PS/AA/ACOL NOTE -9
/lmg - 0051b 2.4.1984.

Resumé of a work session on plasma lens development

Persons present : K. Frank, University of Erlangen

G. Dellecave, L. De Menna, G. Miano — University of Naples

B. Autin, E. Boggasch, H. Riege — CERN

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The meeting took place on 8th/9th March, 1984. In the frame of his PS-Seminar (8.3.2984, 11h00) K. Frank presented the results of measurements with the first plasma lens prototype.

H. Riege stressed the point that the next stage of development at CERN aims at laboratory life tests of a second prototype lens under realistic operational conditions. This goal has to be achieved quickly and not necessarily with the best ultimate equipment. A note with a short specification for the lens and the pulse generator is attached at the end.

L. De Menna and G. Miano presented a possible final plasma lens generator lay out (Note also attached at the end). During the discussion we concluded that some further calculations are required to determine the behaviour of the circuit and the type, size and price of the proposed magnetic switches. The construction of such a circuit in parallel to the above mentioned set-up is excluded at the moment due to financial reasons.

Furthermore, L. De Menna proposed to develop a special computer code for plasma lens circuits in order to avoid the troubles which we encountered with big circuit analysis programs such as SCEPTRE (IBM). It is, of course, desirable to possibly include the pinch dynamics into such a special code.

H. Riege

PS/AA/HR/afm 16 mars 1984

TECHNICAL SPECIFICATION

PROJECT: PLASMA LENS DEVELOPMENT

Goal: Design and fabrication of a plasma lens and its pulse generator for life tests.

A plasma lens is a device for focusing high energy particles (antiprotons) by means of the azimuthal magnetic field B_θ around a high current carrying plasma column (Z-pinch). Such a plasma lens (PL) has to be tested in the laboratory at the required operational conditions. The question has to be answered if the PL can withstand the following conditions for sufficiently long time.

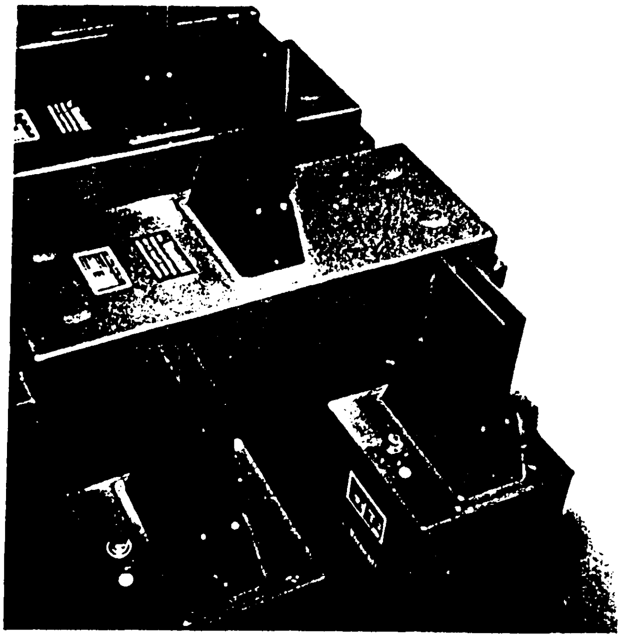
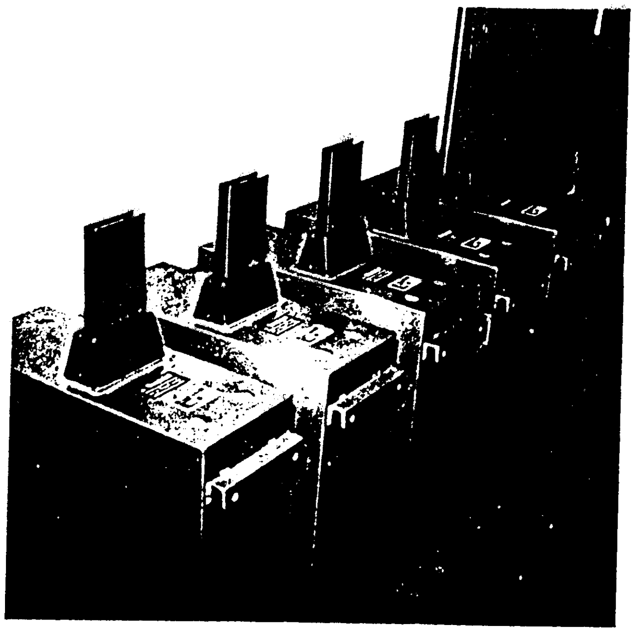
Peak current	:	>500 kA
Half-cycle time (sinusoidal)	:	10 µs
Pulse energy	:	20-30 kJ
Repetition rate (cooling required)	:	1/5 - 1/3 (1/s)
PL-pressure	:	≈ 1 mb (Argon)
Pre-ionization	:	5 kV / 1-10 mA
PL-dimensions	:	Ø ≈ 200 mm; l ≈ 250 mm
PL-insulator	:	Quartz tube
Electrodes	:	Pseudo-spark geometry (hollow electrodes, partially tungsten)

24 capacitors for a bank of 100 µF/40 kV have already been ordered (Fig. 1). Figure 2 shows the electrical scheme of the discharge set-up. In Fig. 3 the PL-principle is given without showing the return conductors, the cooling system and the cylindrical saturable inductor surrounding the quartz tube. The design of a presently used prototype PL can be seen in Fig. 4. The vacuum tightness is here achieved by O-rings which are rapidly destroyed by radiation from the Z-pinch. For the new PL a sealing system has been proposed by Heraeus (Fig. 5, a, b, c). The main problems of the lens proper are:

- seals between electrodes and quartz tube.

