

DOCUMENTATION SUR LES ANODES TOURNANTES DÉMONTABLES POUR TUBE À RAYONS X ENRAF-NONIUS

FICHE N° 4034

PRÉSERVER
SAUVEGARDER
VALORISER

Période de fabrication : 1950-1974

Fabricant : ENRAF-NONIUS

Domaines : Chimie, Physique

Sous-domaines : Cristallographie, Cristallographie

Organisme : Université de Rennes

Ville : Rennes

Modèle : anode tournante

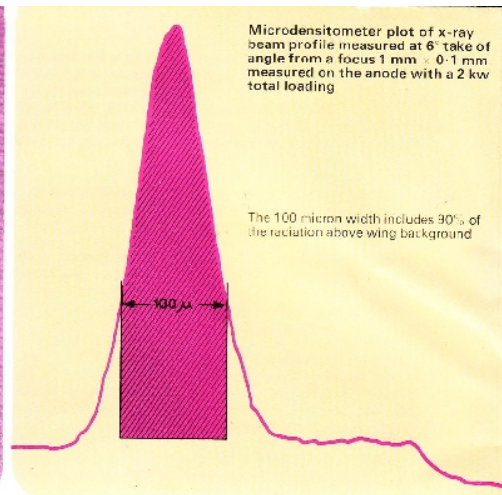
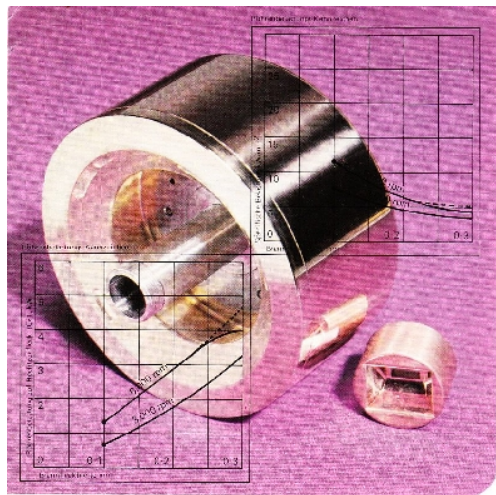
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Description

Une documentation complète était fournie avec les anodes tournantes en cuivre pour tubes à rayons X. Diffusée par l'entreprise Enraf-Nonius mais aussi par d'autres constructeurs comme Eliott, elle décrivait la pièce, ses caractéristiques et propriétés mais aussi tout son environnement technique (tubes et générateurs de rayons X).

Utilisation

Cette anode, était une pièce essentielle d'un tube émetteur de rayons X. On applique sur celui-ci une puissance électrique très forte de l'ordre de 15 kW et son échauffement peut être extrêmement élevé. Le dispositif à anode tournante en cuivre à très grande vitesse (3000 à 6000 tours par minute) va accélérer la dissipation de chaleur ce qui permet d'augmenter la puissance électrique et donc la brillance du faisceau de rayons X. Le tube était utilisé avec un générateur Enraf-Nonius du type GR 20 ou G 21.



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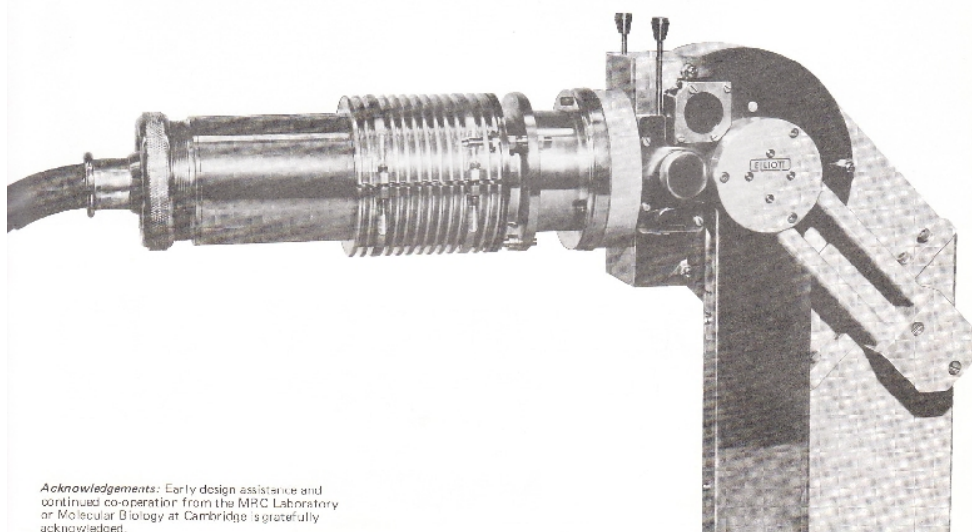
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SPECIFICATION

