Review of early IR temperature measurements and research on thermal problems in TUG

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Outline

Early interests – 1965 – 1985/90

- optical and IR pyrometers
- research and industrial applications
- thermal problems in semiconductor devices

Friday presentation

IR Thermography in medicine – 1997 - 2017

- Active Dynamic Thermal Imaging – ADT
- Thermal Tomography – TT
- medical applications

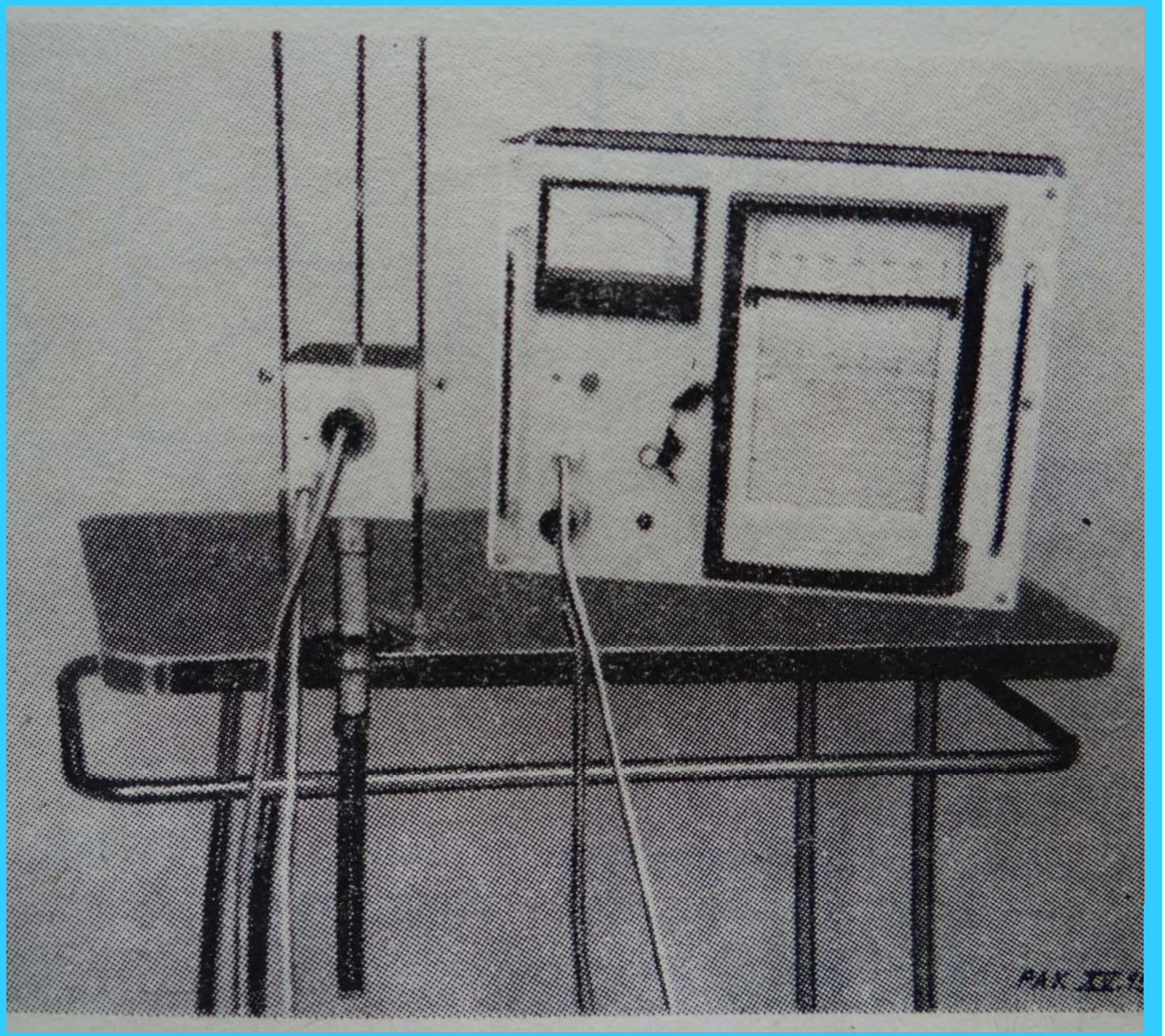
The early interests of the thermal research team came from industry and science suffering lack of availability of modern measurement instrumentation. This was especially painful in infrared domain strictly controlled by embargo restrictions.

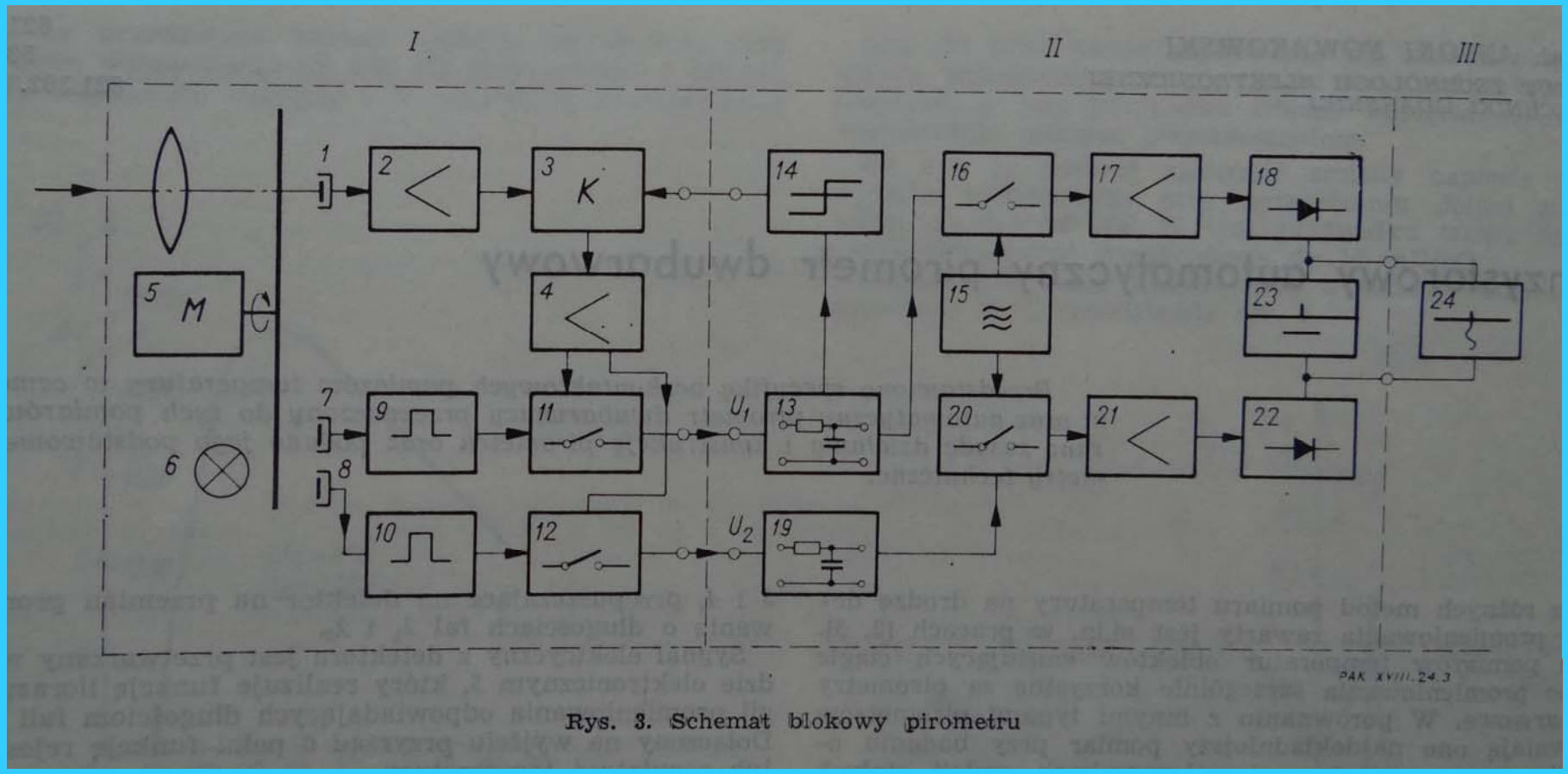
The practical goals of projects run in 70/80-ties were developments:
of non-invasive methods of diagnostics using electrical and IR technology in analysis of thermal problems in semiconductor devices and circuits but also other industrial applications.