- reliable high current contacts between electrodes and return conductors in the presence of water (or gas) cooling), pre-ionization and pre-magnetization of the saturable inductor.

Reliable and demountable contacts are also necessary between the PL and the stripline, as well as between different parts of the generator striplines (Fig. 6, a, b). Another problem is the construction of reliable high-current pseudo-spark switches (see Fig. 7). Prototypes (Fig. 8) have been run at 150 kA, 10 kV, but new units have to be properly engineered. With charging voltages of 20 to 30 kV an effort has to be made to avoid external flashover at striplines or switches. A minimum of diagnostics (current transformers mounted on switches, differential high voltage probes, etc.) as well as some security installations (security and dump switches, etc.) have to be built in.

Stoßentladungs-Kondensatoren

<u>Typ St.K. 4/3o</u>

Kapazität:	4 uF
Ladespannung:	3o kV
Prüfspannung:	6o kV-
Ws :	18oo
Bandleiteranschluß,	Querschnitt 1oo x 3 mm
	beide Pole für volle Ladespannung isoliert.
Gehäusegrundfläche:	495 x 2oo mm
Gehäusehöhe:	58o mm
Gewicht:	114 kg

Fig. 1: How the capacitors will look like.

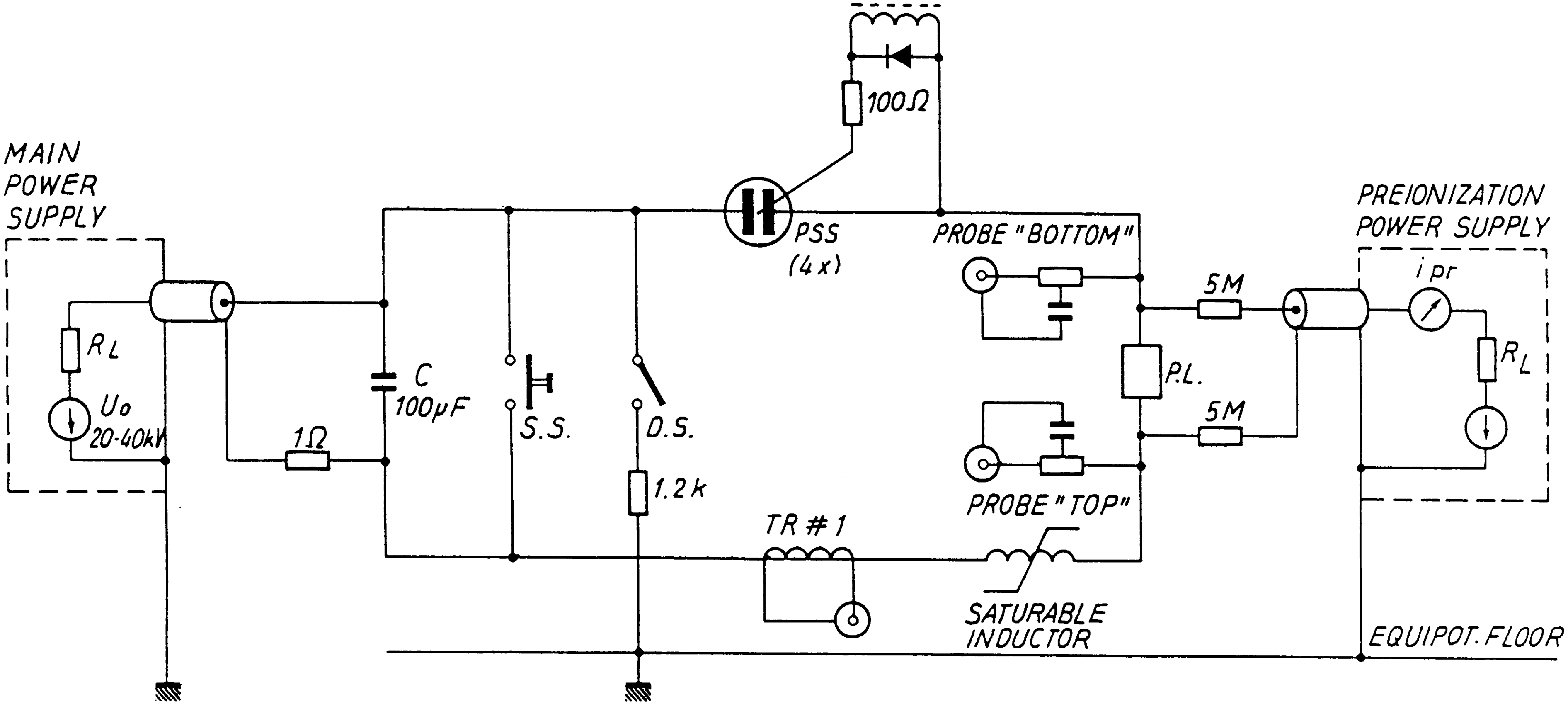


Fig. 2: ELECTRICAL SET-UP OF DISCHARGE -CIRCUIT FOR NEXT PL-DEVELOPMENT STAGE

P.L. = PLASMALENS	D.S. = DUMP SWITCH
TR#1 = MEASURING TRANSFORMER 1	S.S. = SECURITY SWITCH
R_L = CHARGING RESISTOR	PSS = PSEUDO-SPARK SWITCH

