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OBSERVATIONS ON BEAMKICKER FOR NEUTRINO EXPERIMENT

by

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I. INTRODUCTION

It has been proposed to increase the pion flux in the direction of the neutrino detectors by means of a double set of pulsed magnets which are located in the same straight section immediately following the target. The magnets are powered with opposite polarity so that the circulating protons receive a resulting kick of probably negligible magnitude, whereas the secondaries, originating from the target, obtain already in the first magnet sufficient bending so as to miss the second magnet by a good margin. A suitable configuration of the magnets may result in two improvements: firstly the secondaries reaching the detector will come from lower target emission angles, and secondly the over-all focusing may be improved.

II. ALTERNATIVES

In general, but not always, focusing in one plane is accompanied by defocusing in the other plane but the product may be larger than one.

We have considered two of such cases, using rectangular air coils.

Figure 1 demonstrates the edge effect of the magnet which gives horizontal focusing by a factor 2½ and vertical defocusing by a factor of 1.8. However, the latter factor is not fully effective because the collimator formed by the coils of magnet 5 is seen at somewhat larger vertical angle.

The arrangement of Fig. 2 tries to squeeze the beam of secondaries through the collimator but the final conclusion on this principle has not yet been obtained due to the lengthy computations involved.

A case of horizontal focusing without loss in the vertical plane is shown in Fig. 3. The magnets here are septum magnets. As there is no horizontal field, horizontal focusing, due to the edge effect, is not accompanied by vertical defocusing. An additional advantage is the reduction by a factor 10 of the required energy per pulse. The septum may be part of the vacuum enclosure so that there is no extra loss upon traversing the septum. We may also consider the double focusing septum magnet, in which the septum is curved, but as yet no data are available.

The following graphs show the possible improvements, under the condition that

a) the magnet units of the accelerator remain in situ,

b) existing power supplies are used,

c) the momentum range between 1 and 4 GeV/c for positive pions is taken into account.

Figure 4 gives a comparison between the range of the angles of emission in the horizontal plane which produce exit angles centred around the 6° line and which fall within c.m. decay of 90°.

It will be noticed that there is a net improvement in range and shift towards forward angles of emission for either air coil magnet or septum magnet as compared with the present situation, i.e., without kicker. Between air coil magnet and septum magnet it should be remembered that the latter has no vertical defocusing.

Figure 5 shows exit angles v. target emission angles for the present situation as compared with a septum magnet. In this case the conditions in the vertical plane are approximately the same, so that with a septum magnet of only 40 cm length an appreciable gain can be obtained.

III. ANTI-NEUTRINO BEAM

A beam of negative pions may be directed towards the detector provided magnet 5 could be moved downstream so as to make straight section 5 a long section and straight section 6 a short one. The long section provides more drift space so that with some overshoot on the beamkicker the coil edge may be cleared. In this case an auxiliary kicker must be placed near the edge of magnet 5, which cancels the overshoot.

Figure 6 shows the layout of this proposition. It will be clear that the arrangement is likewise suitable for the beam of positive pions, simply by reversing all polarities.