Anode diameter	3.5in (89mm)
Anode rotational speed	3,000rpm or 6,000rpm
Standard target	Cu
Number of windows	2 (RA2) 3 (RA3)
Inherent filtration	0.2mm beryllium
Focus sizes measured on anode	1mm x 0.1mm 2mm x 0.2mm 3mm x 0.3mm
Focal spot loading	1.2kW for 1mm focus 3.0kW for 2mm focus 4.0kW for 3mm focus

Power Supply

Maximum anode voltage	50kV
Maximum tube current	80mA
Maximum power (kV x mA)	4.0kW
Voltage stability	Better than 0.1%
Current stability	Better than 0.1%
Voltage ripple (max. peak to peak)	30 volts/mA (2.5kV max.)
Voltage range by digital selection	0-50kV by 1kV
Current range by digital selection	0-80mA by 1mA
Type of rectification	Constant potential voltage doubler using silicon diodes
Type of voltage stabiliser	Solid state servo using thyristor primary current control
Type of current control	Solid state servo using triac primary current control of filament transformer
Filament transformer maximum voltage	12V
Filament transformer maximum current	10A
Bias supply maximum voltage	500V d.c. approx.



Acknowledgements: Early design assistance and continued co-operation from the MRC Laboratory of Molecular Biology at Cambridge is gratefully acknowledged.

GX 20 ROTATING ANODE X-RAY DIFFRACTION GENERATOR

Design Features

High Intensity

Micro Focus

Micro-focus cathodes are available with all Elliott Rotating Anode Generators.

Low Vibration

Spatial stability of the X-ray source approximately $1 \mu\text{m}$ after warm up.

Approximately Gaussian Energy Distribution in the Focal Spot

Unlike many fine focus X-ray tubes the GX20, has no "Double Humping" in the focal spot energy distribution.

Long Filament Life

The focusing system permits use of a relatively large emitting surface giving a substantial gain in filament life as compared with other micro-focus cathodes.

Pure Beryllium Windows

Inherent filtration 0.2mm of Be.

These equipments are complete X-ray generators, consisting of fine-focus rotating anode X-ray tubes together with associated vacuum systems, closed circuit cooling systems and a 50kV stabilised constant potential high voltage generator.

The X-ray Tubes

The continuously pumped X-ray tubes have rotating anode assemblies driven by an electric motor. The tubes' cathodes are fully insulated and demountable. The combination of the fine focus cathode with the rotating anode provides a reliable and continuous X-ray source of very high intensity, thereby greatly facilitating X-ray diffraction work by reducing the exposure times which would otherwise be required.

Tube Power Supplies

The power supplies for the tube are of advanced design, employing solid-state techniques throughout to ensure the very high stability of output needed. Digital selection gives repeatability of desired voltage settings. The current in the X-ray tube is also selected and stabilised within 0.1% by a similar type of system controlling the filament heating transformer. A variable bias supply is included to enable focal spot conditions to be optimised for each cathode configuration employed.

Cooling System

A closed circuit cooling system is incorporated in the equipment to ensure an adequate flow of water in the anode

independent of the quality, pressure and quantity of available site supplies.

Control System

The control system consists of a number of sub-units, each devoted to a specific group of circuit functions. Several of the sub-units are in the form of plug-in printed circuit boards which are extremely easy to exchange during servicing. The operator's controls and indicators are grouped on two small panels which are mounted one above the other at a convenient height in the control rack.

The control system uses solid-state techniques exclusively.

