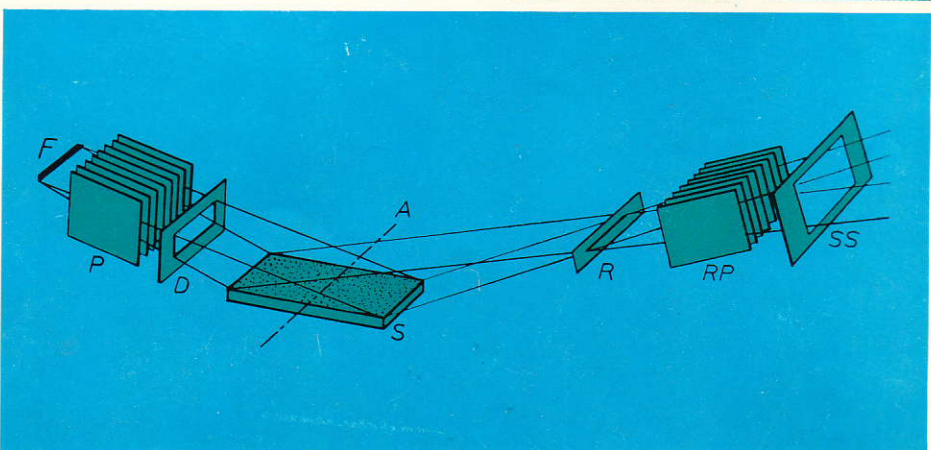
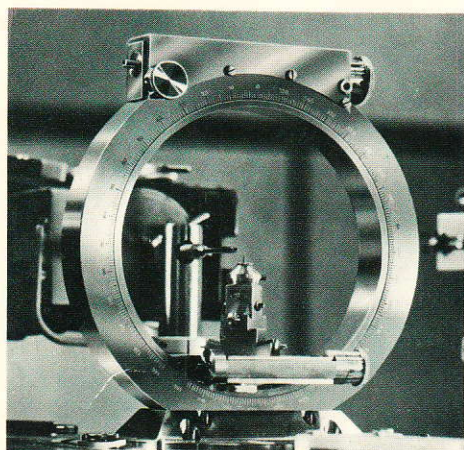
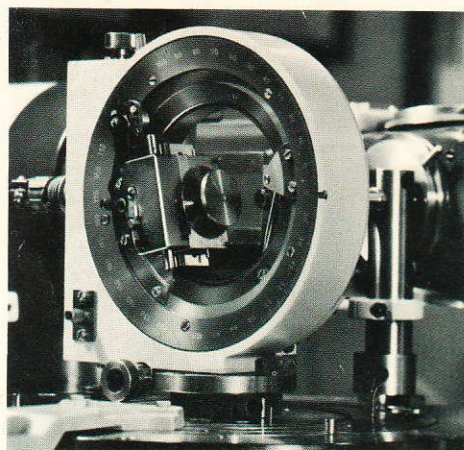
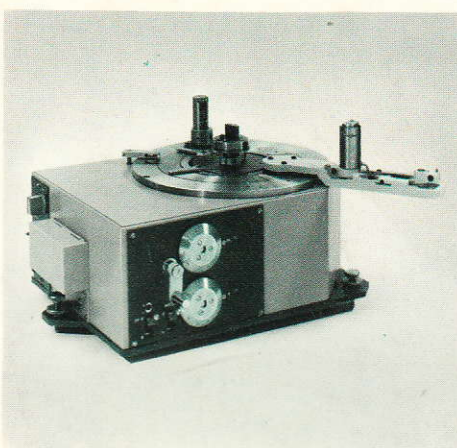
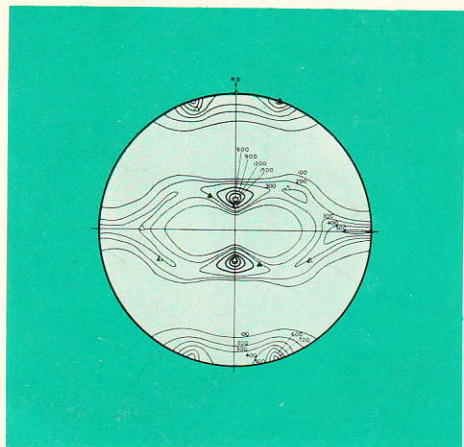
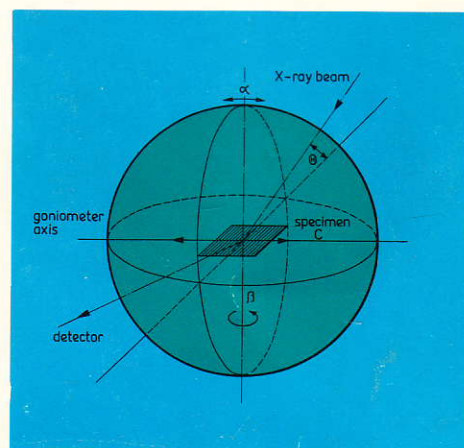
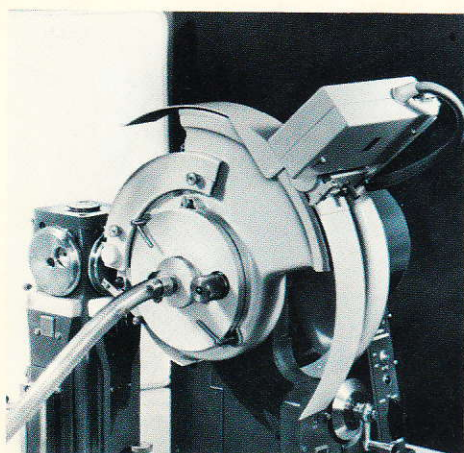