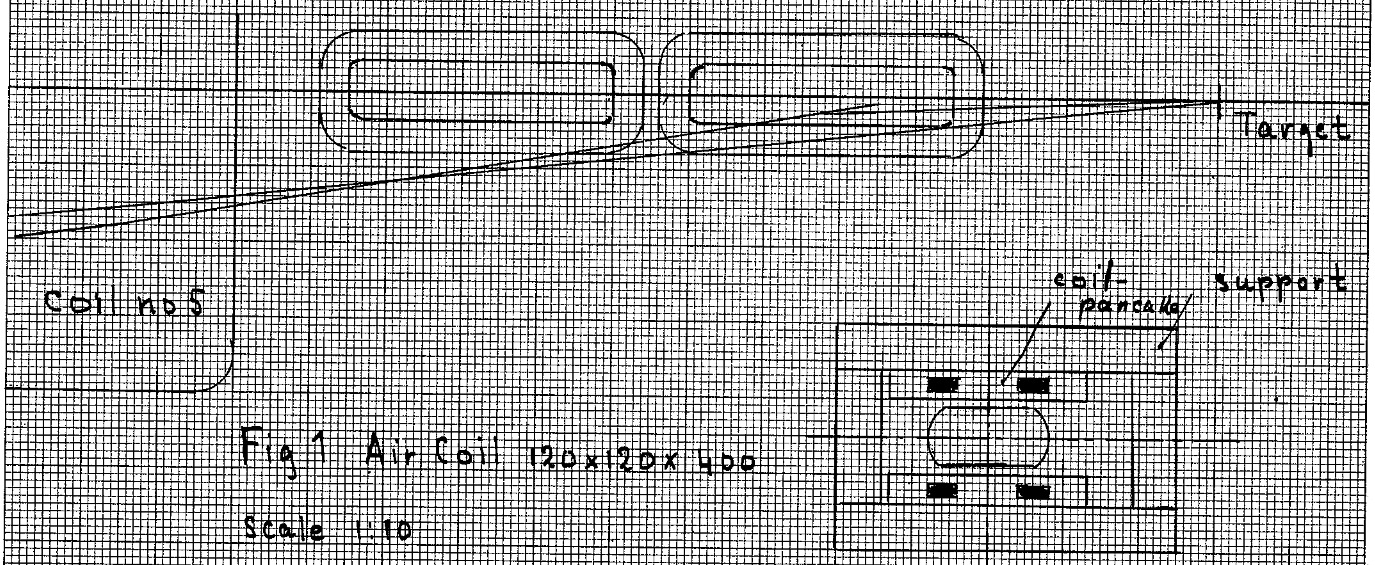

Fig 1 Air Coil 120x120x400

scale 1:10

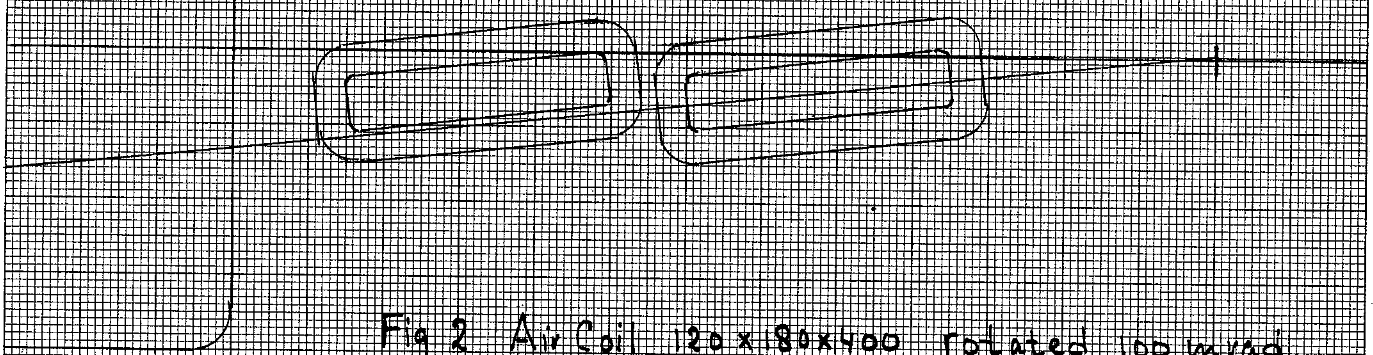

Fig 2 Air Coil 120x180x400 rotated 100 mrad.

