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ENG/Int. EE 62-20
AAS/fd - 31.7.62

ELECTRICAL ENGINEERING

Technical Note No. 58

REPORT ABOUT DIFFERENT TYPES OF 30 cm - APERTURE QUADRUPOLE LENSES

SUMMARY

At the Meeting of the Study-group for secondary beams and PS-extracted beam facilities it has been suggested to compare by model measurements different types of 30 cm - aperture quadrupoles. The following types, all designed for a field - gradient x iron length $g \cdot L = 900 \; (\frac{G}{cm} \cdot m)$ and adapted to a CERN standard type III generator were investigated :

a) the "Classical" type

b) the Wilson "Figure of Eight" type

c) the "CERN Eng Division" type

d) the "Desy" type

This report gives the main parametres for these quadrupoles as well as the region with a magnetic field linearity deviation inferior to 1 o/o, using the pole pieces described in the figures.

It should be borne in mind, that only in the "CERN Eng. Div." design have special efforts been made to linearise the field by shaping the poles.

It is reasonable to assume that the region of good field (in which the deviation < 1 o/o) for the "Desy" design can be made the same as that produced by the "CERN" design if special shims are attached to the edges of the pole-pieces.

The "CERN" type has the largest field uniformity region at a gradient $g = 900 \frac{G}{cm}$.

The "Figure of Eight" type has also a large field uniformity region, but attains a gradient of about only $600 \frac{G}{cm}$. The overall dimension of this quadrupole in one direction (either height or width) is small.

With the "Classical" type a gradient of about $g = 740 \frac{G}{cm}$ could be obtained. The field linearity is limited to a circle of 0,85 ... 0,9 times the geometrical aperture.

Due to their comparable iron weight and winding types, the costs for the quadrupoles a) ... c) would roughly be equal.

RESULTS

The main parametres of the 4 considered quadrupole lenses are summarized in Table I :

Table I

"Classical"

Quadrupole	"Classical" Type	"Figure of Eight"	"Cern" Type	"Desy" Type
Gradient $g(\frac{G}{cm})$	740	600	900	1000
Iron length L(mm)	1230	1500	1000	900
Max. excit. current I_{max}(A)	830	830	860	830
Winding resist. $R_{20^oC}(\Omega)$	0,44	0,435	0,41	0,423
Excit. power P(kW)	330	330	330	330
Conductor size (mm)	9,84x9,84 / /4,67x4,67 hole	9,84x9,84 / /4,67x4,67 hole	8,7 x 8,7 / / 5,0 ∅	9,37x9,37 / /4,25x4,25 hole
Temper. rise $\Delta T(^oC)$	50	50	50	48
Pressure drop Δp(at)	15,0	15,0	10,0	15,0
Overall dimens. (mm)	1030 x 1030	1260 x 640	1350 x 1350	1570 x 1570
Steel weight (ton)	6,0	7,3	7,0	11,0
Copper weight (ton)	0,55	0,52	0,65	0,3
Geom. dimens. acc. drawing	1	2	3	4
Field uniformity curve on drawing	5,6	7,8	9,10	11

Fig. 1 ... 4 show what would be the cross-sections of these quadrupoles, while Fig. 5 ... 11 show the field uniformity curves, measured in the x and r directions as well as the region where the field linearity error is inferior to 1 o/o.

Presenting the results for four different quadrupoles, it is not the intention of this report to suggest the adoption of one or the other type. The relative usefulness of each of the four designs of quadrupole in collection from a target is not simply determined by the ratio of overall width to aperture, which would favour the "Figure of Eight" type. If the quadrupole forms part of a doublet the lower field gradient of the "Figure of Eight" design which necessitates a longer length of magnet may cause a severe reduction in the acceptance from the target.

It is hoped, that the present report will help the beam-layout specialists and physicists in showing what could be expected from various large aperture quadrupoles, which could still be powered from our standard generators.