As the result several unique pyrometric type instruments were developed:

- an IR thermometer to measure temperature of electric motor internal rotating elements;
- a scanning radiation pyrometer for analysis of temperature distribution in thick film electronic devices, both using non-selective thermistor bolometer detectors;
- a two-wavelength pyrometer for measurements and control of temperature of cement mills scorch zone supplied by coal powder, operating in near IR;
- series of TGS – pyroelectric IR detectors applied to handheld pyrometers to detect fires in coal mines.
-a mirror scanning microscope with MCT cooled detector to study temperature distribution in semiconductor structures; following are selected illustrations:

IR thermometer to measure temperature of electric motor internal rotating elements

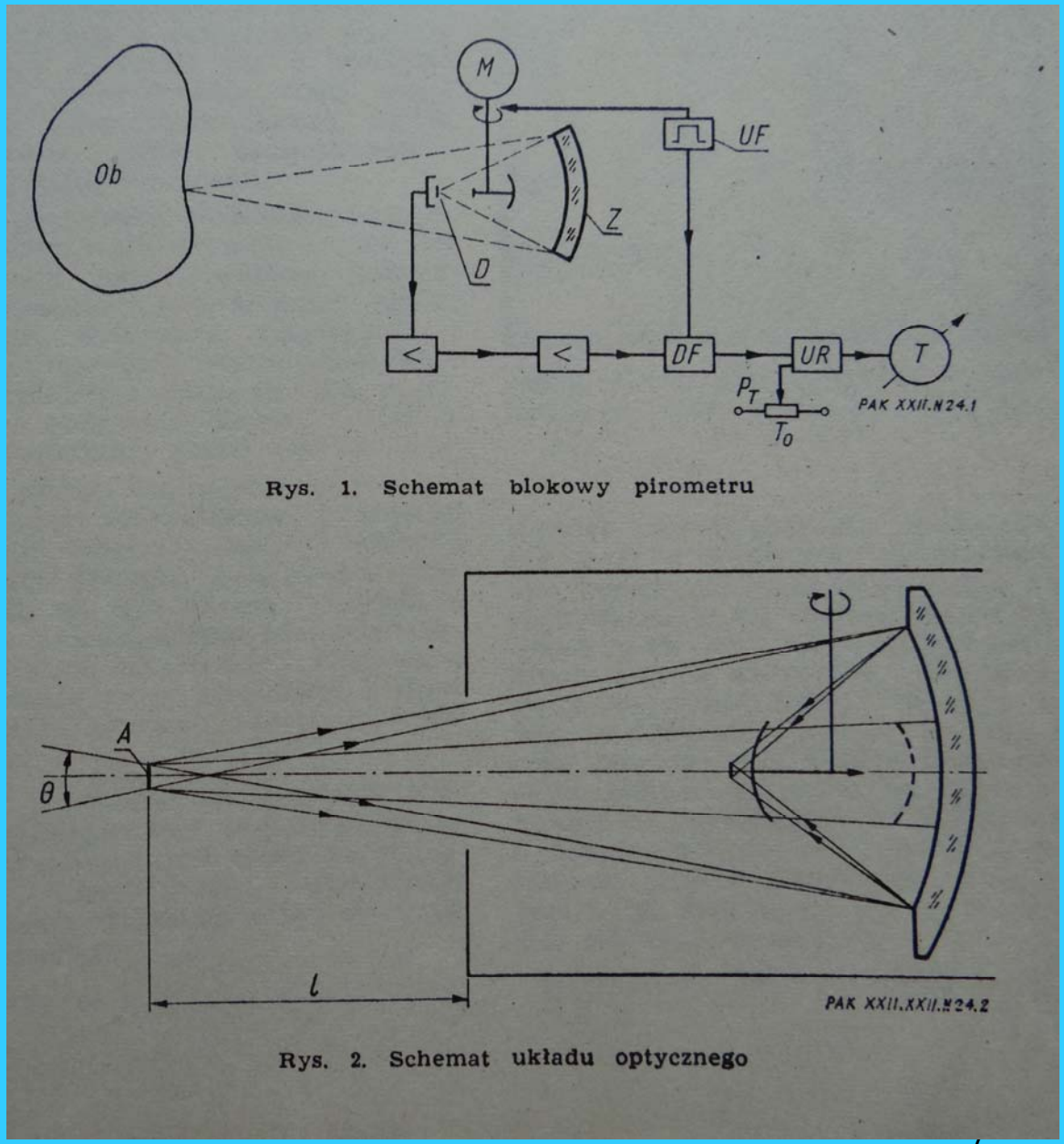




Rys. 3. Schemat blokowy pirometru

Block diagram of two-wavelength pyrometer

Handheld pyrometer with TGS detector, to detect fires in coal mines

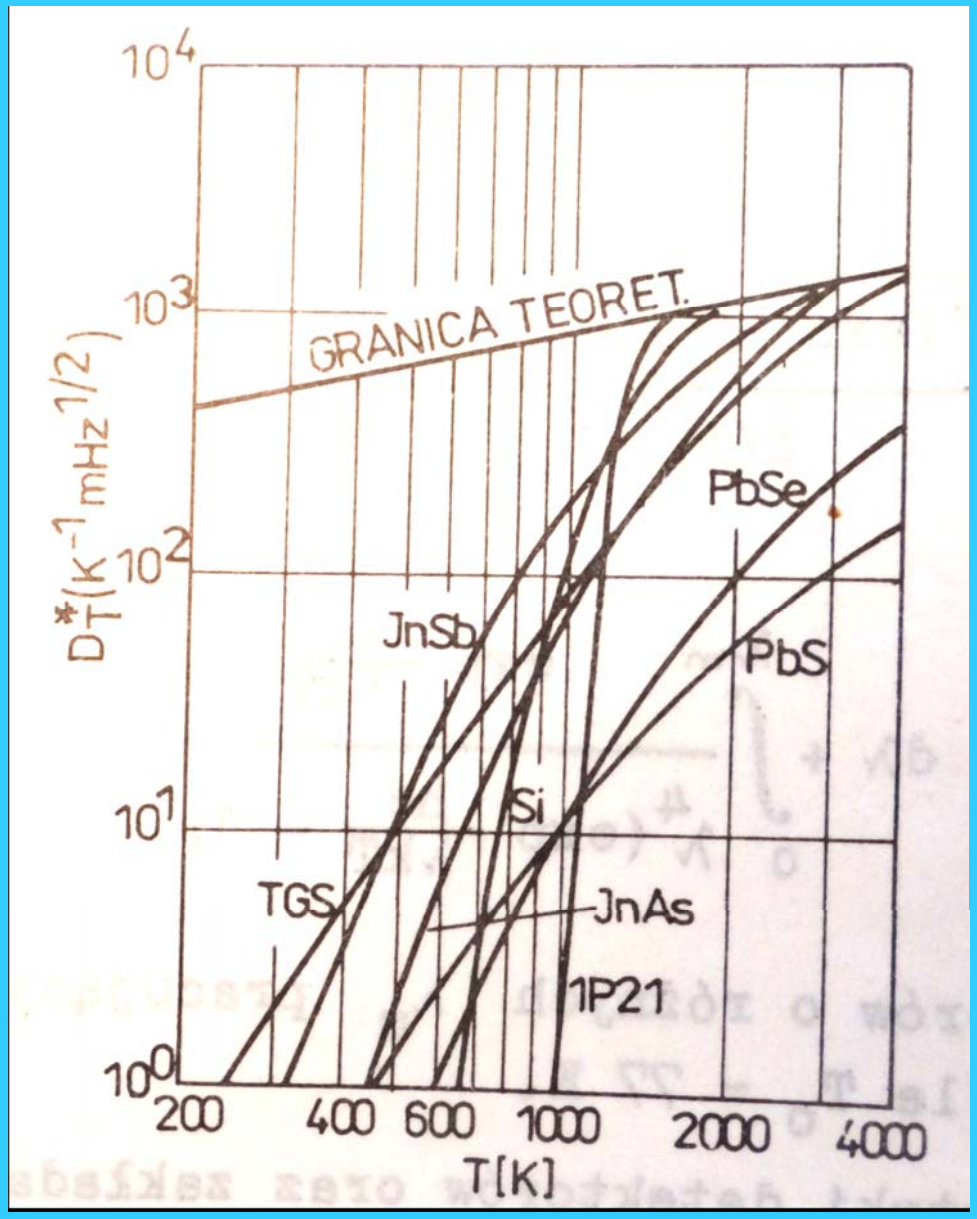


Rys. 1. Schemat blokowy pirometru

Rys. 2. Schemat układu optycznego

PhD dissertation,
Politechnika Gdańska, 1973

Nowakowski A.:
Analiza ekstremalnych właściwości detekcyjnych pirometrów – Analysis of detection limits in pyrometry,



