Nixie-tube, that might reveal the wire with a potential in it. Or again, perhaps a sound wave could be induced in a quartz rod or fiber, the detection of which would reveal the position of the wire in a manner analogous to a magnetostrictive wire chamber. Not knowing enough about how these work, I will consider instead a scanner that would utilize an electron beam. One can imagine that the electron beam could be swept uniformly past the end of each wire so that the wire with a signal potential would deflect the beam ever so slightly onto a special target wire, thus revealing the position of the charged wire by the timing of the output signal. Reference signals could be imposed by deliberately biasing some of the wires.

Another method would use secondary electrons produced by the scanning beam of electrons. In this method. shown in Fig. 1, the electron beam would be focused so that it would impinge on a plate located as close to the wires as possible. On the other side of the wire grid, another plate would be located and would be biased positively so that it would act as a collection plate for the secondaries. In a sense the three electrodes, i.e., emitter electrode, grid and collector plate would constitute an extended triode. A fine spot of emission of secondary electrons is carried along the emitter electrode so that it passes each wire of the grid. Normally the emitter electrode and the collector electrode will be biased so that some of the electrons will be collected on the collector plate. The wires will serve as a conventional grid. In general there will be a dc current of secondaries to the plate except when the scanning beam passes a wire with a negative potential, at which time the current will be interrupted and a positive signal will appear on the collection plate. Fiducial marks can be made to appear by biasing some of the wires. Perhaps the wires of the grid will cause a modulation of the current which will automatically calibrate the position measurement.

The speed of scanning will depend on the current in the electron beam and the amplification used to detect the signal on the collection electrode. The scanning process can be initiated, for example, by a thin scintillation counter placed in front of the proportional counter.

It may be necessary to have a pressure of about 10 atmospheres in the proportional counter part of the tube in order to get enough ions for efficient detection and an adequately large signal. It would also be easy to have a sandwich of two proportional counters within one tube that could be scanned by a common device at the end of the tube. This would allow one to correct for a particle that does not strike the grid in an exactly perpendicular direction. It would also allow for some redundancy in detecting a particle.

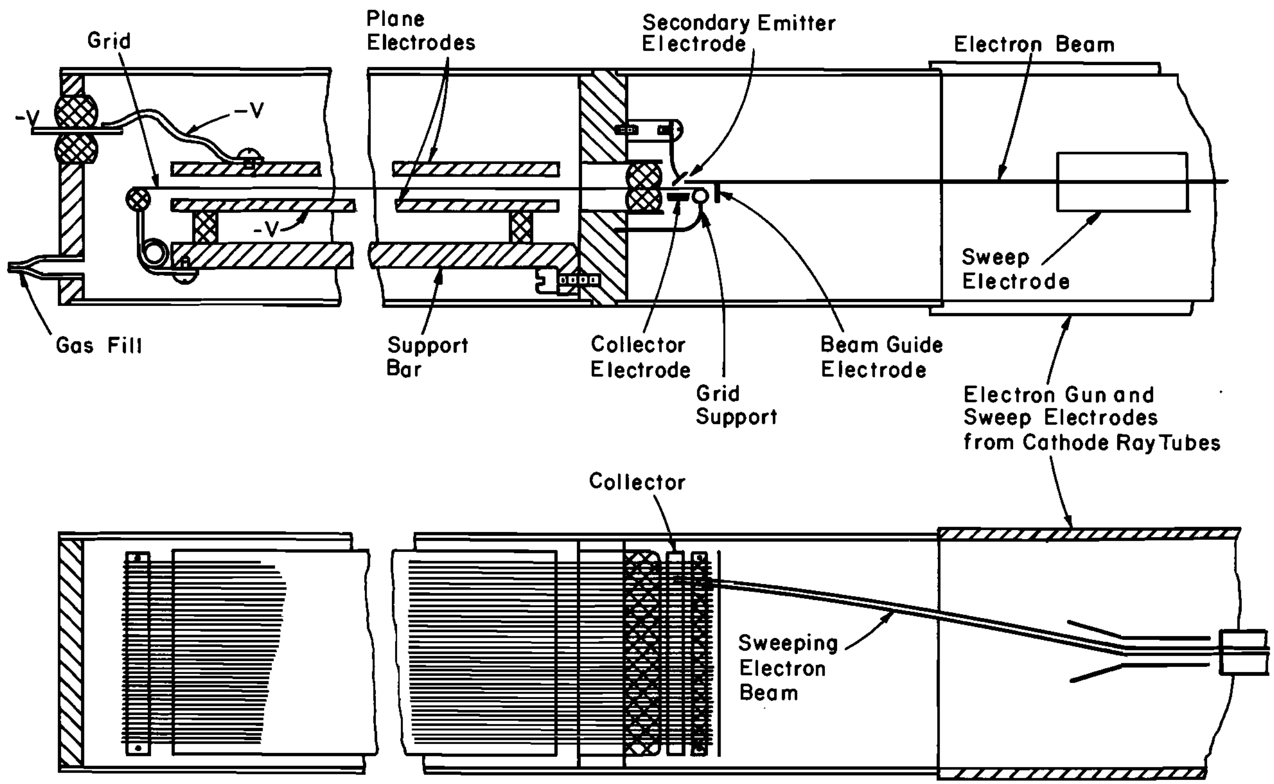

Fig. 1. Position-determining proportional counter array, with scanning electron-beam readout.