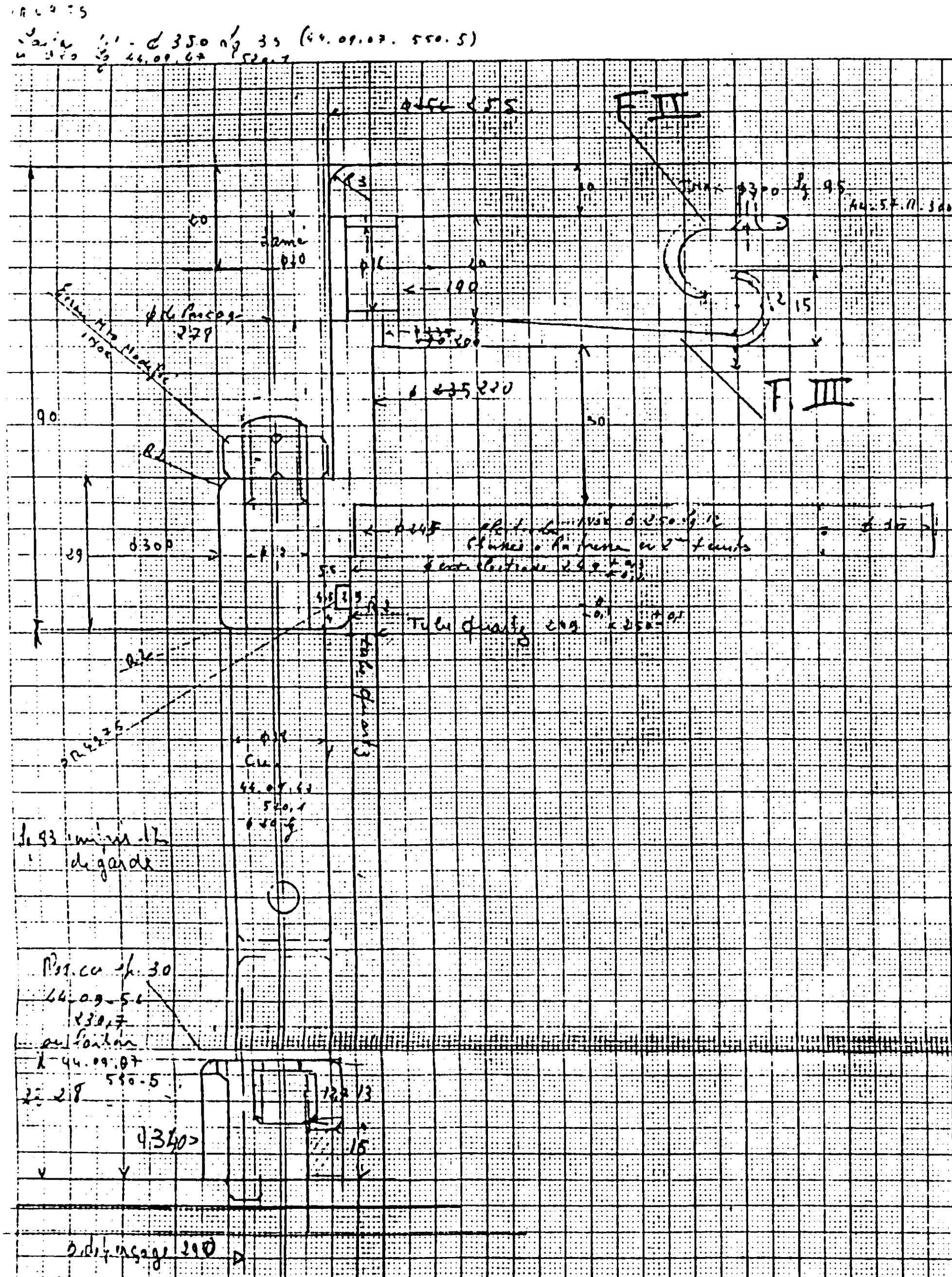


Fig. 4 Drawing of present PL-proto type.