A. Ašner, E.J.N. Wilson

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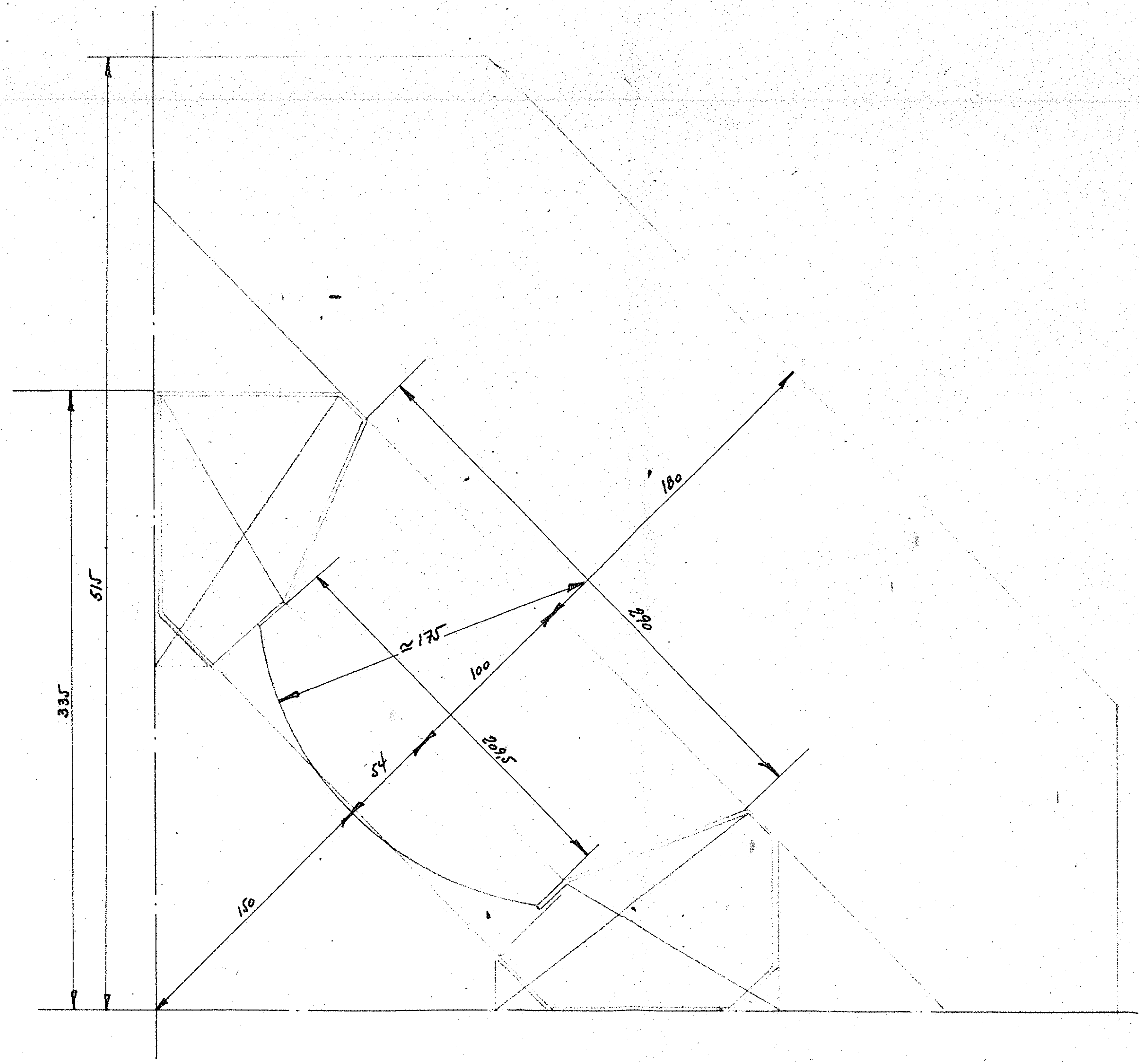