PHILIPS

X-ray Goniometers and Accessories



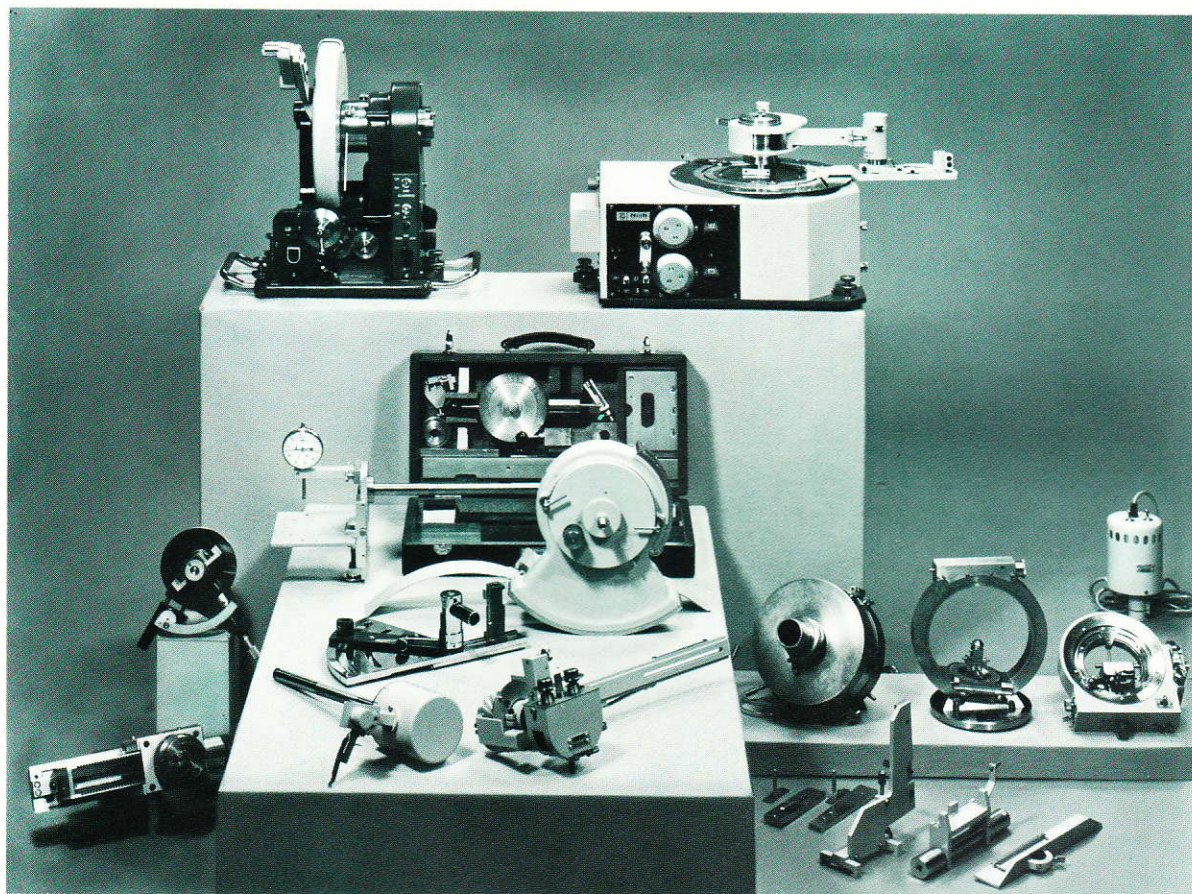
X-ray goniometers and accessoires

For more than twenty years, Philips have been world leaders in the design and manufacture of X-ray goniometers. This equipment — with its related accessories — serves as the heart of analytical equipment used for both X-ray diffractometry and X-ray spectrometry.

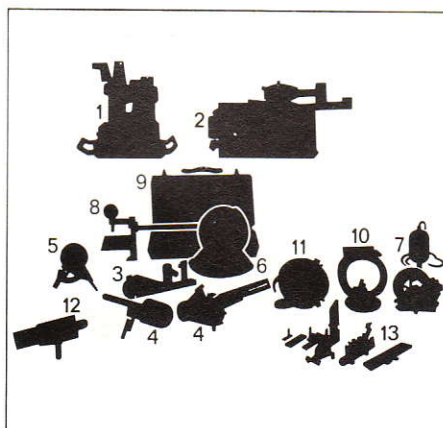
The Philips range includes both vertical and horizontal goniometers — each type unequalled for precision and resolution.