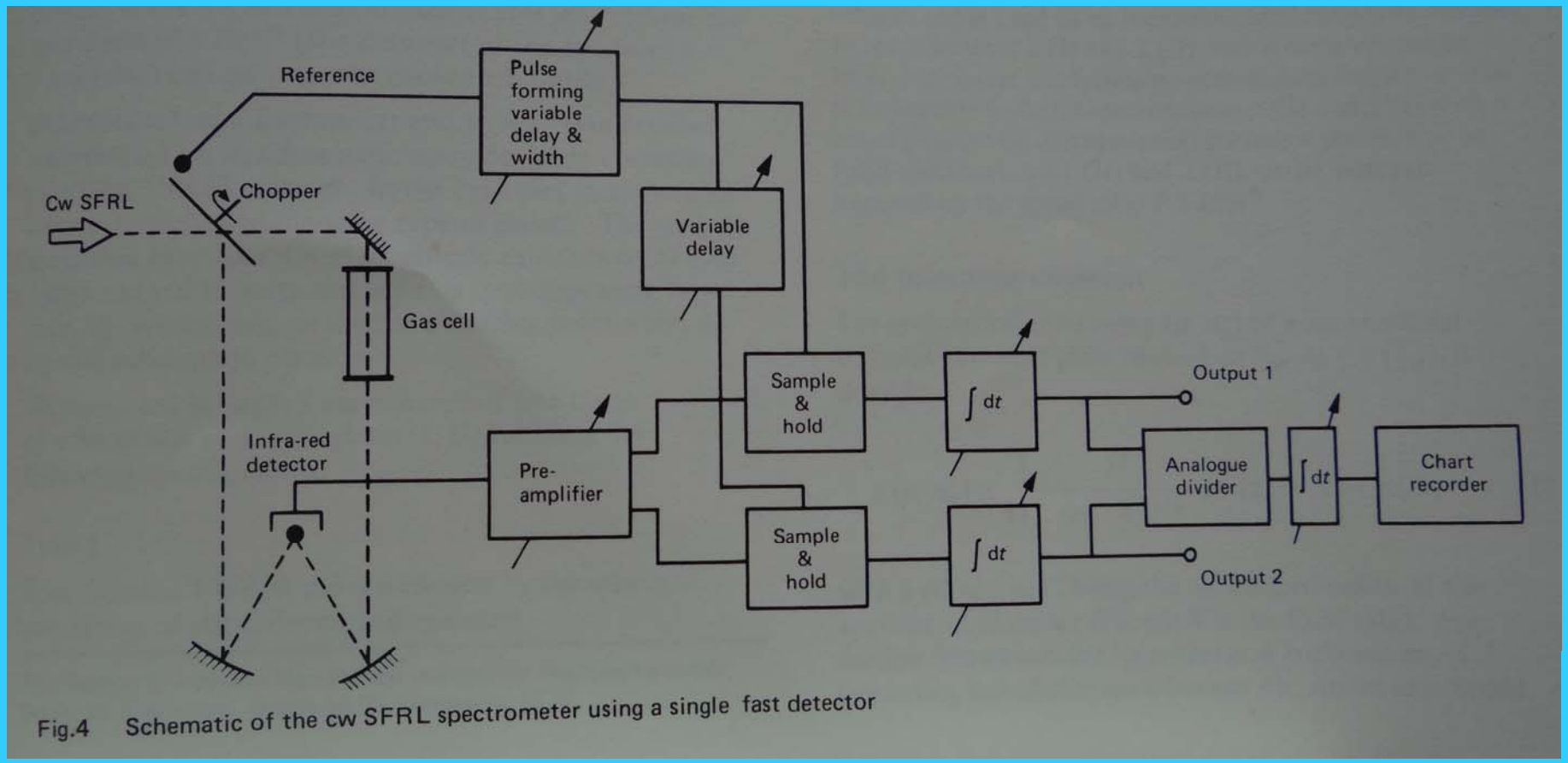


Fig.4 Schematic of the cw SFRL spectrometer using a single fast detector

1974 – 75 postdoctoral fellowship – Heriot Watt University
block diagram of high resolution SFRL IR spectrometer (~ 10 – 11 μm; 0,001cm^{-1})

The period 1975 – 1990 was important for advanced studies on thermal problems in semiconductor devices.

As practical implementation of the research results several advanced measurement and testing sets have been developed and implemented for industrial production control in the NPCP CEMI, factories TEWA, LAMINA, KAZEL, including:

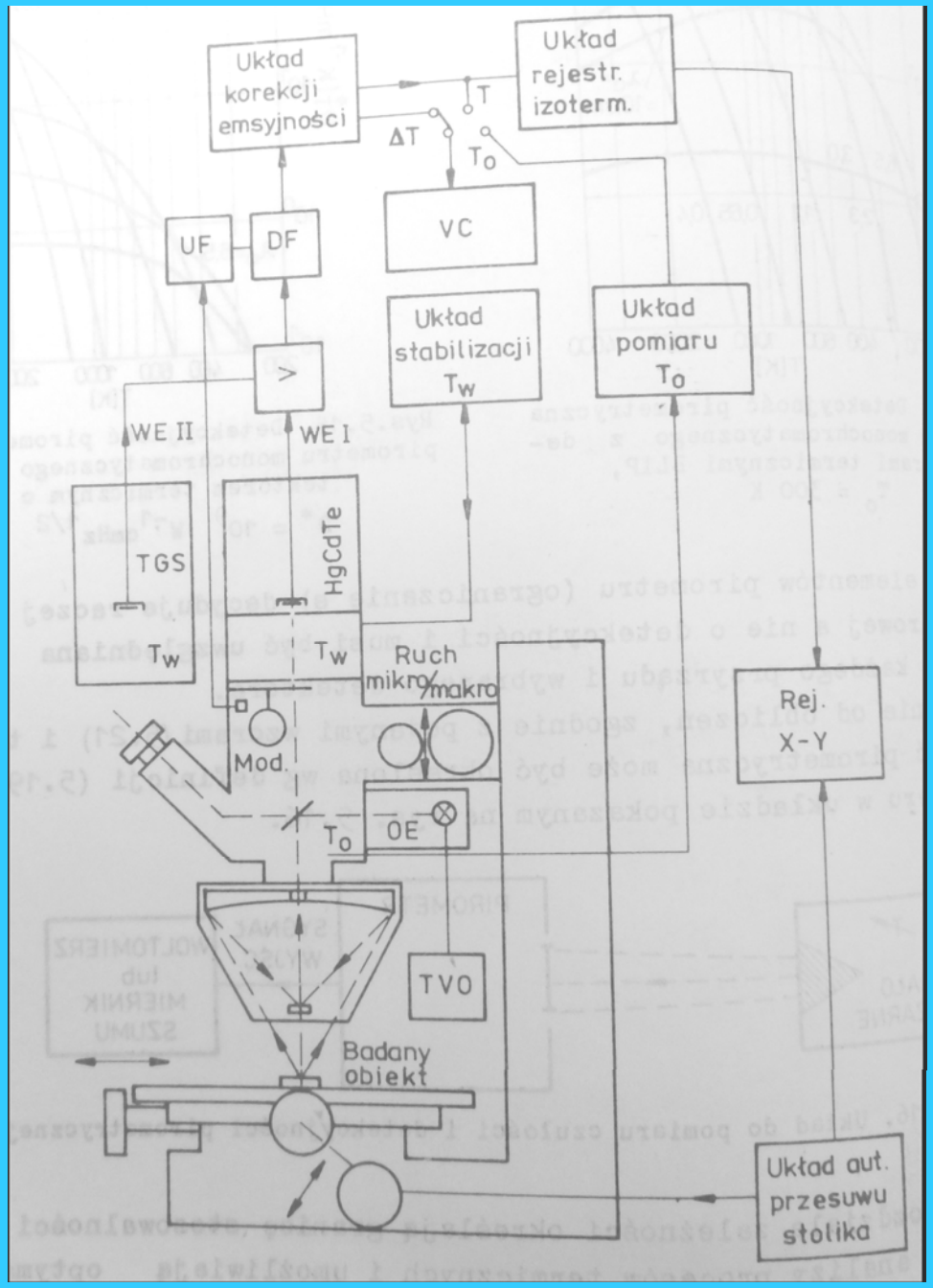
-a microscope to study recombination radiation of high power diodes and thyristors, operating in near IR;