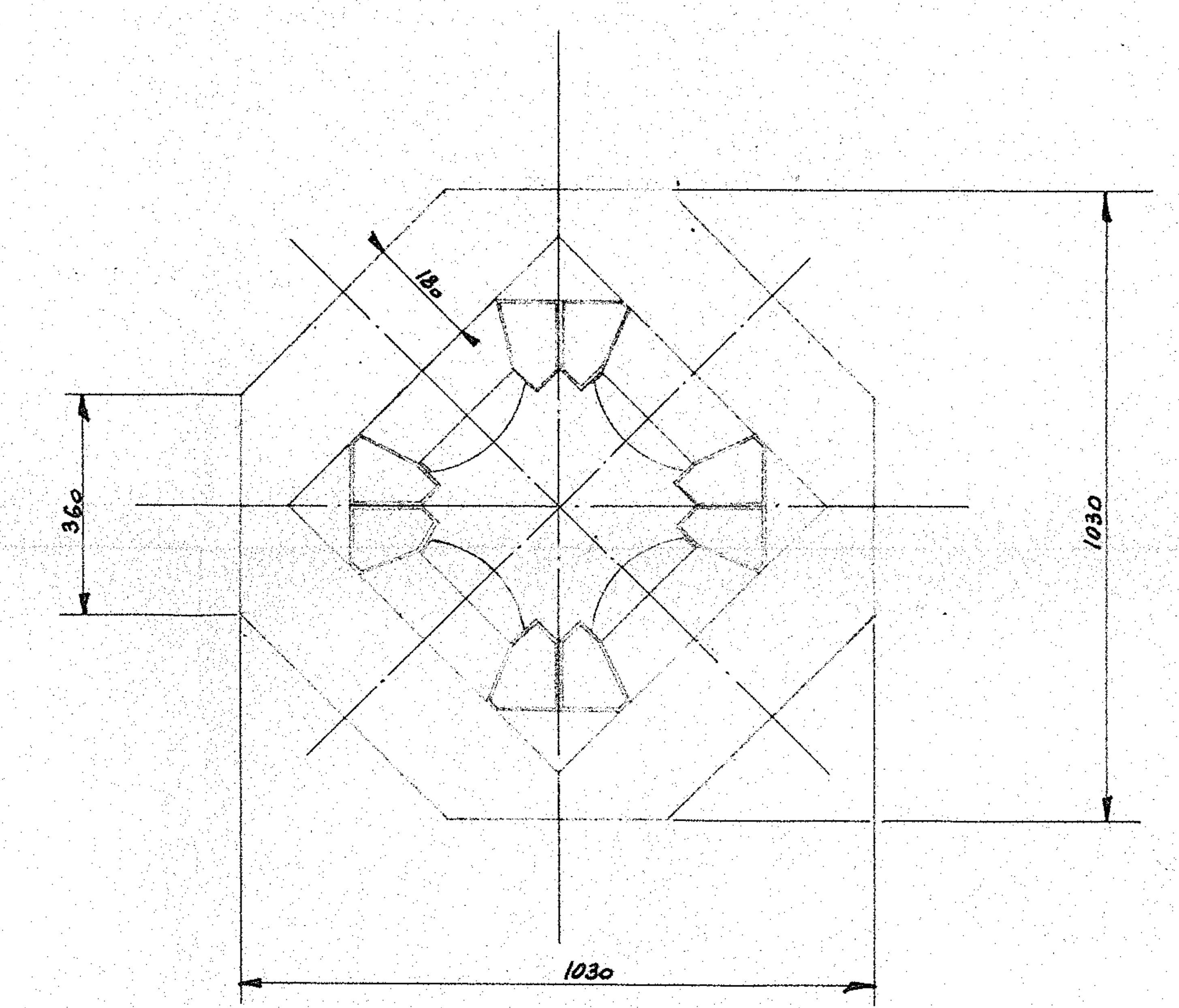
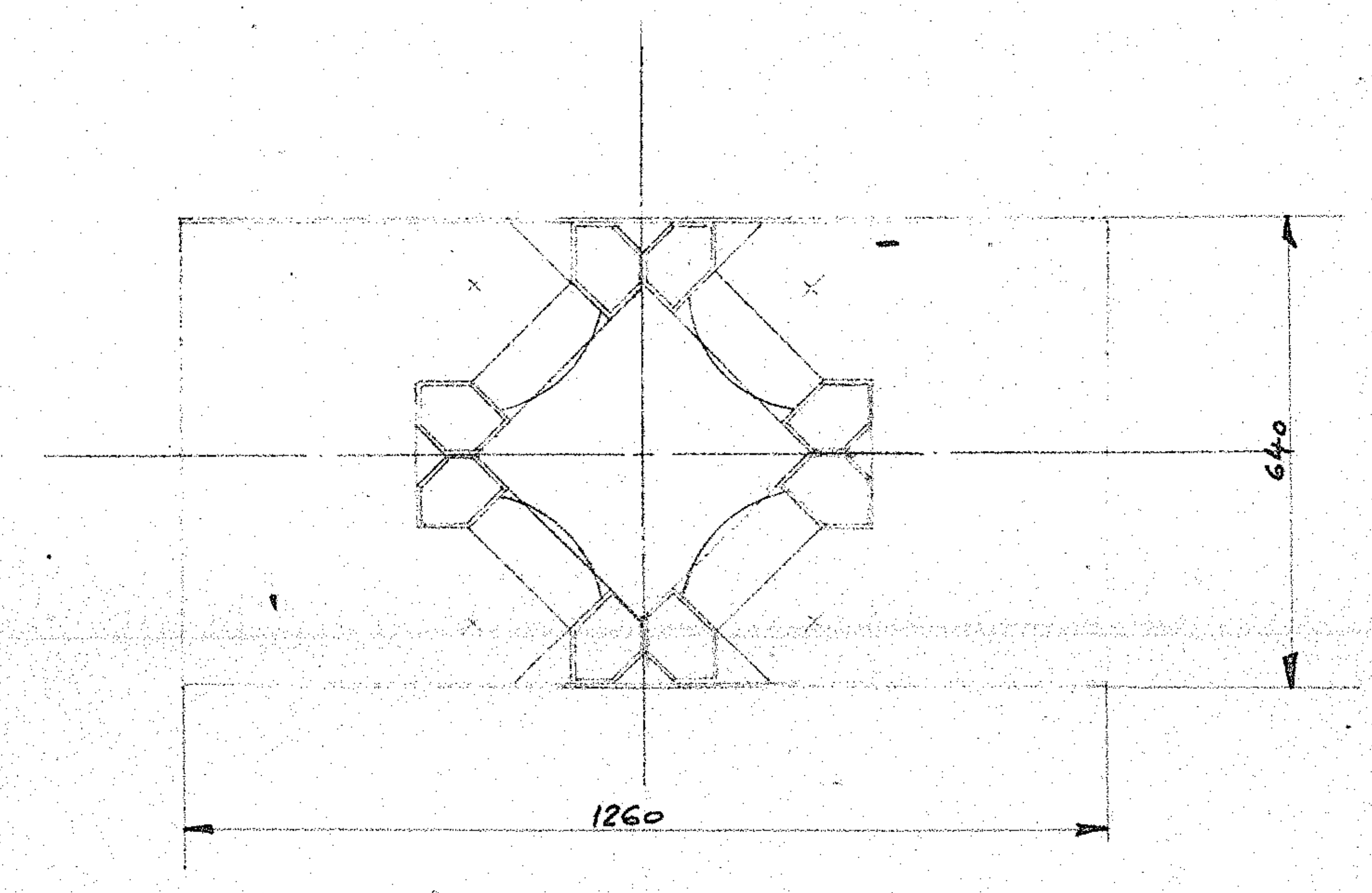
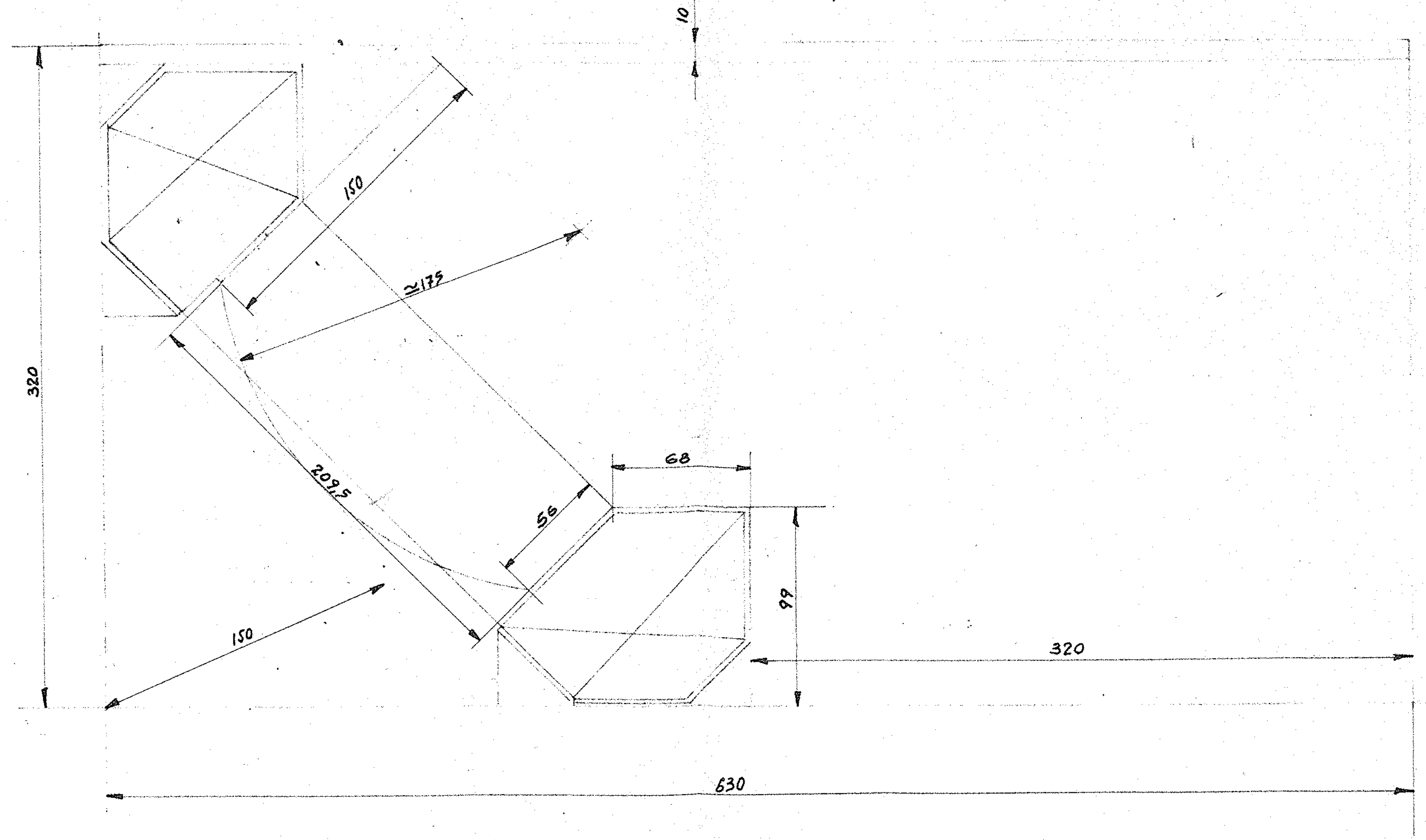


