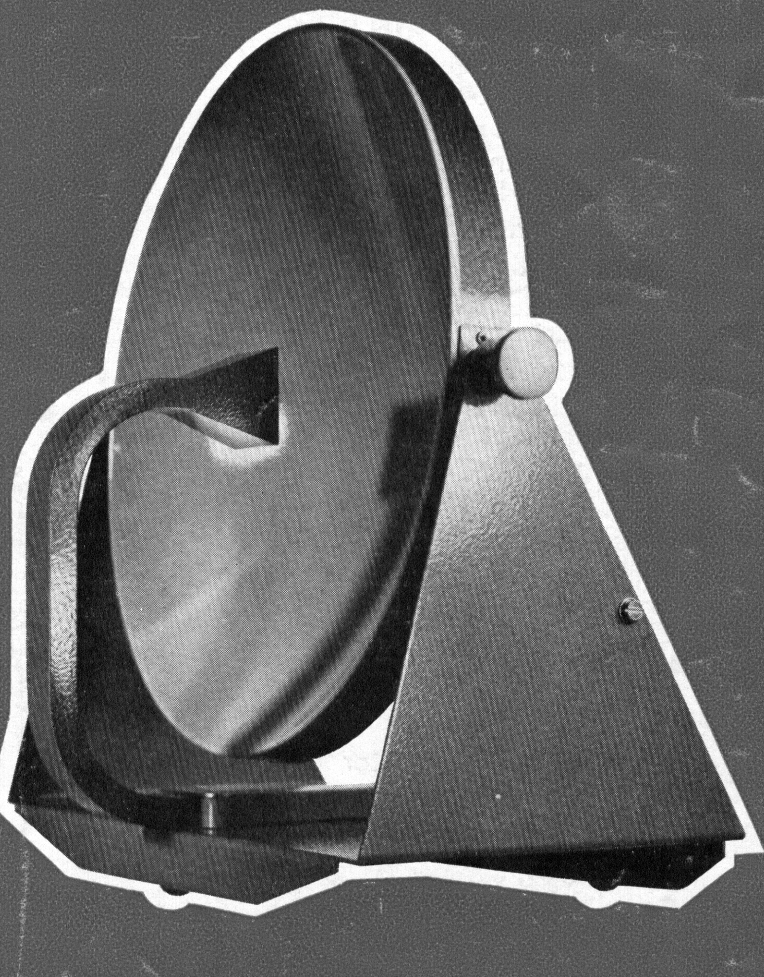
Microwaves

for students



MICRO WAVE

MICROWAVE INSTRUMENTS LIMITED . PARK LANE . SHIREMOOR . NORTHUMBERLAND . ENGLAND

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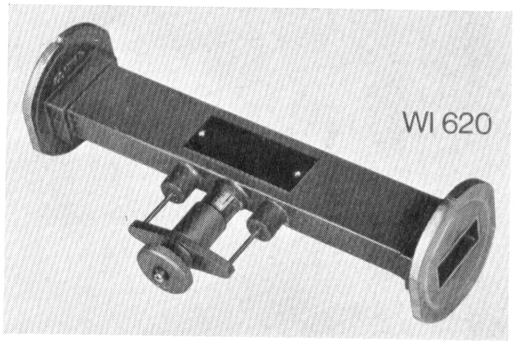
Microdesk WI 612

The Microdesk is the microwave generator for the Student Series of components. It incorporates a KS9-20A klystron with associated power supplies, an amplifier feeding a $4\frac{1}{2}''$ clear-view meter, an audio amplifier and loudspeaker, and an internal square-wave modulator of variable frequency.
The unit thus enables a modulated microwave signal to be amplified after detection and the resultant output to be displayed on a meter or heard by a classroom of students.