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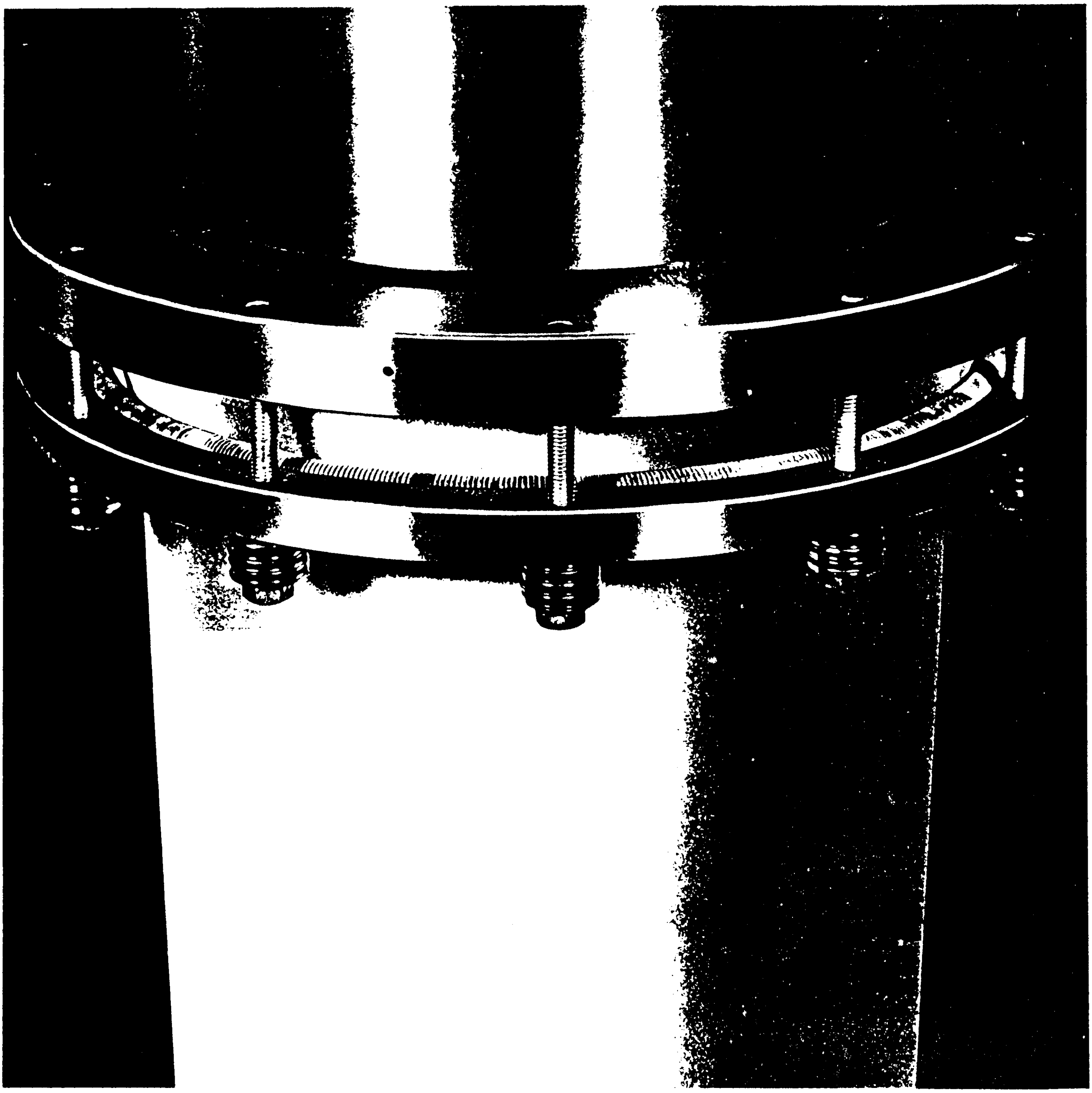
Fig. 5 a)

Der ROTOSIL®-Metall-Übergangsflansch APM
The ROTOSIL®-Metal Connecting Flange APM
Bride APM pour raccordement ROTOSIL®-Métal