Accessories for these goniometers include the following:

- X-ray focussing monochromator
 - Curved crystal focalizer
 - Auto-focus specimen holder
 - Vacuum attachment
 - Texture attachment
 - Metallurgical kit
 - Stress attachment
 - Eulerian cradle
 - High-temperature attachment
 - Automatic sample changer
- These, along with a set of goniometer tools for alignment of both the vertical and horizontal models, constitute the Philips range of X-ray goniometers and accessories. They are described on the following pages.



	page
1. Horizontal goniometer	3
2. Vertical goniometer	4
3. X-ray focussing monochromator	6
4. Curved crystal focalizer	8
5. Auto-focus specimen holder	10
6. Vacuum attachment	11
7. Texture attachment	12
8. Metallurgical kit	14
9. Stress attachment	14
10. Eulerian cradle	15
11. High-temperature attachment	16
12. Sample changer	17
13. Alignment tools	18



PW 1380 Horizontal Goniometer

The horizontal PW 1380 goniometer is for X-ray diffraction studies. Its large weight-carrying capacity enables it to handle specimens and attachments up to 25 kg. The specimen table (theta-drive) accepts Philips accessories, and is removable for large specimens or special accessories.

The two-theta axis can be decoupled from the theta axis for independent theta scanning. Both axes can be externally connected with driving motors. The full two-theta scanning range of this goniometer is from -100° to $+165^\circ$, in comparison with -65° to $+165^\circ$ for the PW 1050/25 vertical goniometer. The full angular range may be set without demounting or readjustment.

DESCRIPTION

Two concentrically-mounted shafts are driven in a 1 : 2 ratio by independent worm wheels and worms through a gear box (transmission). For direct reading of the angles theta and two-theta, two dials are provided which have a reading accuracy of $\pm 0.002^\circ$.

The theta/two-theta coupling can be disconnected by a lever, for independent theta scanning. In manual operation, both theta and two-theta can be set independently.

The specimen shaft with specimen clamp fit into the theta driving cable. The cover plate of the theta driving table can be removed, to uncover a hole 7.5 cm in diameter. This allows easy handling of odd-shaped specimens and the use of bulky, improvised accessories.

A set of interchangeable spur gears is supplied to allow a variety of scanning speeds. X-ray protection during alignment is provided with the PW 1077 alignment tool set. Alignment time is less than 30 minutes.

X-RAY OPTICAL ARRANGEMENT

The same as for the vertical goniometer PW 1050 (see page 5) with a slight modification of the slit system: by using broadened slits (broader in the direction of the line focus) a larger strip of the specimen is irradiated. This results in higher intensities which are, however, accompanied by somewhat less resolution.

TECHNICAL DATA

Precision of angular setting (2θ and θ)
 $\pm 0.0025^\circ$

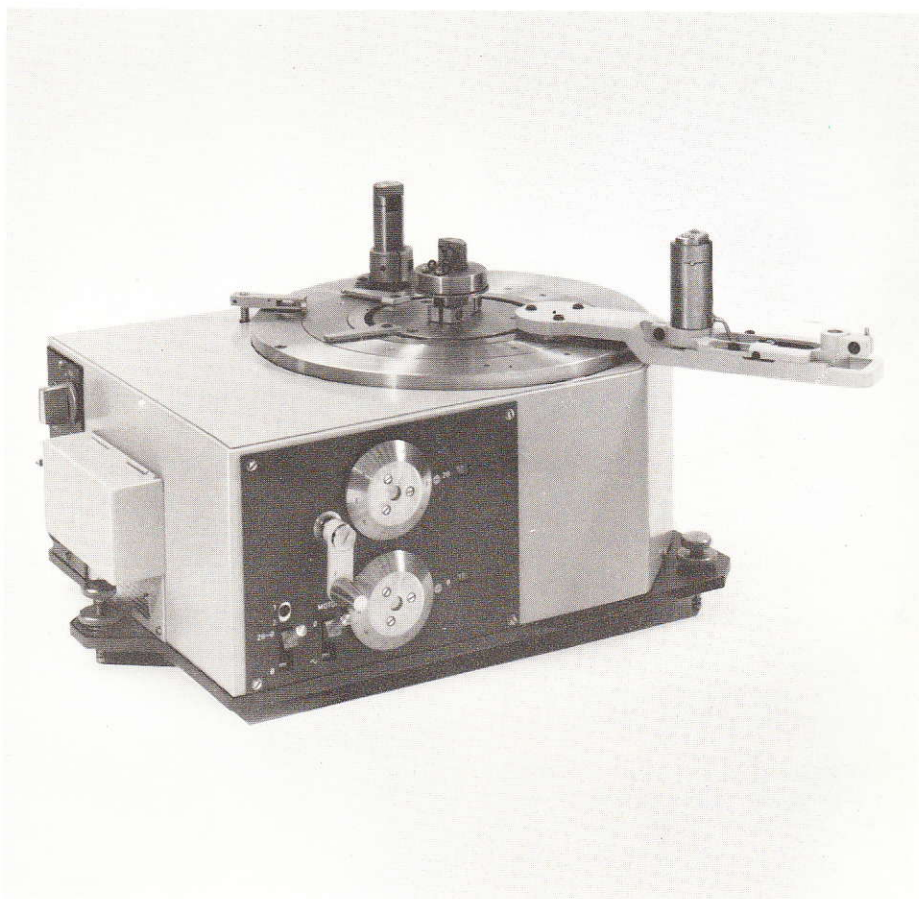
Reading accuracy of angular setting
 $\pm 0.002^\circ$