Specification

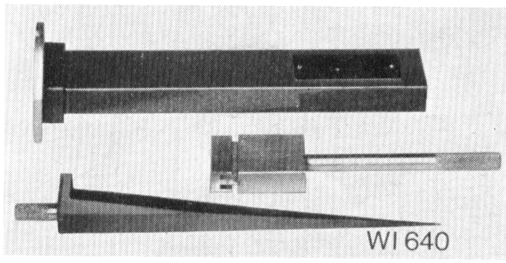
Output power	15 mW : through flanged WG 16 waveguide.
Frequency	Variable : by knob on front panel within the waveband 8.7 - 9.5 GHz.
Modulation	Internal : 1 KHz squarewave. External : To the klystron reflector via a coaxial socket from external source.
Input	240V (+10% – 20%) 50 HZ. (115V 60 Hz unit also available).
Meter	100 μA with 4″ scale calibrated 0 - 100 driven by a two-stage transistor amplifier. (Typical path attenuation of approx. 25 dB will give F.S.D.).
Audio	1W max. from internal loudspeaker.
Other checkpoints and controls	Klystron current : check by external milliameter through jack socket. Klystron reflector voltage : controlled by knob with calibrated scale on front panel.
Cabinet	The unit is housed in a metal cabinet 13″ × 10″ × 8″ (*33 × 25 × 20 cm* approx.) finished in dark grey hammertone with a light grey front panel.
Weight	21 lb. *(9.5 Kg)*.

Attenuator, Variable, WI 620



This instrument is used whenever it is necessary to adjust the power level in the waveguide or to introduce padding before a component of high V.S.W.R. in order to reduce its effect upon other components.
The instrument consists of a resistive card vane mounted on two rods which pass through the narrow face of the waveguide. The vane is moved from the side to the centre-line of the waveguide by a screw adjustment in order to increase the attenuation. The variable range is 0 - 30 dB with a V S.W.R. better than 1.05 (0.95), and the atteunator is fitted with a millimetre scale.

Phase Shifter, 180°, WI 630



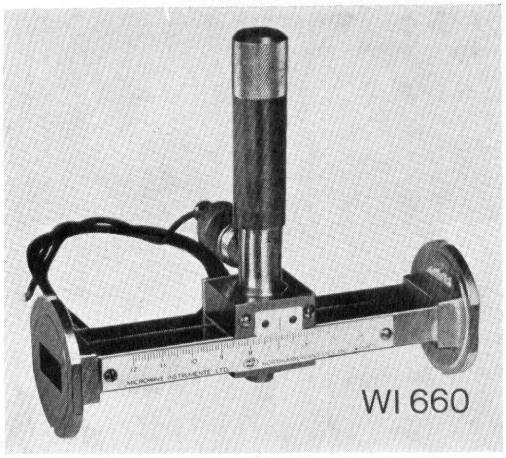
The construction of this instrument is similar to that of the variable attenuator, but the resistive vane is replaced by a dielectric plate whose effect varies with insertion, the phase shift increasing as the dielectric approaches the waveguide centre-line.
The range of phase shift is 180° with a V.S.W.R. better than 1.1 (0.9).
The value of the phase shifter lies mainly in changing the effective length of a waveguide path in order that, for example, the phases of two waves may be aligned.

Load/Short Circuit WI 640

This is a double-purpose component enabling a short length of waveguide to be terminated by a resistive wedge, thus giving a good V.S.W.R., or by a short-circuit piston, thus giving maximum reflection. The phase of the reflection may be adjusted by sliding the short circuit piston in the waveguide.
The short-circuit incorporates a choke section in order to avoid the necessity for sound electrical contact with the waveguide walls.
The piston may be used to indicate its own standing wave by sliding it along the waveguide.

Bends, 90°: H-plane WI 650, E-plane WI 652

Bends are often necessary to connect waveguides in special installations and where space saving is required. They are often needed to align components on a free space transmission path, and may be used as test components to illustrate the introduction and matching of V.S.W. ratios.
The WI 650 has a centre-line radius of 3″ and a V.S.W.R. better than 1.05 (0.95) ; the WI 652 has a centre-line radius of $2\frac{3}{4}''$ and a V.S.W.R. better than 1.04 (0.96).

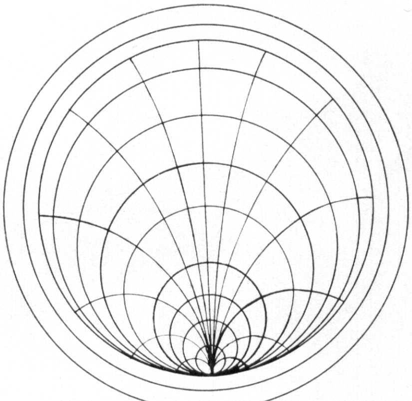


Standing-Wave Indicator WI 660

Where there are discontinuities in the waveguide, reflections occur which result in standing waves. The measure of reflection is called the voltage standing wave ratio (V.S.W.R.) which is the ratio of minimum to maximum standing wave voltage.

