A FAST GAP LENGTH MEASURING SYSTEM*

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(Presented by M. DEUTSCHMANN)

Ionisation measurements on bubble chamber tracks are usually done by the mean gap length method. Based on this method an instrument is described here which automatically measures gap length's at variable speed along the track. The measured quantities are recorded on punched tape which subsequently is transferred to a computer giving the desired ionisation result.

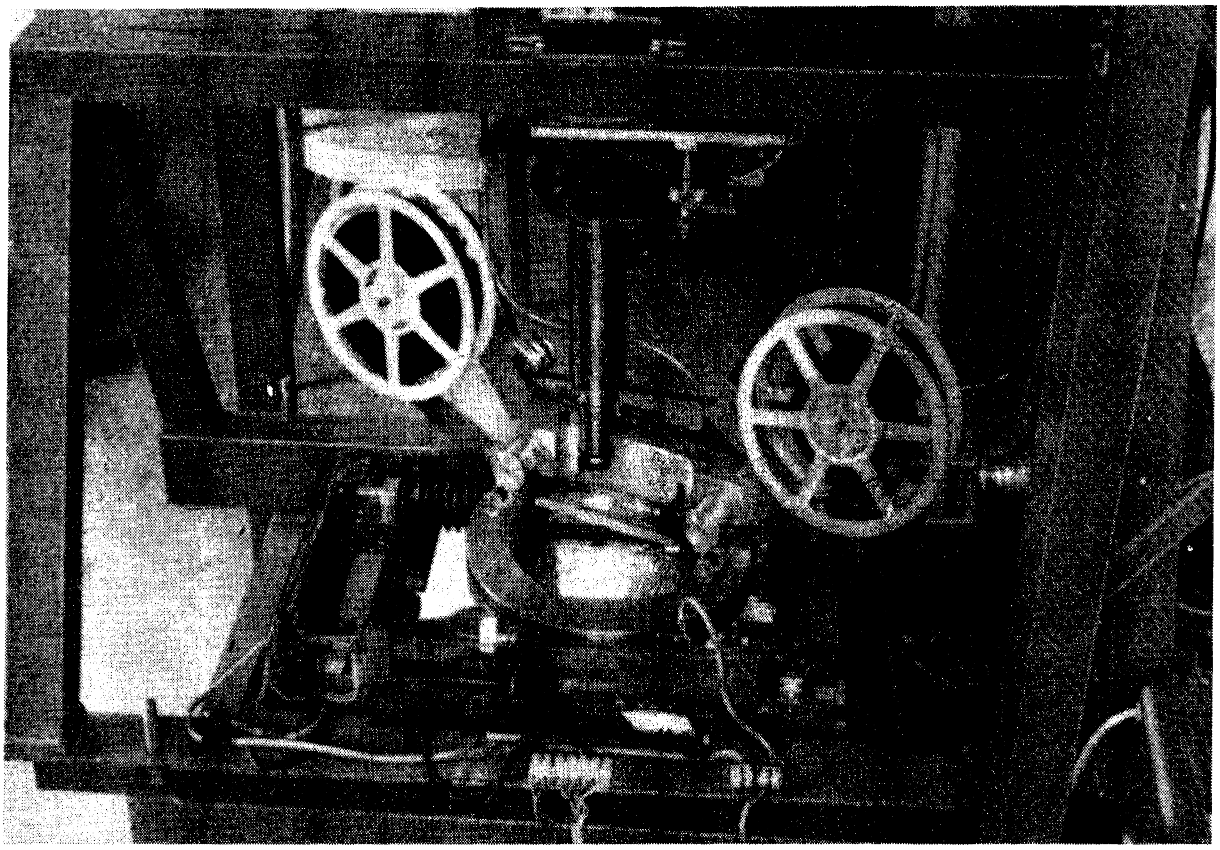

Fig. 1. A photograph of the film stage.

THE PROJECTOR

The film is mounted on a stage free to move in horizontal x and y directions (Fig. 1). An additional turn-table allows a rotation of the film about a vertical axis in a way that the track to be measured can be brought in parallel to the y axis, i. e. to the axis of measurement. Movements along this axis are read out in steps of 2.5 μ by means of a linear optical digitizer *. No measurements are done along the x axis. Only correcting movements in this direction are needed to cope with a possible slight misalignment and with the small curvature of the track **. The image of the film is projected on to a horizontal table (Fig. 2) at 80 times magnification. In the plane of this table a photosensitive unit is mounted having an entrance slit 12 mm long (in x direction) and 1 mm wide (in y direction). The image of a track being centered onto

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* Type LID by Heidenhain Traunstein, FRG.