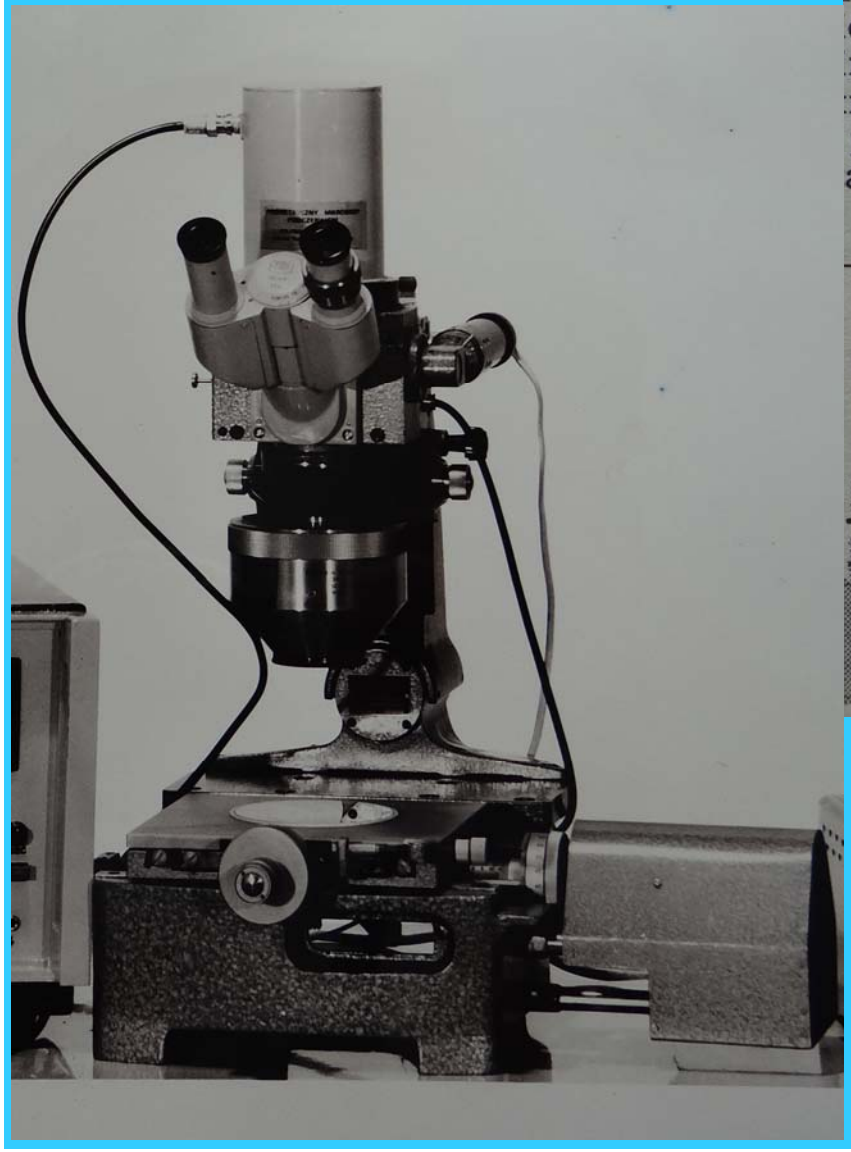
-testers for non-destructive determination of second breakdown of high power transistors; several automatic sets of SOA – safe operation area of different semiconductor devices;

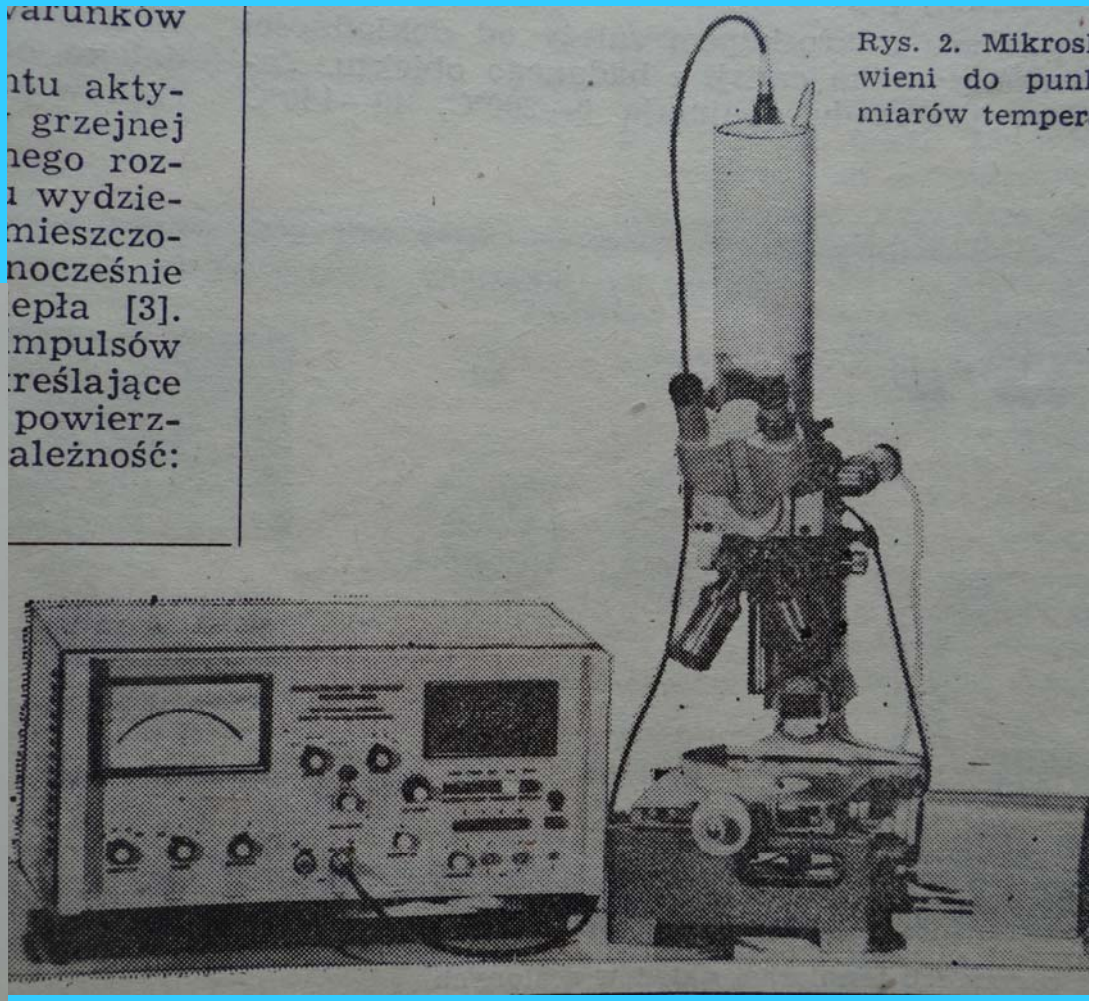
-several instruments for determination of thermal resistance and thermal impedance of diodes, transistors and integrated circuits.