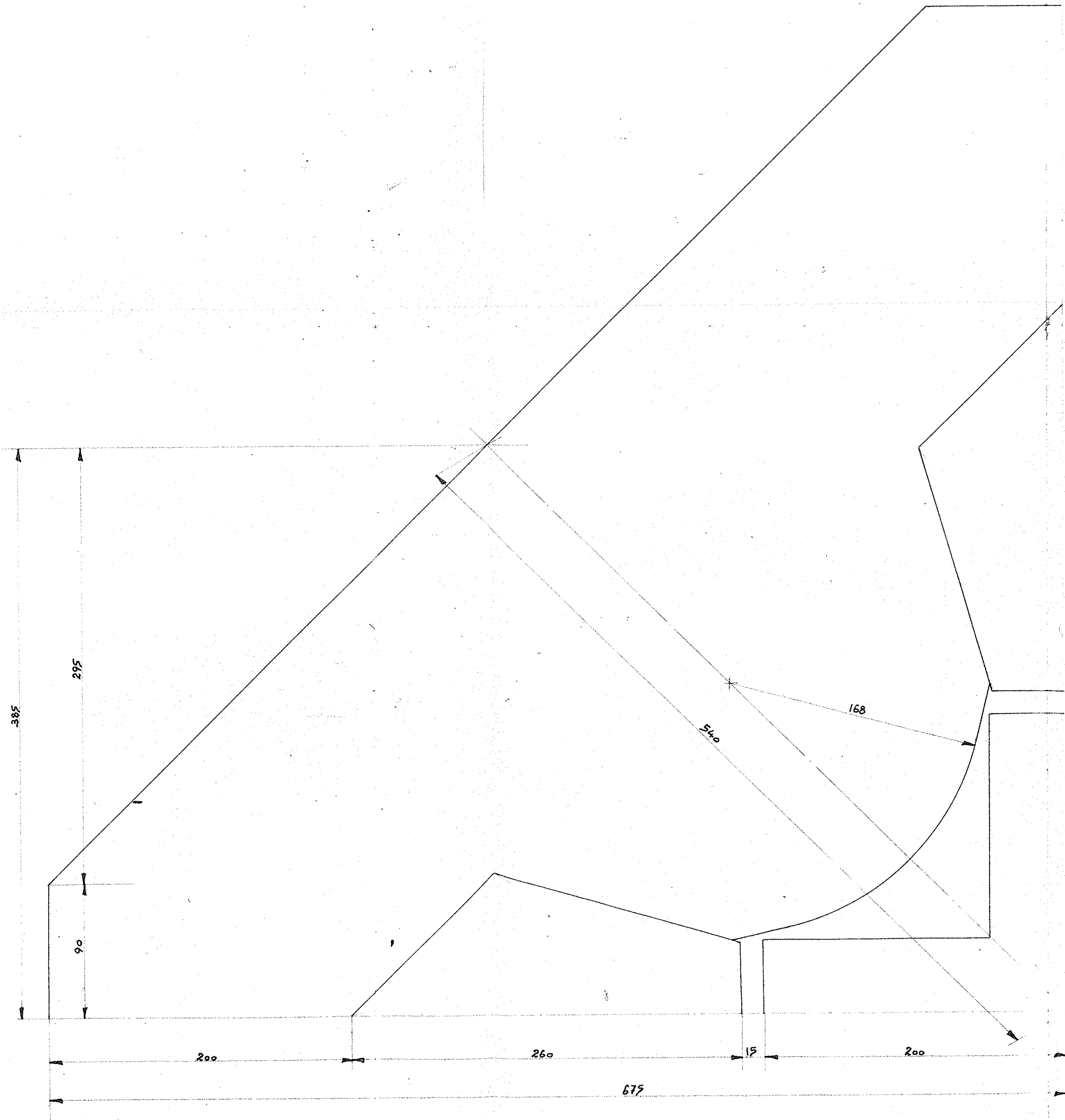


Nombre de pièces			Designation			Pos.	Matière	Poids	Observations
III	II	I	Mod.	Date	Nom	Tolérances générales			Etat des surfaces selon VSM 10320
			A			de à ±			Rugosité en μ VSM
			B			de à ±			Abréviations VSM 10319
			C			de à ±			
			Ensemble			S. Ensemble			Dessiné [signature] 1-8-62
			FIG-1			Echelle			Controlé
			CLASSICAL QUADRUPOLE			1:2			Vu
Dossier No	Dossier No	Dossier No	30 cm Ø 740 $\frac{G}{cm}$			1:10			Remplace
									Remplacé par
									Réduction
			CERN ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE - GENÈVE						





Nombre de pièces			Designation			Pos.	Matière	Poids	Observations
III	II	I	Mod.	Date	Nom	Tolérances générales			Etat des surfaces selon VSM 10320
			A			de à ±			Rugosité en μ VSM
			B			de à ±			Abréviations VSM 10319
			C			de à ±			
			Ensemble			S. Ensemble			Dessiné [illegible] 2.8.62
			FIG-2					Echelle	Controlé
			FIGURE OF EIGHT-TYPE QUADRUPOLE 30 cm Ø 600 G/cm						Vu
									Remplace
									Remplacé par
									Réduction
Dossier No	Dossier No	Dossier No	CERN ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE - GENÈVE						



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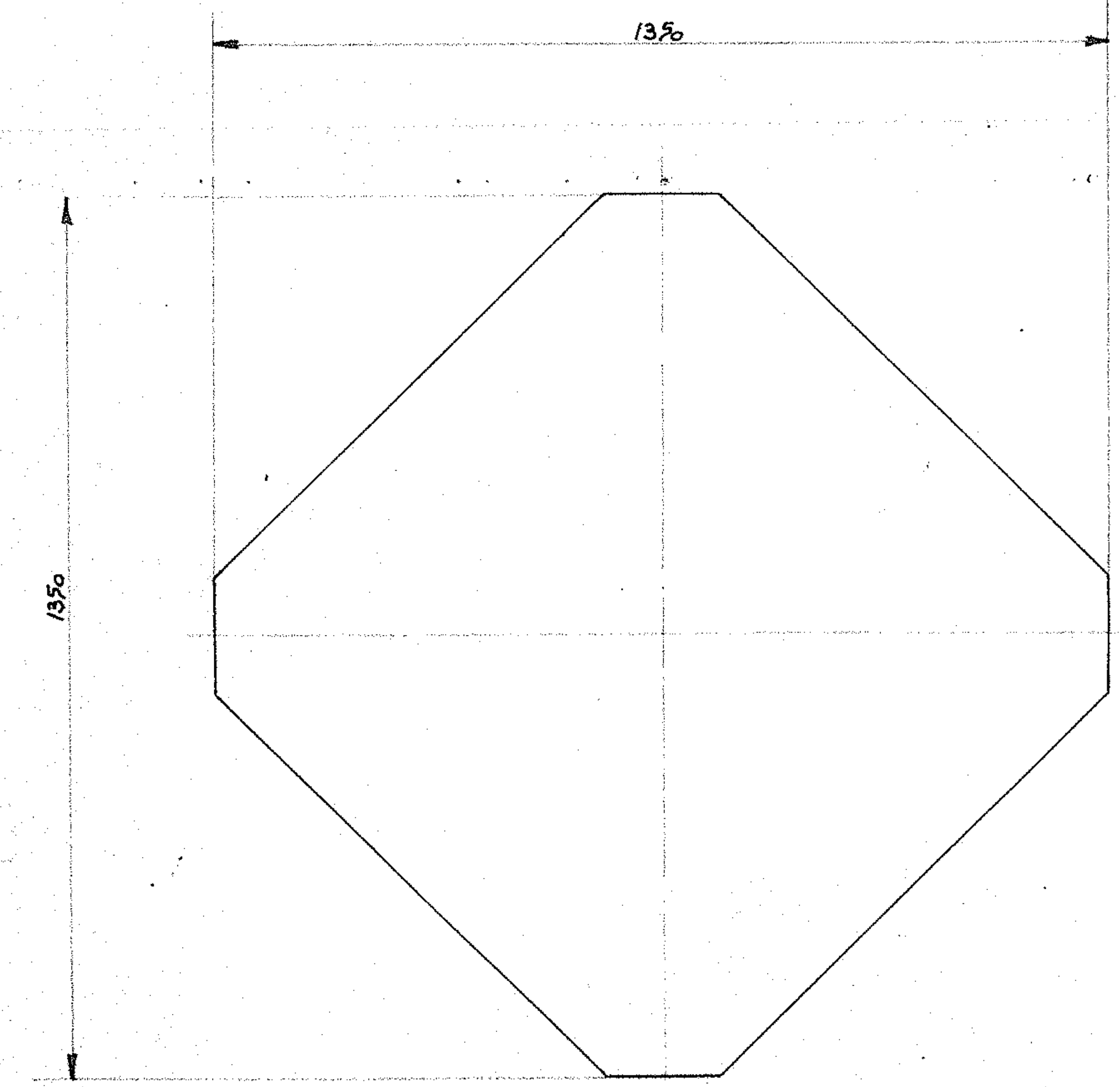