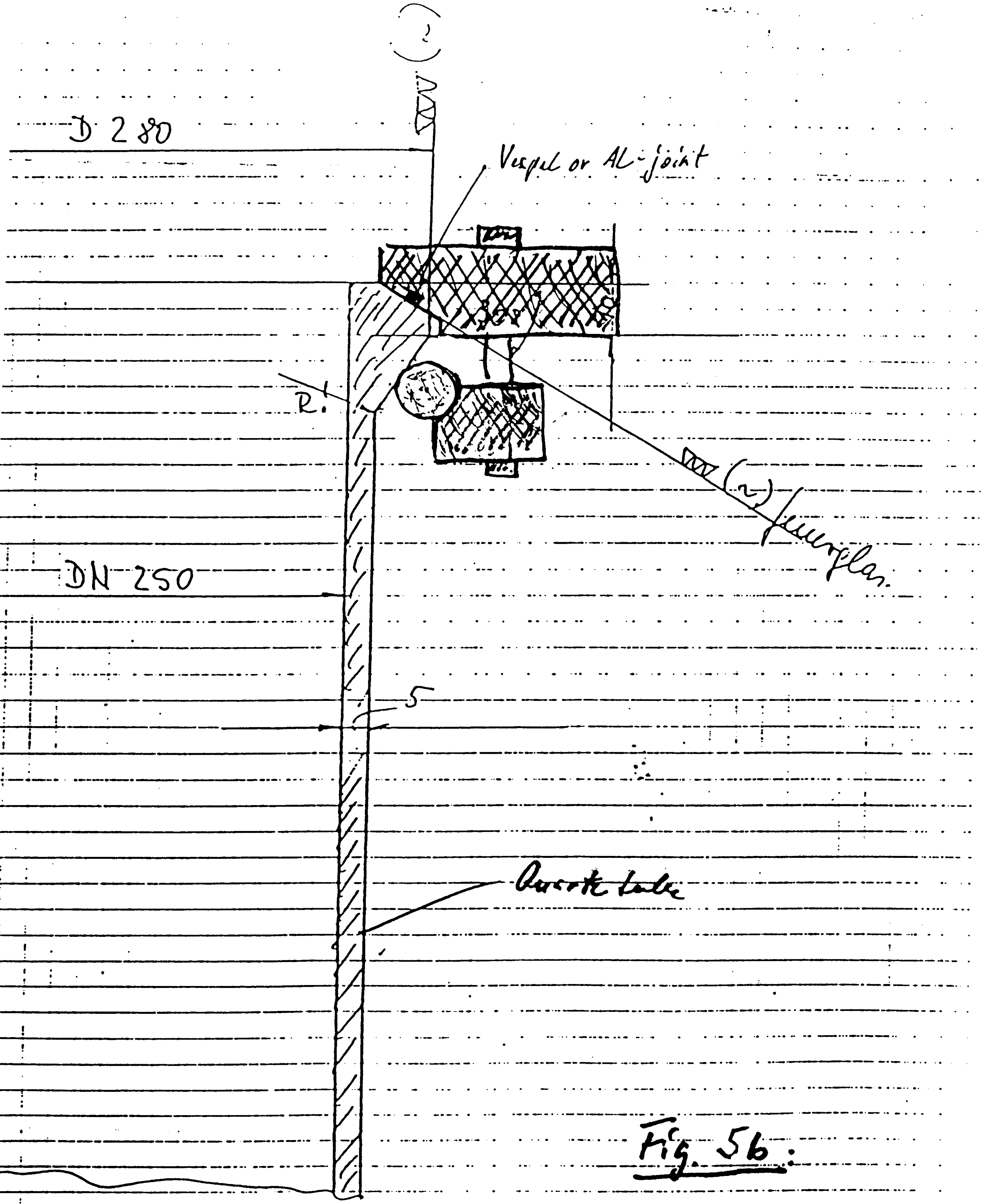
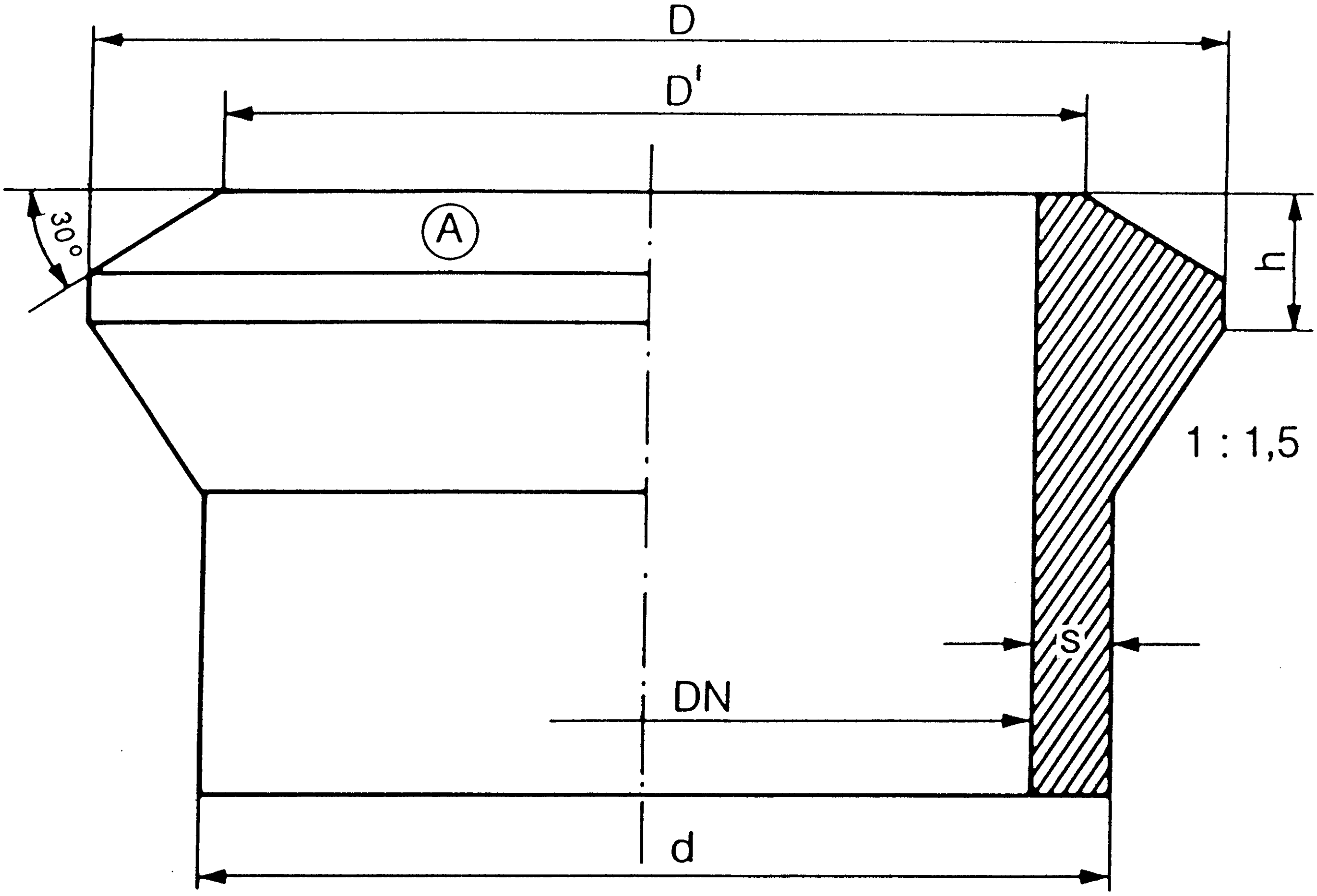


Fig. 5b:

Sonderflansch APM
für Heralux-Rohr

Angebot 1 St. Hx



DN	D	D'	h	d	S (mm)
80	125	91	15	97	8,5
100	150	112	17	120	10
150	210	165	20	174	12
200	262	217	21	228	14
300	376	319	25	336	18
400	480	420	27	440	20
450	530	470	27	490	20