Block diagram of IR microscope for investigation of temperature distribution in semiconductor structures – point measurements with step motor X-Y moving support

for ITE Warsaw







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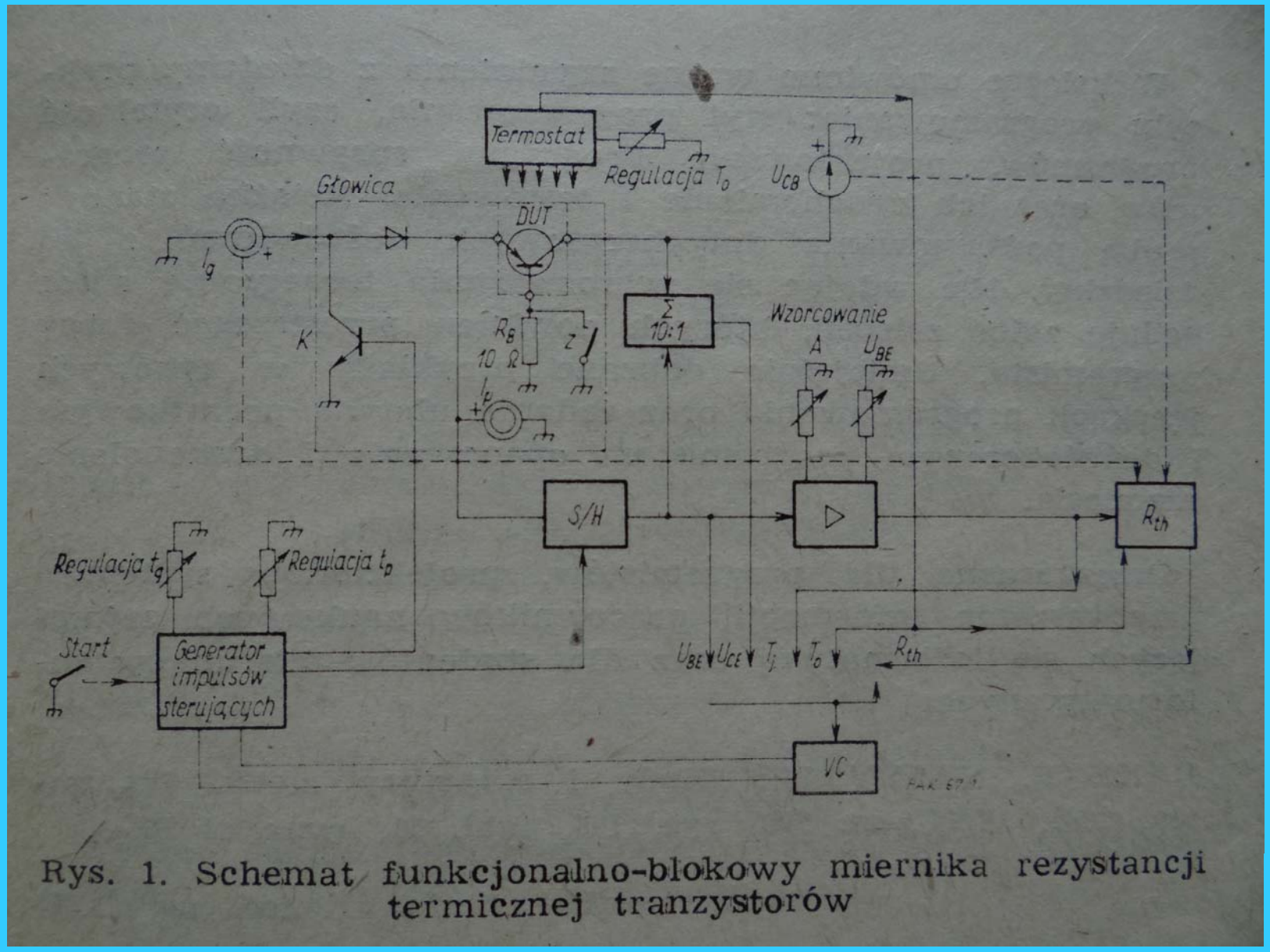
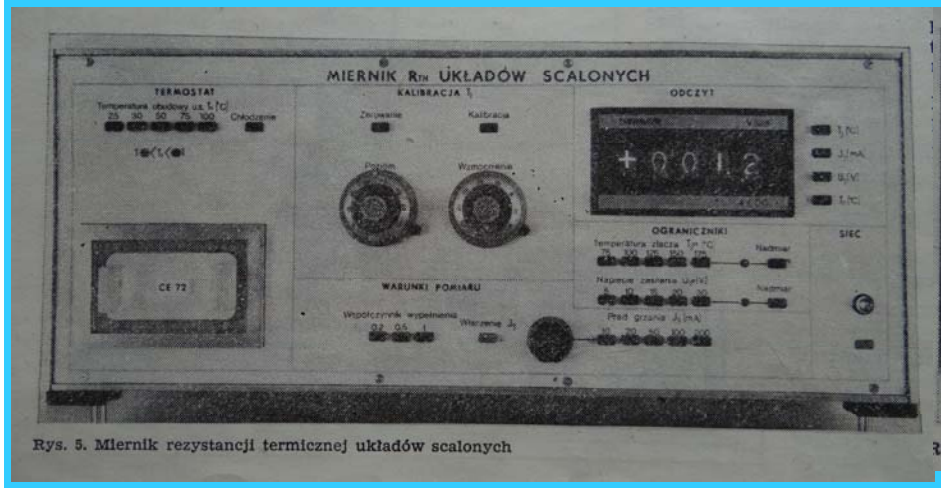
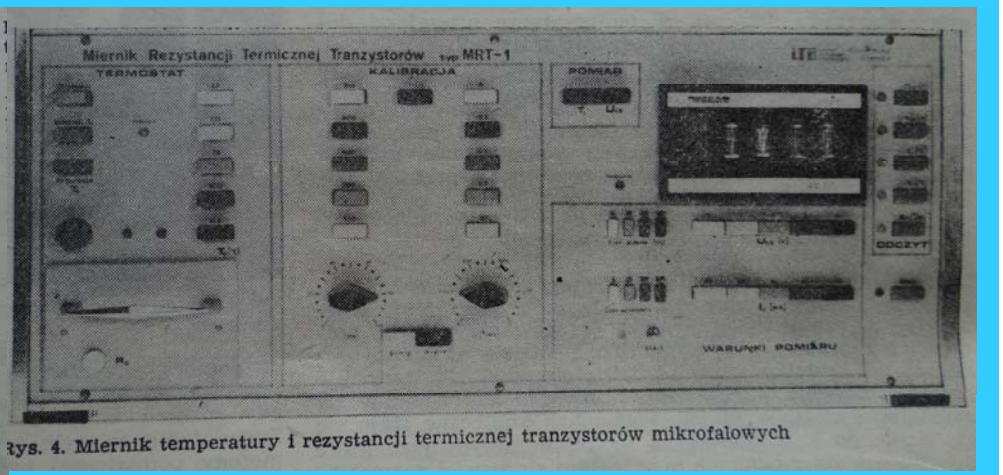


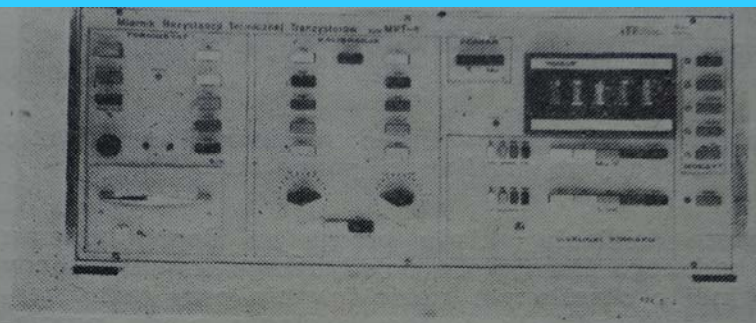
Rys. 1. Schemat funkcjonalno-blokowy miernika rezystancji termicznej tranzystorów