The V.S.W.R. may be measured by using a standing-wave indicator ; this consists of a length of waveguide with a slot cut accurately along the centre of its broad face. A probe with fixed penetration is moved by hand to traverse the slot and is connected via a tuned coaxial line to a crystal detector. Due to the nearly square law characteristic of the crystal the V.S.W.R. is given by the ratio $\sqrt{\frac{I_{max}}{I_{min}}}$

This simple standing-wave indicator is quite adequate for student use, having a maximum error of 0.03 V.S.W.R. For more accurate work our Grade I or II instrument should be used.

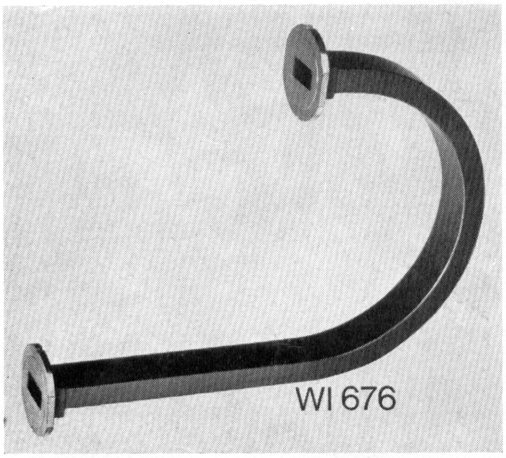

WI 662

Smiths Charts WI 662

Packs of 25 Smith Charts (circle diagrams) are available to record measurements of V.S.W.R. in phase and amplitude, and to assist in impedance calculations and matching.

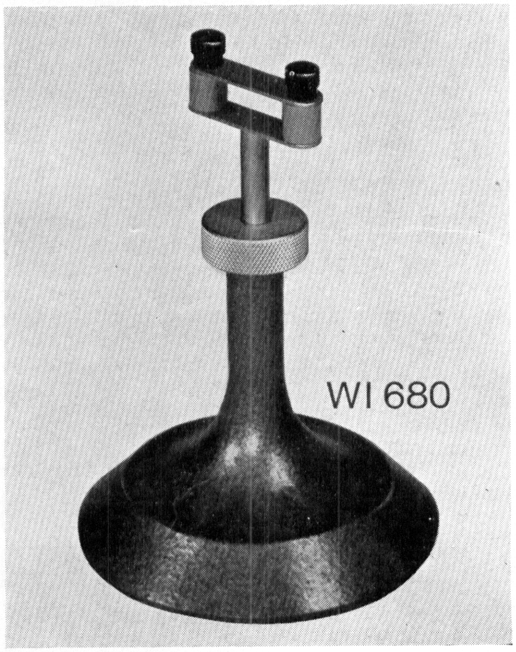
Twist, 90°, WI 670

This component enables the plane of polarisation to be rotated through 90°, both for the purpose of changing the polarisation of radiated energy or for bringing the mechanical controls of a number of components into a different plane. Used in conjunction with E- and H-plane bends it enables various geometrically convenient assemblies to be constructed.



Bend, 180°, WI 676

The purpose of this E-plane bend is to enable a number of radiating elements to be mounted upon Rotating Joint WI 6156 so that their electrical centres may be brought very nearly to the centre of rotation. The two legs of the bend are of unequal length, thus providing two alternative centres of rotation for use with linear arrays or radiating horns. The centre-line diameter or the bend is 6½″ *(165 mm)* ; the two flanges are offset by 5″ *(127 mm)*.



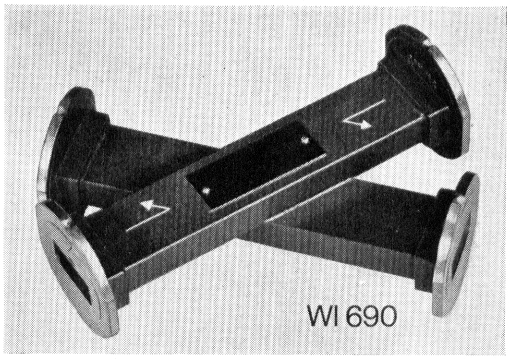
Free Standing Support WI 680 (WX 19)

This item is offered as an alternative to a rigid waveguide bench as a number of components may be supported separately or in straight or angled assembly.