Scanning

Unidirectional or oscillatory between -65° to $+165^\circ$ (2θ); $\theta = 360^\circ$

- ☐ A wide-range high- and low-angle instrument
- ☐ High precision achieved by special worm drive system
- ☐ Unique, high-resolution optical arrangement provides extremely accurate measurement of diffraction angles and line intensities
- ☐ Capacity for heavy specimens up to 25 kg

- ☐ Large central hole allows use of odd-shaped specimens and bulky accessories
- ☐ New design slit system provided large gains in intensity
- ☐ Two-theta axis can be decoupled from theta axis for independent theta scanning
- ☐ Alignment time less than 30 minutes



Scanning speeds

$1/8^\circ$, $1/4^\circ$, $1/2^\circ$, 1° , 2° (2θ) per minute by using change gears PW 1059/00, —/01, —/02 which are included in the PW 1380

Scanning stops

Quickly adjustable limit switches for limiting scanning range to required value; also prevent overtravel at extreme of scale

Step scanning

Mechanical step scanning device PW 1063/00 can be mounted so that goniometer advances at 0.01° , 0.02° or 0.05° per step; enables of fixed count line profile measurement

Goniometer radius, i.e. also distance between focal spot tube and specimen
170 mm

Motor

Special synchronous fractional horse-power type

Alignment

Easily performed with the aid of fixtures, gauges and a standard silicon sample which are part of the equipment; with new set of alignment tools PW 1077 the alignment procedure is more accurate, simpler and shortened considerably.

PW 1050/25 Vertical Goniometer

- ☐ A wide-range high- and low-angle instrument
- ☐ High precision achieved by special worm drive system
- ☐ Unique, high-resolution optical arrangement provides extremely accurate measurement of diffraction angles and line intensities

The vertical PW 1050/25 wide-range goniometer is especially suited to standard powder diffractometry, in which the specimen and radiation detector are rotated and positioned in a fixed 1 : 2 ratio.

DESCRIPTION

Two concentrically-mounted shafts are driven in a 1 : 2 ratio by a precision worm wheel and worm drive. The radiation detector probe is attached radially to the worm wheel.

With each revolution of the worm drive, the detector moves 1° . A dial is fixed to the worm drive for direct readings of the angle two-theta. The reading accuracy of angular setting is $\pm 0.002^\circ$.

The specimen is placed in a holder carried by a hollow shaft positioned within the hollow bearing of the worm wheel and coupled to the wheel by a set of accurate herringbone gears. These gears rotate the specimen or crystal at exactly one-half the angular speed of the scanning arm carrying the detector probe. A set of interchangeable spur gears supplied with the goniometer allows a variety of scanning speeds.

Alignment time, using the Philips alignment tool set, is less than 30 minutes. Full X-ray protection is provided during alignment.

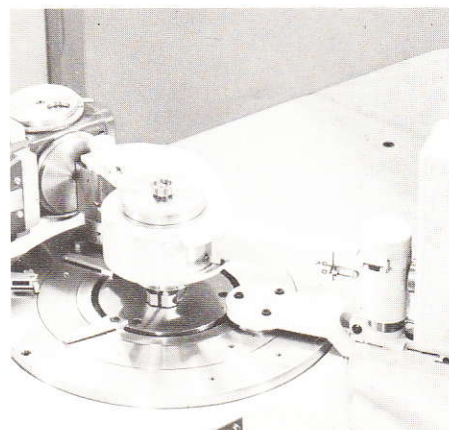
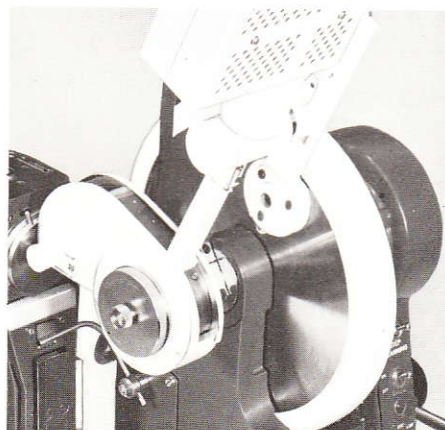
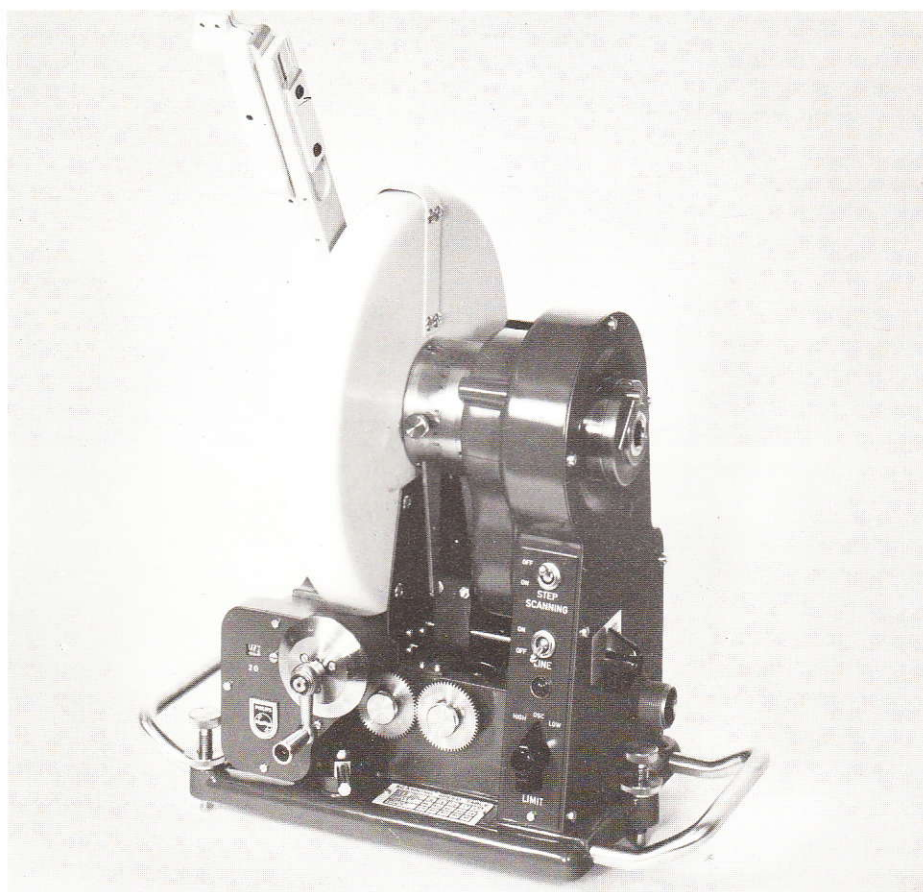
Diffracton set