* In general ionization measurements are requested only for tracks having particle momenta larger than $\sim$ 0.6 GeV/c. Consequently the curvature is small enough to be of no practical influence on the accuracy of our measurement along the straight line.

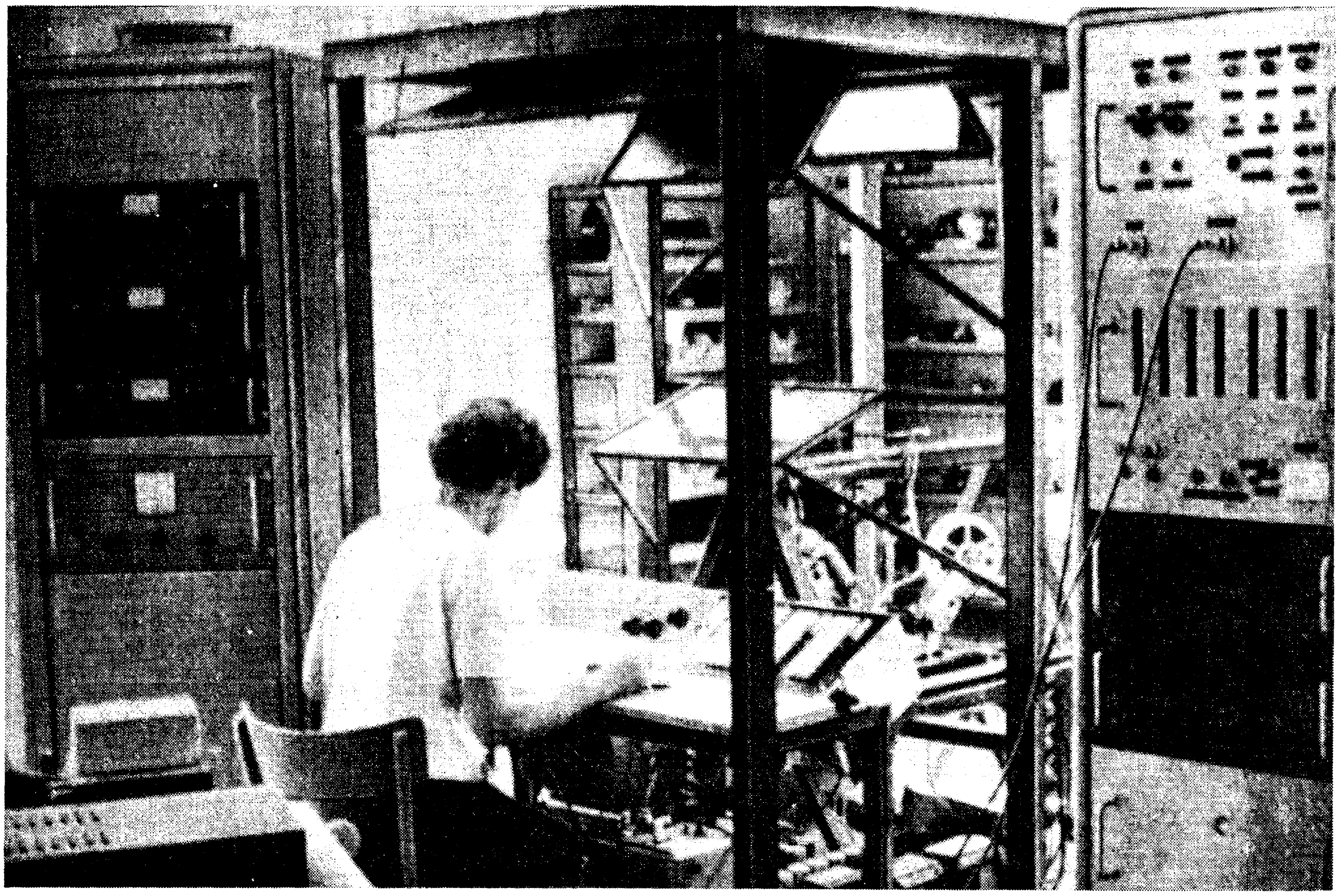

Fig. 2. An overall view of the measuring system. The scaler and logic units on the right hand rack, the power supplies on the left hand side and the tape punch in the foregound.

this slit is scanned along the slit 1000 times per sec. by means of rotating disc having 20 radial slits 1 mm wide. The horizontal distance between the axis of the disc and the fixed slit is adjusted in such a way that, in the absence of a bubble image, the transmitted light intensity is nearly constant in time. A ten stage photomultiplier receives this light. Upon arrival of a bubble image on the slit short periodic pulses several tenth of a volt high, are producted at the anode of the multiplier.