The weight of the base is sufficient to support a horn and crystal detector and a number of other components. A minimum of two supports is recommended for general use as the Microdesk also provides a support for one end of a waveguide assembly.

The waveguide clamp enables vertical adjustment between heights of 5″ (127mm) and 7″ (178mm) to be obtained.

Directional Coupler WI 690



This directional coupler is a 4-port device in which a branch waveguide diverts a fixed percentage of the power flowing in the main waveguide.

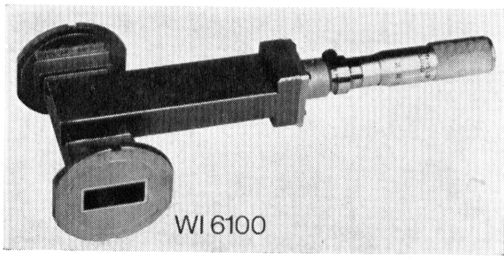
The construction is symmetrical and the directional coupling value is reciprocal so that a number of alternative uses are possible.

The coupling value in dB relates to the ratio of branch arm power to main power, whilst the directivity is a measure of the ratio of the branch arm forward power to that coupled back in the unwanted direction. In normal use this unwanted power is absorbed by a terminating load, Terminating Cap WI 6130 being suitable.

When crystal detectors are mounted on both branch arms the ratio of forward power to reflected power in the main guide may be measured, thus producing a simple reflectometer.

The directional coupler is available with forward coupling values of 20, 30 and 40 dB. The required value should be specified when ordering as a suffix to the catalogue number, e.g. WI 690/20. This value is recommended for general use.

Frequency Meter WI 6100



A short length of rectangular waveguide, closed at one end by a fixed plate and at the other by an adjustable piston, will resonate when its length is an integral number of half guide wavelengths. Tuning is achieved by moving the piston with a 0-25 mm micrometer reading to 0.01 mm.

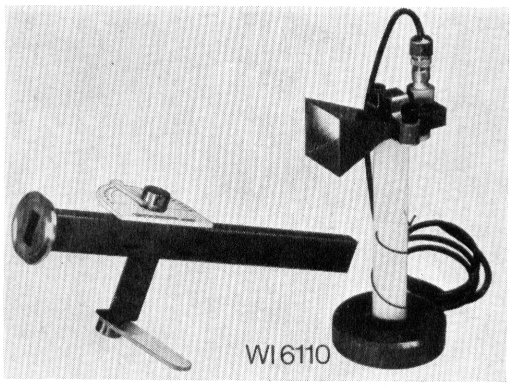
The cavity of this wavemeter is mounted across a short length of standard waveguide having a coupling hole or iris on the centreline of the mutual broad face.

Once the frequency of the wave in the main guide has been determined the wavemeter should be placed off resonance in order to prevent its absorption characteristic being superimposed upon any other changes which are being measured.

Calibration range	8.4 - 10.12 GHz
Accuracy	± 2 parts in 10^4
Resonance mode	H_{012} absorption
Micrometer discrimination	1.7 - 0.7 MHz
Q	3000 approx.

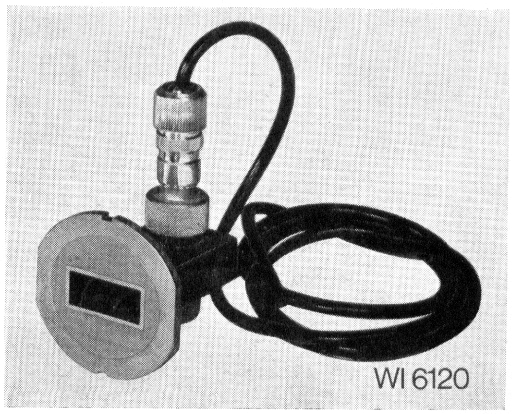
A calibration curve is supplied with each instrument.