Fig. 5c:

Heraeus
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Fig. 6a: New PL- Pulsegenerator (side view)

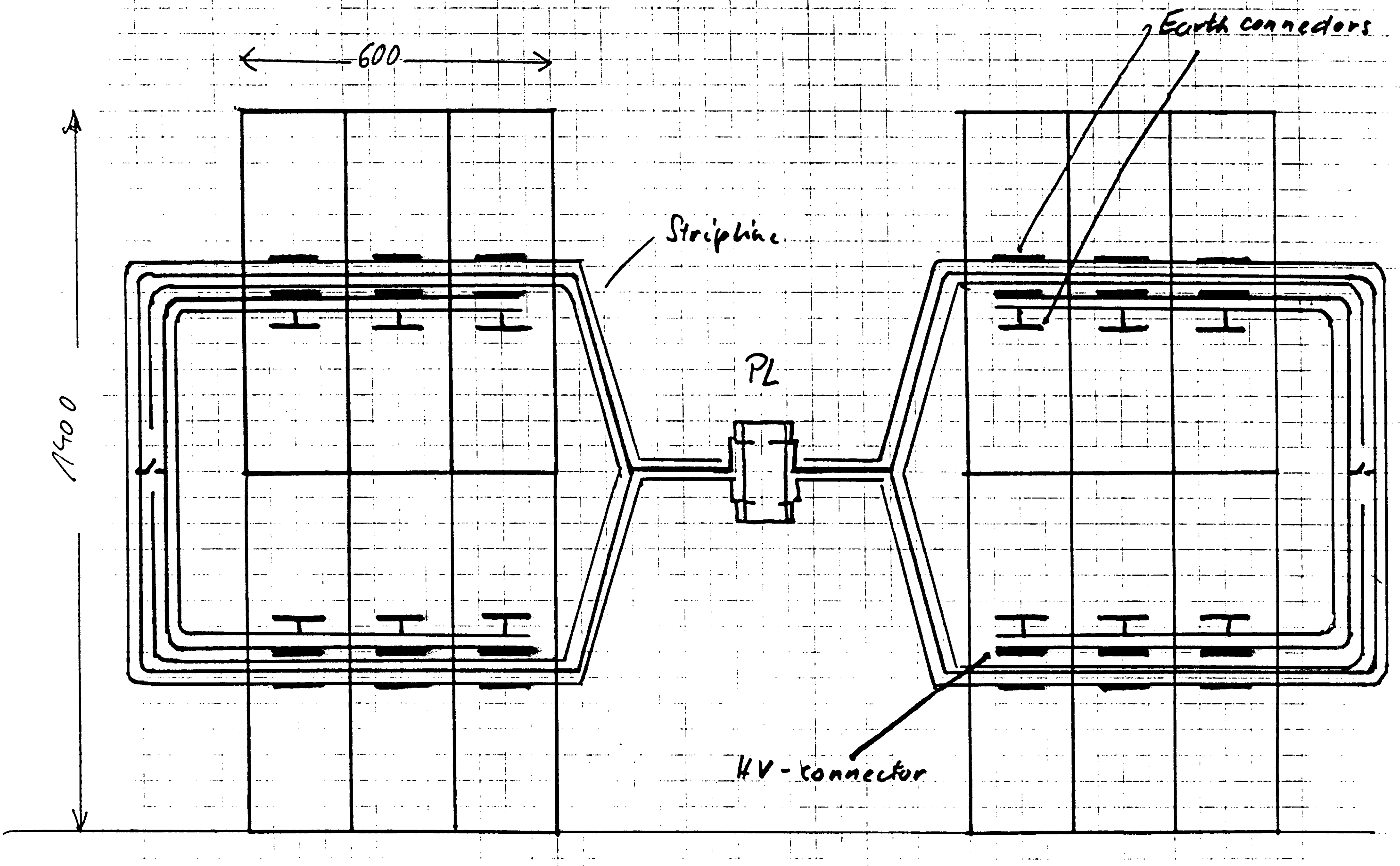
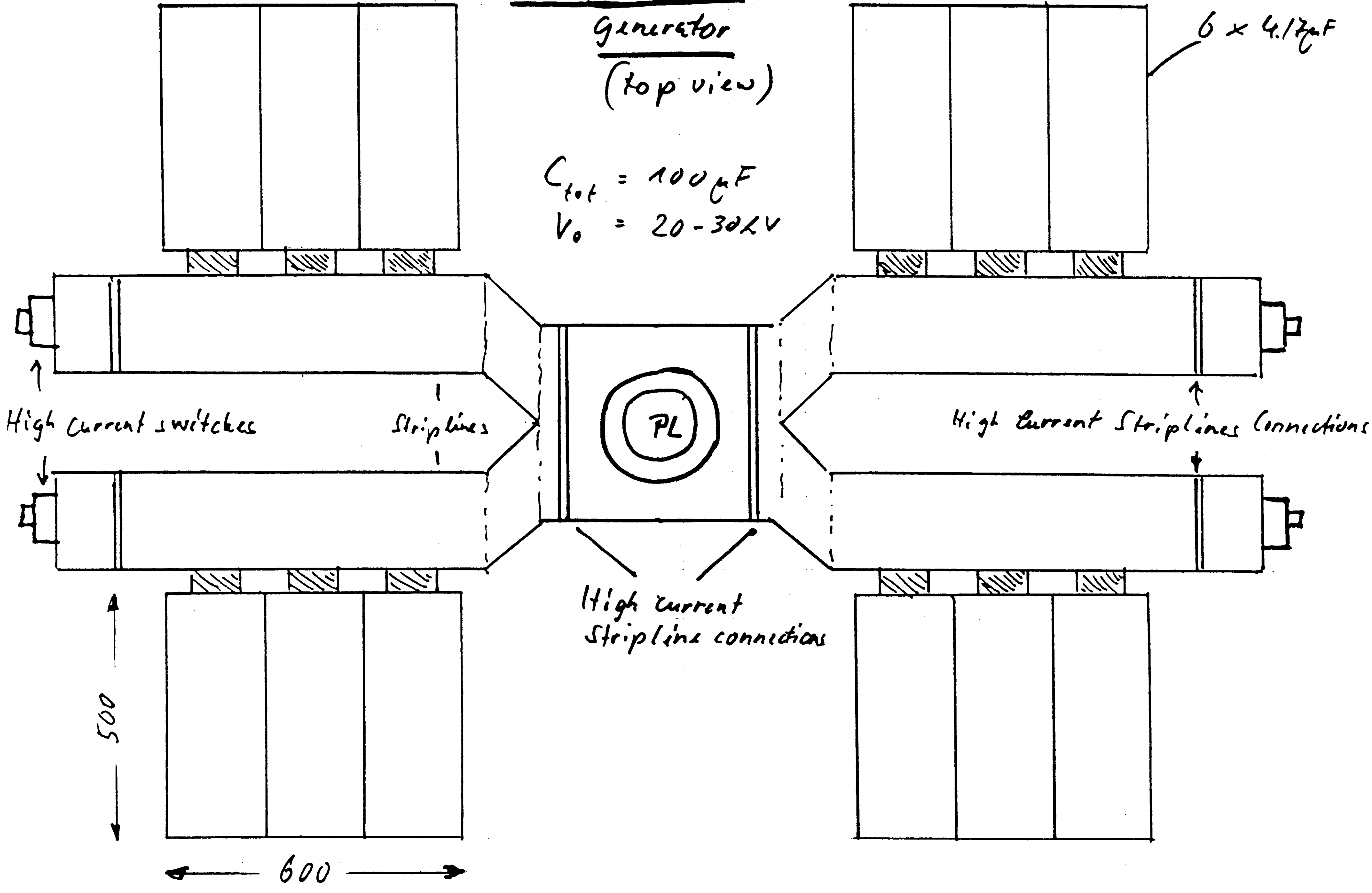