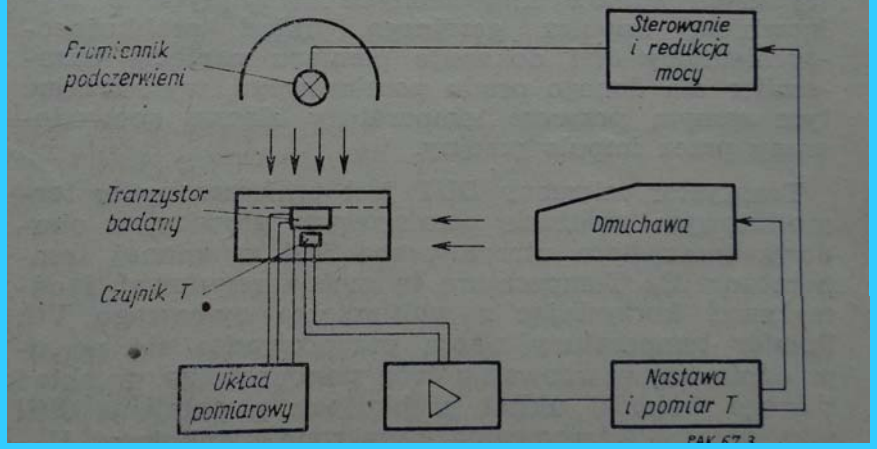
Rys. 5. Miernik rezystancji termicznej układów scalonych



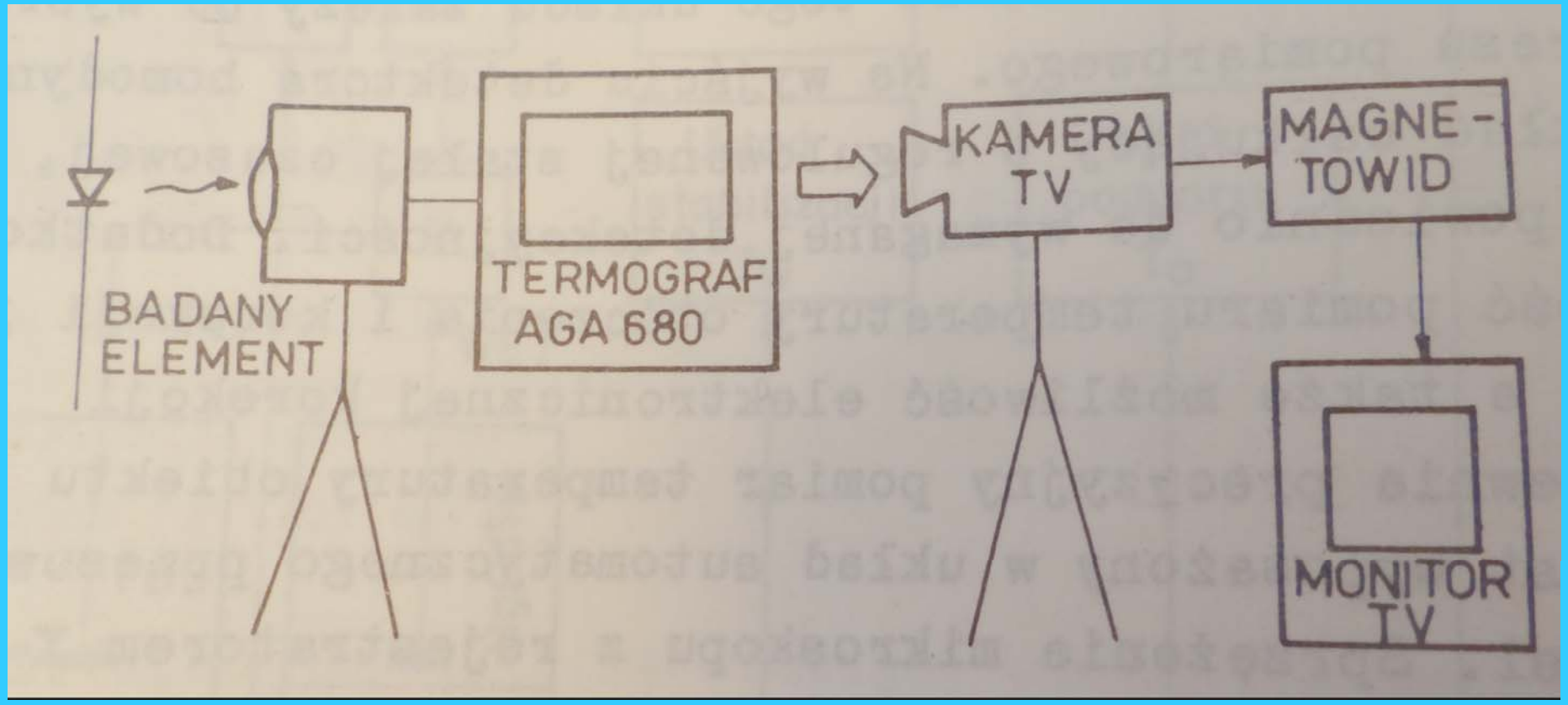
Rys. 4. Miernik temperatury i rezystancji termicznej tranzystorów mikrofalowych

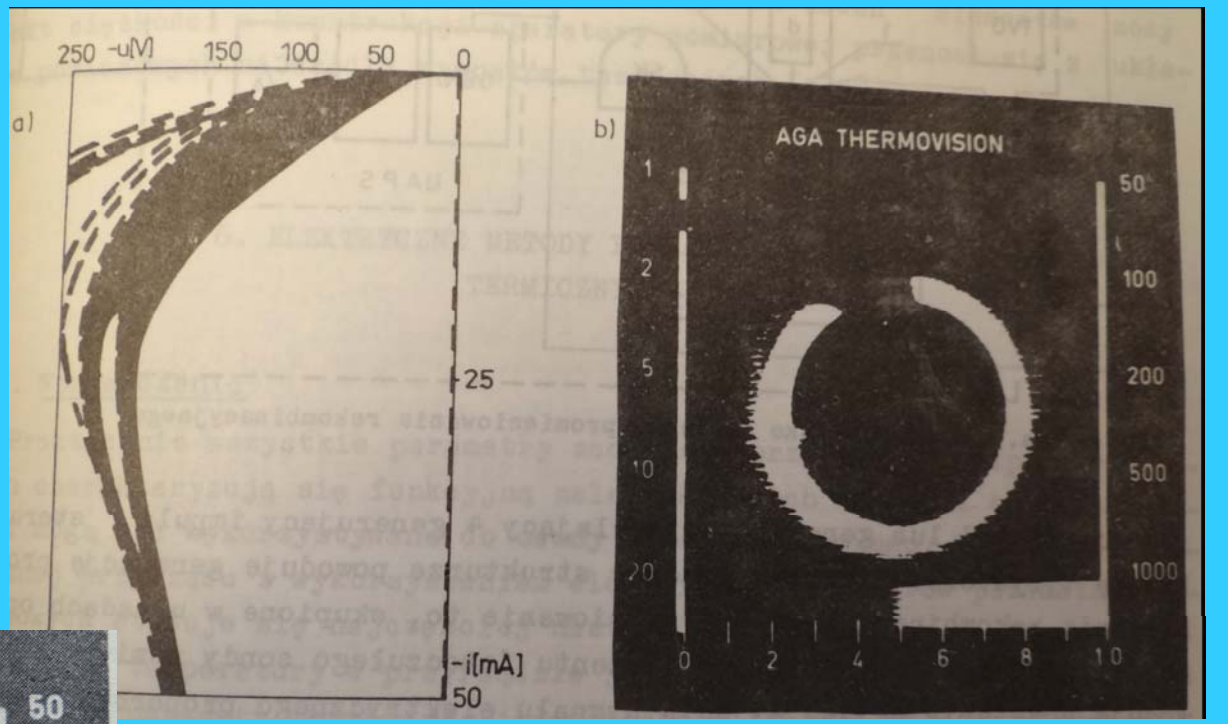


Rys. 2. Miernik temperatury i rezystancji termicznej tranzystorów mikrofalowych typ MRT-1