Integrated Trip Protection Circuit

Flashover protection is provided. This is sensitive to surges of current. Isolated surges cause the high voltage supply to be shut off and then automatically restored at a controlled rate to the pre-set level. The high voltage supply will only shut off completely if the surges occur frequently or if they are severe.

This protection circuit is adjustable according to conditions of use. Not only does the flashover protection circuit protect the generator itself from the effects of surges it also protects the X-ray tube.

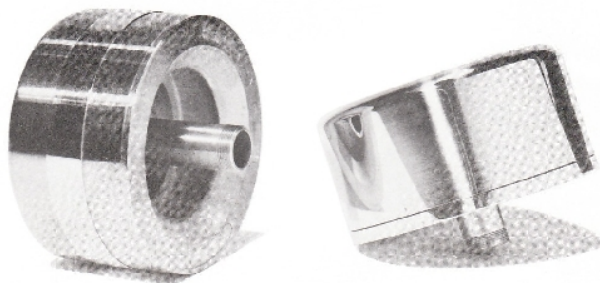
ACCESSORIES

Demountable Anodes

Special y balanced demountable anodes with various target materials are now available for the GX20.

Material	Type No.	Rating
Copper	F710000	See curves
Silver	F833000	As copper
Molybdenum	F832000	As copper
Chromium	F830000	80% of copper
Iron	F831000	40% of copper

Other materials, such as aluminium, can be supplied to special order.



Focusing Cups

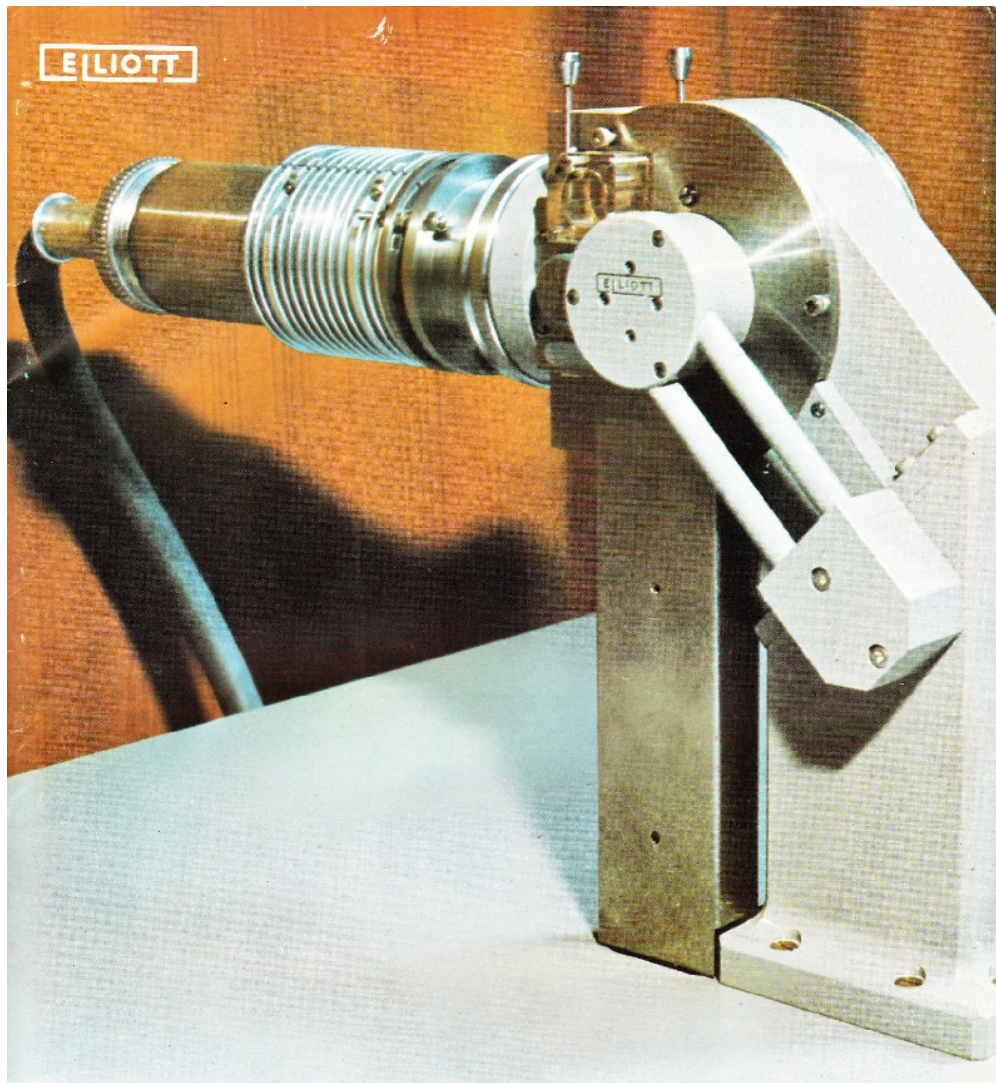
In order to change the focus size, it is a simple matter of changing a focusing cup and re-setting the filament. The following focusing cups are now available.