scale 1:10

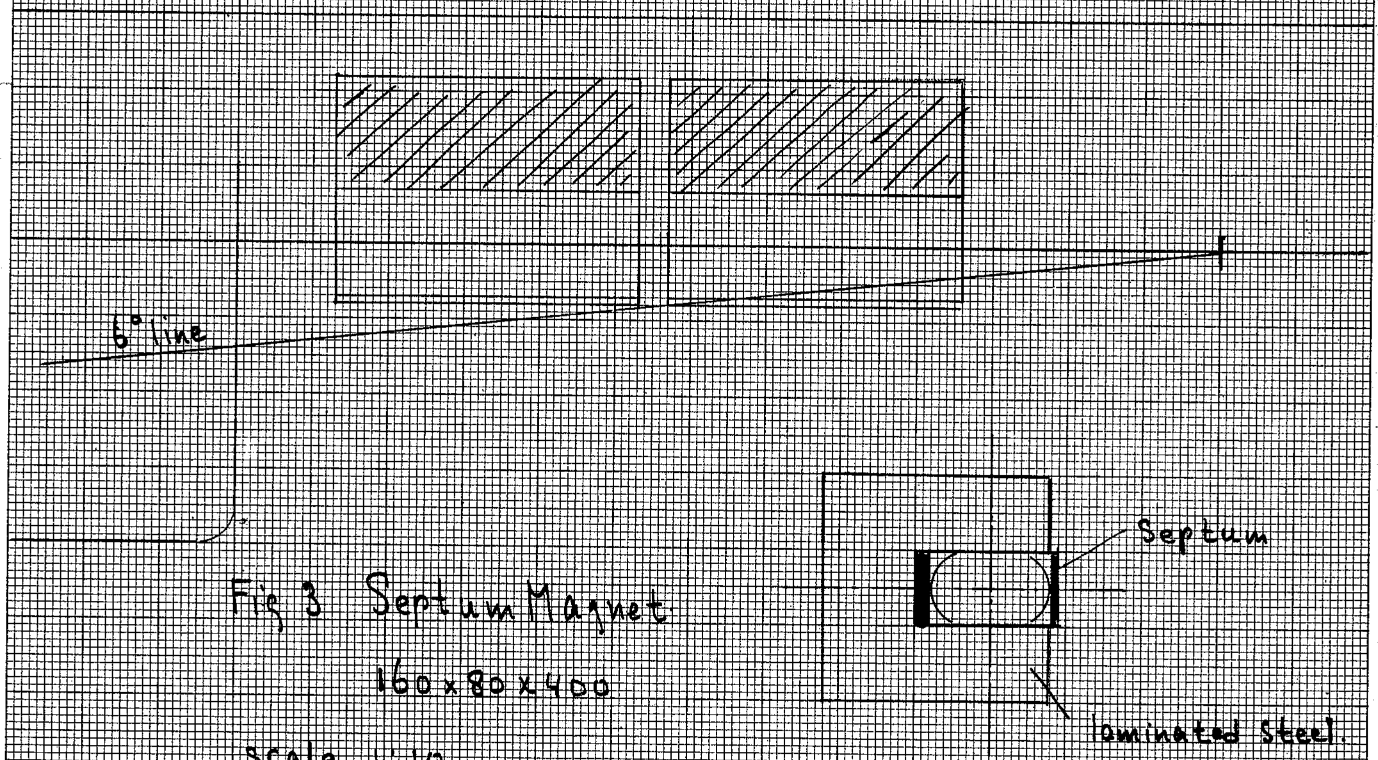

Fig 3 Septum Magnet

160x80x400

scale 1:10

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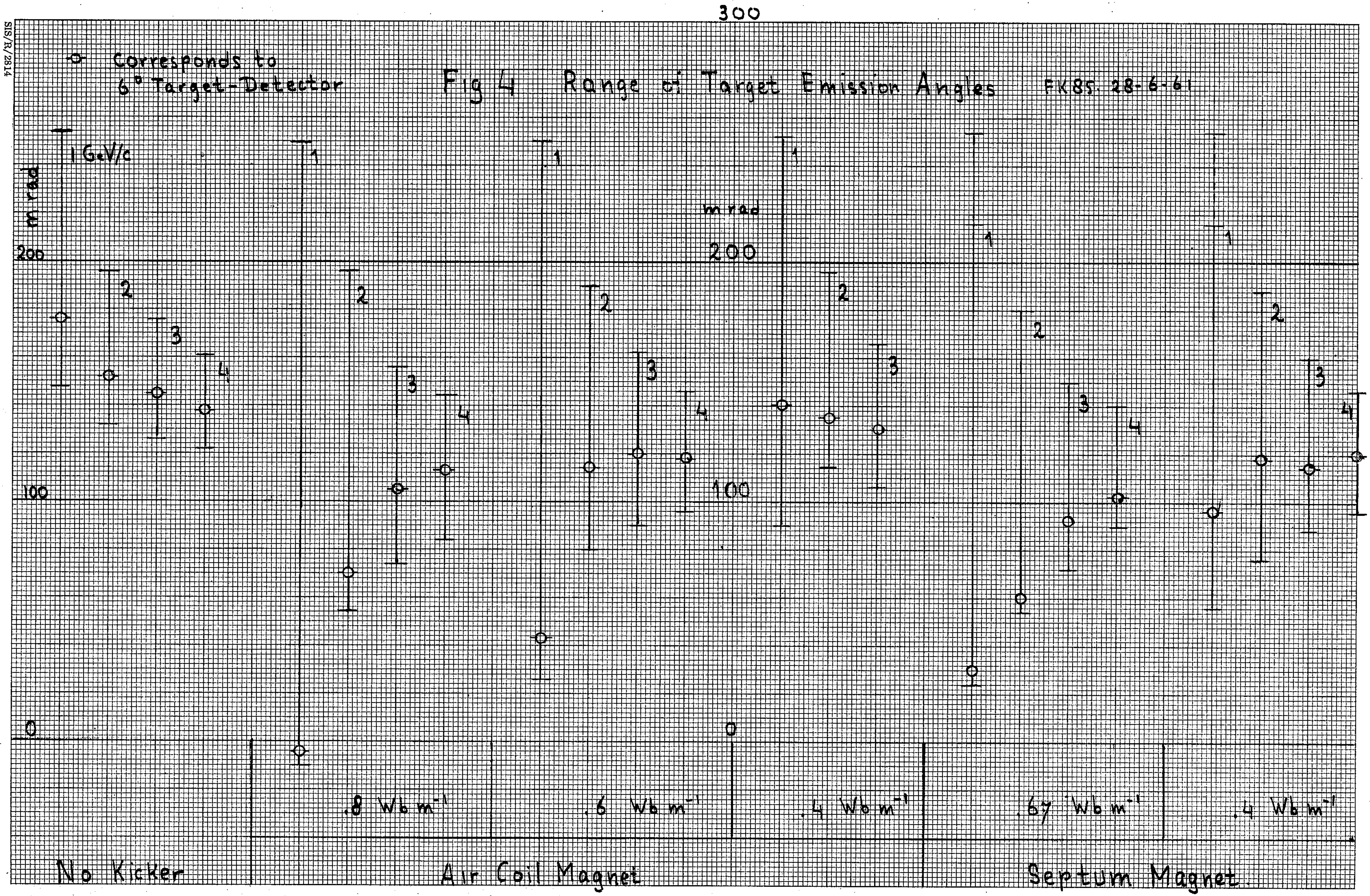

300
Corresponds to
6° Target-Detector
Fig 4 Range of Target Emission Angles
FK85. 28-6-61
1 GeV/c
m rad
200
100
0
1
2
3
4
.8 Wb m⁻¹
.6 Wb m⁻¹
.4 Wb m⁻¹
.67 Wb m⁻¹
.4 Wb m⁻¹
No Kicker
Air Coil Magnet
Septum Magnet