When used for X-ray powder diffractometry, the goniometer PW 1050 must be completed with the PW 1049/10 diffracton set. This set includes all accessories which are **required** for doing powder diffractometry with the PW 1050.

For the PW 1380 the diffracton set is included in the typenumber PW 1380.

Radiation protection

The radiation protection shield is an important part of the diffracton set. It completely shields off the X-ray path during operation of the diffractometer; shuts off X-ray beam when cover shield is removed.



X-RAY OPTICAL ARRANGEMENT

The X-ray optical set-up has been designed for use with one of the line foci of a modern X-ray diffraction tube.

The angular aperture of the beam in the plane of Bragg focussing (sometimes called Brentano para-focussing) is indicated by the divergent lines. It is defined by a single divergence slit (D) which also limits the primary beam to the specimen area.

Apertures of various sizes are available from 2 minutes, for large d-spacing measurement, to 4 degrees for the back reflection region where the area of sample irradiated by the incident beam is small. A 1° aperture is normally used for general work in the front reflection region. The intensity increases with increasing angular aperture and the resolution is practically unaffected. The instrument is designed for flat specimens (S), 15 x 20 mm. Smaller specimens may be used by reducing the size of the divergence slit.

The receiving slit (R), in front of the Receiving Parallel Slit Assembly (RP), defines the width of the converging reflected beam from the sample to the detector. The resolution decreases slightly and peak intensity increases markedly when this slit width is increased. Various sizes are available.

Equally spaced thin metal foils (Parallel Slit Assembly) limit the divergence of the beam in the plane perpendicular to Bragg focussing to an angular aperture of 2 degrees 12 minutes.

Two sets are used: one between the X-ray source and specimen (P) and the other (RP) between the specimen and detector (SS). These slits make it possible to obtain high resolution and excellent line shape for the extended line source.

A scatter shield cylinder surrounds the specimen and a scatter slit (H) is placed between the receiving parallel slit assembly and detector, to assure the detector receiving only those rays diffracted from the specimen surface.

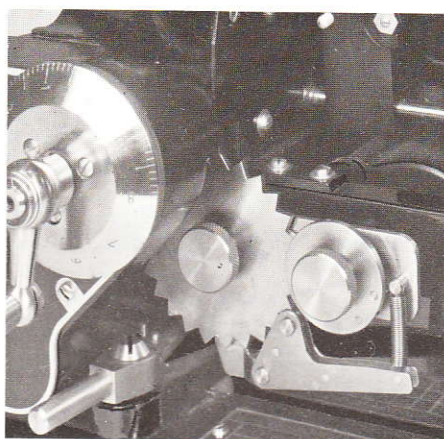
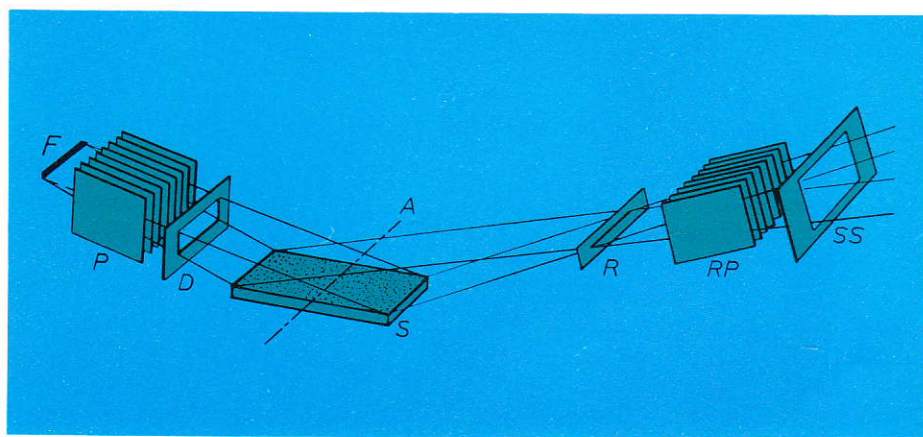
Step scanning

Step scanning with both goniometers becomes possible with:

- Step scanning device PW 1063/00, consisting of a mechanical unit with gear wheels for stepwise angular advancement of the goniometer with 0.01° , 0.02° and 0.05° (2θ) per step
- Step scan control unit PW 1364/00, which provides the necessary start/stop signals for the stepwise advancement of the goniometers PW 1050 and PW 1380.