THE LOGIC UNITS

The way the information passes through the different electronic units can be seen from the block diagram, Fig. 3. The counting pulses from the digitizer enter an input stage from which they are sent to two sets A and B of decadic counters *. Counter A recordes the total measured length of the track. This information is transferred to the tape punch only once at the end of a measurement. Counter B on the other hand, consisting of two decades, measures each individual gap length. For this purpose the counting pulses have to be transmitted through a gate unit containig an integrator which receives the periodic pulses of the photomultiplier. As long as these latter pulses arrive, due to the presence of a bubble on the slit, no digitizer pulses are transmitted to B. As soon as however a gap begins the integrator ceases to produce a blocking voltage. Consequently counter B starts running with the speed of the y axis movement. The arrival of the next bubble stops B, initiates the read out of the counter position into the buffer store and transfers this figure to the tape punch. In the meantime counter B is reset to zero position. 1.5 ms are needed between the arrival of the bubble and the counter reset. The fast tape punch * recordes one gap-length (inclu-

* Bondar I. L. Nucl. Instrum. and Meth., **24**, 280 (1963).

* Type PE 1500 of Facit (maximum speed 150 characters/sec.).

ding end characters) within 26 ms. Thus up to ~35 gaps/sec can be measured.

to press a switch in order not to record the ambiguous part of the track.

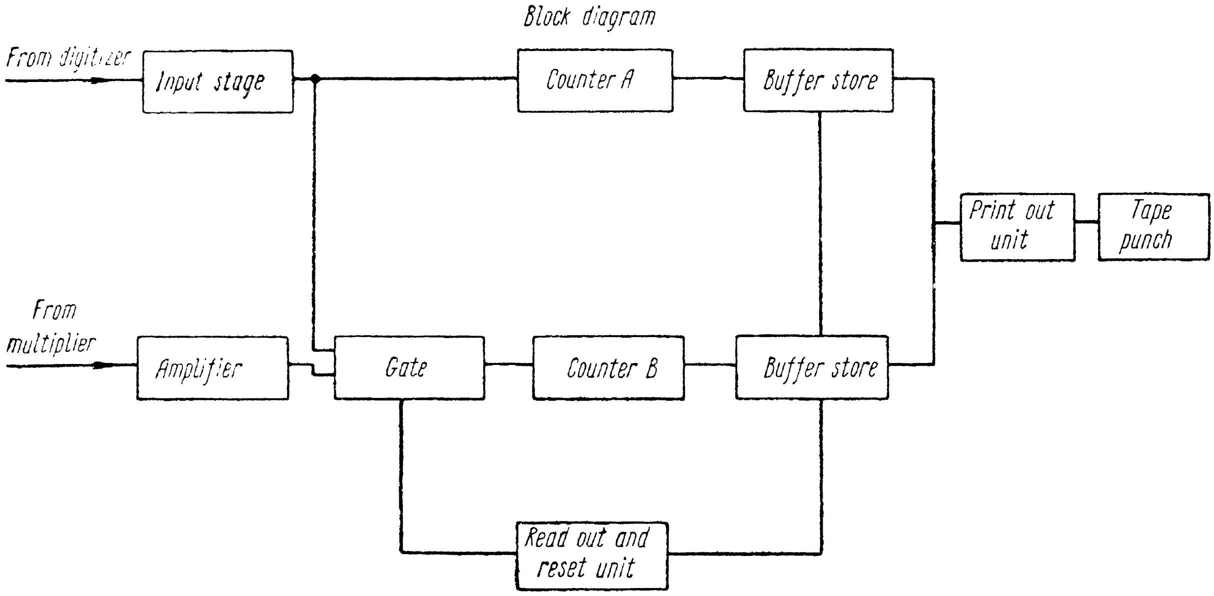

Fig. 3. Block diagram of the logic units.