Radiation Plotter WI 6110



The radiation plotter enables the free space interference pattern caused by two adjacent radiating sources to be demonstrated. It consists of a small horn and crystal detector mounted on an insulating stand which is connected by a length of cord to a pointer at the centre of a protractor scale mounted upon the radiating waveguide. The polar diagram can easily be plotted by moving the detector on an arc controlled by the retaining cord. The slots are not exactly half a guide wavelength apart, giving to the polar diagram a squint which varies with frequency. The tapered load from WI 640 should be used to terminate the waveguide of WI 6110. The small horn may also be used to plot polar diagrams of other radiating elements. A Twist WI 670 is needed to bring the radiated energy into a horizontal plane.

Crystal Mount WI 6120

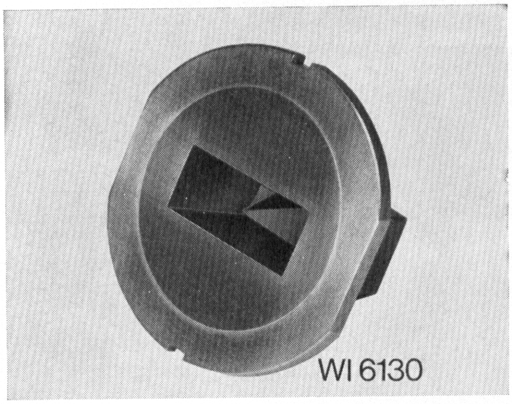


A semiconductor junction is used in rectifying the microwave energy in the waveguide. The junction is encapsulated in a small plug-in unit which may be physically inverted in the mount, thus changing the polarity of the output.

The crystal is mounted on the centreline of the broad face of the waveguide, slightly in front of a short circuit. An R.F. choke and bypass capacitor are incorporated in the base of a coaxial socket from which direct (rectified) current is taken. The detector may be used to feed a microammeter or an A.C. amplifier if the microwave energy is modulated.

Two crystal mounts, one giving a positive and one a negative output, may be used as detectors in a bridge circuit to indicate balanced signal conditions. They may be used in conjunction with the WE 34* which has twin input sockets for this condition of operation.

* Leaflet WE 34 refers.


WI 6130

Terminating Cap WI 6130

The terminating cap is a short dummy load which may be used where a V.S.W.R. of about 1.2 is acceptable and where space is at a premium. It may be used, for example, to terminate the reverse arm of a directional coupler. It consists of a pyramidal cone of synthetic resin loaded with a lossy material, mounted on the centreline of a 1″ (25mm) length of waveguide.


WI 6140

Paraboloid with Dipole and Crystal Detector WI 6140

This 12″ *(30 cm)* diameter parabolic receiving antenna employs a plug-in crystal detector mounted within the dipole assembly at the focal point of the paraboloid. The dipole assembly may be rotated to any plane of polarisation. The detected signal is taken from the unit by means of a coaxial plug and socket.
The polar diagram of the assembly has a beam width of about 8° between 3-dB points.
The paraboloid is pivoted on a horizontal axis and may be locked in position by two knurled nuts.

Dielectric Chamber WI 6142

Where measurements on dielectrics are required the dielectric chamber is used to terminate a standing-wave indicator. It consists of a short length of waveguide with a brass shorting plate lapped flat and held in place by a standard coupling ring. The dielectric constants of solids which are machined to fit accurately in the chamber are then compared. If the frequency, and thus the guide wavelength, is known and the position of the minima from the shorting plate is measured the effect of a dielectric block placed immediately in front of the shorting plate is a measure of its dielectric properties. Shift of the minima is related to dielectric constant and changes in V.S.W.R. amplitude are determined by power factor. The thickness of the dielectric block is, of course, taken into account. Further details of this method of measurement are available upon request.