Fig. 6b: New PL - Pulse Generator (top view)



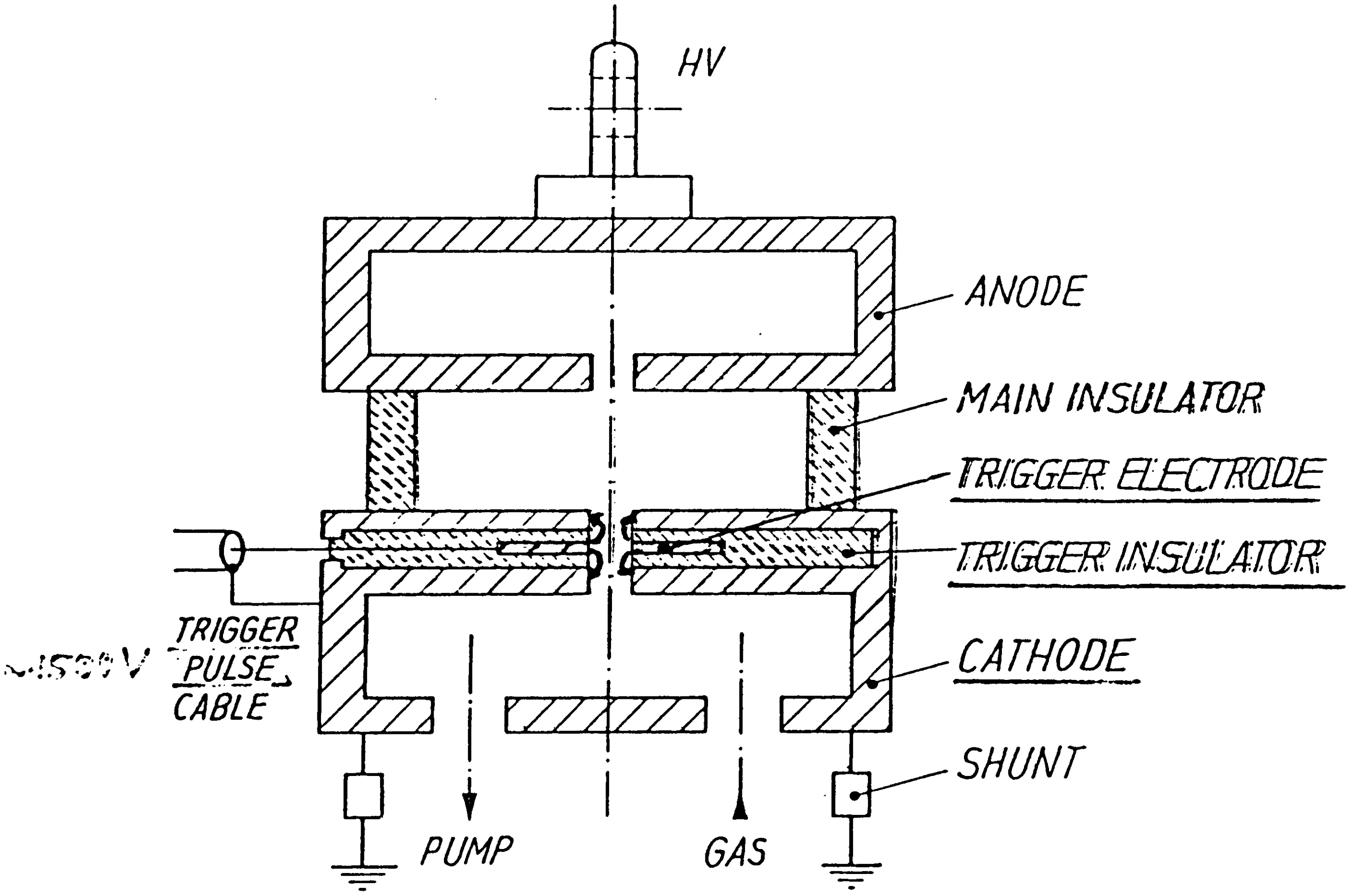


Fig. 7:
PSEUDO SPARK SWITCH WITH A DIELECTRIC