Nombre de pièces III	II	I	Désignation			Pos	Matière	Poids	Observations
			Mod.	Date	Nom	Tolérances générales			Etat des surfaces selon VSM 10 320
			A			de à			Rugosité en μ VSM
			B			de à			Abréviations VSM 10 319
			C			de à			Dessiné 26-10-61
			Ensemble			S. Ensemble			Contrôlé
			FIG-3				Echelle		Vu
			QUADRUPOLE 30cm. ϕ $g=900\frac{G}{cm}$				1:2		Remplace
			L=1,0m				1:10		Remplacé par
Dossier N°	Dossier N°	Dossier N°	CERN ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE - GENÈVE						Réduction

11 10 9 8 7 6 5 4 3 2 1

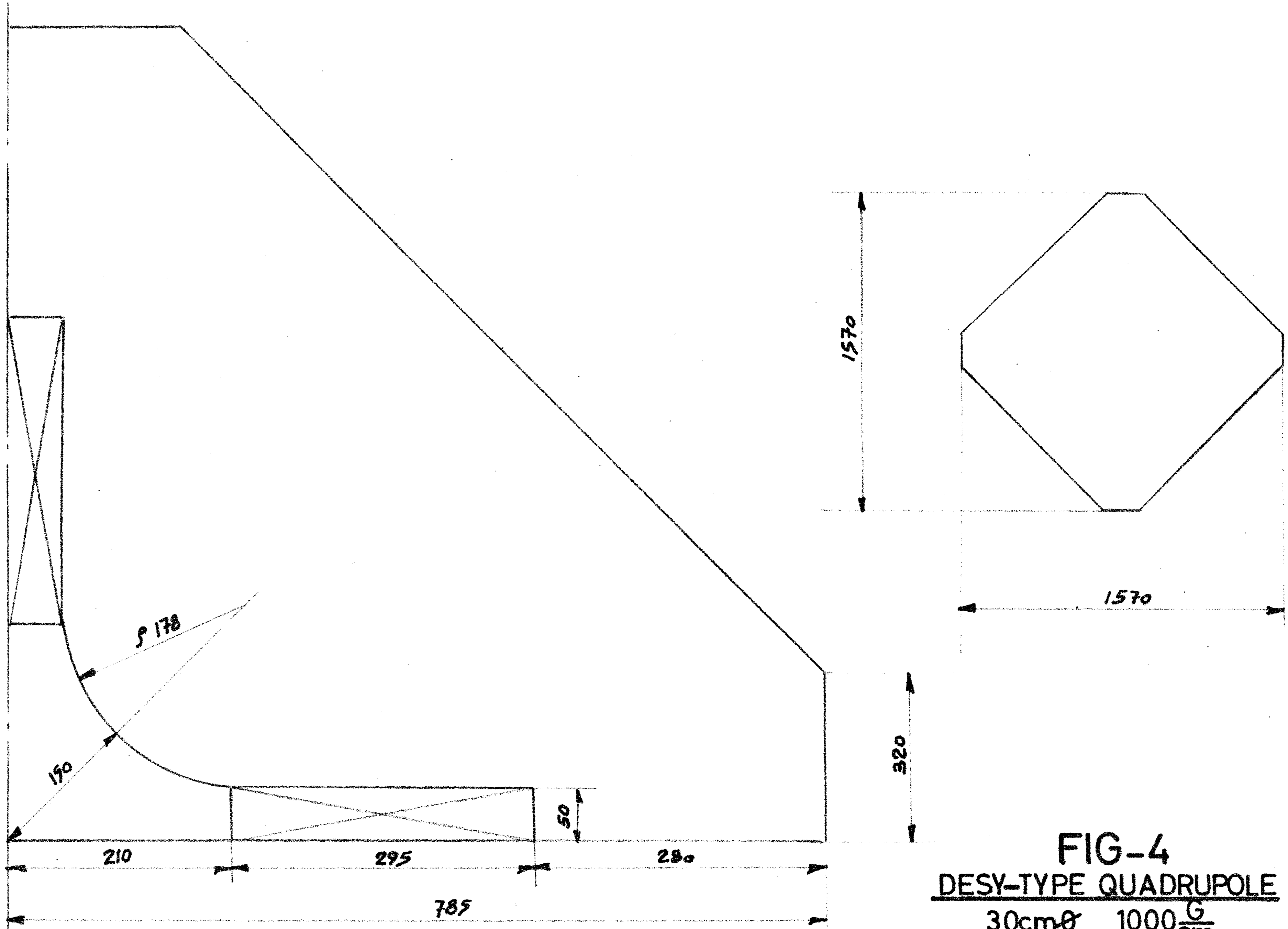

FIG-4

DESY-TYPE QUADRUPOLE

30cm⌀ 1000 $\frac{G}{cm}$