When the above two units are extended with the numerator PW 4233, printer control PW 4255 and the high speed digital printer PW 4202, the numerator produces a two digit sequence number by which analogue or digital measuring results of the individual steps can be identified.

Fig. 1 X-ray optical arrangement of both horizontal and vertical goniometers



TECHNICAL FEATURES

Precision of angular setting (2θ and θ)
 $\pm 0.0025^\circ$

Reading accuracy of angular setting
 $\pm 0.002^\circ$

Scanning

Unidirectional or oscillatory between
 -38° to $+175^\circ$ (2θ)

Scanning speeds

$1/8^\circ$, $1/4^\circ$, $1/2^\circ$, 1° , 2° (2θ) per minute
by using change gears PW 1059/00, —/01,
—/02 which are included in the
PW 1050/25

Scanning stops

Quickly adjustable limit switches for limiting scanning range to required value; also prevent overtravel at extreme of scale

Step scanning

Mechanical step scanning device PW 1063/00 can be mounted so that goniometer advances at 0.01° , 0.02° or 0.05° per step; enables the measurement of fixed count line profile

Goniometer radius, i.e. also distance between focal spot tube and specimen
170 mm

Motor

Special synchronous fractional horse-power type

Alignment

Easily performed with the aid of fixtures, gauges and a standard silicon sample which are part of the equipment; with new set of alignment tools PW 1077 the alignment procedure is more accurate, simpler and shortened considerably.

PW 1075 Curved Crystal Focalizer

Typical applications of this accessory are studies of texture, measurement of large d-spacings, measurement of angular errors due to deviations of specimen surface, line profile studies, and investigations of limited quantities of material.

The accessory permits comparison of a transmission pattern with a reflection pattern from a standard diffractometer. Effects of fluorescent radiation are eliminated.

The curved crystal focalizer consists of a flat plate of quartz (1011) elastically bent by two adjustment knobs on the crystal holder. The surface approximates a section of a logarithmic spiral.

The holder is mounted on the detector arm of the standard diffractometer, with the counter tube moved further out. Counter tube and specimen rotate in a 2 : 1 ratio as in the standard instrument. Focussing is adjusted by changing the curvature of the crystal. (Geometry is illustrated in figure 4).

☐ For use with vertical or horizontal goniometer

☐ For transmission diffractometry in a number of applications

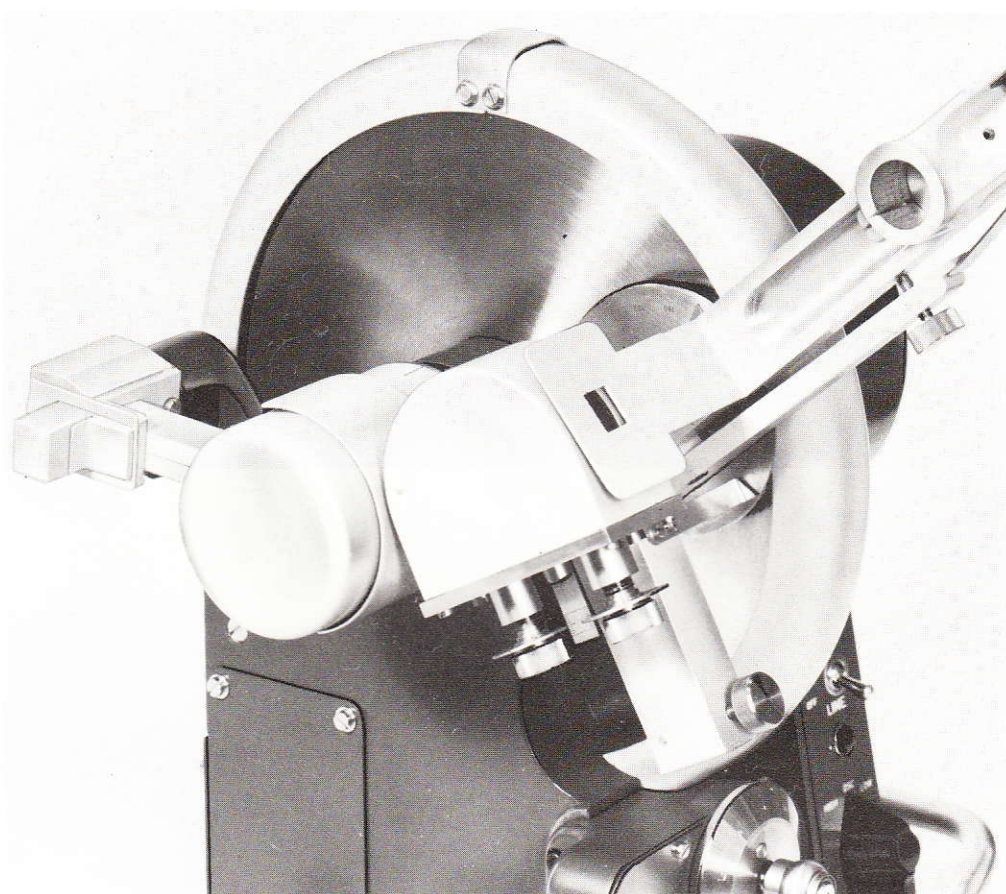
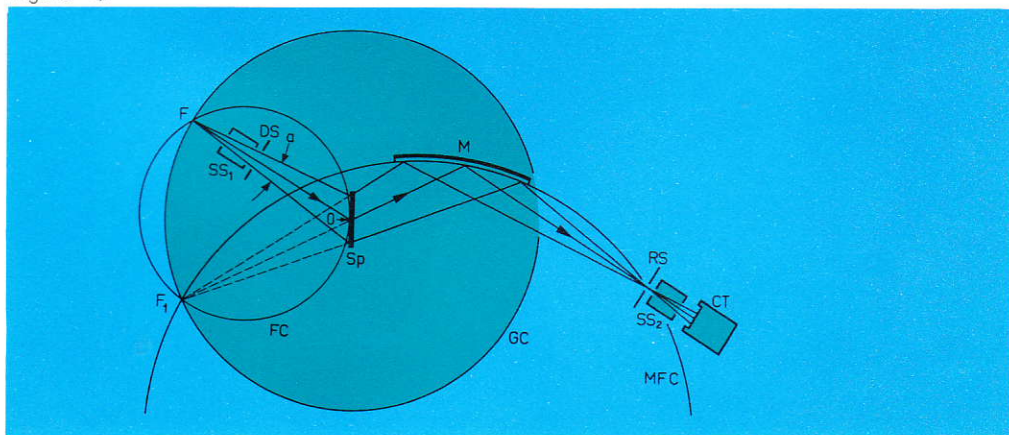