Investigation of electrical & thermal breakdown of high power semiconductor devices for LAMINA

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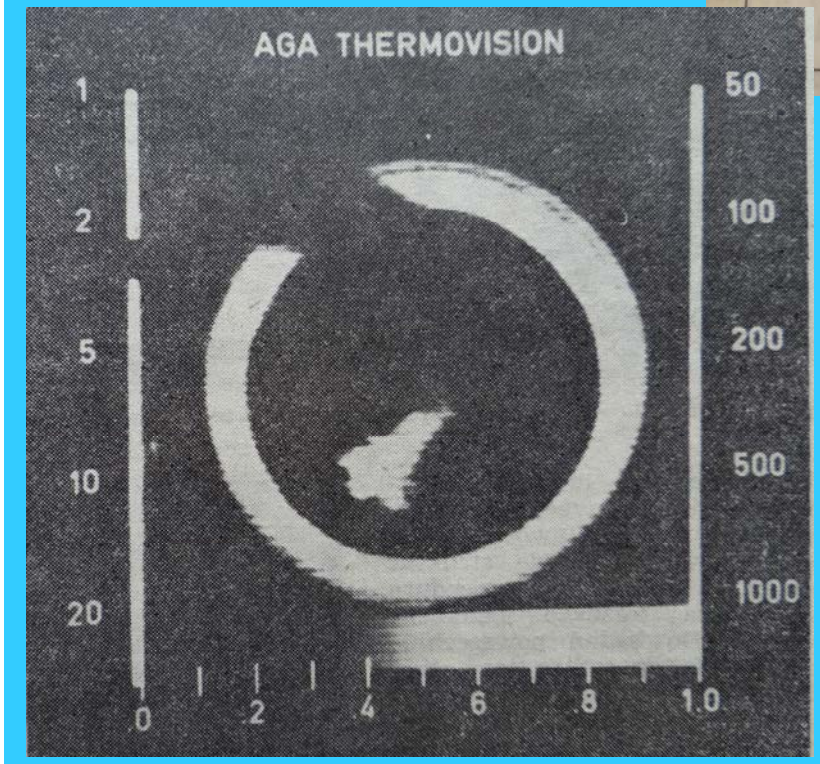
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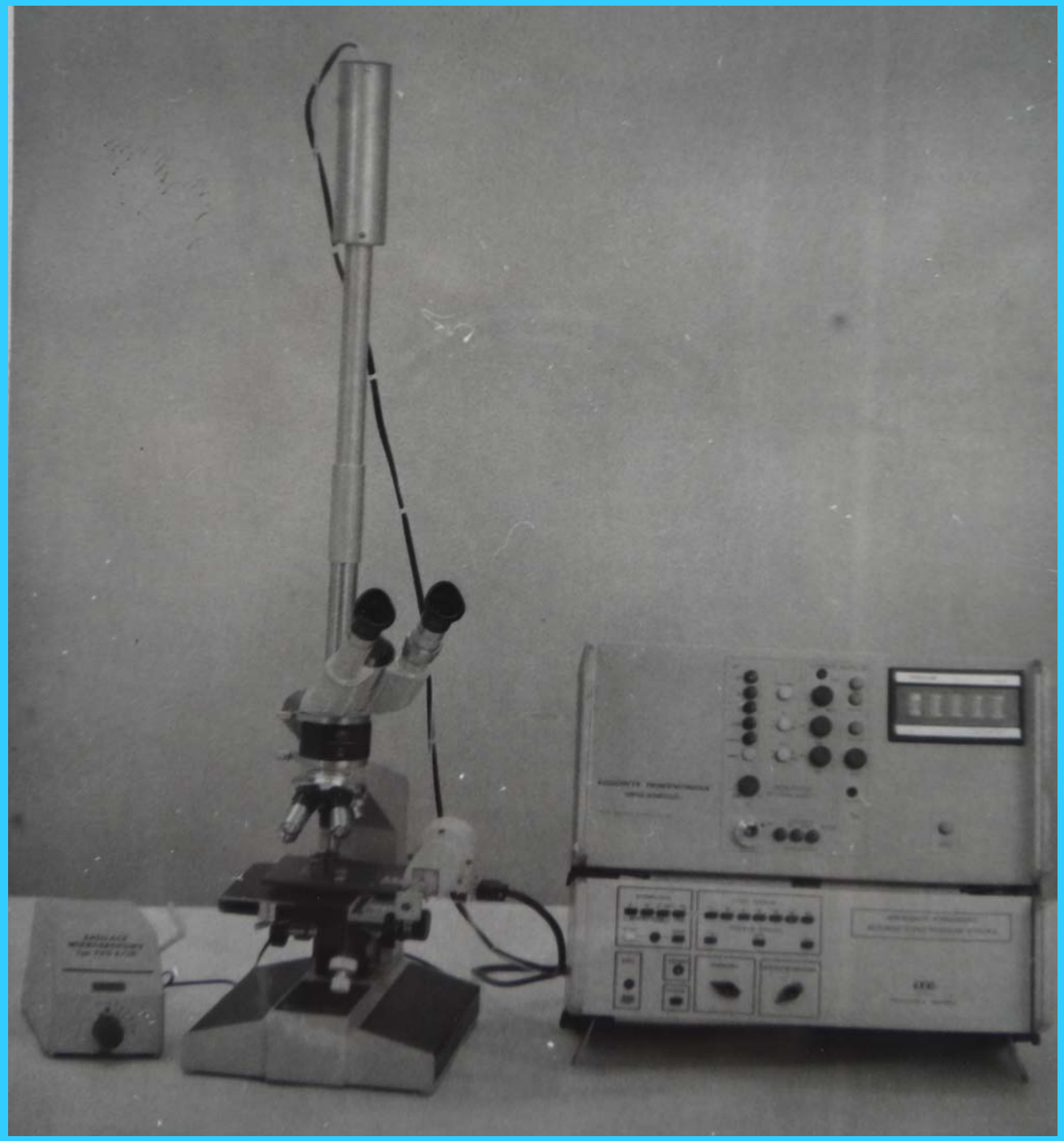
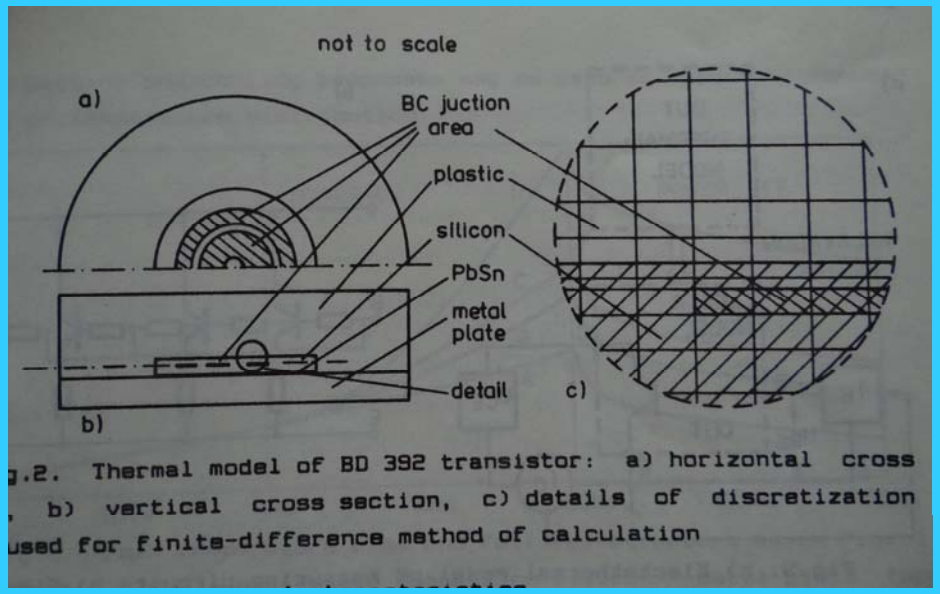
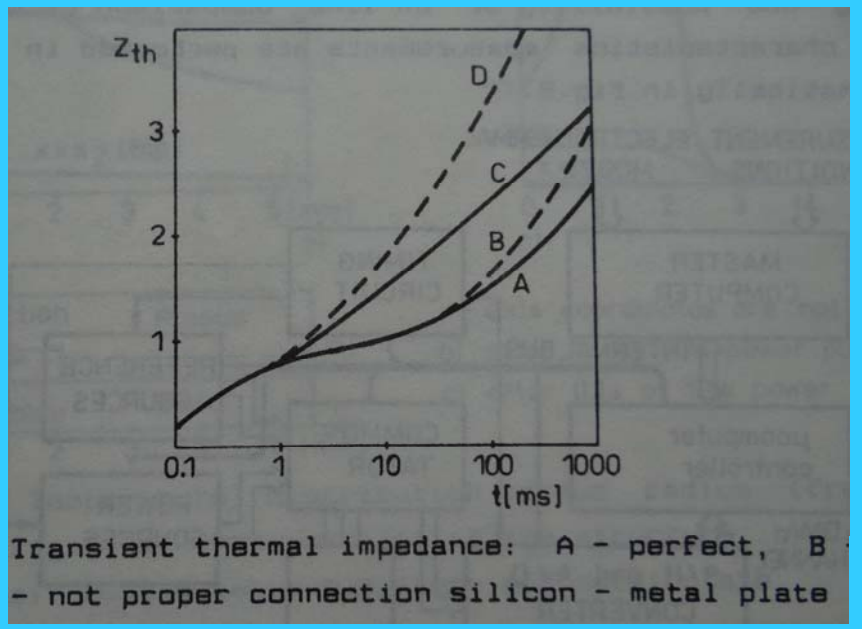
Microscope for measurements of IR recombination radiation