	Size on Anode	Projected Point	Projected Line
F525028	3mm x 0.3mm	0.3mm x 0.3mm	3.0mm x 0.03mm
F525028	1mm x 0.1mm	0.1mm x 0.1mm	1.0mm x 0.01mm
F525026	2mm x 0.2mm	0.2mm x 0.2mm	2.0mm x 0.02mm

Inquiries are invited for different size focusing cups to meet specific needs.



ELLIOTT



**GX 20 ROTATING ANODE
X-RAY DIFFRACTION
GENERATOR**

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the X-ray tube and opening of the shutter are constantly indicated, and are preceded by warning signals.

Control System

The control system is of advanced solid state design. The entire system is self-maintaining. The generator protects itself against variations in mains supply, coolant water flow, vacuum conditions, current surges, anode rotation speed, etc., and automatically seeks to restore normal operating conditions. When normal operation cannot be restored, the subsystem in need of attention is visibly indicated.

Ease of Maintenance

Replacement of consumable components and exchange of focal cups and anodes in the fully remountable X-ray tube is facilitated by an automatically controlled sequence for switching off and switching on the X-ray tube. The modular control system is designed for easy replacement of components.

Working Surface

The CX21 generator is housed in three cubicles of identical size which are bolted together on site to provide a working

surface 1136 by 2318 mm.

Low Attenuation

The X-ray windows are 0.25 mm beryllium discs.

Vacuum System

The X-ray tube is rapidly evacuated to a very low pressure by means of turbo-molecular pump backed by a rotary pump. This results in highly stable operating conditions and prolonged filament life.

Cooling System

The anode is cooled by internal closed circuit water circulation.

Anode Rotor

The anode rotation speed can be either 3000 or 6000 r.p.m. according to the power loading desired.

Power Limiter

There is a device for preventing accidental overloading of the anode for any combination of target material and focal dimension.

ACCESSORIES

Adjustable Cathode

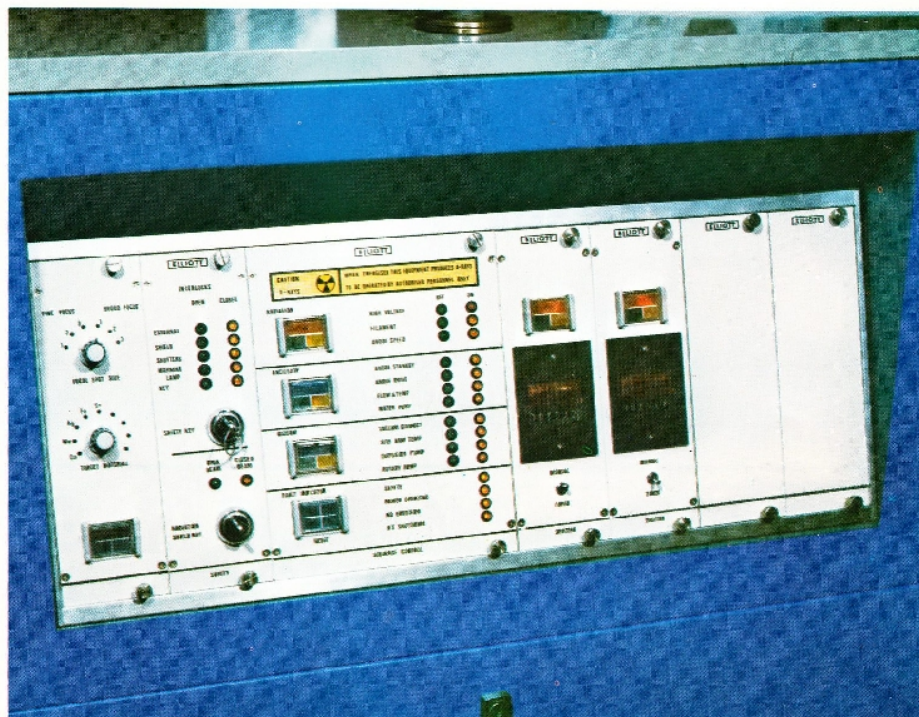
An adjustable cathode can be supplied as an optional accessory in order to facilitate the refinement and maintenance of focal dimensions of 0.1 mm and less.