FIG-5 WILSON : CLASSICAL 30Ø QUADRUPOLE

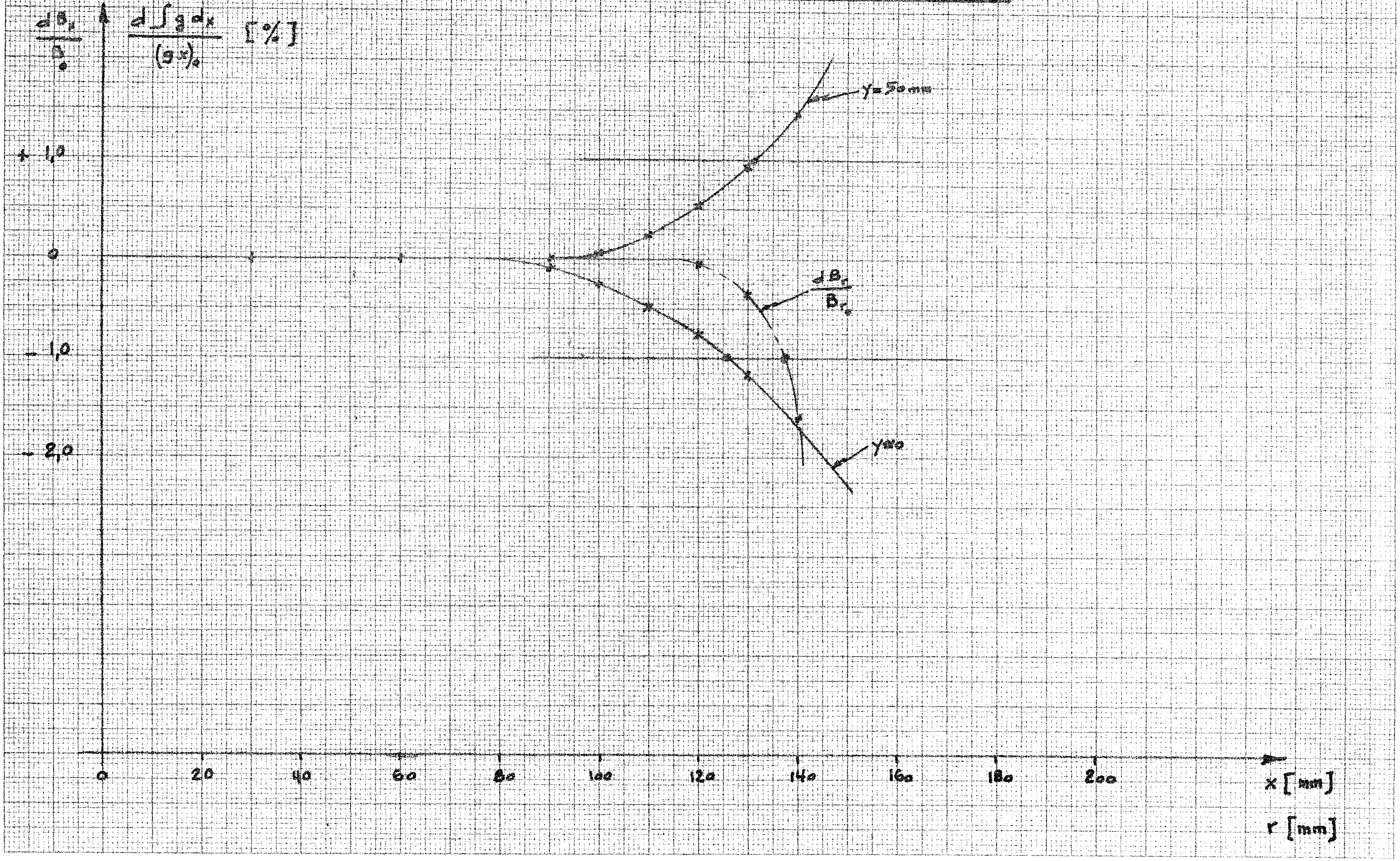

FIG - 6

WILSON CLASSICAL 30 cm QUADRUPOLE

REGION WITH $\frac{dB}{B} \leq 0{,}01$

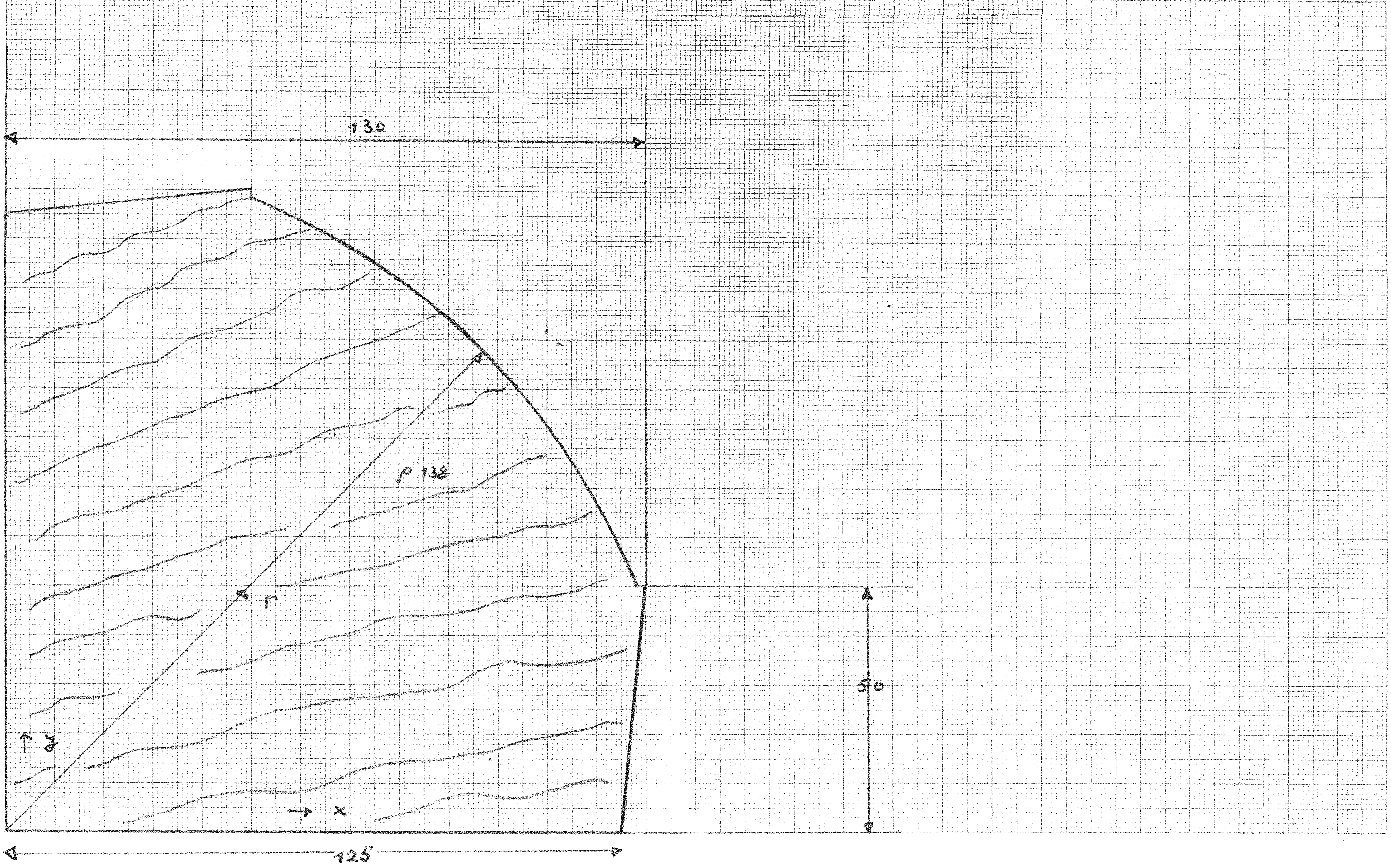

FIG-7 II FIGURE OF EIGHT WILSON QUADRUPOLE 30 Ø

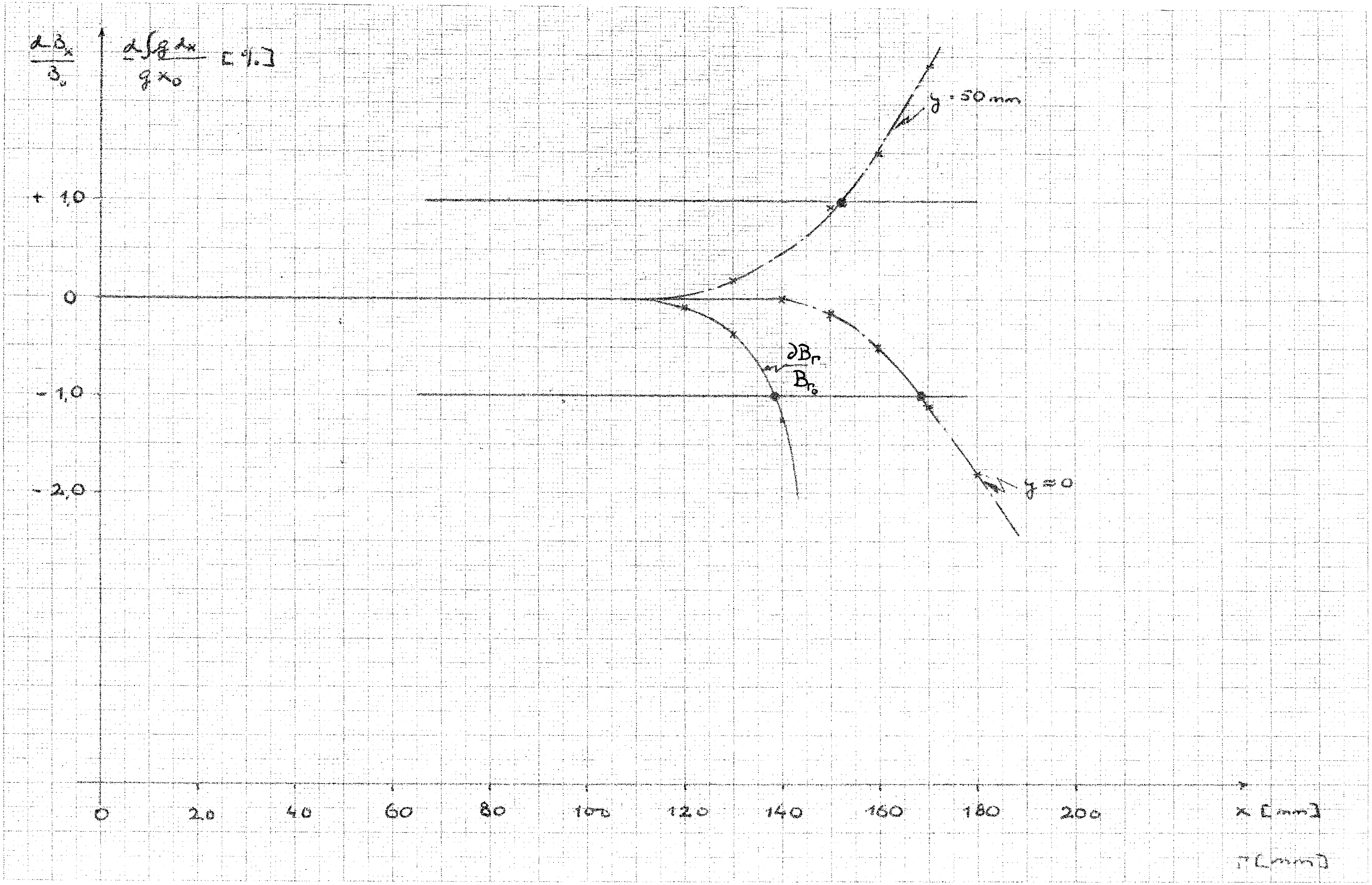

FIG - 8

WILSON: FIGURE OF EIGHT QUADRUPOLE 30 ⌀