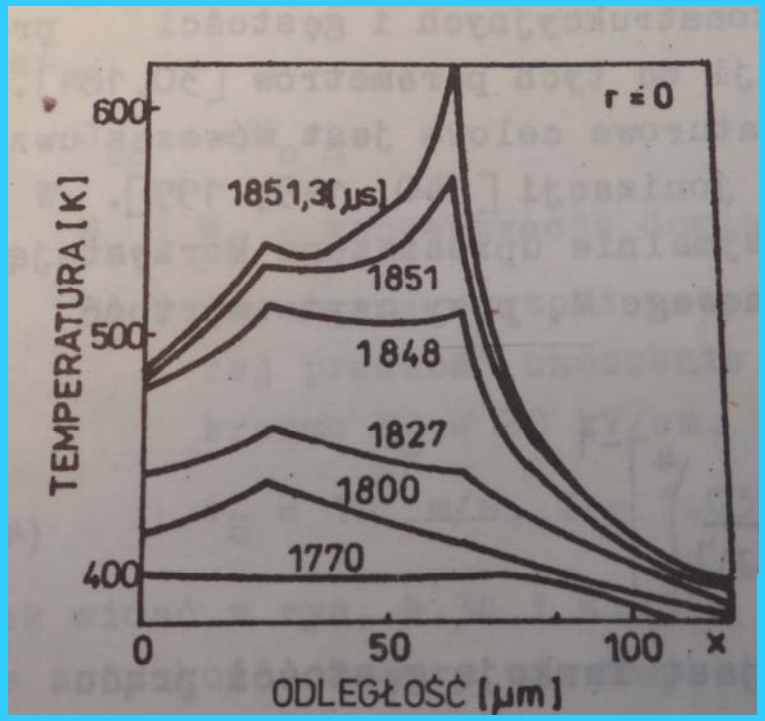
Modelling & simulation analysis of semiconductor devices



g.2. Thermal model of BD 392 transistor: a) horizontal cross , b) vertical cross section, c) details of discretization used for finite-difference method of calculation



Transient thermal impedance: A - perfect, B - not proper connection silicon - metal plate



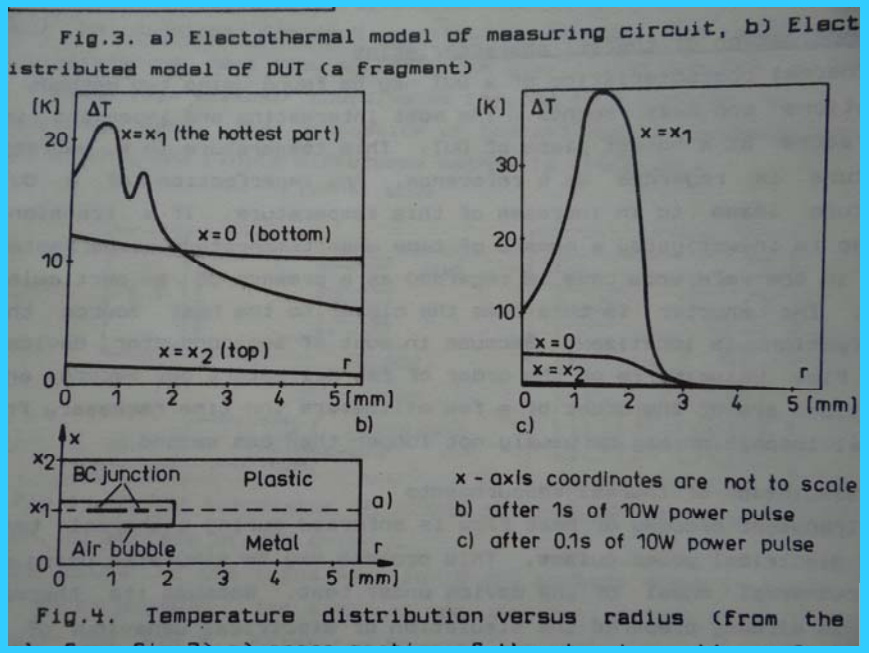
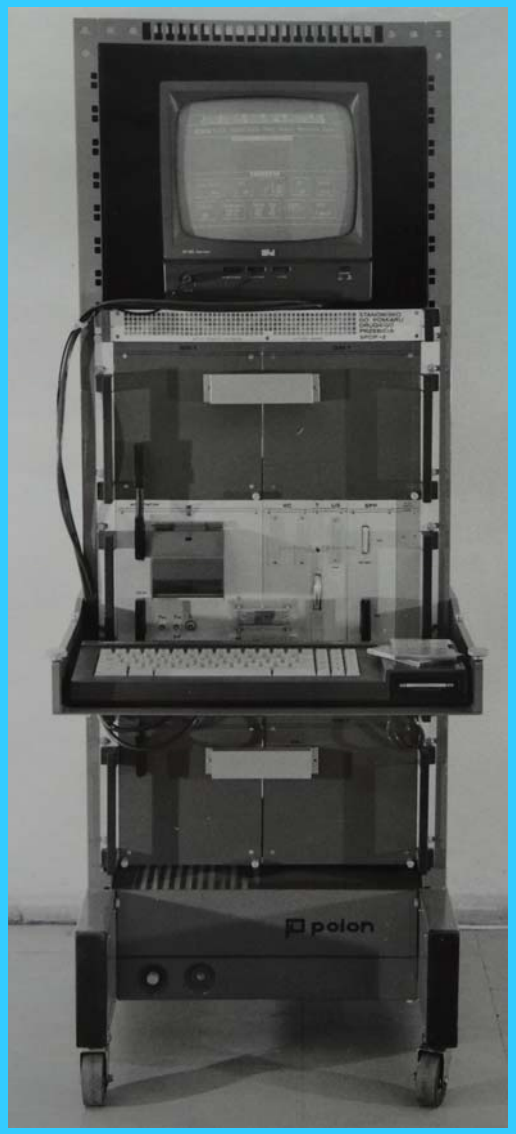


Fig.4. Temperature distribution versus radius (from the

Industrial testers based on electrical measurements: thermal impedance, determination of SOA and measurements of second breakdown of high power transistors – implemented in NCPC - TEWA, KAZEL.



Habilitacja - 1985
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