Radiation Safety Enclosure

An enclosure covering the entire working surface to a height of 773 mm can be provided as an optional accessory to shield personnel using diffraction instruments in which the X-ray beams are not enclosed. Permanent beam stops are fixed opposite each X-ray port, and sliding side panels of transparent but X-ray absorbent plastic are interlocked with the X-ray supply. The enclosure is fitted with lamps and cooling fan.

Supplementary Cubicles

Additional cubicles may be provided to extend the working surface, size 772 by 1136 mm.



GX 21 ROTATING ANODE X-RAY DIFFRACTION GENERATOR

X-ray sources of very high intensity are required for X-ray diffraction experiments in which the time duration would be intolerably long using conventional stationary anode generators. By spinning a cylindrical anode at high velocity, the conduction of heat from the focus is accelerated so that a high power dissipation can be sustained, with enhanced X-ray output and focal brilliance.

DESIGN FEATURES

High Power Rating

The maximum anode current of 0.3 Amperes permits a power dissipation of up to 15 kW, obtainable with a 0.5 by 10 mm focus on copper at 50 kV.

High Brilliance

The maximum focal brilliance is 12 kW/mm^2 , obtainable with a 0.1 by 1.0 mm focus on a copper target.

High Stability

Stabilisation of the cathode voltage and tube current to within 0.1% is provided using advanced solid state servo techniques. The spatial stability of the X-ray focus is better than 5 microns.

Choice of Focal Dimensions

The GX21 generator is designed to produce X-rays within a wide range of focal areas on the anode, between a micro-focus of 0.1 by 1.0 mm and a "normal" focus of 0.5 by 10 mm, with a corresponding range of maximum power ratings. The focal cups are easily interchanged.

Choice of Focal Configurations

Two versions of the equipment are offered, with the RA5 head as illustrated in which the X-ray source is viewed through two beryllium windows and can be arranged to give either two point sources or two vertical lines. An alternative configuration uses the RA6 head in which two point and two horizontal line sources can be viewed simultaneously, utilising four shutter assemblies.