SURFACE DISCHARGE TRIGGER

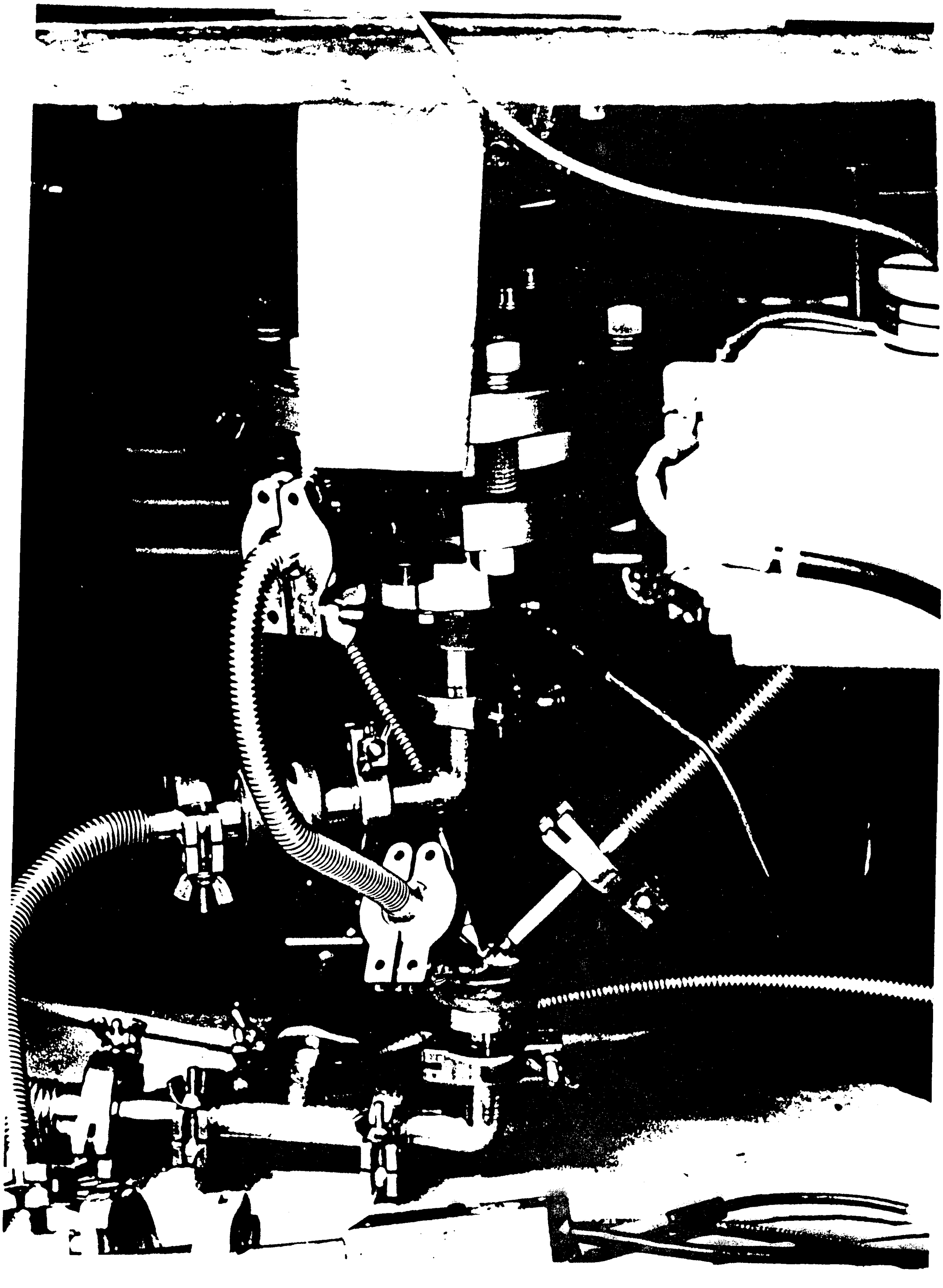


Fig. 8: High current pseudo-spark switch in capacitor discharge circuit