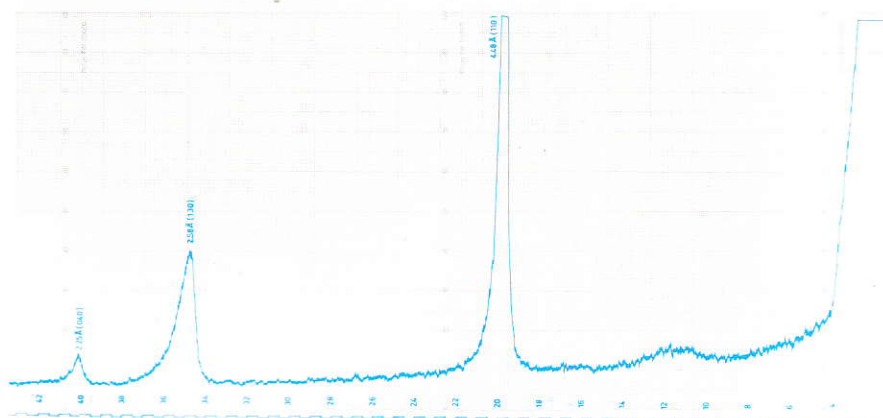
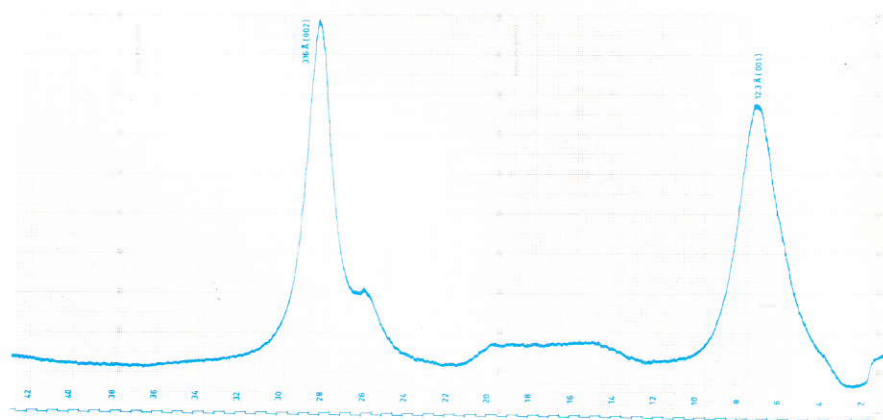
Figure 4.

Figure 4.

- Sp — transmission specimen
- M — curved crystal focalizer
- F — virtual image of the source
- a — angular aperture of the primary beam
- CT — counter-tube
- MFC — monochromator focussing circle
- SS 1 and SS 2 — soller slits
- DS — divergence slits
- RS — receiving slit
- FC — focussing circle
- GC — goniometer circle



For transmission diffractometry, the accessory offers a number of geometrical advantages. Intensity loss caused by the monochromator is partially compensated by larger apertures. Much smaller volumes are required for transmission specimens compared with the standard diffractometer set-up. For reflection patterns it is not necessary to remove the specimen holder. The specimen can be tilted over 90° , the crystal removed, and a normal arrangement for reflection work obtained, without extra specimen preparation and mounting.