Choice of Target Material

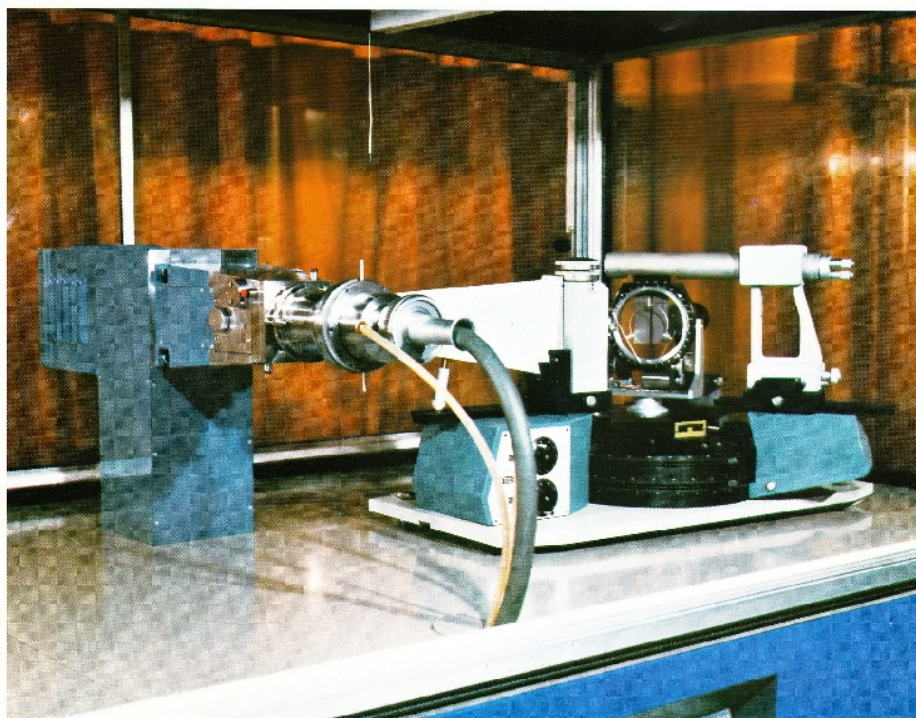
Interchangeable anodes are provided. The standard target materials are copper, molybdenum, chromium, silver. Other anodes available on request.

Voltage and Current Range

Voltage and current are digitally selected. The voltage range is 0 to 60 kV by 1 kV; the current range is 0 to 300 mA by 1 mA.

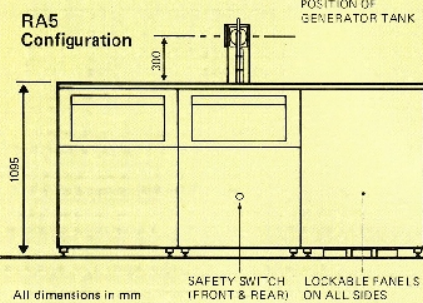
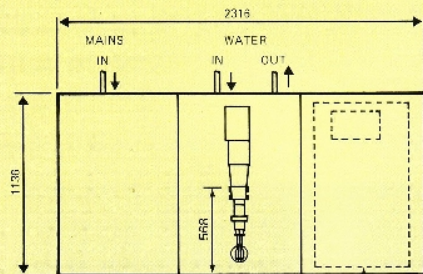
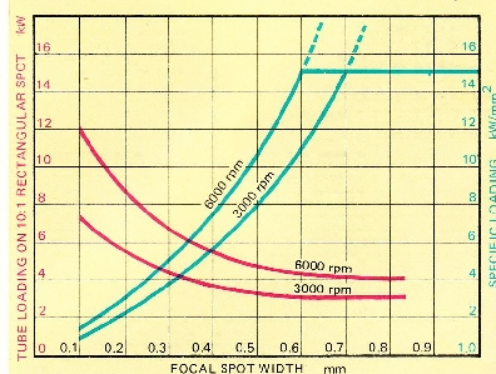
Safety

The safety shutter is designed to comply fully with the requirements of the U.K. Health and Safety Executive and X-rays can only be emitted from the tube port when a diffraction instrument is properly interlocked in position. Energisation of



SPECIFICATIONS

Voltage range	10 to 60 kV by 1 kV steps
Current range	0 to 300 mA by 1 mA steps
Maximum power loading	15 kW
Voltage and current stability	Better than 0.1%
Standard target materials	Cu, Mo, Cr, Ag
Standard focal dimensions	0.1 by 1.0 mm 1.2 kW
with maximum power ratings	0.2 by 2.0 mm 3.0 kW
for copper anode	0.3 by 3.0 mm 5.0 kW
	0.5 by 5.0 mm 10.0 kW
	0.5 by 10 mm 15.0 kW
Range of take-off angles	0 to 12°
Inherent filtration	0.25 mm beryllium
Physical dimensions	
Height of cubicles	1095 mm
Width of cubicles	1136 mm
Length of cubicles	2316 mm
Height of focus from working surface	RA5 300 mm
	RA6 382 mm
Total weight	2150 kg
Maximum power supply requirement	400 V 80A single phase
Maximum water supply requirement	35 l/min. at < 15°C at a pressure of 4 kg/cm ²



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