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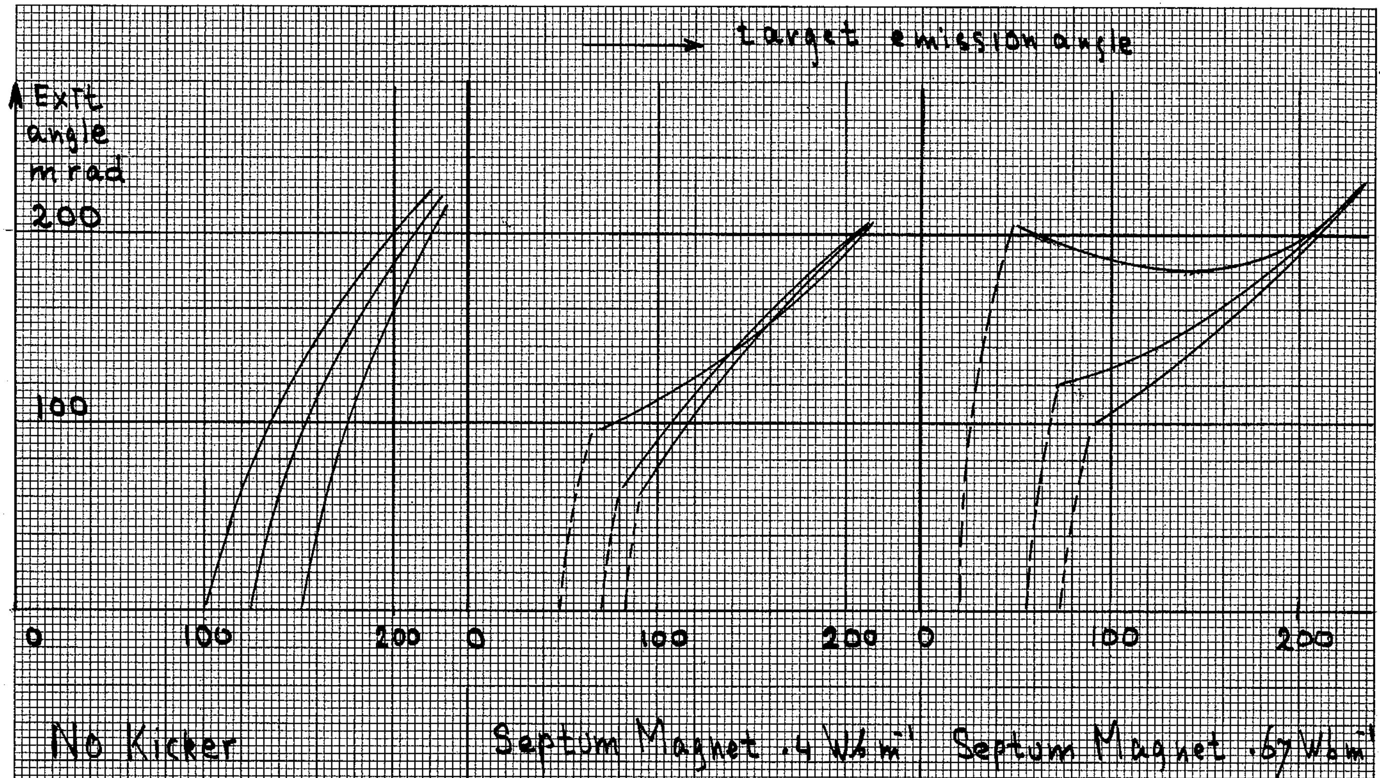

Fig 5. Exit angle v. Target Emission angle.
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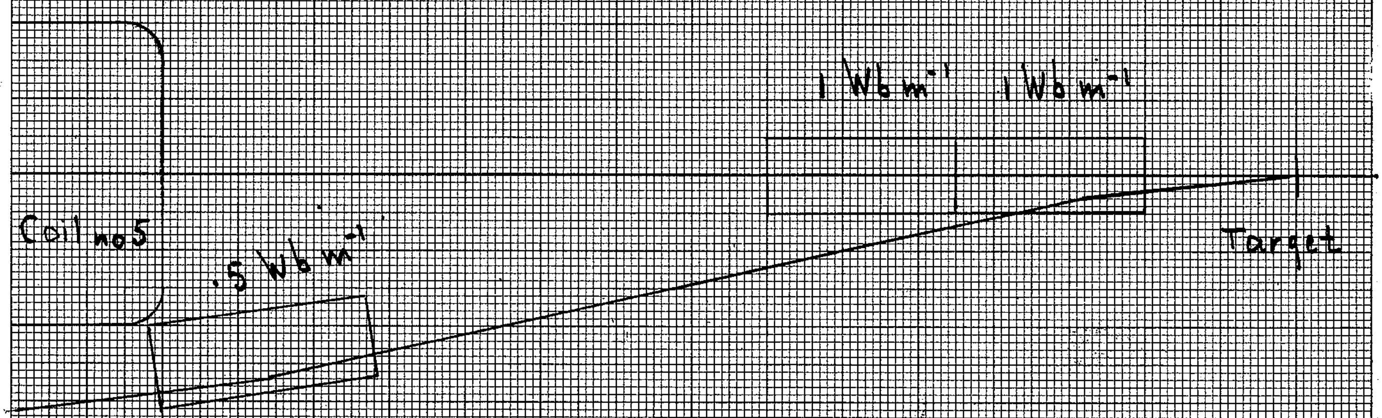

Fig 6. Beam Kicker in Long Straight Section.
scale 1:20 FK87 28-6-61