OPERATING CONDITIONS

	Transmission	Reflection
Tube	Cu 50 kV — 40 mA	Cu 50 kV — 40 mA
Filter	None	Ni
Detector	Proportional + Discriminator	Proportional + Discriminator
Scale	4×10^2 cps	4×10^3 cps
Divergence slit	2°	1°
Scatter slit	None	1°
Receiving slit	0.3 mm	0.2 mm
Scanning speed	$\frac{1}{2}^\circ 2\theta/\text{min}$	$\frac{1}{2}^\circ 2\theta/\text{min}$
Paper speed	400 mm/h	400 mm/h
Time constant	4 s	4 s

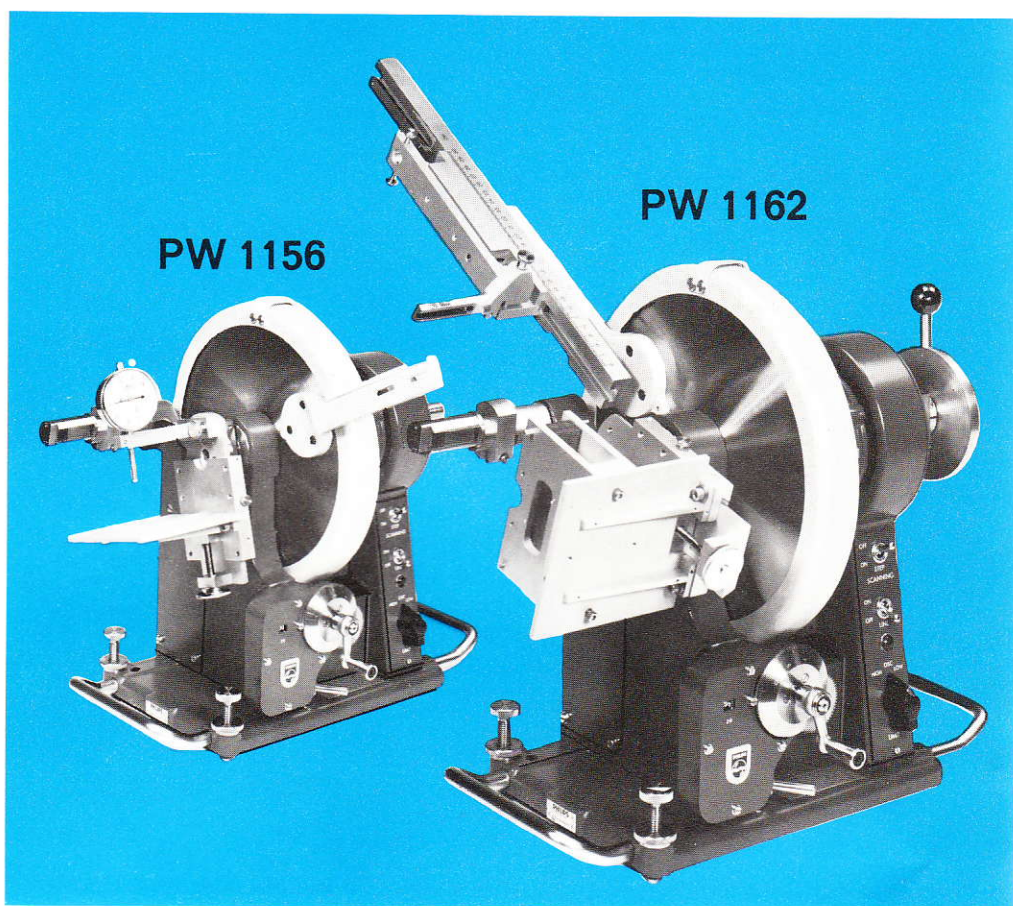
PW 1156 Metallurgical Kit with PW 1162 Stress Attachment

- ☐ For use with horizontal or vertical goniometer
- ☐ Increases usefulness of standard diffractometer to the metallurgist
- ☐ Accepts specimens as large as 10 cm (4 inches) in any dimension
- ☐ Allows precise measurement of residual stress
- ☐ Includes calibrated bending device for measuring additional stress and absolute stress
- ☐ Makes possible measurement of local stress through use of a pin hole collimator

These two attachments, in combination, provide the metallurgist with a simple, precise means of making X-ray diffraction studies on bulky specimens.

This kit includes a base plate to allow the goniometer to be moved back from the center line of the X-ray beam about 4.75 cm beyond its normal position, to accommodate bulky specimens. A fully adjustable extension fixture allows the slit assembly to be moved forward. A standard powder specimen holder with extra-long shaft is provided along with a large specimen holder. A special fixture is used to bring the specimen surface exactly into the goniometer axis. It consists of a centering pin that fits into the specimen holder shaft.

The stress attachment consists of a track and slide which connects the receiving slit-detector assembly to the goniometer arm. This replaces the block used for this purpose in the standard Metallurgical Kit. It is adjustable so that the receiving slit moves exactly along a radius of the goniometer. This unit allows the precise determination of the position of the diffraction line at two psi angles, and thus may be used to provide precise determinations of residual stress.



Also included is an attachment which allows the specimen holder shaft to be rotated rapidly to the desired psi angle, and another attachment which provides for calibration of additional stresses applied to the specimen while on the goniometer. Mounted on the specimen table, it is used to apply known stresses to a flat specimen, and thus determine the stress constant of the material.