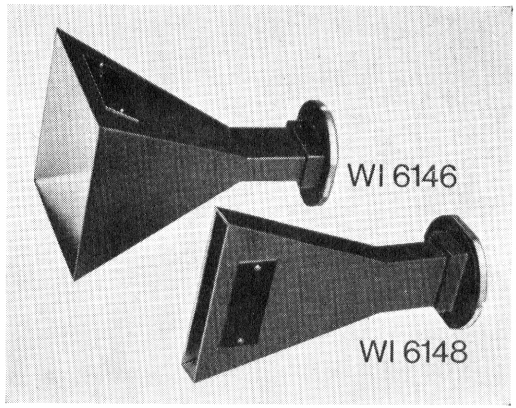

WI 6142

Polarised Screen WI 6144

This item consists of a number of parallel wires contained in a circular supporting framework. It is generally mounted between a pair of waveguide horns in order to show that when the direction of the wires is in line with the electric vector maximum reflection takes place, whilst when the wires are at 90° to the electric vector transmission is possible.
A scale marked 0 - ±90° is engraved around the perimeter of the mount. It is supplied complete with a supporting stand which enables it to be pivoted about a vertical axis.


WI 6144

Horns: 3 x 3 in. (76 x 76 mm) aperture, WI 6146
3 x 0.4 in. (76 x 10.2 mm) aperture, WI 6148

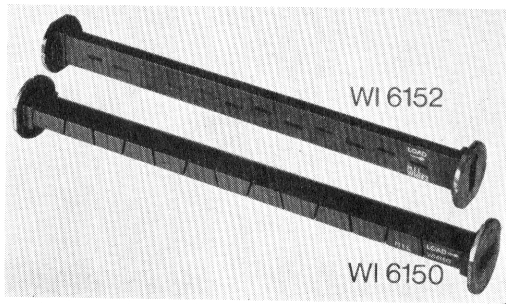


Either of these horns may be connected to waveguide to transmit or receive radiation in free space. To use as a receiver all that is necessary is to mount a crystal detector on the horn and to feed the output to a suitable amplifier or indicator.

Two types of horn are offered so that differences in polar diagram may be demonstrated.

The polar diagram of the 3″ × 3″ horn is symmetrical and is approximately 22° between half-power points. The 3″ × 0.4″ horn has an asymmetrical polar diagram, being 22° in one plane and almost 90° in the other.

Short Linear Arrays: Shunt-Inclined WI 6150
Series Resonant WI 6152



WI 6150 : This radiating element contains 12 shunt-inclined slots in the narrow face of the waveguide. The angle of the slots alternates each half wavelength in order to keep the radiated energy in phase. The spacing is not exactly one half of a guide wavelength in order to prevent resonance at the operating frequency. The distribution of energy along the array follows an approximate sine curve in order to minimise side lobes. Radiation from the narrow face has its polarisation at right-angles to the slots, i.e. along the length of the array, the main lobe being tilted by approximately 4°. The beam width is about 6.5° between half-power points.

WI 6152 : A number of series resonant slots are machined in the broad face of the guide, alternate slots being on either side of the centre-line in order to preserve the phase of radiation. The energy distribution follows an approximate sine curve along the length of the radiator, thus minimising side lobes. The beam width is about 6.5° between half-power points.

In common with all slot radiating elements the plane of polarisation is at 90° to the slots, i.e. at 90° to the length of the array. A terminating load is required for these arrays.

Paraboloid with Waveguide Horn Feed WI 6154

WI 6154
FRONT COVER
ILLUSTRATION

This 12″ *(30 cm)* diameter parabolic antenna may be used either as a transmitter or a receiver. When used as a receiver a waveguide-mounted crystal detector is needed, and when used as a transmitter it may be connected directly to a microwave source provided with suitable modulation.

The antenna has a beam width of about 8° between 3-dB points, and is fed at its focal point by a small horn whose polarisation is vertical.

A limited amount of tilt is provided on the paraboloid mounting which pivots near its focal plane and is locked by two knurled nuts.

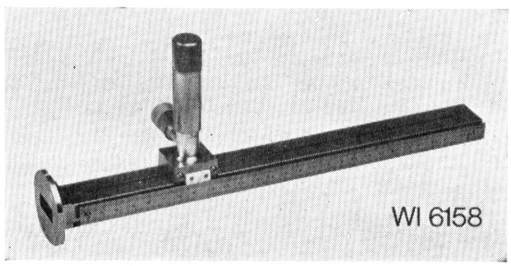
Rotating Joint WI 6156

This item enables antenna assemblies to be mounted for rotation during polar diagram measurements. It consists of two transformers mounted upon a short length of circular guide operating in the E_0 mode, thus enabling rotation to be obtained without appreciable change of power. In practice the change during rotation is only about 3%.