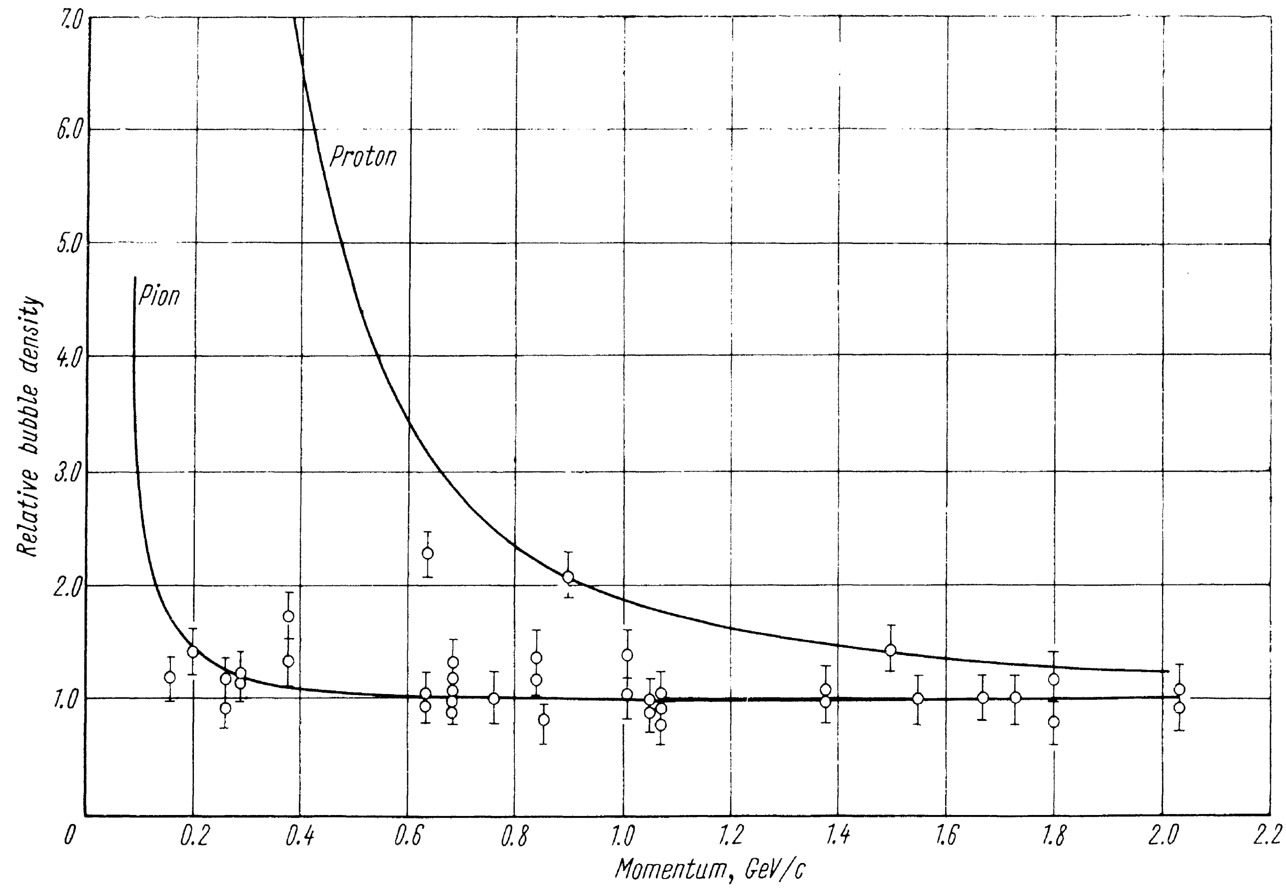

Fig. 4. Measured bubble density as a function of the particle momentum. Minimum cut off in gap length: 1/3 of the effective bubble diameter.

Virtually the average speed is limited to roughly 15 gaps per sec. by the occurrence of crossing tracks or of other disturbing objects on the film. In that case the operator has

RESULTS

The punched tape containing all the information of the gap length's of the track itself and of a reference track is transferred to a computer which gives the desired ionisation including errors for any arbitrarily chosen minimum gap length cut off.

Fig. 4 shows measurements on pion and on (assumed) proton tracks from a hydrogen bubble chamber after having corrected for (small) dip angles. Here the cut off was chosen as 1/3 of an effective bubble diameter. Some points represent repeated measurements on partially different portions of the same tracks on different times.

It should be mentioned that, for getting unambiguous results from tracks under normal operating conditions, i. e. when the illumination changes over the field of the view and when slight scatches occur, two auxiliary electronic units proved to be necessary: i. A regulation of the projected light intensity has been applied by means of a photocell controlling the voltage of the projection lamp; ii. Very short «bubbles» are suppressed by a logic requiring a dark phase of sufficient length.