REGION WITH $\frac{dB}{B} \leq 0{,}01$

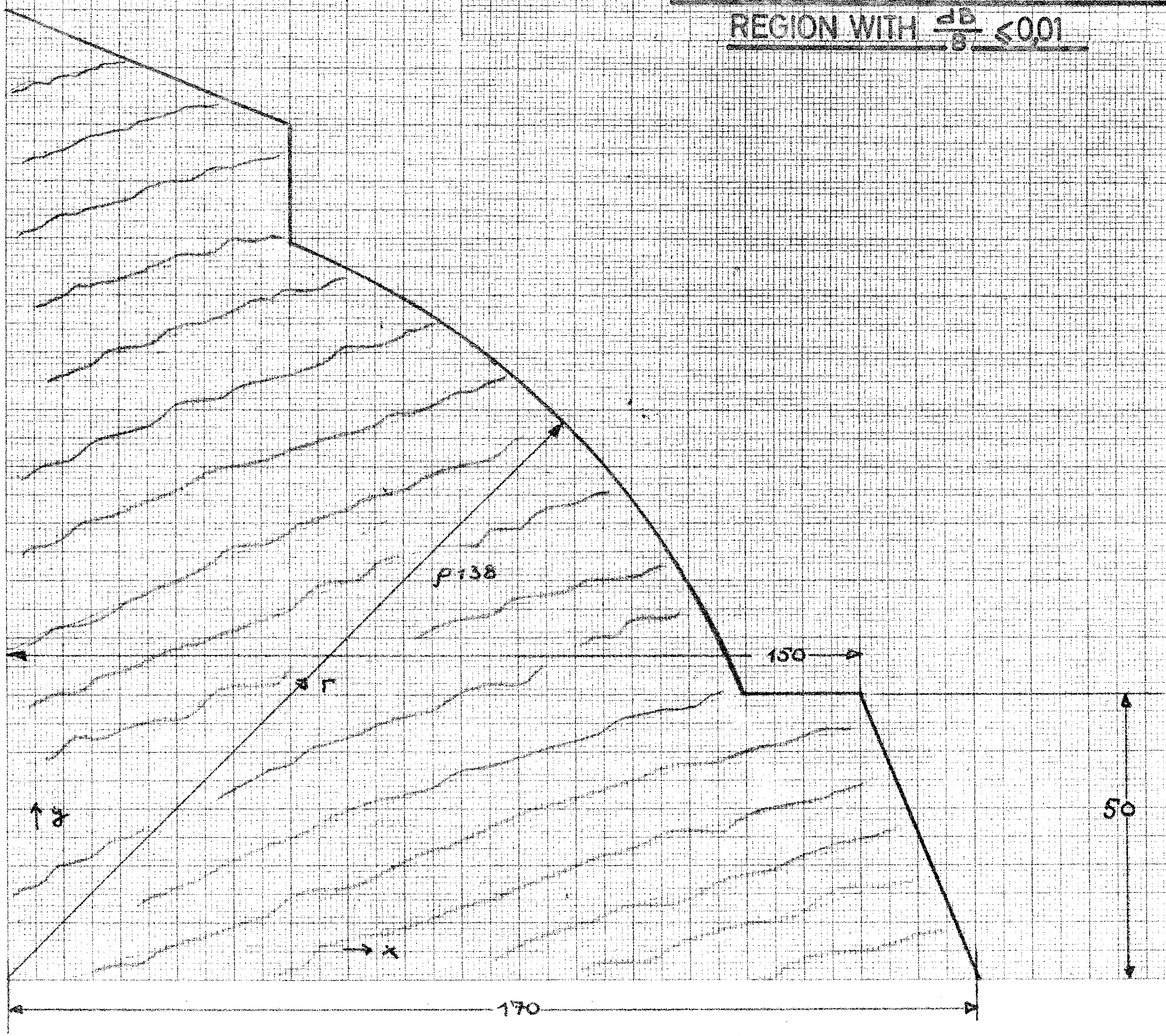

FIG-9 CERN 30cm QUADRUPOLE

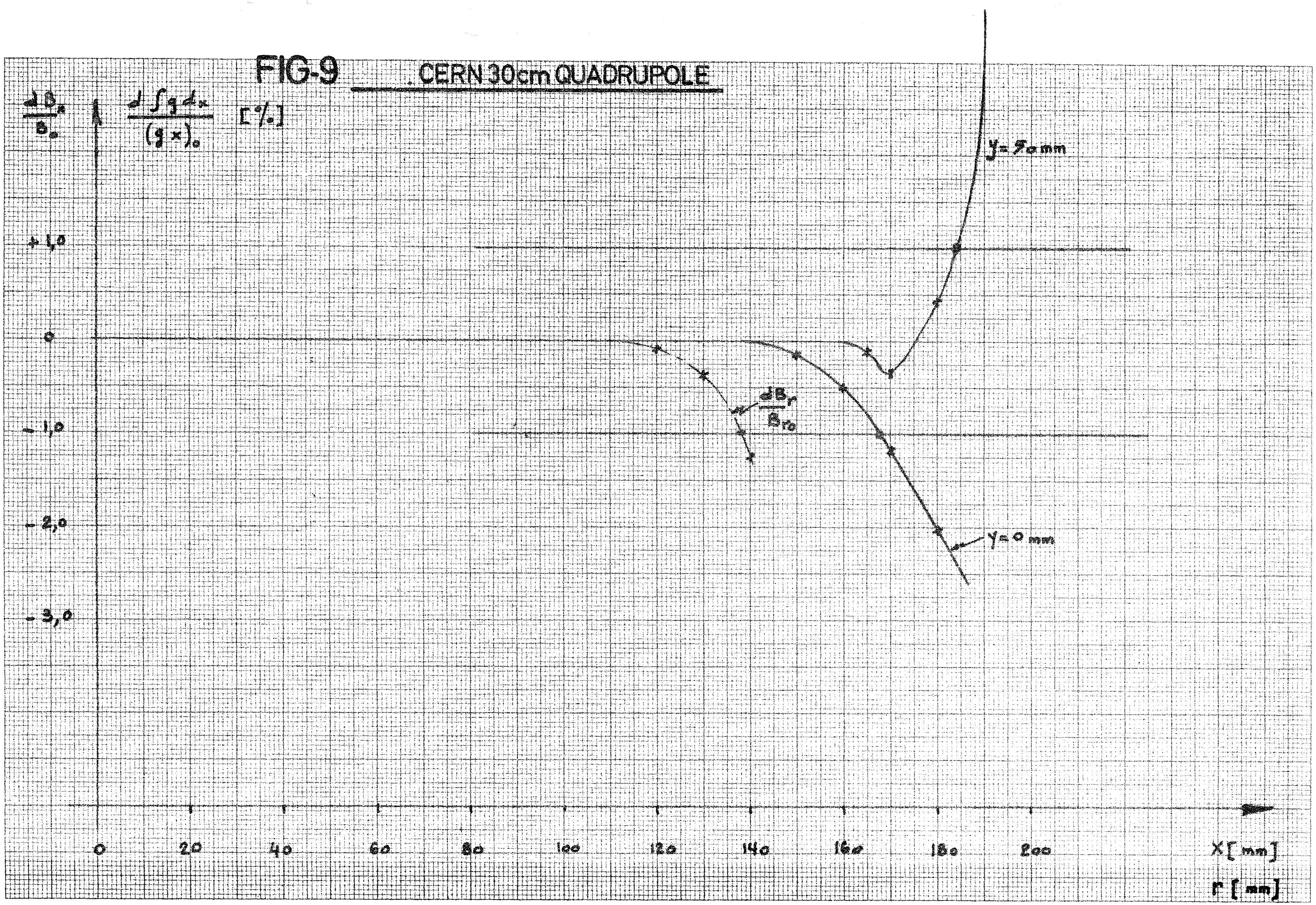

FIG-10

CERN 30cm QUADRUPOLE

REGION WITH $\frac{\Delta B}{B} \leq 0{,}01$

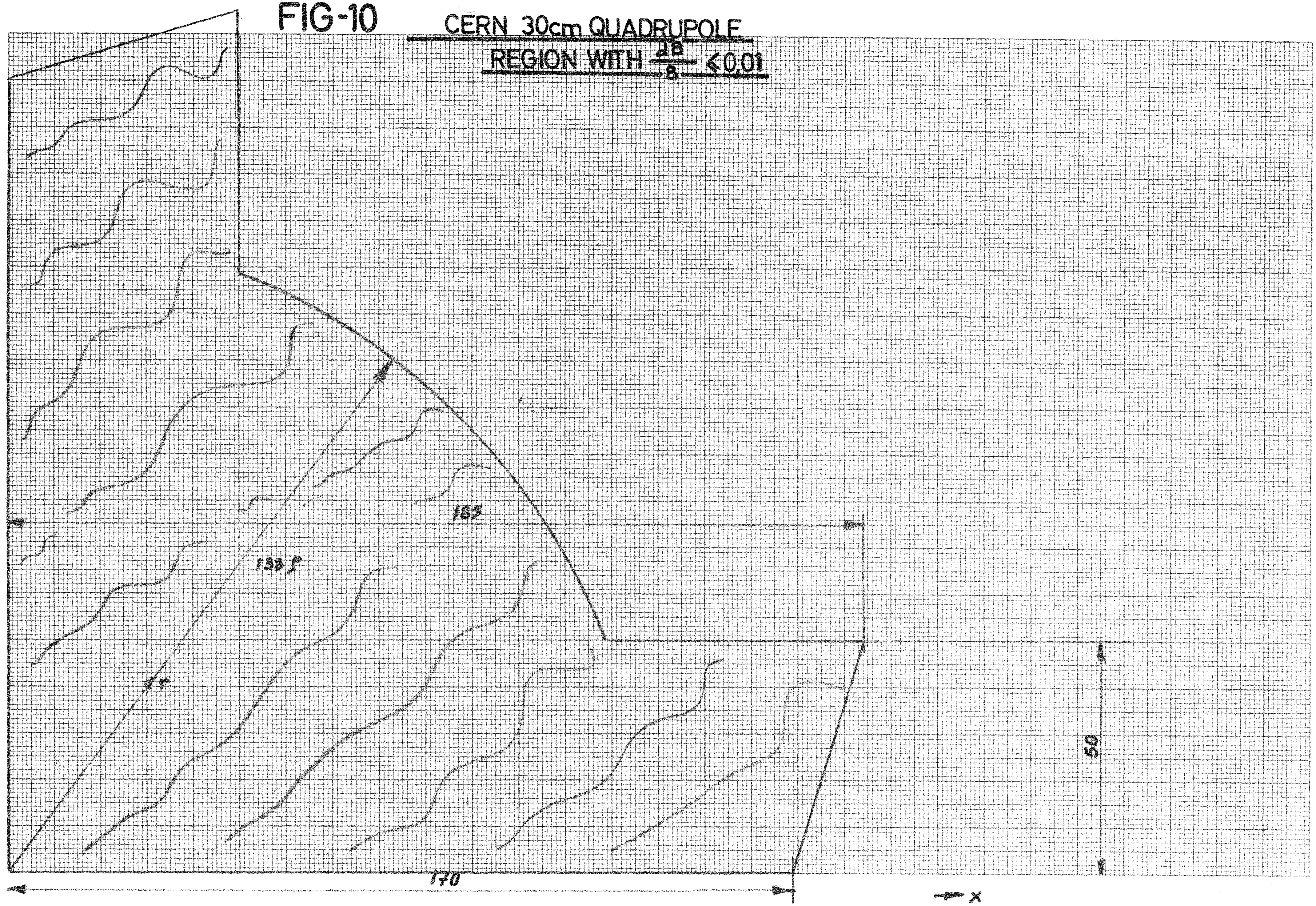

FIG.11 **IV DESY-TYPE 30cm QUADRUPOLE**