The joint incorporates plain sleeve bearings and is not suitable for continuous mechanical drive. It is recommended for use in the frequency range 8.8 – 9.8 GHz and has a V.S.W.R. better than 1.18 at 9.375 GHz.

Three 2BA tapped holes are provided at each end of the circular body to assist mounting in an assembly.

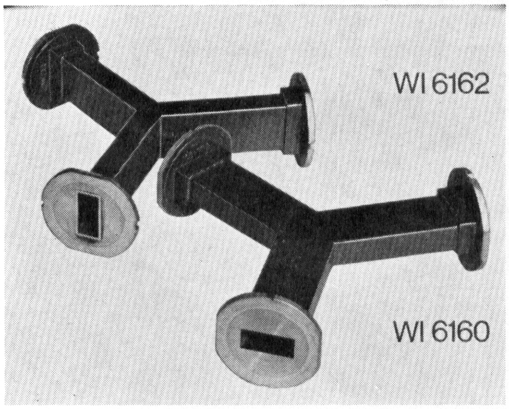
Taper Cut-Off Unit WI 6158



This item is similar in construction to a standing-wave indicator, but has internal tapered wedges reducing the waveguide size from 0.9″ × 0.4″ to 0.4″ × 0.4″. The detector carriage mechanism slides in a section of parallel guide before the tapered portion is reached, thus enabling changes of guide wavelength along the guide and with frequency to be plotted.

A millimetre scale mounted along the side of the instrument enables guide wavelengths and the cut-off point to be determined.

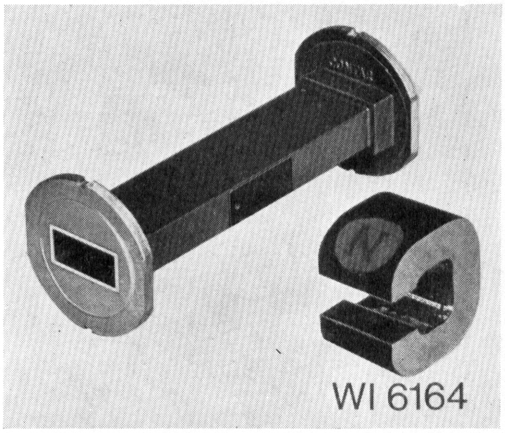
The detector is similar in construction to that used on the Standing-wave Indicator WI 660.



Three-Way Junctions: H-plane WI 6160, E-plane WI 6162

These are symmetrical junctions of 120° and enable power to be split into two arms or to be re-combined at a detector from two arms of a bridge.

They are unmatched and do not have inherent directional properties. The coupling values in the arms depend upon the terminations which, if fairly good, should each receive 50% of the incident power.



Ferrite Isolator WI 6164

A straight section of waveguide fitted with a ferrite vane is supplied together with a loose magnet in order to demonstrate the directional attenuation due to the presence of the magnetic field and the effect of polarity on direction.

Used instead of an attenuator after the Microdesk it isolates the klystron from subsequent mismatches without reducing the forward power appreciably.

The value of isolation is determined by the magnetic field, and the placing of the magnet upon the waveguide will affect this value, which is about 20 dB.

Transistorised V.S.W.R. Meter WE 34

This instrument has selective and wide-band facilities, the sensitivity in the selective condition being better than 2 µV for f.s.d. with less than 3% circuit noise.

Gain is continuously variable and also switched in four decades. Twin inputs are provided for use in bridge balancing circuits. Battery operation renders the unit free from spurious pick-up and mains hum.

Further details are available on a separate leaflet, reference WE 34.

E.S.R. Cavity WI 6174

This simple rectangular cavity is designed for electron spin resonance experiments and forms part of our ESR.47 assembly, details of which are available on a separate leaflet.

The cavity is designed to operate at 9.4 GHz in the H_{012} mode, and has a Q in the region of 3000. It incorporates a matching screw which is controlled by an extension shaft and knob. Two 6-mm diameter quartz sample tubes and two tube-holders are provided.

The cavity is suitable for use with samples of amorphous powders, powder or small crystals, liquids and solutions. The nominal magnetic field is 3350 gauss for which our Magnet WI 6170 is suitable.

The entire assembly is silver and rhodium plated as a protection against corrosive samples.